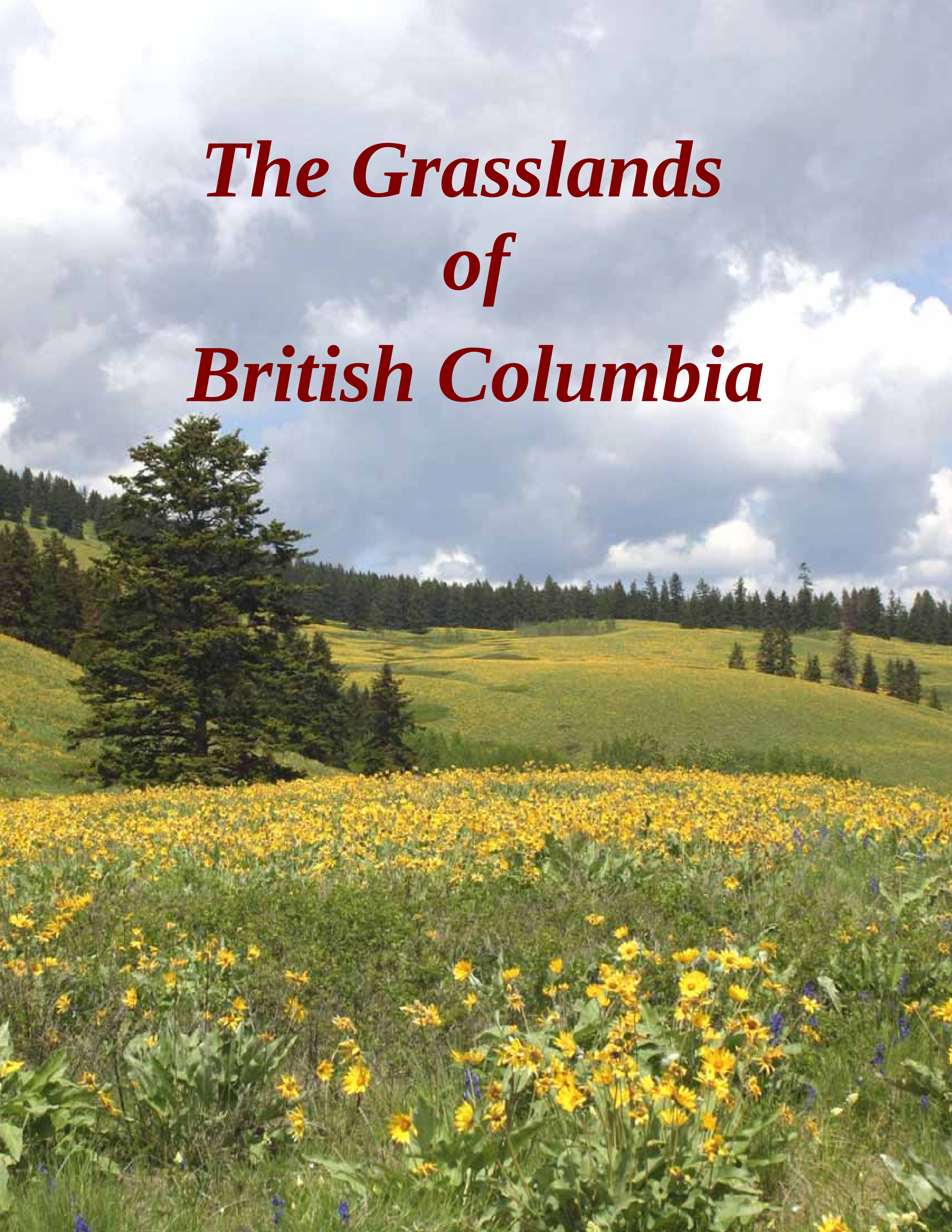
The Grasslands of British Columbia



The Grasslands

of

British Columbia

Brian Wikeem

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Grasslands Conservation Council
of British Columbia

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COVER PHOTO

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Dedication

Dr. Vernon Brink
Dr. Alastair McLean
Dr. Edward Tisdale
Dr. Albert van Ryswyk

This book is dedicated to the pathfinders of our ecological knowledge and understanding of grassland ecosystems in British Columbia. Their vision looked beyond the dust, cheatgrass and grasshoppers, and set the course to restoring the biodiversity and beauty of our grasslands to pristine times. Their research, extension and teaching provided the foundation for scientific management of our grasslands. More importantly, they bestowed the gift of a land use ethic and love of grasslands that will lead us into the future.

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Brian Wikeem

Sandra Wikeem

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Preface

The *Forests of British Columbia*, published in 1918 for the Commission of Conservation Canada,[18] provided the first written description of grasslands in British Columbia (B.C.). Later, in 1926, a description of the flora of the province was published in the *Naturalist's Guide to the Americas*, which explained in detail the diversity and complexity of B.C. grasslands and other ecosystems.[2] Between then and 1947, studies were conducted that provided detailed descriptions of the physical, biotic, and geographic distribution of grasslands, concentrating mostly on those areas south of 52^{o} N latitude. In 1947, Dr. Ed Tisdale published *The grasslands of the southern interior of British Columbia* in *Ecology*; the first comprehensive treatment of the grasslands based on field data.[17]

Left to right Drs. Edward Tisdale, Alastair McLean and Rexford Daubenmire ponder grassland formation at symposium field tour in 1982.

Photo: B. Wikeem

A grassland symposium held in Kamloops in 1982 marked the last major effort to compile information on British Columbia grasslands,[13] although several publications since have described rangelands in general, including grasslands.[14,15,19,20] Despite the considerable research published in scientific articles, theses, and government reports since 1982, much of this information is scattered throughout the province, and is virtually unavailable to the scientific community and general public.

The Grasslands of British Columbia provides a comprehensive source that synthesizes ecological information for grasslands in each region of the province. It also provides information on grassland plant and animal species at risk and other wildlife that depend on grassland habitats. This report complements the Geographic Information System that the Grasslands Conservation Council of British Columbia has developed to map the abundance, distribution and status of provincial grasslands.

Grasslands are considered from two perspectives in this report. First, they are described as individual ecological units that vary over the landscape in response to changes in climate, soils, and topography. Grazing, fire, and fire suppression are also recognized as important ecological factors that have influenced the distribution and composition of steppe and shrub-steppe vegetation. Second, grasslands are viewed as part of the broader landscape environment consisting of dry uplands, riparian areas, wetlands, talus slopes, and other specialized habitats.

The location, distribution and ecological characteristics of grassland ecosystems are described using the Ecoregion Classification system (Figure 1)[3] and the Biogeoclimatic Classification system.[12] These systems were developed in British Columbia to address local conditions, and are widely used as decision-making tools by resource managers in the province. A brief description of these systems is provided in Appendix 1.

Grassland descriptions have been organized primarily according to gradients of temperature and moisture as reflected by latitude and elevation. These descriptions begin in the East Kootenay Trench and Okanagan Valley, and proceed northward to the grasslands of the Muskwa Foothills, Liard Plateau and Stikine Plateau. Within each geographic region, grasslands are described over an elevational gradient, where one exists, from plant communities that occupy the valley bottoms to those occurring at the highest elevations.

Information was collected from published sources, internet web sites and unpublished material provided by researchers, resource managers, contractors, and agrologists. Data describing the extent and distribution of grasslands in provincial parks were provided directly by BC Parks or were obtained from their Internet websites. Information regarding endangered or threatened (red listed), or sensitive or vulnerable (blue listed) grassland plant and animal species, and plant communities at risk, was obtained directly from the Conservation Data Center in Victoria, B.C. or from their files on the Internet. Additional information was compiled from Terrestrial Ecosystem Mapping projects posted on Internet web sites. Distribution and habitat use of grassland fauna were derived from *Wildlife Diversity in British Columbia*.[16] The Grasslands Conservation Council of British Columbia provided maps and statistics describing the distribution and extent of provincial grasslands.

No effort was made to evaluate or interpret the information gathered on plant and animal distributions. Only common names are used in the text, but scientific and common names are provided in Appendices 2 and 3. Nomenclature for vascular plants and vertebrate

FIGURE 1. Ecoprovinces of British Columbia.

follow the protocols presented in *The Illustrated Flora of British Columbia*[4-11] and *The Vertebrates of British Columbia*.[1]

Although this report was written for a broad audience, some level of knowledge was assumed, and the text was prepared for a level equivalent to a student completing their first year in a natural sciences program. A glossary is provided to assist the reader with technical terms (Appendix 4).

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1. Introduction

For many people, the word 'grassland' evokes an image of treeless plains with grasses waving in the breeze as far as one can see. Several approaches have been used to define and classify grassland using general appearance (physiognomy[1]), plant species composition, ecological relations, or successional status as criteria.[1,22] Based on general appearance alone, grasslands cover about 44 million km^2 of the earth's surface, and are as diverse as bamboo jungle, steppe, savannah, and arctic tundra.[23]

The Society for Range Management defines grassland as "Land on which grasses are the dominant plant cover."[11] *The Rangeland Handbook for British Columbia* broadens the definition by adding that grassland "is dominated by grasses, grasslike plants, and/or forbs...[and] ... this herbaceous vegetation should comprise at least 80% of the canopy cover excluding trees."[2] Based on this approach, which relies on a combination of species composition and appearance, natural grasslands cover about 9.25 million km^2 of the globe.[22]

Grasslands are found on every continent except Antarctica. Numerous synonyms have been used for grassland reflecting both their geographic origin and their physical characteristics. Grasslands are known as prairies in North America, steppe in Asia, pampas in South America, and veldts in South Africa.[22]

Grasslands are broadly classed as temperate grassland or savannah. Temperate grasslands are areas where grasses dominate and trees are absent. Shrubs may comprise a significant part of the floral composition, and often co-dominate with grass to form shrub-steppe communities.[5] The largest areas of temperate grasslands are found in South Africa, Hungary, Uruguay, Russia, Australia, Argentina, and central North America.[23]

Typically, temperate grasslands have semi-arid, continental climates with average precipitation ranging from 250 to 500 mm annually. In most temperate grasslands, rain and snow fall during winter when plants are dormant, and serve as a moisture reservoir when growth begins in spring. In other temperate grassland areas, rain may fall in spring during the growth cycle.[9] Summers are hot and dry depending on latitude and elevation, and moisture deficits are common during the growing season. Extreme temperatures vary dramatically with summer maximums often exceeding 38° C, while winter minimums can drop below -40° C. Seasonal drought, occasional fires, and grazing by large mammals are

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[1] See Appendix 1 for definitions of special terms, or common words used in a special context.

also important environmental factors that impede tree and shrub growth on temperate grasslands.

Although grasses (Poaceae)[2] dominate temperate grasslands, members of the sunflower (Asteraceae) and pea (Fabaceae) families are usually conspicuous allies. Dominance by family, or species, changes considerably over moisture and temperature gradients with cactus (Cactaceae) becoming more prominent where grasslands merge with desert, and sedges (Cyperaceae) gaining prevalence where they unite with alpine and tundra environments. Soils on temperate grasslands are derived from mineral parent materials, and are generally deep and dark with fertile upper layers.

Savannah is grassland with scattered individual trees.[5] Climatic savannahs are found in warm or hot climates such as Africa, India, South America, North America, and Australia where annual rainfall ranges from 500 to 1250 mm. Savannahs can also occur as a result of specific soil conditions that restrict tree growth, and they can be derived and maintained by fire, grazing, logging, insect infestations, and periodic drought. Open stands of ponderosa pine, lodgepole pine, Douglas-fir, and Garry oak are examples of edaphic and derived savannah grasslands in North America.

1.1 North American Grasslands

Grasslands form the most extensive biome on the North American continent, occupying about 28% of the land area.[1,22] North American grasslands have developed under a variety of conditions, and are distributed over elevations ranging from 2100 m on the east slopes of the Rocky Mountains to sea level along the coastal plains of Texas.[9]

Photo: B. Wikeem

Sonora Desert in southwest Texas.

Seven grassland associations have been described in North America (Figure 2).[9] The True Prairie and Mixed or Short-grass Prairie associations form the largest expanse of grasslands on the continent. These grasslands occupy the middle of the continent east of the Rocky Mountains, and extend from central Alberta, Saskatchewan, and

[2] See Appendix 2 for common and scientific names of vascular plants.

southern Manitoba where they merge with the Desert Plains Grasslands and Coastal Prairie along the Gulf of Mexico (Figure 2).[5,26]

On the eastern edge of the North American grasslands, the True Prairie merges with deciduous forest and annual precipitation varies from 500 in the southeast to over 1000 mm in the northwest.[9] Two grass species, big bluestem and little bluestem, often comprise more than 70% of the ground cover, but porcupinegrass, junegrass, and sideoats grama are common associates. Big bluestem and little bluestem are closely spaced and individual plants can reach 2 m in height.[9]

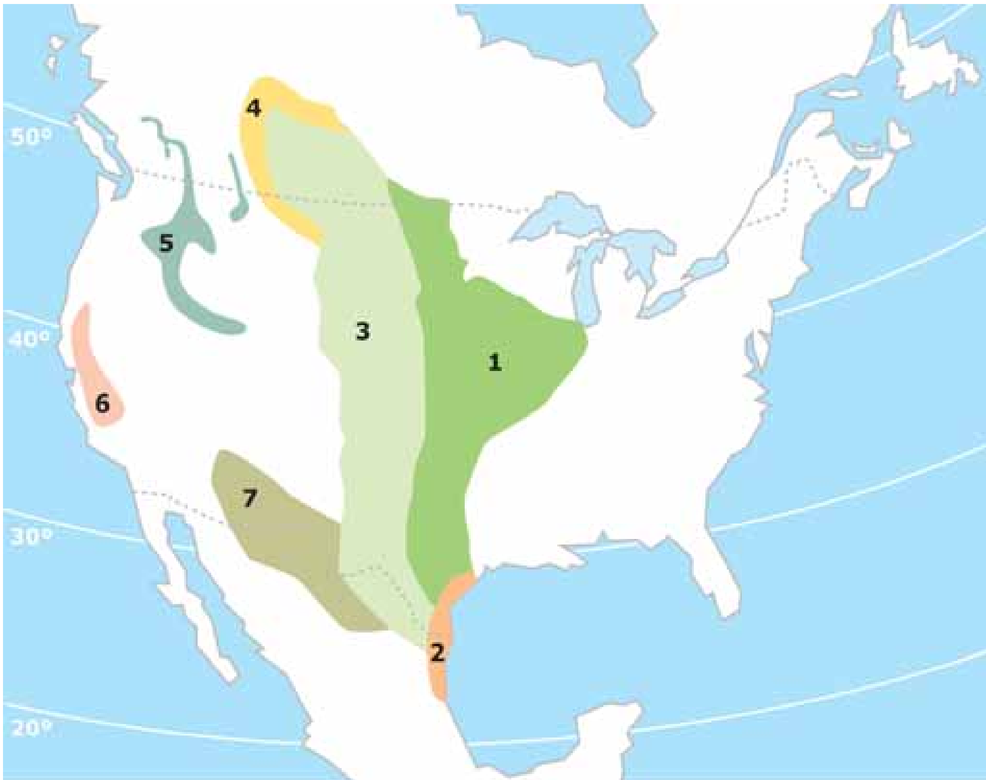
Many different climatic conditions occur on the Mixed Prairie. Annual precipitation averages nearly 800 mm in the south and southeast, and progressively declines to about 260 mm in the rain shadow of the Rocky Mountains in the west and northwest.[9] Tall grasses are replaced with blue grama, buffalo grass, and western wheatgrass, which seldom exceed 50 cm in height.[23]

The Fescue Prairie extends west from southern Manitoba and central Saskatchewan to the Rocky Mountains and southward along the foothills of Alberta to central Montana. Generally, moisture efficiency is higher in these grasslands than on the Mixed Prairie to the south because of slightly higher precipitation, lower temperature, and lower evaporation rates. Annual precipitation ranges from 240 to 360 mm with 70% falling as rain from May to September.[9] Rough fescue is the sole dominant of this grassland association but porcupinegrass, timber oatgrass, slender wheatgrass, and several species of sedges are important associates.[9] Aspen groves are often found in depressions and protected slopes and are a common feature of the grassland environment.[22]

Temperatures vary dramatically throughout the mid-continental grassland region east of the Rocky Mountains with summer extremes approaching 50^{o} C in the southern extent of the Mixed Prairie, and winter lows descending to -50^{o} C in the Fescue Prairie.[9] The dominant grasses usually have a period of dormancy induced by low temperature, low precipitation, or both.

Two large grassland areas occupy the intermountain region between the Rocky and Coast/Cascade mountains (Figure 2). The Pacific Prairie is confined entirely to California and has been divided into two divisions differentiated by climate and dominant species.[9]

In the southern part, where precipitation ranges from 250 to 500 mm annually, original plant communities were dominated by purple needlegrass mixed with big bluegrass



1	**True or Tall-grass Prairie**	**5**	**Palouse Prairie**
2	**Coastal Prairie**	**6**	**Pacific Prairie**
3	**Mixed or Short-grass Prairie**	**7**	**Desert Plains Grassland**
4	**Fescue Prairie**		

FIGURE 2. Grassland associations of North America.[5]

(Sandberg's bluegrass), deer grass, blue wildrye, and junegrass as subordinates. Most of the native perennial species have been replaced with annual grasses such as wild oats, cheatgrass, soft brome, seagreen brome, and numerous annual alien forbs.[9,22] Likely less than 5% of the original vegetation remains.[23]

The northern part of the Pacific Prairie occupies northern California at mid to high elevations where annual precipitation approaches 1250 mm. California oatgrass, tufted hairgrass, western wheatgrass, and Idaho fescue were the original dominants of this grassland association. At the higher elevations and at its northern extent, the Pacific Prairie converges with savannah-like communities consisting of pine and oak.[9,22]

A large area of shrub-steppe and steppe vegetation dominated by sagebrush and bunchgrass occupies the northern part of the intermountain region. Originating in the

Great Basin,[5] the distribution, extent, and name of this association have been matters of widespread disagreement, and no name has gained universal acceptance.[25] Estimates of the total area covered by this association vary from 38 to nearly 110 million hectares.[26]

Collectively, Daubenmire[22] referred to the entire association as the *Agropyron spicatum* Province, but divided it into two sections[5]. The southern section extends south from central Oregon and southern Idaho to northern California and Nevada. It also spreads east into Utah, Wyoming and southern Montana. The northern part of the association has been called the Palouse Prairie,[9] Pacific Northwest Bunchgrass grassland,[25] and Sagebrush-grass Region,[26] depending of the criteria used in describing the area. The northern section occupies the intermountain region between the Coast and Cascade mountains on the west and the Rocky Mountains on the east. This section extends from central Oregon northward through Washington and Idaho, and into British Columbia (Figure 2).

Grassland environments in the Sagebrush-grass Region are generally hot and dry. Variations in temperature between summer and winter, and from south to north are generally more moderate than on the Great Plains. Winter lows in the north can drop below –40°C and summer highs in the south exceed 40°C where the shrub-steppe association merges with desert.[9]

Photo: B. Wikeem

Western extent of the Sagebrush-grass Region in Eastern Oregon.

The semi-arid continental climate of the Sagebrush-grass Region is strongly influenced by oceanic air masses, and is similar to that of grasslands on the Great Plains east of the Rockies, except that most of the precipitation falls during winter. In Washington State, annual precipitation varies from 200 mm in the west to 635 mm in the east, and from 260 mm in the south to 640 mm in the north.[9,22] These variations also occur over elevational gradients. Evaporation usually exceeds precipitation, so the total supply of moisture for plant growth is low.

Except for the presence of shrubs, the Sagebrush-grass Region resembles the Shortgrass Prairie of the Great Plains in appearance. The dominant species, however, are distinctive and include a variety of bunchgrasses including bluebunch wheatgrass, Idaho fescue, needle-and-thread grass, Indian ricegrass and Sandberg's bluegrass. Species diversity of forbs is generally low but arrowleaf balsamroot, mariposa lily, and numerous species of *Lomatium* are common associates. Depending on elevation and latitude, dominant shrubs include big sagebrush, antelope-brush, and common rabbit-brush.[5] Big sagebrush and other shrubs decline in dominance over elevational gradients and are absent at higher elevations where grassland gradually merges with forest.

1.2 British Columbia Grasslands

Grasslands are relatively scarce in British Columbia, covering about 0.74 million hectares (less than 1%) of the province.[8] Grasslands predominate where a combination of temperature, precipitation and physical factors combine to produce conditions that are too dry for trees.[22] These same factors also determine grassland physiognomy and plant species composition.

Climatic conditions in the province differ considerably from south to north, and from low to high elevations (Figure 3). Pacific Maritime, Great Basin Desert, and Polar Continental air masses all affect regional climates. For example, a pronounced rain shadow effect produces hot and dry conditions in the southern interior as Pacific air tracks eastwardly

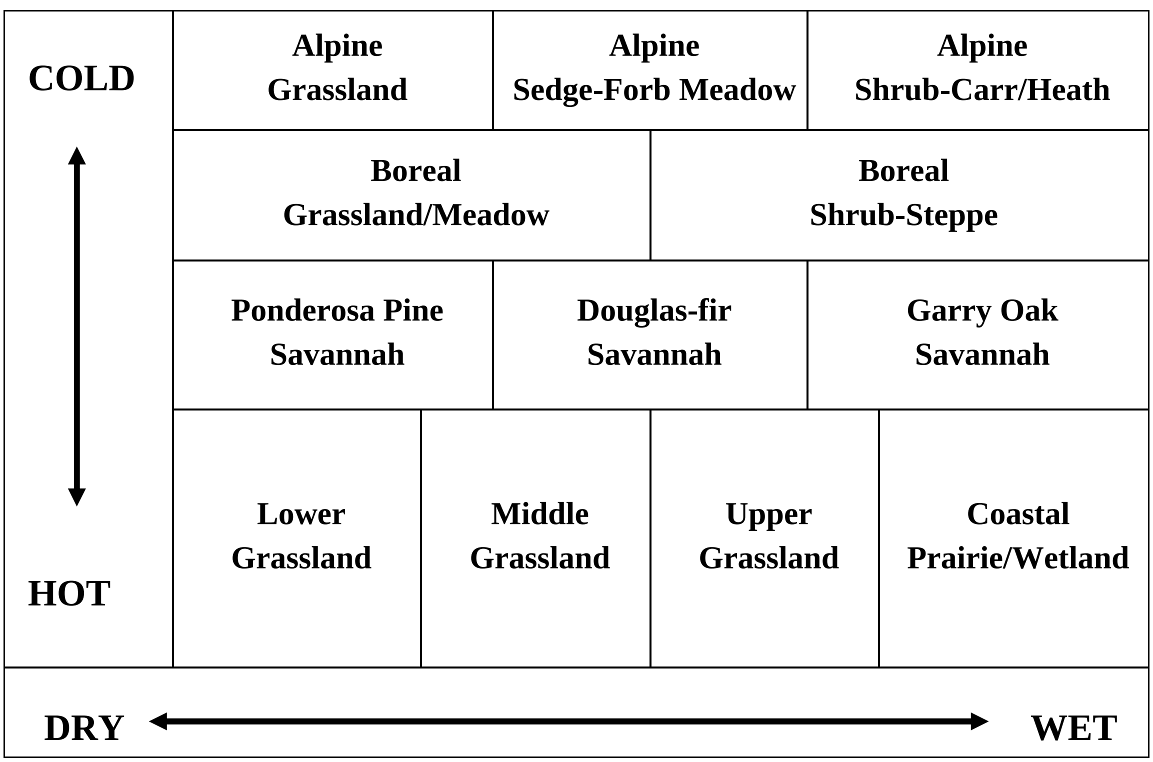


FIGURE 3. Schematic diagram depicting the relationship of grassland in British Columbia to approximate gradients in temperature and moisture.

across the Coast Mountains. North of 52° N latitude, this effect diminishes, although local rain shadows occur in the northern interior and east of the Rocky Mountains (Figure 4).[18]

The development of arid conditions relates directly to the amount and timing of precipitation, but topo-edaphic factors such as steep slopes, aspect and soil texture can also affect availability of soil moisture. For example, sites with steep slopes, southerly aspects, and shallow, coarse soils create soil moisture deficits similar to those in much hotter environments. These factors have a greater influence on the development and maintenance of northern grasslands[19] and Garry Oak savannah than they do on southern interior grasslands. Native grasslands also develop on sites with level topography where severe frosts collect frequently enough to limit tree establishment, while on other sites, saline soils limit growth for most species other than grasses and grasslike plants.[3]

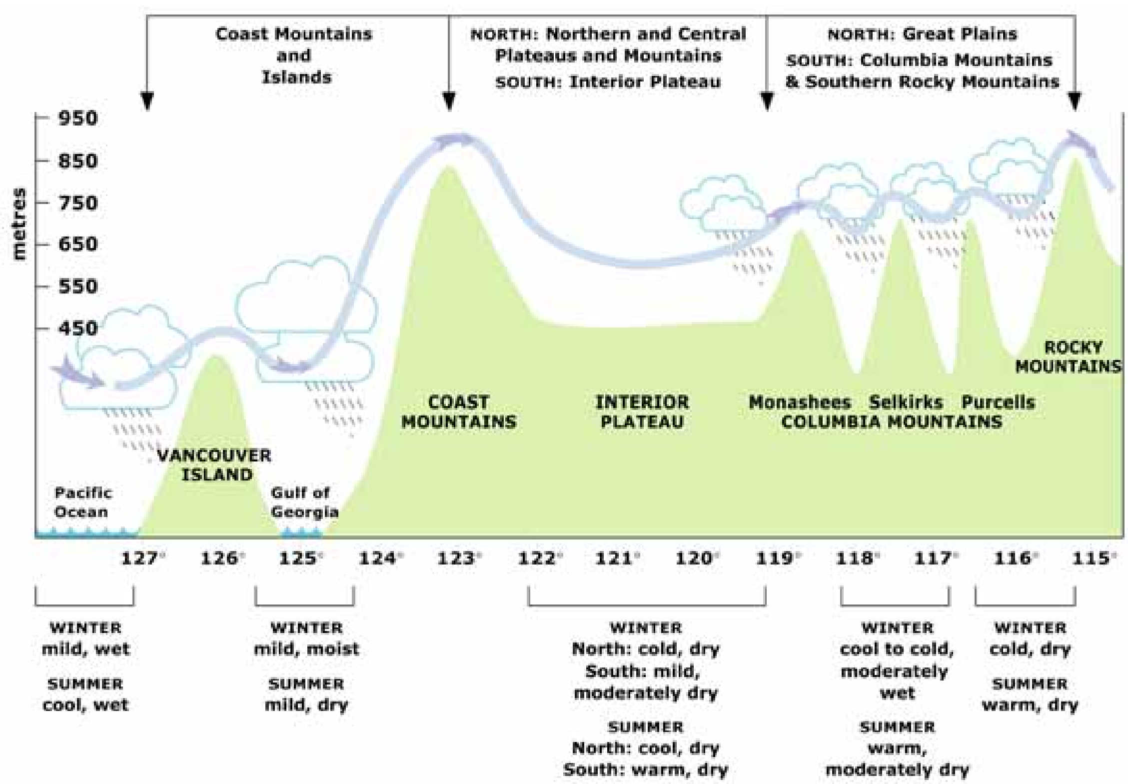


FIGURE 4. Longitudinal cross-section of southern British Columbia illustrating the effects of physiography on local climates.[29]

Grassland landscapes in British Columbia often change abruptly from deeply incised valleys to undulating plains and level plateaus, to mountain slopes. Soil parent materials range from volcanic materials to mineral deposits moved by ice, and are comprised of basalt, limestone, granites, gneiss, and shales.[21] A fine layer of wind-blown loess is a common feature over most of the landscape, and varies from a few centimeters to greater than 20 cm in depth.[27]

Photo: B. Wikeem

Grassland landscape and ancient lake bed of Glacial Lake Deadman east of Savona.

Grasslands in British Columbia can be broadly divided into two sections: the semi-arid grasslands that occur south of 52° N latitude, and the cool grasslands found north of 52° N latitude. The southern grasslands are most commonly associated with the hottest and driest parts of main valleys and adjacent benches dissected by the Kootenay, Kettle, Okanagan, Similkameen, Thompson, Nicola, Chilcotin, and Fraser rivers.[4,24,25] Covering about 650,000 ha, they account for almost 90% of the total grassland area in the province.

In the southern interior, severe moisture deficits and high temperatures produce a grassland environment characterized by widely spaced desert shrubs, bunchgrasses, occasional cacti, relatively few sedges and rushes, and and often a well-developed microbiotic crust. Soils are derived from mineral parent material and range from Chernozems to Regosols.

Photo: B. Wikeem

Shrub-steppe ecosystems are co-dominated by bunchgrasses and shrubs.

Typical climax species found in southern interior grasslands include bluebunch wheatgrass, rough fescue, Idaho fescue, Sandberg's bluegrass, junegrass, porcupinegrass, and big sagebrush. [12,24] Over an elevational gradient, plant communities develop as shrub-steppe, steppe, or meadow-steppe associations depending on the climate and geographic location (Figure 5). Zonal grasslands are found in the valley bottoms and on low-elevation gentle slopes in the Bunchgrass Biogeoclimatic zone.[16] Azonal grasslands often occur in other biogeoclimatic zones on steep slopes or on the plateau surfaces above the main river valleys. Some of these associations blend with subalpine and alpine communities.

Photo: B. Wikeem

Steppe and meadow-steppe ecosystems are most common near the forest edge and are characterized by bunchgrass mixed with numerous forbs but few shrubs.

Other grasslands occur as large prairies that contain aspen copses and a variety of wetlands, or as intrusions within larger areas of deciduous or coniferous forest. These landscapes are often called parklands, and have high biological diversity because they provide a mosaic of habitats for other organisms.

Photo: B. Wikeem

Aspen parklands often occur where grassland and continuous forest meet.

Savannahs occur under open canopies of ponderosa pine or Douglas-fir in the southern interior. These grasslands likely developed from a combination of soil type, topography and fire history. Generally, the understories are similar to those found in the Bunchgrass zone, and include bluebunch wheatgrass, rough fescue or Idaho fescue mixed with a diversity of broadleaf herbs.

Photo: B. Wikeem

Ponderosa pine savannah is characterized by widely spaced trees and openings with an understory of grasses, forbs, or shrubs.

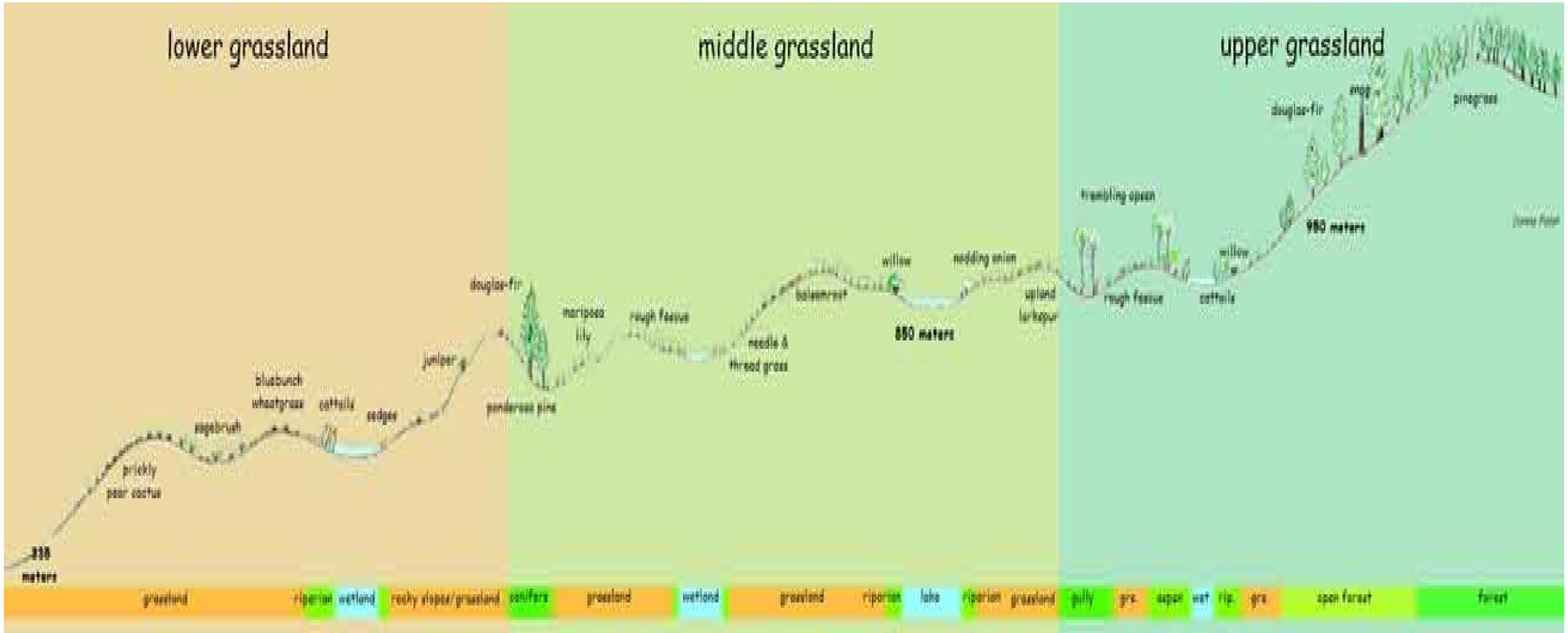


FIGURE 5. Changes in associated plant communities from the lower to upper grassland.

South of Penticton, big sagebrush and antelope-brush are common understory shrubs. Soils are generally Brunisols.[28] These communities often form on steep terrain and benches along the major valleys in the southern interior, and are commonly associated with cliffs and talus slopes. Small areas of grassland are also present in parklands and openings below alpine in the Engelmann Spruce-Subalpine Fir zones.[10,20]

In the Alpine Tundra zone of the southern interior, effective precipitation can be higher than in the Bunchgrass and low-elevation forest zones. Sedges, kobresia, broadleaf forbs, and some low-growing shrubs are better adapted to the severe cold and short growing seasons than the relatively few grass species that inhabit this environment. Regosols and Cryosols, derived from mineral parent material, are the most common soils.

Photo: B. Wikeem

Subalpine and alpine grasslands in the north Okanagan Valley.

Grasslands north of 52^0 N latitude persist mostly on steep south-facing slopes from low to high elevations.[18] Relic plant associations from the Yukon and Alaska that escaped glaciation influence the composition of northern grasslands in British Columbia on both sides of the Rocky Mountains. This results in a complex flora comprised of grassland, montane, alpine, and tundra influences. Slender wheatgrass, purple reedgrass, fuzzy-spiked wildrye, and glaucous bluegrass are common bunchgrasses on these cooler grasslands,[20] while Altai fescue – Mountain sagewort communities are common at high-elevations.[19]

Photo: B. Wikeem

Grasslands in northern environments are often associated with steep slopes.

East of the Rocky Mountains in the Peace River region, grasslands contain components of the Fescue Prairie and Shortgrass Prairie of the Great Plains that reach their northern distribution here.[14] Prairie crocus, spreading needlegrass, and fennel-leaved desert-parsley are a few examples of prairie plants that reach their northern limits in the Peace River region, while spike trisetum, Altai fescue, northern wormwood and tundra milk-vetch have circumpolar distributions or originate from arctic environments. Grassland soils are variable in these environments and range from Dark Gray Luvisols on the lowlands to poorly developed Chernozems and Regosols at higher elevations.

Savannah-like vegetation forms under the most extreme rain shadow effects and on shallow mineral soils along the east coast of Vancouver Island. Grasslands consisting of grasses, broadleaf herbs and mixed shrubs develop under an open overstory of Garry Oak and/or arbutus on shallow, rocky, dry sites.[7,10]

Coastal prairies in the Fraser Valley, and wetlands in the Central and Southern Interior, occasionally produce plant communities that look similar to grasslands, especially when they are not submerged. These communities develop under different environmental conditions than steppe communities. In contrast to grasslands, coastal prairies and wetlands form on Organic soils where temperatures are moderately cool and where periodic or persistent flooding is a dominant factor. Trees can not survive long periods of inundation; consequently, sedges, rushes, cattails and shrubs usually dominate depending on water quality and the soil substrate. These communities are not described in this report.

1.3 Grassland Associated Ecosystems and Species Diversity

Grassland environments that contain a variety of habitat types generally have greater biodiversity than a landscape dominated by a single, or few communities. Diverse habitat types that may occur within grassland landscapes include riparian areas and wetlands, shrub-steppe, forest-grassland ecotones, cliffs and talus slopes, and clay banks (Figure 6).[17] Cottonwood stands and aspen copses are also important associated ecosystems for a wide range of fauna and are commonly used by red- and blue-listed grassland species.[17]

Nearly 42% (1190) of the 2854 vascular plant species that occur in British Columbia are found on grasslands, and 137 (4.8%) species are restricted to the steppe zone. A large part of the provincial flora is introduced (553 species or nearly 20%), and many of these species are found in grassland ecosystems,[6] demonstrating the vulnerability of grasslands to invasion by non-native plants.

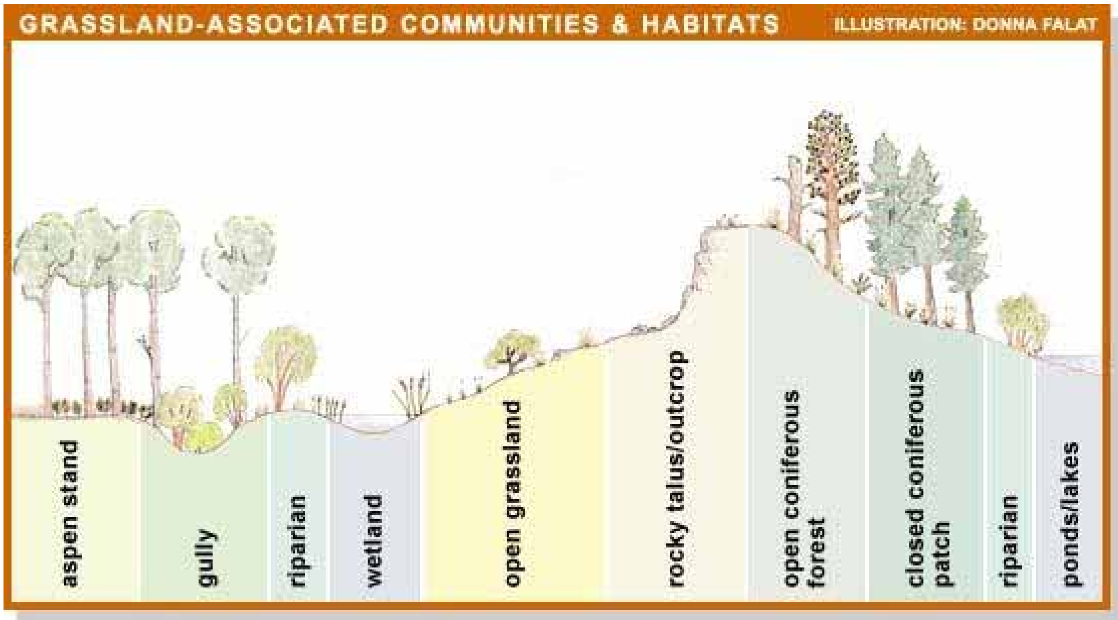


FIGURE 6. Associated plant communities commonly found on grassland landscapes.

Plant species composition of British Columbia grasslands varies considerably depending on latitude, elevation, climate, and soils. Plant communities in the southern Okanagan Valley are similar to those in the Sagebrush-bunchgrass Region, but species diversity gradually declines from south to north (Appendix 12). Similarly, plant species diversity generally reaches a maximum in steppe communities just below the grassland-forest edge where moisture deficits are less severe than in the valley bottoms and at lower elevations in the Okanagan, Thompson Basin, and Cariboo-Chilcotin.[15] Several species, however, are ubiquitous in grasslands throughout the province including saskatoon, prairie sagewort, slender wheatgrass, junegrass, Sandberg's bluegrass, and yarrow (Appendix 12).

Wide variation in grassland climates throughout the province also affects the distribution of grassland plant species that use different physiological processes to fix carbon. Warm-season plants, which are characteristic of desert climates, are poorly represented, and are mostly depleted from the flora north of 52^{o} N latitude. Some representative warm-season species include blue grama, sand dropseed, brittle prickly-pear cactus, plains prickly-pear cactus, silvery orache, and Nuttall's orache.[13,24] Cool-season grasses such as bluebunch wheatgrass, junegrass, Sandberg's bluegrass, and needle-and-thread grass are most abundant on arid grasslands in the southern part of the province.

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2. Grassland Formation and Maintenance

Grasslands in British Columbia are scattered over a broad geographic area and span nearly 11^{o} of latitude and 25^{o} of longitude. The physical features of the landscape supporting steppe and shrub-steppe vegetation are highly variable and range from Garry oak grassland and savannah at sea level to grasslands in the alpine and near tundra. This section describes the physical and biological components of B.C. grasslands and focuses on some of the most influential biological factors affecting their current and future status.

2.1 Physiography and Landforms

Grassland landscapes in British Columbia are a product of ongoing geomorphic events spanning millions of years. Most bedrock in the province results from volcanic and sedimentary materials deposited during the Paleozoic, Mesozoic, and Cenozoic eras, although some are of Precambrian origin dating back to before 570 million BP (Figure 7).

Photo: B. Wikeem

Lavas overlaying Tertiary rock near Kamloops.

The Cretaceous period (140 – 65 million BP) was a time of intense tectonic activity. During this period, at least five major rock formations from the Pacific Ocean collided with the ancient North America Plate. This was also a time of major uplifting and mountain building.

The Rocky Mountains were formed between 70 and 35 million BP as the landscape buckled and folded from the collisions of landmasses and subsequent uplifting.[93] By the Pliocene epoch (ca 6 million BP), the Rockies had nearly attained their present height creating an effective rain shadow to the east.[22]

Fossil records of needlegrasses (*Stipae*) and millets (*Panicae*) found in Miocene sediments east of the Rockies indicate that this uplift marked the beginning of ecological separation of plants and animals east and west of the mountains. As steppe vegetation developed east of the Rocky Mountains, temperate forests dominated the gently rolling landscape in the cooler and wetter environment to the west.[22]

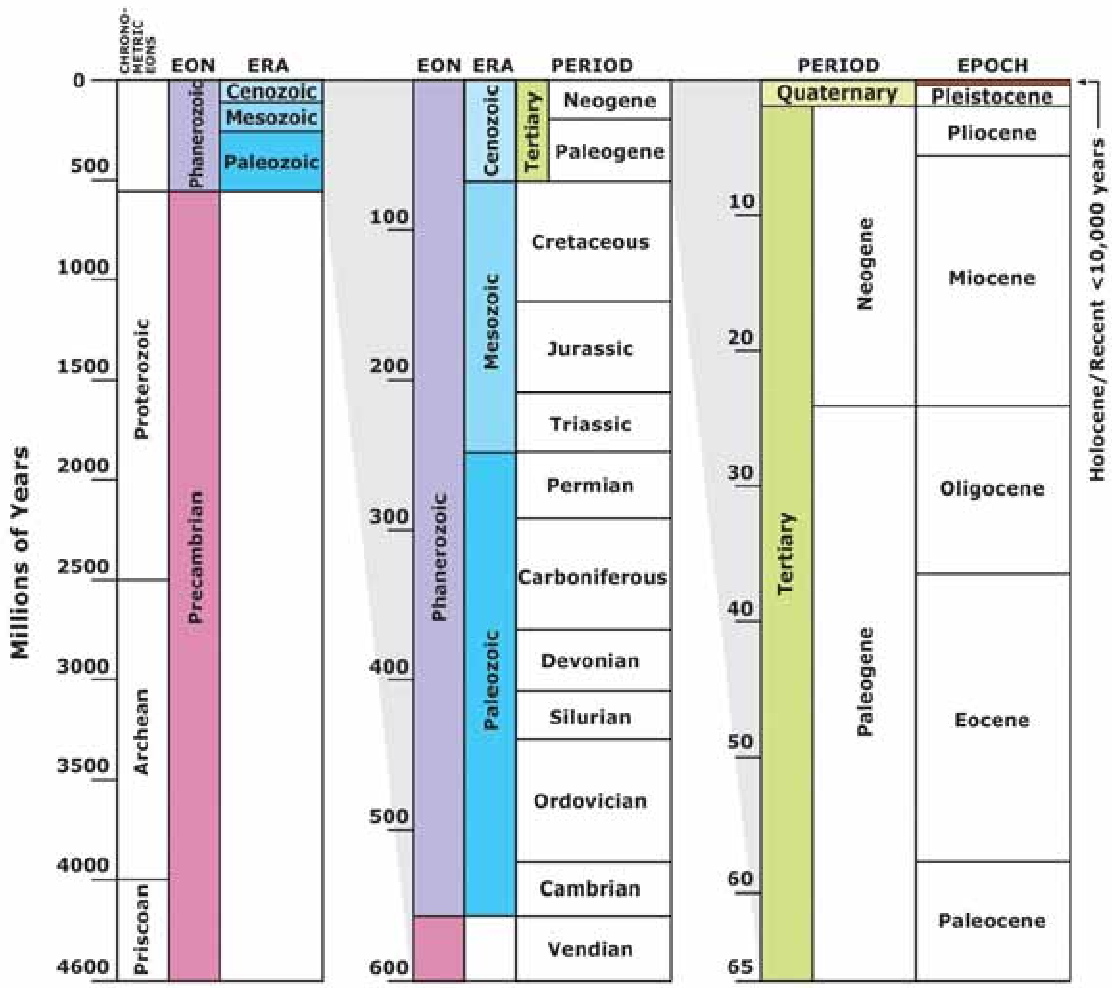

FIGURE 7. Geological time scale.

Intensive volcanic activity during the mid-Eocene (45 million BP) produced the first of two major lava flows that covered most of the Interior Plateau.[93] These flows covered the landscape as great lava plains that were thought to be continuous with the Columbia lavas of Washington, Oregon and Idaho.[105] Further uplifting between 50 and 40 million BP resulted in folding and faulting of the bedrock that created deep cracks and great rift valleys on the huge plateau that occupied central and

Photo: B. Wikeem

Basalts at Cinnamon Ridge near Kamloops are vestiges of ancient volcanic activity.

northern B.C., Idaho and Washington State.[90] Covering most of the terrain west of the Rocky Mountains, the plateau surface varied only slightly from 450 to 600 m in relief.[93] Rainfall, sometimes approaching 1000 cm annually, drenched the landscape and significantly eroded the plateau surface, depositing huge masses of detritus on the landscape. These events also produced an enormous river system that formed the basis of the present day drainage.[90]

Photo: B. Wikeem

The Coast Mountains in the background emerged about 13 million BP.

Mountain ranges emerged along the Pacific coast as the land continued to lift in central B.C. during the mid-Tertiary. By the mid-Miocene (13 million BP), the St. Elias and Insular mountains, and the Coast-Cascade Mountains had gained sufficient altitude to become effective barriers to air masses moving onto the mainland from the Pacific.

Vegetation began to change dramatically in the lee of the mountains, and temperate forest gave way to species that migrated into this new area of steppe from the south such as wheatgrasses, goosefoot and atriplex , fescues, bluegrasses, common rabbit-brush, and antelope-brush.[22]

A second episode of volcanic eruptions occurred between 10 and two million BP that spread lava over parts of the Thompson Plateau and Okanagan Highland. A new system of deep fissures and fault valleys developed during this time, and extensive plateau basalts were extruded onto the land surface. These features are still prominent on the landscape today.[90,93] This volcanic activity completely changed drainage systems and buried pre-existing streambeds, and some of the largest ancestral valleys of our present terrain were likely created then as streams and rivers were diverted.[90]

Virtually all of British Columbia was glaciated repeatedly during the Pleistocene epoch (Figure 7), with each episode lasting about 100,000 years.[94] Beginning about 20,000 BP, the Fraser Glaciation gradually advanced for about 10,000 years before rapidly extending across the Interior Plateau over the next two millennia.[94] During this period, the Fraser and Thompson Plateaus were covered with ice varying from 500 to 1000 m thick, and only the highest peaks in the Coast, Columbia, and Rocky mountains remained ice-free.[94]

East of the Rocky Mountains, the Laurentide ice sheet extended west into the Peace River region from the Great Plains.[93] All of these glaciers began retreating about 13,000 BP, and within two or three millennia, most of the Interior Plateau and valleys were ice-free.[94]

Events associated with the numerous Pleistocene glaciations modified the physical features already present on the landscape, and shaped the present topography of the province. Direct effects of moving ice resulted in the rounding off of hills and ridges and a widening and straightening of the main pre-glacial valleys.[105] A mantle of glacial till was deposited on the landscape as the ice melted. Subsequent erosion removed most of this till where the deposits were shallow, but more than 100 m of till was deposited in some of the main depressions such as the Okanagan valley and along the Fraser River.[93] Glacial till deposits developed into various forms as the ice melted. Some till remained in place producing drumlins and other features that form part of the present topography. Others were immediately moved by meltwater and redeposited, forming eskers, kames, and outwash terraces.[94]

Glacial meltwaters further eroded river canyons and valleys formed during the Miocene, and created the river terraces and scarp slopes that form the foundation of the present grasslands.[94] Surface erosion was also prevalent as the glaciers melted, and ranged from minor sheet erosion on the plateau surfaces to the formation of deep gullies. Some of these gullies remain as silt beds along the south Thompson River and at the south end of Okanagan Lake.[94]

Photo: B. Wikeem

Silt banks along the Thompson River are relics of glacial recession.

Glacial till provided parent materials for most grassland soils that were enhanced with a fine layer of loess. Loess deposits were produced when wind-blown materials were picked up along the margins of the glaciers and carried by updrafts to the plateau surfaces.[113] Similar processes also produced the sand dunes at Walhachin along the Thompson River, and at Farwell Canyon above the Chilcotin River.[94] These sand deposits provide a soil substrate that supports a narrow range of plant species that are adapted to very dry conditions.

Historical eruptions of Mount Mazama in Oregon (6000 BP) and Glacier Peak in Washington (12,000 BP) deposited large volumes of volcanic ash that now comprise part of the soil matrix in British Columbia. These deposits are widespread in grassland soils in the Okanagan, Thompson-Pavilion and Cariboo-Chilcotin, and often form a distinctive layer in the soil profile. Despite the extensive deposition and movement of materials during glaciation, rock out-crops comprised of bedrock are common throughout the grassland area.[105]

Photo: B. Wikeem

Volcanic ash layer in the Ponderosa Pine zone west of Kamloops.

2.1.1 Physiographic Characteristics of Grassland Regions

Grasslands occur in all five physiographic regions found in British Columbia,[112] but the largest area occupies the Interior Plateau (Figure 8). Other significant areas of steppe vegetation are found in the Great Plains, and in the Columbia Mountains and Southern Rockies. Grasslands in the Northern and Central Interior Plateaus and Mountains region are often edaphic and associated with river valleys, steep slopes, or high-elevation plateaus. Small areas of edaphic grasslands also occur on east coast of Vancouver Islands and the Gulf islands.

2.1.1.1 Columbia Mountain and Southern Rockies

The Columbia Mountains and Southern Rockies region is comprised of a complex mix of parallel mountain ranges, intervening valleys and a variety of geological materials. The Rocky Mountain Trench (East Kootenay Trench) is the dominant feature determining the extent and distribution of grasslands in the region. The Trench is bounded on the east by the Rocky Mountains that rise abruptly from the valley floor. The Columbia Mountains provide the western boundary and are comprised of three separate and parallel ranges including the Monashee, Selkirk and Purcell mountains.[93]

The floor of the Trench is largely dominated by glacial sediments from post glacial lakes. Glacial till and drift contained in drumlins and outwash terraces form the parent materials for many grassland soils in the region. Fluvial sediments, which were deposited later in

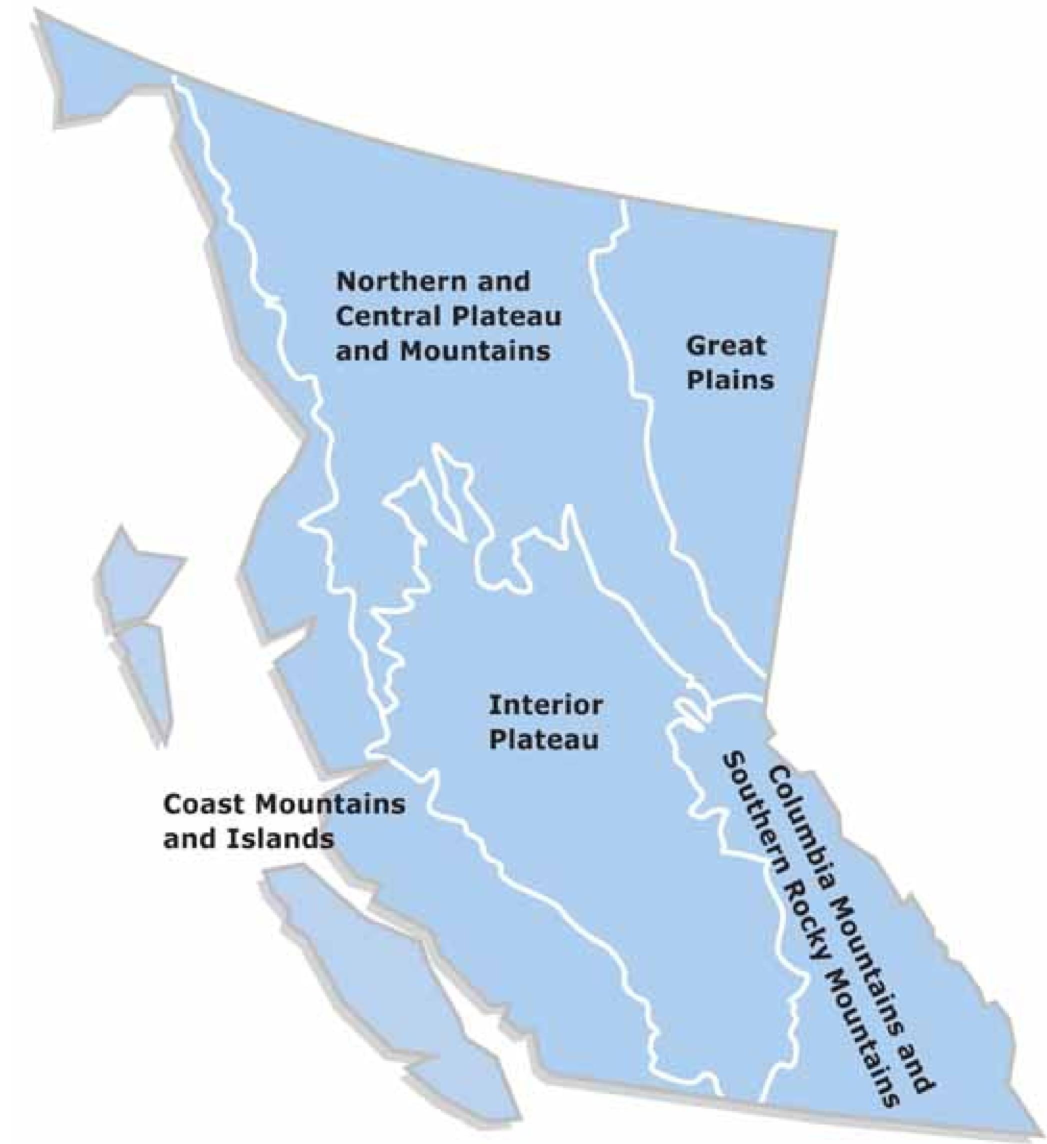

FIGURE 8. Physiographic regions of British Columbia.[66]

glacial recession, occupy extensive areas, and consist of terrace gravels and floodplain silts, sands and gravels.[93]

2.1.1.2 Coast Mountains and Islands

Grasslands in the Coast Mountains and Islands region are confined to a very small area on the east coast of Vancouver Island and on some of the Gulf Islands. This region consists of two parallel mountain belts consisting of the St. Elias - Insular Mountains to the west and the Coast-Cascade Mountains to the east.[93] The Vancouver Island Mountains and Olympic Mountains in Washington State, however, are of much greater significance to the limited area of grassland because of the rain shadow they create on the southeastern part of Vancouver Island. The terrain supporting grassland in the region is generally comprised of lowlands and islands in the Georgia Depression where elevations rarely exceed 600 m. Thick deposits of glacial drift are common, although rock outcrops also are prevalent,[93] especially where Garry oak grasslands and savannah occur.

2.1.1.3 Interior Plateau

The Interior Plateau occupies the central region of south and central British Columbia. The plateau is bound on the east by the Rocky Mountains and on the west by the Coast and Hazelton mountains. Extending 800 km in a northwesterly direction, the relief of the plateau decreases from 1200 and 1800 m elevation in the south to 600 and 1200 m in the north.[93] Similarly, the plateau averages about 60 km wide on the southern boundary and broadens to 320 km at its widest extent in the north.

The dominant landscape feature of the Interior Plateau is the Tertiary erosion surface mantled with glacial drift and capped in places by extensive ancient lava flows. The drainage systems of the Fraser, Thompson, and Okanagan rivers are prominent features on the landscape. The Fraser and Chilcotin rivers converge at approximately the central part of the plateau as they flow through deeply dissected channels cut 100 to 200 m below the plateau surface.[93] North of the confluence, relief along the Fraser River is less dramatic as the river discharges from the Fraser Basin near Prince George where the plateau surface ranges from 600 to 900 m above sea level.[93]

Similarly, the North and South Thompson rivers and their tributaries dissect the southern part of the Interior Plateau flowing through U-shaped valleys ranging from 600 to 900 m below the adjacent upland. Extensive, rolling plains occupy the upland surface at elevations ranging from 1200 to 1500 m, or higher in some places.[93] Most of the grasslands in the central and southern part of the Interior Plateau are associated with the valley bottoms, steep canyon walls, river terraces, and adjacent plateau surfaces along these river systems.

Most of the northern two-thirds of the region (Fraser and Nechako Plateaus) consists of a gently rolling terrain at elevations varying from 1200 to 1500 m. Grasslands in this part of the plateau are mostly associated with steep, south-facing slopes, or on south-facing uplands along lakes, ponds and wetlands.

2.1.1.4 The Northern and Central Plateaus and Mountains

The physiography of this region consists of mountains, plateaus and plains. Grasslands are primarily associated with the plateaus, river canyons and with the foothills of the Rocky Mountains in the eastern part of the region.

The Stikine and other small plateaus within mountainous regions of the north and west are remnants of Tertiary erosion that are dissected to varying degrees by streams and rivers. Generally, the plateau surfaces are flat or gently rolling, and are located between 1500 and 1800 m elevation. All of the Northern and Central Plateaus and Mountains region was completely covered with ice during the Pleistocene. The fluted topography and drumlins that currently dominate the landscape are products of glacial scarring on bedrock and till deposits that were left as the glaciers retreated. Evidence of ancient volcanic activity persists in the region, especially on the Stikine Plateau where the shield volcano of Mt. Edziza rises to 2700 m.[93]

The Skeena, Cassiar, and Omineca mountains form the western boundary of the region, and rise to 2700 m at their summits. These mountains create another barrier for Pacific air masses moving to the east, and produce a minor rain shadow that is partly responsible for the grasslands in the region.[93]

The Nass Basin and Liard Plain occupy flat or gently rolling topography at elevations from about 750 to 1000 m. Drumlins and fluted terrain consisting of drift and bedrock are common in the area, and several esker systems traverse the Liard Plain.[93] The terrain of the northern Rocky Mountains and Rocky Mountain Trench is generally less rugged than in the southern part of the Trench, and mountain summits are lower. Grasslands are most common on the Liard Plain, and on steep slopes along river valleys in the foothills of the Rocky Mountains.

2.1.1.5 Great Plains

The Great Plains physiographic region is bound on the west by the toe slopes of the Rocky Mountain Foothills, and extends eastward over a flat to gently rolling terrain into Alberta. Elevations vary from 900 to 1200 m on the Alberta Plateau to below 600 m in the Fort Nelson Lowland.[93] Sandstones of marine origin underlie most of the uplands, while erodible shales usually dominate the bedrock of the flat lowlands.[38]

The Peace River is the most striking physiographic feature in the region weaving a course from the Rocky Mountains onto the Great Plains through a river valley that descends 650 m below the plateau surface in places. The Liard River is the second major drainage in the region flowing north and eventually joining the McKenzie River that flows into the Arctic Ocean.

The entire region was covered with ice during the last glaciation. Cordilleran ice from the Rocky Mountains advanced only a short distance eastwards beyond the foothills where it merged with the larger mass of Laurentide ice from the east. Drumlins and fluted till plains are common throughout the area as relic deposits of decomposed glacial ice. Numerous moraine features, pitted outwash and meltwater channels also occupy the lowland.

In the northern part of the region, meltwaters drained eastwards and northwards from the Cordilleran ice sheet, and deposited outwash gravels and sands along the plateau margins of the Fort Nelson and Hay rivers. Lacustrine sediments, relics of ancient post-glacial lakebeds, are common in parts of the Fort Nelson and Peace lowlands. These deposits consist mainly of clay and silt mixed with outwash sands and gravel,[93] and they support large areas of aspen parklands and some open grasslands.[38]

2.2 Climate

The importance of climate in developing and maintaining natural grassland has been recognized for decades,[22,36,96,104] and described succinctly by A.C. Carder when he stated: "Climate is only one of a number of factors promoting natural grasslands but it is the predominant one." Carder identified five typical climatic features of grasslands, but the first four are most relevant to grasslands in British Columbia:[12]

1. *Continentality* – Most grasslands are separated from the moderating influences of oceans and climates, and tend to be highly variable with respect to temperature and precipitation both seasonally and annually.
2. *Drought* – Dormancy allows grasses to survive periods of recurrent drought better than trees. Perennial grasses rely on moisture mostly in spring and early summer during their annual growth cycle, and become dormant when soil moisture is depleted, whereas annual grasses survive as seed in the soil seed bank.
3. *Extended periods of cold*- Grasses are less vulnerable to extreme cold than trees. Long periods of cold temperatures often coincide with dormancy, and living tissues are protected from sub-zero temperatures below the soil surface.
4. *Wind* - Grasses are better adapted than trees to withstand desiccation from wind in both summer and winter. Hot winds in summer, and warm Chinook winds in winter, disrupt the boundary layer on plants and increase evapo-transpiration.[21] Moisture losses are minimized in grasses because their foliage hugs the ground and escapes desiccating winds. Grass blades also roll inward during periods of drought, which reduces exposure of stomata to air movement. Trees are susceptible to winter kill by desiccation when soil water is made unavailable due to frost and frozen soils, but grasses are dormant during winter.[21]

5. *Prehumid conditions* – Prehumid grasslands are non-forested ecosystems where standing water persists long enough annually to limit the establishment and survival of trees. Wetlands, coastal prairies, swales, and moist draws are examples of some habitats where tree growth is limited, but where grasses and grasslike plants survive.

Grassland climates in British Columbia vary considerably and are affected by several interacting factors including the source of air masses, orientation of mountain systems, topographic effects, and direction of river valley systems.[54,124] The relative importance of each of these factors varies among geographic regions.

2.2.1 Southern Interior Grasslands

The grassland climate in the southern interior of British Columbia is typically hot and dry. Pacific Maritime, Great Basin Desert, and Polar Continental (Arctic) air masses all affect local grassland climates in the southern interior. The combination of these air masses produces a continental climate with a temperature range from summer to winter that exceeds 25^{o}C, nearly double that of the lower mainland.[95]

Pacific air masses influence the climate year round from the East Kootenay Trench to the Cariboo-Chilcotin. Frontal systems that contact the coastline during summer are confronted with a series of mountain systems aligned in a northwest to southeast direction that lie approximately perpendicular to the prevailing winds. These air masses are lifted by the Coast and Cascade mountains and deposit most of their moisture on the windward side of the ranges, which produces a strong rain shadow in their lee (Figure 4).[53] On its descent, the air is compressed and becomes much warmer and drier producing high summer temperatures and moisture deficits for plants in the southern interior. These air masses often produce winds as they move eastward, especially on the Thompson Plateau, which create even higher evaporation rates from plants and the surrounding landscape.

The warm air is heated further as it spills down into the deep depressions of the Fraser and Chilcotin rivers and other major valleys in the interior. This produces much drier conditions in the valleys than on the upper hillsides and plateaus. Clear skies and low humidity at night promote radiation cooling that results in frequent summer frosts, especially at higher elevations on the Chilcotin Plateau.[99]

The effects of the rain shadow from the Coast Mountains decreases to the east, and precipitation increases abruptly as the Columbia and Rocky mountains are approached.[124] Most of this moisture is released on the windward sides of the Monashee, Selkirk, Cariboo, and Purcell mountains leaving the East Kootenay Trench in a rain shadow.

Precipitation is bi-modally distributed on most grasslands in the southern interior with peaks occurring in June-July (rain) and November-January (mostly snow). March and April are typically dry months.[14,53,124] Rainfall in May and June often penetrates the soil surface and is mostly available for plant growth.[105] Later in the summer, intense heating on the plateau surface produces convective showers. Water from these storms, however, often evaporates or runs off, contributing little to soil moisture storage.[26,124]

Most 'effective precipitation' occurs from spring snowmelt.[113,124] Annual snow cover can be highly variable though, and its contribution to soil moisture inconsistent. In some years, snowfall is lost to sublimation as a result of late-winter and early-spring warm temperatures. At other times, when spring temperatures rise rapidly, meltwater runs off into adjacent lowlands and ponds without recharging soil moisture on the uplands.[124]

Hot, dry air masses originating in the American Great Basin migrate north in July and August, and penetrate river valleys running north and south. Some of this hot air flows east and west along the Kettle, Similkameen, and Thompson River valleys, and onto the Thompson Plateau. Hot air from the Great Basin also continues north along the Fraser River to the confluence of the Chilcotin River. This air can create high daytime temperatures and clear skies in the valleys during the summer, but usually has little effect on the Fraser Plateau.[14]

Great Basin air masses significantly influence climate in the East Kootenay Trench, Okanagan Valley and Thompson Basin. Their effects are most pronounced in the Southern Okanagan Basin where average daily temperatures in summer are 2 to 4^{o}C warmer than elsewhere in the region.[95]

Most of the low-elevation grasslands in the southern interior experience winter temperatures that are moderated by large lakes in the valley bottoms. Polar Continental air periodically descends into the southern interior during winter or early spring. Arctic air masses during winter influence semi-arid grasslands in the Cariboo-Chilcotin[14] and the East Kootenay Trench more significantly than in the southern interior. In the East Kootenay, cold air in winter drains south along the Rocky Mountain Trench and descends into the valley bottom from the eastern mountain passes.[53] These 'Arctic outbreaks' can result in periods of severe cold in some years, and are often accompanied with high snowfall.[39,124] Maximum low temperatures vary over the Southern Interior grassland region from extremes of -47.2^{o}C at Big Creek in the Chilcotin and –40.0^{o}C at Cranbrook to –26.5^{o}C at Osoyoos in the south Okanagan Valley.[3]

Arctic outbreaks generally occur in winter when grassland plants are dormant. These events can be catastrophic when they occur suddenly in spring as native plants break dormancy. Most plants are vulnerable to severe cold as they begin to respire and produce annual growth, and are highly susceptible to freezing. Plant vigor can be adversely affected during sub-zero conditions and plant mortality may be high.[21]

Topography, elevation and aspect significantly modify local climates on all southern interior grasslands, especially in the large valleys where heat is trapped. The hottest and driest climates of the province occur in the valley bottoms east of the Coast Mountains,[95] particularly in the southern Okanagan Valley between Oliver and Osoyoos, and western part of the Thompson Valley near Ashcroft (Table A 5.2; Table A 5.3). Soil moisture deficits are very high especially on the valley floors.

A gradual transition in climate takes place over elevational gradients with average temperatures declining 5^{0}C for every 1000 m increase in elevation.[95] Precipitation generally follows a similar pattern with the lowest amounts falling on the valley floors, and more rain and snow accumulating at higher elevations. The Lac du Bois grasslands near Kamloops serve as an example of this. There, annual precipitation in the valley bottom (335 m elevation) averages about 240 mm compared to 300 mm on the grasslands above 850 m elevation (Table A 5.3).

Photo: B. Wikeem

Deposition and snowmelt on Lac du Bois illustrates the moisture gradient from Lower to Upper Grasslands.

Generally, the climate becomes progressively moister and cooler in all the major valleys over elevational gradients along the valley floors. In the Okanagan Valley, annual total precipitation at Armstrong is nearly 50% higher than at Oliver over an elevational gradient of 68 m (Table A 5.2). Plant communities in the Cariboo-Chilcotin, Thompson Basin, East Kootenay Trench, and Okanagan Valley reflect these subtle changes in climate over small elevational differences. In the north Okanagan, grasslands on the valley floor and adjacent slopes are similar to the Upper Grasslands in the south Okanagan Basin and Similkameen Valley. Vertical zonation of plant communities is less evident over an elevational gradient, and often ‘Upper Grassland’ communities merge directly with Douglas-fir forest at higher elevations.

2.2.2 Northern Interior and Great Plains Grasslands

Topo-edaphic factors are common on all grasslands landscapes in British Columbia but may be more important in maintaining northern grasslands than those to the south. Steep slopes, aspect, and shallow, coarse soils are particularly prevalent features of grasslands in sub-boreal and boreal regions.[83] These conditions can create moisture deficits similar to those in much hotter environments.

North of 52 ° N latitude, mountains in the Coast Range attain lower elevations than those along the south coast, and the rain shadow effect is diminished compared to the southern interior.[2] Pacific air masses interact more frequently with Arctic air from the north, which produces a cooler and moister environment than on southern interior grasslands. Total annual precipitation in Vanderhoof, for example, is 55% higher than in Clinton, and the average January temperature is about 6^{o}C lower than at Clinton and Williams Lake (Table A 5.5).

A continental climate dominates most of the Sub-Boreal Interior and Northern Boreal Mountains ecoprovinces producing cool to warm summers and long, cold winters. Generally, average temperatures in July and January decrease from south to north and precipitation increases (Table A 5.5; Table A 5.8; Table A 5.9; Table A 5.10).

Grasslands throughout the region lie in the lee of the St. Elias Mountains and Boundary Ranges, which results in relatively dry conditions.[26] The average annual temperature in the main valleys is approximately –2.5^{o} C with temperatures ranging from 10^{o} C in July to –16^{o} C in January, and annual precipitation varying from 225 to 300 mm.[3]

The Rocky Mountains significantly influence the climate of the Hyland Highland, Muskwa Foothills and Peace Foothill ecosections where significant areas of grasslands are found. These grasslands tend to be moister and slightly warmer on average than those west of the Rocky Mountains. Precipitation averages 500 to 600 mm annually depending on latitude and elevation, and the annual temperature averages –2.0^{o} C.[30]

The climate of the Great Plains east of the Rocky Mountains is characterized by long, cold winters and short, warm summers. This area is seldom affected by Pacific air masses because of the many mountain ranges that separate the region from the Pacific Ocean and block their advance. The Rocky Mountains have a pervasive influence on the climate of the region creating a significant rain shadow effect from Pacific air masses that reach their windward slopes. These air masses warm as they descend to the plateau below and moderate local climates.[58]

Long periods of cloud cover and unstable weather often prevail in the Peace River area in summer because Arctic and Pacific air masses often converge in the region. Summer temperatures are slightly warmer east of the Rocky Mountains compared to the foothills, and annual precipitation peaks during the summer months.[95] Although precipitation over the Great Plains averages 400 to 500 mm annually, moisture deficits frequently occur during summer owing to the relatively high temperatures and long periods of solar insolation.[95] These conditions are particularly pronounced on south slopes that support grassland communities. Convective showers are common during summer as a result of strong surface heating.[26] In winter, cold air masses from the Arctic descend on the area, but are prevented from moving westward by the barrier of the Rocky Mountains. Chinooks are common on the Great Plains during winter, which alleviate long-periods of cold temperatures.[103]

2.2.3 Coastal Savannah and Grasslands

Air masses from the Pacific Ocean dominate the climate over the southeastern lowlands of Vancouver Island and the Gulf Islands year round. Laying in the rain shadow of the Vancouver Island and Olympic mountains, the climate on the east coast of Vancouver Island has been described as dry Mediterranean, and is characterized by warm, dry summers and mild, wet winters.[73]

Average annual temperatures are the highest in Canada at just over 10^{o}C, while the annual range of temperature of 15^{0}C indicates a slightly greater continental influence than on the outer coast of Vancouver Island. The total annual precipitation of 650 mm at sea level makes the east coast of Vancouver Island the driest region on the British Columbia coast.[95] Very little precipitation falls as snow, and less than 5% of the total annual precipitation accumulates over July and August.[33] High water deficits are common through the summer,[51] especially on shallow soils close to bedrock where Garry oak grasslands and savannah commonly occur. Climatic conditions change gradually from warmer and drier in the south to cooler and moister in the north over the distribution of Garry oak (Table A 5.11).

Air masses from the Great Basin are blocked on the east by the Coast and Cascade mountains and have no influence on the region. Arctic outflow winds periodically move through the area during late fall and winter. These air masses mix with the milder and warmer Pacific air, which occasionally results in snow. The extreme low temperature recorded for this region during winter is –15.6^{o}C,[3] but lows rarely exceed 0^{o}C.

2.3 Soils

Soils form as a result of five interacting factors: parent material, climate, biota (vegetation and animals), topography, and time.[111] Grassland environments in British Columbia occupy a wide range of elevations and latitudes where topography is complex, parent materials are variable, and numerous vegetation types often come into close contact. Consequently, eight of the nine soil orders classified in the province are found in grassland environments, but some are more common than others (Appendix 6).

Typical soils of all true grasslands belong to the Chernozemic order.[77,111] These soils are characterized by vegetation dominated by grasses, forbs and shrubs, but in some areas, they extend into the forest-grassland transition.[77] The climate supporting Chernozems is generally sub-arid to sub-humid, and is characterized by low rainfall, high summer temperatures and high evapotranspiration rates. These factors inhibit tree growth and limit the leaching of nutrients from the decomposition of above-ground biomass and roots deeper into the soil profile.[111]

Chernozemic soils are characterized by the presence of a dark-colored surface layer, or 'Ah', horizon. Herbaceous steppe vegetation produces an abundant rooting system that penetrates deep into the soil profile.[77] The combined accumulation of organic matter derived from the roots and decomposition of leaves on the soil surface is the dominant process forming Chernozemic soils. These materials are mixed with mineral matter by repeated ingestion and excretion by soil fauna, which produces the well-developed granular structure and characteristic dark colored surface layer.

Photo: K. Iverson

The organic content of Brown Chernozems is low because of arid conditions.

In British Columbia, Chernozemic soils are most commonly found in the valleys and adjacent plateaus of the south central interior (Appendix 6). These soils occur on a wide variety of parent materials ranging from fluvial deposits or terraced lake silts in parts of the southern Okanagan Valley to till in the Chilcotin region.[111] Local factors such as aspect affect evapotranspiration, and many Chernozemic soils occur on south- and west-facing slopes that have high evapotranspiration rates.[113]

Four kinds of Chernozemic soils occur in the province, and are classified as Brown, Dark Brown, Black, and Dark Gray Great Groups based on variations in the surface Ah horizon. These variations are mostly associated with organic matter content, which in turn is a reflection of the aridityof the environment.[111] Changes in the organic content of Chernozemic soils are described best using the elevational gradient near Kamloops, which reflects a continuum from the driest to wettest conditions on the grasslands.[113]

Brown Chernozems dominate the driest conditions at the lowest elevation where Big sagebrush – Bluebunch wheatgrass communities are prevalent. These soils gradually change to Dark Brown Chernozems on sites dominated by needle-and-thread grass and Sandberg's bluegrass, and to Black soils in the relatively sub-humid environment with a rough fescue plant community.[113] At the highest elevations and relatively wettest conditions, soils change to Dark Gray Chernozems at the forest-grassland transition. Similar soils sequences occur over elevational gradients in the Okanagan Valley and Cariboo-Chilcotin. Transitions from Brown to Black Chernozems over elevational gradients are more poorly defined in the East Kootenay Trench, and in the Kettle, Similkameen, and Nicola valleys (Appendix 6).

East of the Rocky Mountains in the Peace River region, soils that have formed on sites with steep slopes and south-facing aspects are classified as Rego Black Chernozems.[58] They are generally shallow, and form on rocky, sandy, or gravelly parent materials that support steppe vegetation.[82] These soils have a poorly developed surface (Ah) horizon and no development in the lower B horizon. Grasslands and savannahs are found on Brunisolic soils in all parts of the province (Appendix 6). These soils commonly occur where grasslands merge with the Ponderosa Pine and Interior Douglas-fir zones

Brunisols often form where conifer litter affects soil development.

Photo: B. Wikeem

in the sub-humid to semi-arid zones of the southern interior, especially where long winters and low temperatures have restricted the progression of soil weathering. Brunisols have developed mainly on very coarse-textured materials such as sands and gravels where soluble salts and carbonates have leached from the upper soil horizon. Brunisols have undergone only moderate development, but weathering has proceeded far enough to change the morphology of the parent material in the second soil horizon below the soil surface (Bm). This horizon may or may not be overlain by an Ah horizon containing mineral and organic matter mixed by soil fauna.[111]

Soils in the Brunisolic Order are differentiated based on the presence or absence of an Ah horizon, and on the relative acidity of the soil.[111] In British Columbia, Orthic Eutric Brunisols form on calcium-rich glacial deposits in the East Kootenay where soil development is influenced by the presence of coniferous and deciduous trees. The understory of these communities is still dominated by steppe vegetation. Similarly, Garry oak savannah and grasslands on the southern tip of Vancouver Island occur on acidic, coarse-textured soils that have been classified as Melanic or Sombric Brunisols.[10,51,73]

Large but discontinuous areas of steppe, shrub-steppe and savannah occur on Regosolic soils in British Columbia (Appendix 6). Regosols exhibit little alteration of the parent materials. All soils in this order lack a B horizon, and some are even missing an A horizon.[111] Regosolic soils are often found in unstable conditions associated with steep slopes, cliffs, talus slopes, sand dunes, and large areas were bedrock protrudes or is close to the soil surface. Most of these soils are found along river canyons, and in subalpine and alpine environments.[58]

Solonetzic soils are widespread on the grassland landscape in British Columbia, but usually are not dominant (Appendix 6). These soils contain high levels of sodium, or sodium and magnesium salts in their B horizon, which distinguishes them from all the other orders.[111] The characteristic columnar structure of these soils is formed when the salt-rich soils dry, and when residual water freezes and expands in the winter.[111] The high concentration of salts in these soils often limits vegetation to the most salt tolerant plants,[111] usually grasses and forbs, but trees occasionally grow on marginally saline soils where leaching has reduced their salt content.

Photo: B. Wikeem

Solonetzic soils form in the grassland environment where salts accumulate from evaporation.

Solonetzic soils develop locally in semi-arid regions of the southern interior near Merritt, Kamloops, in the south Cariboo near 70 Mile House and on the Chilcotin Plateau. Water from the uplands carries calcium, sodium and magnesium salts in solution to poorly drained depressions on the rolling landscape. High concentrations of salts accumulate in the soil profile and on pond beds as water evaporates in summer and fall.[111]

Solonetzic soils are most prominent in the Peace River lowlands in areas that supported open grassland and parkland before European settlement.[9,38,68] Generally, the landscape is a gently undulating plateau, but the high concentrations of soil salts in the region are the result of residual salinity rather than a concentration of salts resulting from evaporation. The ubiquitous salinity of these soils over the landscape arises from the parent materials that originated from marine shales, siltstones and mudstones.[38]

Luvisolic soils cover a large area of the province, and are formed under a deciduous or mixed deciduous-coniferous forest (Appendix 6). These soils are commonly associated with grassland-forest ecotones and they are also found in the forest-grassland transition zone east of the Rocky Mountains.[111] Abrupt changes in soils along these forest edges indicate that historically grassland vegetation has occupied adjacent forests such as in Lac du Bois Protected Area.[40]

Luvisols form in humid or sub-humid soil moisture regimes that are sufficient to promote translocation of clay-size particles from the A to B horizon. These particles of clay, or ‘clay skins’, are the distinguishing characteristic that sets Luvisols apart from other soils. Other processes that contribute to their formation are the addition of organic matter on the mineral soil surface, and the leaching of soluble salts and calcium carbonate into the C horizon.[111]

Gleysolic soils are uncommon in the grassland environment, and occur only in wetlands (Appendix 6). These soils develop in areas where water is added to the soil faster than it drains away, such as in depressions or at the foot of slopes. Gleysols form in areas that are saturated for long periods and where oxygen is excluded from the pore spaces. Consequently, soil microorganisms rapidly consume all the oxygen in the water, and the anaerobic conditions that develop allow chemical-reduction processes to prevail for at least part of the year.[111]

Gleysolic soils also develop in areas where fine-textured parent materials fill soil pores and restrict soil drainage. For example, gleysols occur over large areas of the Peace River Lowlands that are underlain by very fine marine shales that impede soil water movement.[111] Gleysolic soils also are commonly associated with the wetlands that occur throughout the hummocky topography of the Fraser Plateau.

Organic soils are present in all regions of the province where grasslands are associated with wetlands (Appendix 6). These soils have developed under highly saturated conditions, and are composed mainly of organic matter.[111] Organic soils typically develop in areas where low temperatures combined with a lack of oxygen restrict decomposition, and promotes an accumulation of dead organic material.

On grasslands, organic soils are most commonly found in depressions where the soil is saturated for most of the year. The specific characteristics of these soils are controlled by the amount and quality of the water flowing into them, and by the species composition of the resident vegetation. Water quality ranges from neutral to slightly alkaline over most of the grassland area, and the vegetation consists mainly of sedges, willows and bog birch.[111]

Cryosolic soils are associated with high-elevation grasslands, alpine tundra vegetation, and occasionally, subalpine parklands on north-facing slopes. The distribution of these soils in the high mountains is primarily controlled by climate, but aspect, exposure, vegetation, soil or rock type, and amount of snow cover are also important factors.[111] Cryosolic soils contain permafrost close to the surface, which sets them apart from all other soil orders. Permafrost, or perennially frozen ground, occurs only where soil temperatures remain below $0^{o}C$ continuously for several years. Permafrost is generally most stable in the lower part of the soil profile, and stays frozen throughout the summer, while the surface layer often thaws.[111]

Cryosols are generally poorly developed because rates of chemical and microbiological reactions are slow, and transformations within the soils are limited in such cold environments. Mineral soils often have deep organic surface horizons because the low soil temperatures inhibit microbial decomposition of organic matter.[111]

2.4 Fire and Forest Encroachment

2.4.1 Fire

Photo: E. Batke

Lightning-caused fire in Okanagan Park 2003.

Fire has always been a significant factor in terrestrial environments, especially in drier climates that support grasslands and savannahs.[21] These ecosystems are generally more susceptible to fire than others because plants are closely spaced and fuel loads build up when plants become dormant and annual foliage dies.

Historically, lightning has been the dominant cause of 'natural' fires in most biomes, but volcanic eruptions, spontaneous combustion, and sparks generated from rockslides have ignited fires periodically. Burning by aboriginal peoples has also been a prominent factor in grassland and savannah environments in North America for millennia.[19]

First Nations peoples purposely burned vegetation to promote the production of particular plants and animals that were used for food, encourage growth of medicinal plants, improve visibility of their enemies, and enhance travel. Fires were also set to create stands of firewood, provide forage for horses, and to signal other tribes. Other fires occurred accidentally when they escaped from campfires.[52]

Photo: B. Wikeem

First Nations aspen burning at East Moberly has maintained grassland for over 75 years.

Both lightning-caused fires and those set by native peoples had important influences on grasslands and open forests in British Columbia.[33,105,107] Burning at regular intervals in ponderosa pine, Douglas-fir and coastal Garry oak communities contributed to maintaining ecotones between grassland and forest, and controlling tree recruitment in mature forest stands.[8,79,100,102] Fire frequency declined in the interior after 1900 as aboriginal burning virtually stopped and grazing by domestic livestock reduced fuel loads that could carry fire.[102]

Early settlers also burned the landscape for similar reasons as the local natives, but these fires were set much more regularly, at least initially.[52] Some fires were intentionally set while others were accidentally ignited by sparks from trains and other sources, especially in the East Kootenay Trench.

2.4.1.1 Fire Regimes

In the broadest sense, 'fire regime' describes the typical frequency, seasonal timing, intensity, and geographic size of fires. Numerous estimates of fire frequencies have been made for various biogeoclimatic zones in British Columbia (Table 1). Fire cycles are often closely associated with plant species composition, structure of vegetation types, and local climates. Shorter intervals between fires are expected in dry grasslands in the Bunchgrass and Ponderosa Pine zones compared to those in higher-elevation grasslands and open forest in the Interior Douglas-fir zone (Table 1). Nonetheless, fire cycles of five to 20 years have been reported in low-elevation grassland and dry forests [16] compared to intervals ranging from five to 15 years in the southern part of the Interior Douglas-fir zone in the East Kootenay Trench. Farther north in the Trench, where conditions are slightly cooler and moister, the fire interval increases to 15 to 25 years (Table 1).

Photo: B. Wikeem

Needle cast and bunchgrass litter provide fine fuels for fire in the Ponderosa Pine zone.

TABLE 1. Estimated average fire intervals and time between fires in selected biogeoclimatic zones in British Columbia.

Biogeoclimatic Zone/Location	Average Fire Interval	Range	Reference
Bunchgrass			
Okanagan	[12.5][1]	5 – 20	16
Cariboo (Lower Grassland)	19.1	3 – 81	6
Ponderosa Pine			
Okanagan	[12.5]	5 – 20	16
Kamloops - Battle Bluff	8.5	None Given.	97
Interior Douglas-fir			
East Kootenay Trench (Dry)	[10.0]	5 – 15	7
East Kootenay Trench (Wet)	[17.5]	15 – 20	62
Kamloops - Dewdrop	18.4	None Given.	97
Merritt	13.0	1 – 46	37
Cariboo	14.0	3 – 36	6
East Chilcotin	[11]	10 – 12	75
Riske Creek	9.8	None Given.	16
Williams Lake area	14.5	2 - 54	17
Sub-Boreal Spruce			
Unspecified (Stand Replacing)	100	None Given.	5
Coastal Douglas-fir			
Garry oak (Vancouver Island)	[150][2]	100 – 200	33, 76

[1] Numbers in square brackets are averages calculated from the range provided.
[2] Refers to stand replacing fires in coastal Douglas-fir forest. Fires set by the coastal Salish were likely more frequent.

Less is known about fire frequencies in northern grasslands. At high elevations in cool, moist environments, grassland fires often coincide with those in adjacent forests because grasslands are usually a smaller part of larger forest ecosystems. In the Sub-Boreal Spruce zone, for example, forest fires return at approximately 100-year intervals (Table 1), and grasslands are likely burned during these events. Fire is widely regarded as an important ecological factor that maintains grasslands east of the Rocky Mountains,[26,68,85] but no information is available that documents natural frequency in the region.

2.4.1.2 Characteristics of Fire

Compared to other vegetation types, grasslands and savannahs are particularly predisposed to fire because they are dry and plants are closely spaced. The specific effects of burning relate to the kind of fire, weather conditions, and the amount of fuel available to carry the fire.[19]

Lightning ignitions are most common in British Columbia in July and August. These strikes occur most frequently at mid- to upper-elevations and less often at lower elevations or in the valley bottoms.[52] Initially, most fires progress upslope from their ignition point, particularly as updrafts develop when the fire gains momentum. Back-burns also occur down slope as the fire moves laterally across the landscape.[52]

Grassland fires, or ground fires, are characterized by a linear zone of flames passing slowly over a relatively uniform source of fuel. The fine texture of the fuel makes it responsive to minor changes in humidity, which can profoundly affect flammability and fire intensity in steppe vegetation. Fuel conditions are coupled with the prevailing weather conditions before and during the fire, which defines the rate of spread and severity of the fire event.[19]

Photo: BC Parks

Cool ground fires consume fuels at the soil surface without damaging most trees.

All ground fires occur as either backfires or head fires.[21] Backfires gradually move over the soil surface and slowly burn into the crowns of bunchgrass and some low-growing shrubs. These fires are often more damaging to plants than head fires because seeds and living tissues are exposed to higher maximum temperatures for a longer duration.[19]

Head fires rapidly sweep over the landscape and most of the heat is projected upwards into the air. These fires can be less detrimental than backfires, especially when most of the vegetation is dormant, such as in late summer. Air temperatures immediately above grassland fires range from 600 to nearly 900°C depending on the fuel load and kind of fire.[19]

Crown fires occur when the tops of shrubs and trees ignite and the canopy becomes the main source of fuel carrying the fire.[21] The understory also is consumed as the overstory burns, but roots, other below-ground organs, and buried seeds often escape damage. Crown fires are often hotter than surface fires, and temperatures may reach 1150°C or higher when forest canopies are involved.[19]

Photo: B. Wikeem

Crown fires can quickly move across the landscape and consume all vegetation.

2.4.1.3 Environmental Impacts

Fire has both positive and negative effects on the physical features of grassland environments. While fertility is often enhanced in the short-term by the release of nutrients from fire-consumed vegetation, some nutrients are lost from the environment through volatization, wind erosion, leaching, and surface runoff.[18] Also, loss of the protective cover of living plants, litter, cryptogams, and humus layers increases soil losses on steep slopes,

Photo: B. Wikeem

Very hot fires often kill all age-classes of trees and leave soils exposed to possible erosion.

and interrupts normal hydrological processes.[18] The volume of ash available as potential fertilizer depends on the biomass of the original vegetation burned. When fires reach shrub and forest canopies, the amount of ash produced can be substantial, but on grasslands it tends to be scant or negligible.[19]

The effects of burning on soil erosion depend on the soil type, slope, amount of precipitation or wind, and the cover of vegetative matter and litter remaining after the fire.[19] Generally, accelerated erosion diminishes over time as vegetation, litter and other soil surface features are restored.

2.4.1.4 Effects on Individual Plants

Fire is an integral part of the grassland environment, but its specific effects on ecosystem structure and function vary considerably.[46] Fire regimes dictate the specific response of individual plants to burning and the plant communities that form in the post-fire environment. Season, frequency and intensity are important aspects of fire that interact with the present plant species composition, phenological stages of growth, plant moisture content, and many other factors to produce specific outcomes.[6,46,120]

Fire directly injures plants by exposing living tissues to lethal temperatures, which range from 45 to 60°C for most terrestrial plants.[19] Heat intensity, and the length of time living tissues are exposed to lethal temperatures, determines the ecological effects fire has on plants.[46] In turn, many plants have acquired adaptations to defend against fire effects, although some are better adapted than others. The morphological characteristics of plants often determine their susceptibility to fire.[61,120] Mature Douglas-fir, ponderosa pine and Garry oak trees are highly resistant to fire because they have a thick layer of bark that protects their vegetative tissues from surface fires. Younger trees with a thinner bark layer often perish, which creates or maintains savannah conditions.[8]

Species that reproduce from rhizomes and underground growing points are more fire-resistant than those with fibrous roots and elevated growing points. Accordingly, species such as Kentucky bluegrass, quackgrass, yarrow and trembling aspen are better adapted to resist fire than Sandberg's bluegrass, junegrass, long-leaf phlox, parsnip-flowered buckwheat and most other forbs.[120] Sagebrush mariposa lily, death camas, yellow bell, and arrowleaf balsamroot are also fire-tolerant because they form well-developed bulbs or tubers that are located deep below the soil surface.[120] These species are often unaffected or increase following fires.

Bluebunch wheatgrass crown damaged by fall burn near Ashcroft.

Photo: B. Wikeem

Large bunchgrasses and forbs with fibrous root systems display variable reactions to fire that are partly associated with the position of their growing points and with fire intensity. Bluebunch wheatgrass, rough fescue, lemonweed, pussytoes, and field goldenrod usually recover after cool, spring fires, whereas these same species can be adversely affected by late-spring or summer burning.[41,61,64,65,98] Idaho fescue is usually less resistant to fire than other bunchgrasses, and often declines in abundance more readily than other perennial grasses because its growing points are elevated slightly above the soil surface.[120] Recovery to pre-fire levels of cover and frequency is highly variable and may be up 30 years depending on the intensity and season of burning.[44]

Annual plants usually escape the direct effects of fire, and even if they are burned, their mortality does not regulate future populations. Populations of annual plants can be affected, however, when fire destroys the seed bank.[46] Weedy species like cheatgrass, tall tumble-mustard, and tall annual willowherb display variable responses to fire, but often invade burned sites.[6,67] As an exception, diffuse knapweed populations were unaffected by fire in one study in British Columbia.[71]

Phenological patterns in grasslands create a mosaic of species with variable vulnerability to fire because some species are vegetative during spring, summer and fall.[81] Ultimately, this may result in changes in species composition on burned sites because plants that are actively growing are more susceptible to fire than those that have produced seed, stored food reserves and become dormant.[19]

Saskatoon, choke cherry, snowbrush, and most willows have very deep root systems and re-sprout from their roots after fire, while threetip sagebrush, big sagebrush, and common rabbit-brush are usually killed.[67,97,120] The response of antelope-brush is variable and may relate to variations among ecotypes. The antelope-brush ecotype that occupies northern Washington and the Okanagan Valley usually dies after fire,[20] but most plants in the East Kootenay Trench re-sprout from the crown.[29]

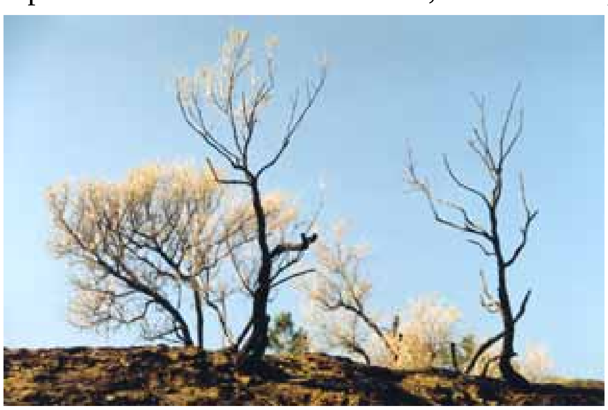

Photo: B. Wikeem

Sagebrush is highly susceptible to fire, but fire behavior spares some plants.

Several shrubs common in savannah and dry forests in British Columbia produce large quantities of hard-coated seeds that remain dormant in the soil until fires occur.

Kinnikinnick, redstem ceanothus, snowbush, and smooth sumac are examples of shrubs that require fire for seed germination.[21] This accounts for their increase in dominance on some previously forested sites that have been burned.

Indirectly, fire affects plants by changing the structure of plant communities, reducing the organic content of the soil surface, and modifying the abundance and distribution of litter.[21] Reductions in litter and living biomass alter the amount of light and heat reaching the soil surface, and change hydrological patterns.[19] These changes often create a drier microenvironment for perennial bunchgrasses that can reduce their productivity in the first few years following a burn.[19,120]

Photo: B. Wikeem

Fire temporarily removes all ground-cover and can alter ecological conditions until a new ground cover is restored.

Even though some plant species are smaller and less productive in the first few years following fire, others respond with increased flowering and seed production for one or two years.[46] Recovery of litter to its pre-fire levels of cover can take from one to six years depending on the site and characteristics of the fire.[18]

2.4.1.5 Effects on Plant Communities

Fire can be catastrophic for many organisms, especially in the short-term, but long-term changes in habitat structure, species composition, and nutrient distribution favor others.[46] Fire commonly favors forbs over grasses in both annual and perennial stands of grass, although there are exceptions.[19] In some circumstances, particularly where fires have been very hot, annuals may gain at the expense of perennial grasses, especially if seed disperses onto the burned area from adjacent plant communities. Under these circumstances, plant species diversity may be enriched as a result of fire, but some of the immigrants may be noxious weeds and other non-native plants.[19]

Although prescribed burning has been used intermittently in the East Kootenay Trench,[25,29,35,55] Thompson Basin,[97] Cariboo-Chilcotin,[14] and Peace River regions,[24,85] little research has documented the successional pathways that develop following fire. Some generalized aspects of succession, however, can be extrapolated from the responses of individual plants, and from research conducted in similar plant communities elsewhere.

Shrub-steppe communities generally shift to open grasslands, or shrubs become more widely spaced on the landscape when fire intensity is low. Depending on the season of burn, perennial grass cover may remain unchanged, or may increase in response to the resources made available as shrub cover declines.[20] When fire intensity is high, perennial grasses, small shrubs, and some forbs are vulnerable to fire, and a greater proportion of annual species can dominate plant communities.[19,120]

Fire contributes greatly to creating and maintaining grassland and savannah in ponderosa pine and Douglas-fir forests.[8,13,107] Hot fires that reach the forest canopy usually kill ponderosa pine and Douglas-fir trees, resulting in these communities abruptly reverting to grassland, or becoming savannahs with widely trees. Grassland shrubs, grasses and forbs often increase in cover, productivity, and abundance in response to increases in light and moisture after the forest canopy has been removed.[19] Burning also maintains well-defined ecotones between forest and grasslands,[102] which is an important feature of wildlife habitats for numerous animals from ungulates to birds.

Recovery times for forests to regenerate after fire is variable and depends on the site, weather and tree species. On the Wigwam Flats in the East Kootenay Trench, grasslands in the Interior Douglas-fir zone remained open for over 35 years after they were burned in 1931.[25] Initially, these grasslands were dominated by Rocky Mountain fescue, junegrass and poverty oatgrass combined with numerous forbs. By 1968, western larch, lodgepole pine, and Douglas-fir regeneration began to dominate the sites and restore forests onto derived grasslands.[25]

Photo: B. Wikeem

A hot summer fire on Greenstone Mountain near Kamloops killed immature Douglas-fir trees and restored a robust cover of bluebunch wheatgrass after five years.

Aspen regeneration on similar sites in the Trench has been more rapid. Douglas-fir sites that were burned in 1931 and again in 1951 were converted to grassland that was dominated by rose, junegrass, and wild bergamot. Cheatgrass, yarrow, spreading dogbane, and fuzzy-tongued penstemon were also common. Fifteen years after the second fire, most of the grassland had been re-colonized by trembling aspen.[25]

Landscape-level fires often exhibit an array of behaviors simultaneously and produce a range of outcomes from low intensity burned areas to extremely scorched sites. Other other areas may escape fire entirely. Orientation of valleys, wind patterns, variable fuel loads, roads, lakes, and topographic features combine to divert, deflect, and alter the intensity of site specific components of the fire.[52] The resulting landscape often becomes a mosaic of successional stages in close proximity to one another, which creates diversity of habitats for plants and animals after the fire.[109]

Photo: B. Wikeem

Fire behavior can be highly variable leaving some parts of the landscape severely scorched and other areas unburned.

2.4.1.6 Effects on Animals

The effects of fire on animals can be variable depending on the nature of the fire. Indirectly, fire affects all wildlife species by immediately modifying habitat structure, removing thermal and hiding cover, depleting food resources, and ultimately, causing changes in species composition of plant communities.[19,46,115] Fire infrequently results in direct mortality to invertebrates, small mammals, large mammals, or birds.

Photo: B. Wikeem

Bunchgrasses often have a higher nutritional value and are more available to grazing animals after fire.

Most adult ungulates are fleet enough to escape fires, but their young may perish, especially if they are separated from their mother. Forage quality and palatability is usually enhanced after fire, but improvements in forage quality usually decline after one or two growing seasons.[19,46] Animal weight gains may occur after a fire, but only if the total nutrients in the post-burn forage exceed those that were previously available. This may not always occur, however, as the recovering vegetation can be less productive than the pre-fire plant community, especially if species composition has changed.[120]

Burned areas often attract domestic and wild ungulates, which alters animal distribution patterns, and can make these areas susceptible to over use.[19] In other cases though, changes in animal distribution patterns have no apparent effects on vegetation or on animal population levels.[49]

Intensive fires that remove all or most of the ground cover can be detrimental to small mammals such voles and mice that require grassland vegetation and litter for escape cover and forage.[19] Burrowing animals such as pocket gophers, ground squirrels and marmots are less susceptible to predation when ground cover is removed by fire, but they still suffer from the loss of food. Most small mammals remain at risk to predation, however, until plant community structure is restored.

Most birds escape fires by flying away. Depending on the timing of fires, ground nesting birds such as the Bobolink, Long-billed Curlew, Savannah Sparrow, Vesper's Sparrow, and Short-eared Owl can lose eggs or fledglings if fires occur during the nesting season, or they may abandon their nests and not lay another clutch of eggs.[49] Fire not only destroys protective cover for nesting, it removes building materials for new nests, and reduces insect food resources. Conversely, some birds may benefit from fires as they take advantage of the brief abundance of food supplied when insects are flushed by the advancing front of the fire.[19]

2.4.2 Forest Encroachment

Since glacial recession, forests have periodically advanced and receded on British Columbia's landscapes in response to climatic variations. The climate has been relatively cooler and moister in the last 6000 years compared to the preceding four millennia,[11,47] and forests have expanded onto grasslands unabated except for relatively brief periods of drought and fire.

Photo: B. Wikeem

Ponderosa pine and Douglas-fir encroachment onto grasslands in the Kettle Valley.

2.4.2.1 Ecological Considerations

Forest encroachment involves three phases: immigration, establishment and multiplication.[18] Immigration for all conifers results from seed dispersal, but trees can only establish when other ecological conditions such as soil moisture, temperature and the absence of fire permit germination and rapid growth. Dispersal of most deciduous trees and shrubs is controlled by the same factors, although aspen, cottonwood and numerous shrubs rely mostly on vegetative reproduction from roots and underground stems.[78] As trees colonize open sites, they promote their own growth by modifying environmental conditions through shading of understory species, and by changing local microclimate and soil conditions.[18]

Photo: B. Wikeem

Conifer encroachment into Big sagebrush–Bluebunch wheatgrass communities at Lac du Bois.

Trees advance into open grassland or savannah in two interrelated ways: by encroachment or ingrowth. Forest encroachment involves the dispersal of trees into open areas that were historically unforested. An exception is when trees reclaim grasslands that were derived from forest by fire or other disturbances. Forest ingrowth occurs when trees fill in the spaces between existing trees, even in widely spaced stands such as in savannahs.

Generally, forest encroachment and ingrowth results in the conversion of grassland to forest, thus affecting species composition of the understory. Numerous forms of encroachment, reestablishment, and ingrowth occur in British Columbia including:

- conifer encroachment onto open, previously unforested grassland;
- aspen and deciduous encroachment onto unforested grassland;
- conifer and deciduous re-invasion of historical forested sites that were opened and maintained by past fire;
- confer and aspen ingrowth between widely spaced trees in savannah-like stands; and
- Douglas-fir encroachment and ingrowth in Garry oak woodlands on Vancouver Island.

2.4.2.2 Geographic Distribution and Encroachment Rate

Forest encroachment has been recognized in all parts of British Columbia since earliest times.[23,116] In 1950, Dr. Ed Tisdale offered:[105]

Invasion of open or lightly timbered ranges by forest growth ….is a significant problem affecting forest range carrying capacity…[and] the invasion of open or semi-open areas by tree growth, with consequent reductions in grazing capacity and usefulness as early range is a common phenomenon over much of the interior…it seems to be mainly a natural return of trees to areas deforested in the past by repeated fires.

Photo: B. Wikeem

High intensity fires can remove the forest canopy or selectively kill trees creating grassland or savannah.

Fire, and to a lesser extent large grazing animals, have been the most influential factors in slowing the advancement of forest into those areas climatically suitable for tree establishment. More than any other factor, fire suppression and control have contributed to the rate of forest advancement onto grasslands in British Columbia since the 1930s.

Fire intervals in all parts of the province are now longer than before fire suppression policy was introduced in the 1930s. As a result, considerable floristic changes have taken place in all biogeoclimatic zones that support grasslands and savannahs.[35] Several studies have documented losses in grassland from forest ingrowth and encroachment in various biogeoclimatic zones throughout the province. Specific patterns of invasion and potential impacts vary by geographic region.

Uncontrolled immigration of trees into natural and derived grasslands throughout the Ponderosa Pine zone in the East Kootenay Trench has resulted in a loss of more than 13,350 ha of open grassland.[88] In some parts of the Trench, the total area of grassland has been reduced by up to 50%.[34,92] Most of this area, however, likely supported forests historically, and was converted to grassland by extensive fires that occurred in the 1900s.

In drier parts of the Trench, such as Skookumchuck Prairie, ponderosa pine encroachment into grasslands has been slower than elsewhere in the Trench. Data collected in an ungulate-proof exclosure constructed in 1951 indicate that there was no pine regeneration for the first 30 years following construction, and that pine cover increased from 2.5 to 10.0% between 1981 and 1995.Forest encroachment and ingrowth have converted nearly

Photo: B. Wikeem

Forest encroachment on to grassland in the Interior Douglas-fir zone near Findlay Creek.

16,500 ha of grassland to forest in the Interior Douglas-fir zone of the East Kootenay Trench over the last 70 years.[88] In the northern part of the Trench, Douglas-fir often invades grasslands where soil moisture is sufficient for tree establishment, but on dry sites there is often little evidence of invasion.[62] Based on an assessment of air photos taken 30 years apart, grasslands are being converted to forest at a rate of about 1% per year, while crown closure on open and moderately closed forests averages 3% annually.[34]

In the south Okanagan and lower Similkameen, trees have encroached into grassland and open forest communities, even in the hottest and driest habitats.[108] Overall, nearly 5000 ha, or about 20% of the grassland area, has been invaded in various biogeoclimatic zones from the Bunchgrass to the Alpine Tundra zone. The greatest losses to open grassland have occurred in the Montane Spruce (53%), Interior Douglas-fir (32%) and Engelmann Spruce-Subalpine Fir (24%) zones along ecotones between grassland and forest. In the lower Similkameen, Douglas-fir and ponderosa pine ingrowth has also reduced open forest and savannah by 21%.[41]

In the Thompson Basin, forest encroachment onto Douglas-fir grasslands, and forest ingrowth in open stands of ponderosa pine and Douglas-fir were recognized by 1950,[106] and has progressed unabated over the last 50 years. Recent estimates indicate that nearly 47,000 ha of open forest and grassland in the Bunchgrass (4000 ha), Ponderosa Pine (17,700 ha) and Interior Douglas-fir (24,300 ha) zones have been lost.[88]

Forest encroachment and ingrowth are considered principal threats to the extent and and biodiversity of grasslands in the Cariboo-Chilcotin.[6,13] Nearly 20,000 ha or 11% of grasslands in the region have succeeded to forest since fire suppression began in the

1960s.[13] About 30% of the grasslands on Bald Mountain and Becher's Prairie were lost to Douglas-firand lodgepole pine encroachment between 1965 and 1997 alone.[91]

Aspen suckering and lodgepole pine encroachment have been common on grasslands in the intermountain valleys and plateaus between the Coast and Rocky mountains,[8] especially in the Sub-Boreal Spruce zone west of Francois Lake.[8,127] Sub-Boreal Spruce forests probably burned every 100 years on average,[5] but fire suppression has resulted in aspen and shrubs encroaching into 20 to 80 % of the shrub-steppe and grassland communities in the region between 1949 and 1994, particularly those on moist sites.[42]

Photo: B. Wikeem

Aspen suckering onto grasslands can be set back by fire, browsing or drought.

In Alberta, the aspen parkland zone has been described as a "tension area between the prairie to the south and boreal forest to the north."[4,69] This description is equally apt for the aspen parklands of the Peace River region in British Columbia, which is the northern extension of this vegetation type. Aspen invasion may be permanent on some sites, but more often is temporary, as aspen suckering is restricted by fire, ungulate grazing, damage by rabbits, and by desiccating winds and drought.[69] Without frequent fires, many of these grasslands would rapidly succeed to an aspen-spruce climax.[69] Local experience suggests that aspen encroachment onto burned or cultivated land can occur within 10 to 20 years on some sites without human intervention.[122]

Indirect evidence suggests that historically, grasslands were more extensive in northern British Columbia than in relatively recent times. Degraded grassland soils, such as Eutric Brunisols and Dark Grey Luvisols found west and east of the Rocky Mountains, indicate a long presence of steppe vegetation before trees encroached.[9,32,58,69]

2.5 Grazing

Grazing is defined as "the consumption of standing forage by livestock or wildlife."[56] Grazing of herbaceous plant species involves the defoliation or removal of a portion of the plant's standing biomass. This can occur once, or numerous times in the plant's life cycle, and most animals will graze some plant species and parts over others unless forage demand exceeds supply.

Almost all of the grassland and open forest in British Columbia is grazed by one or more large ungulates at some time of the year. Cattle graze all but the most inaccessible areas supporting steppe vegetation during their annual grazing cycle. This grazing often overlaps with elk, deer and bighorn sheep use of the same areas for fall, winter and spring range. Proper use of the forage resource can sustain grasslands in a steady state, often referred to as a 'zootic climax,'[27] whereas long-term overuse by domestic or native ungulates usually results in changes in species composition and other physical effects to the environment.[46]

Photo: B. Wikeem

Cattle grazing in ponderosa pine savannah.

Large grazing animals affect individual plants physically and by selective grazing. Physical damage can occur when herbivores uproot uneaten plants, remove bark through rubbing, cover vegetation with dung, and trample plants while walking, rolling, or bedding. These effects often relate to behavior and social patterns that restrict distribution or concentrate animals in certain areas such as herding, distance animals will travel from water, and the need for other habitat components such as cover and escape terrain.[27, 46]

Four grazing factors control the rate and kind of changes induced in plant communities by grazing animals: selective grazing, intensity of grazing, frequency of grazing, and season of use.[46] These factors occur simultaneously, and cannot be separated from one another.[1,46]

Selective grazing refers to the choices grazing animals make in acquiring food from the assortment of grasses, forbs and shrubs that are available to them.[46] Animal food habits vary dramatically from those that choose few plant species and parts to those that select a wide range of forages (i.e., they have cosmopolitan food habits). The Monarch Butterfly serves as an example of an herbivore in British Columbia with a narrow diet as it forages almost exclusively on milkweeds and dogbane.[86] In contrast, cattle, elk, deer, and bighorn sheep have cosmopolitan food habits, and use almost all grassland plant species for forage at some time of the year.[118,119,125,126]

Most plant species provide a diversity of foraging opportunities for different animals throughout their growth cycle. Prairie rose, for example, is a common shrub in grasslands and savannah. In the East Kootenay Trench, leaves and stems are used in spring, summer and fall by Mule Deer, White-tailed Deer and Rocky Mountain Elk, while stems are available for winter browsing.[92] Porcupines and Beavers also forage on the leaves in summer,[43] and birds, small mammals, and ungulates eat rose hips during winter when other food sources are covered with snow.[121] These variations in use contribute to the total grazing effect on individual plants as they are defoliated by some herbivores, and their seeds are consumed or redistributed by other animal species.

Intensity of defoliation is "the degree to which herbage has been removed" and is sometimes expressed as 'utilization' or 'use.' [46] All plants tolerate defoliation to some critical threshold, but beyond this limit, physiological processes are impaired. Although the amount of foliage removed is a significant factor, the timing and frequency of use are also important variables that determine grazing impacts.[46]

Photo: B. Wikeem

Bluebunch wheatgrass moderately grazed by California Bighorn Sheep.

The most immediate effect of grazing and browsing during the growing season is defoliation of leaves, stems and buds, which initially alters the plant's growth form. Such defoliation may also impair the plant's ability to grow, and reduce its capacity to manufacture and store carbohydrates.[27,46] In turn, a plant's susceptibility to defoliation depends on a number of factors including the position of the apical buds and meristematic tissue on the plant.

Ungulate browsing on saskatoon shrubs removes annual growth of leaf and wood but new leaves and shoots develop from the remaining stems in spring.

Photo: B. Wikeem

Apical buds on grasses arise near or below the soil surface, and once they have been removed, there is little opportunity for regrowth. Most forbs and shrubs produce meristematic tissue on the tips of current annual growth of leaves and stems.[48] Generally, growth stops when meristematic tissue is removed from grasses and forbs. Most shrubs, however, can produce new shoots from buds on previous year's wood, even when the current annual growth has been heavily cropped.[48] Browsing on apical buds of shrubs often removes apical dominance, and stimulates lateral branching if defoliation occurs early in the growing season. Several important browse species in British Columbia, such as antelope-brush, saskatoon, red osier dogwood, and Douglas maple can re-sprouting following early-season defoliation.[121]

Frequency of grazing refers to the number of times individual plants are defoliated over a period of time. The interval between successive grazing events is of great importance to plants because it determines the length of time they have to grow new foliage, photosynthesize and store carbohydrates. When plants are defoliated too frequently, they must rely on root reserves to complete their life cycle, which can deplete stored carbohydrates for winter carryover.[48]

Season of defoliation can have significant effects on carbohydrate deposition for many grasses, forbs and some shrubs. In addition, some species may be vulnerable to defoliation in more than one season. In British Columbia, rough fescue and bluebunch wheatgrass grow most actively in early spring, but occasionally they produce significant regrowth in the fall.[87,101,117] Excessive defoliation during these periods, especially during spring, can result in dramatic decreases in growth for both species.[64,65] Repeated high intensity defoliations during the active growing period can reduce plant vigor, and eventually, mature plants will die.[65,80]

Photo: B. Wikeem

Long-term overuse of grasslands by domestic or wild ungulates can result in changes in species composition.

Plant species are often classified as increasers, decreasers, or invaders with respect to their response to grazing. The terms increaser and decreaser, however, do not portray intractable characteristics of plant species, but rather, possible outcomes of complex interactions between herbivores and plants. The total grazing effect is an integration of intensity, frequency, season of use, and the kind of grazing animal combined with site and climate factors that vary in time and space.

Virtually all plant species can be classified as increasers, decreasers or invaders,[80] depending upon the mix of biotic and abiotic factors that affect their growth and reproduction. For example, bluebunch wheatgrass can be considered a decreaser on lower grassland sites where repeated spring grazing by cattle defoliates plants beyond their capacity for recovery.[63] This same species could also be regarded an increaser on similar habitats that are grazed by California bighorn sheep in winter when plants are dormant and defoliation has no physiological impact.[118]

Until physical and biological thresholds have been exceeded, grazing has relatively little effect on plant species, or may even stimulate growth.[50,64,65] Under these circumstances, grazing may result in plant communities remaining in a steady state or moving towards a later seral stage. Once thresholds have been exceeded though, numerous changes can occur including:

- reduction of foliage cover;
- reduction of storage of plant foods;
- reduction in root growth and production;
- reduction in forage production;
- reduction in plant regrowth;
- reduction of litter and mulch;
- reduction in plant vigor;
- changes in plant phenology;
- changes in nutritional value of forages;
- impaired reproduction and seedling survival;
- changes in plant growth form;
- reduced longevity and higher mortality of plants; and
- changes in floristic composition.[1]

2.6 Other Disturbances and Alien Plants

2.6.1 Other Disturbances

Disturbance, in an ecological context, refers to the introduction of conditions into a natural community that prevent or disrupt the stability of the ecosystem.[18,57] Temporary or permanent changes occur when the rate or magnitude of disturbance exceeds the ’normal’ variations that are typical of the ecosystem in its ‘stable’ condition or ‘steady state.’[18,45] Outside the bounds of normal variation, communities of organisms change together to adjust to the new conditions imposed on them by disturbances.[45]

The consequences of disturbance are not always easily defined, and range from little, if any, to catastrophic impacts depending upon the magnitude of the disturbing factor(s).

Intermediate levels of disturbance often create conditions that support greater plant and animal species diversity than climax or early-seral stages do, and at a landscape level, offer opportunities for a broader range of organisms than might exist otherwise.[57]

Change is an ongoing ecological phenomenon that occurs daily, seasonally, and annually.[18,45,46] A host of factors can operate either independently or simultaneously to cause disturbances to grasslands.[49] Disturbance factors include such things as short- and long-term climate fluctuations, fire, grazing by native ungulates, grasshopper outbreaks, recreational activities, forest encroachment, farming, and livestock grazing. More recently, road construction, subdivision and other urban development, and rock quarries have caused disturbances to grassland ecosystems.[49] Although livestock grazing has had a pervasive effect on grasslands in British Columbia, the introduction of non-native plants will likely be the greatest threat to these ecosystems in the future.

2.6.2 Alien Plants

Alien or non-native plants are widespread in steppe, shrub-steppe and savannah communities in British Columbia. Not all introduced plants, however, are a threat to native plant communities. Those that do threaten grasslands are typically well-adapted to dryland conditions, persistent and able to disperse readily. Generally, regions with the longest histories of European settlement and the largest human population densities tend to have the largest weed populations. While the specific effects of non-native plants on B.C. grasslands are not documented, weed infestations could result in:

Photo: B. Wikeem

Dalmatian toadflax forms dense stands on grassland slopes along the Yalakom River near Lillooet.

- losses of biological diversity in native plant communities;
- the prevention of seral communities advancing to higher successional stages; and
- reductions in the ability of grasslands to support insects, birds and small mammals by changing habitat structure and function.

Almost 20% (553 species) of the vascular plant species in British Columbia are listed as non-native, and many of these species are associated with grasslands and dry forests.[28] Forty-nine alien species that are regarded as threats to agricultural production or potential factors in environmental degradation are designated as noxious weeds by the Weed Control Act of British Columbia.[15] About 30 of these species are adapted to grassland or associated habitats. Of these, spotted and diffuse knapweed are the most widespread, occupying over 40,000 ha of grassland and savannah in the province.[70]

Common hound's-tongue, Dalmatian toadflax, leafy spurge, and sulphur cinquefoil also present serious environmental threats, but they are relatively more localized in distribution and presently occupy significantly smaller areas. Numerous other non-native grassland species such as cheatgrass, common dandelion, Russian thistle, common mullein, silvery cinquefoil, and Scotch broom are not listed as noxious weeds list in British Columbia.[15]

Several agricultural plant species are intentionally seeded on heavily disturbed sites in grassland environments to stabilize soils, prevent noxious weed invasion and provide forage for livestock and wildlife. While these species serve valuable purposes, some have become well established and are now a naturalized part of the grassland flora. Some common domestic plants that are used to seed grassland sites in British Columbia include crested wheatgrass, smooth brome, red fescue, alfalfa, and clovers.

2.6.2.1 East Kootenay Trench

Diffuse and spotted knapweed are common on early-seral grasslands in the Ponderosa Pine and Interior Douglas-fir zones of the East Kootenay Trench. These species have also invaded shrub-steppe communities on steep slopes in the eastern part of the region from Wadner to Elko. Diffuse and spotted knapweed often occupy sites with disturbed soils and a low cover of vascular plants, but they are also found on islands and disturbed shorelines adjacent to grasslands along the St. Mary's and Kootenay rivers.

Photo: B. Wikeem

The yellow flowers are St. John's-wort and sulfur cinquefoil mixed with native plants on Sheep Mountain near Elko.

Common hound's-tongue is widely distributed throughout the Trench, especially south and east of Cranbrook. Generally, this species occupies moist habitats in high elevation grasslands, but it is also commonly found in shrub-steppe, open coniferous forests, aspen copses, and forest edges. *Mogulones cruciger*, a weevil of Eurasian origin, has successfully controlled this weed in many locations in the Trench.[123]

Other exotic species including St. John's-wort, silvery cinquefoil, sulphur cinquefoil, cheatgrass, butter-and-eggs, common mullein, and common dandelion are widespread in the region. St. John's-wort is particularly conspicuous in the southern part of the region from Baynes Lake to the Tobacco Plains. Even though biocontrol agents are available for St. John's-wort control,[84] this species is still abundant in the area, and forms mixed stands with silvery cinquefoil and sulphur cinquefoil.

Silvery cinquefoil and sulphur cinquefoil are widespread in the southern part of the Trench in open grassland, shrub-steppe and savannah. These species frequently colonize disturbed sites, but are often associated with late-seral species such as rough fescue, Idaho fescue and bluebunch wheatgrass. Sulphur cinquefoil is listed as regionally noxious in the East Kootenay Trench,[15] but silvery cinquefoil has no provincial or regional status.

2.6.2.2 Okanagan

Noxious weeds are prevalent on grasslands in the Okanagan, Similkameen and Kettle valleys except for those at high-elevations in the Ashnola drainage. Diffuse knapweed, spotted knapweed and hound's tongue are of particular concern, but Dalmatian toadflax, common toadflax, sulphur cinquefoil, leafy spurge, and nodding thistle are also common.[122]

Grasslands in the Okanagan region have the highest diversity of noxious weeds and non-native plants in the province, and a long history of presence in the region. For example, diffuse knapweed was collected as early as 1936 near Oyama but was known in Okanogon County, Washington State before 1900.[70] Common hound's-tongue was found near Keremeos in 1922.[110]

Photo: B. Wikeem

Diffuse knapweed in the Similkameen Valley forms dense and persistent stands.

Diffuse knapweed and Dalmatian toadflax are widespread on low-elevation grasslands in the Bunchgrass and Ponderosa Pine zones. Common hound's-tongue occupies moister habitats on high-elevation grasslands and open forests in the Interior Douglas-fir zone in the Kettle Valley, Similkameen, and north Okanagan.[74] Rush skeletonweed is a relatively recent immigrant to British Columbia. This species reproduces from its extensive root system and is a prolific seed producer, but its distribution is presently limited to the north Okanagan Basin, Slocan Valley, and West Kootenay.[82]

Several non-native species and noxious weeds are also found in wetlands within the grassland environment. Eurasian water-milfoil and purple loosestrife mostly are restricted to fresh water lakes and rivers. While milfoil is pervasive in the southern interior, purple loosestrife is relatively confined to the Okanagan River drainage from Penticton to Osoyoos, and in patches in the Kettle Valley.[74] Until recently, the distribution of puncture vine was confined to the shores of Osoyoos Lake, but isolated plants have been found along the Okanagan River near Oliver.[74]

Cheatgrass is common and often dominates heavily disturbed sites in the Southern Okanagan Basin, and in the Kettle and Similkameen valleys. Other widespread non-native and noxious species in the region include soft chess, Japanese brome, green foxtail, night-flowering catchfly, Russian thistle, summer-cypress, and black medic.[15,74]

2.6.2.3 Thompson-Pavilion

Diffuse knapweed, spotted knapweed and Dalmatian toadflax are the most prevalent noxious weeds on grasslands throughout the Thompson Basin. Diffuse knapweed and Dalmatian toadflax usually inhabit low- to mid-elevations. Spotted knapweed is more widespread in the Upper Grasslands, savannah and forest openings in the Ponderosa Pine, Douglas-fir and Montane Spruce zones.[74] Local populations of all these species can be found from the driest to wettest conditions in the region.


Photo: B. Wikeem

Diffuse knapweed is a biennial plant that flowers in its second year of growth.

Diffuse knapweed is a biennial plant that reproduces by seed,[74] and may have been present at Pritchard as early as 1918.[70] It often forms dense, persistent stands especially near Pritchard, Kamloops and along the Deadman River north of Savona. Dalmatian toadflax occupies similar habitats as diffuse knapweed, and is widely distributed through the Thompson River Valley. Plants are often more widely spaced in Dalmatian toadflax infestations than in diffuse knapweed stands, but this species has a more pervasive distribution across the landscape.

Spotted knapweed is a perennial plant that occupies relatively moist grasslands in the Interior Douglas-fir zone, but large infestations are found from Walhachin to Ashcroft in some of the driest grasslands in the province.[74] Russian knapweed, common hound's-tongue, and sulphur cinquefoil are also present on relatively moist sites.[122] Historically, Russian knapweed, a close ally of diffuse and spotted knapweed, was common in cultivated fields, orchards, pastures, roadsides, and riparian areas. More recently, this species appears to be moving into moister environments in the Middle and Upper Grasslands. Scattered populations of leafy spurge occur along the Thompson Valley, but the highest concentrations occupy grassland, ponderosa pine, and Douglas-fir savannah east of Kamloops.

Wetlands within grasslands at all elevations are occasionally infested with perennial sowthistle and Canada thistle. Other introduced species such as alfalfa, clovers, quackgrass, redtop, and smooth brome frequently establish in transition zones and uplands adjacent to wetlands. Purple loosestrife was recently found on one site near Kamloops.

2.6.2.4 Southern Thompson Upland

Compared to other grassland areas of the province, the Southern Thompson Upland is relatively weed-free. Diffuse knapweed and spotted knapweed are found in the Nicola Valley, and west of Merritt along Highway 8 to Spences Bridge. Other species such as blueweed, Russian thistle, Russian knapweed, Dalmatian toadflax, and common hound's-tongue can be locally abundant but are not widespread.[74]

Dalmatian toadflax is widespread on southern interior grasslands, but occurs relatively infrequently in the Nicola Valley.

Photo: B. Wikeem

Perennial sow-thistle and Canada thistle are present in some wetlands and mesic habitats on the Hamilton Commonage and at Tunkwa Lake. Agricultural species such as alfalfa, clovers, quackgrass, redtop, and smooth brome frequently become established in transition zones between uplands and wetlands, and in aspen copses. Cheatgrass, which once was widespread in the Nicola Valley, can still be found on disturbed sites, but populations have decreased dramatically over the last 70 years.

2.6.2.5 Cariboo-Chilcotin and Central Interior

Noxious weeds are not as widespread throughout in the Cariboo-Chilcotin and Central Interior as in grassland areas farther south. Diffuse knapweed, spotted knapweed, common burdock, leafy spurge, hound's tongue, blueweed, and cocklebur, however, are all found in the Cariboo-Chilcotin and Central Interior. Diffuse and spotted knapweed are concentrated mostly in the southern part of the region south of 100 Mile House, although isolated patches have been found north to Williams Lake and west to the Chilcotin.[74,84]

Isolated pockets of leafy spurge occur in the Cariboo-Chilcotin, especially along Canoe Creek and the Fraser River near Gang Ranch, and as far north as the Nechako Basin.[82] *Apthona nigriscutis*, a biocontrol agent for leafy spurge, has controlled the largest population at Canoe Creek.

Although not listed as noxious,[15] meadow salsify and cheatgrass are widespread non-native plants on Cariboo-Chilcotin grasslands, particularly in the Interior Douglas-fir zone. Meadow salsify is particularly persistent on Becher's Prairie where it forms dense stands. Other non-native species such as orchard grass, red fescue, timothy, dandelion, and clovers are present in shrub-steppe, grassland, and moist grassland meadows.

Photo: B. Wikeem

Yellow salsify is widespread throughout the province but is especially common at Becher's Prairie in the Chilcotin.

2.6.2.6 Sub-Boreal Interior and Northern Boreal Mountains

The distribution and extent of noxious weeds and alien species inhabiting grasslands north of 52^{o} N latitude has not been surveyed in detail. More than 55 non-native species occur in the area formerly called the Prince Rupert Forest Region.[72] Most of these weeds appear to be concentrated in the farming areas from Vanderhoof to Prince Rupert, and south to Francois Lake.[72]

Twenty-six non-native species occupy steppe, shrub-steppe and savannah habitats in the region, but only 12 species are listed as noxious weeds[15,72] Individual plants and small patches of non-native species have been discovered up to the Yukon border, but population densities of most weeds in the region are low even though extensive suitable habitat exists.[72]

Eight species of knapweed are found in the southern part of the region but only three species are significant on grassland. Both diffuse and spotted knapweed have been present for about 25 years, but neither species has formed large populations in any habitat type.[72] Several patches of diffuse knapweed, each consisting of a few hundred plants, have established in the region, but two other populations near Francois Lake have perished. Isolated patches of diffuse knapweed at Kitwanga (55^{o} N latitude) may be a northern limit for this species.[70]

Spotted knapweed is a serious threat to the ecological integrity of B.C. grasslands.

Photo: B. Wikeem

Scattered patches of spotted knapweed are widely distributed from Terrace to Bednesti Lake near Vanderhoof.[72] An isolated population at Lone Pine Lake, 80 km north of Dease Lake, occurs above 58^{o} N latitude, which likely approaches the northern limit of this species in B.C. Other noxious weeds found in the region include Canada thistle, leafy spurge, Dalmatian toadflax, and perennial sow-thistle, but none of these species have formed persistent populations on grasslands.

2.6.2.7 Boreal and Taiga Plains

Alien plants were introduced into the Peace River region by at least the 1930s.[89] Reed canary grass, Canada bluegrass, alfalfa, white and yellow sweet-clover, and other clovers are likely agricultural escapes, although some may have been seeded intentionally to provide forage for animals. Other species such as green bristle grass, yellow chamomile and yellow salsify were likely garden escapes, or they arrived with agricultural products.[89]

Noxious weeds, including common toadflax, cleavers, oxeye daisy, perennial sow-thistle, and Canada thistle were present by the mid-1930s as well. Some of these species were originally confined to railway yards but have dispersed into grassland communities in the region.[89] Spotted knapweed was recorded 65 km north of Fort St. John on the Alaska highway (57^{o} N latitude),[70] but no persistent populations to occur on grasslands in the region.

Photo: B. Wikeem

Oxeye daisy, a pretty flower, but a serious weed in cool, moist environments.

2.6.2.8 Georgia Depression

Garry oak communities are extensively invaded by non-native species but their effects on plant communities are unknown.[59] Kentucky bluegrass, orchard grass and clovers likely appeared immediately following European colonization in the mid- to late-1800s.[59] Other exotic grasses such as common velvet-grass, barren brome, hedgehog dogtail, and sweet vernalgrass also are present in Garry oak communities along with dovefoot geranium, cleavers, common chickweed, sheep sorrel, and hairy cat's ear.[33] On some sites, these species comprise 40-75% of plant species composition, and over 80% of the ground cover.[31,60]

Persistent non-native shrubs that are common in Garry oak communities include Scotch broom, gorse, Himalayan blackberry, English ivy, cutleaf evergreen blackberry, and spurge-laurel.[31,114] Noxious weeds such as spotted knapweed, Canada thistle, cleavers, and Dalmatian toadflax also occasionally occupy these communities,[33] but their effects on Garry oak or other native species are unknown.

Photo: M. Fuchs

Scotch broom in the foreground is a widespread non-native plant in Garry oak communities.

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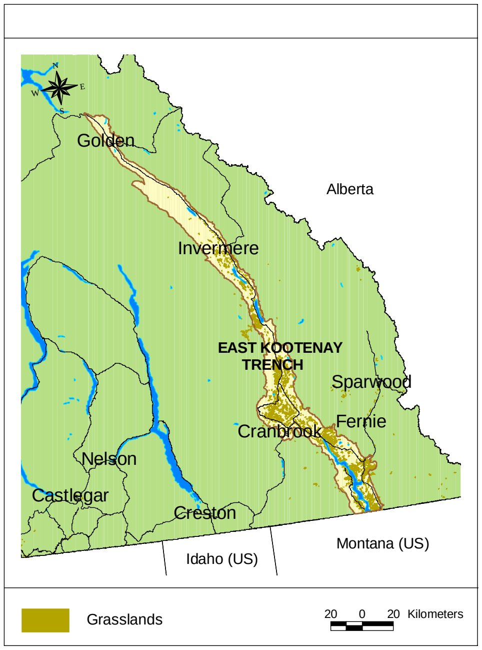
3. Grassland Ecosystems in British Columbia

3.1 East Kootenay Trench

Approximately 45,000 ha of grasslands occur in the Southern Interior Mountains Ecoprovince[10]. Most of these grasslands meander along the river breaks and occupy the benches above the Kootenay, St. Mary's and Columbia rivers in the East Kootenay Trench. The largest expanses of grassland are found on the valley floor extending from the Tobacco Plains at the Canada/United States (U.S.) border to approximately Radium Hot Springs north of Invermere.



Source: Grasslands Conservation Council of B.C.
Location of grasslands in the Southern Interior Mountains Ecoprovince.

In the southern part of the Trench, extensive grasslands follow the Elk, Bull and Wigwam rivers at their lowest elevations where they enter the Trench. Open grasslands become more prominent as the elevation drops from the ramparts of the Rocky and Purcell mountains to the shores of Lake Koocanusa.

As the Trench reaches its maximum width at the Canada/U.S. border, these grasslands become large openings intermingled with ponderosa pine savannah, and finally extend south into the greater expanse of rolling steppe in Montana. Large areas of historical grassland and shrub steppe were lost in this area when the Libby Dam was constructed

Photo: B. Wikeem
The Tobacco Plains looking towards Lake Koocanusa and south into Montana.

in 1972 creating Lake Koocanusa, which covers about 72,770 ha.[9]

Extensive tracts of open grassland and ponderosa pine savannah also extend north from Cranbrook to Skookumchuck Prairie. Joseph's Prairie, once of aboriginal importance as pasture for horses, is now the city of Cranbrook. St Mary's Prairie still remains one of the largest contiguous grasslands in the region extending north of the St. Mary's River to Skookumchuck Creek on the west side of the Kootenay River. Rural and urban development, however, are slowly eroding and fragmenting the original prairie.

Photo: B. Wikeem

Saint Mary's Prairie with the Steeple Range of the Rocky Mountains in the background.

North of Skookumchuck Prairie, small patches of grassland are often associated with steep, south-facing slopes and terraces along Columbia Lake and the Columbia River, and with the floors of tributary valleys to the Trench such as Findlay Creek. The grasslands along the steep, south-facing slopes of Sinclair Creek near Radium represent the most northerly sizable area of grassland in the Trench, although small patches occur north to Brisco.

Many of the grasslands in this region endure as openings because of periodic fire, especially those in the Interior Douglas-fir and Montane Spruce zones. Conifers are gradually reclaiming some of these grasslands, which were derived from forest and have persisted for over a century.

Grassland vegetation in the Trench can be divided into three broad associations: the lower elevation open grasslands, the slightly higher elevation shrub-steppe, and the open savannah dominated by either ponderosa pine or Douglas-fir.[4,7] Open grassland and savannah associated with ponderosa pine are dominated by rough fescue, Idaho fescue and bluebunch wheatgrass, whereas antelope-brush and bluebunch wheatgrass are more characteristic of Douglas-fir grasslands and savannah.

Physiography, Climate and Soils

The East Kootenay part of the Rocky Mountain Trench is a glaciated valley that extends from the United States border in the south to the Windermere Valley in the north. Ranging from three to 24 km wide, the Trench is bounded on the east by the Rocky Mountains, which ascend abruptly from the valley floor. To the west, the Purcell Mountains rise from rounded foothills that give way to rugged mountains.

All landscapes in the Rocky Mountain Trench were covered by ice during the last glacial period that ended about 11,000 BP. Wasting of the glacial ice created a temporary lake in the main valley that extended for about 130 km, and resulted in the formation of deep silt deposits over most of the area. Subsequent erosion and deposition of gravel, sand and silts moved by post-glacial rivers and streams further modified the landscape by creating terraces, scarps, erosion gullies, and channels. Eventually, these deposits produced large fans that extended across the valley and created Columbia Lake and Windermere Lake.

Photo: B. Wikeem

Landforms along the breaks and terraces of the Columbia River near Windermere.

The most striking topographic features in the Trench are the landforms associated with the Kootenay and the Columbia rivers. Both rivers come within a few kilometers of each other at Canal Flats at 820 m elevation. From here, the Kootenay River flows south and crosses the 49th parallel at 700 m elevation.[19]

The Columbia River flows north from Canal Flats, and at Windermere Lake, its elevation drops to 799 m, coinciding closely with the northern distribution of grasslands in the Trench. The channels of both rivers consist of a rolling till-plain, eroded knolls, ridges, river and stream valleys, and deep canyons. Elevation across the width of the Trench ranges from 790 to 1130 m, and varies depending on latitude.

The climate of the Rocky Mountain Trench is semi-arid.[19] Winter weather is strongly influenced by continental arctic air masses with January lows occasionally dipping below – 40^{o}C (Table A 5.1). In summer, hot, dry air from the Great Basin penetrates the Trench, and August temperatures sometimes exceed 35^{o}C.[2] Much higher temperatures often occur on the soil surface of the valley floor, which severely limits soil moisture availability for plant growth.

Moisture-laden Pacific air masses also influence weather patterns in the Rocky Mountain

Trench. These air masses approach from the west and deposit their moisture as they cross over the Columbia Mountains leaving the Trench in a rain shadow. Most precipitation falls as snow between November and January, and as rain in May and June. Annual precipitation in the Windermere Valley, the driest part of the Trench, averages less than 280 mm, while total precipitation ranges from about 355 mm in Cranbrook to 390 mm near Radium.[2]

Most soils in the region originated from glacial deposits derived from sedimentary limestones and dolomites. As a result, the parent materials over large areas of the Trench contain high concentrations of calcium.[21,34] Orthic Dark Brown Chernozemic soils dominate the open grasslands from the Tobacco Plains to Invermere, but these soils often intergrade with Eutric Brunisols in areas where grassland and forest mix (Appendix 6). Black Chernozems, typical of higher elevation grasslands elsewhere in the province, are absent in the East Kootenay.[21]

Development of Grasslands

Grasslands in the region evolved and were modified by a number of interacting factors including climate, soils, fire, forest ingrowth, logging, land alienation and grazing by domestic livestock and wildlife.[33] Most of the Trench was drier than present during the early post-glacial period which began about 13,000 BP. Grasslands dominated the landscape as pioneering plants colonized openings in the post-glacial ice.

Pollen cores from Bluebird Lake southwest of Canal Flats indicate that sagebrush was an important part of the vegetation up to about 6600 BP.[17] Vegetation changed gradually from a pine-birch forest during the cool and moister period from 6600 to 3200 BP, to the present plant communities dominated by larch/Douglas-fir/lodgepole 'parkland' mixed with grassland openings.

Historically, lightning-caused and aboriginal-set fires were common in ponderosa pine and Douglas-fir forests,

Photo: B.C. Archives

Ktunaxa peoples likely had horses by the early 1700s.

which maintained a mosaic of grassland, open forest and dense forest in the Trench. The Ktunaxa peoples (Kootenae) likely had horses by the early- to mid-1700s, and used fire to maintain grassland and savannah communities for horse pasture.[27] David Thompson's journal entry for July 25, 1807 confirmed aboriginal burning in the Trench when he recorded "The ground was set on fire by the Kootenaes 8 days ago below, & the fire now fast approaches us". At the time, he and his men were building Kootenae House near present day Windermere.[3]

Both the direct effects of logging, and the fires that followed, contributed to opening up large areas of successional grassland and shrub-steppe vegetation throughout the southern part of the Trench. Numerous large fires occurred between 1914 and 1931 as the litter of limbs, treetops and broadaxe chips dried and became extremely flammable. The last major fire in 1931 burned about 81,000 ha of forestland alone.[6] Fire-suppression, which began in the Trench during the 1920s, has resulted in forest ingrowth, and large areas of derived grassland, shrub-steppe, and open forest have been reclaimed by dense forest over the last 50 years.[28]

Grazing by wildlife, domestic livestock, and aboriginal horses have all been factors influencing East Kootenay grasslands from the earliest recorded times. Peter Fidler, Hudson Bay Company surveyor, met Kootenae Indians in the Alberta foothills in 1792 who were trading horses with the Peigan Indians.[23] The size of horse populations in the Trench from 1800 to 1900 is not known, but by the 1880s, the natives at Joseph's Prairie had nearly 2000 horses and 500 head of cattle, and natives on both sides of the International Boundary Line were pasturing 5000 horses on the Tobacco Plains.

Photo: B.C. Archives

North West Mounted Police on prairie at present day Fort Steele ca. 1888.

Large numbers of sheep, cattle, and domestic horses were brought into the Trench during the gold mining boom between 1865 and 1867. More horses and cattle were moved into the East Kootenay between 1897 and 1915 during construction of the Canadian Pacific Railroad through the Crows Nest Pass. Feral horses also had significant impacts on some East Kootenay grasslands, and by 1925, grasslands around Columbia Lake were severely overused.[8] Hundreds of these horses ran wild on grasslands in the Trench from the late 1940s until the 1960s when they were brought under control by the Forest Service.[15]

Heavy grazing by domestic livestock and wildlife appears to have been widespread in the Trench up to the 1950s. A series of wildlife, soil, and range surveys conducted between 1953 and 1956 concluded that grasslands in the Trench were overgrazed.[1,9,19]

From the 1960s to 1990s, cattle populations declined from historical highs in the 1950s and 1960s, but elk and deer populations have increased dramatically. Range condition on most grassland has continued to deteriorate, or has remained at an early seral stage. Also, forest encroachment, which continues without intervention, has reduced the forage resource for both livestock and wildlife, and concentrated animals on the smaller remaining areas.[33]

3.1.1 Representative Grassland Associations

Most of the grasslands in the East Kootenay Trench originated from shrub-steppe communities south of the glacial boundary in Washington, Idaho and Montana. Although grasslands are distributed among eight biogeoclimatic zones in the region, none of the grasslands in the Southern Interior Mountains Ecoprovince are classified as part of the Bunchgrass zone.[4] Indeed, the lowest elevation grasslands in the Rocky Mountain Trench (700 m) begin at nearly 400 m elevation above those in the Southern Okanagan Basin at Osoyoos Lake (330 m). Almost 90% of the grassland area in the Trench occurs in the Ponderosa Pine and Interior Douglas-fir zones (Table A 8.1), with small pockets distributed among the Montane Spruce, Engelmann Spruce-Subalpine Fir and Alpine Tundra zones.

Following a series of range surveys in 1971, Demarchi [9] concluded, “the history of forest fires in the East Kootenay suggested that …the entire Rocky Mountain Trench is in some state of succession, and very few climatic climax forests exist”. In addition, he claimed it was difficult to recognize or reconstruct seral-shrub and grassland communities because of the confounding effects of fire, domestic livestock grazing and wildlife grazing.[9]

3.1.1.1 Kootenay Dry Hot Ponderosa Pine Variant (PPdh2)

Grasslands and savannahs in this variant occupy nearly 16,000 ha in the East Kootenay Trench (Table A 8.1) at elevations ranging from 700 to 950 m. These communities mainly occupy the valley floor between the St. Mary’s River and Skookumchuck Creek, and between the Tobacco Plains and Baynes Lake.[4] Ponderosa pine is the dominant tree species from Montana to Canal Flats, but it becomes infrequent farther north where it is often mixed with Douglas-fir. Early accounts of the grasslands in this variant speculated that the original vegetation resembled the *Agropyron– Festuca* association, or the Upper Grasslands described in the Thompson Basin.[19,30,32]

Under climax conditions, the understory of open Douglas-fir and ponderosa pine forests contain a mix of rough fescue, Idaho fescue, bluebunch wheatgrass, Sandberg's bluegrass, junegrass, and Columbia needlegrass. Silky lupine, timber milk-vetch, round-leaved alumroot, and meadow death-camas are common forbs. Shrubs generally occur infrequently.[15,19]

Photo: B. Wikeem

Ponderosa pine savannah with a rough fescue and juniper understory near Wasa.

Two site series phases have been classified in this variant. Savannahs are dominated by widely spaced Douglas-fir and ponderosa pine with bluebunch wheatgrass, junegrass and prairie sagewort as an understory. Grasslands contain less Douglas-fir and support additional species such as prairie rose, yarrow, rosy pussytoes, narrow-leaved desert-parsley, and prairie sagewort.

Under heavy grazing, rough fescue, Idaho fescue and bluebunch wheatgrass appear to decline while Sandberg's bluegrass, Columbia needlegrass, needle-and-thread grass, dwarf pussytoes, and yellow fleabane increase. Specific seral stages that result from grazing have not been defined for this variant. Information collected an exclosure at Skookumchuck Prairie over the last 50 years suggests that bluebunch wheatgrass likely increases initially with grazing pressure, and then declines. Ten years after the exclosure was constructed, bluebunch wheatgrass and rough fescue were more abundant inside the exclosure than on an adjacent area grazed by cattle, elk, mule deer, and white-tailed deer.[26, 28] Bluebunch wheatgrass was largely replaced by rough fescue and Idaho fescue after 30 years of complete protection, and Idaho fescue appears to be replacing rough fescue after 50 years.[28] This suggests that Idaho fescue may be the dominant bunchgrass eventually, which often occurs in ponderosa pine understory communities.

3.1.1.2 Interior Douglas-fir Undifferentiated (IDFunn)

Approximately 3750 ha of grasslands are located in the Interior Douglas-fir zone between Invermere and Canal Flats. These grasslands have been classified as 'Undifferentiated,'[4] although ecological classification is still ongoing. Very little is known about the native plant communities in these diverse grasslands because most of the area has been severely overgrazed by horses, cattle, elk, mule deer, and bighorn sheep.[8,9] In addition, some of the area was farmed as early as 1882, especially along the benches of Columbia Lake.

Photo: B. Wikeem

Small areas of grasslands north of Radium still contain arrowleaf balsamroot and Idaho fescue.

At climax, grasslands along Columbia Lake were likely dominated by rough fescue, Idaho fescue and bluebunch wheatgrass under a sparse canopy of Douglas-fir. Associated shrubs included common rabbit-brush, Rocky Mountain juniper, common juniper, saskatoon, mixed with junegrass, Columbia needlegrass, needle-and-thread grass, pinegrass, thread-leaved fleabane, yarrow, and prairie sagewort.[8]

3.1.1.3 Kootenay Dry Mild Interior Douglas-fir (IDFdm2)

Mature or seral Douglas-fir forest often surrounds the Ponderosa Pine zone in the East Kootenay Trench. Open parkland, and about 23,500 ha of grassland occur only on the driest sites at elevations ranging from 800 m in the valley bottoms to 1200 m on the lower slopes of the Rocky Mountains (Table A 8.1). Parklands and grasslands are usually located from crest to mid-slope positions on warm aspects where Douglas-fir and ponderosa pine cover is less than 15%. Eutric Brunisols, rich in calcium, are usually the dominant soil type.

Photo: B. Wikeem

Grasslands mixed with Douglas-fir groves near Sheep Mountain south of Elko.

Shrub-steppe and open Douglas-fir savannah have been classified as the Antelope-brush – Bluebunch Wheatgrass community.[4] This community closely resembles the Ponderosa pine – Antelope-brush association found on coarse sands and gravels in the south Okanagan Valley.[5] Antelope-brush is the most common shrub, but chokecherry, saskatoon, mock-orange, wild rose, common snowberry, and western snowberry are also present. North of Canal Flats, Rocky Mountain juniper frequently occupies park-like stands of Douglas-fir.[25] Bluebunch wheatgrass often dominates climax grasslands along with rough and Idaho fescue, while junegrass, hairy golden-aster, Holboell's rockcress, yarrow, brown-eyed Susan, timber milk-vetch, lemonweed, and kinnikinnick are common associates.

Small areas of grassland occasionally occur in Douglas-fir – Snowberry – Balsamroot communities where Douglas-fir and ponderosa pine cover is less than 20%. These communities are most common on warm aspects at mid-slope positions with calcareous soils.[4] Common juniper, saskatoon, soopolallie, kinnikinnick, and common snowberry are principal shrubs in this type but antelope-brush is absent. Bluebunch wheatgrass is the dominant herbaceous species in association with arrowleaf balsamroot, pinegrass and junegrass.

Extensive fires, logging and grazing by livestock and wild ungulates have created significant disturbance in this variant.[8] Under heavy grazing pressure, rough fescue, Idaho fescue, and bluebunch wheatgrass decrease while Sandberg's bluegrass, needle-and-thread grass, junegrass, and Nuttall's pussytoes increase.[26] Antelope-brush, which is not preferred by most ungulates and resprouts after fire, appears to increase on most sites that are heavily grazed or burned.[33] Other species such as cheatgrass, common dandelion, diffuse and spotted knapweed, and common hound's-tongue invade highly disturbed sites.

The last known contiguous patch of grassland associated with the East Kootenay Trench occurs along Highway 1 about three kilometers east of Golden. Approximately 20 to 30 ha of grassland extend over about one kilometer of steep, south-facing slope above the Kicking Horse River. These grasslands occur in the Dry Mild Interior Douglas-fir zone, and likely represent the northern extent of steppe vegetation in the Trench, and the eastern limit of grassland in the southern interior.

Photo: B. Wikeem

Douglas-fir grasslands just east of Golden mark the northern extent of steppe vegetation in the Trench.

Species diversity of these grasslands is low. Bluebunch wheatgrass is the dominant grass mixed occasionally with pinegrass along forest ecotones and in swales. Other typical steppe grasses, such as rough fescue, Idaho fescue, junegrass, needle-and thread, and Sandberg's bluegrass, are infrequent or absent. The shrub layer consists of widely spaced Rocky Mountain juniper, saskatoon, common snowberry, and spreading dogbane. All of these species are most common in swales and along the forest edge. Tarragon is widespread while other species, such as nine-leaved desert-parsley, lemonweed, Holbell's rockcress and timber milk-vetch, are present but infrequent. Dandelion, a non-native species, is common on the lower slopes where Rocky Mountain Bighorn Sheep appear to graze most heavily.

3.1.1.4 Cool Dry Montane Spruce Subzone (MSdk)

About 2100 ha of shrub-steppe and open parkland are scattered over the drier parts of the Montane Spruce zone from 1200 to 1650 m elevation.[8] Most of these grasslands occur on the steep south- and east-facing slopes of the Galeton Ranges from the U.S. border to Elk River. Small areas of grassland are also found near Gold Creek in the McGillvary Range, and at Premier Ridge east of Skookumchuck Prairie.

Photo: B. Wikeem

Background: Grasslands on steep slopes of the Galeton Range near Grasmere. Foreground: Open grasslands on the Tobacco Plains.

In the northern part of the Trench, pockets of grasslands and open forests occur along the west slope of the Stanford Ranges in the Rocky Mountains from Invermere to the south end of Columbia Lake. South- and east-facing aspects support open Saskatoon – Bluebunch wheatgrass communities or savannah with less than 10% cover of Douglas-fir.[20] Saskatoon and common snowberry are often the dominant shrubs, while Douglas maple may be present, especially in moist draws. Bluebunch wheatgrass dominates the herb layer, and round-leaved alumroot can also be present.[4] No information is available on ecological conditions and seral stages in this variant.

3.1.1.5 Grasslands in Other Biogeoclimatic Units

About 1500 ha of the grasslands in the Southern Interior Mountains Ecoprovince are scattered in small patches over five biogeoclimatic zones, from Douglas-fir grasslands in the valley bottom to alpine meadows (Table A 8.1). Small areas of subalpine and alpine grassland occur in the Southern Park Ranges north of the Elk River where globeflowers, paintbrushes, arnicas, bunchberry, and yellow columbines are common species. At higher elevations, glacier lilies, mountain forget-me-nots and western pasqueflower reflect the cooler, moister conditions found in alpine meadows.

3.1.2 Distinguishing Flora and Plant Species at Risk

Antelope-brush is widespread on the floodplain of the Kootenay River and river terraces at lower elevations in the Ponderosa Pine and Interior Douglas-fir zones. Small patches also occur in the Montane Spruce zone. This species occupies dry sites from the Tobacco Plains to about 15 km south of Canal Flats.[19] Bluebunch wheatgrass, rough fescue, Idaho fescue, mock-orange, and bitterroot are present in the southern part of the Trench, but rough fescue and Idaho fescue extend north to Invermere.[19] Silky lupine also occurs in the southern part of the Trench, but is not found north of St. Mary's Prairie. Brittle prickly-pear cactus has a limited distribution, and is found only on a few sites in the Interior Douglas-fir zone near Invermere and on Premier Ridge. All of these species are commonly found in the Okanagan, Similkameen and Kettle valleys to the west.

Several species that are common to B.C. grasslands south of 52^{o} N latitude are missing or uncommon in the East Kootenay Trench. Big sagebrush is essentially absent, although an exclosure was constructed near Invermere in 1997 to protect the only large patch of this species in the Trench. Individual specimens have also been collected near the U.S. border.[13, 14, 29] Other species, such as common rabbit-brush and arrowleaf balsamroot, are uncommon, and usually found on dry, hot southern exposures.[18]

Nearly 70 rare grassland vascular plants and plant communities are found in this region including 33 broad-leaf herbs and seven monocots that are either red- or blue-listed (Table A 10.1; Appendix 11). Some species, such as yellow buckwheat, androsace buckwheat, elk thistle, elk sedge, fuzzy-tongued penstemon, little bluestem, prairie sandgrass, Spalding's campion, and three-spot mariposa lily, are unique to the region. Other species, such as annual paintbrush, tufted phlox, thin-leaved owl-clover, and viviparous fescue have very limited distributions elsewhere

Photo: B. Wikeem

Yellow buckwheat in full flower on Tobacco Plains.

in the province (Appendix 12).

Yellow buckwheat and three-spotted mariposa lily occur in Montana and Idaho, but appear to be at their northern distribution in the southern part of the Trench. Similarly, thin-leaved owl-clover is found in Idaho, Montana and Oregon, but is uncommon in the southern part of the Trench, and absent on the prairies east of Rockies.[11,22] Other species, such as prairie crocus, prairie coneflower, scarlet gaura, scarlet globe-mallow, blue grama, prairie sandgrass, and little bluestem, likely immigrated from the foothills east of the Rocky Mountains through ice-free corridors. Prairie coneflower, predominantly a Great Plains species, reaches its northern and western distribution in southeastern British Columbia, although plants have been found in the south Okanagan.[11]

Short-awned porcupine-grass is another Great Plains species that is common in moist prairies, parklands and Rocky Mountains in Alberta.[22] Distribution of this species in B.C. is limited to the Peace River region and East Kootenay Trench[12] where it is found along east- and west-facing slopes on the breaks of the Kootenay River from Lake Koocanusa to Invermere.

3.1.3 Grassland Associated Ecosystems

Most of the grasslands in the East Kootenay Trench are small and often discontinuous, occupying specialized habitats such as river breaks, gravelly terraces or steep, and south-slopes within extensive forest ecosystems. In the Ponderosa Pine zone, grassland openings on the river breaks sometimes coincide with cottonwood forests on active floodplains such as along the Kootenay River and Lake Koocanusa. The cottonwood communities exist on unstable, medium-textured soils with high water tables. Species composition is variable, but often a canopy of black cottonwood and hybrid white spruce

Photo: B. Wikeem

Cottonwood and willow communities on the Columbia River near Invermere.

overlies a dense shrub layer consisting of red-osier dogwood, Nootka rose, prickly rose, mountain alder, and western snowberry. Scouring rush and star-flowered false Solomon's-seal comprise the sparse herb layer.[4]

Extensive wetlands occur along the floodplains of the Kootenay and Columbia rivers, but most of the small wetlands that are associated with grasslands and shrub-steppe occur on the gentle terrain of the upland benches. Alkaline ponds and meadows form in poorly drained depressions with deep, fine-textured soils and fluctuating water tables.[20] Bands of plant communities that may include alkali saltgrass, foxtail barley, bulrushes, and rushes frequently surround the wetlands in concentric circles.[18] These ponds provide water for livestock and wildlife during the spring, and habitat for riparian plants, insects, amphibians, and birds. Some of the upland ponds are persistent, but others are ephemeral and often dry up during the summer, especially in the Ponderosa Pine zone. Alkali saltgrass and Nevada bluegrass grow on relatively dry areas with lime-rich soils on the Kootenay River floodplains.[19]

Photo: B. Wikeem

Alkaline pond on uplands above the Kootenay River.

Marshes occur from the valley bottoms up to the montane forests, and are the most common wetland type found in the grasslands. Bulrush marshes often occur in grassland potholes where soils are moderately alkaline. Plant species diversity in these systems is usually low. Soft-stemmed bulrush is the dominant species in potholes and protected lakes, while hard-stemmed bulrush grows in more exposed locations in the Interior Douglas-fir zone.

Common cattail marshes are less frequently found in the Trench than bulrush marshes. These wetlands occur in protected lakes, potholes and ditches containing water with low alkaline concentrations. Plant species diversity is low, and common cattail is often the only species present.[24]

Photo: B. Wikeem

Alkali flats above the Kootenay River north of Cranbrook.

Seral shrublands are most common in the Ponderosa Pine and Interior Douglas-fir zones.[8,9] Species composition of these complex ecosystems is influenced by many factors including topography, soil parent material, frequency and intensity of fire, logging practices, and by grazing and browsing from domestic livestock and wildlife.[9] Seral shrublands that were created by fire and often composed of choke cherry, redstem ceanothus, snowbush, and saskatoon. These shrublands occupy large areas of the landscape, and are commonly associated with grasslands in the Trench.

Antelope-brush dominates shrublands south of Canal Flats below 1150 m in elevation. Saskatoon, birch-leaved spirea, and snowberry are other common shrubs. Understory plants may include spreading needlegrass, Columbia needlegrass, Kentucky bluegrass, and bluebunch wheatgrass. Antelope-brush is replaced by chokecherry, rose and saskatoon on Wigwam Flats.[8]

In shrublands at higher elevations or north of 50^{o} N latitude, snowbrush, redstem ceanothus, and soopolallie are dominant species. On dry sites, the understory consists of bluebunch wheatgrass, kinnikinnick and junegrass, whereas Canada bluegrass, Kentucky bluegrass and pinegrass are common associates on moister sites.[9] These seral shrublands provide important winter range for Rocky Mountain Elk, White-tailed Deer and Mule Deer. They also provide some browse for Rocky Mountain Bighorn Sheep and Moose.[9]

Photo: B. Wikeem

Open stands of trembling aspen provide important habitat for ungulates, birds and small mammals.

Trembling aspen is common throughout the Rocky Mountain Trench, especially as a successional species following fire. Aspen copses are most frequently found in moist depressions and swales, and on the margins of wetlands in the grasslands, especially in the Interior Douglas-fir zone.

Pinegrass, yellow peavine and American vetch are common understory species on moist sites in the Interior Douglas-fir zone.[20] On dry, rocky sites in the southern part of the Trench, bluebunch wheatgrass, common snowberry and junegrass are common understory species, while Rocky Mountain fescue and birch-leaved spirea can become more frequent on the driest sites.[8] Grasslands associated with rocky knolls, ridges and cliffs usually occur on steep slopes with warm aspects. At Premier Ridge, rock outcrops are interspersed with small grasslands containing species such as bluebunch wheatgrass, junegrass, Idaho fescue, and arrowleaf balsamroot.[8]

3.1.4 Representative Fauna and Species At Risk

The East Kootenay Trench has a rich fauna owing to the complex association of grassland, shrub-steppe, open forest, and closed forest habitat types. This habitat richness is further enhanced by the extensive wetland and riparian ecosystems along the Kootenay and Columbia rivers that act as year-round and transitory habitat for a host of bird species. Many of these species also use adjacent grasslands for part of their life cycle. Compared to birds and mammals, amphibians and reptiles are relatively scarce in the East Kootenay Trench. The Long-toed Salamander, Western Toad, Western Garter Snake, and Common Garter Snake are common in wetlands associated with ponderosa pine and Douglas-fir grassland and savannah (Table A 13.1). No reptiles occur in the higher elevation grasslands of the Montane Spruce zone, but the Long-tailed Salamander and Western Toad inhabit adjacent wetlands communities (Table A 13.1). Despite the close proximity of shrub-steppe communities in Montana, the Western Rattlesnake, Gopher Snake, and Great Basin Spadefoot are all absent in the Trench, but the blue-listed Painted Turtle and Rrubber Boa are found in wetlands in ponderosa pine and Douglas-fir grasslands.

More than 70% of the bird species known in British Columbia, and over 60% of the breeding birds in the province are found in the Southern Interior Mountains Ecoprovince.[10] The Brewer's Blackbird, Black-billed Magpie, Bank Swallow, Common Nighthawk, Vesper Sparrow, and Western Meadowlark are representative species on open grasslands. Other less conspicuous species such as the blue-listed Bobolink and Lewis's Woodpecker use open grasslands and savannahs from the Ponderosa Pine to Montane Spruce zone. Grasslands in low- to mid-successional stages provide nesting habitat for the blue-listed Long-billed Curlew. Between 35 and 40 pairs of curlews nest on open grassland from Grasmere to Windermere with the greatest concentration occurring on Skookumchuck Prairie.[16] Small pockets of aspen forest within the grassland, and especially those with a well-developed shrub layer, provide important winter habitat for the Ruffed Grouse, and nesting habitat for a variety of songbirds.

Several species such as the Black-chinned Hummingbird (blue listed), Black-billed Cuckoo, Common Poorwill, and Western Bluebird are present in the Trench, but they have very limited distributions elsewhere in the province. The Trench is also the provincial breeding center for the White-breasted Nuthatch, which is commonly found in pine and fir savannah. Numerous raptors, including the Peregrine Falcon (red-listed), Turkey Vulture, Cooper's Hawk, American Kestrel, and Bald Eagle, hunt over grassland, shrub-steppe, savannah, and wetlands, but nest elsewhere. The Turkey Vulture, which feeds exclusively on carrion, has become a more frequent resident, and breeds at lower elevations in the southern part of the Trench.[16]

A variety of shorebirds, ducks, geese, and passerines use wetlands within the grasslands for nesting, foraging, and resting during migration. Typical resident species include the Killdeer, American Coot, Mallard, Canvasback, Cinnamon Teal, Red-winged Blackbird, and Marsh Wren. Ponds, marshes and small lakes within the grasslands are also important habitats for the red-listed American Avocet, Great Blue Heron, and American Bittern, while the red-listed Upland Sandpiper nests along the edges of these wetlands (Table A 13.1).

Most grassland birds spend spring and summer on the grasslands and migrate south in fall. Other species such as the Clark's Nutcracker, Bohemian Waxwing, Harris's Sparrow, Pine Siskin, Black-capped Chickadee, and nuthatches use open forests and adjacent grasslands in the autumn and winter for foraging and resting.

Some of the largest populations in the province of Rocky Mountain Elk, Mule Deer, White-tailed Deer, and Mountain Goat use grasslands in the Trench for foraging during part of the year. The blue-listed Rocky Mountain Bighorn Sheep is most dependent on grasslands in the East Kootenay for year-round forage, and nearby rugged cliffs and talus slopes for escape terrain and lambing.

Photo: B. Wikeem

Rocky Mountain Elk depend on grasslands for fall, winter and spring forage, and on adjacent forests for resting and thermal cover.

The mosaic of habitats in the Trench supports a wide variety of species dependent on a mix of deciduous and coniferous forest, and grassland. Grassland openings provide forage for Rocky Mountain Elk, Mule Deer and White-tailed Deer, while open forest furnishes food and thermal cover on winter ranges. Higher elevation grasslands in the Montane Spruce are important fall and early winter range for Rocky Mountain Elk, Mule Deer, and White-tailed Deer, Moose, and Rocky Mountain Bighorn Sheep, and can be important habitat for the blue-listed Grizzly Bear.

Mule deer, Rocky Mountain Bighorn Sheep and Mountain Goats use the ridges and alpine meadows in the Engelmann Spruce-Subalpine Fir and Alpine Tundra zones, but these habitats are not as important for moose and elk. Marmots are also found in subalpine and alpine meadows, and wolverines are sighted occasionally.

Small mammals such as the Meadow Jumping Mouse, Montane Vole, Long-Eared Myotis, Hoary Marmot, Columbian Ground Squirrel, Coyote, and Deer Mouse are all common grassland species, but the Badger and Ermine (subsp. *anguina*) are the only listed small mammals in the region (Table A13.1). The Gray Wolf is slowly reestablishing itself in its historical habitats.

Photo: B. Wikeem

The Columbian Ground Squirrel is a common small mammal on grassland and open forest.

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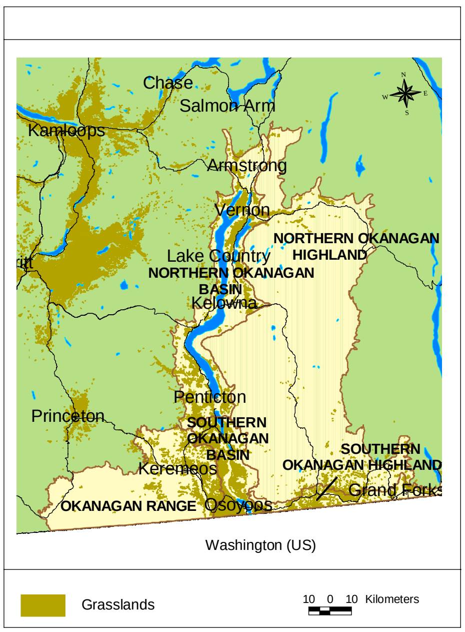
3.2 Okanagan

The Okanagan Region occupies the southern part of the Interior Plateau within the Southern Interior Ecoprovince.[48] Bordered on the west by the Coast Mountains and Okanagan Range, and on the east by the Monashee Mountains, the Southern Interior Ecoprovince contains more than 65% (480,000 ha) of the grasslands in British Columbia. Most of these grasslands are located in three broad geographic areas dominated by the Southern Okanagan Basin and Northern Okanagan Basin, Thompson Basin, and Southern Thompson Upland Ecosections (Table A 7.2).



Source: Grasslands Conservation Council of B.C.
Location of grasslands in Okanagan, Kettle and Similkameen valleys.

The Okanagan region contains nearly 120,000 ha of grassland, shrub-steppe, and savannah distributed over the Okanagan, Similkameen and Kettle valleys (Table A 7.2). These grasslands account for approximately 16% of the grasslands in the province.[14] Extending north from the Columbia Plateau in Washington State, the Okanagan Valley runs north and south to the height of land north of Armstrong that separates the Columbia and Fraser river drainages.

Although most of the grasslands are found within the main valley, smaller areas of steppe vegetation occupy tributary watersheds to the west at Trout Creek and Shorts Creek. Other grasslands are found along Vaseux Creek, Shuttleworth Creek, and Mission Creek on the east side of the Okanagan Valley.

In the southern Okanagan Valley, plant communities are distributed over an elevational gradient from the very hot, dry valley floor to the cooler, moister environment of the Interior Douglas-fir zone. Shrub-steppe and steppe vegetation occupies the valley floor, benches and steep walls of the main valley. Shrub-steppe communities are dominated by either antelope-brush or big sagebrush with an understory consisting of widely spaced bunchgrasses and a well-developed cryptogam layer.

Ponderosa pine savannah mixed with open grassland often forms a band on the rugged terrain above the lower-elevation grasslands of the Bunchgrass zone. These communities occasionally descend to the lower slopes or valley bottom, and usually merge with Douglas-fir forests at higher elevations. Big sagebrush is typically the dominant shrub on open grasslands or under a canopy of widely spaced ponderosa pine. Bluebunch wheatgrass, Idaho fescue and rough fescue often co-dominate the herb layer mixed with a variety of forbs.

Photo: B. Wikeem

Lower benches in the Bunchgrass zone and ponderosa pine grassland merging with open forest above Skaha Lake.

At higher elevations, grasslands extend onto the lower margins of the plateau surfaces on both sides of the Okanagan Valley, and abut against dense forest. Generally, the landscape changes from steep slopes and rugged terrain to gently rolling topography where grasslands mix with deciduous and coniferous forest. The shrub layer is usually absent, or big sagebrush is replaced by widely spaced common rabbit-brush. Rough fescue is generally the dominant bunchgrass forming a continuous cover, but is often mixed with Idaho fescue and bluebunch wheatgrass depending on slope, aspect and soil conditions.

Grasslands in the Southern Okanagan Basin have the greatest connectivity to the vast shrub-steppe vegetation of the Great Basin, and contain the highest diversity of plants and animals adapted to arid conditions in the province. This is most strongly expressed in the shrub-steppe and savannah communities in the Bunchgrass and Ponderosa Pine zones at low elevations.

The valley floor and lower slopes of the valley walls contain a rich mix of plant communities and landscape features ranging from open grassland, shrub-steppe and savannah to wetland and riparian ecosystems. Canyons, cliffs, and talus slopes are common in both the Similkameen and Okanagan valleys. This mix of physical features and flora provides habitat for many insects, mammals, birds, reptiles, and amphibians.

Grasslands in the Northern Okanagan Basin are transitional between the Rough fescue –Bluebunch wheatgrass communities of the Upper Grasslands in the Thompson-Pavilion region and the south Okanagan,[46] but there is little vertical zonation of plant communities compared to those in the south Okanagan. Most of the grasslands from Kelowna to

Armstrong, and in the Coldstream Valley, are classified as part of the Interior Douglas-fir zone, even at the lowest elevations.[25] Limited areas of subalpine and alpine grasslands are present north of the Shuswap River on the Hunters Range at elevations up to 2240 m.

Photo: B. Wikeem

Subalpine parklands on Hunters Range near Enderby.

Grasslands in the Similkameen Valley share many life-forms with the Southern Okanagan Basin, but plants and animals likely followed a migration corridor along the Similkameen River from shrub-steppe communities in Washington State after glacial retreat. Vertical zonation of plant communities is strikingly pronounced in the region because of the marked changes in relief from the valley floor to the plateau surface and mountain tops.[29] Further variations in the distribution and species composition of plant communities result from changes in slope, aspect and soils.

Most of the grasslands in the Similkameen Valley are contained in the Ponderosa Pine and Interior Douglas-fir zones, but large areas of grassland also occur from the Montane Spruce zone to the alpine. Shrub-steppe communities dominated by big sagebrush and bluebunch wheatgrass occupy the lower slopes and terraces in a narrow band above the Similkameen River. These communities may occur as open grassland, or under an open canopy of ponderosa pine.

Photo: B. Wikeem

Grassland and Douglas-fir forest occurs as bands along the Similkameen River.

At higher elevations in the Ponderosa Pine and Interior Douglas-fir zones, the shrub layer vanishes and rough fescue, Idaho fescue and parsnip-flowered buckwheat become climax co-dominants. Unusual shrub-steppe communities dominated by Vasey's big sagebrush or threetip sagebrush and bluebunch wheatgrass are sometimes found at higher elevations in the Interior Douglas-fir and Montane Spruce zones.[29]

Grasslands in the Kettle Valley occur primarily in the Ponderosa Pine and Interior Douglas-fir zones except for some disjunct patches that are found in the Montane Spruce zone. At the lowest elevations, ponderosa pine grassland and savannah have a ground cover consisting primarily of rough fescue, Idaho fescue, bluebunch wheatgrass, and a variety of forbs. Soil moisture is sufficient enough to provide complete ground cover, and the microbiotic layer is generally poorly developed except on the driest sites.

Photo: B. Wikeem

Interior Douglas-fir grasslands between Bridesville and Rock Creek.

At higher elevations on level to rolling topography, open grasslands are co-dominated by rough fescue, Idaho fescue, and bluebunch wheatgrass combined with a diverse mix of forbs. Generally, the shrub layer is better developed than in the Ponderosa Pine zone, and few cryptogams are present under the dense herbaceous layer.

Physiography, Climate and Soils

The Okanagan Valley is one of the most outstanding features of the Okanagan Region extending 240 km from Osoyoos north to Shuswap Lake.[5] The southern part of the valley varies from five to 10 km wide, but near Armstrong, it broadens to nearly 20 km. Elevation changes by only about 75 m over the length of the valley from Osoyoos Lake (297 m) to Armstrong (373 m). All of the principal grasslands follow the main valleys where glaciation was extensive.

Generally, the topography in the Okanagan Region consists of irregular plateaus separated by broad and deep valleys. The entire area was covered with up to 2150 m of Cordilleran ice during the Pleistocene epoch.[23] An ice dam near Okanagan Falls produced Glacial Lake Penticton that occupied the Okanagan Valley and drained south to the Columbia River.[27] The current drainage in the valley is south from the present height of land east of Armstrong though Okanagan Lake and the Okanagan River to the Columbia. North of Armstrong, water flows to Shuswap Lake and through the Thompson River system to the Fraser River.[5]

During glacial recession, water flowed from the plateau on both sides of Okanagan Lake, and contacted the ice dome that remained in the main valley. Shallow, slow moving rivers flowed along both sides of the lake south of Kelowna depositing silts and fine sands from the upland mountain glaciers.[23] Relics of this deposition remain as prominent silt cliffs along Okanagan Lake and these deposits provided the parent material for many of the grassland soils on the upland terraces. Tributary streams flowed into the main valley depositing sorted tills and producing gravelly and sandy terraces that often overlay lateral moraines.

Photo: B. Wikeem

Narrowing of the Okanagan Valley at McIntrye Bluffs south of Vaseux Lake formed a glacial ice dam.

Post-glacial erosion was prevalent throughout the entire valley, carving channels through the glacial lake and river terraces that shape much of the present landscape. Deposits from this erosion produced fans in the valley bottoms. The most significant of these fans was the post-glacial ice dam built by deposits from Shingle Creek and Ellis Creek at Penticton that divided glacial Lake Okanagan into Okanagan Lake and Skaha Lake. Similar deposits separated Kalamalka Lake and Duck Lake in the North Okanagan.

The Similkameen Valley extends from Princeton east to Keremeos, and then south paralleling the Okanagan Valley to the Canada/U.S. border. Throughout its drainage, it rarely exceeds 1200 m in width except at the confluence of the Ashnola and Similkameen rivers. From Keremeos to the 49th parallel, the valley widens to a maximum of about four kilometers. Elevation of the valley floor drops from 640 m at Princeton to about 330 m at the border. Grasslands on steep slopes in the Similkameen and Ashnola valleys extend to 1800 m or higher on some aspects.[13, 29]

The continental ice sheet covered the entire Similkameen Valley, moving south and southeast along the valley.[29] A thin mantle of glacial drift composed of lavas and sedimentary rock was overlaid on the entire area as the glaciers receded[17]. Further down-wasting produced terraces and fans that border the steep slopes of the Similkameen River valley, and provided the parent material for most of the soils in the area.

On the east side of the Okanagan Valley, the land rises abruptly from the valley floor to the Okanagan Highland. The valleys of the West Kettle, Granby and Kettle rivers are deeply dissected, and three to five kilometers wide with terraces extending to 60 m above the valley floors. Elevation of grasslands along the Kettle River range from about 600 m at the 49th parallel to 760 m at river level in the Christian Valley, although they extend to higher elevations along the valley slopes. Glacial ice gouged out the Kettle Valley and its tributaries as it extended 160 km into the United States in the late Pleistocene and then receded dumping glacial debris. Some of this debris was sorted by water but other material was deposited *insitu* forming the parent material for grassland soils. In the final stages of deglaciation, ice dams formed in the main valley creating temporary lakes. The sediment carried into these lakes from further wasting of upland ice left glaciolacustrine deposits over a large area of the valley floors.[42]

The climate throughout the Okanagan region is typically hot and dry, but topography, elevation and aspect significantly affect local climates. The entire region lies in the rain shadow of the Coast and Cascade mountains. Warm, moist Pacific air masses release most of their moisture on the west-facing slopes of the Coast Mountains. Total precipitation at Armstrong is nearly 70% higher than at Oliver in the South Okanagan Basin where annual precipitation averages 305 mm (Table A 5.2). Precipitation at Grand Forks in the Kettle Valley averages 420 mm annually, but snowfall accumulation in the region is significantly lower than in the Similkameen and Okanagan valleys (Table 5.2).

Hot, dry air masses from the Great Basin in the south influence maximum summer temperatures and available moisture for plant growth. This is most pronounced in the Southern Okanagan Basin where average daily temperatures in summer are 2 to 4^{o}C warmer than elsewhere in the region, and moisture deficits are often extreme. Arctic air masses in winter and early spring can affect maximum low temperatures, although most of the low-elevation grasslands experience moderate winter temperatures. The large lakes throughout the Okanagan Valley further moderate local temperatures year round by cooling the air in summer, and warming it in winter.

Photo: B. Wikeem

Effects of aspect on snow melt.

All mineral soils underlying grasslands in the region are derived from glacial material that was transported by ice and water. This material originated from many mineral sources such as mica schists, granites, basalts, and limestone.[23] Glacial till, glacial outwash, alluvium, colluvium, aeolian and organic deposits all provide parent material for soils in the area. Chernozems are the most common grassland soils, but Regosols are present where soil profiles are shallow, and Brunisols form where conifer litter influences soil development.[33]

Typically, soils develop from Brown to Black Chernozems along gradients of increasing moisture and humidity, and decreasing temperature.[49] Consequently, Brown Chernozems are found at low elevations in the South Okanagan Basin and extend north to Oyama, while Black Chernozems are most prevalent in the Northern Okanagan Basin and at high elevations in the Kettle and Similkameen valleys (Appendix 6).

Development of Grasslands

Climate, soils, fire and grazing by domestic livestock are all factors that have contributed to the historical and recent development of grasslands in the Okanagan. The Okanagan Valley and tributary valleys have undergone significant floristic changes since glacial recession. Pollen cores taken from the south Okanagan and near Kelowna indicate that grasslands reached their maximum extent between 12,000 and 8000 BP when climatic conditions were warmer and drier than present.[18] The preponderance of sagebrush pollen in local bogs also indicates that sagebrush was much more abundant in the past.[8]

Beginning about 6600 BP, grasslands began to decline with the onset of cooler and wetter conditions, and 3000 BP, the vegetation had slowly changed to conifer-birch forests with grasslands restricted to the valley bottoms.[18] From 3000 BP to recent times, grasslands expanded to reoccupy areas they had previously inhabited.

Recurrent fire has been a significant ecological factor in maintaining grasslands and savannah in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones.[4,8,46,47] Historically, lightning and aboriginal burning were the principal sources of fire, [8,11] but burning by prospectors and settlers augmented these fires after European settlement.[46]

Horse and cattle grazing likely influenced Okanagan grasslands before European settlement as indigenous peoples owned large numbers of livestock.[45] The Okanagan people could have acquired horses as early as the 1730s from the Sanpoil, Columbian, and Colville peoples to the south.[40,45] In addition to grazing, it is likely that local natives modified the landscape by excavating water holes and burning vegetation to enhance grass production for their horses.[40]

The fur trade established the first European presence in the Okanagan Valley when David Stuart of the Pacific Fur Trade Company built Thompson's River Post (Kamloops) in 1811. Subsequently, a network of fur trading posts was created from Fort Stuart to Kamloops with the main transportation corridor passing through the Okanagan. This enterprise required huge brigades of 200 to 300 horses to transport furs from New Caledonia to the Pacific Ocean before the border between Canada and the U.S. was settled in 1846. Horses were also left to pasture on their own at various points along the route as replacements for the brigades, and many escaped and formed feral bands.

Photo: B.C. Archives

Ellis homestead at present day Penticton ca. 1865.

The onset of the gold rush in 1858 brought large numbers of livestock north of the 49th parallel, and initiated the permanent settlement of people and livestock. By 1892, there were about 20,000 head of cattle foraging on grasslands between Osoyoos and Enderby.[45] Large herds of cattle, horses, sheep, and mules were also present in the Similkameen, Osoyoos and Boundary areas.[42] Although overgrazing was acknowledged along roadsides as early as the 1870, widespread overgrazing was reported in soil surveys throughout the Okanagan, Similkameen and Boundary areas by the 1960s.[23, 45] The long history of overgrazing on these low-elevation grasslands also allowed dense infestations of diffuse knapweed to develop, some of which persist today.

3.2.1 Representative Grassland Associations

In the Okanagan Region, shrub-steppe communities are scattered among seven biogeoclimatic zones from the valley floor to the alpine. Nearly 50% of these grasslands occur in the Bunchgrass and Ponderosa Pine zones in the Okanagan and Similkameen valleys. The remaining grasslands are found mostly in the Interior Douglas-fir zone in the North Okanagan Basin, Kettle Valley, and to a lesser extent in the Similkameen Valley. Less than 5% of the total grassland in the region occurs in other zones (Table A 8.2).

3.2.1.1 Okanagan Very Dry Hot Bunchgrass Variant (BGxh1)

The lowest elevation grasslands in the Southern Okanagan Basin occupy some of the hottest and driest conditions in the province where summer maximums often exceed 35^{o}C and winter temperatures rarely drop below –25^{o}C.[1] Nearly 23,000 ha of shrub-steppe vegetation occupies the valley bottoms, benches, and lower slopes from 250 to 700 m in the Okanagan Valley south of Summerland, and along the Similkameen River to the Ashnola River (Table A 8.2).[25] On the east side of Okanagan Lake, these grasslands hug the lake edge below 500 m elevation and extend as far north as Okanagan Mountain Provincial Park. These grasslands form the northern extension of shrub-steppe vegetation from Washington, Idaho, Montana, and Oregon, and have the greatest diversity of grassland plants and animals in the province, reflecting their desert-like origin.

Photo: B. Wikeem

Antelope-brush shrub-steppe on benches above Osoyoos Lake.

Antelope-brush and common rabbit-brush, which are the most common shrubs on the driest sites, are replaced by big sagebrush under slightly moister conditions at higher elevations and north of Kaleden. Saskatoon, common chokecherry, Douglas maple, blue elderberry, mock-orange, and rose occupy moist draws and swales, while threetip sagebrush is widely distributed on dry sites in the very southern part of the area. Smaller shrubs such as green rabbit-brush and grey horsebrush are often associated with big sagebrush in the southern part of the variant.[12]

Under climax conditions, bluebunch wheatgrass is the dominant herbaceous species, and a well-developed microbiotic layer consisting of lichens, mosses, algae, and fungi often fills the interspaces between widely spaced bunchgrasses.[12,19,28] Prairie sagewort, junegrass, Sandberg's bluegrass, needle-and-thread, and yarrow are characteristic herbs associated with bluebunch wheatgrass.[34] Other common species such as long-leaved phlox, Columbia bladderpod, prickly phlox, bitterroot, and snow buckwheat gradually decline in abundance farther north in the valley, and are mostly absent in the ThompsonValley.

Plant communities vary with latitude, site, aspect, topography, and drainage.[34] Idaho and rough fescue can dominate north or east-facing slopes, whereas needle-and-thread grass, sand dropseed, red three-awn, and Indian ricegrass are common on sandy sites with poor moisture-holding capacity. Giant wildrye often occupies moist sites and moderately saline areas at higher elevations, and Kentucky bluegrass may dominate swales. Bluebunch wheatgrass is often associated with compact selaginella or Wallace's selaginella on very dry, rocky sites with shallow soils. Ponderosa pine and Douglas-fir occur on steep rocky slopes, colluvial fans and in moist draws.

Early grazing by horses, cattle, mules, and sheep has strongly influenced plant communities. On some sites, bluebunch wheatgrass is replaced by Sandberg's bluegrass, big sagebrush, needle-and-thread grass, low pussytoes, and brittle prickly-pear cactus.[29, 34] Trampling by livestock and native ungulates can also modify the species composition and cover of the microbiotic layer,[28] although specific effects have not been well-documented. Infestations of non-native species and noxious weeds such as cheatgrass, spotted knapweed, and diffuse knapweed are extensive on severely overgrazed sites[35]. Needle-and-thread grass can decrease with overgrazing on sandy soils where it is a climax dominant.[29]

3.2.1.2 Okanagan Very Dry Hot Ponderosa Pine Variant (PPxh1)

Open grasslands and savannah occupy 28,660 ha of the Ponderosa Pine zone from the Canada/U.S. border to Vernon, and along the Similkameen River to Keremeos (Table A 8.2). Ponderosa pine communities mostly occur as a band above the Bunchgrass zone and below the Interior Douglas-fir zone from 335 to 940 m elevation.

The Ponderosa Pine zone is the warmest and driest forest zone in the province,[20] and is characterized by hot, dry summers that result in large moisture deficits during the growing season. Spatial distribution of soil nutrients is not uniform, and is influenced by sagebrush canopies. Higher nitrogen concentrations have been found under big sagebrush canopies compared to the interspaces between plants, which might account for the spatial arrangement of plants in sagebrush-dominated communities.[54]

Photo: B. Wikeem

Ponderosa pine savannah south of Penticton.

Extensive parklands in the zone include a mosaic of grassland, open forest, and shrub-steppe that are often similar to plant communities in Washington,[12] and farther north in British Columbia, [29] but species diversity declines from south to north. On slightly moister grassland sites, the rhizomatous form of bluebunch wheatgrass (var. *inermis*) co-dominates with Idaho and rough fescue [4] forming communities resembling the Big Sagebrush–Idaho Fescue association in Washington.[12] Other communities occur west of Kaleden at about 600 m elevation, and between 750 and 1100 m elevation of south-facing slopes near Keremeos.[29] These communities closely resemble the Ponderosa pine – Bluebunch wheatgrass – Idaho fescue site association that is considered the zonal vegetation.[25]

Ponderosa pine – Antelope-brush – Red three-awn communities form a savannah on coarse-textured soils. Red three-awn, bluebunch wheatgrass, snow buckwheat, brittle prickly-pear cactus, compact selaginella, and arrowleaf balsamroot provide a sparse herb layer under an open canopy of ponderosa pine. Plants are generally widely spaced, and exposed soil often is present.[25]

Photo: B. Wikeem

Ponderosa pine-Antelope-brush-red three-awn community near Vaseux Lake.

Big sagebrush and bluebunch wheatgrass communities are found on gentle, upper- to mid-slope positions on south aspects.[25] Idaho fescue co-dominates on more mesic sites while antelope-brush communities occupy drier sites.

Sandberg's bluegrass, junegrass, yarrow, and arrowleaf balsamroot are common associated forbs, and compact selaginella also is common on dry sites. Other perennial forbs such as showy phlox, prickly phlox, long-leaved phlox, bitterroot, false-agoseris, and Columbia bladderpod also are present at higher stages of succession.[39] Although brittle prickly-pear cactus is present, plains prickly-pear cactus is absent (Appendix 12).

Phenological patterns of individual plant species and species groups demonstrate that the flora in this variant is dynamic and well adapted to variations in soil moisture.[39] Spring Ephemerals such as sagebrush buttercup, yellow bells, and balsamroot start growth in early March and complete their life cycles by mid-May. This group also contains numerous annual plants with very short life cycles.

Bluebunch wheatgrass and long-leaved phlox on ponderosa pine grassland.

Photo: B. Wikeem

Summer Dormant plants initiate growth in late March and early April, complete flowering by early June, then generally remain dormant. Characteristic species include Sandberg's bluegrass, low pussytoes, woollypod milk-vetch, bitterroot, and Thompson's paintbrush.

Summer Quiescent plants have a similar phenology as Summer Dormant plants, except that they may resume growth in August and September if soil moisture and temperatures are adequate. This adaptation is characteristic of perennial plants such as bluebunch wheatgrass, rough fescue, needle-and thread grass, and showy phlox.

Big sagebrush, common rabbit-brush and snowy buckwheat exhibit protracted growth. These species initiate vegetative growth early in spring, but flower from August to September depending upon elevation and latitude.[39]

Successional patterns resulting from grazing likely follow similar sequences as those in other Big sagebrush – Bluebunch wheatgrass communities in Washington and British Columbia.[12,29] Bluebunch wheatgrass, Idaho fescue, and silky lupine are less abundant on heavily grazed areas, and are often replaced by Sandberg's bluegrass, Columbia needlegrass, low pussytoes, balsamroot, and shaggy fleabane. A variety of non-native and native annuals and biennials such as cheatgrass, soft brome, dandelion, yellow salsify, western stickseed, woolly plantain, and diffuse knapweed often invade heavily grazed sites.[29,35] Diffuse knapweed and cheatgrass can dominate early- to mid-successional sites, and form enduring plant communities. On slightly mesic sites with gentle slopes, cheatgrass also persists in communities at higher seral stages.[25,35] These communities occur under a sparse canopy of ponderosa pine, and are dominated by bluebunch wheatgrass in association with arrowleaf balsamroot, yarrow, compact selaginella, lemonweed, and cheatgrass.

3.2.1.3 The Kettle Dry Hot Ponderosa Pine Variant (PPdh1)

Ponderosa pine grassland and savannah occupy the southern Kettle River valley between Johnstone Creek and Boundary Falls, and between July Creek and Christina Lake at elevations ranging from 450 to 950 m.[3] This variant is relatively small and isolated with grasslands covering only 5150 ha on valley bottoms, south-facing slopes and terraces (Table A 8.2).

Photo: B. Wikeem

Ponderosa pine savannah at Rock Creek with rough fescue - Idaho fescue understory.

The climate is characterized by very hot, very dry summers and mild winters with insignificant snow packs (Table A 5.2).[3] Although annual precipitation is nearly 50% higher (485 mm) than in ponderosa pine grasslands in the Okanagan Valley, soil moisture deficits during summer limit plant growth. Grasslands are more common than forested sites in this variant.

Under climax conditions, bluebunch wheatgrass, rough fescue and Idaho fescue co-dominate and provide most of the ground cover, while silky lupine, arrowleaf balsamroot, sticky geranium, parsnip-flowered buckwheat, and lemonweed are common associates.[42] Rough and Idaho fescue are often absent on dry sites with coarse-textured soils.

Photo: B. Wikeem

Compact selaginella is well adapted to rock outcrops and shallow soils.

Ponderosa pine savannah communities are most common on south-facing slopes. At climax, ponderosa pine provides an open overstory for rough fescue, bluebunch wheatgrass, Columbia needlegrass, timber oatgrass, and junegrass. A wide variety of forbs including arrowleaf balsamroot, sticky geranium, silky lupine, and parsnip-flowered buckwheat also characterize these communities.[42] Introduced species such as cheatgrass, great mullein, yellow salsify, and sulphur cinquefoil are now common on many sites indicating that these communities are below climax, and that non-native species may be part of the long-term potential natural community.[22]

Photo: B. Wikeem

Rock outcrops provide unique habitats with distinctive plant communities.

Plant communities consisting of compact selaginella and bluebunch wheatgrass occupy steep, upper slope positions on shallow, colluvial soils and rock outcrops. Trees are usually absent. Saskatoon or common snowberry are present, but occur very infrequently. Compact selaginella dominates these sites in association with several mosses and lichens. Bluebunch wheatgrass is the most abundant herb mixed with thread-leaved phacelia, cheatgrass, arrowleaf balsamroot, junegrass, and small blue-eyed Mary.[3]

Ponderosa pine grasslands occupy mid-slopes on sites with course-textured soils. Ponderosa pine is scarce and shrubs are absent. Bluebunch wheatgrass and arrowleaf balsamroot usually co-dominate in association with compact selaginella, thread-leaved phacelia, junegrass, and cheatgrass. Red-listed species such as northern gooseberry, Lyall's mariposa lily, many-headed sedge, Columbian goldenweed, cup clover, narrow-leaved brickellia, northern linanthus, obscure cryptantha, pink fairies, and western stickseed (var. *cupulata*) can also be present in these communities (Table A 10.2).

Many of the grasslands in the Kettle Valley have been overgrazed in the past, and remain at some stage of succession below climax.[22,42] Under heavy grazing, junegrass, Sandberg's bluegrass, needle-and-thread grass, umber pussytoes, and cheatgrass replace bluebunch wheatgrass and the fescues. Red three-awn can also increase on some sites with lighter-textured soils.

Many plant communities in this region are infested with noxious weeds and other non-native species. Dense stands of diffuse knapweed have formed on some sites that were heavily disturbed by cultivation or grazing before the 1960s.[42] Diffuse knapweed and cheatgrass are often present in bluebunch wheatgrass communities on south-facing slopes between 600 and 1200 m, and may account for nearly 50% of the ground cover.[22] Kentucky bluegrass often dominates on relatively moister sites, and is mixed with non-native species such as creeping bentgrass, field bindweed, common hound's-tongue, bull thistle, diffuse knapweed, and sulphur cinquefoil.[22,35]

3.2.1.4 Okanagan Very Dry Hot Interior Douglas-fir Variant (IDFxh1)

Photo: B. Wikeem

Open grasslands on a south-facing slope along Gallagher Creek near Vaseux Lake.

Douglas-fir grasslands occupy more than 56,000 ha in the Southern and Northern Okanagan Basins, Okanagan Range and the Southern Okanagan Highland with nearly 80% of the total area falling within this variant (Table A 8.2). Grassland and open forest extend from the Canada/U.S. border to Enderby in the Okanagan Valley, and west along the

Similkameen River to Princeton.

Most of these grasslands are found between the Ponderosa Pine and Montane Spruce zones at elevations ranging from 400 to 1250 m. Extensive Douglas-fir grasslands also occur between Vernon and Lumby in the Coldstream Creek valley, and on the east side of Okanagan Lake from Kelowna to Woods Lake[25] Warm dry summers, and a fairly long growing season characterize the climate but moisture deficits and frosts during the growing season can limit plant growth.

In the Kettle Valley, Douglas-fir grasslands account for about 50% of the steppe vegetation. These grasslands are usually found above the Ponderosa Pine zone on gently rolling terrain and southerly slopes. Except for some areas of open savannah, most of the grasslands are virtually treeless, or are intermingled with small groves of aspen and Douglas-fir that occupy cool slopes, moist draws and depressions.

Photo: B. Wikeem

Douglas-fir grasslands near Grand Forks.

Near Bridesville, the land rises to 1030 m elevation, or about 300 m above the lowest elevation grasslands at Boundary Falls, and Douglas-fir grasslands extend from the valley floor upslope until they abut dense forest. Idaho fescue distinguishes these grasslands from those in the lower-elevation Bunchgrass zone in the Okanagan and Similkameen valleys.

Climax sites are dominated by Idaho fescue, rough fescue and bluebunch wheatgrass in association with silky lupine, arrowleaf balsamroot, parsnip-flowered buckwheat, and junegrass. Saskatoon, common snowberry, mock orange and mallow ninebark are often present in moist draws, depressions and on cool aspects. Drier sites are dominated by bluebunch wheatgrass along with silky lupine and arrowleaf balsamroot.[42] Kentucky bluegrass becomes more abundant in mid- to low-seral stages, especially on moist sites.[30,34] Other species such as junegrass, Columbia needlegrass, needle-and-thread grass, Sandberg's bluegrass, silky lupine, and timber milk-vetch are indicative of intermediate stages of succession. Cheatgrass, dandelion, great mullein, compound fleabane, and spotted and diffuse knapweed can dominate highly disturbed sites.[9,30,35]

3.2.1.5 Kettle Dry Mild Interior Douglas-fir Variant (IDFdm1)

Dry Douglas-fir forests and grasslands extend from Osoyoos to Kelowna along the east side of the Okanagan Valley between 560 and 1200 m elevation. They also occupy the southern part of the Monashee Mountains along valley bottoms and lower slopes from Anarchist Mountain to Bridesville, from Rock Creek to Midway, and on south- and west-facing slopes along the Granby River. Although they have a wide geographic distribution, most of the 6640 ha of grasslands are found on drier sites in the Kettle Valley, usually above the Ponderosa Pine zone and the slightly warmer grasslands in the Interior Douglas-fir zone (Table A 8.2).

Photo: B. Wikeem

Bunchgrass Hill on the Granby River north of Grand Forks.

The climate is characterized as hot and dry with relatively mild, snow-free winters. Summer and winters temperatures vary considerably with summer highs occasionally exceeding 42°C [1] and both moisture deficits and frost can occur during the growing season (Table A 5.2).[42] Bluebunch wheatgrass is the dominant species at climax combined with junegrass, yarrow and silky lupine. Mosses and lichens are mostly absent. Shrubs are sparse, but big sagebrush can occur on drier sites in the Okanagan Valley,[25] and saskatoon and common snowberry are present in small amounts in the Kettle Valley.[3] Rough fescue can dominate on slightly moister sites where it is mixed with Idaho fescue, bluebunch wheatgrass, Kentucky bluegrass, junegrass, parsnip-flowered buckwheat, silky lupine, and yarrow.[22]

Most of the grasslands in this variant appear to be in early seral stages as a result of past grazing and cultivation, and noxious weeds and non-native plants are often significant components of plant communities. Some seral stages have been described such as the Diffuse knapweed – Cheatgrass – Bluebunch wheatgrass community, which is also prevalent in ponderosa pine grasslands in the Kettle Valley.[22]

Kentucky bluegrass – Columbia needlegrass communities are also scattered throughout the variant on zonal grassland sites. Shrubs are generally lacking on these sites, and Kentucky bluegrass dominates the herb layer in association with Columbia needlegrass, quackgrass and junegrass. Bluebunch wheatgrass and rough fescue are infrequent on some sites. Noxious weeds and non-native species such as common hound's-tongue, sulphur cinquefoil, black medic, great mullein, Japanese brome and cheatgrass often accompany a sparse cover of parsnip-flowered buckwheat, lemonweed, rosy pussytoes, and yarrow.[22]

3.2.1.6 Grasslands in Other Biogeoclimatic Units

Small areas of grasslands, shrub-steppe and alpine meadows are found in the Montane Spruce, Interior Cedar-Hemlock, Engelmann Spruce-Subalpine Fir, and Alpine Tundra zones, collectively covering about 4240 ha (Table A 8.2). About 1300 ha of these grasslands occur in the Interior Cedar-Hemlock zone on steep, south-facing slopes, and on warm aspects along the Granby River and above Christina Lake. Despite their small area, some of these grasslands contain rare plants, and are important for wildlife, especially in the Ashnola River drainage.

In the south Okanagan, almost 65% of these grasslands are located from about 1450 to 1650 m elevation in the Montane Spruce zone near the Canada/U.S. border.[25] Grassland communities in this zone are found on Mount Kobau near Oliver, and from Keremeos to Hedley in the Okanagan Range.

Vasey's big sagebrush – Pinegrass communities are found at higher elevations, and are classified as red-listed communities in the Montane Spruce and Engelmann Spruce-Subalpine Fir zones (Table A 10.2). These communities are transitional between grassland and montane forest, and form an edaphic climax in forest openings, usually on south-facing aspects.[29] Species characteristic of both grassland and forest are present including pinegrass, Idaho fescue, silky lupine, western meadowrue, wild strawberry, and old man's whiskers.[25,29]

Photo: B. Wikeem

Montane Spruce and Engelmann Spruce-Subalpine Fir grasslands merging with alpine on Crater Mountain.

Vasey's big sagebrush – Bluebunch wheatgrass – Idaho fescue communities are present on drier sites on moderately steep slopes. Cover of Vasey's big sagebrush is highly variable depending on soil, elevation and aspect. The herb layer is dominated by bluebunch wheatgrass and Idaho fescue in association with junegrass, silky or arctic lupine, sulphur buckwheat, and green wintergreen.[15] Moderate amounts of common juniper may be present on some sites.[24] Abundance of bluebunch wheatgrass and Idaho fescue declines with overgrazing on these grasslands, and are replaced by Columbian needlegrass and junegrass.[15]

3.2.2 Distinguishing Flora and Plant Species at Risk

The present diversity and distribution of grassland plants in British Columbia result, in part, from uplift and erosion during the Tertiary period 50 to 1 million BP. This uplifting left the southern part of the Interior Plateau much higher (1200 to 1800 m) than in the Central Interior of the province (670 m near Prince George),[5] and it created a barrier that stalled the northern migration of plants and animals after the Pleistocene glaciers retreated. Consequently, there is a concentration of rare plants along the 49th parallel,[44] which is most pronounced in the Okanagan Range, Southern Okanagan Highland, Southern Okanagan Basin, and the southern part of the Northern Okanagan Highland. This area also represents the northern distribution of many plants and animals with centers of origin in the Great Basin region of the south-central United States.

Grassland and desert species that are characteristic of the Sonoran Desert penetrate at low elevations in the Okanagan and Similkameen valleys, and to a lesser extent, the Rocky Mountain Trench. Many of these species gradually drop out of the flora and fauna along elevational and latitudinal gradients in response to variations in moisture and temperature.

Two hundred and twenty-five red- and blue-listed animals, plants, and plant communities occur in the Okanagan, Similkameen, and Kettle valleys (Table A 9.2). The greatest concentration of these species occurs in the Southern Okanagan Basin, which supports about 30% of the threatened or endangered species in British Columbia. In addition, more than half of the 57 red- and blue-listed species in the south Okanagan and lower Similkameen are associated with grasslands.

Short-flowered evening-primrose, Andean evening primrose, Watson’s cryptantha, strict buckwheat, Whited’s halimolobos, and Columbian goldenweed are red-listed plant species that are mostly restricted to the Southern Okanagan Basin. Similarly, the only known populations of branched phacelia, hairgrass dropseed and nettle-leaved giant hyssop are found on low- to mid-elevation grasslands near Spotted Lake on Kruger Mountain.

Green rabbit-brush, Okanagan stickseed, Lyall’s mariposa lily, wild tobacco, and Harkness’ linanthus are other red-listed species whose distributions are centered in the Southern Okanagan Basin. Their distributions outside the area are very restricted. Threetip sagebrush, which forms climax stands with bluebunch wheatgrass on some soils in

Washington,[12] is most common near the 49^{th} parallel, and reaches its northern distribution at Summerland. Scattered plants have been found west to Keremeos and east to Rock Creek in association with Idaho fescue.[29]

Some rare or uncommon species, such as alpine buckwheat, Leiberg's fleabane, and Vasey's big sagebrush, reach their northern distribution in the Ashnola watershed, often above timberline. Other species have restricted distributions in the South Okanagan and along the Canada/U.S. boarder. Prickly phlox, showy phlox, and false-agoseris are confined mostly to the South Okanagan Basin, while Columbia bladderpod, long-leaved phlox, plains prickly-pear cactus, prairie pepper-grass, and snow buckwheat are found infrequently outside the Okanagan Valley (Appendix 12).

Photo: B. Wikeem

The distribution of long-leaved phlox is confined mainly to the Okanagan Valley.

Bitterroot, also found in the East Kootenay Trench and near Ashcroft in the Thompson Basin, appears to reach its eastern limit from the Okanagan Valley on grasslands in the Ponderosa Pine zone near Midway.

Antelope-brush, also found in the East Kootenay Trench, is abundant from Osoyoos to Kaleden. Disjunct plants have been found as far north as Westbank near Kelowna, and west to Osprey Lake near Princeton. To the east, antelope-brush extends to at least the southwest slopes of Anarchist Mountain where it occurs at about 870 m elevation in the Ponderosa Pine zone.

The relative number of threatened species and habitats generally declines along latitudinal and elevational gradients. Except for silvery sagebrush, all of the red- and blue-listed species found in the Northern Okanagan Basin are northern extensions of species found in the southern part of the Okanagan Valley.

Mallow ninebark and mountain prickly gooseberry are mainly found in open forests in the Kettle Valley of British Columbia. Both species are likely range at their northern limits of larger populations in the United States. Other species such as least bladdery milk-vetch and prairie sandgrass are found in the Kettle Valley, possibly as western extensions from the East Kootenay Trench (Table A 10.5).

In the Okanagan region, a total of 38 red- and blue-listed plant communities have been identified on grasslands and associated habitats in five biogeoclimatic zones. Most of these (27) have been classified as endangered or threatened, while 11 are regarded as vulnerable (Appendix 11). Of these, the Antelope-brush – Needle-and-thread grass community is ranked as one of the four most endangered ecosystems in Canada. Less than 10% of the antelope-brush habitat remains in the South Okanagan, and continues to be threatened by agricultural expansion.

3.2.3 Grassland Associated Ecosystems

Cottonwood forests develop on floodplains within the Bunchgrass and Ponderosa Pine zones. Although these ecosystems were once extensive along the Okanagan River, they have been reduced to 15% of their historic extent.[38] Soils on these sites are predominantly Regosols or Brunisols that have developed on fluvial parent materials.

Cottonwood forests are dominated by black cottonwood mixed with small amounts of ponderosa pine or Douglas-fir. A dense shrub layer is often present consisting of common snowberry, Douglas maple, saskatoon and paper birch with small amounts of roses, black twinberry and water birch. Star-flowered false Solomon's seal is a common forb in these communities, and Kentucky bluegrass and kinnikinnick may be present on some sites in the southern Okanagan.[24,25]

Photo: Brian Wikeem

Cottonwood, willows and other shrubs rapidly colonize exposed soils following the spring freshet.

Narrow-leaf willow (sandbar willow) and other shrubs form dense stands in areas of prolonged flooding and strong currents, such as on sand bars of large rivers or along the edges of wave-washed large lakes. Species diversity is low, but mountain alder or cottonwoods may be present.[26] These sites eventually succeed to cottonwood forests.

Despite the arid climate, a variety of wetlands are found in the Okanagan, Similkameen and Kettle valleys. Bulrush and cattail marshes, saline meadows, and sedge fens are well represented in the Bunchgrass and Interior Douglas-fir zones, but are uncommon in Ponderosa Pine and Montane Spruce zone grasslands. Marshes are the most common wetland type associated with grasslands, and are found in all zones. Soft-stemmed bulrush marshes occur in small ponds and potholes with moderately alkaline conditions, and where there is substantial draw down to allow aeration. Bulrush and woolly sedge marshes are also found under similar conditions. Common cattail marshes are usually found in freshwater potholes, lake edges, small ponds, and ditches. Mannagrass marshes occur in the Interior Douglas-Fir zone on level sites with fine-textured soils on lacustrine deposits. Fowl mannagrass dominates these marshes mixed with hard-stemmed bulrush, and marsh cinquefoil.[26]

Alkali saltgrass meadows occur in seasonally flooded riparian areas of saline or alkaline potholes and lakes in the Bunchgrass and Interior Douglas-Fir zones. These sites are usually dominated by alkali saltgrass, but alkali cordgrass and Nevada bulrush also may be present. Nuttall's alkaligrass – Foxtail barley communities occupy shallow ponds in the drawdown zone, or basins that are temporarily flooded in spring.[26] The soils in these ponds are generally fine-textured, poorly drained, and slightly saline or alkaline because of high levels of evaporation.

Nuttall's alkaligrass dominates except where foxtail barley increases with heavy grazing. On slightly moister sites, Alkaligrass – Foxtail barley communities are replaced by Baltic rush – Field sedge marshes.[26] These communities are often associated with the edges of bulrush marshes where longer periods of flooding persist compared to alkaline ponds.
Beaked sedge – Water sedge fen/marshes are commonly found on grassland sites that flood annually with shallow, non-alkaline water, such as in basins, depressions and lacustrine flats.[26] Species diversity is usually low in these marshes, and may include marsh cinquefoil, bluejoint reedgrass and the two large water sedges.

Aspen groves are a common feature on grassland landscapes from the Bunchgrass zone in the valley bottoms to higher-elevation grasslands in the Interior Douglas-fir and Montane Spruce zones.
Most aspen communities have a prominent shrub layer consisting of a variety of species depending on soils conditions and moisture availability.

Photo: B. Wikeem

Shrubs often dominate under aspen canopies.

Nootka rose, prickly rose, common snowberry, saskatoon, and trembling aspen suckers are common components of the shrub layer in aspen copses. At low elevations, and on dry sites such as talus slopes, white clematis, chokecherry, tall Oregon-grape, Douglas maple and poison ivy are often present, while red-osier dogwood, water birch, and Sitka alder are frequent on wetter sites. Black cottonwood and paper birch can also form part of the overstory on seepage sites and along water courses. The herb layer also varies in density and species composition depending on soil moisture conditions and tree canopy density. In the Bunchgrass zone, bluebunch wheatgrass, spreading dogbane, giant wildrye, Canada goldenrod, and scouring-rush may be present in the sparse herb layer depending on moisture availability and canopy cover of the overstory.[24,25] Pinegrass, blue wildrye, showy aster, wild sarsaparilla and star-flowered false Solomon's seal become more prominent in the Ponderosa Pine zone in both the Okanagan and Kettle valleys.[3,25]

Plant species diversity in aspen copses is generally higher in the Interior Douglas-fir zone than the Ponderosa Pine zone. Typical native species include pinegrass, sticky purple geranium, purple peavine, fowl bluegrass, American vetch, yarrow, arctic lupine, blue wildrye, and wild strawberry. Rough fescue can also be found on some sites with an open aspen canopy. Disturbance by livestock and wildlife alters species composition in aspen stands resulting in Kentucky bluegrass, clovers, and common dandelion frequently occurring on these sites.[53]

Cliffs, rock outcrops and talus slopes are common elements of grasslands in the Bunchgrass, Ponderosa Pine and Interior Douglas-Fir zones throughout the Okanagan, Similkameen and Kettle valleys. These special landscape features are important habitats for some plants and animals because they provide unique environments not present elsewhere on the grassland landscape.

Photo: B. Wikeem

Rock outcrops and cliffs provide specialized habitats for plants and animals.

At low to mid elevations, rock outcrops occupy crests and upper slopes with various gradients and aspects. These sites are typically very dry with shallow soils, and bedrock is often exposed. Vegetation cover is usually sparse, but scattered ponderosa pine or Douglas-fir may be present along with common rabbit-brush, big sagebrush and saskatoon. In the south Okanagan, bluebunch wheatgrass and compact selaginella are often the dominant species, and parsnip-flowered buckwheat, snow buckwheat, bitterroot, Idaho fescue or arrowleaf balsamroot may be common associates. Kinnikinnick, pasture sage and Sandberg's bluegrass are more likely associates in the North Okanagan.[24,25] Rock outcrops, with scattered Douglas-fir and lodgepole pine, occur on steep upper slopes and crests in the Montane Spruce zone.

Common juniper is the most conspicuous shrub, but other species such as falsebox, saskatoon and black huckleberry may be present. Widely spaced pinegrass, shrubby penstemon, kinnikinnick, compact selaginella, timber oatgrass, white Pussytoes, and spotted saxifrage provide a sparse herb layer.[24]

Talus forms at the base of many cliffs in the Bunchgrass and Ponderosa Pine zones. These habitats are characterized by a very sparse cover of shrubs and herbs, occasionally with widely spaced ponderosa pine or Douglas-fir trees. In the south part of the Okanagan Valley, mock-orange, antelope-brush, smooth sumac, and squaw currant may be present combined with herbs such as bluebunch wheatgrass, compact selaginella, arrowleaf balsamroot, silverleaf phacelia, thread-leaf phacelia, and fern-leaved desert-parsley. Western cliff fern is often present on north slopes and in rock crevices.

Photo: B. Wikeem

Talus slopes form at the base of cliffs and provide habitat for plants and animals that are adapted to this environment.

Talus slopes in the north Okanagan Valley have a greater diversity of shrubs including chokecherry, saskatoon, big sagebrush, Rocky Mountain juniper, shrubby penstemon, rose, smooth sumac, and poison-ivy. Minor amounts of kinnikinnick, bluebunch wheatgrass and Sandberg's bluegrass are also present.[24,25]

3.2.4 Representative Fauna and Species at Risk

Faunal diversity in the Okanagan region is among the highest in the province, and many species depend on grassland or grassland-associated habitats to complete some or all of their life cycle. Several animals are unique to the region; others are at, or near, their northern distribution in the Okanagan Valley.

The Southern and Northern Okanagan Basins have the largest number of threatened and vulnerable arthropods in British Columbia. Perhaps 35,000 species of insects reside in British Columbia, but only about 15,000 have been discovered so far,[7] and over 350 species are potentially rare and endangered. Insects serve many ecological roles in grassland ecosystems such as providing food for other animals, pollinating plants, and cycling nutrients through the system.

Eleven insect species have been identified as vulnerable or threatened throughout the Okanagan Valley, but most of these species occur in the South Okanagan (Table A 9.2; Table A 13.2). Numerous insect species are known only from this region, and some occur nowhere else in Canada. The Vivid Dancer, Parowan Tiger Beetle, Ground Mantid, Apiocerid Fly, Scoliid Wasp, and Robber Fly are all unique to the Okanagan Valley (Table A 9.3). The Mormon Metalmark is among nine species of butterflies that are restricted to the south Okanagan and Similkameen.[7] Other species, such as the immaculate green hairstreak and Monarch Butterfly, have slightly broader distributions in the Thompson and Okanagan valleys. The viceroy butterfly has been extirpated from the province.

Photo: Min. Water, Land andAir Protection

The distribution of Mormon Metalmark is limited to the most southerly grasslands in the Okanagan Valley.

Grassland environments support about 40% of the 22 amphibian and 18 reptile species that are native to British Columbia, some with very narrow distributions.[50] The Night Snake, Northern Leopard Frog and Pygmy Short-horned Lizard are extremely rare species found only in the Southern Okanagan Basin.[36,37] Only one Night Snake has been collected near Kaleden, and the Leopard Frog and Short-horned Lizard may be extirpated.

The Great Basin Spadefoot, Painted Turtle and Tiger Salamander breed in the warm water of ponds and shallow lake edges.[50] The Great Basin Spadefoot can survive the extremely warm temperatures of shallow

Photo: B. Lincoln

The blue-listed racer occurs in the South Okanagan.

water, while the salamander tolerates saline or alkaline conditions. The Tiger Salamander has a limited range in the province with its northern distribution occurring in the Northern Okanagan Basin.

The Rubber Boa, Western Rattlesnake and Racer use a variety of habitats including open grasslands, wetlands, and riparian woodlands for foraging and hiding. Many snakes bask on sun-warmed rocks in spring, and all hibernate under talus and in rock outcrops in winter.

More than 300 species of birds are found in the Okanagan Valley, and nearly 200 species breed and nest in grassland and wetland habitats in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones.[6] This represents nearly 75% of all the bird species found in B.C., and 70% of the breeding species known to the province.[14] Most of these species also use grasslands and associated habitats periodically throughout the year for foraging and resting during migration.

Photo: B. Wikeem

Western bluebirds are a common species on grasslands at all elevations.

Thirteen red- and 22 blue-listed bird species are found on grasslands in the Okanagan Region (Table A 13.2). All of these species are present in the Okanagan or Similkameen valleys, but the diversity of listed species declines by nearly 50% in the Kettle Valley where only five red-listed and 11 blue-listed species remain (Table A 13.2). Many of the red-listed species that have disappeared from the fauna in the Kettle Valley are those dependent on shrub-steppe habitat, such as the Sage Thrasher, Brewer's Sparrow and Burrowing Owl. Some blue-listed species such as the Sharp-tailed Grouse have been extirpated.

Numerous bird species that are representative of grassland habitats reside in the Okanagan, Similkameen and Kettle valleys from the Bunchgrass to the Interior Douglas-fir zone. The Western Meadowlark, Vesper Sparrow, Horned Lark, and Common Nighthawk are conspicuous ground-nesting species on grasslands. Other species that nest on the ground, such as the Common Poorwill, Bobolink, and Long-billed Curlew, tend to be secretive and less conspicuous. The California Quail, an introduced partridge, is most common in the Bunchgrass zone, but nests on grasslands and savannahs at elevations up to the Interior Douglas-fir zone. Other familiar grassland birds, such as the Mountain Bluebird and Black-billed Magpie, are usually found along the forest edge, or in gullies that support shrub communities.

Sage Thrashers breed regularly only in the southern Similkameen and Okanagan valleys. They occur in dry shrub-steppe below 500 m elevation that has dense stands of big sagebrush, antelope-brush and common rabbit-brush.[7] Breeding thrashers have been found mainly near White Lake and Chopaka Mountain in the Similkameen Valley. Sage Thrashers occasionally breed in the North Okanagan Basin, and one record exists for the Thompson Valley.

The red-listed Brewer's Sparrow and Black-chinned Hummingbird, and the blue-listed Yellow-breasted Chat, are restricted mainly to sagebrush grassland and adjacent riparian habitats in the south Okanagan.[7] The Brewer's Sparrow is found most frequently in shrub-steppe communities with medium to high densities of sagebrush where they nest and forage for insects and seeds. The chat breeds only in the South Okanagan and Similkameen valleys in riparian woodlands with dense thickets of wild rose. Although the Black-chinned Hummingbird is found in the East Kootenay Trench, it breeds mainly in the south Okanagan.[14] This species, Canada's smallest bird, requires shrubby riparian habitat in the grasslands for foraging and nesting.

Four additional blue-listed birds, the Gray Flycatcher, Lewis's Woodpecker, Flammulated Owl, and Canyon Wren are found on grasslands and associated parklands and rock outcrops in the Ponderosa Pine zone in the Okanagan, Similkameen and Kettle valleys. The flycatcher, woodpecker and owl inhabit open ponderosa pine savannah. Of these species, the gray flycatcher is the most elusive; a small population is known to occur only in the south Okanagan.[50] The only known populations of the Canyon Wren in Canada are found in cliffs and talus in the Okanagan Valley between Osoyoos and Naramata although sightings have been reported at Vernon, and at Hedley in the Similkameen Valley. This species may also breed occasionally near Castlegar.[50]

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Photo: J. Hobbs

The canyon wren nests in rock cliffs with deep crevices and talus slopes.

Aspen groves provide food and habitat for a diversity of bird species ranging from passerines to raptors. In addition to berries and seeds, they supply numerous insect species as food for birds. Aspen stems provide nesting habitat for an many of woodpeckers and flickers including the Downy, Hairy, Pileated, and blue-listed Lewis's Woodpecker. The White-breasted Nuthatch, Pygmy Nuthatch, and Western Bluebird are common residents that feed on insects, and nest in tree cavities.

Shrub understories provide nesting cover for Ruffed Grouse, while the American Robin, Black-billed Magpie, and Warbling Vireo nest in shrubs and aspen trees. Additionally, the Red-tailed Hawk, American Kestrel, Merlin, and red-listed Ferruginous Hawk perch and nest in aspen stands, and forage over adjacent grasslands and wetlands (Table A 13.2).

Photo: B. Wikeem

Aspen groves provide a high diversity of habitats, food, and shelter for grassland-associated animal species.

Numerous species of shorebirds, passerines, waterfowl, and raptors are found around freshwater marshes, ponds, lakes, saline meadows, and their surrounding grassy uplands. Some of the most common and familiar wetland species in the Bunchgrass, Ponderosa pine and Interior Douglas-fir zones include the Red-winged Blackbird, Yellow-headed Blackbird, Killdeer, American Coot, Mallard, Marsh Wren, and Spotted Sandpiper. Other species such as the red-listed American Avocet, blue-listed American Bittern, Sora, and Virginia Rail tend to be more secretive and less conspicuous. Additionally, the Common Yellowthroat lives around the reed-beds and willow edges of ponds and marshes. Though not regarded as threatened or endangered, populations of this colorful warbler have declined in some areas because of habitat loss.

The Southern Interior Ecoprovince supports 74 mammal species or nearly 75% of all land mammals in the province. Some of these species are unique to British Columbia and Canada, and many species are classified as threatened or endangered. Most of the grassland species of concern originate from the Great Basin, and all are found in the Southern Okanagan Basin.

California Bighorn Sheep, Moose, Mule Deer, Mountain Goat, Rocky Mountain Elk, and White-tailed Deer are all present in the Southern Interior Ecoprovince. Although Mule Deer are the most widely distributed ungulate in the region, California Bighorn Sheep are

most dependent on grassland. Some populations, such as the Ashnola band, migrate from low-elevation grasslands in winter to subalpine and alpine grasslands in summer. [2,15]
Other populations in the Okanagan Valley remain on low-elevation grasslands and open forest most of the year where they forage on grasses, forbs and shrubs.[51,52] Important winter ranges for California Bighorn Sheep are found from Oliver to Penticton on the east side of the Okanagan Valley, at Shorts Creek near Fintry in the Northern Okanagan Basin, and in the Ashnola River watershed in the Okanagan Range.[41] Some populations of California Bighorn Sheep have been declining in recent years and no longer occur in many areas of Okanagan Valley.[50]

Photo: B. Wikeem

High-elevation grasslands in the Montane Spruce zone in the Ashnola River Valley.

Mule Deer and White-tailed Deer are abundant in the Okanagan, Similkameen and Kettle valleys, and use grasslands in the Bunchgrass and Ponderosa Pine zones for fall, winter and spring range. Some important winter ranges include the east slopes along Okanagan Lake from Penticton to Summerland, and the Ashnola River drainage in the Similkameen Valley. Higher elevation grasslands in the Ashnola also serve as important summer ranges for both species.[31] In the Kettle Valley, mule deer and white-tailed deer use Interior Douglas-fir grasslands and ponderosa pine savannahs located between Grand Forks and Christina Lake, and in the Granby River Valley as spring, fall and winter range.

A wide variety of small mammals and carnivores use grasslands or specialized habitats associated with the grasslands year round. For example, Muskrats, Rocky Mountain Pikas, Bushy-tailed Woodrats, Bog Lemmings, Red Squirrels, Yellow-bellied Marmots, Columbian Ground Squirrels, Coyotes, and Black Bears are all common on grasslands and associated habitats in the Bunchgrass and Ponderosa Pine zone.[10, 43]

The Western Harvest Mouse is the smallest mouse in British Columbia. This species occurs only in shrub-steppe communities, wetlands, and open, ponderosa pine and Douglas-fir forests below 780 m in the Okanagan and Similkameen valleys.[16] The Western Harvest Mouse appears to be absent from the Thompson River and Kettle River valleys. A disjunct population has been found at Vernon, where the species reaches the northern distribution in North America.

The Great Basin Pocket Mouse has a similar distribution to the western harvest mouse, and is found only in the southern dry interior in the Okanagan, Similkameen, and Kettle valleys. A disjunct population was reported in the Thompson Valley, but it has not been found there since the 1960s.[16] The Great Basin Pocket Mouse occupies shrub-steppe and ponderosa pine parklands on soils that are suitable for burrowing. In antelope-brush communities, it helps maintain shrub populations by caching seeds in the soil that sprout and introduce new plants into the environment.

Nuttall's Cottontail occupies sagebrush habitat throughout its limited distribution in the southern Okanagan and Similkameen valleys. Although populations of this species may be expanding, its re-occupation of historical range has been slow.[50] Historically, the range of the White-tailed Jackrabbit extended into the southern Okanagan Valley, which was the northern limit of its range. This species has not been found in recent surveys of the Okanagan Valley, and is the only grassland mammal that has been extirpated.[32]

Photo: J. Hobbs

Nuttal's cottontail distribution in British Columbia is limited to the southern Okanagan Valley.

The red-listed Badger occurs in the Okanagan and Similkameen valleys on grassland, shrub-steppe, and open stands of ponderosa pine or Douglas-fir at elevations ranging from 400 to 1500 m. Population levels are generally low throughout its range in B.C. and this species is still considered to be vulnerable to local extirpation.[50]

Photo: B. Wikeem

The red-listed Badger is one of the largest members of the weasel family.

Fifteen species of bats have been found in the south Okanagan, and most use grassland and associated wetland habitat for foraging. Adjacent cliffs provide secure habitat for rearing their young in the sun-warmed crevices.[43, 50] The distribution of the Pallid Bat is restricted to the south Okanagan area in Canada. Like other bats, this species roosts on cliffs, crevices in rock outcrops and ponderosa pine trees, and feeds over open grassland. The known distribution of this species extends only from Osoyoos to Okanagan Falls.[50] Similarly, the Western Red Bat is very rare in Canada, and found only in the Skagit Valley and near Okanagan Falls (Table A 13.2). Two other bats, the Western Small-footed Myotis and Little Brown Myotis, are found in the Similkameen Valley and north to Kalamalka Provincial Park.

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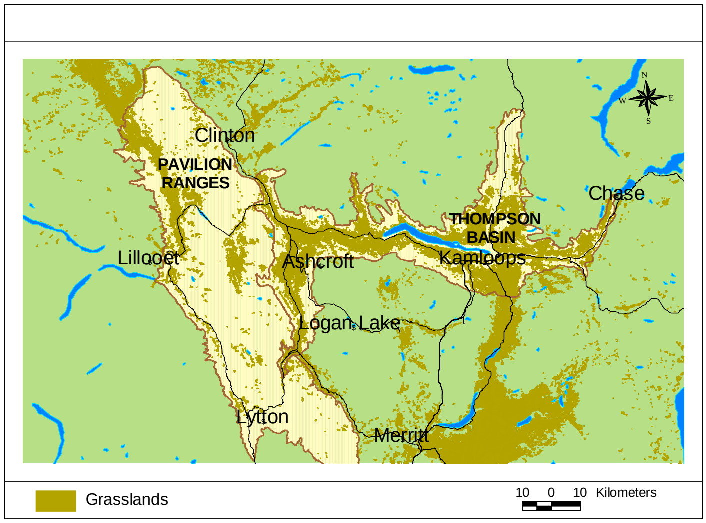
3.3 Thompson-Pavilion

Grasslands in the Thompson-Pavilion region are primarily defined by the South and North Thompson rivers, and extend from Little Shuswap Lake in the east to Spences Bridge in the west in the Thompson Basin and Pavilion Ranges Ecosections.[8] Most of the 144,000 ha of grassland are associated with the valley bottoms, steep slopes of the valley walls, and benches along the Thompson River and its tributaries.



Source: Grasslands Conservation Council of B.C.

Location of grasslands in the Thompson Basin and Pavilion Ranges.

On the southern margin of the Thompson-Pavilion region, steppe vegetation blends with the vast expanse of grassland on the Southern Thompson Upland in the Nicola Valley where the topography becomes more moderately sloped, and the terrain a rolling plain.

Photo: B. Wikeem

The Thompson River Valley looking west towards Ashcroft.

To the north, grasslands follow the North Thompson River where they merge with ponderosa pine savannah. North of Heffley Creek, these grasslands gradually decline in area to discontinuous patches, and are usually restricted to south-facing slopes.

Grasslands also extend along the Bonaparte River drainage and adjacent slopes of the Pavilion Ranges north of Cache Creek. These grasslands progressively disappear over an elevational gradient as they join with ponderosa pine and Douglas-fir savannah on mid-elevation sites. Elsewhere on the northern boundary of the Thompson-Pavilion region, grasslands vanish abruptly, and are replaced by dense coniferous forest as elevations increase on the Bonaparte Plateau.

Rain shadow effects from the Coast and Cascade mountains, and elevational gradients also influence the distribution and composition of grasslands from west to east throughout the Thompson River Valley. Some of the most arid conditions in the province occur on the valley floor near Ashcroft where plants are widely spaced and soils closely resemble the desert soils of the Great Basin. At the higher elevations of Cornwall Hills Provincial Park, extensions of these grasslands merge directly with alpine and subalpine vegetation over a distance of about 15 km and a rise of 1500 m elevation.

The influence of elevation is pronounced throughout the Thompson Valley with a gradual transition from the very hot and dry Lower Grasslands to the relatively cooler and moister Upper Grasslands. At the lowest elevations, shrub-steppe communities are dominated by big sagebrush and bluebunch wheatgrass.

Photo: B. Wikeem

Saline pond in the Lower Grasslands with the Upper Grasslands south of the Thompson River in background.

These communities have a well- developed cryptogam layer comprised of mosses, lichens, liverworts, and soil algae. At middle and higher elevations, conditions become relatively cooler and moister, plants become more closely spaced, and the flora gradually changes to steppe in the Middle Grasslands. At climax, these communities are dominated by bluebunch wheatgrass and Sandberg’s bluegrass, and microbiotics are common in the spaces between bunchgrasses. Meadow-steppe communities in the Upper Grasslands are dominated by rough fescue mixed with a variety of forbs and few cryptogams.

Physiography, Climate and Soils

During the Pleistocene epoch, the entire Thompson Basin area was covered with ice up to 1000 m thick.[48] Beginning about 13,000 BP, the glaciers began to melt forming a large lake that occupied the present Thompson River valley. Initially, Lake Thompson was confined to the valley by glacial dams at Kamloops and Pritchard. As deglaciation progressed, a glacial tongue formed at Deadman River near Savona, and the lake grew in size until it extended east to Shuswap Lake. Throughout this period, the level of Lake Thompson was controlled by a spillway near Squilax (955 m elevation), and the lake drained south through the Okanagan Valley to the Columbia River system.[22]

Photo: B. Wikeem

Erratics and evidence of ancient lake shores (the lines on Mount Paul in the background) are a testament to past glacial activity.

When the glaciers melted, they deposited morainal debris on the valley floors to a depth of over 200 m, and formed terraces and benches that support present-day grasslands in the Thompson Valley.[22] Subsequent down wasting of the glaciers produced deltas composed of sands and gravels in the lake at the present locations of the Bonaparte River, Deadman River, and Brassy Creek. Other finer materials, such as silt and fine sands, were laid down as lacustrine deposits on the lake bottom.[48] Lake Thompson had successive shorelines at about 550, 490, and 425 m elevation as the glacial waters receded. The final drainage of the last glacial lake in the region, Glacial Lake Deadman, was a catastrophic outburst flood that likely flowed down the Fraser Valley and into Georgia Strait. Erosion from this event created many of the present landscape features found in the western part of the region.

Two main depressions, which are defined by the South and North Thompson rivers, dissect the surface of the Interior Plateau.[31,35,36,46] Both rivers meander through steep-sided valleys 600 to 900 m below the plateau surface. The Kamloops Depression cuts a deep transverse over 115 km from Little Shuswap Lake (340 m) in the east to the west end of Kamloops Lake (335 m).[31] From there, the Thompson River descends to about 300 m at Ashcroft over 24 km.

The North Thompson Depression extends north of Kamloops for approximately 160 km. Elevational gradients on the North Thompson River are much more severe than along the

South Thompson River, declining from 406 m at Clearwater to 335 m at Kamloops Lake over a distance of 135 km.

Topography throughout the Thompson-Pavilion region is irregular. Large flat areas occupy part of the valley floors, and the uplands are dominated by benches, terraces and deep gullies. In the western part of the Thompson Valley, the valley width ranges from 1.5 to 3.5 km, but it broadens to about 8 km at Ashcroft [39] and Kamloops.

Lying in the rain shadow of the Coast and Cascade mountains, the climate in the Thompson-Pavilion region is strongly influenced by weather systems that move from west to east off the Pacific Ocean in both summer and winter.[39] In summer, hot, dry air masses from the Great Basin to the south influence maximum temperatures and moisture availability for plant growth. Arctic air masses affect maximum lows in winter and early spring although most of the low-elevation grasslands usually experience moderate winter temperatures.

Photo: B. Wikeem

Sagebrush and bunchgrass canopies affect the distribution of snow on grasslands.

Topography, elevation and aspect significantly modify local climates throughout the Thompson-Pavilion region, especially in the large valleys where heat is trapped (Table A 5.4). The climate in the hottest and driest part of the region at Ashcroft is similar to the south Okanagan (Table A 5.3) where summer maximums can exceed 40°C, and winter temperatures rarely drop below –25°C.

Soil moisture deficits are very high, which limits plant growth especially in the valley bottom. Even in this driest part of the Thompson Valley, the significant influence of the rain shadow is expressed over an elevational gradient as grasslands extend from the valley floor to parklands on south-facing slopes in the Engelmann Spruce-Subalpine Fir zone on Cornwall Hill. The effect of elevation on local climate has been documented best on the Lac du Bois grasslands near Kamloops where annual precipitation varies from about 240 mm in the valley bottom to 300 mm on grasslands above 850 m elevation. Also, temperatures are warmer and frost-free periods are longer in the valley bottoms than at higher elevations (Table A 5.3).

The climate becomes progressively moister and cooler from west to east through the Thompson Valley. At Chase, the climate is more moderate than at Ashcroft, and is similar to mid-elevation grasslands near Kamloops. Total precipitation at Chase (280 mm) is about 30% higher than at Ashcroft (193 mm) (Table A 5.3).

Photo: B. Wikeem

Grasslands in the Interior Douglas-fir zone descend to the valley bottom and mix with cottonwood communities near Chase.

In the eastern part of the Thompson Valley, grassland communities resemble higher elevation grasslands elsewhere in the region, and they merge with riparian and cottonwood communities along the South Thompson River and Little Shuswap Lake near Chase.

Compared to most of the Thompson-Pavilion region, the climate of the North Thompson Depression is generally cooler and wetter, and influenced more by Continental Polar air masses in the winter than by hot air masses from the Great Basin in summer. Large areas of grassland are confined mainly to the southern part of the depression between the Heffley Creek drainage and Kamloops, but small pockets of steppe vegetation can be found on steep, south-facing slopes as far north as Clearwater.

The parent material for all grassland soils in the region originated from mica, schists, gneisses, orthoclase feldspars, argillites, quartz, granites, basalts, and limestones that were transported by ice and water. Parent materials for most soils above 590 m elevation were derived from glacial till and outwash. Most of the outwash overlaid till and subsequent channeling by glacial meltwater produced hummocks, kames, and eskers that are dominant landscape features today.[48]

Below 590 m, surficial deposits on the upland terraces consist of glacial and glaciofluvial deposits. These deposits are interspersed with areas of rock outcrop or near-surface bedrock. Streams that reworked the glacial materials have added more recent deposits and wind has covered these coarse fragments with a layer of fine loess that exceeds 35 cm on some sites.[39,48]

Numerous grassland soils are found in the region (Appendix 6). Brown Chernozems are most common at the lowest elevations in the Thompson valley where the vegetation is dominated by bunchgrasses and big sagebrush. Regosolic soils are also common, especially along the Thompson River from Savona to Ashcroft. Recent wind-blown deposits and alluvial sediments contribute to the parent materials, but high soil moisture deficits often restrict soil development to the shallow surface horizons.[39] On other sites, Solonetzic soils can develop on Chernozems where water percolation is restricted and high evapotransporation rates result in an accumulation of soluble salts.[47] This is particularly common in the western part of the region.[29]

Photo: B. Wikeem

Saline soils often form in small ponds where evaporation is high, while Brown or Dark Brown Chernozems dominate the uplands.

Dark Brown Chernozems characterize mid-elevation grasslands. These soils develop from coarse-textured compact till where the climate is slightly moister and cooler than in the valley bottoms. Dark Brown and Black Chernozems are often dominant at higher elevations depending on slope and topography, [48] while Dark Gray Chernozems prevail where grasslands and Douglas-fir forest merge.[11] Dark Brown Chernozems are common on grassland in the Ponderosa Pine zone, but these soils are replaced by Dark Gray Chernozems under pine savannah where needle-cast creates a thin layer of forest litter.

Eutric Brunisols occupy forest sites where canopies begin to close.[26] Most of these soils are well drained with textures varying from sandy to gravelly loam, to sandy-clay loam.[26] Ponds and wetlands often have saline or alkaline soils that can form in localized areas of depression or restricted drainage.

Development of Grasslands

Grasslands in the Thompson-Pavilion region developed in a similar manner as those elsewhere in the province. Episodic advances of grassland vegetation have occurred since the initial glacial retreat about 13,000 BP. The extent of grasslands in the province, however, varied as climate fluctuated over six distinct periods. Fossil pollen data collected from the Hat Creek Valley indicate that shrub-steppe communities containing sagebrush existed as early as 10,500 to 8500 BP and then declined in extent from 8500 to 4000 BP.[13]

Fire has influenced the development and maintenance of grasslands in the Thompson-Pavilion region.[44,45] Depending on the biogeoclimatic zone, recurrent fires at 5 to 50 year intervals, likely sustained forest-grassland ecotones, and maintained open, savannah stands in dry forests.[4] In addition to lightning-caused fires, aboriginal peoples also used fire to create and maintain areas for hunting. Fire frequency probably increased with European settlement as a result of railroad construction and from settlers creating open range for domestic livestock.[45] Fire has not been a significant factor on most of the grasslands in the region for over a century because of fire suppression or insufficient fuel loads resulting from grazing.

Deer and elk were the primary ungulates that grazed grassland in the Thompson-Pavilion region before Europeans arrived in 1811. Historical ungulate populations levels are unknown, but by the early 1800s, elk herds in the Thompson-Pavilion region were decimated and have never recovered.[37]

Horses were introduced to the Nlaka’pamux peoples on the Southern Thompson Upland around the 1790s, and in the Thompson Valley the Secwepemc likely had horses by 1830.[41] By the 1840s, horses were common among most aboriginal bands, and by 1870, several entrepreneurial natives had large herds of horses that they traded to the Hudson’s Bay Company.[2] These horses roamed freely and grazed on grasslands year-round.

The grazing potential of the interior grasslands was recognized not long after the first fur traders arrived at Kamloops in 1811, particularly at Westwold (Grande Prairie) and Lac du Bois, which were used as breeding and wintering grounds for horses.[1] Hundreds of horses were needed for the fur brigades, and by 1849, the Hudson’s Bay herd stood at “400 horses, mares and colts,”[43] and by 1855 the herd had grown to 735 animals.[2]

Photo: B.C. Archives

Roundup at Knutsford about 1910.

About 1846, the Hudson's Bay Company transferred most of their horses and cattle to

Kamloops from trading posts south of the 49th parallel in response to the impending settlement of the International Boundary dispute. These were probably the first cattle brought into the interior of British Columbia,[32] but for 12 years the population levels remained low. The discovery of gold in 1858, however, brought thousands of cattle, horses, mules, and sheep in from Oregon and Washington. These animals were driven over the Okanagan Trail along Okanagan Lake to Grande Prairie, through the Thompson Valley to Cache Creek, and north along the Cariboo Road to Barkerville.

Between 1861 and 1865, cattle were wintered under minimal supervision in the Thompson, Bonaparte, Hat Creek, and Nicola valleys, and then driven to gold fields in the spring.[42] Cache Creek was also a good wintering place for oxen, mules, donkeys, and horses that were used for mining and transportation. These animals wintered along the Thompson River and foraged on meadows and upland bunchgrass slopes until they were moved north to Barkerville.[12]

Overgrazing was recognized as early as 1873 when the Rev. George M. Grant journeyed down the North Thompson River and through to the coast as ‘Secretary’ to Chief Engineer Sandford Fleming's railroad planning expedition. At Ashcroft, he recorded in his diary “The cattle have eaten off the bunch grass within three or four miles of the road, and a poor substitute for it chiefly in the shape of a bluish weed or shrub ..... called sage bush [sic], has taken its place.”[1] In 1875, the botanist John Macoun also commented:

> *The benches near the river are altogether bare, except for a few bunches of grass and the Artemisia frigida (sage brush), which on all the interior plains... replaces bunch grass when it has been eaten down. The extreme bareness of the lower benches near the road arises, I believe, from the fact of the grass having been completely killed out by the traveling stock.*[21]

Photo: Agriculture Canada

Sheep grazing on Lower Grasslands west of Kamloops.

Overgrazing by cattle and sheep was not the only factor depleting grasslands in the area during early settlement. By 1913, there were an estimated 11,000 horses using the range; many of these were feral animals that had escaped or were turned loose by the Hudson’s Bay Company, settlers, and local aboriginals. These animals roamed the grasslands in the Thompson-Pavilion region and elsewhere in the province, until they were removed from the range between 1950 and 1970.[3]

In 1930, concern over the depleted condition of the interior rangelands led to the establishment of the Grazing Committee Enquiry chaired by chief forester P.Z. Caverhill. It took another 15 years, however, before range management was implemented based upon scientific principles.[50] This was the beginning of more conservative use of the grasslands,[45] and in recent years, significant improvements in range condition have occurred on many sites.

Numerous attempts were made to convert grasslands to agricultural crops between 1870 and 1920. At higher elevations on the Lac du Bois range, large tracks of land were cultivated and planted to wheat under dryland conditions, but after a few successful years, the crops failed and the land was bandoned.[24] At Walhachin, more than 2000 ha of grassland were converted to orchards under irrigation.[49] This enterprise also failed and left large tracts of plowed land vacant to slowly reestablish to native vegetation.

Photo: B.C. Archives

Construction of an irrigation system at Walhachin for orchards, 1910.

3.3.1 Representative Grassland Associations

Although grasslands are found in eight biogeoclimatic zones and over 18 biogeoclimatic units in the Thompson-Pavilion region, more than 98% of steppe vegetation occurs in the Bunchgrass, Ponderosa Pine and Interior-Douglas-fir zones (Table A 8.3). Most of these grasslands are divided among four variants that occupy the lowest elevations in the region.

3.3.1.1 Thompson Very Dry Hot Bunchgrass Variant (BGxh2)

The Lower Grasslands are distributed over 45,500 ha (Table A 8.3) from valley bottoms to about 700 m elevation. These grasslands are located primarily in the Thompson Valley from Prichard to Spences Bridge.[19] Grasslands in this variant subsist under some of the driest and hottest conditions in the province, especially at the lowest elevations between Ashcroft and Spences Bridge. Most of the grasslands occur below the Ponderosa Pine zone, but others merge directly with Douglas-fir -forest in some places.[29]

The Lower Grasslands were originally classified as the Big Sagebrush zone.[38,44] Species diversity in these grasslands is generally low because of the hot, dry environment. The vegetation is characterized by the dominance of big sagebrush and widely spaced bunchgrasses mixed with few forbs. Interspaces between vascular plants are covered with numerous species of lichens, mosses, fungi, and soil algae, such as cow pie lichen, pixie-cup, and rusty steppe moss. On undisturbed sites, these inconspicuous plants form a continuous crust on the soil surface (Appendix 2),[26,29] and play an integral role in grassland ecosystems by providing protection against soil erosion, and enhancing water uptake and retention. Some species also fix nitrogen in the soil.

Photo: B. Wikeem

Big sagebrush-Bluebunch wheatgrass landscape on an east-facing slope north of Kamloops.

At climax, big sagebrush and bluebunch wheatgrass co-dominate in association with Sandberg's bluegrass, needle-and-thread grass, sand dropseed, and low pussytoes. Collectively, these six species can comprise 90% of the sparse ground cover on some sites.[38] Other species such as common rabbit-brush, junegrass, brittle prickly-pear cactus, thread-leaved fleabane, large-fruited desert-parsley, mariposa lily, yellow bell, and Thompson's paintbrush are occasional associates.[44] Needle-and-thread grass may form a climax with big sagebrush on very dry sites with coarse-textured soils,[33] while sand dropseed, Indian ricegrass and needle-and-thread grass often co-dominate on sandy soils.[44]

Rough fescue, which is most frequently found on Upper Grasslands, descends to the valley floor on north slopes along the Thompson Valley and on north- and east-facing slopes along the North Thompson River. Round-leaved alumroot, parsnip-flowered buckwheat, saskatoon, common snowberry, and western cliff fern are common associates on these sites, even though they more characteristic of higher-elevation grasslands. On relatively drier sites, rough fescue is mixed with big sagebrush and bluebunch wheatgrass.

Most of the Lower Grasslands were heavily grazed by the late 1870s, and range recovery has been slow where plant communities were severely disturbed. On most sites, bluebunch wheatgrass and needle-and-thread grass become less abundant under prolonged heavy grazing,[27] but on slightly moister sites, needle-and-thread grass may initially increase in abundance and then decline. In mid-seral stages, these species are often replaced by big sagebrush, common rabbit-brush, low pussytoes, and Sandberg's bluegrass in varying proportions. Cheatgrass, Russian thistle, woolly plantain, diffuse knapweed, Dalmatian toadflax, and leafy spurge are possible dominants at early stages of succession, while big sagebrush often remains in dense stands as the dominant shrub.[31] Seral plant communities can persist for long periods of time because of the hot, dry conditions in the Lower Grasslands, even after disturbance has been removed. The recolonization of climax dominants such as bluebunch wheatgrass onto some sites will likely be very slow, especially where historical overgrazing has extirpated these species and depleted the seed bank. These sites can only be restored to late stages of succession with artificial seeding or immigration of native seed back onto the site.

3.3.1.2 Thompson Very Dry Warm Bunchgrass Variant (BGxw1)

Nearly 30,000 ha of Middle Grassland occupies elevations ranging from 700 to 1000 m from Kamloops east to Pritchard and on the Lac du Bois range north of Kamloops.[19] Small patches of Middle Grassland are also found near Ashcroft on Elephant and Rattlesnake hills. Formerly classified as the Bluebunch wheatgrass-Sandberg's bluegrass zone,[38,44] these grasslands are usually found above the Lower Grassland and below the Upper Grassland. Often they intergrade directly with the Ponderosa Pine or Interior Douglas-fir zone.[29] Bluebunch wheatgrass and Sandberg's bluegrass are the climax dominants, and big sagebrush is mostly absent or infrequent.[26,44] Bluebunch wheatgrass is more closely spaced and forb diversity is higher than on the Lower Grasslands.[25,44] Microbiotic crusts are generally patchy, and exposed soils are common, especially on dry sites.[19]

Photo: B. Wikeem

Middle Grasslands at Lac du Bois Protected Area.

The occurrence and abundance of other plant species depends on the site and past grazing history, but may include parsnip-flowered buckwheat, prairie sagewort, needle-and-thread grass, and junegrass. Forbs generally provide little cover at climax, but characteristic species include thread-leaved fleabane, large-fruited desert-parsley, mariposa lily, and yarrow. Arrowleaf balsamroot may be present on some sites, while saskatoon, choke cherry, and Douglas maple frequently occupy moist draws.[27,44] Giant wildrye and rushes are found on moisture-receiving sites at the base of slopes.[19]

Large areas of Middle Grassland were overgrazed by the turn of the 20th century,[44] and have been slow to recover. Under prolonged, heavy grazing, bluebunch wheatgrass is replaced by needle-and-thread grass, and mid-seral stages often contain junegrass, Sandberg's bluegrass, low pussytoes, prairie sagewort, and common rabbit-brush.[27]

Ruderal species such as cheatgrass, Japanese brome, common dandelion, diffuse knapweed, spotted knapweed, and Dalmatian toadflax invade at the lowest seral stages, and are often accompanied by decumbent perennials such as low pussytoes[31]. Excessive trampling by livestock or wildlife, and soil disturbance by off-road vehicles can modify or reduce the microbiotic crust as well.[23]

3.3.1.3 Thompson Very Dry Hot Ponderosa Pine Variant (PPxh2)

Open grasslands and savannahs in the Ponderosa Pine zone can be floristically similar to the Lower, Middle, and Upper Grasslands depending on elevation, slope and aspect. About 21,570 ha of this variant occupy valley bottoms along the Fraser River between Lytton and Lillooet, along the Yalakom River to Bridge River, and as a narrow band above the Thompson, North Thompson, and Nicola rivers (Table A 8.3). It is most often located above the Bunchgrass zone and below the Interior Douglas-fir zone spanning elevations from 400 to 950 m.[14]

Photo: B. Wikeem

Open grassland and ponderosa pine savannah along the North Thompson River near Kamloops.

The vegetation is characterized by a mosaic of open stands of ponderosa pine interspersed with grasslands. A well-developed ground cover of grasses under the pine usually resembles adjacent grasslands. There is a sparse cover of lichen and mosses. Generally, the shrub layer is poorly developed although big sagebrush occupies drier sites, and scattered saskatoon and rose are often conspicuous on slightly moister locations such as depressions and gullies.[26] At climax, bluebunch wheatgrass and rough fescue are dominant grasses but their relative composition and cover depend on soil moisture and the canopy cover of ponderosa pine.

On cool, moist sites at higher elevations, rough fescue contributes more to cover than bluebunch wheatgrass.[4] Under drier conditions with open stands of ponderosa pine, bluebunch wheatgrass and big sagebrush are often associated with Sandberg's bluegrass, junegrass, yarrow, and lemonweed. Rough fescue can also be present but usually as a subordinate species.[19] On very dry sites, or where soils are shallow, big sagebrush and compact selaginella co-dominate with lesser amounts of rough fescue, junegrass, yarrow, Sandberg's bluegrass, and prairie sagewort. Big sagebrush is usually absent on sites with very shallow soils.

Historical grazing by horses, sheep and cattle have influenced plant communities. This is particularly true on the Dewdrop range from the Tranquille River to Copper Creek, where the combined herd of feral horses, and those owned by the Cooney family, exceeded 400 head during the late 1800s.[30] Needle-and-thread grass replaces bluebunch wheatgrass as the dominant species on drier sites that have been heavily grazed, whereas Kentucky bluegrass replaces rough fescue in moister locations. Bluebunch wheatgrass and rough fescue are usually replaced by needle-and-thread grass, junegrass, and Sandberg's bluegrass with heavy grazing, and arrowleaf balsamroot, low pussytoes, and western yarrow become more abundant. Non-native annuals and noxious weeds such as cheatgrass, diffuse and spotted knapweed, leafy spurge, and Dalmatian toadflax are often present on overgrazed sites that are in an early seral stage.[31]

3.3.1.4 Thompson Very Dry Hot Interior Douglas-fir Variant (IDFxh2)

Upper Grasslands and parklands occupy 24,945 ha of the Thompson-Pavilion region from 850 to 1130 m elevation.[15] These grasslands are usually found above the Ponderosa Pine or Bunchgrass zone north and south of Kamloops, and at the north end of the Hat Creek Valley. Grasslands occur primarily on rolling terrain with gentle gradients, and on all slope positions. Rough fescue and bluebunch wheatgrass often co-dominate mid- to late-seral communities combined with junegrass, spreading needlegrass, and Columbia needlegrass on the lower elevations of the Upper Grasslands. The abundance of rough fescue varies greatly among sites, but is usually most prevalent on north and east slopes.[44]

Photo: B. Needham

Upper (foreground) and MiddleGrasslands (background) in Lac du Bois Grassland Protected Area.

Plants are closely spaced and often form a continuous canopy. Plant species diversity increases over an elevational gradient from the Lower to Upper Grasslands. Typical forbs that occur at higher elevations include perennials such as arrowleaf balsamroot, common harebell, sticky purple geranium, lemonweed, parsnip-flowered buckwheat, yarrow, short-beaked agoseris, and timber-milkvetch. Other members of the pea family such as pulse milk-vetch, field milk-vetch, and meadow birds-foot trefoil are more common than in lower elevation grasslands.[54] Shrubs are generally absent, and the moss layer is usually poorly developed.[19] Rusty steppe moss is the most common cryptogam in a sparse microbiotic layer controlled by the dense herbaceous cover. Cow pie lichen becomes less abundant than on lower elevation grasslands, but other species, such as dog pelt, become relatively more abundant.

Dry sites are dominated by bluebunch wheatgrass with small amounts of prairie sagewort, junegrass, needle-and-thread grass, and umber pussytoes. In moist drainage channels and swales, Kentucky bluegrass is often the principal species, mixed with death camas, meadow birds-foot trefoil, nodding onion, and early blue violet as infrequent associates.

Livestock overgrazing dating back to the late 1800s, has altered large areas of Upper Grassland in the Thompson-Pavilion region, however, considerable improvement in range condition has occurred on some sites over the last 30 years as a result of good range management. At early-seral stages, bluebunch wheatgrass and rough fescue contribute little to cover, or may be absent, and exposed mineral soil is common.[27] Needle-and-thread grass, low pussytoes and yarrow are common native perennials mixed with non-native annuals and biennials such as dandelion, cheatgrass, and Russian thistle. On moist sites that are heavily grazed, Kentucky bluegrass often dominates, while sand dropseed becomes prevalent on dry, sandy soils.

The role of cheatgrass, Russian thistle, and other ruderal annuals as invaders [27,44] appears to have changed over time. In more recent years, their dominance has been reduced or replaced with noxious weeds such as spotted knapweed, common hound’s-tongue, leafy spurge, and Dalmatian toadflax, which have become more prevalent since the 1970s.

An abundance of needle-and-thread, junegrass, prairie sagewort, Sandberg’s bluegrass, and exposed mineral soil characterizes mid-seral stages.[27] Kentucky bluegrass can still dominate moist sites at mid-succession. Columbian needlegrass, Richardson’s needlegrass, bluebunch wheatgrass, and rough fescue can also be present, but they are not abundant until late seral stages. Arrowleaf balsamroot, timber milk-vetch, yarrow, and meadow salsify are typical mid-seral forbs.[44]

Bluebunch wheatgrass can attain dominance in late-seral communities, but is eventually replaced by rough fescue, especially on cooler east and north aspects. Rough fescue alone can provide up to 95% of the vegetative cover on some sites. At climax, plant diversity often declines because few species can compete with rough fescue or establish in the thick litter layer.[54]

Dryland farming during the early 20th century destroyed the native vegetation on considerable areas of grassland. Weedy and agricultural forage species colonized abandoned fields, and some species, such as quackgrass and redtop, still persist on moist sites. Kentucky bluegrass dominates many of these sites that now resemble mid- to early-seral stages induced by overgrazing. Columbian needlegrass, bluebunch wheatgrass, and rough fescue have colonized some sites still dominated by Kentucky bluegrass, but none of these species are abundant. Forbs such as timber milk-vetch, yellow-rattle, pussytoes, long-stalked starwort, and old man's whiskers are also present on these sites.[54]

3.3.1.5 Thompson Dry Cool Interior Douglas-fir Variant (IDFdk1)

Grasslands in the Thompson Dry Cool Interior Douglas-fir Variant occupy about 5745 ha between 1130 and 1460 m elevation (Table A 8.2). These grasslands are a continuation of the Upper Grasslands on cool, moist aspects, and often form 'islands' of grassland in an 'ocean' of forest. The largest areas of steppe vegetation are found in the Trachyte Hills west of Cache Creek and northeast of Paul Lake near Kamloops.

Photo: B. Wikeem

Upper Grasslands in the Interior Douglas-fir zone west of Cache Creek.

Rough fescue and bluebunch wheatgrass are climax dominants with spreading needlegrass, yarrow, and junegrass as common associates. Bluebunch wheatgrass and junegrass dominate drier sites while moister sites support dense stands of trembling aspen with an understory of Nootka rose, common snowberry, rough fescue, Kentucky bluegrass, American vetch, and star-flowered Solomon's-seal.

Past overgrazing has altered many of these grasslands. Early-seral communities contain Sandberg's bluegrass, Kentucky bluegrass, stiff needlegrass, low pussytoes, cut-leaved daisy, trailing daisy, and dandelion. Exposed soil is often prevalent, and noxious weeds such as spotted knapweed and Dalmatian toadflax are common.

Mid-seral sites are more densely vegetated, and are dominated by Kentucky bluegrass, stiff needlegrass and spreading needlegrass. Forbs such as timber milk-vetch, field locoweed, western pasqueflower, and small-flowered penstemon are present. Kentucky bluegrass dominates moister sites along with timber oatgrass, sticky purple geranium, old man's whiskers, and upland larkspur.

3.3.1.6 Very Dry Cool Montane Spruce Subzone (MSxk)

Edaphic grasslands in the Montane Spruce zone are occasionally found at mid-elevations between the Interior Douglas-fir and the Engelmann Spruce-Subalpine Fir zones, especially in the Pavilion Ranges Ecosection. Small, isolated areas of grasslands totaling 1500 ha occupy south slopes of the Clear Ranges near Lillooet and on Cornwall Hills west of Ashcroft at elevations ranging from 1320 to 1650 m.

Photo: B. Wikeem

Grasslands on south-facing slopes in Cornwall Hills Provincial Park.

Several plant communities containing bluebunch wheatgrass have been classified. On some sites, bluebunch wheatgrass is the sole dominant with junegrass and white pussytoes as common associates. Douglas-fir savannah is prevalent on other sites that have a moderate shrub layer consisting of tall Oregon-grape and common snowberry. Bluebunch wheatgrass dominates the understory on these sites along with pinegrass and showy aster. Sometimes, big sagebrush may be a co-dominant with bluebunch wheatgrass, common juniper and arctic lupine. Western fescue, sulphur buckwheat, green wintergreen, and western pasqueflower can also be present on some sites. Rough fescue communities also can form in the Montane Spruce zone, but species diversity is usually low. Shrubs are usually absent in these communities, and herbs other than rough fescue are sparse but may include bluebunch wheatgrass, junegrass, field chickweed, and Kentucky bluegrass.[18]

Pinegrass – Arrowleaf balsamroot communities are found at about 1700 m elevation on steep south slopes at Cornwall Hills. Yellow rattle, sticky purple geranium, death camas, and arctic lupine are common associates with pinegrass and arrowleaf balsamroot.

Richardson’s needlegrass, Kentucky bluegrass and spike trisetum are also abundant.[53] Pinegrass – Mixed forb communities are also found in clearings on moderate slopes at slightly higher elevations where pinegrass dominates. These communities have a diverse herb layer consisting of sticky purple geranium, death camas, arctic lupine, yarrow, fireweed, and old-man’s whiskers. Spike trisetum and timber oatgrass may also be present but not abundant, and kinnikinnick may co-dominate on drier sites.[53]

Little information exists regarding ecological condition and seral stages of Montane Spruce grasslands in the Thompson Basin area. No exclosures exist to compare grazed plant communities with other sites having long-term protection. Nonetheless, old man’s whiskers appear to increase with grazing on some sites on Cornwall Hills, which confirms observations from other Montane Spruce subzones in the Central Interior Ecoprovince.[16]

3.3.1.7 Grasslands in Other Biogeoclimatic Units

Nearly 8000 ha of grassland are found in small, discontinuous patches dispersed among numerous variants in six biogeoclimatic zones in the Thompson-Pavilion region, but nearly 90% of them are found in the Interior Douglas-fir zone (Table A 8.3). Small parcels of grasslands are also found in the Montane Spruce, Interior Cedar-Hemlock, Alpine Tundra, Sub-Boreal Pine-Spruce and Engelmann Spruce-Subalpine Fir zones (Table A 8.3).

Photo: B. Wikeem

Subalpine parkland in Cornwall Hills Provincial Park.

Although grasslands in the Very Dry Cold Engelmann Spruce-Subalpine Fir Subzone occupy less than 500 ha in the Thompson-Pavilion region, they have a unique flora where low-elevation grassland communities merge with alpine vegetation. Parklands at Cornwall Hills Provincial Park form a mosaic with Barclay’s willow shrub-carrs, moist forb meadows, pockets of lodgepole pine forest, and open grasslands. The grasslands usually occupy dry sites with moderate to steep south-facing slopes.

Pinegrass often dominates more mesic sites while kinnikinnick and pussytoes co-dominate in dry habitats. Common herbs include old man’s whiskers, thread-leaved sandwort, short-beaked agoseris, and fireweed. Spike trisetum and timber oatgrass are also present, especially near the grassland-forest ecotone. Moist forb meadows have high floristic diversity, and include species such as alpine timothy, sedges, showy pussytoes, old man's whiskers, thread-leaved sandwort, showy Jacob's-ladder, western meadowrue, and diverse-leaved cinquefoil.[53]

3.3.2 Distinguishing Flora and Plant Species at Risk

The present grassland flora of the Thompson-Pavilion region represents the northern distribution of plant species that immigrated into British Columbia from the Great Basin region following glacial recession. The principal migration corridors were through the major depressions created by Tertiary uplifting and subsequent erosion during deglaciation. Barriers into the Thompson-Pavilion region included heights of land separating the Okanagan and Thompson drainage systems, and the highest elevations of the Interior Plateau in the Southern Thompson Upland. These barriers resulted in geographic isolation of some grassland plant populations, and restricted immigration of other species beyond the Okanagan Valley.

Although elevations on the valley floors are similar in the Okanagan and Thompson valleys, less than 50% of the red- and blue-listed plant species found in the Okanagan still remain in the Thompson-Pavilion region (Table A 9.2; Table A 9.1). This decline in species diversity occurs over less than 2^{o} of latitude. The Thompson-Pavilion region, however, has not been inventoried as intensively as the Okanagan, which may partly explain the discrepancy between the two regions.

Fifty-five red- and blue-listed vascular plants are found in the Thompson-Pavilion region (Table A 10.3), but only a few species are unique to the region. Low hawksbeard, a red-listed species, is known only from Pavilion Lake and Lac du Bois grasslands.[10] Rough dropseed and satin grass also appear to be unique to the area, and are restricted to the Lower Grasslands.

Photo: B. Wikeem

Okanagan fameflower is well adapted to rock outcrops in the Okanagan and Thompson valleys.

Tall beggarticks, scarlet globemallow, Okanagan fameflower, and rabbitbrush goldenweed are found in dry, Lower Grassland habitats in the Okanagan and Thompson valleys.[6] Several other red- and blue-listed species such as Geyer's onion, freckled milk-vetch, poverty weed, and threadstalk milk-vetch occupy more than one grassland variant in the Thompson-Pavilion region. Oregon checker-mallow, another red-listed species, occupies ephemeral drainages and moist meadows from 800 to 950 m elevation in the Middle and Upper grasslands of Lac du Bois Protected Area north of Kamloops. This species is not only unique to the Thompson Valley, but collections at Lac du Bois are the only verified specimens found in Canada.[51] Blue grama and scarlet gaura are red-listed species also found in the Middle and Upper Grasslands in the Thompson-Pavilion region. Both species are present in the East Kootenay Trench where they appear to have originated from east of the Rocky Mountains.

Photo: B. Wikeem

Oregon checker-mallow is known in Canada only from Lac du Bois Protected Area.

A number of non-threatened grassland species reach their northern distribution in North America in the Thompson-Pavilion region. Idaho fescue and rough fescue, which are both climax dominants in Ponderosa Pine and Interior Douglas-fir grasslands, reach their northern limits near Cache Creek and just north of Lillooet, respectively.[9,27,28] Grey horsebrush, a small shrub that is relatively common in the South Okanagan Basin,[10] is likely at its northern distribution limit in the Middle Grasslands in Lac du Bois Protected Area.[55] Similarly, shaggy daisy, Weiser milk-vetch, and tufted phlox are not found north of the Thompson Valley.

Green rabbit-brush, bitter-root, plains prickly-pear cactus, and snow buckwheat, which are all present in the South Okanagan Basin, are found infrequently in the Thompson Valley near Ashcroft at low- to mid-elevations.[6] These species likely immigrated through corridors from the Similkameen Valley to the Nicola Basin and then along the Nicola River to the lower Fraser River.

Twenty-five red- and blue-listed grassland communities have been classified in the Thompson Basin area: eighteen in the Bunchgrass zone, three each in the Ponderosa Pine and Interior Douglas-fir zones, and one in the Engelmann Spruce-Subalpine Fir zone (Appendix 11). More than 70% of these communities are considered endangered.

Meadow-steppe communities near Chase represent some of the most unique grasslands in the province. These forb-rich communities are likely a northern extension of relatively similar grasslands in the Okanagan Valley, and share numerous species that are more abundant in southern grasslands such as silky lupine, Columbia bladderpod, silverleaf phacelia, and thread-leaved phacelia. Silky lupine, which is common in the Okanagan Valley and Southern Thompson Upland, is abundant east of Pritchard to Chase, and from the valley floor to the forest edge. On relatively drier sites, bluebunch wheatgrass is the dominant species mixed with many forbs including balsamroot, upland larkspur, yellow bell, mariposa lily, lemonweed, and several species of desert parsley. Idaho fescue, characteristic of these grasslands, often co-dominates with bluebunch wheatgrass and reaches its northern distribution from the Okanagan Valley on the north side of the South Thompson River at Chase.

Upper Grasslands north of Chase have one of the most diverse forb communities in the province.

Photo: B. Wikeem

On mid- and high-elevation grasslands, glacier lily becomes abundant, especially near timberline, and combined with other forbs, provides a magnificent spring floral display. Shrub-steppe communities also form on slightly moister sites where prickly rose, common snowberry, black hawthorn, saskatoon, and chokecherry produce an overstory for many of the same forbs that occur on open grassland.

3.3.3 Grassland Associated Ecosystems

The physical diversity of the grassland landscape in the Thompson-Pavilion region provides ecological conditions that support a variety of associated ecosystems. At the lowest elevations, plant communities are strongly influenced by high temperatures, coarse-textured soils, the steep slopes of the valley walls, and the major rivers that meander through the valley bottoms. Cliffs, talus slopes, and rocky outcrops that remain along the river valleys after episodes of glacial flooding provide specialized habitats for plants and animals. Marshes, fens, swamps, and alkaline meadows dot the rolling terrain of the plateau, and act as oases in the larger grassland environment.

Cottonwood forests are most common along the floodplains of the Thompson River and its tributaries in the Lower Grassland and Ponderosa Pine zones. In the Lower Grasslands, black cottonwood, trembling aspen and paper birch form a mixed canopy over a dense understory of Douglas maple, red-osier dogwood and common snowberry. Showy aster and common horsetail occur frequently, but the herb layer is poorly developed.[19]

Cottonwood forests in the Ponderosa Pine zone are diverse and often include additional species such as ponderosa pine, water birch, roses, choke cherry, tall Oregon-grape, star-flowered false Solomon's seal. Poison-ivy, mountain alder and white clematis occur less frequently.[18,19] Dense stands of narrow-leaf willow form on sand bars where prolonged flooding and strong currents impede soil development. Generally, plant species diversity on these sites is low, but reed canarygrass, mountain alder, and black cottonwood may be present.[18,20]

Despite the arid climate, a variety of wetlands occur throughout the grassland landscape as relics of glacial deposits and melting. Some of these wetlands are rock-lined, while the bottoms of others are covered with a fine layer of sand or silt. Water conditions can be saline or fresh, and some contain persistent water while others dry out annually, or periodically over many years.[7] A diversity of plant communities form depending on soils, water movement, and water quality factors such as alkalinity.

Photo: B. Wikeem

Cottonwood forest along the North Thompson River.

Saline flats develop on fine-textured, poorly drained soils in depressions or on edges of shallow ponds from the Lower to Upper Grasslands and in the Ponderosa Pine zone. These meadows are seasonally flooded in spring and then dry rapidly in the summer, leaving a salt crust on the exposed soil surface. Alkali saltgrass is usually the dominant herb, but alkali cordgrass, sedges, and Nevada bulrush are often common associates.[20] On other sites, maritime or red glasswort forms a scarlet band between the upland vegetation and pond bed. Kentucky bluegrass and foxtail barley become prevalent on heavily grazed sites.

Photo: B. Wikeem

Saline flats often develop on lake bottoms in very dry years.

Cattail and bulrush marshes occur from valley bottoms to montane forests, and are the most common wetland associations on the rolling terrain of the Upper Grasslands. Cattail marshes have low species diversity, and are most common in non-alkaline potholes, lake edges, small ponds and ditches whereas Bulrush – Woolly sedge – Baltic rush marshes usually form in moderately alkaline conditions. Bulrush marshes may be dominated by hard- or soft-stemmed bulrush, American bulrush, or Nevada bulrush.

Bands of various Baltic rush communities frequently surround marshes on fine-textured soils. Varying amounts of Kentucky bluegrass and Baltic rush dominate these sites. Silver weed and field mint are characteristic native species in these communities, but non-natives such as quackgrass, redtop, white sweet-clover, black medic, white clover, dandelions, bull thistle, and Canada thistle occur with excessive grazing or disturbance.[52] Perennial sow thistle, a palatable noxious weed, is often prevalent on both grazed and ungrazed areas. Baltic rush – Field sedge marshes often surround bulrush meadows where longer periods of flooding persist.

Photo: B. Wikeem

Bulrush marsh on the Upper Grasslands.

Kentucky bluegrass – Baltic rush communities also occupy moist depressions, channels and swales from the Lower to Upper Grasslands and in the Ponderosa Pine zone. On dry sites, giant wildrye, roses, blue wildrye, and timber milk-vetch are common associates with Kentucky bluegrass and Baltic rush.[18] Spike-rush, Baltic rush and western witchgrass dominate moist sites in depressions and along streams in association with field mint, silverweed, and beaked sedge. Forbs are more prevalent in Kentucky bluegrass – Baltic rush communities on the Upper Grasslands where purple sticky purple geranium, northern bedstraw, early blue violet, meadow birds-foot trefoil, and field milk-vetch are common associates under a shrub layer of prairie rose.[52]

Fens are a common feature in the Upper Grasslands as conditions become slightly cooler and moister than those at lower elevations. Water sedge – Beaked sedge fens occupy a wide variety of landscape positions such as basins, depressions and flats. These wetlands usually flood each year to form shallow ponds that draw down through the summer. Species diversity is generally low in these communities.

Bebb's willow – Bluejoint reedgrass swamps occasionally occur on Interior Douglas-fir zone grasslands. These communities occupy sites such as gullies, channels and lake margins that are temporarily flooded in spring and dry out by mid-summer.[20] Bebb's willow usually dominates these diverse communities in association with thickets of mountain alder, pussy willow, red-osier dogwood, black twinberry, roses, and red raspberry. Bluejoint reedgrass dominates the herb layer, especially on slightly drier sites, along with common horsetail, violets, tall mannagrass, field mint and purple-leaved willowherb.

Trembling aspen groves are widespread throughout the Thompson Basin. They occupy level to gentle sites, toe slopes and gullies from valley bottoms to the Upper Grasslands. Trembling aspen frequently occupies riparian or seepage sites in the Ponderosa Pine zone, especially on mid- to lower-slopes with cool aspects. Rough fescue, arrowleaf balsamroot, bluebunch wheatgrass, pinegrass, yarrow, and prairie sagewort are common associates in open stands of aspen. Rough fescue or pinegrass dominate the understory of drier and wetter sites, respectively. A dense mix of common snowberry, birch-leaved spirea, Douglas maple, and Nootka rose usually form under mature aspen stands with closed canopies. These communities generally have a poorly developed herb layer.[18,19]

Photo: B. Wikeem

Aspen swales on Upper Grasslands at Lac du Bois Protected Area.

Trembling aspen communities are represented best in the Upper Grasslands where they are part of a mosaic of habitats that includes grasslands, dry forests, and wetlands. Here, aspen copses occur on cool aspects and in moist swales and depressions. Open to dense aspen stands provide an overstory for a moderately dense shrub layer depending on the extent of tree canopy closure. Prairie rose, Nootka rose, and common snowberry are often dominants mixed with smaller amounts of red-osier dogwood, water birch, mountain alder, saskatoon, or choke cherry. Typical herbs include Kentucky bluegrass, Columbian needlegrass, pinegrass, blue wildrye, American vetch, asters, blue wildrye, Canada violet, timber milk-vetch, long-stalked starwort, old man's whiskers, star-flowered false Solomon's seal, and lemonweed.[52] Non-native species such as dandelions and common hound's-tongue can become abundant in heavily disturbed areas.

Rock outcrops are common in the region, especially along the Thompson River valley and its tributaries. Soils, where present, are shallow, and are derived from colluvial materials or bedrock. Bluebunch wheatgrass and compact selaginella dominate these sparsely vegetated sites in the Lower and Middle Grasslands. Scattered big sagebrush, common rabbit-brush, Sandberg's bluegrass, brittle prickly-pear cactus, and prairie sagewort are also frequently present. Sites with cool aspects in the Ponderosa Pine zone may have less common species such as grey reindeer lichen, pretty shootingstar and small-flowered fringecup.

On rock outcrops at higher elevations, widely spaced ponderosa pine or Douglas-fir may be present. Species composition of the shrub and herb layers is highly variable depending on slope, aspect and elevation, but may include a mix of common rabbit-brush, big sagebrush, Rocky Mountain juniper, Sandberg's bluegrass, rough fescue, bluebunch wheatgrass, or needle-and-thread grass.[19] Some less common species on these sites include western cliff fern, Michaux's mugwort and golden-aster.[54] Okanagan fameflower also occurs infrequently on rock outcrops from the Lower Grasslands to the Montane Spruce zone in the Thompson Basin, although it can be locally abundant, especially on exposed lavas.

Photo: B. Wikeem

Rock outcrops are a common feature on many grasslands in the Thompson River Valley.

Species composition on rock outcrops in the Montane Spruce zone reflect the flora of the surrounding forest with widely scattered lodgepole pine and saskatoon often forming a sparse overstory. Common understory herbs include compact selaginella, falsebox, black huckleberry, pinegrass, shrubby penstemon, kinnikinnick, timber oatgrass, white pussytoes, and spotted saxifrage.[18]

Photo: B. Wikeem

Talus slope at the foot of a cliff in the Bunchgrass zone.

Cliffs and talus slopes are commonly associated with grasslands in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones, especially along the valley walls from Kamloops to Spences Bridge. Cliff vegetation is very sparse and persists only where vestiges of soil can form in rock crevices or on relatively flat areas on cliff faces.

Talus slopes are characterized by a coarse matrix of colluvial material that functions as a rock mulch even on steep slopes. Depending on the slope and aspect, representative plant species can include Douglas-fir, Douglas maple, saskatoon, Rocky Mountain juniper, bluebunch wheatgrass, and Sandberg's bluegrass. The shrubs often form a garland around the margins of the talus. Choke cherry, big sagebrush, roses, and poison ivy usually dominate steep, south-facing talus slopes, while saskatoon is more characteristic of cool aspects.[19] At higher elevations in the Interior Douglas-fir zone, trembling aspen, Douglas-fir, and Rocky Mountain juniper are often prevalent, and the herb layer is sparse or absent.[18]

3.3.4 Representative Fauna and Species At Risk

The mosaic of open grasslands, deciduous forests, savannah forests, wetlands, cliffs, and talus slopes that occurs in the region provides a diversity of habitats for wildlife. Most species use a variety of habitat types to complete their life histories, and move freely among different grassland types and their associated ecosystems.

No fauna are unique to the Thompson-Pavilion region, although several species approach their northern distribution limit in the region. In addition, the diversity of fauna declines from the Southern Okanagan Basin to the Thompson Basin. For example, 76 rare and endangered species occur in the Okanagan, Similkameen, and Kettle valleys (Table A 13.2) compared to 21 in the Thompson-Pavilion region (Table A 13.3). No insects are listed as rare and endangered in this region; likely because fewer surveys have been completed in the Thompson-Pavilion region compared to southern parts of the province.

Photo: B. Wikeem

The Mormon Cricket is a common insect in sagebrush grassland.

Fewer rare and endangered reptiles and amphibians occur in the Thompson-Pavilion region (11) than in the south Okanagan (17), and all these species are blue-listed (Table A 13.2; Table A 13.3). Most of the amphibians and reptiles in this region occur in steppe vegetation and associated wetlands, especially in the Lower Grasslands. Species diversity declines from the Lower to Upper Grasslands, and only a few hardy species remain at the highest elevation grasslands in the Montane Spruce and Engelmann Spruce-Subalpine Fir zones.

The Common Garter Snake, Long-toed Salamander, Western Garter Snake, and Spotted Frog are found in almost all grasslands from low to high elevation. Other species such as the blue-listed Gopher Snake, Western Rattlesnake, Great Basin Spadefoot, Rubber Boa and Racer are mostly confined to the hotter, lower elevation grasslands in the Bunchgrass and Ponderosa Pine zones[40]. The Western Rattlesnake is found from Kamloops to Lytton, particularly on south-facing slopes below 850 m along the north side of Kamloops Lake.

Photo: B. Wikeem

The Western Rattlesnake reaches its northern distribution near Lillooet.

Although 10 amphibians and reptiles are found in the Interior Douglas-fir zone,[40] only the Common Garter Snake, Wood Frog, and Great Basin Spadefoot inhabit the Upper Grasslands. Other species that are found in slightly moister and cooler grasslands include the Long-toed Salamander, Western Toad, Spotted Frog, and possibly, the Racer. The Long-toed Salamander, Spotted Frog and Western Toad are the only amphibians found on Montane Spruce zone grasslands and no reptiles are present in this zone.[40]

Avian diversity declines from over 300 bird species in the south Okanagan[5] to less than 180 species in the Thompson-Pavilion region. Three red-listed and eight blue-listed species are found in the area including the Bobolink, Lewis's Woodpecker, and Western Screech-owl (Table A 13.3). Other species such as the Pygmy Nuthatch and Spotted Towhee are at their northern distribution in the Thompson Valley.[24] Most of the birds found in the Thompson-Pavilion region use grasslands and associated habitats for foraging, nesting, and resting during migration.

Numerous species of birds use upland habitats for nesting and foraging.[24] The Western Meadowlark, Vesper Sparrow, Horned Lark, and Long-billed Curlew are conspicuous ground-nesting species. The Bobolink, Sharp-tailed Grouse and Common Poorwill also nest on the ground, but are more secretive, and are usually seen only when they are flushed from their nests or hiding cover. The Mountain Bluebird and Black-billed Magpie are usually found along the forest edge, or in gullies that support shrubs. The Chukar, an introduced partridge, is common on the Lower and Middle Grasslands, and is especially prominent in winter on the Lower Grasslands.

Photo: B. Wikeem

The Sharptail Grouse nests on grasslands, and uses bluebunch wheatgrass and balsamroot for cover.

Wetlands, which are scarce and widely scattered in the Lower Grasslands, are common features in the Middle and Upper Grasslands. On the Lower Grasslands, Tranquille Pond is one of the largest meadows on the Thompson River, and is particularly important for migrating, breeding and over-wintering birds. Cottonwood and riparian areas along the South and North Thompson rivers also support migrating and resident songbirds, swans, geese, and a host of duck species and shorebirds. Persistent and ephemeral wetlands occupy the Middle and Upper Grasslands, especially in Lac du Bois Protected Area, where they provide an assortment of habitats for migratory and resident birds. Up to 15 species of ducks nest in these wetlands and surrounding uplands including the American Widgeon, Mallard, Northern Pintail, Common Goldeneye, Ruddy Duck, and Canvasback.[24] Additionally, species such as the American Coot, Red-winged Blackbird, and Yellow-headed Blackbird nest in emergent vegetation along the margins of these wetlands. The Killdeer, a common shorebird in the region, nests on sparsely vegetated knolls and other barren sites in the grassland.

Photo: B. Wikeem

Tranquille meadow provides resting and foraging habitat for a wide variety of migratory and resident birds.

Aspen groves provide a rich structure and diversity of habitats for cavity-nesting birds, passerines and ground nesters that require forest or shrub canopy cover. These ecosystems also support an array of invertebrates that provides food for birds. About 135 bird species are associated with western aspen forests in North America,[34] but not all species are present in British Columbia. These stands are especially important for the Ruffed Grouse, but the White-breasted Nuthatch, Pygmy Nuthatch, Spotted Towhee, and Rock Wren also use this habitat type.[24] The Swainson's Hawk commonly nests in aspen groves, and forages over open grassland and wetlands.

The American Kestrel, Cooper's Hawk, Northern Harrier, Red-tailed Hawk, Golden Eagle, and Turkey Vulture are raptors that typically feed over grasslands from the Bunchgrass to the Engelmann Spruce-Subalpine Fir zones. Other species such as the Short-eared Owl and Burrowing Owl have narrower distributions. The Short-eared Owl is found mostly on the Upper Grasslands where it nests on the ground. The red-listed Burrowing Owl, locally extirpated, has been reintroduced on grasslands in the region.

Five red- and blue-listed mammals are found in region. The badger is the only red-listed species, while California and Rocky Mountain Bighorn Sheep, Fringed Myotis and the Spotted Bat are blue-listed (Table A 13.3).

The Mule Deer is the most common ungulate in Thompson-Pavilion region, and uses bunchgrass communities, wetlands, and aspen copse habitat for foraging and cover. Open stands of ponderosa pine and Douglas-fir, such as those found on the Dewdrop range, provide thermal cover and forage on winter ranges, while open grasslands on south slopes are important for early spring grazing.[56,57] During the summer, most deer migrate to higher elevation forests, and may use scattered open grasslands in the Montane Spruce zone as part of their summer range.

Photo: J. White

Mule Deer use sagebrush grasslands mostly as spring, fall and winter range.

California Bighorn Sheep also use open grasslands and savannah forests in the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir zones on the Dewdrop range west of Kamloops, and from Paul Mountain to Harper Ranch. Low-elevation grasslands provide mostly spring, fall and winter range. In summer, bands of California Bighorn Sheep move higher into open Douglas-fir habitat, but some sheep remain at low elevations virtually year round.

Introduced populations of Rocky Mountain Elk and Rocky Mountain Bighorn Sheep occupy open grassland and savannah habitats in the region, especially those on south-facing slopes near Spences Bridge. Low-elevation grasslands in the area provide spring, fall and winter range, while higher elevation grasslands in the Montane Spruce zone may be locally important as summer range. Cliffs and talus slopes provide escape terrain and lambing grounds for both California and Rocky Mountain Bighorn Sheep.

A variety of small mammals use grasslands and associated habitats seasonally or year round. The Yellow-bellied Marmot is found mostly on the Lower and Middle Grasslands, often establishing a network of burrows near rock outcrops. The Spotted Bat, Yuma Myotis, and several other species of bats roost in cliff crevices and ponderosa pine forests, and feed over adjacent wetlands and grasslands (Table A 13.3). The Muskrat, Western Harvest Mouse, and Meadow Vole are also present in wetlands throughout the grasslands. The Northern Pocket Gopher reaches its northern distribution south of the Thompson River.

Coyotes are the most common predators in the region, using grasslands at all elevations throughout most of the year. Other predators such as the Lynx, Bobcat, and Black Bear, use grasslands periodically. The red-listed Badger is found infrequently, and populations in the area have been supplemented with recent introductions.

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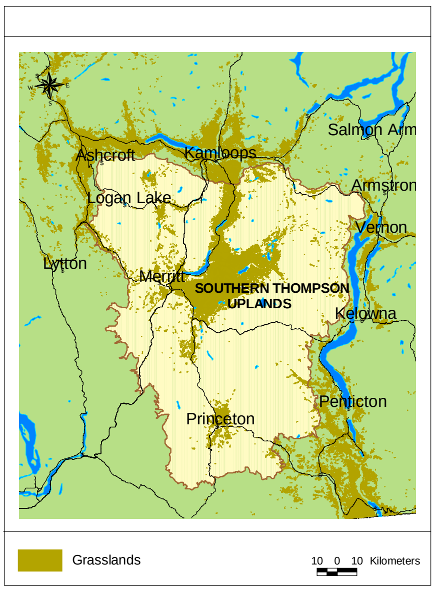
3.4 Southern Thompson Upland

The Southern Thompson Upland coincides with the southwestern portion of the Interior Plateau,[10,42,43] and is defined by the Fraser River to the west and the Thompson River to the north. These rivers flow though steep-sided valleys that are 600 to 900 m below the plateau surface.[36,42] The Similkameen Valley, and the height of land between the Okanagan and Nicola valley systems, delimits the southern and eastern edges of the upland.



Source: Grasslands Conservation Council of B.C.

Location of grasslands in the Southern Thompson Upland Ecosection.

More than 85% of the 134,325 ha of grasslands in this region are found in the Bunchgrass and Interior Douglas-fir zones in the Nicola Valley (Table A 8.4). Small areas of steppe and shrub-steppe vegetation also occur at Tunkwa Lake, and in the Mamit Valley, while low-elevation grasslands occupy the steep valley walls of the Nicola River near its confluence with the Thompson River. In the Thompson Basin, these grasslands are classified as the Lower Grasslands, and consist of shrub-steppe communities dominated by big sagebrush and bluebunch wheatgrass.[23,38,40]

Most of the grasslands in the Southern Thompson Upland are associated with the two large lowlands that are topographic relics of ancient glacial lakes. The largest expanse of steppe vegetation occupies the Merritt Basin. These grasslands extend over a gently rolling landscape that follows reaches of the glacial lake and its tributary

Photo: B. Wikeem

Rolling terrain of the Hamilton Commonage grasslands with the Coast Mountains in the background.

to higher elevations on the plateau where they abut with forest. At the lowest elevations streams in the Merritt Basin, the vegetation resembles the Middle Grasslands of the Thompson Valley.[23,38,40] Widely-spaced bluebunch wheatgrass dominates the vegetative cover mixed with a variety of forbs. Common rabbit-brush is often present but infrequent on the landscape. The microbiotic layer is usually well-developed and contains numerous lichens, mosses, and soil algae.

As the landscape lifts from the valley floor, bluebunch wheatgrass is slowly replaced by rough fescue as the climax dominant, and the topography becomes a gentle rolling plain dotted with wetlands, aspen copses, and small stands of Douglas-fir. Under these slightly cooler and moister conditions, rough fescue produces a dense cover over the soil surface. Both the shrub and cryptogam layers are poorly developed.

The Princeton Basin forms the southern limit of extensive grassland on the Southern Thompson Upland.[16] Topography here is much more variable than on the plateau surface of the Thompson Upland, and grassland and forest often join abruptly. Grasslands in Princeton Basin are located almost 100 m above the Merritt Basin. These grasslands have a floristic composition that is transitional between grassland communities in the Okanagan Valley and those on the plateau in the Nicola Valley. Rough fescue usually dominates relatively cool, moist sites, and bluebunch wheatgrass occupies drier habitats such as south-facing slopes. Idaho fescue is commonly found on grasslands in the Princeton Basin,[30] but is uncommon elsewhere in the Southern Thompson Upland.

Physiography, Climate and Soils

The topography of the Interior Plateau resulted from geomorphic activity during the Paleocene to Eocene epochs, 50 million years BP (Figure 7).[42] During the Pleistocene epoch, the entire area was covered with ice ranging from 500 to 1000 m thick. About 13,000 BP, the glaciers began to retreat, and a series of glacial lakes were formed at the edge of the melting ice-sheet. On the plateau, Lake Quilchena, Lake Hamilton, and Lake Merritt formed as the melting ice successively dammed one narrow basin after another during downwasting.[4,25] Similar lakes were created in the Princeton Basin along the Similkameen, Tulameen and Pasayten rivers.[19]

After the glaciers retreated, the scoured landscape was covered with a thick mantle of glacial drift. Terraces, composed of sand and gravel, formed where glacial meltwater entered lakes and finer materials settled as lacustrine deposits. Fluvioglacial materials were also deposited by meltwater which created drumlins, eskers and kames[36] that form the foundation of the present topography. Topography throughout the region is irregular with large flat areas occupying part of the valley floors, and uplands being dominated by benches, terraces and deep gullies.

Both Pacific maritime and continental air masses influence the climate. Warm, moist air masses moving east from the Pacific Ocean are forced up and over the Coast and Cascade Ranges in both summer and winter. As the air cools, moisture is released on the windward side of the mountains as rain or snow. These air masses are warmed as they descend on the lee of the mountains, and their associated wind is often an important factor on the plateau that creates high evaporation rates from the surrounding landscape. In summer, hot, dry air masses from the Great Basin advance northward following intermountain valleys, and influence summer maximum temperatures throughout the region. In winter or early spring, polar continental air descends from the north, which results in periods of severe cold in some years.[1,16]

Photo: B. Wikeem

Storm approaching the Upper Grasslands on Hamilton Commonage in the lee of the Coast Mountains.

Topography, elevation and aspect modify local climates throughout the Southern Thompson Upland. Merritt and Princeton, at lower elevations than Highland Valley, have the hotter and drier climates with July temperatures averaging slightly higher than 26^{o}C (Table A 5.4). Annual precipitation between these location, however, varies slightly with Princeton accumulating only about 10% more annual precipitation, mostly as snow (Table A 5.4). At Logan Lake (Highland Valley), the climate is slightly cooler and wetter than at Merritt or Princeton. Isolated pockets of grassland at Tunkwa Lake, 15 km of northwest of Logan Lake, lay in a minor rain shadow caused by Forge Mountain.

The parent material for all grassland soils in the region is comprised of an array of rock types including carbonaceous sedimentary rock, granites, gneisses, limestones, and basalts that were transported by ice and water. Most of the large areas of grassland are associated with the basins that were glacial lake bottoms.[4] The lacustrine deposits in these lakes were exposed when ice plugs broke and the glacial lakes drained leaving large areas of stone-free till. On the uplands in the Nicola Valley, parent materials are coarse-textured and primarily composed of drumlinized and compact tills. An aeolian veneer, derived from fine materials deposited in the lake bottoms and volcanic ash, cover most of the grassland terrain in the Southern Thompson Upland.[36]

Dark Brown and Black Chernozems are the dominant soils on grasslands in the Bunchgrass and Interior Douglas-fir zones.[14,44] Brunisols are also common in the Ponderosa Pine and Interior Douglas-fir zones where soil depths are shallow or conifer litter influences soil development. Black and Dark Grey Chernozems are widespread on higher elevation grasslands in the Interior Douglas-fir zone, and Regosols occur on very dry sites, particularly where bedrock is exposed or restricts development of a soil profile.[14,44]

Soils of wetlands within the grasslands vary considerably from Solonetzic soils where water percolation is restricted and high evapotransporation rates result in an accumulation of soluble salts,[43] to coarse-textured Gleysols or Organics depending on the vegetation and drainage.[30]

Development of Grasslands

Climate, soils, fire, land alienation and grazing by domestic livestock have all contributed to the historical and recent development of grasslands in the Southern Thompson Upland. Significant floristic changes have occurred since glacial recession. Although the pollen record for the Southern Thompson Upland is scant, pollen cores taken from the south Okanagan, Kelowna, and the Hat Creek Valley indicate an early post-glacial presence of steppe vegetation in the region.[18] The extent of grasslands reached their maximum 12,000 to 8000 BP when climatic conditions were warmer and drier than at present. The prevalence of sagebrush and grass pollen in these pollen cores also indicates that steppe vegetation was more widespread than at present.[6] The onset of cooler and wetter conditions beginning about 6600 BP resulted in grasslands slowly receding and gradually being replaced by conifer-birch forests. Grasslands were likely restricted to the valley bottoms by 3000 BP.[18]

Indigenous peoples have a long history in the Similkameen Valley, and their presence on the Thompson Plateau dates back about 8000 years before European contact. Natives who lived in the Similkameen Valley hunted and fished in the area and traded ochre collected near Princeton for dried salmon from the coast.[16] Historical aboriginal (Nlaka'pamux)

Nlaka'pamux woman weaving basket.

Photo: B.C. Archives

settlements were also present along the Nicola River above Spences Bridge to Nicola Lake and east to Douglas Lake.[39]

Periodic fires have likely been a significant ecological factor in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones of the Southern Thompson Upland.[3,6,40,41] These fires, which resulted from aboriginal burning and natural events such as lightning, contributed to the maintenance of grassland and savannah communities throughout the southern interior region.[17] Although horses were introduced to the Nlaka'pamux peoples by 1790, the impacts on grasslands of early horse grazing and aboriginal-set fires remains elusive.

The grasslands of the Nicola Valley were discovered by European fur traders who were searching for new routes from the interior to the coast in anticipation of the International Boundary settlement with the United States in 1846. These new routes were necessary to confine Hudson's Bay Company operations to British Territory after the boundary settlement. The last fur brigade came down the Okanagan Trail in 1841, and thereafter, trails were established between Kamloops and Fort Langley by way of Nicola Lake, and then down the Nicola River or up the Coldwater River.[49] The locations of campsites along the route were sometimes rotated because it was recognized that large herds of horses could cause overgrazing, particularly in dry years.[2]

The onset of the gold rush in 1858 brought large numbers of livestock north of the 49th parallel, and began the permanent settlement of people and livestock in the B.C. interior. During the gold rush era, many of the freight owners wintered oxen in the Nicola Valley after the freighting season was over,[17] but it wasn't until 1868 that the first herds of cattle were brought into the Nicola Valley.[29] Historically, cattle, sheep, horses, and mules grazed various parts of the Nicola Valley during the gold rush era, but currently, cattle are the primary domestic grazing animals.

Photo: B.C. Archives

Sheep foraging in ponderosa pine savannah near Merritt.

Historical populations of Mule Deer and Rocky Mountain Elk also occupied the grasslands, but by 1915 elk were nearly extirpated in the Southern Thompson Upland.[37]

By the late 1890s, ranchers recognized that many ranges in the Nicola Valley were becoming overgrazed.[17] These effects were exacerbated in the 1930s and 1940s when winter grazing by horses damaged much of the Upper Grasslands.[45] In 1860, the British Columbia government adopted a policy to grant settlers up to 160 acres with full title being confered after certain improvements were made. This was changed to 320 acres in 1861. Some of these pre-emptions resulted in the development of ranches, but other areas were farmed, especially in the northern part of the Nicola Valley. Large areas of grassland were plowed and planted to agricultural crops between 1870 and 1920, but similar to Lac du Bois, crops failed and the farms were abandoned. Most of this land reverted to native grassland, but succession has been very slow, particularly on dry sites.

Photo: B.C. Archives

Plowing grassland in the Nicola Valley.

3.4.1 Representative Grassland Associations

Grasslands are present in five biogeoclimatic zones and 12 variants in the Southern Thompson Upland (Table A 8.4). Nearly 75% of the grasslands, however, are found in two variants in the Interior Douglas-fir zone, and about 20% occur in the Bunchgrass zone. Small, isolated patches of grassland totaling about 6500 ha are also found in the Ponderosa Pine, Montane Spruce, and Engelmann Spruce-Subalpine Fir zones (Table A 8.4).

3.4.1.1 Thompson Very Dry Hot Bunchgrass Variant (BGxh2)

A small vestige of the Lower Grasslands from the Thompson Basin extends south along Thompson River and along the Nicola River to the confluence of Gordon Creek. These grasslands occupy about 1100 ha in the hottest and driest climate associated with the upland at elevations ranging from 300 m to 550 m.[23]

At climax, big sagebrush co-dominates with bluebunch wheatgrass, and common rabbit-brush can be widespread on some sites. Grasses, forbs and shrubs are generally widely spaced reflecting the dry climate, and bare soil, or a microbiotic crust, often fills the interspaces between plants.[28,33] Some common forbs include yarrow, pussytoes, brittle prickly-pear cactus, fleabanes, sagebrush mariposa lily, large-fruited desert-parsley, and

Holboell's rockcress.[22] On sandy soils, sand dropseed, Indian ricegrass and needle-and thread grass often co-dominate, while compact selaginella and bluebunch wheatgrass are the main plants occupying rock outcrops.[23]

Under prolonged heavy grazing, needle-and-thread grass often replaces bluebunch wheatgrass on dry sites with coarse-textured soils.[31] In mid-seral stages, these species may be replaced by big sagebrush, common rabbit-brush, low pussytoes, and Sandberg's bluegrass. At early stages of succession, cheatgrass, Russian thistle, diffuse knapweed and Dalmatian toadflax can dominate these sites.[34]

Photo: B. Wikeem

Shrub-steppe vegetation in the Lower Grasslands near Spences Bridge.

3.4.1.2 Nicola Very Dry Warm Bunchgrass Variant (BGxw1)

Steppe vegetation, similar to the Middle Grassland of the Thompson Basin,[40,41] occupies about 27,650 ha from 700 m to about 1000 m elevation in the Nicola Valley. These grasslands follow the main drainage defined by Shumway, Stump and Nicola lakes from Knutsford to Merritt. They also extend east following the Nicola River from Nicola Lake to Chapperon Lake, and south along Quilchena Creek.

Photo: B. Wikeem

Middle Grasslands above Nicola Lake near Quilchena.

Climatically, conditions here are slightly cooler in summer and colder in winter than in the Lower Grasslands near Spences Bridge. Bluebunch wheatgrass is the climax dominant mixed with a sparse cover of needle-and-thread grass and junegrass.[33] Thread-leaved fleabane, large-fruited desert-parsley, mariposa lily, prairie sagewort, yarrow, lemonweed, and arrowleaf balsamroot are common associates, but each species contributes little to overall cover. Silky lupine, more frequent at higher elevations in the Nicola Valley, is common on these grasslands, and ranges in color from deep blue to lavender and white. Common rabbit-brush is often widely spaced on the upland, while saskatoon, choke cherry and Douglas maple occupy moist draws.[31,40] Although cow pie lichen and rusty steppe moss are often present, cryptogams are usually lacking and exposed soils are common in the interspaces between bunchgrasses.[26]

Bluebunch wheatgrass is usually replaced by needle-and-thread grass with heavy grazing, and junegrass, Sandberg's bluegrass, low pussytoes, prairie sagewort, and common rabbit-brush become more prevalent at mid-seral stages.[31] Non-native species like cheatgrass, Japanese brome, common dandelion, and giant mullein invade at the earliest seral stages.

Photo: B. Wikeem

Cryptogams can provide a complete ground cover on dry sites.

Low-growing native perennials such as low pussytoes and cut-leaved daisy often accompany these species. The microbiotic layer is also affected by livestock trampling,[26] but little information is available that describes changes in species composition, cover, and recovery that results from trampling.

3.4.1.3 Thompson Very Dry Hot Ponderosa Pine Variant (PPxh2)

Approximately 4235 ha of ponderosa pine grassland and savannah occupy lower slopes along the Nicola River and the west shore of Nicola Lake between 400 and 950 m elevation (Table A 8.4). Small patches also occur in the Campbell Creek area. The climate is typically hot and dry in summer while winters are cool with little snowfall. Large moisture deficits are common during the growing season because of high temperatures and drying winds.

Bluebunch wheatgrass usually dominates the understory of open ponderosa pine savannah but rough rescue may be present on some sites.[20,31] Common rabbit-brush, needle-and-thread, Sandberg's bluegrass, junegrass, arrowleaf balsamroot, slender hawksbeard, and yarrow are common allies.[31] On grassland sites with shallow soils, bluebunch wheatgrass and compact selaginella often co-dominate, and are mixed with a sparse cover of rough fescue, junegrass, yarrow, Sandberg's bluegrass, and prairie sagewort.[23]

With excessive grazing, Kentucky bluegrass replaces rough fescue on moist sites while needle-and-thread grass displaces bluebunch wheatgrass as the dominant species in drier habitats. At mid-seral stages, needle-and-thread grass, junegrass, and Sandberg's bluegrass are often the dominant grasses, and balsamroot, low pussytoes, and western yarrow become more abundant. Pioneer species and decumbent native perennials such as cheatgrass, pink twink, dandelion, woolly plantain, low pussytoes, and cut-leaf daisy often become prominent species at early seral stages.

3.4.1.4 Okanagan Very Dry Hot Interior Douglas-fir Variant (IDFxh1)

Interior Douglas-fir grasslands in the Princeton Basin are the western extent of the hot, dry Upper Grasslands from the Interior Douglas-fir zone in the Okanagan Valley. About 8115 ha of these grasslands occur over a range of aspects, slope positions and soil parent materials. Grasslands Princeton Basin contain a complex mix of communities including steppe, savannah, aspen copses, and wetlands.[30,51] This complexity results from the topographic diversity of the Southern Thompson Upland, which declines from about 1065 m at Aspen Grove near the edge of the plateau surface to 700 m elevation in the Similkameen Valley at Princeton.

Photo: B. Wikeem

Interior Douglas-fir grasslands east of Princeton.

The climate of the Princeton Basin consists of warm, dry summers and cold, cloudy winters. The presence of Idaho fescue distinguishes these grasslands from those in the Bunchgrass zone in the Okanagan and lower Similkameen, and from the Upper Grasslands in the Thompson Basin.[23] The driest sites in the Princeton Basin are dominated by bluebunch wheatgrass mixed with silky lupine and balsamroot. Ponderosa pine and Douglas-fir may be present but are widely distributed, and the shrub layer is poorly developed. Idaho fescue and bluebunch wheatgrass dominate climax grasslands on slightly moister sites. Common associates include stiff needlegrass, silky lupine, arrow-leaved balsamroot, parsnip-flowered buckwheat and junegrass.[23,30,51] Prairie rose – Idaho fescue communities form on moisture-receiving areas where Idaho fescue usually dominates the herb layer. Kentucky bluegrass may also provide substantial cover on some sites, and becomes a third co-dominant. Secondary species such as bluebunch wheatgrass, parsnip-flowered buckwheat, stiff needlegrass, long-leaved fleabane, and graceful cinquefoil provide a minor proportion of plant cover.[23]

Past grazing has altered many grasslands in the Princeton Basin. Bluebunch wheatgrass and Idaho fescue are usually replaced with needle-and-thread grass, Columbia needlegrass and junegrass, whereas yarrow, silky lupine and timber milk-vetch become more abundant in mid-seral communities that result from heavy grazing.[30]

Kentucky bluegrass is often prominent on moister sites in early- to mid-seral stages.[30] Early seral stages are often dominated by native species such as Sandberg's bluegrass, prairie sagewort, pussytoes, yarrow, and cut-leaved daisy,[28] or by introduced species like cheatgrass, Japanese brome, western stickweed, and diffuse knapweed.[34]

3.4.1.5 Thompson Very Dry Hot Interior Douglas-fir Variant (IDFxh2)

Nearly 40,000 ha of grassland in the Southern Thompson Upland, are a southern extension of the dry Upper Grasslands found in the Thompson-Pavilion region (Table A 8.4).[23] These grasslands account for nearly 30% of the total grassland area in the Southern Thompson Upland. Most of the grasslands in this variant are located above Douglas Lake from Knutsford to Merritt, and from Mamit Lake to Lower Nicola. Generally, they are positioned above the Middle Grasslands and below the Upper Grasslands on the Nicola and Douglas plateaus, where they occupy the lower, south-facing slopes at elevations ranging from 850 to 1130 m. Summers are usually warm and dry, and winters are cold.

Photo: B. Wikeem

Upper Grasslands in the Interior Douglas-fir zone on the Hamilton Commonage.

Grasslands primarily occupy gentle gradients on all slope positions. Rough fescue and bluebunch wheatgrass provide the principal cover in late-seral communities mixed with junegrass, yarrow, arrow-leaved balsamroot, and timber milk-vetch.[21,23,51] Silky lupine is also present, but not abundant, and Idaho fescue is absent.[22]

Drier sites are dominated by bluebunch wheatgrass combined with small amounts of prairie sagewort and umber pussytoes. Kentucky bluegrass communities form in moist sites, such as swales and depressions, with Baltic rush, timber milk-vetch, hillside milk-vetch, and early blue violet as common associates. Wetter sites support stands of trembling aspen with a moderately open understory consisting of Nootka rose, common snowberry, blue wildrye, Kentucky bluegrass, and asters.[23]

At mid-seral stages, needle-and-thread grass, junegrass, and Columbia needlegrass replace bluebunch wheatgrass on sites where heavy grazing has altered the plant community. Arrowleaf balsamroot, timber milk-vetch and silky lupine also increase in abundance. Bare mineral soil is conspicuous on severely altered sites in early stages of succession. Sandberg's bluegrass, prairie sagewort, yarrow, and low pussytoes comprise most of the ground cover, and non-native species like cheatgrass can invade. On moister sites, Kentucky bluegrass replaces rough fescue, whereas yarrow, silky lupine, dandelion, and timber milk-vetch become abundant.[21,28]

3.4.1.6 Thompson Dry Cool Interior Douglas-fir Variant (IDFdk1)

These grasslands are an extension of the slightly cooler and higher-elevation portion of the Upper Grasslands from the Thompson-Pavilion region[40,41,44] Covering nearly 48,300 ha, they account for more than 35% of the total steppe vegetation on the Southern Thompson Upland (Table A 8.4). These grasslands are most extensive on the east side of the Southern Thompson Upland above Douglas Lake, but large areas also occur around Tunkwa Lake and in the Mamit Valley.[23]

Photo: B. Wikeem

Douglas-fir grasslands near Tunkwa Lake dominated by rough fescue.

The vegetation is characterized by high species diversity, closely spaced plants, and a poorly-developed microbiotic layer. Rough fescue and bluebunch wheatgrass are climax dominants, but the rhizomatous variety of bluebunch wheatgrass (*inerme*) often replaces the bunch form on moist sites at higher elevations.[44] Columbia or spreading needlegrass may be present along with field chickweed, timber milk-vetch, short-beaked agoseris, meadow aster, western pasqueflower, and mountain death camas. Silky lupine and Idaho fescue occupy some sites near Mamit Lake, but both species are absent at Tunkwa Lake.

Bluebunch wheatgrass and rough fescue decline with heavy livestock grazing. At mid-seral stages, Kentucky bluegrass, stiff needlegrass, and spreading needlegrass dominate the community mixed with timber milk-vetch, field locoweed, dandelion, western pasqueflower, and small-flowered penstemon.[31] Bluebunch wheatgrass and rough fescue may still be present in small amounts. Kentucky bluegrass dominates moister sites mixed with with silky lupine, old man's whiskers, upland larkspur, and common dandelion.

Exposed mineral soil is common in early seral communities. Bluebunch wheatgrass and rough fescue are replaced with Sandberg's bluegrass, pussytoes, cut-leaved daisy, trailing daisy, prairie sagewort, Kentucky bluegrass, and stiff needlegrass. Common dandelion, great mullein, cheatgrass, and other non-native species usually dominate the earliest seral stages.[31]

3.4.1.7 Cascade Dry Cool Interior Douglas-Fir Variant (IDFdk2)

Small and scattered patches of these grasslands occupy about 2385 ha south of Merritt along the Coldwater River, and along Hayes Creek and Trout Creek west of Summerland. Generally, they occur between 600 and 1000 m elevation at mid-slope positions on gentle south-facing slopes. Idaho fescue and bluebunch wheatgrass dominate climax communities combined with California brome, junegrass, silky lupine, and parsnip-flowered buckwheat. Cryptogams are generally absent. Big sagebrush and bluebunch wheatgrass dominate some sites combined with Idaho fescue, junegrass, arrow-leaved balsamroot, and pinegrass. These communities usually support a well-developed microbiotic layer.[22]

Little information exists regarding seral stages on these grasslands. Under heavy grazing, Idaho fescue and bluebunch wheatgrass decline while junegrass, arrowleaf balsamroot, silky lupine, and big sagebrush become more abundant.

3.4.1.8 Very Dry Cool Montane Spruce Subzone (MSxk)

Small patches of steppe and shrub-steppe vegetation exist in the Montane Spruce zone, usually on steep, south-facing slopes. About 1120 ha of grassland and parkland are found between 1450 and 1650 m elevation in the northeast part of the plateau from Dairy Lake south to Paska Lake, and from Rev Lake south to Saxon Lake (Table A 8.4).

Bluebunch wheatgrass dominates upper slope and crest positions on dry sites. Vasey's big sagebrush, more common in the Similkameen Valley, may be present on some sites. Common herbs include sulphur buckwheat, western fescue, green wintergreen, yarrow and junegrass.[22] Rough fescue and Columbia needlegrass dominate cool, moist sites in association with sticky purple geranium, field chickweed, small-flowered penstemon, and showy daisy.[22]

On mid-slope positions, pinegrass replaces bluebunch wheatgrass as the co-dominant with Vasey's big sagebrush. These species can be accompanied by rough fescue, western fescue, junegrass, wild strawberry, western meadowrue, silky lupine, yarrow, and old man's whiskers.[23]

Seral stages resulting from heavy livestock grazing have not been described. In mid-seral communities, bluebunch wheatgrass and rough fescue are likely replaced with junegrass, Columbia needlegrass and western fescue, whereas silky lupine, yarrow, and old man's whiskers may increase in abundance.

3.4.1.9 Grasslands in Other Biogeoclimatic Units

Small patches of isolated grasslands are scattered throughout Southern Thompson Upland in other variants of the Interior Douglas-fir and Montane Spruce zones, and in the Engelmann Spruce-Subalpine Fir and Interior Cedar-Hemlock zones. Collectively, these patches cover about 1800 ha, and comprise slightly more than 1% of the grasslands in the region (Table A 8.4). Most of these grasslands are found on steep, south-facing slopes with shallow soils. No information is available regarding soils, vegetation, and seral stages for this variant.

3.4.2 Distinguishing Flora and Plant Species at Risk

The flora of the Southern Thompson Upland is a progression of plant communities that emigrated from the Great Basin along the Similkameen River corridor and onto the Thompson Plateau. Corridors for dispersal likely included Allison Creek and the Tulameen River from the south, and Trout Creek and the Shorts Creek drainage from the east.

Climatic conditions on the Southern Thompson Upland were likely cooler and moister than those in the Okanagan Valley during all climatic intervals since glacial recession. The existing flora on the Southern Thompson Upland suggests that some species presently inhabit the Okanagan Valley were not adapted to the plateau climate. Indeed, the number of red- and blue-listed plant species on the plateau in only about 55% of that found in the Thompson-Pavilion region, and 25% of that in the Okanagan, Similkameen and Kettle valleys (Table A 9.2; Table A 9.3; Table A 9.4).

Sixteen red- and five blue-listed vascular plants are present in the Southern Thompson Upland including two shrubs, four monocots and fourteen herbaceous dicots (Table A 10.4). Few of these species appear to be unique to the region, or have very limited distributions. Silvery sage, a red-listed species, occurs only on grasslands in the Interior

Douglas-fir zone near Merritt, and possibly in the Bunchgrass zone.[7,11] The red-listed cut-leaf daisy (var. *discoideus*) may be unique to the region, but was previously regarded as a misidentification.[11,12]

Suksdorf's lupine is a red-listed species found in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones in the Southern Thompson Upland. This species appears to be most abundant here, but possibly occurs in the Thompson-Pavilion region and the East Kootenay Trench.[12] The blue-listed freckled milk-vetch is found on Ponderosa Pine and Douglas-fir grasslands (Table A 10.4). This species has a limited distribution in the Okanagan and Thompson valleys,[12] and is close to its northern distribution in the Southern Thompson Upland. Similarly, blue-listed threadstalked milk-vetch is found infrequently on Interior Douglas-fir grasslands on the Hamilton Commonage near Goose Lake. All other red- and blue-listed grassland species occurring in the Southern Thompson Upland are found in other geographic regions of the province.

Several non-threatened grassland species approach their northern distribution in British Columbia in the Southern Thompson Upland. Idaho fescue, which is a climax dominant in Ponderosa Pine and Interior Douglas-fir grasslands in the Okanagan and Kettle valleys, has a limited distribution in the Southern Thompson Upland. This species is most abundant south of Douglas Lake, but it has not been found west of the Nicola Valley on the Southern Thompson Upland, even though it reaches its northern limit near Cache Creek.[12,32] Historical grazing may have been a factor that has limited its present distribution.

Photo: B. Wikeem

Silky lupine is common in the Okanagan and Nicola valleys, but is rarely found north of the southThompson River except near Chase.

Silky lupine is a common grassland forb in the Okanagan Valley from the Bunchgrass to the Interior Douglas-fir zone.[12] In the Southern Thompson Upland, it is locally abundant in Interior Douglas-fir grasslands from Princeton to Knutsford, mostly east of the Nicola Valley. From Knutsford, silky lupine extends west along Peterson Creek until the grasslands abut against dense Douglas-fir forest near Jacko Lake.

Big sagebrush, the dominant shrub in grasslands in the Bunchgrass zone, occurs only in localized populations in the Southern Thompson Upland. It is found in the Bunchgrass zone at the confluence of Nicola River with Nicola Lake and at Napier Lake. Another small population occurs along Guichon Creek west of Tunkwa Lake in the Interior Douglas-fir zone. Vasey's big sagebrush grows at one of its highest known elevations (1790 m) in Greenstone Park in the Montane Spruce zone.[47] Likewise, Okanagan fameflower, a blue-listed species found in the Okanagan Valley and Thompson-Pavilion region, grows at its highest known elevation (1540 m) in Mount Savona Park.[48]

Grey horsebrush is a relatively common species in dry shrub-steppe communities in the South Okanagan Basin.[13] Although this species appears to be scarce in the Southern Thompson Upland, a large patch of several hundred plants occurs at the junction of Highway 3 and the Penask Lake Road. A few, scattered plants have also been found on the Hamilton Commonage between Goose Lake and Staple Lake at 1200 m elevation.[50]
Twenty-one red- and blue-listed grassland communities have been classified in the Southern Thompson Upland (Appendix 11). Of these, 14 occur in the Bunchgrass zone, three each in the Ponderosa Pine and Interior Douglas-fir zones, and one in the Engelmann Spruce-Subalpine Fir zone. More than 65% of these communities have been classified as red-listed.

3.4.3 Grassland Associated Ecosystems

The grassland landscapes of the Southern Thompson Upland are varied and contain many associated ecosystems. A chain of large lakes lines the bottom of the Nicola Valley, and each lake has unique wetland complexes. Most of the valley slopes are grass-covered except where they are interrupted with cliffs, talus and rock outcrops, particularly along Nicola Lake. Aspen groves, lakes, ponds and wetlands dot the gentle terrain of the plateaus above the grasslands.

Cottonwood forests are found primarily along the floodplains of the Nicola River in the Bunchgrass and Ponderosa Pine zones. Black cottonwood generally forms the overstory, but trembling aspen, water birch and ponderosa pine can also be present. Thickets of common snowberry, roses, red-osier dogwood, black twinberry, Douglas-maple, chokecherry, tall-Oregon grape, paper birch, and water birch are common in the shrub layer. The herb layer is usually sparse and species composition can be variable. Rough fescue or pinegrass dominate the understory of drier and wetter sites, respectively. Other common herbs are Kentucky bluegrass, star-flowered false Solomon's seal, asters, bluejoint reedgrass, and horsetails.[22,23] Pockets of cottonwood also occur along the edge of Nicola Lake, and narrow-leaf (sandbar) willow commonly colonizes gravelly, unstable soils along the shoreline.

Wetlands are a common feature throughout most grasslands, and range in size from large lakes such as Stump Lake and Nicola Lake to small, internally drained ponds or marshes on the uplands. Some wetlands are shallow with well-developed riparian bands, while others are steep-sided with a sparse, narrow transition zone between the water and the uplands.

Photo: B. Wikeem

Bulrush marsh on the Upper Grasslands at Hamilton Commonage.

Bulrush, cattail and sedge marshes are widespread throughout the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones. Various bulrush marshes are found in small ponds, depressions, and channels where the pond bed often has a thin layer of organic material overlaying a lacustrine base, and where water conditions are moderately alkaline.[24] Species composition varies considerably depending on water and soil conditions, but woolly sedge, Baltic rush, small-flowered bulrush, seacoast bulrush, soft-stemmed bulrush, and American bulrush are all common dominants or co-dominants. Reed canarygrass also co-dominates on rich, wet sites.[24]

Common cattail marshes occur in non-alkaline potholes, small ponds, ditches, and along lake edges. Some of these marshes are part of larger wetland complexes that contains bulrush or beaked sedge marshes. Water sedge – Beaked sedge marshes and fens flood annually with shallow water that usually evaporates over the summer. Beaked sedge dominates sites with deep water and mineral soils, while water sedge occupies sites with deep peat soils and calm waters. Bluejoint reedgrass can be present on drier sites within this type.[24]

Photo: B. Wikeem

Vegetation bands form below the emergent vegetation zone when ponds dry out.

Bands of transitional communities frequently form around lakes, ponds and marshes in the Bunchgrass and

Interior Douglas-fir zones. Kentucky bluegrass – Baltic rush meadows are common in depressions, swales, or at pond edges with fine-textured soil. Giant wildrye, roses, blue wildrye, and timber milk-vetch are common associates. On wetter sites, common spike-rush, Baltic rush and western witchgrass dominate.[22]

Kentucky bluegrass, creeping bentgrass and Baltic rush dominate a narrow riparian zone on rocky soils at the edge of some steep-sided lakes. Common silverweed, rayless alkali aster and dandelions are common forbs, and a thin band of Bebb's willow may occupy adjacent, slightly higher ground.[50]

Alkali-tolerant species inhabit sites with poor drainage and high evaporation rates. Alkali saltgrass meadows form on poorly drained, fine-textured soils that are seasonally flooded such as the extensive, shallow basins south of Tunkwa Lake. Shallow water in these meadows evaporates rapidly in the summer leaving a salt crust. Alkali saltgrass dominates these sites, but alkali cordgrass and Nevada bulrush may also be present.[24] Nuttall's alkaligrass – Foxtail barley meadows occupy relatively less saline or alkaline sites in the draw down zone of shallow ponds, or in basins that are temporarily flooded in spring. Nuttall's alkaligrass usually dominates, but foxtail barley increases on heavily grazed sites. Baltic rush-field sedge marshes replace Alkaligrass – Foxtail barley communities on moister sites. These communities often develop at the edges of bulrush meadows where longer periods of flooding persist compared to alkaline ponds.

Trembling aspen groves are widespread throughout the grasslands, and are particularly common in the Interior Douglas-fir zone. Aspen copses most frequently occur on moist sites such as gullies, toe slopes, seepage sites, and depressions. Trembling aspen dominates the forest canopy, but ponderosa pine, Douglas-fir, or white spruce may be present on some sites. The composition and development of the understory can be variable depending on stand age and the density of the overstory. Mature stands with an open canopy usually have a grass understory consisting of species such as rough fescue or Kentucky bluegrass. Other copses, with a moderate to dense canopy, usually contain a well-developed shrub layer, but the composition of the understory varies depending on moisture availability and canopy closure.

Photo: B. Delasalle

Trembling aspen establishes in swales and depressions where water accumulates in the grassland environment.

Most aspen stands have a moderate to dense shrub layer consisting of common snowberry, Nootka rose, saskatoon, and Douglas maple. Red-osier dogwood, waterM birch, and willows are common understory shrubs on seepage sites and flood plains in the Bunchgrass zone.[22,23] Shrub composition changes considerably in the Upper Grasslands where tall Oregon-grape, prairie rose and baldhip rose are the most common species, and Kentucky bluegrass blue wild rye, pinegrass, and star-flowered false Solomon's seal comprise the herb layer. Other secondary species often include Canada violet, asters, false Solomon's seal, baneberry, and American vetch.[22,23]

Rock outcrops are widely distributed over the Southern Thompson Upland. Typically, they have dry, shallow soils interspersed with exposed bedrock, and are sparsely vegetated. Species composition varies depending on slope, aspect and elevation. Most sites are dominated by compact selaginella and bluebunch wheatgrass combined widely scattered trees and shrubs such as Douglas-fir and saskatoon. Common rabbit-brush, Rocky Mountain juniper and Sandberg's bluegrass are often present on low-elevation sites, while ponderosa pine and kinnikinnick may occur in the Ponderosa Pine zone.[22,23]

Rock outcrops in the Douglas-fir grasslands on the Southern Thompson Upland can be highly diverse. Trees and shrubs such as choke cherry, squaw currant, common juniper, shrubby penstemon, and trembling aspen are present on some sites, while only herbaceous vegetation occurs on other outcrops. Round-leaved alumroot, Idaho fescue, western cliff fern, parsnip-flowered buckwheat, and lance-leaved stonecrop are common herbaceous species found on many sites. Common snowberry and shrubby penstemon are found on rock outcrops in Douglas-fir grasslands near Princeton.

Rock outcrops in the Montane Spruce zone differ floristically from those at lower-elevations. Scattered Douglas-fir and lodgepole pine are present along with a shrub layer consisting of common juniper, falsebox, and saskatoon. Black huckleberry may be present on some sites. The sparse herb layer contains pinegrass, shrubby penstemon, kinnikinnick, compact selaginella, timber oatgrass, white pussytoes and spotted saxifrage.[22]

Talus slopes are widely distributed throughout the Southern Thompson Upland. Usually, these sites are poorly vegetated except at the base of the talus slope. Trees and shrubs may be widely scattered across the slope, and herbs are frequently sparse or absent. Douglas-fir may be present at all elevations while ponderosa pine extends only to the bottom of the Douglas-fir grasslands. Saskatoon and bluebunch wheatgrass are often present on most sites below the Montane Spruce zone, sometimes combined with Rocky Mountain juniper, Douglas maple, kinnikinnick, and Sandberg's bluegrass. Mock-orange is found on some talus slope on Douglas-fir grasslands near Princeton,[22] but is not present on the plateau surface.

3.4.4 Representative Fauna and Species at Risk

A mixture of open grasslands, deciduous forests, savannahs, wetlands, cliffs, and talus slopes create a rich diversity of habitats for wildlife. Numerous species rely on a variety of habitat types for foraging, thermal and hiding cover, and rearing their young.

Photo: B. Delesalle

Mixes of wetlands, forest and grasslands provide a variety of habitats for grassland fauna.

No fauna are unique to the Southern Thompson Upland, and only a few species reach their northern distribution in the area. In addition, the diversity of red- and blue-listed fauna declines from 75 species in the Okanagan, Similkameen and Kettle valleys to 25 in the Southern Thompson Upland (Table A 13.4). Nonetheless, more than 119 species including 14 reptiles and amphibians, 79 birds, and 26 mammals, use grasslands in the region for some of their life history requirements (Table A 13.4). No vulnerable or threatened insects are listed in the Southern Thompson Upland, but fewer surveys have been completed in this ecosection compared to other parts of the province.

The arthropods of the Southern Thompson Upland has not been studied but insects are abundant on all grasslands in the region. Although amphibians and reptiles are distributed over grasslands and wetlands from low to high elevations, species diversity is highest in the low-elevation grasslands. Some common species in the Bunchgrass and Ponderosa Pine zones include the Common Garter Snake, Wood Frog and Long-toed Salamander (Table A 13.4).

Photo: B. Wikeem

Ants are abundant on grasslands and important agents for nutrient cycling and distributing seeds.

Up to 12 amphibians and reptiles are found on grasslands in the Interior Douglas-fir zone (Table A 13.4). The proximity of these grasslands to steppe communities in the Similkameen and Okanagan valleys likely accounts for their relatively high species diversity. Some characteristic grassland species include the Garter Snake, Rubber Boa, Long-toed Salamander, and Great Basin Spadefoot. All of these species require wetlands for foraging or spawning. The Long-toed Salamander, for example, spends most of its life in riparian habitats, underground, or under woody debris before returning to ponds and wetlands to spawn.[9]

Only six of the 11 rare and endangered reptiles and amphibians that occur in the Southern Okanagan Basin are present in the Southern Thompson Upland (Table A 13.4). Of these, the Rubber Boa and Great Basin Spadefoot are most common, and are found in grasslands extending into the Interior Douglas-fir zone. Red-listed grassland species such as the Night Snake and Tiger Salamander are not present, while the blue-listed Western Rattlesnake is found in the Princeton Basin but not on the plateau.

Photo: B. Wikeem

Wood Frogs dot the shoreline of ponds on Upper Grassland as they change from tadpoles and migrate upland.

Although avian diversity appears to be considerably lower on grasslands in the Southern Thompson Upland compared to the Okanagan Valley, over 160 species have been identified on Douglas Lake Ranch alone. A wide range of upland birds and raptors are found on grasslands at all elevations. Some common species include the American Crow, Black-billed Magpie, Eastern Kingbird, Long-billed Curlew, Vesper Sparrow, and Western Meadowlark. The American Kestrel, Red-tailed Hawk, and Northern Harrier are often seen hovering over wetlands and grasslands as they hunt for mice, frogs, and snakes. Other less conspicuous species include the Prairie Falcon, Eastern Kingbird, Bobolink, Common Poorwill, and Common Nighthawk.

Wetlands are a common feature in some parts of the Middle Grasslands, especially along the main drainage from Shumway Lake to Nicola Lake and at higher elevations where the Bunchgrass zone meets with Interior Douglas-fir grasslands. These ponds and riparian areas provide a diversity of habitats for migratory and resident birds. Some common species include the American Widgeon, Mallard, Common Goldeneye, and Canvasback.

The Ruddy Duck and American Coot also occupy ponds and marshes along with the Red-winged Blackbird, and Yellow-headed Blackbird.[45] Sandhill Cranes and Tundra Swans use the small lakes and ponds throughout the Nicola Valley for feeding and resting during migration, while the American Avocet feeds and nests along shorelines.

The red-listed American Avocet is an infrequent visitor to grassland ponds and lakes in the Okanagan and Thompson regions.

Photo: J. Hobbs

Aspen copses provide habitat for cavity and ground-nesting birds. Many woodpeckers such as the Downy, Hairy, and Lewis's Woodpecker, and the Red-shafted Flicker create cavities for nesting that are later occupied by other species such as the Mountain Bluebird, White-breasted Nuthatch, Bufflehead, Barrow's Goldeneye, and Wood Ducks.[9] The Ruffed Grouse and Sharp-tailed Grouse use the dense shrub understory in aspen copses for food and cover. Numerous raptors, including the American Kestrel, Red-tailed Hawk, Great Horned Owl, Northern Saw-whet Owl, and Flammulated Owl nest, roost, and hunt in aspen groves. The Prairie Falcon, Turkey Vulture, Cliff Swallow, and White-throated Swift nest on cliffs and rock outcrops, such as those along Nicola Lake, and forage over wetland and grassland habitats.

Sixteen red- and blue-listed birds are found in the Southern Thompson Upland region including the American Avocet, Brewer's Sparrow, Bobolink, Lewis's Woodpecker, and Western Screech- owl (Table A 13.4). Both the Burrowing Owl and Sharp-tailed Grouse have recently been re-introduced onto grasslands in the Nicola Valley. Known breeding locations of the red-listed Ferruginous Hawk are restricted to the Southern Thompson Upland near Aspen Grove and Logan Lake. Other potential breeding habitat exists, however, in the Nicola Valley and elsewhere on the Upland.

Photo: J. Hobbs

Burrowing owls have been reintroduced to the Nicola Valley grasslands.

This species forages over grasslands and wetlands in the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir zones.[15]

The Mule Deer is the most common ungulate on the Southern Thompson Upland, and uses grasslands, wetlands and aspen copses at all elevations for foraging and cover. Low-elevation grasslands in the Bunchgrass and Ponderosa Pine zones are particularly important for fall, winter and early spring range, while open stands of ponderosa pine and Douglas-fir provide thermal cover and forage on winter ranges. Most deer migrate in summer, and may use grasslands in the Montane Spruce zone as part of their summer range.

A small population of Rocky Mountain Elk was introduced in the Tulameen River system near Princeton in the 1930s, and is still present.[37] Seasonal habitat varies from old-growth forest to wetlands and open grassland slopes in the Interior Douglas-fir zone, but no specific information is available describing habitat use. Moose are also present on the plateau, but rely mostly on upland forests and shrubby wetlands. White-tailed Deer are also use grasslands periodically, but they are not abundant in the Southern Thompson Upland.

A variety of small mammals use grassland seasonally or year round. The Northern Pocket Gopher is perhaps the most ubiquitous small mammal on grasslands in the Interior Douglas-fir zone, but it is not found north of the Thompson River. This species lives underground in a long network of burrows and deposits excavated soil in mounds above ground.[8] This species forages on roots, stems, bulbs, and tubers that it stores in underground chambers as a food source during winter and mid-summer when it is inactive above ground.[5] The Yellow-bellied Marmot occurs in local widespread populations throughout the grasslands from the Bunchgrass to the Interior Douglas-fir zone in the Southern Thompson Upland. This species establishes a network of burrows near rock outcrops and talus slopes, and feeds on a variety of grasses and forbs.[8]

The Muskrat, Western Harvest Mouse and Meadow Vole are the most common small mammals associated with wetlands throughout the grasslands. The Meadow Vole is widely distributed, and occupies grasslands with a good ground cover of litter or live plants, wetlands and ponds, sedge meadows, and grassy forest openings.[35]

The Badger, Fringed Myotis and Spotted Bat are the only that are red- or blue-listed small mammals in the ecosection (Table A 13.4). The red-listed badger is found infrequently, and populations in the area have been supplemented with recent introductions. The Fringed Myotis uses cliffs, crevices, caves, and snags found in arid

Photo: J. Hobbs
Coyotes are one of the most common grassland predators.

grasslands and ponderosa pine forests for roosting and nesting.[46] Similarly, the Spotted Bat, considered one of the rarest bats in North America, roosts in cliffs and forages in dense or open coniferous and deciduous forests, wetlands, and grasslands. Other bats, such as the Big Brown Bat and Yuma Myotis, are also present in the Southern Thompson Upland.

Coyotes are the most common predator using grasslands in this ecosection. This species can be found at all elevations throughout most of the year. Other predators that may use grasslands periodically include the Lynx, Bobcat and Black Bear.

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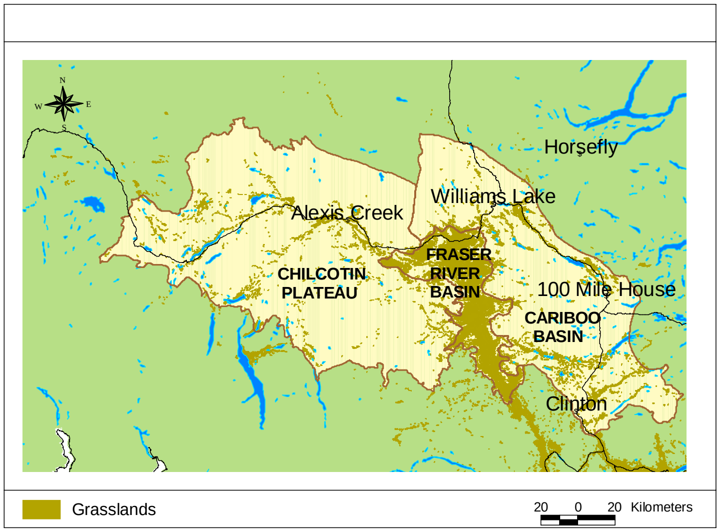
3.5 Cariboo-Chilcotin and Central Interior

The Central Interior Ecoprovince occupies the northern and central portions of the Interior Plateau between the Coast Mountains to the west and the Cariboo Mountains to the east. This broad region extends from the Thompson Plateau in the south to include the southern two-thirds of the Nechako Plateau and Fraser Basin in the north.[12]



Source: Grasslands Conservation Council of B.C.

Location of grasslands in southern part of the Cariboo-Chilcotin.

More than 90% of the 230,000 ha of grassland in the Cariboo-Chilcotin occurs in the Fraser River Basin, Cariboo Basin and the Chilcotin Plateau ecosections. Another15,200 ha of steppe is found in the Central and Western Chilcotin Ranges while the rest of the grasslands are scattered among five other ecosections (Table A 7.4).

Photo: B. Wikeem

Grasslands occur over an elevational gradient at the confluence of the Chilcotin and Fraser rivers.

Deeply incised valleys, river terraces and benches, and gently undulating plateaus characterize most of the grassland landscape of the Cariboo-Chilcotin. These grasslands extend over an elevational gradient from the valley floors of the Fraser and Chilcotin rivers to the surrounding plateaus where they integrate with open or closed forests. Nearly 75% of the grasslands in the region are found within 20 km of the Fraser and Chilcotin rivers, or their tributaries, in the Bunchgrass and Interior Douglas-fir zones.[8]

The Lower Grasslands of the Bunchgrass zone in the Fraser River Basin extend north along the Fraser River to Sheep Creek Bridge on Highway 20, and continue west along the Chilcotin River to Farwell Canyon. These areas represent the hottest and most arid conditions in the region. Bluebunch wheatgrass and big sagebrush are the characteristic species of shrub-steppe communities in the valley bottoms, on the steep slopes of the canyon walls, and on river terraces below 650 m elevation.[9,26] Bunchgrasses and shrubs generally are widely spaced and mixed with a variety of forbs, while the cryptogam layer is usually well developed and dominated by scale lichens.

At slightly higher elevations between 650 and 850 m, shrub-steppe communities give way to grasslands dominated by bluebunch wheatgrass, needle-and-thread grass, mixed forbs, and a microbiotic layer dominated by cladonia and cow pie lichens.[9] Big sagebrush is confined to steep slopes or the lower reaches of this zone. These grasslands are similar to the Middle Grasslands near Kamloops,[51] and occupy mid to upper slopes along the Fraser River and the lower part of the Chilcotin River valley. The landscape is transitional between the steep slopes of with the river canyons and the gentle rolling terrain of the plateaus.

Photo: B. Wikeem

Grasslands merge with Douglas-fir forests above the Fraser River.

Grasslands of the Interior Douglas-fir zone mostly occupy the plateau surface along the Fraser and Chilcotin rivers above the Bunchgrass zone and generally below 1200 m. Landscapes on the plateau surfaces tend to have low to moderate relief, and support a mix of plant communities. Large prairies are interrupted by wetlands, aspen copses and coniferous forest groves. Eventually, the grasslands merge with Douglas-fir forests as the elevation gradually increases from the plateau surface to the Coast and Cariboo mountains.

At climax, grasslands in this zone are dominated by porcupinegrass, bluebunch wheatgrass, spreading needle grass, and Rocky Mountain fescue.[22] Generally, bunchgrasses are closely spaced with a moderately developed microbiotic layer, and numerous forbs are mixed with the bunchgrasses. Shrubs are mostly absent except for those associated with aspen copses.

Higher on the plateau and into the Sub-Boreal Pine-Spruce zone, the topography remains a gentle rolling plain where subtle differences in aspect and relief can result in significant changes in plant communities. Grasslands become more localized, and are often associated with gentle, south-facing slopes between lodgepole pine forests and wetlands. Occasionally, they sprawl onto larger level surfaces.

Grasslands at the lowest elevations of the Sub-Boreal Pine-Spruce zone are dominated by widely spaced bluebunch wheatgrass mixed with a variety of shrubs and forbs similar to Upper Grasslands in the Douglas-fir zone.

Source: Grasslands Conservation Council of B.C.

Location of grasslands in the northern part of the Cariboo-Chilcotin.

At higher elevations, where the climate becomes cooler and moister, bluebunch wheatgrass is gradually replaced by spreading needlegrass and Rocky Mountain fescue mixed with old man's whiskers, wooly cinquefoil, and numerous lichens and mosses.[24]

Over 7000 ha of grassland occur north of 52° N latitude in the Nazko Upland, Bulkley Basin, and Quesnel Lowland ecosections (Table A 7.4). Although

Photo: B. Wikeem

Edaphic grasslands mixed with aspen west of Francois Lake.

these grasslands comprise a small area, they mark a significant transition from the arid steppe vegetation of the south, to grasslands dominated by the influence of adjacent montane and alpine flora. These grasslands usually occupy steep, south-facing slopes within a larger expanses of surrounding forest. Slender wheatgrass, interior bluegrass and stiff needlegrass entirely replace bluebunch wheatgrass as the dominant bunchgrass, and forbs such as northern bedstraw, purple peavine and old man's whiskers supplant broadleaf species that are characteristic of the Great Basin.

Physiography, Climate and Soils

The dominant landscape feature in the Cariboo-Chilcotin is the broad, flat surface of the Interior Plateau that is divided into three physiographic regions that support grasslands: the Chilcotin Plateau, the Fraser Basin, and the Cariboo Basin. Small areas of grassland are also contained in the Nechako and Thompson Plateaus to the north and south, respectively. Nearly 70% of the Cariboo-Chilcotin is underlain with flat Tertiary lavas[6] that are believed to be contiguous with the Columbia lavas of Washington, Oregon and Idaho.[51] The surface of the northern two-thirds of the region is relatively homogeneous and uninterrupted by river drainages whereas the southern part is deeply incised by the Fraser and Chilcotin River valleys.[40,41]

The Fraser Plateau generally occurs at elevations above 1000 m between the Coast Mountains and the Fraser River from approximately Francois Lake in the north to the Bonaparte River in the south. At its southern extent, a small part of the plateau also occurs east of the Fraser River.[41] The Fraser Plateau is underlain by flat volcanic bedrock that is covered with deep glacial deposits. The landscape has a gently rolling surface with localized drumlins, terraces, and eskers.[45] The southern part of the plateau is deeply dissected by the Chilcotin River and by the Fraser River south of Alkali Lake.[6]

The Cordilleran ice sheet covered most of the Fraser Plateau during the Pleistocene epoch as evidenced by prominent rounded summits and ridged crests in both the Coast and Cariboo mountains.[40] Ice flowed from the Coast Mountains in an easterly and northeasterly direction, while the glaciers moved southwesterly across the plateau from the Cariboo Mountains.[1] Some of the highest peaks in the adjacent Pacific Ranges projected as nunataks above the ice sheet, and may have acted as refugia for pre-glacial fauna and flora.[19]

The glaciers scoured the bedrock and deposited a thick mantle of medium- to coarse-textured glacial till on the flat to moderately sloping terrain above the valley floor.[40] As the last ice retreated about 10,000 BP, it left behind drumlins and eskers that contribute to the present topography of the area.

Photo: R. Holmes

Eskers left by the receding glaciers add aesthetic appeal to the grassland landscape near Big Bar Lake.

Below 1000 m elevation, the plateau gives way to the Fraser and Cariboo Basins. Grasslands in these basins extend from approximately Soda Creek north of Williams Lake to Dog Creek in the south, and from the Fraser River to Highway 97. The landscape in the northern part of this area is generally a low-lying plain covered by drumlinized till deposited by the glaciers. As the ice retreated in a southeasterly direction, the Fraser River was dammed forming a glacial lake that covered the Williams Lake area up to 760 m elevation.

When the ice sheet waned, the lakes drained leaving behind fine lacustrine deposits that formed the parent materials for some grassland soils. The current drainage of the Fraser River forms a deep depression through the Fraser Basin where the plateau surface ranges from 60 to over 600 m above the river level from Quesnel in the north to Gang Ranch in the south.[6]

Photo: B. Wikeem

Benches above Fraser River rise to the plateau surface.

Pacific, Great Basin, and Polar Continental air masses converge in the Cariboo-Chilcotin, and interact with the physiography of the area to produce a continental climate characterized by cold winters and warm summers. Most precipitation falls in spring or early summer.[12]

The Coast and Cariboo mountains significantly modify local weather by creating a rain shadow in the west and a wet belt in the east. Pacific air masses influence weather year round. Moist air is lifted and cooled on the windward side of the Coast Mountains where precipitation falls as rain or snow. As the air is forced down the side of the mountains, it warms and dries creating high moisture deficits on the Fraser Plateau. This warm air is heated further as it spills down into the deep depressions of the Fraser and Chilcotin rivers producing much drier conditions in the valleys than on the adjacent hillsides and plateau. In summer, intense surface heating and convective showers often occur during the day.[12] Clear skies and low humidity at night produce radiant cooling that results in summer frosts, especially at higher elevations on the plateau.[47]

Photo: B. Wikeem

Cold air drains from the upper slopes into the valley bottoms.

Hot, dry air from the Great Basin penetrates the Cascade and Coast mountains bringing high daytime temperatures and clear skies during the summer. These air masses follow the Fraser River valley north to the confluence of the Chilcotin River but usually have little influence on weather at higher elevations on the Fraser Plateau. Outbreaks of cold, dry Polar Continental air from the north can result in extended periods of very cold temperatures during winter. These outbreaks are sometimes accompanied with high snowfalls.

Photo: Paul Sanborn

Rain clouds gathering over grasslands near Big Bar in the south Cariboo.

Latitude, elevation, topography, and aspect significantly influence precipitation and temperature gradients from south to north, and west to east. For example, total annual precipitation varies from about 450 mm at 100 Mile House to slightly more than 540 mm at Quesnel, although average July temperature between these location remains similar(Table A 5.5). Similarly, total annual precipitation near Tatlayoko Lake averages 428 mm, but as the Pacific air moves eastward across the Fraser Plateau, precipitation increases to 450 mm at Williams Lake (Table A 5.4), and 564 mm at Horsefly.[1]

North of 52° N latitude, the Coast Mountains attain lower elevations than in the southern part of the ecoprovince and the rain shadow effect is diminished.[1] Also, moisture-laden Pacific air masses interact more frequently with Polar Continental air, which produces a slightly moister environment in the north than in the south. Total annual precipitation in Vanderhoof is about 10% higher than in 100 Mile House, but annual temperatures in July and January are very similar between these centers (Table A 5.5).

Soil parent materials on grasslands below 1000 m are predominantly medium- to coarse-textured glacial till that was transported relatively short distances by Pleistocene glaciers. Consequently, the mineral composition of the parent material is often similar to local bedrock.[9] Glaciofluvial materials are common in the valleys and meltwater channels on the plateaus, and lacustrine deposits cap till in areas where glacial lakes existed.[6]

Grassland soils in the Cariboo-Chilcotin below 1000 m elevation are similar to those on the Middle Grasslands in the Thompson-Pavilion region,[54] and vary from Brown to Dark Brown Chernozems depending on elevation (Appendix 6). A fine-textured aeolian veneer overlays the till to depths of 50 cm on many sites.[9]

Photo: B. Wikeem

Black Chernozems on Upper Grasslands near Gang Ranch cover a thick layer of volcanic ash.

Dark Brown, Black and some Dark Grey Chernozems occur in the Upper Grasslands on the Fraser Plateau. These soils have a silt-loam to loam texture, and were derived from a thick layer of aeolian deposits that overlay basal moraine.[9] Regosols and Brunisols also occur on very dry sites with steep slopes, and where development of a soil profile is restricted by surficial bedrock.

Solonetzic soils can develop where high evapotransporation rates and restricted water percolation promote the accumulation of soluble salts.[53] Wetlands are widespread in the ecoprovince, especially on the Fraser Plateau where water gathers along drainage channels and in depressions in the grasslands. Gleysols are usually the dominant soil on poorly drained, wet mineral deposits, whereas Organic soils are common in sedge and shrub fens.[9]

Development of Grasslands

The origin of grasslands in the Cariboo-Chilcotin likely dates back to the first half of the Quaternary period (Figure 7). For, example, sediments near Dog Creek contained pollen from numerous conifer species as well as alder, birch, sagebrush, and the goosefoot (Chenopodiaceae) family that were present in the region during this period.[19]

Earlier fossil pollen records for the Cariboo-Chilcotin are scanty, but studies of lake and bog sediments revealed that conifers began to establish in the interior between 11,000 and 10,000 BP. During the early Holocene, beginning about 10,000 BP, the climate in the interior became hot and dry, and many of the valleys were covered with shrub-steppe vegetation dominated by sagebrush. Studies in the south Cariboo at Finney Lake and Fountain Mountain found grass and sagebrush pollen dating back to between 10,000 and 8500 BP. Steppe vegetation likely extended from the valley bottoms to the alpine zone,[19] as it still does in some parts of the Cariboo and Chilcotin today.

Photo: B.C. Archives

Aboriginal drying racks for salmon along the Fraser River.

Between 8500 and 4000 BP, the extent of sagebrush-steppe vegetation diminished but it still persisted on the lower slopes and valleys in the interior. The total area of grassland in the Cariboo-Chilcotin declined further between 7000 and 4000 BP, as the climate cooled, and the vegetative composition of appeared much as it does today.[18,19]

Native peoples have inhabited the Fraser River valley for at least 8000 years as hunters and gatherers, but their staple diet consisted mainly of salmon.[50] Fire was likely used to improve conditions for hunting, and to enhance production of certain foods.[8] Fire-scar information from the Cariboo-Chilcotin indicates that historical fires recurred at about 10-25 year intervals in dry forests, and that most fires were confined to the forest understory.[10,49] These fires likely maintained an open forest canopy and the ecotone between grassland and forest.

It is not known when Dakelh and Tsilhqot'in peoples in the north Cariboo and Chilcotin regions, respectively acquired horses, but when Simon Fraser met indigenous peoples at Soda Creek in 1808 he bought horses from them on his voyage down the Fraser River.[25]

Between 1821 and 1858, the Hudson's Bay Company maintained trading posts at Fort Kamloops, Fort Alexandria and Fort Chilcotin. The latter was established in 1829 at the forks of the Chilcotin and Chilanko rivers near Redstone. Fort Kamloops and Fort Alexandria were especially important for the company's operations as they provided provisions and horses for the fur brigades that traveled from Oregon to Fort St. James. Horse populations in the Cariboo-Chilcotin were likely small compared to those in Kamloops, which was the main wintering area and breeding ground for company horses.[56] Any overuse of grasslands by horses was likely confined to the area immediately around the forts.

The onset of the Cariboo gold rush in 1858 brought thousands of prospectors into the area. Between 1862 and 1870, over 100,000 people traveled the Cariboo Wagon Road from Lillooet north into the Cariboo. Only two months after the gold rush started, the first herd of cattle was driven into B.C. from Oregon, along the old Hudson's Bay Company's fur brigade trail through the Okanagan and Thompson valleys. Between November 1861 and July 1864, 7720 cattle, 5378 horses, 1371 sheep, and 948 mules passed through customs at Osoyoos traveling to the Cariboo gold fields. By the height of the Cariboo gold rush in 1862, over 4000 cattle per year were being herded into the province from Oregon and Washington, while other cattle, horses, and sheep were being raised on developing ranches.[2]

Photo: B.C. Archives

Grasslands in the Cariboo have provided forage for livestock since the first ranches were established.

Ranchers and farmers were attracted by the fortunes of the gold fields, but many of them stayed and settled the grasslands. In 1860, Donald McLean, chief factor at Fort Kamloops, resigned from the Hudson's Bay Company, and started the first ranch and road house in the interior at the Bonaparte-Hat Creek junction.[2] Other ranches and roadhouses also were established along the Cariboo Wagon Road to provide feed for the horses and accommodations for drivers and passengers. In 1862, the Cornwall family built Ashcroft Manor at the southern end of the Cariboo Wagon Road, and began ranching on 2425 ha of land with 1500 head of cattle.[2] Other ranches, such as the Alkali Lake Ranch, were established farther north in the Cariboo beginning in 1861. Settlement started later in the Chilcotin, and between 1872 and 1885, large areas of land were pre-empted to start ranches beginning with Riske Creek Prairie.[13]

In 1873, the Rev. George Grant journeyed through the Thompson River valley as ‘Secretary’ to Chief Engineer Sanford Fleming's railroad planning expedition. When he reached Ashcroft he noted “The cattle have eaten off the bunch grass within three or four miles of the road, and a poor substitute for it chiefly in the shape of a bluish weed or shrub, called sage grass or sage bush, has taken its place.”[2] Later, in 1877, George Dawson traveled into the Chilcotin and found the range with an “abundance of bunchgrass”.[11] The grasslands still appeared to be in good condition in 1903, but by 1914, indications of overgrazing were becoming apparent.[13]

Photo: B.C. Archives

Riske Creek exclosure, 1931.

Surveys conducted in the 1930s in the Cariboo and Chilcotin confirmed that many of the grassland ranges, such as Becher’s Prairie and Riske Creek Prairie, were overgrazed.[29] Corrective measures were not taken immediately, and by the mid-1940s, the entire lower Chilcotin area was considered to be overgrazed.[13] With the implementation of proper range management in the 1970s, the grasslands began to slowly recover, however, some areas still remain in early- to mid-seral stages.

3.5.1 Representative Grassland Associations

Grasslands in the Cariboo-Chilcotin are found in seven biogeoclimatic zones, and range in elevation from 400 m in the Bunchgrass zone to 2100 m in the Engelmann Spruce–Subalpine Fir and Alpine Tundra zones. Nearly 90% of the grasslands occur within six variants of the Bunchgrass, Interior Douglas-fir and Sub-Boreal Pine-Spruce zones (Table A 8.5).

3.5.1.1 Fraser Very Dry Hot Bunchgrass Variant (BGxh3)

Grasslands in the Bunchgrass zone are divided into the Lower and Middle Grasslands. Lower Grasslands occupy about 20,250 ha along the Fraser River from the Thompson Basin north to the confluence of the Chilcotin and Fraser rivers,[46] and west along the Chilcotin River to Farwell Canyon (Table A 8.5).[13] These grasslands occur on the valley floors, steep slopes, and bench lands of the Fraser and Chilcotin river valleys up to 650 m elevation, and have the warmest and driest climate in the region (Table A 5.6).[46]

Zonal sites are dominated by widely spaced bluebunch wheatgrass and big sagebrush, but total cover of all vascular plants rarely exceeds 50%. A well-developed microbiotic layer dominated by scale and crust lichens usually occupies the spaces between bunchgrasses and shrubs on undisturbed sites. Associated plants include needle-and-thread grass, sand dropseed, Sandberg's bluegrass, junegrass, common rabbit-brush, prairie sagewort, prickly-pear cactus, large-fruited desert-parsley, yellow salsify, pussytoes species, Holboell's rockcress, and yarrow.[9]

Photo: B. Wikeem

Lower Grasslands extend from the valley floor along the Fraser River onto the upland benches.

On steep north aspects, bluebunch wheatgrass cover is significantly greater than on zonal sites, and big sagebrush is much less abundant. Old man's whiskers is common. Bluebunch wheatgrass, needle-and-thread grass, big sagebrush, compact selaginella, and prickly-pear cactus provide a sparse cover on steep, south aspects, while sand dropseed and needle-and-thread grass dominate sandy soils. Moist lower slopes have a relatively dense cover of bluebunch wheatgrass and needle-and-thread grass, and a sparse cover of big sagebrush. Taller shrubs, such as Douglas maple, water birch and mountain alder, occur in riparian areas.[9]

Seral stages and rates of recovery from overgrazing follow similar patterns as those on the Lower Grasslands of the Okanagan and Thompson Basin.[31,32] Under heavy grazing, bluebunch wheatgrass is replaced by junegrass, needle-and-thread grass and sand dropseed at mid-seral stages. Big sagebrush, prickly-pear cactus, prairie sagewort, low pussytoes and cheatgrass are often abundant at early stages of succession.[9]

3.5.1.2 Alkali Very Dry Warm Bunchgrass Variant (BGxw2)

Middle Grasslands occupy about 41,700 ha of the mid- to upper-slopes of the Fraser and Chilcotin river valleys and small tributaries of the Fraser River at elevations ranging from 650 to 900 m (Table A 8.5). They are also found between the Lower and Upper Grasslands on the Fraser Plateau near the junction of the Fraser and Chilcotin rivers.

These grasslands are slightly cooler and moister than the Lower Grasslands (Table A 5.6). Bluebunch wheatgrass dominates late-seral and climax sites mixed with needle-and-thread grass, junegrass, a variety of forbs, and ground lichens. Other common species include umber pussytoes, meadow salsify, trailing fleabane, cut-leaved daisy, prairie sagewort, dryland goldenrod, western blue flax, northern wormwood, large-fruited desert-parsley, Holboell's rockcress, and slender hawksbeard. Total plant cover is generally higher than in the Lower Grasslands, but big sagebrush is usually absent except on steep, warm slopes where the Lower and Middle Grasslands merge.[9]

Photo: B. Wikeem

Middle Grasslands on slopes below the Fraser Plateau near Alkali Lake.

A sparse cover of bluebunch wheatgrass, needle-and-thread grass, pasture sage and sand dropseed occupies dry, south-facing slopes where big sagebrush and common rabbit-brush are often present. On moist lower slopes and in depressions, short-awned porcupinegrass occurs along with spreading needlegrass, arrowleaf balsamroot, northern bedstraw, lemonweed, and numerous other forbs. Prairie rose and western snowberry are common shrubs in deeper depressions.[9]

Photo: B. Wikeem

A complex microbiotic layer can form on some sites, especially on north-facing aspects.

Patterns of secondary succession follow trends similar to those in the Middles Grasslands of the Thompson Basin.[31,51] Bluebunch wheatgrass vigor declines with heavy grazing, and needle-and-thread grass, junegrass and sand dropseed increase in cover to form mid-seral communities. At early seral stages, the small bunchgrasses are eventually replaced by low-growing native forbs such as pussytoes, fleabanes and prairie sagewort, and bare soil becomes more conspicuous. Prairie pepper-grass, tumble-mustards, flixweed, summer-cypress, and Russian thistle are common ruderals that can occupy heavily disturbed sites.[9]

3.5.1.3 Very Dry Mild Interior Douglas-fir Subzone (IDFxm)

Over 74,000 ha of Upper Grassland occur in the Cariboo Basin and on Chilcotin Plateau at elevations ranging from 550 to 1200 m (Table A 8.5). This subzone contains the largest extensive area of grassland in the province. The small areas of grassland near Castle Rock along the Fraser River also mark the northern distribution steppe vegetation from the Great Basin.[15]

Grasslands occupy the upper slopes of the Fraser River Valley and the adjacent plateau from French Bar Creek north to near Williams Lake, and along the lower Chilcotin River Valley to Alexis Creek. They are most extensive on level to gently rolling topography from Becher's Prairie to Bald Mountain north of the junction of the Fraser and Chilcotin rivers, on the plateau north of Dog Creek on the east side of the Fraser River, and on the plateau north of Alkali Lake.[9] Grasslands occupy the hotter and drier parts of the plateau, especially where warm air rising out of the Fraser and Chilcotin river valleys affects local temperatures and precipitation.[9]

Photo: B. Wikeem

Upper Grasslands near Gang Ranch.

The Upper Grassland environment of the Cariboo-Chilcotin is topographically and floristically similar to Upper Grassland landscape in the Thompson-Pavilion region.[51,58] A mixture of forests, wetlands and grasslands is distributed over the landscape in response to variations in local climate, soils, topography, past grazing history, and fire. Bluebunch wheatgrass, short-awned porcupinegrass and spreading needlegrass co-dominate late-seral communities on zonal sites, but forbs and cryptogams are also well represented. Bunchgrasses and litter provide a nearly continuous cover on all but the driest sites. Other common species in late-seral communities include Rocky Mountain fescue, junegrass, prairie sagewort, blunt sedge, yarrow, and cut-leaved anemone. Idaho fescue and rough fescue are absent,[58] and needle-and-thread grass is uncommon.[9] Meadow salsify occurs over large areas on disturbed sites, especially on Becher's Prairie.

Vegetation on gentle north- and east-facing slopes is often dominated by short-awned porcupinegrass mixed with a sparse cover of bluebunch wheatgrass. Extensive communities of short-awned porcupinegrass dominate the gentle terrain on Becher's Prairie, and on the plateau above Dog Creek and Alkali Lake.

Spreading needlegrass often dominates on moderate to steep north-facing slopes, while spreading needlegrass, Kentucky bluegrass, and Baltic rush are the principal species on moist, lower slopes adjacent to wet meadows. These species are often associated with timber oatgrass, cut-leaf anemone, field milk-vetch, field chickweed, sticky purple geranium, and northern bedstraw.[35] Bluebunch wheatgrass is the most common species on south-facing slopes. Other vascular plants generally contribute little to ground cover, but cover of mosses and lichens varies depending on the site and level of disturbance.[9]

Large areas of grasslands in this subzone are in early- to mid-seral condition as a result of overgrazing in the late 1800s and early 1900s. Bluebunch wheatgrass, short-awned porcupinegrass, and spreading needlegrass are frequently replaced with junegrass, stiff needlegrass, and needle-and-thread grass at mid-seral stages. Early-seral stages are dominated by bluegrasses and a combination of introduced and native forbs such as, pussytoes, prairie sagewort, woolly cinquefoil, and meadow salsify. Disturbance by grazing animals also reduces the abundance and composition of the microbiotic layer.[28] On moister sites, Kentucky bluegrass is often the dominant grass, and may persist into later seral stages.

3.5.1.4 Very Dry Warm Interior Douglas-fir Subzone (IDFxw)

A small area of discontinuous grassland occurs in this subzone and covers about 5150 ha in the south Cariboo along the Bonaparte River and Loon Lake valleys, and along the Fraser River south of Big Bar (Table A 8.5). These grasslands are a northern extension of an equally small area of grasslands in the same variant that occurs in the Cache Creek Hills west of Kamloops Lake (Table A 8.3).

This subzone is the driest and warmest part of the Interior Douglas-fir zone. Grasslands mainly occupy very dry sites such as rock outcrops, and steep south- or west-facing slopes from 600 to1000 m elevation. These grasslands often extend into the Ponderosa Pine zone, [46] although ponderosa pine is usually absent, or is present only on dry sites with steep, south-facing slopes. Douglas-fir is the dominant tree on climax zonal sites and north-facing slopes.

On sites where conifers are present, Douglas-fir or ponderosa pine either form savannahs of widely spaced trees, or the trees are aggregated into groves within areas of open grassland. In open forests, bluebunch wheatgrass dominates the understory combined with kinnikinnick, common juniper, and common rabbit-brush, which form the shrub layer. Rocky Mountain fescue, pinegrass, lemonweed, compact selaginella, large-fruited desert-parsley, round-leaved alumroot, and yarrow are often present in the herb layer.[5,46]

Small areas of grasslands inhabit dry, south-facing slopes near Loon Lake, in the Bonaparte River valley, and along the west side of Hart Ridge. They also occur on very steep, west-facing slopes along the east side of the Fraser River in the Edge Hills. Species composition on these sites resembles Middle Grassland communities along the Fraser River, where widely spaced bluebunch wheatgrass is the dominant grass mixed with prairie sagewort, pussytoes and junegrass.

3.5.1.5 Fraser Dry Cool Interior Douglas-fir Variant (IDFdk3)

Grassland communities in this variant occupy the gently rolling topography of the Fraser Plateau east of the Fraser River from Clinton to Alexandria. These grasslands cover nearly 31,000 ha at elevations ranging from 750 to 1200 m (Table A 8.5).

Photo: B. Wikeem

Grassland at east end of Meadow Lake near 70 Mile House.

Small pockets of edaphic grassland occur locally on south-facing slopes in the Cariboo Basin near Meadow Lake east of 70 Mile House, and between 100 Mile House and Lac la Hache. These grasslands are interspersed with lakes, wetlands, stands of lodgepole pine, and trembling aspen groves.

The climate in these grasslands is cool and moist relative to other grasslands in the Interior Douglas-fir zone (Table A 5.7). Bluebunch wheatgrass usually dominates late-seral sites on moderate to steep south-facing slopes, while short-awned porcupinegrass, spreading needlegrass, and timber oatgrass are more prominent on gently sloping sites. These grasslands usually have a high diversity of forbs including spike-like goldenrod, showy aster, and timber milk-vetch.[46]

Bluebunch wheatgrass, spreading needlegrass, and Rocky Mountain fescue are likely late-seral dominants on level sites in the south Cariboo, and become less abundant with heavy grazing. Junegrass becomes more abundant in mid-seral communities. Kentucky bluegrass often dominates mid-seral stages on moist sites such as depressions and toe slopes, while spreading needlegrass and Baltic rush become more abundant on moist sites adjacent to wet meadows. Other species that are often present in mid-seral communities include field sedge, small-flowered penstemon, and graceful cinquefoil. Sandberg's bluegrass, dwarf pussytoes and junegrass dominate early successional sites,[4] and non-

native species such as dandelion and sweet-clover are frequently abundant.[44]
Under prolonged heavy grazing, bluebunch wheatgrass cover declines and weedy forbs such as meadow salsify and cut-leaved daisy increase. Lichen cover is also reduced, and exposed mineral soil becomes prevalent.[28]

3.5.1.6 Chilcotin Dry Cool Interior Douglas-fir Variant (IDFdk4)

Small areas of steppe vegetation occupy gently rolling terrain on the Chilcotin Plateau below the forest edge between 1050 and 1350 m elevation.[46] These grasslands cover nearly 23,800 ha along both sides of the Chilcotin River valley from the Fraser River west to Chilanko Forks (Table A 8.5). Grasslands are also found along the west side of the Fraser River valley between the Chilcotin River and Lone Cabin Creek, and in the Taseko River valley.

The dry, cool climate of this variant produces savannah-like stands of Douglas-fir and open seral lodgepole pine forests, especially on sites with sandy soils. Pinegrass and kinnikinnick are common understory species, but common juniper, saskatoon, spreading needlegrass, Rocky Mountain fescue, junegrass, umber pussytoes, and yarrow are also present.[46] Pockets of grasslands are also common on steep, warm aspects along the Chilanko River and Chilcotin River valley east of Hanceville and near Churn Creek. Bluebunch wheatgrass dominates the driest sites while porcupinegrass, spreading needlegrass, and timber oatgrass are prevalent on cold, level, and moister sites.
Other communities consisting of bluebunch wheatgrass and prairie sagewort, or arrowleaf balsamroot, are present on moderate to steep south-facing slopes. Bluebunch wheatgrass and pussytoes are usually the dominant herbs on the driest sites, while meadow salsify, prairie sagewort, pulse milk-vetch, and northern bedstraw are common associates. Slightly moister sites have a diverse composition of grasses and forbs that include junegrass, Columbia needlegrass, arrowleaf balsamroot, pasture sage, yarrow, timber milk-vetch, and cow pie lichen.[44] Bluebunch wheatgrass decreases under prolonged heavy grazing and is replaced with junegrass, Kentucky bluegrass, pussytoes, and meadow salsify. Lichen cover also declines on disturbed sites.[44]

Spreading needlegrass communities dominate lower slopes, moist depressions, and moisture-receiving areas adjacent to wetlands. Spreading needlegrass and Baltic rush often co-dominate, but slender wheatgrass can be abundant on some sites. Kentucky bluegrass dominates heavily grazed sites along with smooth brome, foxtail barley, salsify, dandelion, clovers, and alfalfa.[44,45]

Short-awned porcupinegrass communities persist on some north aspects, and in gentle swales with deep, medium-textured soils near Churn Creek. In late-seral communities, short-awned porcupinegrass and litter provide almost complete cover of the soil. Pussytoes, junegrass, and stiff needlegrass dominate mid-seral sites along with short-awned porcupinegrass and Kentucky bluegrass.[44]

3.5.1.7 Dry Warm Interior Douglas-fir Subzone (IDFdw)

Small areas of isolated grassland and parkland are widespread in the Chilko and Tatlayoko lake valleys and along the west branch of Mosley Creek from valley bottoms to about 1400 m.[46] Occupying steep south-facing slopes, these grasslands only represent about 2.5% of the grassland in the Cariboo-Chilcotin (Table A 8.5). Because of the influence of coastal air masses, the climate of this subzone is generally warm and moist compared to other parts of the Interior Douglas-fir zone that support grasslands (Table A 5.7). No information is available that describes the plant communities, seral stages, or associated ecosystems of this subzone.

3.5.1.8 Very Dry Very Cold Montane Spruce Subzone (MSxv)

Although grasslands are uncommon in the Montane Spruce zone, about 4270 ha of steppe vegetation occurs in this subzone on the Chilcotin Plateau (Table A 8.5) at elevations ranging from 1250 to 1500 m.[46] Most of these grasslands are found near Itcha Lake, on the upper Chilcotin River and in Hungry Valley.

High elevations and the rain shadow of the Coast Mountains strongly influence the climate. Winters are typically cold, and summers are moderately short and warm. Frost during the growing season contributes to the formation and persistence of grasslands on level sites by restricting conifer establishment.[46]

Grasslands in this subzone occur most commonly on level, well-drained sites, particularly around Itcha Lake. Several communities have been described based on slope, aspect and soil moisture conditions. For the most part, familiar grassland species from the Bunchgrass and Interior Douglas-fir zone are absent, and are replaced by grasses and forbs that are typical of subalpine, alpine and boreal environments.

Altai fescue grasslands are dominated by Altai fescue, timber oatgrass, Pyrenean sedge, and coral lichens, with broom moss, reindeer lichens, and ruffle leaf lichens as common associates. Vegetative cover is higher on slightly moister sites dominated by timber oatgrass and Altai fescue. Altai fescue grasslands also contain widely spaced lodgepole pine, dwarf blueberry, small-flowered penstemon, and diverse-leaved cinquefoil.

Timber oatgrass and spreading needlegrass communities occur adjacent to shrub-carrs in

Big Creek Park.[24] Timber oatgrass dominates these sites with minor amounts of other grasses and forbs. Old man's whiskers, which has a moderately high cover on some sites, is the most common forb, and likely increases in cover as a result of heavy cattle grazing.[24]On spreading needlegrass sites, forbs tend to increase with grazing pressure, while spreading needlegrass decreases.[24]

Grasslands dominated by Rocky Mountain fescue and prairie sagewort occupy steep, south-facing slopes with loose, exposed soils.[24] Rocky Mountain fescue, purple reedgrass, and junegrass are widely spaced on these sites, and mixed with prairie sagewort, pussytoes, cut-leaf daisy, and several cinquefoils. The microbiotic layer is comprised of a variety of lichens and mosses, but forms a discontinuous ground cover. Spreading needlegrass often becomes the dominant grass on moderately sloped, south-facing aspects in association with numerous forbs, lichens and mosses that provide a dense and nearly continuous ground cover.

Vestiges of Great Basin flora occupy the driest and lowest-elevation grasslands in the Montane Spruce zone, but they are often accompanied by alpine and boreal species. Bluebunch wheatgrass – Junegrass communities dominate upper slopes with gentle to moderate relief and warm aspects in the Churn Creek Protected Area.[44] Bluegrasses, Rocky Mountain fescue, yarrow, old man's whiskers, timber milk-vetch, and pussytoes are common associates. Occasionally, common juniper forms a nearly continuous mat on these sites, mixed with small amounts of bluebunch wheatgrass, junegrass, and forbs. On steeper slopes, juniper and kinnikinnick dominate in association with bluebunch wheatgrass, shrubby penstemon, northwestern sedge, yarrow, and purple reedgrass. Sometimes low shrub climax communities form comprised of a continuous cover of juniper and kinnikinnick.[44]

Very little information exists on ecological conditions and seral stages for grasslands in the Montane Spruce zone. The abundance of pussytoes, old man's whiskers and woolly cinquefoil appears to increase in plant communities dominated by spreading needlegrass. Spreading needlegrass and litter cover decrease in response to heavy grazing.[24]

3.5.1.9 Big Creek Very Dry Very Cold Engelmann Spruce-Subalpine Fir Variant (ESSFxv2)

Grasslands are common in high-elevation valley bottoms in the Engelmann Spruce–Subalpine Fir zone where cold air drainage limits tree growth. These isolated pockets of grassland only cover about 1800 ha at elevations ranging from 1650 to 2100 m. Steppe vegetation is found mostly on moderate to steep south-and east-facing slopes leeward of the Coast Mountains, and the Camelsfoot Range southeast of Taseko Lake. The growing season is cool and short, while winters are long and cold. Snow packs are generally high and persist into summer. Frosts occur in every month.[46]

The species composition of grasslands in this variant is strongly affected by both alpine and boreal influences, but Altai fescue and Rocky Mountain fescue are generally the dominant species.[46] Altai fescue and alpine fescue dominate grassland communities and meadows in Relay Valley.[42] These communities occur on gentle to moderate south-facing slopes on dry sites. A wide range of sedges, forbs and small shrubs are common associates and include Dunhead sedge, field chickweed, diverse-leaved cinquefoil, small-flowered penstemon, yarrow, mountain sagewort, thread-leaved sandwort, and showy Jacob's ladder. Most of these communities have been heavily grazed in the past, and the existing vegetation may represent a seral stage rather than climax.[42]

Photo: D. Blumenauer

High-elevation grasslands in the Coast Mountains.

Slightly moister sites on warm aspects are dominated by alpine timothy and Dunhead sedge. These communities also contain spike trisetum, yarrow and diverse-leaved cinquefoil. Junegrass meadows occupy drier sites with moderate to steep south-facing slopes, and yarrow, field chickweed, northern bedstraw, wild strawberry, and short-beaked agoseris are common associates. Some of these meadows are transitional to dry shrub communities that contain common juniper and soopolallie.[42]

3.5.1.10 Dry Cold Sub-Boreal Pine – Spruce Variant (SBPSdc)

Isolated pockets of grassland in this variant are scattered over about 1000 ha from 900 to 1225 m elevation (Table A 8.5).[46] These grasslands are mainly found on the north shores of the Kluskus Lakes chain, and near Palmer Lake. The climate is characterized by cold, dry winters; and cool, dry summers (Table A 5.8). Frosts occur in all months.

Small areas of grassland occupy steep to moderate south- and west-facing slopes, and the lower slopes of small valleys where frost accumulates. Other grasslands subsist on sites with high evaporation rates where salts accumulate within the rooting zone.[46] Grassland communities are comprised of a mix of species including purple reedgrass, spreading needlegrass, timber oatgrass, Ross's sedge, and dwarf woody shrubs in association with kinnikinnick, cut-leaf anemone, wild strawberry, and field chickweed.

3.5.1.11 Very Dry Cold Sub-Boreal Pine – Spruce Variant (SBPSxc)

West of Alexis Creek, isolated pockets of grassland occur on the Chilcotin plateau northwest of the Chilcotin River to Tatla Lake, and north to Anahim Lake and beyond. Landscapes in the area gently rise from 850 to 1300 m elevation, and eventually abut against the Coast Mountains. Small patches of grassland also occur south of the Chilcotin and Chilanko rivers from 1100 to 1500 m elevation.[46] These grasslands are the western extent of more than 15,600 ha of steppe vegetation found in the Sub-Boreal Pine-Spruce zone. They also mark the northwestern distribution of the steppe vegetation that originates in the Great Basin.[51,52] The climate along the leeward side of the Coast Mountains is characterized by cold, dry winters and cool, dry summers. Frosts are common in all months (Table A 5.8).

Several grassland communities have been described in this variant that reflect differences in slope, aspect, climate, and soils. Large areas of grassland occur on south aspects above Tatla Lake that are similar to Altai fescue communities found in the Montane Spruce zone. Spreading needlegrass often dominates communities on moderate, south-facing slopes. These communities usually contain variable amounts of lichens and mosses, and a sparse cover of forbs.[24] On heavily grazed sites, pussytoes, old man's whiskers, and woolly cinquefoil become more abundant, while spreading needlegrass and litter decline.

Remnants of arid bunchgrass communities are found as Bluebunch wheatgrass – Prairie sagewort associations on steep, warm slopes where active erosion occurs.[46] Widely spaced bluebunch wheatgrass plants are mixed with familiar species from the lower-elevation grasslands such as saskatoon, prairie sagewort, pulse milk-vetch, northern bedstraw, Columbian needlegrass, spreading needlegrass, and junegrass. Lichen and moss cover is usually low because of erosion. These sites may be the northern distribution of bluebunch wheatgrass in British Columbia and North America.

Rocky Mountain fescue – Prairie sagewort communities occupy steep, warm aspects with loose, exposed soils in Big Creek Park.[24] Widely spaced Rocky Mountain fescue, purple reedgrass and junegrass are the dominant grasses in these communities, while prairie sagewort, pussytoes, cut-leaf daisy, and cinquefoils combine with lichens and mosses to form an incomplete ground cover.[24]

Timber oatgrass communities form adjacent to shrub-carrs or on dry meadows. On level sites where frost and cold air accumulates, spreading needlegrass often accompanies timber oatgrass along with minor amounts of other grasses and forbs. Old man's whiskers increases in cover on heavily grazed sites, and spreading needlegrass decreases.[24] On dry, level sites, timber oatgrass co-dominates with field sedge, and tufted hairgrass, Kentucky bluegrass, reed canarygrass, and violets are common associates.[45]

Photo: B. Wikeem

Grasslands are mostly confined to south-facing slopes, and are often associated with wetlands and forest complexes.

3.5.1.12 Dry Cool and Moist Cold Sub-Boreal Spruce Subzones (SBSdk, SBSmc)

Very small, isolated steppe and shrub-steppe communities are widely distributed throughout the Sub-Boreal Spruce zone with the greatest concentration occurring in the Nazko Uplands and Bulkley Basin Ecosections (Table A 8.5). Collectively, they cover about 5445 ha, and are confined to the drier and cooler subzones that extend from Trembleur Lake in the north to Ootsa Lake in the south.[33] These grasslands are most prominent on the north shore of Francois Lake, around Fraser Lake, and along the Stellako River.

Historically, these grasslands were probably more extensive, but some have been inundated as a result of dams. Other areas of arable land associated with lakeshores, river valleys, and the grassy plains between Francois and Ootsa lakes have been cultivated.[3,34] The climate in the Sub-Boreal Spruce zone is continental and characterized by cold, snowy winters; and warm, moist summers. Annual precipitation ranges from about 390 to 575 mm (Table A 5.8).

Steppe and shrub-steppe communities are generally limited to the lowest elevations on moderate to steep south-facing slopes.[3] Saskatoon – Slender wheatgrass associations occupy dry rock outcrops or ridges where droughty conditions restrict tree growth.[17] These communities support a mixture of shrubs that are typical of southern grasslands including saskatoon, common snowberry, choke cherry, prickly rose, and stunted trembling aspen. Localized populations of Rocky Mountain juniper establish on warm, dry sites at low elevations, and are most abundant in the Bulkley Valley.[17] The diverse herb layer consists of slender wheatgrass, interior bluegrass, stiff needlegrass, spreading needlegrass, purple peavine, and northern bedstraw. A well-developed microbiotic layer is often present.[3,17]

Although Interior bluegrass – Slender wheatgrass grasslands are uncommon in the Sub-Boreal Spruce zone, some communities are present along the north shores of Francois, Ootsa, Cheslatta, and Natalkuz Lakes.[3,17] These grasslands are mainly found on gentle, warm aspects, or on level terrain. The diverse herb layer is usually well-developed, but trees, shrubs and mosses are sparse or lacking. Native grasses such as slender wheatgrass, interior bluegrass, Sandberg's bluegrass, spreading needlegrass, stiff needlegrass, blue wildrye, and timber oatgrass are common, but agronomic species such as Kentucky bluegrass, timothy and red fescue are often abundant. Purple peavine, fireweed and yarrow are common forbs in the herb layer.[17]

Photo: B. Wikeem

Edaphic grasslands on a south-facing slope on the north shore of Francois Lake.

Slender wheatgrass – Prairie sagewort communities occur on sites with steep slopes and well-drained soils.[17] These communities are dominated by slender wheatgrass, native bluegrasses, needlegrasses, and pasture sage. Other small areas of grassland are dominated by timber oatgrass. These communities occur on south-facing ridge crests from valley bottom to subalpine along the Telkwa River near Goathorn Creek, and in the Zymoetz River valley. The species composition of these ecosystems can be diverse, and includes spreading needlegrass, western needlegrass, northern bedstraw, yarrow, dwarf blueberry, sweetgrass, northern gentian, stonecrop, wild strawberry, and pussytoes.[17]

3.5.1.13 Grasslands in Other Biogeoclimatic Units

Numerous small steppe and shrub-steppe communities are distributed over an additional 17 variants in five biogeoclimatic zones in the Central Interior Ecoprovince. Collectively, these grasslands cover approximately 4300 ha, but represent only about 2% of the total grassland area of the Cariboo-Chilcotin (Table A 8.5). Although most of these grasslands are small in extent, several communities are unique to the region and to the province.

Open grassland and savannah-like forests occur at upper elevations in the Engelmann Spruce-Subalpine Fir zone from Anvil Mountain west to Tweedsmuir Park, and in the Itcha and Ilgachuz mountains at elevations ranging from 1650 to 2100 m. These communities contain numerous herbs and dwarf shrubs that are characteristic of alpine tundra.[46]

Grasslands dominated by white mountain avens and Altai fescue are found on exposed dry ridges on gentle, west-facing slopes from the upper parkland to the lower alpine. Both these species are frequently found in alpine environments. Other common species in this community include dwarf blueberry, subalpine daisy, small-flowered penstemon, white mountain-avens, alpine clubmoss, green reindeer lichen, and ground lichens.[46]

Photo: BC Parks

High-elevation grasslands in the Itcha and Ilgachuz mountains

A complex of Altai fescue – *Cladonia* grasslands and Scrub birch – Altai fescue shrub-steppe occupy sites with moderate relief in the upper parkland to lower alpine. These communities occur on coarse-textured soils that developed on morainal deposits. Grasslands are dominated by Altai fescue, green reindeer lichen, and haircap mosses mixed with timber oatgrass, field sedge, mountain sagewort, dwarf blueberry, and various reindeer lichens. Shrub-steppe communities have a similar species composition but they also contain scrub birch, coral lichens, and minor amounts of alpine fescue and northern goldenrod.

Grasslands in the Alpine Tundra zone occur on dry sites in the Chilcotin on the leeward slopes of the Coast Mountains.[36] These ecosystems often support a diversity of small bunchgrasses including Altai fescue, alpine fescue, green fescue, fuzzy-spiked wildrye, alpine sweetgrass, purple reedgrass, timber oatgrass, and numerous species of sedges.

Alpine fescue meadows, and Altai fescue – Alpine fescue communities have been described from Relay Valley. These communities occur on gentle to moderate slopes with warm aspects and rocky, well-drained soils.[42] Dunhead sedge dominates these sites mixed with a diversity of forbs including field chickweed, diverse-leaved cinquefoil, small-flowered penstemon, yarrow, mountain sagewort, thread-leaved sandwort, and showy

Jacob's ladder. Climax stages of these communities are difficult to define because they have been heavily grazed by livestock.[42]

3.5.2 Distinguishing Flora and Plant Species at Risk

Grasslands in the Cariboo-Chilcotin occupy only about 2% of the geographic area of the Central Interior Ecoprovince, but they support nearly 86 provincially threatened and endangered plants and plant communities (Table A 9.5; Table A 10.5; Appendix 11). Grasslands with southern, northern, and alpine influences merge in the north Cariboo and West Chilcotin. Consequently, numerous plant species reach their ecological limits in the region, or form unique plant communities not found elsewhere in the province.

Few grassland plant species are unique to the Central Interior Ecoprovince, but at least 66 vascular plants are red or blue-listed for the Cariboo-Chilcotin (Table A 10.5). Some examples of red-listed species include porcupinegrass, rough dropseed, satin grass, bristly mousetail, freckled milk-vetch, mock-pennyroyal, and tall beggarticks. Blue grama, a species abundant on the Great Plains east of the Rocky Mountains, is also found infrequently in small patches along the Fraser River near Gang Ranch.

Booth's willow and autumn willow, both blue-listed species, are found in wetlands on the Upper Grasslands. Booth's willow reaches it northern distribution north of Williams Lake, whereas autumn willow approaches its southern limit in approximately the same area.[14] Some other blue-listed species found on Cariboo-Chilcotin grasslands include marsh muhly, purple oniongrass, spangle top, elegant Jacob's ladder, and threadstalk milk-vetch (Table A 10.5). Hood's phlox, another blue-listed species, reaches its northern distribution in the Cariboo, and is found only infrequently in the Thompson-Pavilion region and East Kootenay Trench ecosections.[14] Drummond's campion, another blue-listed plant, is found infrequently on the Middle and Upper Grasslands of the Cariboo-Chilcotin.

Several plant species in the Cariboo-Chilcotin are of special interest even though they are not red- or blue-listed. For example, wooly cinquefoil is generally uncommon on grasslands in the Chilcotin, except on heavily grazed sites where it often increases in abundance.[22] Otherwise, this species is found only east of the Rocky Mountains along the Peace River.[14] Similarly, lotus milk-vetch very infrequently occupies hot, dry slopes in the Lower Grasslands, but it is more abundant in the Thompson Basin, South Okanagan Basin and East Kootenay Trench.[14] Other species such as American bush-cranberry, Wheeler's bluegrass, little-seed ricegrass, northern sweet-vetch, American chamaerhodos, and Fee's lipfern have local distributions, or occupy unusual habitats, making them unique to the region.[22]

Relatively little research has been conducted on the species composition and distribution of cryptogams in grassland ecosystems in British Columbia. A survey of nine sites in the Cariboo-Chilcotin in 1986, however, identified four species that were new to North America: *Crossidium rosei*, *Phascum vlassovii*, *Pottia wilsonii*, and *Pterygonerum kozlovii*. Five additional species were new to British Columbia including *Bryoerythrophyllum columbianum*, *Mannia fragrans*, *Pottia bryoides*, *Tortula canivervis*, and *Weissia brachycarpa* were new to the province.[28]

Photo: B. Wikeem

Complete cover of mosses and lichens on a north-facing slope in the Lower Grasslands.

Many plant species that originate in the Great Basin grasslands reach their northern distribution n the Cariboo-Chilcotin. Big sagebrush and common rabbit-brush, which are dominant shrubs in the Great Basin, reach their northern distribution north of Williams Lake and west to Farwell Canyon. Bluebunch wheatgrass remains the dominant bunchgrass on climax Lower and Middle Grasslands, but reaches its northern distribution near Castle Rock on the Fraser River.[15] To the northwest, it extends into Sub-Boreal Pine-Spruce grasslands on the Chilcotin Plateau. Other species, such as timber milk-vetch, Pursh's milk-vetch, low pussytoes, arrowleaf balsamroot, and thread-leaved fleabane also reach their northern limit at 52^{o} 30' N latitude, whereas the distributions of sticky purple geranium and Indian ricegrass extend farther north to Francois Lake and Telegraph Creek, respectively.

Short-awned porcupinegrass, which is found infrequently in the Southern Interior Ecoprovince, is most abundant in the Cariboo-Chilcotin.[14] This species is characteristic of most late-seral grasslands at higher elevations in the Interior Douglas-fir zone, and essentially replaces rough fescue as the co-dominant in the Upper Grasslands of the Cariboo-Chilcotin. Short-awned porcupinegrass is also found in moist swales in the Middle Grasslands but becomes less abundant further north in British Columbia.

Altai fescue has a circumpolar distribution and extends from Alaska and the Northwest Territories south to British Columbia[20,21] where it reaches its southern limit on Sub-Boreal Pine-Spruce grasslands near 52^{o} N latitude. It also occurs as a dominant grass in subalpine and alpine communities in the West Chilcotin. At its southern limit, and at low elevations, Altai fescue co-dominates with short-awned porcupinegrass, but it becomes the dominant grass further north.

The merging of grasslands with northern and southern influences produces numerous unique plant communities. Twenty red- and blue-listed grassland and shrub-steppe communities have been identified in the Cariboo-Chilcotin and Central Interior (Table A 9.5). These communities are dispersed over six variants in the Bunchgrass, Interior Douglas-fir and Sub-Boreal Pine-Spruce zones (Appendix 11).

3.5.3 Grassland Associated Ecosystems

Many ecosystems, including cottonwood forests, wetlands, aspen copses, rock outcrops, cliffs, and talus slopes, are associated with the extensive grasslands of the Cariboo-Chilcotin. These ecosystems occur from the valley floors of the Fraser and Chilcotin rivers to the plateau surface and slopes of the Coast Mountains, but vary in relative importance, abundance, and distribution over the landscape.

Cottonwood forests establish on moderately active floodplains and islands along the Fraser River, Chilcotin River, Churn Creek, and other large creeks in the Bunchgrass and Interior Douglas-fir zones.[38] These stands typically have an open canopy of black cottonwood and trembling aspen, but paper birch and Douglas-fir may be present as minor species on some sites. The shrub layer in the understory can be variable depending on soils and available moisture but often includes mountain alder, red-osier dogwood, red raspberry, common snowberry, and prairie rose. Scouring rush, slender wheatgrass, bluejoint reedgrass, and Kentucky bluegrass often comprise the herb layer.
The microbiotic layer is usually poorly developed. Frequent flooding maintains some sites in an early-seral stage dominated by immature cottonwoods and a sparse understory of shrubs.[44, 45] Introduced species such as alfalfa and white sweet clover are also present on some sites. Sandbar willow communities occupy very active floodplains.

Photo: B. Wikeem

Wetland surrounded with bog birch and grassland on uplands south of Riske Creek.

Wetland ecosystems are widespread in the Cariboo-Chilcotin but are most common in the Interior Douglas-fir, Sub-Boreal Pine-Spruce and Sub-Boreal Spruce zones. Although numerous wetland types have been identified in this region,[38] grasslands are mainly associated with marshes, fens, shrub-carrs, and meadows. These communities often occur as complexes where plant species composition changes from sparse associations of emergent vegetation around the open water at the center of the complex to dry upland communities. The species composition of wetlands can also change dramatically over a few years in response to variations in available moisture.

Marshes are most prevalent below 800 m elevation where the climate is relatively warm and dry. These wetlands are permanently or seasonally inundated with water that is less than 2 m deep.[38] The rooting zone for plants usually consists of fine-textured lacustrine deposits covered with a thin layer of organic material. Water quality varies from neutral to moderately alkaline, which affects plant species composition.

Marshes are uncommon in the Bunchgrass zone, especially in the Lower Grasslands where the terrain is often steep. Sedge, bulrush and cattail marshes occur in depressions on the upper margins of the Middle Grasslands where the topography is relatively level. Awned sedge, woolly sedge and bulrushes usually are the dominant species in alkaline marshes, whereas cattails are most frequent in non-alkaline potholes, lake edges, small ponds, and ditches.

Common spike-rush marshes often occur adjacent to bulrush marshes; or in shallow open water along lakeshores, large potholes and oxbows in the Interior Douglas-fir zone. These marshes usually flood in spring and then draw down to shallow ponds, or dry out completely, as the summer progresses.[27] On other sites, complexes of common spike-rush and northern mannagrass border the shorelines of lakes and deeper ponds that have persistent water. Sedges, mint, wapato, and water smartweed are also present in these wetlands. A band of common spike-rush and beaked sedge often separates the northern mannagrass from the upland meadows.[44,45]

Fens are widespread throughout the Cariboo-Chilcotin in the Interior Douglas-fir and Montane Spruce zones, but they are most common on the plateau in the Sub-Boreal Pine-Spruce zone. Fens generally form in poorly drained basins and depressions, and are characterized by deep peat soils that are enriched by external sources of ground water. These ecosystems are generally flooded for all or part of the growing season, but the water table remains at or just above the soil surface.

Sedges dominate fens at all elevations in the region. Beaked sedge and water sedge usually dominate on sites where the water table remains less than 30 cm from the soil surface.[27, 38] Slender sedge and awned sedge are also frequently present and may be mixed with slimstem reedgrass, small yellow-water buttercup, water smartweed, and northern mannagrass. Buckbean, slender sedge, seaside arrowgrass, and lesser-panicled sedge dominate less acidic fen communities that are inundated with 10 to 60 cm of standing water year round.[38]

Numerous meadow complexes occur on mineral soils in shallow depressions, or as bands of vegetation in the upland adjacent to other wetlands. These meadows are usually flooded during spring runoff, before the water table drops below the rooting zone throughout the growing season.

Photo: B. Wikeem

Meadow complex in the Sub-Boreal Pine-Spruce zone.

Saline meadows are common features on grasslands from the Bunchgrass to Montane Spruce zone, although in the Bunchgrass zone they are limited to areas with gentle relief. They are most common in Sub-Boreal Pine-Spruce grasslands, especially on the Chilcotin Plateau, and in the Interior Douglas-fir zone near Meadow Lake. Saline meadows form on sites that are flooded briefly each spring, and where poor drainage and high evaporation rates produce an accumulation of salts.[27, 53] These meadows often surround shallow lakes, but may occur as solitary communities on flats, or in slight depressions.

Species composition varies considerably among meadows, primarily in response to the degree of alkalinity on the site. Nuttall’s alkaligrass – Foxtail barley meadows are widespread in the Interior Douglas-fir zone, often as a transition zone between emergent vegetation and upland communities. Nuttall’s alkaligrass usually dominates wetter sites, while foxtail barley is more abundant on relatively drier soils. Foxtail barley and Nevada bulrush often increase with heavy cattle grazing.[9,27]

Alkali saltgrass meadows are locally abundant in the Interior Douglas-fir and Sub-Boreal Pine-Spruce zones, especially on the Chilcotin plateau near Puntzi Lake and in the west Chilcotin. Alkali saltgrass and alkali cordgrass usually co-dominate these communities mixed with Nevada bulrush, Nuttall’s alkaligrass, seablite, and red glasswort.[9, 27] These meadows often blend with grasslands on sites with low relief where cold air collects. Alkali saltgrass, Nuttall’s alkaligrass and foxtail barley are dominant grasses mixed with alkali bluegrass and silverweed as common associates. Foxtail barley often increases on sites that have been altered by cattle grazing.[9,43]

Saline meadows are also associated with Baltic rush-field sedge meadows on wetter sites in the Interior Douglas-fir zone.[27] These communities cover large areas on the Fraser and Chilcotin plateaus that are subjected to long periods of flooding.[9]Baltic rush and field sedge dominate late-seral stages, and are associated with foxtail barley, common silverweed, slender wheatgrass and tufted white prairie aster.[27] Kentucky bluegrass often dominates these meadows in mid- and early-seral stages.[9]

Tufted hairgrass meadows are found in the cold, dry parts of the Montane Spruce and Sub-Boreal Pine-Spruce zones on the Chilcotin Plateau.[27] Typically, they form around the edges of wetlands, or on well-drained sites where frost accumulates. Tufted hairgrass provides continuous cover on level sites that are saturated early in spring. Kentucky bluegrass, Baltic rush and beaked sedge are common allies, although beaked sedge is more abundant on wet sites. In some areas, tufted hairgrass communities are often integrated with dry meadows containing timber oatgrass or Altai fescue.[27]

Shrub-carrs develop on mineral soils that are seasonally saturated with spring run-off, and where water quality ranges from neutral to alkaline. These communities often form in low-lying areas that are susceptible to frost and the accumulation of cold air during the growing season. Hummocks, which result from frost heaving, are a characteristic feature of these ecosystems.

Shrub-carr ecosystems are usually associated with wetland complexes where they form a fringe around larger wetlands. In the Montane Spruce zone on the Fraser Plateau, scrub birch and willows often surround meadows, and have an understory consisting of timber oatgrass, numerous forbs and glow moss.[24] On other sites in the Sub-Boreal Pine-Spruce zone, scrub birch and kinnikinnick grow on hummocks while the herb layer consists mostly of mat muhly and Bellard's kobresia. Depending on water chemistry and soils, other species such as grey-leaved willow, wild strawberry, yarrow, kinnikinnick, and Lindley's aster can also found in these ecosystems.[24,27]

Swamps form where there is constant movement of ground water and where soils remain moist throughout the growing season. They may be found in depressions, adjacent to shallow lakes, moist meadows or marshes, or along seepage channels and streams. These communities generally form on mineral soils or well-decomposed peat. Water conditions are usually neutral to slightly acidic. Bebb's willow or water birch swamps are uncommon in the Middle and Upper Grasslands. Where they do occur, these tall shrubs provide an open to dense canopy over an understory of roses, red-osier dogwood, common snowberry, bluejoint reedgrass, Kentucky bluegrass, sedges, and fowl bluegrass.[9, 27]

Kentucky bluegrass and quackgrass often dominate heavily grazed sites. In the cooler climates of the Montane Spruce or Sub-Boreal Pine-Spruce zone, tea-leaved willow or Drummond's willow form a canopy over an understory of beaked sedge and water sedge.[44,45]

Trembling aspen groves are a common feature on the gentle terrain of much of the Upper Grasslands. Aspen stands frequently occupy moist areas around wetlands, in upland depressions, in gullies, and at the grassland/forest edge.[46] A mix of prickly rose, prairie rose, common snowberry, red-osier dogwood, and soopolallie form a dense shrub layer under moderate to closed aspen canopies.[35,44,45] Northern bedstraw, pinegrass, showy aster, blue wildrye,

Photo: B. Wikeem

Aspen copses dot the landscape in the south Cariboo, and provide habitat for wildlife and cover for livestock.

and American vetch are common herbs. Aspen stands with an open canopy contain similar species, but the shrub layer is poorly developed and herbs dominate the understory. Prolonged heavy use of aspen groves by livestock can alter the species composition of the understory so that shrub cover is reduced, and Kentucky bluegrass and common dandelion usually become the dominant herbs.[44,45]

Cliff and talus slope habitats associated with grasslands in the Cariboo-Chilcotin are limited mainly to river valleys in Bunchgrass and Interior Douglas-fir zones. These features are widespread throughout the region, but uncommon.[9] Cliffs are most prominent along the canyons of the Fraser, Chilcotin, and Bonaparte rivers, and in the Loon Lake valley, but they are also found along Dog Creek, Canoe Creek and Churn Creek.

Big sagebrush and saskatoon are widely scattered across cliffs in the Lower Grasslands, and Douglas-fir occasionally establishes in rock crevices.[9] Other plants that occur infrequently in cliff habitats include bluebunch wheatgrass, prairie sagewort, brittle prickly-pear cactus, junegrass, and compact selaginella. In the Middle Grasslands, saskatoon and chokecherry are scattered across near-vertical rock faces while prairie sagewort, bluebunch wheatgrass, cliff ferns, and round-leaved alumroot cling to soil pockets and crevices.

Talus is mostly restricted to the lowest reaches of the Bunchgrass zone. Douglas-fir, big sagebrush, saskatoon, and prairie rose are often found at the base of moderate to steep talus slopes. These plants are widely spaced, and provide an overstory for a sparse herb layer that includes bluebunch wheatgrass and cliff ferns. Douglas-fir, Douglas maple, junegrass, and spike-like goldenrod are often present on north- and east-facing aspects.[9] Talus slopes in the Middle Grasslands support a diversity of species including big sagebrush, Rocky Mountain juniper, choke cherry, saskatoon, bluebunch wheatgrass, prairie sagewort, sand dropseed, small-flowered ricegrass, and cliff ferns, but each species contributes little to total cover.[9]

Photo: R. Holmes

Cliffs and talus slopes provide unique habitats for plants and animals.

Rock outcrops occur on steep, rocky slopes and ridge crests where shallow soils overlay bedrock. In the Bunchgrass zone, these sites are dominated by a sparse cover of big sagebrush mixed with either prickly-pear cactus or prairie sagewort. Saskatoon, common rabbit-brush, and Rocky Mountain juniper are often present but infrequent, and stunted Douglas-fir occasionally grows in rock fractures. Widely spaced bluebunch wheatgrass and prairie sagewort dominate the herb layer along with numerous secondary species such as pussytoes, junegrass, sand dropseed, brittle junegrass, compact selaginella, Holboell's rockcress, and lance-leaved stonecrop.[9]

Shrubs are mostly absent in rock outcrop habitats on higher-elevation grasslands in the Interior Douglas-fir zone. Total vegetative cover is usually sparse to moderate, and is dominated by widely spaced bluebunch wheatgrass with minor amounts of needle-and-thread grass, prairie sagewort, and scattered forbs.[9] On slightly moister sites, a sparse cover of Douglas-fir provides an overstory for widely spaced Rocky Mountain juniper and prickly rose, while the herb layer consists of bluebunch wheatgrass, compact selaginella, Rocky Mountain fescue, kinnikinnick, pinegrass, large-fruited desert parsley, nodding onion, and reindeer lichens.[46]

3.5.4 Representative Fauna and Species at Risk

The combination of open grasslands, wetlands, forest groves, and rugged topography in the Cariboo-Chilcotin provides a diversity of habitats for reptiles, amphibians, birds, and mammals. Two hundred and forty-six species of amphibians, reptiles, birds, and mammals are associated with grasslands in the Cariboo-Chilcotin, but none of them are unique to the region.[22] Forty-five of these species have been designated as threatened or endangered in the region (Table A 9.5; Table 13.5). This number is lower than in the Okanagan (60), but higher than in the Thompson-Pavilion region (21) and Southern Thompson Upland (16). The number of threatened and endangered species found on the Cariboo-Chilcotin grasslands represents 14% of the red-listed and 39% of the blue-listed species that occur in the province.[22] Most of the rare and endangered vertebrates associated with grasslands are found in riparian and shrub-steppe habitats.[22]

Photo: A Bezener

The Gopher Snake reaches its northern distribution in North America in the Cariboo.

Eleven species of reptiles and amphibians inhabit in the Lower and Middle Grasslands of the Cariboo-Chilcotin compared to 17 species in the Okanagan Valley. In the Upper Grasslands, this number declines further to nine species. The Long-toed Salamander, Spotted Frog, Western Toad, and Western Garter Snake are the most widely distributed amphibian and reptile species in the region, occupying wetlands and grassland communities from the valley bottoms to the alpine (Table A 13.5).

Six blue-listed reptiles and amphibians reach their northern distribution on Cariboo-Chilcotin grasslands (Table A 13.5). Of these, the Western Rattlesnake has the most southerly distribution, and is confined to the Lower Grasslands south of Lillooet.[38,48] The Gopher Snake, Racer, Rubber Boa, Painted Turtle, and Great Basin Spadefoot are restricted to cottonwood forests, wetlands and sagebrush grasslands from the valley

Photo: A Bezener

The blue-listed Rubber Boa reaches its northern distribution in the Cariboo-Chilcotin.

floor in the Fraser Canyon to the plateau surface. The northern limits of the Rubber Boa and Gopher Snake coincide approximately with the northern distribution of big sagebrush along the Fraser and Chilcotin rivers.[38] The Great Basin Spadefoot has been found as far north as 70 Mile House on grasslands in the Interior Douglas-fir zone.[7]

Grasslands in the Cariboo-Chilcotin support a rich avifauna. Sixty-five percent of all bird species, and 61% of the breeding bird species in British Columbia occur in the Central Interior Ecoprovince.[12] Grasslands in the Cariboo-Chilcotin also represent the northern distribution of many bird species from steppe and shrub-steppe communities in the southern part of the province and the Great Basin.

Two hundred and nine bird species are found in the Chilcotin-Cariboo, but not all of them inhabit grasslands. Those species associated with grassland use a variety of habitats including open grasslands, cliffs, wetlands, and forest habitats for foraging, nesting and resting during migration.[22, 39] Upland species such as the Black-billed Magpie, Brown-headed Cowbird, Common Nighthawk, Horned Lark, Mountain Bluebird, Vesper Sparrow, Western Kingbird, Western Meadowlark, and Long-billed Curlew are typical grassland birds that are found throughout the region.[37] Many raptors including the Cooper's Hawk, Red-tailed Hawk, Prairie Falcon, and American Kestrel hunt over the grasslands and nest in adjacent forests. Ground-nesting species such as the Savannah Sparrow, Blue Grouse, Sharp-tailed Grouse, Common Nighthawk, and Common Poorwill tend to be secretive and inconspicuous.[1]

The Common Nighthawk is frequently found on most grasslands in the province.

Photo: J. Hobbs

At higher elevations, avian diversity is affected by northern and alpine influences. The Rock Ptarmigan, Willow Ptarmigan, and White-tailed Ptarmigan are common upland birds that accompany familiar grassland species from lower-elevation grasslands such as the Horned Lark, Black-billed Magpie, and Western Meadowlark. The Common Raven and Golden Eagle are also more prevalent at higher elevations in the Sub-Boreal Spruce and subalpine environments than in the lower-elevation grasslands.

The Spotted Towhee and Mourning Dove, and many red- and blue-listed species such as the Brewer's Sparrow, Prairie Falcon, Bobolink, Flammulated Owl, Lewis's Woodpecker, White-throated Swift, and Short-eared Owl reach their northern distribution limits on the Upper Grasslands near Riske Creek.[37] (Table A 13.5). The Long-billed Curlew also occurs on grasslands at Riske Creek but some birds have been found as far north as Vanderhoof.

Rare sightings of the red-listed Yellow-breasted Chat, which is found mostly in the south Okanagan and infrequently in Garry Oak savannah on Vancouver Island (Table A 13.2; Table A 13.7), have been made near Alkali Lake.[55] Similarly, the red-listed Upland Sandpiper and Sprague's Pipit, and Common Poorwill were discovered breeding on grasslands in the Cariboo-Chilcotin only within the last 10 to 15 years.[22]

Riparian sites and wetlands support the greatest number of wildlife species that are associated with grasslands in the Bunchgrass and Interior Douglas-fir zones in the region.[22] Aspen parklands and wetlands on the Fraser Plateau are especially important because they support one of the highest breeding populations of aquatic birds in Canada.[22] Up to 21 species of waterfowl, mostly cavity-nesting and dabbling ducks, nest in these habitats. Wetlands in the Cariboo-Chilcotin are also the world breeding

Cariboo-Chilcotin wetlands provide nesting habitat for the Red-winged Blackbird.

Photo: J. Hobbs

center for Barrow's Goldeneye, but the American Coot, Cinnamon Teal, Blue-winged Teal, Ruddy Duck, Eared Grebe, and numerous other species of waterfowl breed in the abundant ponds, marshes, and lakes on the Fraser Plateau as well.[37] Most birds are not restricted to specific aquatic features but use complexes of wetlands for home ranges.

Cariboo-Chilcotin wetlands also provide important habitat for other birds, and are the world breeding center for the Greater Yellowlegs and Yellow-headed Blackbird.[22] In addition, the Marsh Wren, Sora and Red-winged Blackbird use emergent vegetation for nesting, while the Killdeer and Least Sandpiper feed along shorelines. Wetlands also supply important breeding areas for the Sandhill Crane,[12] and ice-free ponds near Becher's Prairie provide resting habitat for swans.[22]

Grassland-associated wetlands and lakes in the Interior Douglas-fir and Sub-Boreal Pine-Spruce zones provide foraging habitat, staging areas, and nest sites for about 200 American White Pelicans. This red-listed species migrates annually to its nesting site at Stum Lake near Riske Creek after wintering in southern California and along the Pacific coast in Mexico. Stum Lake is the only known nesting location in the province, but pelicans forage in many other lakes in the region.

The Mule Deer and Moose are the most common ungulates in the Cariboo-Chilcotin, using grasslands and open forest from the Bunchgrass zone to the subalpine. Mule Deer are especially abundant on the southern part of the Fraser Plateau along the Fraser River where they use open grasslands in the Bunchgrass and Interior Douglas-fir zone as important fall, winter, and early spring range. As summer progresses, they migrate to higher elevations and use parklands and steep south-facing grasslands in the Montane Spruce and Engelmann Spruce-Subalpine Fir zones.[23] In contrast, Moose forage in shrub-carr and wetland communities adjacent to grasslands, especially in winter. The Black Bear, Coyote, Red Fox, and Bobcat are other typical large mammals and predators that use the Lower, Middle and Upper Grasslands as seasonal habitats.

Photo: B. Wikeem

Mule Deer use grasslands for spring and fall range and Dougals-fir forest in winter.

Numerous small mammals occupy grassland, open forest, and wetland habitats at all elevations for foraging, cover and reproduction (Table A 13.5). Some representative species include the Deer Mouse, Yellow-bellied Marmot, Columbian Ground Squirrel, Long-tailed Weasel, and Striped Skunk. The Montane Vole and Northern Bog Lemming are also common in wetlands, wetland edges, and forest habitats.

Seven red- and blue-listed mammals are found in the region including the Badger, California Bighorn Sheep, Grizzly Bear, and five species of bats (Table A 13.5). The distribution and abundance of the red-listed Badger is poorly understood in the Cariboo-Chilcotin, but numerous sightings have been made over the last 10 years in the Meadow Lake, China Lake, Alkali Lake, and Churn Creek areas. Most sightings and burrows have been found on grasslands, although some have been located in forested habitats.[16]

Several large populations of blue-listed California Bighorn Sheep use Lower, Middle and Upper Grasslands year-round for foraging, escape terrain and lambing.[13] The largest band of sheep inhabits the steep slopes and breaks of the Fraser and Chilcotin rivers, and the uplands along Churn Creek. The steep slopes and break provide excellent escape terrain and lambing habitat,[1,13] and the uplands supply forages such as bluebunch wheatgrass, pasture sagewort and numerous forbs.[57] Grizzly bears are not common on lower elevation grasslands, but they can be found in the Montane Spruce, Engelmann Spruce-Subalpine Fir and Sub-Boreal Pine-Spruce zones during summer where they use grasslands and open aspen stands for foraging and cover.[47]

Ten species of bats are found from the lowest elevations in the Bunchgrass zone to grasslands in the Sub-Boreal Pine-Spruce zone (Table A 13.5).[48] All of these species use cliffs, crevices, caves, and snags adjacent to grasslands for roosting and rearing their young, and they forage for insects over open grasslands and wetlands. The Fringed Myotis, Spotted Bat, Townsend's Big-eared Bat, and the Western Small-footed Myotis are blue-listed, while the Pallid Bat is red-listed. Only the Big Brown Bat and Townsend's Big-eared Bat hibernate in the region.[12]

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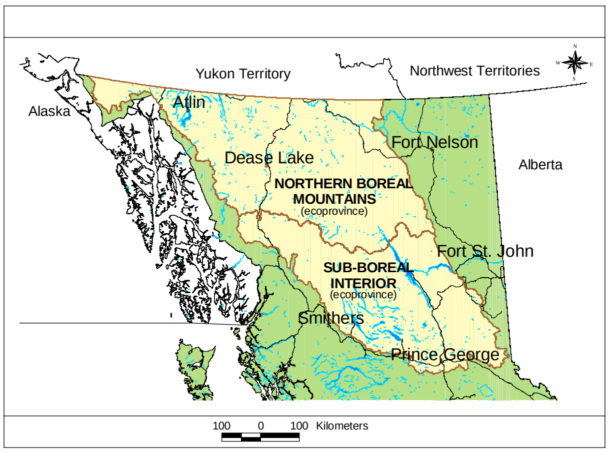
3.6 Sub-Boreal Interior and Northern Boreal Mountains

The Sub-Boreal Interior and Northern Boreal Mountains ecoprovinces occupy northwestern British Columbia from approximately Hazelton in the south to the Yukon border, and from the Coast Mountains to the eastern edges of the Rocky Mountain foothills.[8] Small areas of grassland are widely scattered throughout these ecoprovinces but they never dominate the landscape except in some alpine environments.



Source: Grasslands Conservation Council of B.C.

Grasslands in the Sub-Boreal Interior and Northern Boreal Mountains

Steppe vegetation is found both east and west of the Rocky Mountains in the Northern Boreal Mountains Ecoprovince. More than 36,900 ha of grasslands occur in the Muskwa Foothills Ecosection to the east of the Rockies. These grasslands occur mainly along the Toad River, Eight Mile Creek, Snake Creek, and North Tetsa River (Table A 7.5). Smaller areas of grassland are found in the Eastern Muskwa Ranges Ecosection along MacDonald Creek and Churchill Creek, and on steep, south-facing slopes of the Liard River in the Hyland Highlands Ecosection (Table A 7.5). Grasslands are mostly associated with steep south-facing slopes on the Liard Plateau, and on the lower slopes and floors of the river valleys. Generally, these grasslands represent small areas within larger forested ecosystems except at higher elevations in the subalpine and alpine where they become a more dominant landscape feature.

West of the Rocky Mountains, steppe vegetation is scarce and widely distributed among six ecosections, but no data are available describing their total area (Table A 7.5). Most of these grasslands are associated with the Stikine River and its tributaries from its headwaters in Spatsizi Plateau Wilderness Park west to Telegraph Creek.[16] Other small areas of steppe and shrub-steppe are found on steep, south-facing slopes north of Atlin, and along the Nakini, Dease, and Major Hart rivers. The terrain supporting grasslands is broadly similar to the landscape east of the Rocky Mountains. Grasslands occur on the rolling plains of the high-elevation plateaus, and occupy the lower slopes and bottoms of wide valleys. Occasionally, these grasslands are interrupted by shrubfields and wetlands, which are also common on the plateau.[25]

Photo: B. Drinkwater

High-elevation Altai fescue grasslands on the Spatsizi Plateau.

Most of grasslands in the Sub-Boreal Interior Ecoprovince are found the Babine Upland Ecosection. Limited areas of steppe and shrub-steppe vegetation are found a on the gently rolling terrain of the Nechako and Fraser plateaus in the Sub-Boreal Spruce zone.[22] These communities mainly usually occupy west- and south-facing slopes.[22] and are concentrated in the area between North Cunningham Lake, South Trembleur Lake and the south end of Talka Lake. Additional patches of grasslands extend along the Bulkley River west to Hazelton.[14,24]

Physiography, Climate and Soils

The Northern Boreal Mountains Ecoprovince consists of a mix of rugged mountains, high plateaus, and lowlands. Elevations range from 750 m in the lowlands to over 1800 m on the plateau surfaces. The entire area is underlain with a complex mix of sedimentary strata, slates and schists. In the northwestern part of the region, elevations range from 900 m on the valley floors to 2700 m in the Cassiar and Omineca mountains.[27] The topography of the Nechako Plateau, which dominates the landscape in the southern part of the region, is generally a flat, rolling plain dissected by river valleys.[26] Most of the underlying bedrock is comprised of lavas extruded by shield volcanoes during the late Tertiary and Pleistocene.[13] Elevations on the plateau surface vary from 1900 to 2300 m.

Cordilleran ice covered most of the area below 1800 m during the Pleistocene glaciation. As the glaciers advanced, they scoured the bedrock and picked up materials from previous glaciations. These materials were re-deposited as a thick mantle of till on the plateau surface and in the river valleys.[15] As the glaciers retreated, these deposits were re-worked further by post-glacial water, which created the distinctive landforms and parent materials found in the region today.[26]

A continental climate dominates most of the region, producing cool to warm summers and long, cold winters. Climatic comparisons between Smithers and Cassiar indicate that precipitation increases, and average temperatures in July and January decrease from south to north (Table A 5.10). Rain shadows occur in both the Northern Boreal Mountains and Sub-Boreal Interior ecoprovince. In the north, Pacific air masses deposit moisture on the windward side of the St. Elias Mountains and Boundary Ranges, which creates a rain shadow to the east of these ranges.[8] Annual precipitation varies from 225 to 300 mm.[13] In the western part of the region, the Rocky Mountains significantly influence climate in the Hyland Highland, Muskwa Foothills and Peace Foothill ecosections where most of the grasslands are found. Precipitation averages between 500 and 600 mm annually depending on latitude and elevation.[13]

Grassland soils have not been classified in detail throughout these ecoprovinces. Some soils that support grasslands on steep south-facing slopes have been classified as shallow Brunisols or Rego Chernozems.[18] These soils generally form on rocky, sandy, or gravelly parent materials.[24] Regosols also occur where soil development is restricted by surficial bedrock, particularly on very dry sites with steep slopes.

Development of Grasslands

The flora of the Sub-Boreal Interior and Northern Boreal Mountains region is very recent, and strongly influenced by the vegetation that remained in ice-free refugia to the north during the Pleistocene glaciation. Pollen records indicate that grass – sagebrush communities were present north of the glacial front during the last glacial period between 25,000 to 10,000 BP.[28] Present-day grasslands on south-facing slopes along the Alsek River in the southern Yukon contain sagebrush, selaginella and other steppe species.[9] Many grassland species in the Sub-Boreal Interior and Northern Boreal Mountains region have circumpolar distributions, that reflects a northern influence.[31]

Archaeological records suggest an aboriginal presence in the region approximately coincided with the last glacial retreat about 10,000 BP,[2] but their influence on the development of the local vegetation is poorly understood. In recent times, human disturbance on grasslands has been minimal reflecting the low human population in the region. In addition, most of the grasslands are only lightly grazed by domestic livestock, but Stone Sheep, Mountain Goat, Caribou, and Rocky Mountain Elk periodically forage on grasslands throughout the year.[24]

3.6.1 Representative Grassland Associations

Steppe vegetation occurs in four biogeoclimatic zones and 13 subzones and variants in the Sub-Boreal Interior and Northern Boreal Mountains ecoprovinces (Table A 8.6). Most of these grasslands are found in the Engelmann Spruce-Subalpine Fir, Boreal Black and White Spruce, and the Spruce-Willow-Birch zones.

3.6.1.1 Graham Moist Very Cold Engelmann Spruce-Subalpine Fir Variant (ESSFmv4)

About 8000 ha of grassland and shrub-steppe vegetation in this variant (Table A 8.6) are located in the Misinchinka Ranges and Peace Foothills ecosections at elevations ranging from 1000 to 1550 m.[6] These communities are found mostly in the lee of the Rocky Mountains where winters are long and cold, and the short growing season is cool and moist. The harsh climate and heavy snow packs, which sometimes exceed 200 cm, restrict conifer growth.[6,33]

Most of the variant is forested, but subalpine parklands and grasslands are present at higher elevations.[3] On moister sites at these higher elevations, subalpine fir is the dominant tree, but the physiognomy of parklands varies from groves of krummholz trees or treeless meadows to treeless heath depending on moisture and nutrient regimes.[33]

Subalpine steppe and parkland vegetation has not been described in detail, but plant communities have a similar appearance to those in the Alpine Tundra zone. White and pink mountain-heathers dominate the heaths that usually occur where snow persists for long periods of time. Altai fescue (northern rough fescue)[10] grasslands usually occur on steep, south-facing slopes.[3] Other communities are dominated by junegrass, Rocky Mountain fescue, common starwort, wild strawberry, and old man’s whiskers, while common secondary species include showy Jacob’s-ladder, northern bedstraw, diverse-leaved cinquefoil, bluegrasses, yarrow, small-flowered penstemon, and field locoweed. The moss and lichen layer is usually sparse.[3]

At higher elevations, where subalpine and alpine communities join, species such as alpine bluegrass, spike trisetum, alpine fescue, and northern bedstraw become dominant. These are often mixed with low-growing shrubs and perennial forbs including net-veined willow, four-angled mountain-heather, white mountain-avens, three-toothed saxifrage, snow cinquefoil, and arctic lupine.[7] On other sites, alpine species such as arctic sagewort, mountain sagewort, white mountain-heather, arctic lupine, small-flowered paintbrush, and alpine timothy are common. Species found at lower elevations are also present on these sites.[33]

3.6.1.2 Dry Cool Boreal White and Black Spruce Subzone (BWBSdk)

Most of the grasslands in this subzone occur west of the Rocky Mountains on the Stikine and Yukon plateaus, and in the Cassiar, St. Elias, and Skeena mountains. Approximately 6700 ha of steppe vegetation (Table A 8.6) occur around Atlin Lake, and along the Stikine, Turnagain and Ketchika rivers at elevations ranging from 500 to 1050 m. Small areas of grassland are also found in the Liard River valley from 350 to1200 m elevation.[1]

Photo: BC Parks

Grassland and shrub-steppe along the Stikine River.

The climate in these grasslands is northern continental with long, very cold winters and short summers.[4] Coastal air masses have a slight influence on local weather patterns in the western part of the region, which results in drier, warmer winters, and slightly cooler summers than in the Liard River valley.

Several grassland communities have been described for this subzone. Widely scattered Prairie sagewort – Slender wheatgrass associations are the most common grassland community east of the Coast Mountains. These communities form on steep south-facing slopes from the lowlands to the subalpine.[24] Prairie sagewort is the dominant shrub, but northern wormwood often co-dominates, and on some sites, it becomes the principal shrub. Purple reedgrass can also co-dominate or replace slender wheatgrass as the dominant herb, especially on calcareous soils, and glaucous bluegrass frequently becomes abundant north of 57^{o} N latitude. Other secondary species include prickly rose, saskatoon, common juniper, Rocky Mountain juniper, and kinnikinnick.

Shrub-steppe communities are locally common in river valleys; on dry, south-facing slopes with coarse-textured soils. Dominant trees and shrubs include stunted trembling aspen, lodgepole pine, prickly rose, saskatoon, common juniper, and Rocky Mountain juniper. Slender wheatgrass, purple reedgrass and glaucous bluegrass are dominant grasses, mixed with secondary species such as kinnikinnick, prairie sagewort, northern wormwood, western snowberry, junegrass, needle-and-thread grass, yarrow, northern bedstraw, and rosy pussytoes.[4] Similar communities exist in the Liard River drainage, but fuzzy-spiked wildrye is frequently the dominant grass, and prickly rose, saskatoon, common juniper, Rocky Mountain juniper, northern wormwood, and kinnikinnick are common associates.[1]

Needle-and-thread grass – Junegrass communities are limited to the Stikine Canyon near Telegraph Creek, but species diversity is relatively high. In addition to the site dominants, slender wheatgrass, western wheatgrass, northern wheatgrass, green needlegrass, porcupinegrass, Pumpelly brome, Nevada bluegrass, and fuzzy-spiked wildrye can be present. The herb layer contains numerous species such as nodding onion, northern bedstraw, tufted white prairie aster, western blue flax, pale comandra, tufted fleabane, silky locoweed, showy locoweed, Pennsylvanian cinquefoil, white cinquefoil, and wild bergamot.[24]

Little is known about grassland seral stages in this subzone although horse grazing has likely caused changes in species composition in Prairie sagewort – Slender wheatgrass and Needle-and-thread grass – Junegrass communities in the Stikine Canyon near Telegraph Creek.[24]

3.6.1.3 Graham Wet Cool Boreal White and Black Spruce Variant (BWBSwk2)

Grasslands occupy about 3000 ha in the Muskwa Foothills Ecosection from the Graham River in the south to where the Sikanni Chief River discharges from the Rocky Mountains. Most of the grasslands in this variant occupy small openings surrounded by forests with varying densities of canopy closure. These grasslands extend over an elevational range from 900 to 1300 m. Long, very cold winters and short summers characterize the northern continental climate of this area.

White spruce dominates mature forests, while black spruce occupies wetter sites where forests against open grasslands. On other sites at lower elevations, grasslands are associated with extensive seral forests of lodgepole pine or trembling aspen.[5]

Prairie sagewort – Slender wheatgrass communities are common on steep, south-facing slopes with coarse soils.[24] Slender wheatgrass dominates the herb layer but other grasses, such as purple reedgrass or fuzzy-spiked wildrye, can co-dominate. Northern wormwood may also be present and replaces prairie sagewort on some sites. Other common species include prickly rose, saskatoon, common juniper, Rocky Mountain juniper, and kinnikinnick.[24]

3.6.1.4 Fort Nelson Moist Warm Boreal White and Black Spruce Variant (BWBSmw2)

Small remnants of the Boreal White and Black Spruce zone containing grassland extend westward from the Taiga Plains into the Northern Boreal Mountains Ecoprovince along river valleys in the Rocky Mountain foothills. Although most of this variant is forested, nearly 4000 ha of grasslands occupy high-elevation sites up to 1000 m. Virtually all the grassland in this region occupy steep, south-facing slopes and they are usually associated with aspen forests or parkland.

Many grasslands, such as those along the Tuchodi River, are maintained by frequent fires that were ignited to provide forage for livestock and wildlife. Fuzzy-spiked wildrye is the dominant grass mixed with slender wheatgrass, bluegrasses and pumpelly brome. Aspen and shrubs often encroach onto the grasslands from adjacent, unburned seral aspen stands that contain balsam poplar, white spruce, Mackenzie willow, and Scouler's willow.[29]

Fuzzy-spiked wildrye – Bluegrass communities also form on sites with warm slopes that are transitional between the Boreal White and Black Spruce, and Spruce-Willow-Birch zones.[29] These grasslands exist as openings among groves of trembling aspen, balsam poplar, white spruce, and willows, but shrubs are usually uncommon in these communities. Fuzzy-spiked wildrye dominates these sites, and is often accompanied by mutton bluegrass, Kentucky bluegrass, slender wheatgrass, pumpelly brome, and Rocky Mountain fescue.

Photo: P. Grilz

Grasslands along the Tuchodi River.

3.6.1.5 Moist Cool Spruce-Willow-Birch Zone (SWB)

North of 57° N latitude, subalpine ecosystems are classified as part of the Spruce-Willow-Birch zone, and are similar to those in the Engelmann Spruce-Subalpine Fir zone farther south. Dry to moist grasslands occupy the valley floors and lower slopes on the Stikine Plateau west of the Rocky Mountains, and on the Liard and Yukon plateaus to the east, especially where cold air drainage inhibits tree growth.[25] These grasslands have not been classified to subzone or variant.

Most of the nearly 36,000 ha of steppe that occurs in this zone (Table A 8.6), is found in the Muskwa Foothills. Grasslands extend from 800 to 1850 m elevation where the climate is cold in winter, and cool in the summer.[24,29] Annual precipitation averages 580 mm with most falling as snow (Table A 5.9).

Prairie sagewort – Wheatgrass steppe apprear to be the predominate type of northern grassland. These grasslands are widespread east of the Coast Mountains and form local, discontinuous communities from low elevations to the subalpine.[24] Prairie sagewort and slender wheatgrass usually dominate sites with shallow, coarse soils or those on steep slopes. These species are often associated with northern wormwood, glaucous bluegrass, purple reedgrass, Altai fescue, and fuzzy-spiked wildrye. Northern wormwood occasionally co-dominates or replaces prairie sagewort on calcareous soils in the Liard drainage. Three-toothed saxifrage and Pennsylvanian cinquefoil are also often found in these communities.[24,25] Although some Prairie sagewort – Slender wheatgrass and Altai fescue communities have been heavily grazed by horses, very little information exists on seral stages in northern grasslands.[24]

Glaucous bluegrass and northern wormwood communities are present on dry subalpine sites with steep, south-facing slopes. These communities contain a diverse mix of grasses and sedges including glaucous bluegrass, slender wheatgrass, junegrass, Altai fescue, Rocky Mountain fescue, spike tristeum, spreading arctic sedge, pasture sedge, and blunt sedge. Pennsylvanian cinquefoil and Alaskan locoweed are typical forbs. The moss layer is poorly developed but often contains rusty steppe moss, dog lichen, *Parmelia separata*, and *Physconia muscigena*.[25] Altai fescue sometimes replaces glaucous bluegrass as the dominant grass at higher elevations, and is commonly associated with Rocky Mountain fescue, glaucous bluegrass, Cusick’s bluegrass, mountain sagewort, and diverse-leaved cinquefoil.[25]

On the Stikine plateau, Altai fescue grasslands develop on high-elevation valley bottoms where the topography is flat to gently rolling.[24,25] Characteristic species associated with Altai fescue include mountain monkshood, mountain sagewort, tall Jacob’s-ladder, diverse-leaved cinquefoil, thick-headed sedge, and alpine timothy.[24,25] Altai fescue also frequently occurs in shrub-steppe communities along with scrub birch and willows.

Several subalpine shrub-steppe communities have been described for the Muskwa Foothills in the eastern Rocky Mountains. These communities contain similar plant species, but their floristic composition varies. Altai fescue – Pumpelly brome communities occupy sites ranging from 900 to 1250 m elevation along the Halfway River and Sikanni-Chief River drainage.[29] A mix of grasses consisting of Altai fescue, Pumpelly brome, fuzzy-spike wildrye, and slender wheatgrass dominate these communities, but low-growing willows, shrubby cinquefoil and scrub birch are abundant on some sites.

Hairy wildrye – Altai fescue communities occupy sites on very steep, south-facing slopes along the upper Prophet River at elevation ranging from 1500 m 1900 m on Nevis Mountain.[19] These communities contain a rich mix of forbs and small shrubs comprised of white mountain-avens, arctic lupine, alpine bistort, shrubby cinquefoil, grey-leaved willow, scrub birch and kinnikinnick. Small, discontinuous communities dominated by hairy wildrye and slender wheatgrass occupy steep slopes below 1600 m. Bluegrasses, locoweed, alpine hedysarum, yarrow, and fireweed are common secondary species in these communities, and shrubs are mostly absent.

Photo: C. Delong

Open grasslands in the Muskwa Foothills.

On Nevis Mountain, Dryas – Altai fescue communities inhabit exposed, west-facing ridges on gentle slopes at elevations ranging from 1700 to 1750 m.[19] Altai fescue and alpine fescue are the most common grasses combined with white mountain-avens, arctic lupine, alpine bistort, three-toothed saxifrage, and moss campion. These communities are replaced by Altai fescue – Dryas associations on very steep, southwest-facing slopes above 1750 m elevation where seepage maintains constant moisture throughout the growing period.[19] This community is floristically similar to the Dryas – Altai fescue community except that grasses are more abundant, saxifrage is absent, and other species such as tall bluebells and northern anemone are present.[19]

3.6.1.6 Grasslands in Other Biogeoclimatic Units

Other small areas of grassland, usually covering less than 1000 ha, are widely distributed throughout this region from the Sub-Boreal Spruce to Alpine Tundra zone. Alpine grasslands occupy small areas mostly above 1500 m elevation. These communities usually merge with parkland vegetation in the lower-elevation Engelmann Spruce-Subalpine Fir zone, or with subalpine grasslands in the Spruce-Willow-Birch zone.[21] Alpine plant communities vary considerably from shrub-steppe at lower elevations, to grass- and forb-dominated grasslands at mid-elevation. Lichen communities dominate the highest altitudes.

Zonal Dwarf shrub – Sedge – Grass – Cryptogam communities form on sites with sloping to flat topography where soils are poorly developed.[21] Netted-veined willow, polar willow, small-awned sedge, and lichens usually dominate these sites, combined with secondary species such as alpine sweetgrass, Altai fescue, alpine bluegrass, alpine fescue, alpine bistort, and moss campion.[21]

A ‘Cushion plant’ – Tundra community also develops on exposed, windswept, convex ridges that are covered with a thin layer of colluvium or gravel. Despite the inhospitable soil substrate, these sites support a complex mix of vascular plants including entire-leaved white mountain-avens, blackish locoweed, moss campion, one-flowered cinquefoil, netted willow, alpine sweetgrass, small-awned sedge, and Bellard's kobresia.[21]

The Alpine Heath association is widespread in the region, especially on moist north- and east-facing slopes. Four-angled mountain-heather, entire-leaved white mountain-avens, and netted and polar willows are common shrubs that occur in association with moss campion, capitate lousewort, and alpine bistort. Numerous sedges and grasses are also present including small-awned sedge, graceful mountain sedge, arctic bluegrass, and Altai fescue.[21] Altai fescue – Lichen tundra communities occupy dry, well-drained sites with discontinuous winter snow cover. Other common herbs include alpine sweetgrass, small-awned sedge, spiked wood-rush, and a mix of lichens.[21]

3.6.2 Distinguishing Flora and Plant Species at Risk

Extensive forest separates the scattered grasslands in the Babine Upland Ecosection from those along the Stikine River and its tributaries, and farther north to the Yukon border. Steppe vegetation along the Liard River in the Hyland Highlands Ecosection represents the northern distribution of extensive grasslands in the province.

Few plant species from the southern interior grasslands remain in northern steppe communities. Some grassland species with ubiquitous distributions, such as junegrass, yarrow, prairie sagewort, saskatoon, and prickly rose (Appendix 12), are common specie son northern grasslands, and occasionally are dominants. Other species, such as common juniper, Rocky Mountain juniper, northern wormwood, western snowberry, kinnikinnick, northern bedstraw, and rosy pussytoes, are found in higher-elevation grasslands in the southern interior.

Grassland flora in the region also has affinities with tundra, alpine and prairie vegetation.

Fuzzy-spiked wildrye, a dominant grass on many northern grasslands, is found in montane habitats at higher elevations as far south as the East Kootenay Trench.[10,11] This species is also widespread throughout Alberta in the boreal forest, but is uncommon in the parkland and southern grasslands.[17] Other prominent grasses in northern B.C., such as western wheatgrass, northern wheatgrass, green needlegrass, and porcupinegrass are prevalent on Alberta prairies.[17]

Several species of herbs on grasslands in the Sub-Boreal Interior and Northern Boreal Mountains ecoprovinces that are present on parklands and prairies in Alberta include nodding onion, northern bedstraw, tufted white prairie aster, western blue flax, pale comandra, tufted fleabane, silky locoweed, showy locoweed, Pennsylvanian cinquefoil, woolly cinquefoil, white cinquefoil, and wild bergamot.[24] Other species, such as alpine bluegrass, spike trisetum, alpine fescue, northern bedstraw, white mountain-avens, three-toothed saxifrage, snow cinquefoil, and arctic lupine have arctic and alpine affinities.

Although grasslands containing montane, prairie, alpine, and arctic plant species join in various combinations north of 53^{o} N latitude, only four grassland plant communities are red-listed in the northern half of the province (Appendix 11). At least 44 vascular plants are red- or blue-listed in the northern half of the province (Table A 10.6), but few of these species are unique to northern grasslands. No red-listed species occur in Sub-Boreal Interior or Northern Boreal Mountains grasslands. Some blue-listed species include short-leaved sedge, Arctic bladderpod, Canada anemone (boreal), milky draba, and tundra milk-vetch (Table A 10.6).

3.6.3 Grassland Associated Ecosystems

Grasslands in the Northern Boreal Mountains are often part of a broad mosaic of vegetation types consisting of aspen forest, parklands and coniferous forests. In the Boreal White and Black Spruce zone in the Rocky Mountain foothills, open stands of trembling aspen dominate a diverse understory of shrubs and herbs. Soopolallie, wild rose, twinflower, highbush-cranberry, and

Photo: K. Vince

Grasslands and associated aspen stands along the Beatton River.

black twinberry occupy drier sites while the shrub layer on moist sites usually is dominated by willow and red-osier dogwood.[18] Canada wildrye, slimstem reedgrass, Indian paintbrush, wild strawberry, and sticky purple geranium are frequent associates, but species composition varies among sites depending on the density of the tree and shrub overstory.[18,23]

Fens, meadows and shrub-carrs are common in subalpine parklands and cold basins in the Spruce-Willow-Birch and Engelmann Spruce–Subalpine Fir zones. Barclay's willow Water sedge fens/swamps develop on slopes and frost-pockets on high-elevations sites where there is continuous seepage and cold soils. Barclay's willow dominates, and a very sparse herb layer contains some water sedge or beaked sedge. These communities can occur alone, or in association with sedge fens and forb meadows.[20] Barclay's willow – Arrowleaf groundsel shrub-carrs occur in similar areas as Barclay's willow – Water sedge swamps but on relatively drier sites such as seepage slopes and lake margins. Barclay's willow is always present but may be very dwarfed, and there is a well-developed herb layer consisting of arrow-leaved groundsel, Sitka valerian, Sitka burnet, subalpine daisy, and yellow anemone.

Grasslands often merge with rocky cliffs, talus, and windswept ridges in the subalpine and alpine zones. These sites are sparsely vegetated with drought- and cold-resistant herbs and low shrubs such as entire-leaved mountain avens, moss campion, small-awned sedge, alpine sweetgrass, Bellard's kobresia, and net-veined willow.[25] Two blue-listed species, Pallas' wallflower and Edward's wallflower, occur on dry talus slopes in the alpine zone.[11,12]

3.6.4 Representative Fauna and Species at Risk

Depending on location and elevation, wildlife species diversity is relatively high throughout the Sub-Boreal Interior and Northern Boreal Mountains ecoprovinces. More than 250 species occur in the Boreal White and Black Spruce zone alone. This likely results from the southern extension of arctic fauna into northern British Columbia, and because of the large number of migratory birds that summer in northern environments.[1] Virtually all fauna that use northern grasslands occupy several habitats during part of their life cycle because of the small size of grassland patches, and their proximity to other habitat types.

The Sub-Boreal Interior and Northern Boreal Mountains ecoprovinces support 55% of the bird species and 45% of all the breeding birds found in the province.[8] No fauna are unique to the region, and only 12 animal species are red- or blue-listed (Table A 9.6).

Little is known about insect species that are associated with northern grasslands, but at least 29 red- and blue-listed butterflies in the northern half of the province (Table A 13.6).[33] Some representative blue-listed species that inhabit steppe, parkland, and subalpine include the mountain alpine, aphrodite fritillary, helca sulphur, jutta arctic, and polixenes arctic (Table A 13.6)

Reptiles and amphibians are not common on northern grasslands, and none are listed as threatened or endangered. The Common Garter Snake is found only in the moist, warm variant of the Boreal White and Black Spruce zone,[30] while the Western Garter Snake also occurs in the Sub-Boreal Spruce zone (Table 13.6). Amphibians such as the Long-toed Salamander, Spotted Frog, and Western Toad are more widely distributed, but are associated mostly with wetlands (Table A 13.6).

The Brown-headed Cowbird, Western Meadowlark, Common Nighthawk, American Crow, and Vesper Sparrow are some familiar grasslands birds that typically occur on northern grasslands.[30] Warblers and other songbirds are abundant and use grasslands periodically. Some common species include the Canada Warbler, Black-throated Green Warbler, Horned Lark, Mountain Bluebird, Savannah Sparrow, Ruby-crowned Kinglet, and Brewer's Sparrow (Table A 13.6).

Photo: Ministry of Water, Land and Air

Brewer's Sparrow is commonly found on southern interior grasslands and less frequently in the north.

Various ducks and shorebirds such as Blue-winged Teal, Cinnamon Teal, Common Goldeneye, Lesser Scaup, Killdeer, and Least Sandpiper breed in or near subalpine lakes and wetlands, or rest there during migration. The Ruffed Grouse and Sharp-tailed Grouse use shrub thickets and aspen copses for nesting, cover and feeding, while the American Kestrel, Northern Goshawk, and Barred Owl prey on birds and small mammals that inhabit wetlands and grasslands. Other raptors such as the Gyrfalcon, Golden Eagle, and Peregrine Falcon nest on cliffs and hunt over grasslands, wetlands and open forest.

Seven red- and 13 blue-listed birds use grassland, or grassland-associated habitats on northern grasslands (Table A 13.6). The most common species that use upland steppe include the Sharp-tailed Grouse and Short-eared Owl, while the American Bittern and

Western Grebe may be found in associated wetlands.

Large and small mammals are abundant in the north, especially east of the Rocky Mountains. Four red- and three blue-listed species occur in the region (Table A 13.6). The Wood Bison, Grizzly Bear, Black Bear, Mule Deer, Stone Sheep, and Dall Sheep use grasslands periodically in spring, summer and fall for foraging, resting and breeding.[3] Grasslands adjacent to cliffs and steep slopes are especially important for Stone and Dall sheep, which use these habitats for escape terrain and lambing.

Wood Bison, White-tailed Deer, and many small mammals such as the Bushy-tailed Woodrat, Dusky Shrew, Long-tailed Vole, and Red Fox are attracted to aspen groves and parklands. Other species, such as the Meadow Vole, Deer Mouse, Muskrat, Common Pika, Hoary Marmot, Columbian Ground Squirrel, and Northern Long-eared Myotis are common in grasslands and wetlands, or on talus slopes (Table A 13.6).

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3.7 Boreal and Taiga Plains

The Boreal Plains Ecoprovince occupies the region south of the Beatton River and east of the Rocky Mountains in northeast British Columbia. It extends onto the Alberta Plateau and eastward from Alberta, to Manitoba.[7]

Source: Grasslands Conservation Council of B.C.

Grasslands in the Taiga and Boreal Plains Ecoprovinces.

The Rocky Mountains and Muskwa Plateau dominate landscapes in the western part of the region, but the rugged terrain of the mountains gradually gives way to the gently rolling topography of the Great Plains in the east. White and black spruce forests dominate uplands but they eventually merge the with aspen parklands and prairies on the lowlands.

This ecoprovince contains most of the grasslands east of the Rocky Mountains in British Columbia (Table A 7.6). Approximately 15,000 ha of steppe vegetation are associated with the lowlands, steep valley sides and adjacent uplands along the Peace River and its tributaries in the Boreal Black and White Spruce zone (Table A 8.6).

Photo: K. Vince

Grasslands along the Peace River Valley and plateau surface.

The Taiga Plains Ecoprovince occupies the northeast corner of British Columbia, and extends from the Muskwa Plateau in the west to the Great Plains in the east.[7] Steppe and shrub-steppe are not extensive in this ecoprovince covering only about 3360 ha. More than 95% of the grasslands in this ecoprovince occur along the Prophet River and its tributaries in the southern Muskwa Plateau (Table A 7.6; Table A 8.7). Grasslands usually occupy the lower slopes of the valley bottoms, and steep, south-facing slopes. At higher elevations they merge with deciduous and coniferous forest.

Physiography, Climate and Soils

The Boreal Plains and Taiga Plains ecoprovinces lie completely within the Great Plains Physiographic Region east of the Northern Rocky Mountain Trench.[32] The entire region was glaciated with both Keewatin ice from the east, and to a lesser extent, by Cordilleran ice from the Rocky Mountains to the west.[29] Glacial till from both ice sheets was deposited over most of the area and formed drumlins, fluted till plains, and a variety of morainal features that are common throughout the region, especially in the lowlands. Ice dams formed by the Keewatin ice sheet created postglacial lakes along the Peace River valley such as glacial Lake Peace.[14]

Lacustrine deposits, consisting mostly of clay and silt, are also found in the Peace River Basin and Fort Nelson Lowland.[19] The Boreal Plains Ecoprovince consists mainly of plateaus, plains, prairies, and lowlands except for the deeply incised riverbeds and upland surfaces that are underlain with sedimentary rocks of shales and sandstones.[19] The Peace River valley is the most prominent physiographic feature in the region, and has dissected the original lakebed of Glacial Lake Peace to depths exceeding 225 m.[14]

Most of the grasslands in the region are associated with the Peace River lowlands, valley slopes and adjacent uplands. Terraces and river benches bound the river valley and are composed mostly of glaciofluvial deposits. Broad outwash plains dominate the lowlands of the Alberta plateau, and are covered with a blanket of glaciolacustrine materials up to 30 m thick in some areas.[19] Glacial deposits of sand and gravel are found along the valleys that border the Rocky Mountain foothills.[19] The Taiga

Physiography of grasslands along the Halfway River.

Photo: K. Vince

Plains Ecoprovince is dominated by an extensive lowland that is dissected below the Alberta Plateau surface by the Halfway, Beatton, Sikanni Chief, Muskwa, Liard, Fort Nelson, and Petitot rivers.[6]

The climate in both the Boreal and Taiga Plains is characterized by long, cold winters and short, warm summers. The Rocky Mountains have a pervasive influence on the climate of the region by creating a rain shadow on the Great Plains.[19] Long periods of cloud cover and unstable weather often prevail in summer because both Arctic and Pacific air masses converge in the region. Summer temperatures are slightly warmer east of the Rocky Mountains than in the foothills.[30] Precipitation over the Great Plains averages only 400 to 500 mm annually (Table A 5.10), and although annual precipitation peaks during the summer, moisture deficits frequently occur as a result of relatively high temperatures and long periods of sunlight.[30] These conditions are particularly pronounced on south slopes that support grasslands. Long periods of drought in summer are interrupted by convective showers that are produced by strong surface heating on the landscape.

In winter, cold air masses from the Arctic descend on the area but are prevented from moving westward by the Rocky Mountains. Arctic air dominates in winter, and frost can penetrate to several meters in the soil profile,[30] and some soils may remain frozen during summer. Chinooks, which moderate winter temperatures on the plains and in the foothills, are common during winter in both ecoprovinces.[31] Temperatures can also be warmer at higher elevations as Pacific air masses cross the Rocky Mountains and override cold Arctic air on the plains.

Photo: D. Blumenauer

Regosols dominate on the steepest slopes along the main river valleys but develop Chernozemic features on gentle slopes with grass cover.

Parent materials for most soils on the uplands are composed of coarse debris that was derived from glacial deposits, and transported by water during glacial retreat. Sands, silts and clay provide parent materials for soils that occupy the ancient glacial lake-bottoms in the lowlands.[14] Some soils are overlain with a deep aeolian capping. Bedrock often protrudes, but is less common on the plains than in the foothills.[19,23] Regosols are the most common soils supporting grassland and shrub-steppe communities.

On steep, south-facing slopes along the main rivers, these shallow soils have characteristics somewhat similar to both wooded and grassland soils.[15] Limited areas of shallow Black Chernozems, degraded Black Chernozems and Solonetzic soils, which supported open grasslands and parklands before European settlement, occur in the Peace River lowlands near Pouce Coupe, Dawson Creek and Fort St. John.[2,23] Brunisolic Gray Luvisols, such as those found on the plains west of Sunset Prairie, typically support seral aspen communities.

Development of Grasslands

Grasslands on the Great Plains east of the Rocky Mountains are a product of climate, soils, fire, and grazing by bison and domestic livestock. Postglacial records from Alberta indicate that a rapid change in vegetation occurred in the Taiga Plains between 11,000 and 9000 BP.[1] During this period, tundra vegetation was initially replaced by shrub-dominated communities that eventually gave way to a landscape consisting mainly of parklands and boreal forest.[1] Although scanty, the pollen record indicates that the vegetation before 11,500 BP was characterized by pine and sagebrush mixed with grasses, soopolallie and aspen.[17] This assemblage changed abruptly between 10,500 and 10,000 BP, and sagebrush, grasses, and the goosefoot family became prevalent.

Prairie vegetation reached its northern extent on the Great Plains between 7500 and 6000 BP as the climate became hotter and drier. Grasslands probably extended about 80 km farther north than their present boundary, but they were gradually replaced by conifer-birch forests that advanced from the north as the climate became cooler and moister after 3000 BP.[1,17] Despite this period of warming and expansion of the southern prairies, the prominence of sedges in contemporary plant communities in the region suggests that the grasslands may have evolved from the tundra through subarctic grass-sedge stages.[23]

The presence of aboriginal peoples in the Taiga and Boreal Plains can be traced back 10,000 years in northwestern Alberta.[1] Indigenous peoples in the boreal region used fire as a tool to provide forage for bison, deer, elk, and later horses.[22,24] Ecotones between the boreal forest and grasslands in the region were maintained by a combination of these fires and bison grazing, trampling, and rubbing.[13]

Natural fire also converted coniferous and deciduous forest to openings dominated by shrubs and herbs. As early as 1879, George Dawson remarked, "there can be no doubt that the prairies of the Peace River have been produced and maintained by fires.[4]" Fire suppression, and the extirpation of bison since European settlement, have resulted in deciduous forest encroachment into many grassland areas. While fire and bison have played important roles in developing and maintaining grasslands in the regions, botanist

E.H. Moss contended that “climate and climatic drift over time” have been the primary factors influencing grassland formation in the region. [24]

Alexander Mackenzie’s crossing of the province in 1793 began an era of fur trading in the Peace River area. By 1805, a fort was constructed near present-day Fort St. John, and fur trading was conducted in the region without further settlement. Permanent settlement of the British Columbian portion of Peace River area began only after 1912 when the 1.42 million hectares of federally controlled land in the ‘Peace River Block’ opened for homesteading. Farming started in earnest in 1918 after the First World War and thousands of hectares of mostly parkland and some grassland were converted to farmland.[23] As of 1998, 400,000 ha of grassland and aspen forest had been converted to farmland, and 265,000 ha were under annual cropping.[3]

Photo: B.C. Archives

Early cultivation of native grasslands near Dawson Creek.

Not all of these conversions resulted in a loss of grassland. Over 54,000 ha of seral spruce and aspen forest have been converted to community pastures. Many have been seeded to domestic forages, but over 30,000 ha were left as derived seral grassland supporting native species such as hairy wildrye, creamy peavine, bluejoint, fuzzy-spiked wildrye, rose, and saskatoon.[25] Without fire or other intervention, however, these sites will succeed to aspen or coniferous forest.[34]

Photo: B. Wikeem

Sunset Prairie Community Pasture west of Dawson Creek.

3.7.1 Representative Grassland Associations

The term ‘Great Plains’ often evokes images of extensive grasslands like those found in the southern prairies of western Canada and the United States.[15] The grasslands of the

Boreal and Taiga Plains, however, comprise only a very small area of the region, and aspen parklands are more abundant. Grasslands in the region occupy over 18,500 ha and are principally found in the Boreal White and Black Spruce zone (Table A 8.7). Although these grasslands occur in six variants, nearly 95% are found in the Peace Moist Warm Boreal White and Black Spruce subzone.

3.7.1.1 Peace Moist Warm Boreal White and Black Spruce Variant (BWBSmw1)

Most of the grassland and parkland in the Boreal Plains Ecoprovince are found in the Peace Lowland. Steppe and shrub-steppe occupy about 14,250 ha, and occur on south-facing slopes, river terraces and uplands adjoining the Peace River, at elevations from 750 to 1050 m (Table A 8.7). Significant areas of steppe are also found on the north shores of Moberly Lake; along the Pine, Halfway, Moberley, Cameron, Beatton, Kiskatinaw and Murray rivers; and at Lone Prairie.

Early studies classified most of the grasslands on the Great Plains in eastern British Columbia as subtypes of the Wheatgrass – Needlegrass – Sedge association, which included the Wheatgrass – Needlegrass, Needlegrass, and Wheatgrass – Sedge vegetation types.[23,24]

Grasslands are common on steep slopes along the Beatton River.

Photo: B. Wikeem

The species composition of grasslands varies greatly in response to changes in local soils and microclimate, or as a result of historical grazing.[23,24] Species diversity also differs among vegetation types. For example, the Wheatgrass – Needlegrass – Sedge community contains 154 species compared to the Needlegrass association which supports 73 vascular plant species. Wheatgrass – Needlegrass communities are intermediate in diversity, consisting of 139 species including 36 grasses, sedges and rushes, 84 forbs and 19 woody plants.[23]

Wheatgrass – Needlegrass communities form the largest expanses of steppe and parkland in the region. These communities mainly occupy the gently rolling terrain of the Great Plains, and steep, south-facing slopes along the main river valleys. Slender wheatgrass, short-awned porcupinegrass, junegrass, blunt sedge, northern bedstraw, yarrow, and veiny meadowrue are the most frequent and characteristic species in this association, while spreading needlegrass, timber oatgrass, meadow sedge, and hay sedge can be locally abundant. Prairie rose, western snowberry and saskatoon are common shrubs on most sites.[23] Vascular plants are also accompanied by a relatively rich microbiotic layer comprised of species such as *Ceratodon purpureus*, *Polytrichum* spp., *Brachythecium salebrosum*, *Cladonia* spp., and *Peltigera* spp.

Photo: B. Wikeem

Shrubs occupy moist swales and depressions on grasslands along the Beatton River.

The Wheatgrass – Sedge association is most prevalent on low, moist, flat areas. This community type is characterized by a high diversity of vascular plants, especially grasses and sedges. These communities are generally dominated by slender wheatgrass, awned sedge, prairie rose, and common snowberry, although species composition can be highly variable.[23] Other common sedges include meadow sedge, blunt sedge, hay sedge, and dry-land sedge, while northern bedstraw, fireweed, and veiny meadowrue are characteristic forbs in a rich herb layer.

Needlegrass communities occupy dry, steep, south-facing slopes and knolls along the river valleys where they compete with poplar vegetation.[23] Although northern, western, and slender wheatgrass are common associates in this community type, porcupine grass, Columbia needlegrass and, to a lesser extent, green needlegrass are the dominant species. These communities also contain a high diversity of forbs and small shrubs with old man's whiskers, prairie sagewort, western mugwort, and brittle prickly-pear cactus locally abundant on some sites.[24]

Recent studies in British Columbia have documented additional species in this community type. Some sites are dominated by needle-and-thread grass and junegrass.[25] These sites are most common on steep, south-facing slopes with well-drained, coarse-textured soils.[25] Common associated species on these sites include slender wheatgrass, Columbia needlegrass, prairie sagewort, yarrow, northern bedstraw, pale comandra, long-stoloned sedge, prairie crocus, blue flax, nodding onion, cut-leaf anemone, and western snowberry.[25]

Prairie sagewort – Western wheatgrass communities also occupy steep, south-facing slopes along the Peace River, but they are located on heavy-textured glaciolacustrine materials.[25] Western snowberry provides an overstory for Junegrass, needle-and-thread grass, brittle prickly-pear cactus, pale comandra, Rocky Mountain butterweed, northern bedstraw, yarrow, and rosy pussytoes, which are common species in the herb layer.[25]

Photo: K. Vince

Grassland and shrub-steppe along the lower Peace River Valley.

Communities dominated by spreading needlegrass (formerly Richardson's needlegrass[11]) and slender wheatgrass are probably late-seral stages that originated from the Wheatgrass – Needlegrass association.[23] These communities occur on well-drained sites where Rego Black Chernozems form.[25] Spreading needlegrass, slender wheatgrass and interior bluegrass are dominant species mixed with Sandberg's bluegrass, Columbia needlegrass, junegrass, purple peavine, northern bedstraw, and old man's whiskers. Saskatoon is often the most abundant shrub and prairie rose may be locally abundant.[23,25]

Shrub-steppe communities are often found on steep, south-facing slopes above the Peace, Beatton and Halfway rivers.[5] A mix of saskatoon, rose, western snowberry, and trembling aspen forms the overstory for an understory consisting of prairie sagewort, northern wormwood yarrow, northern bedstraw, rosy pussytoes, western bluegrass, junegrass, and needle-and-thread grass.[5]

Horse and cattle grazing have been pervasive factors on grasslands and open parklands along the Peace River, and overgrazing has likely altered the present composition of some communities.[23,25,33] The composition of climax communities and seral stages in these grasslands is poorly understood. Under heavy grazing, slender wheatgrass, short-awned porcupinegrass, and spreading needlegrass decline while junegrass and Kentucky bluegrass increase on some sites.[23] Sedge cover increases even under moderate grazing, especially for rhizomatous species like blunt sedge and long-stoloned sedge, which are considered early indicators of grassland retrogression. Rose, northern bedstraw, veiny meadowrue and prairie crocus also decline with grazing, and are replaced with species such as spikelike goldenrod and yarrow. Bare soil also becomes more prominent.[23]

Plant communities dominated by needle-and-thread grass and junegrass, or by prairie sagewort and wheatgrasses probably represent mid-seral stages of Spreading needlegrass – Slender wheatgrass communities.[23,25] Species such as short-awned porcupinegrass, Columbia needlegrass and slender wheatgrass dominate late-seral stages. These species are usually uncommon or infrequent on sites in earlier stages of succession.[23]

3.7.1.2 Fort Nelson Moist Warm Boreal White and Black Spruce Variant (BWBSmw2)

About 3250 ha of grasslands occupy steep slopes along the Prophet River on the southern part of the Muskwa Plateau at elevations ranging from 300 to 1050 m. Smaller areas of grassland occur on the Muskwa River, and north of the Prophet River west of Chips Creek. Species composition of these grasslands is likely similar to grasslands in the Peace Moist Warm Boreal White and Black Spruce Variant.

3.7.1.3 Grasslands in Other Biogeoclimatic Units

About 1025 ha of grasslands are widely dispersed in small patches throughout the Boreal and Taiga Plains ecoprovinces (Table A 8.7). Most of these grasslands are found in other subzones of the Boreal White and Black Spruce zone, and a very small area occurs in the Spruce-Willow-Birch zone. Virtually nothing is known about the species composition, soils and fauna of these grasslands.

3.7.2 Distinguishing Flora and Plant Species at Risk

The merging of vegetation from the southern Great Plains, Arctic tundra, and the cordilleran forest make this region of great botanical interest.[28] The steppe vegetation of the Peace River region is so unique that E.H. Moss suggested "it might be considered an eighth grassland formation of North America."[23]

Grasslands in the Boreal Plains Ecoprovince share many characteristics with the fescue grasslands of Alberta with one significant exception: rough fescue is absent on Boreal Plains in British Columbia.[23] Seventy-seven of the 139 species comprising Wheatgrass – Needlegrass communities in British Columbia, are among the 148 species found in Rough Fescue grasslands in Alberta. Nonetheless, dominant species such as slender wheatgrass, junegrass and porcupinegrass, which comprise most of the cover on climax grasslands in the Peace River, are secondary species in rough fescue communities in Alberta.[23]

Although needle-and-thread grass is abundant on dry grasslands in the southern interior of the province, it occurs only infrequently in northern grasslands.[11] Field studies in the

1980s documented needle-and-thread grass as the dominant species in plant communities along the slopes of the Peace River in British Columbia.[25] Studies conducted in the 1950s reported needle-and-thread grass as a climax species on the Mixed Prairie in central Alberta, but this species was not present in the Peace River region in Alberta or British Columbia.[23,24] Present-day needlegrass communities along the Peace River Valley share floristic characteristics with plant communities in south-central Alberta. A more recent account of needle-and-thread distribution in Alberta indicates its present northern distribution extends into the Peace River region of Alberta from the southern prairies and parklands,[8] suggesting it may be a relatively recent introduction onto Peace River grasslands in British Columbia.

Many common grassland plant species in the Boreal and Taiga Plains, such as Columbia needlegrass, spreading needlegrass, dry-land sedge, prairie sagewort, cut-leaf anemone, nodding wood-reed, and western wheatgrass, are also found on the northern Alberta prairies.[18,24,25,28] Similarly, other species like pale comandra and purple sticky geranium are common in aspen parklands in British Columbia,[24]and likely originated from similar communities on the Great Plains in Alberta.

Several grassland species reach their northern distributions in the Boreal and Taiga Plains. Plains reedgrass, which is also found in the East Kootenay Trench, reaches its northern limit in the Peace River area.[12] Similarly, brittle prickly-pear cactus extends north to 56^{o} N latitude.[24] Although this species is widespread on interior grasslands in B.C. from Osoyoos to Soda Creek, populations in the Peace River region likely originated from Alberta. Green needlegrass is common species in parklands and along forest margins in central Alberta.[18] In British Columbia, this species occupies dry slopes along the Peace River, and is unique to the Taiga Plains Ecoprovince.

Several grassland species that have broad geographic distributions on British Columbia grasslands are also found in the Boreal and Taiga Plains. For example, junegrass, saskatoon, prairie sagewort, yarrow, and old man’s whiskers, which are common species on the Lower, Middle and Upper Grasslands in the southern interior, are all present on northern grasslands (Appendix 12).

At least 44 red- and blue-listed grassland species, including three trees and shrubs, 10 herbaceous monocots and 31 herbaceous dicots, are found in the Boreal and Taiga Plains ecoprovinces (Table A 10.6). A large number of these species are rare in British Columbia likely because their populations originated from the prairies, and the Rocky Mountains prevents further distribution into the province. Other species are probably southern extensions of plant populations from arctic communities to the north.

Some red-listed species, such as fennel-leaved desert-parsley, long-leaved mugwort and Nuttall's orache, occur in the Peace River region in both Alberta and British Columbia. Other species are rare in B.C., but common in Alberta, Saskatchewan and Manitoba. For example, prairie buttercup, which is red-listed in British Columbia, inhabits only a few sites along the Peace River.[9,12] This species, however, is widespread over the prairie provinces and is one of the most common grassland plants in Alberta.[18] Similarly, slender penstemon, which is common on Alberta grasslands, is known to occur only on sandy or rocky grasslands in the Peace River area.[10,18]

Cordilleran and tundra influences are less pronounced on low-elevation grasslands in the Boreal and Taiga Plains than in the Boreal Mountains Ecoprovince, but spike trisetum, timber oatgrass, Rocky mountain fescue, Altai fescue, and northern wormwood occur on grasslands in the region. Meadow willow, arctic bladderpod, Jordal's locoweed, and tundra milk-vetch, which occur at higher elevations, have circumpolar distributions, or originate from arctic environments.

3.7.3 Grassland Associated Ecosystems

Parklands of aspen, poplar and willow groves are the most common communities associated with grasslands in both the Taiga and Boreal Plains ecoprovinces.[19,23,24] The aspen parkland is a transition zone between boreal forests and grassland environments.[31] Groves of aspen and willow populate the moister areas of valley slopes, and are interspersed with grasslands of variable size. The transition from parkland to open prairie or forest is usually gradual.

Photo: B. Wikeem

Prairie parkland east of Dawson Creek.

Aspen parklands generally have a rich flora and fauna because of the complex association of grasslands, wetlands, and coniferous forests. Trembling aspen provides an overstory for numerous shrubs and herbs. Soopolallie, wild rose, twinflower, highbush-cranberry, saskatoon, chokecherry, and black twinberry are typical species in the shrub-layer on drier sites, while willows and red-osier dogwood occur on moist sites.[14,19] Common herbs include Canada wildrye, slimstem reedgrass, Indian paintbrush, wild strawberry, and sticky purple geranium.[19,24]

Grasslands and parklands are sometimes associated with extensive wetlands and muskeg that form in poorly-drained areas of the lowlands.[7] Similarly, riparian communities, dominated by narrow-leaf willow, occasionally merge with grasslands along river shores in the valley bottoms.[20]

3.7.4 Representative Fauna and Species at Risk

A rich diversity of habitats for fauna exist in the Boreal and Taiga Plains ecoprovinces because of the mix of open grasslands, deciduous forests, riparian areas, and wetlands. Steep cliffs, talus slopes and clay banks along the Peace River provide additional habitat for species that rely on these features for foraging, escape cover, and rearing their young.

Photo: B. Wikeem

Game trails along the Beatton River.

Little is known about the invertebrate fauna of northern grasslands, but one red-listed and 14 blue-listed butterflies are found in the region (Table A 13.6). The red-listed eastern pine elfin is associated with open pine forest and forest openings where it feeds on lupines, dogbane, everlasting, and other wildflowers that commonly occur in parklands and adjacent grassland openings.[27] The blue-listed Baird's swallowtail, which is frequently found on southern grasslands, relies on tarragon as its host plant.[27] Although tarragon is uncommon on northern grasslands, it has a circumboreal distribution, and is present in steppe and montane habitats south of 57^{o} N latitude in British Columbia.[8]

No red- or blue-listed reptiles or amphibians are present in the Boreal or Taiga Plains ecoprovinces. The Common Garter Snake reaches its northern distribution in the Boreal Plains, but occurs very infrequently (Table A 13.6). The Boreal Chorus Frog is unique to the region, and has its center of distribution in the Boreal Plains Ecoprovince.[7]

The Boreal Plains Ecoprovince supports 46% of all breeding bird species, and 61% of the resident birds in the province. By comparison, the Taiga Plains has the lowest diversity of birds of any terrestrial ecoprovince. Only 35% of all breeding species, and 43% of the total avifauna in British Columbia occur in this ecoprovince.[7]

Approximately 16 bird species that inhabit the Alberta Plateau in summer are uncommon or absent elsewhere in the province. Seven species of warblers breed only in the Boreal and Taiga Plains ecoprovinces.[21] Most of these species require mature deciduous and coniferous forests for nesting, but some species, such as the blue-listed Canada Warbler, MacGillivray's Warbler, and Orange-crowned Warbler, use riparian habitats and forest-grassland ecotones for nesting and foraging. This region of the province is also the center of abundance for grassland species such as the Sharp-tailed Grouse, Upland Sandpiper, and Eastern Phoebe.[7] Some red- and blue-listed grassland birds that occur in the region include the Gyrfalcon, Short-eared Owl, Smith's Longspur, Bobolink, and Western Grebe (Table A 13.6).

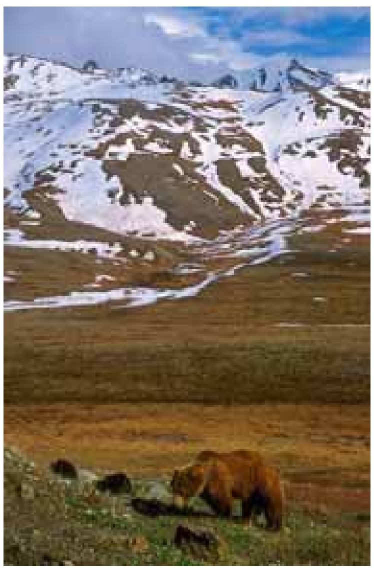

Photo: J. Hobbs

The blue-listed Dall Sheep, Stone Sheep, and Grizzly Bear forage on grasslands in various parts of the region throughout the year. The Wood Bison, once extirpated from the province, has been reintroduced near Pink Mountain, and in the Halfway and upper Sikanni Chief river valleys.[16] Ranked as red-listed, this species inhabits parklands, open aspen forests, wetlands, and shrubby savannah where they forage on grasses, sedges and various browse species.[16] The Arctic Shrew is the only small mammal restricted to this region.[7]

Grizzly Bear are abundant in the north and forage on grasslands during spring and summer.

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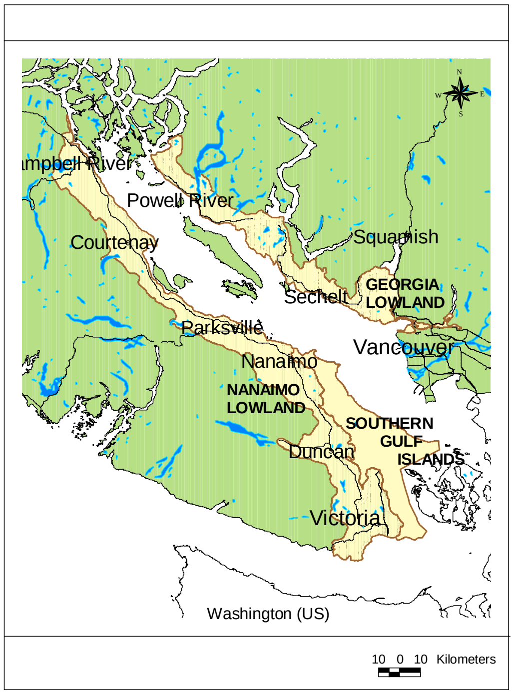
3.8 Georgia Depression

Garry oak savannah (often called woodlands) provides one of the most appealing landscapes in British Columbia, especially in spring when the understory displays a profusion of color with spring flowers. Garry oak parklands also occur in the province and are characterized by oak groves interspersed with grassland. Both these communities coincide with the distribution of the dominant tree, which spans more than 15° of latitude along the Pacific coast from 34° N latitude in California to its northern limit near Savary Island at the 50th parallel.[33]



Source: Grasslands Conservation Council of B.C.

Distribution of Garry oak grasslands and savannah.

In southern California, Garry oak occupies the landscape as stunted shrub communities that ascend to 2290 m elevation, but north of San Francisco, it takes on its more familiar form as a stately tree.[33] Oak savannah is widespread along the Pacific coast from San Francisco to Oregon below 1000 m. Similar communities also occur in the central valleys of California between the Coast Ranges and the Sierra Nevada. These woodlands eventually converge near the Oregon-California border where they continue north along the coastline and through the interior valleys of Oregon and Washington.[32,34] Other populations extend east along the Columbia River at elevations up to 1160 m.[33]

Garry oak woodlands and prairies are most abundant and continuous on the mainland and adjacent islands in the Puget Sound area of western Washington. In this area, large prairies of native fescues are interspersed with groves of large Garry oak trees.[33] Only 3% of the estimated 100,000 ha of historical prairie in western Washington, however, remains in pristine condition.[32]

In British Columbia, Garry oak grasslands and savannah are found as scattered patches on the east coast of Vancouver Island from Comox to East Sooke at elevations ranging from sea level to 415 m[9,13,29] They also occur as small communities on the Gulf Islands.[13] Perhaps the largest continuous grassland within this vegetation type occurs on the south-facing slope of Saturna Island. Garry oak is not found on the British Columbia mainland except for two disjunct populations in the Fraser Valley on Sumas Mountain and near Yale.[14,17,29] On Vancouver Island and the Gulf Islands, some communities occupy rugged, rocky cliffs and steep south-facing slopes that abruptly abut the ocean, while others form on the gently rolling topography of the uplands adjacent to the coast.

Photo: C. Junck

Garry oak savannah with spring flowers.

Collectively, Garry oak communities cover about 2400 ha throughout their distribution in B.C., but over 80% of the sites occupy less than two hectares.[27] Most of these communities are fragmented and considerably altered, particularly by the invasion of non-native species.[24] Currently, Garry oak covers less than 5% of its original range in the province, and probably less than 1000 ha remain as pristine communities.[14] Most remaining communities occur as isolated patches of steppe amid a greater area of coniferous forest.

Physiography, Climate and Soils

The distribution of Garry oak coincides closely with the Nanaimo Lowland and Southern Gulf Islands ecosections.[7] Most of the physiographic features in the Nanaimo Lowland resulted from the folding and faulting of the bedrock, repeated glaciations, and changes in sea levels. The underlying bedrock consists of a matrix of igneous, metamorphic and sedimentary rock that originated in the Mesozoic and Quaternary Period (Figure 7).[22] The entire landscape of southern Vancouver Island was completely covered with ice during the Pleistocene glaciation. Glacial recession left glacio-marine, glacial till, glaciofluvial, and lacustrine deposits. Glacio-marine deposits covered much of the lowland area, which provided the parent material for soils that support Garry oak communities today.

The climate of the region has been described as dry Mediterranean.[7] Laying in the rain shadow of the Vancouver Island and Olympic mountains, the east coast of Vancouver Island experiences a mild and relatively dry climate with warm, dry summers and mild wet winters.[29] Very little precipitation falls as snow, and less than 5% of the total annual precipitation accumulates during July and August;[16] consequently, high moisture deficits are common throughout the summer.[22] Climatic conditions change gradually over the distribution of Garry oak on Vancouver Island from warmer and drier in the south to cooler and moister in the north (Table A 5.11).

Photo: B. Wikeem

Soil profile under a Garry oak stand near Victoria, B.C.

Garry oak communities form on very shallow soils derived from volcanic or sedimentary rock outcrops. They are also found on steep, south-facing slopes, exposed to dry summer winds. On the southern tip of Vancouver Island, Garry oak savannahs and grasslands occur on gravelly loam, or gravelly sandy loam soils that are generally acidic and have been classified as Melanic or Sombric Brunisols.[2,29,38]

Development of Grasslands

Pollen records from southern Vancouver Island indicate that grasses and sagebrush dominated post-glacial plant communities until the climate cooled and lodgepole pine forests advanced.[3,19] Geographic and floristic evidence suggests that Garry oak associations evolved and advanced north from a center of origin in the southwestern United States and northern Mexico.[33] This transition likely began in the early Holocene (Figure 7) as the climate became warmer and drier, and fire frequencies were higher than at present.[37]

Garry oak likely arrived in British Columbia between 8000 and 7000 BP, and formed savannahs, meadows and grasslands that reached their maximum extent approximately 3000 BP.[37] As the climate gradually cooled and became moist again beginning about 6000 BP, these communities retreated to an area similar to their present-day extent, especially over the last thousand years.[37]

The present species composition and distribution of Garry oak communities along the

Fraser and Columbia rivers, and in the intermountain valleys of California, suggests that these communities had historical contact with interior grasslands. This contact likely occurred during the early post-glacial periods when climates were warmer, and interior grasslands were at their greatest extent[20,33] For the last 3000 to 4000 years, however, Garry oak communities on Vancouver Island and the Gulf Islands have been ecologically isolated from interior plant communities by the Strait of Georgia.

Fire appears to have been a significant factor that influenced the distribution and composition of Garry oak communities throughout their range.[30,33] Charcoal records suggest that fires were prevalent during the post-glacial period from about 10,000 to 7000 BP. These fires likely resulted from natural events such as lightning, but the Coastal Salish managed Garry oak communities with fire to provide botanical foods, and to enhance forage conditions to attract deer and elk.[4,16]

The location of Fort Victoria was partly selected because of the open, park-like nature of the landscape surrounding the fort. Soon after the fort was constructed, land was cleared for farming and domestic animals were turned out for grazing. Between 1850 and 1950, most of the Garry oak lands were logged and converted to farms, or were developed into urban areas such as greater Victoria.[16] Sheep, goats, horses, cattle, and even pigs were turned loose to forage on Garry oak grassland and savannah,[26] and overgrazing of native species was recognized as early as 1851. By 1859, many areas that formerly supported native grasses had been seeded to domestic forage species.[24] Since then, other lands have been converted to agricultural crops, but urban expansion has been the most significant factor in reducing the extent of grasslands in the region.[16]

3.8.1 Representative Grassland Associations

Photo: B. Wikeem

Garry oak grasslands often occupy rocky knolls along the coastline.

Virtually all Garry oak communities in British Columbia are located in the Moist Mild Coastal Douglas-fir Variant (Table A 1.2).[13,29] Garry oak ecosystems form on the driest sites in the Coastal Douglas-fir zone such as rocky knolls, south-facing slopes and ridges, and exposed areas near the shoreline and above coastal bluffs. On the southern end of Vancouver Island, they often take on two broad forms: oak parkland or savannah consisting of Garry oak with arbutus as a sub-dominant, and scrub oak-rock outcrop communities dominated by arbutus with Garry oak as the subordinate co-dominant.[25] Over their entire range, Garry oak ecosystems form complexes with coniferous forests, deciduous-conifer woodlands, parklands, shrub-steppe, rock outcrops, forb meadows, and small grasslands.[13,29]

Photo: B. Wikeem

Mosses are a conspicuous part of the ground cover on shallow soils and bedrock, especially in winter.

Climax Garry oak associations have been difficult to find, or to describe retrospectively. Attempts to reconstruct the composition of these communities based on historical records have only provided a broad overview of undisturbed Garry oak habitats.[24] In Washington and Oregon, prairies, oak woodlands and savannahs were probably dominated by widely spaced perennial bunchgrasses and forbs. Idaho fescue, California oatgrass, Pacific reed-grass, Lemmon's needlegrass, and red fescue are typical grasses of the dry prairies included.[32,38] All of these species are present in British Columbia.[12] Native shrubs are frequently well represented on moist sites with deep soils, and may include Indian plum, ocean spray and Nootka rose.[29] Mosses often dominate rocky sites with shallow soils and can provide a dense ground cover.[13]

Garry oak grasslands and savannahs in British Columbia have a rich and diverse flora that varies considerably among sites (Table 2).[13,15] Most species have a short growing season during spring when soil moisture is available, and before the onset of summer drought.[13,15] Several native perennial grasses such as Roemer's fescue, California brome, California oatgrass, Alaska oniongrass, and blue wildrye are often co-dominants with oak on undisturbed sites. Species diversity is often high, and

Photo: Wikeem

Sea blush is a common herb in Garry oak grasslands.

TABLE 2. Selected dominant and associated native and exotic plants found in Garry oak communities.

Plant Association [1]	Dominant Native Vascular Plants	Associated Native Vascular Plants	Associated or Dominant Introduced Plants
Garry Oak Grassland			
California oatgrass – Harvest brodiaea	Alaska oniongrass	American vetch	Field chickweed
Idaho fescue – California oatgrass	Blue wildrye	Great camas	Hairy cat's ear
Lemmon's needlegrass	California brome	Small-flowered blue-eyed Mary	Hairy honeysuckle
	California oatgrass	Tall Oregon-grape	Kentucky bluegrass
	Harvest brodiaea	Wallace's selaginella	Orchard grass
	Idaho fescue	Western buttercup	Sheep sorrel
	Lemmon's needlegrass	Yarrow	Silver hairgrass
		Cleavers	Sweet vernalgrass
		Woolly clover	
Garry Oak Savannah			
Oak – Early camas	Alaska oniongrass	Blue wildrye	Field chickweed
Oak – Great camas	American vetch	California oatgrass	Hairy cat's ear
Oak – Idaho fescue	Blue wildrye	Common snowberry	Hairy honeysuckle
Oak – Blue wildrye	Broad-leaved shootingstar	Hairy honeysuckle	Kentucky bluegrass
Oak – Peavine	California brome	Pacific snakeroot	Orchard grass
Oak – California brome	Common camas	Western buttercup	Scotch broom
Oak – Alaska oniongrass	Garry oak	Cleavers	Sheep sorrel
	Great camas	Woolly clover	Silver hairgrass
	Idaho fescue		Sweet vernalgrass
	Miner's lettuce		
	Purple peavine		
	White fawn lily		

[1] Source: Erickson (1996). Note: The plant species listed do not imply plant communities, and they may form numerous associations.

typical forbs include sea blush, white fawn lily, common camas, greater camas, spring gold, western buttercup, satin-flower, broad-leaved shootingstar, and Hooker's onion.[25,37] Species richness appears to be highest on shallow soils, but site disturbance often influences species composition and richness.[23]

Very few Garry oak communities in British Columbia remain in a pristine state. Many contain non-native species such as Scotch broom, Kentucky bluegrass, orchard grass, and sweet vernalgrass (Table 2).[13] Others are succeeding to conifer-dominated communities as Douglas-fir and other species encroach into open oak environments. On sites that have been heavily disturbed, recovery of the shrub and herbaceous layer may be very slow because native perennials such as Roemer's fescue, blue wildrye, California brome, California oatgrass, Lemmon's needlegrass, and Alaskan oniongrass contribute less to the seed bank than many non-native species.[24]

3.8.2 Distinguishing Flora and Plant Species at Risk

Nearly 700 species, subspecies, and varieties of vascular plants have been documented in Garry oak communities and associated ecosystems,[16] but only about 140 vascular plant species inhabit grasslands, meadows and oak savannahs.[13] Although this accounts for only about 6% of the provincial flora, many of these species are red or blue listed. Others are unique to the province or reach their northern distribution in southern British Columbia (Table A 10.7).

Garry oak is the only native member of the oak family in British Columbia. Roemer's fescue, a sub-species of Idaho fescue,[11,12] is most common in central California and the intermountain regions of Oregon and western Washington, but it reaches its northern distribution on Vancouver Island.[21] Great camas and common camas are common allies of Garry oak in British Columbia, while Lemmon's needlegrass and deltoid balsamroot are at their northern limit in Garry oak associations in B.C.[10,11,12] Macoun's meadowfoam, an infrequent annual species found in vernal pools and grassy meadow in Garry oak woodlands, reaches its northern distribution from California near Victoria.[6]

Photo: W. Erickson

Garry oak is the only native oak in B.C.

Junegrass is widely distributed in temperate regions of the Northern and Southern Hemispheres, and is the only member of the genus *Koeleria* in North America.[35] This plant is characteristic of a group of species including Sandberg's bluegrass, saskatoon, and yarrow, which are present on virtually all grasslands in the province. Although Junegrass is relatively poorly represented in current Garry oak habitats, it reaches its northern limit on Vancouver Island (Appendix 12).[16,21] Other grassland species from interior British Columbia that occur in Garry oak communities include brittle prickly-pear cactus, chocolate lily, death camas, small-flowered blue-eyed Mary, Wallace's selaginella, mock orange, northern wormwood (ssp. *pacifica*[8]), and Tall Oregon-grape.[12] Common snowberry and Nootka rose are also abundant on moist sites.

Photo: M. Fuchs

Chocolate lily is a common species in Garry oak habitats, and frequently occupies the Upper Grasslands in the southern interior.

Nearly 50 red- or blue-listed vascular plants occur in Garry oak communities (Table A 10.7), but the exact number is difficult to determine because Garry oak associations often blend imperceptibly with adjacent communities. Some common red-listed species include white-topped aster, deltoid balsamroot and golden paintbrush. Others species, such as coast microseris, California buttercup, Howell's montia, and dense-flowered lupine are common in California, but rare in Washington and British Columbia, which reflects their southern center of origin. Despite the apparent diversity and small remaining area of Garry oak communities in British Columbia, only four plant associations have been red-listed (Appendix 11).

Photo: C. Junck

Deltoid balsamroot and camas are among many of the flowers adorning Garry oak communities in spring.

3.8.3 Grassland Associated Ecosystems

Numerous ecosystem, such as maritime meadow, coastal bluffs, vernal pools, rock outcrops, riparian woodlands, wetlands, coniferous forests, and grasslands, are associated with Garry oak communities because of their small size.[16] Detailed descriptions of these communities, however, are beyond the scope of this report.

3.8.4 Representative Fauna and Species at Risk

Garry oak savannah and grasslands support a diverse fauna because of their close proximity to a wide range of other habitat types. The number of species that depend on these communities, however, is difficult to determine because most Garry oak stands are small, and animals move freely among many habitat types.

The total number of animal species found on Vancouver Island is lower than on the mainland because of the ecological isolation caused by Georgia Strait; nevertheless, at least 144 species use Garry oak habitats seasonally or annually. These include 15 invertebrates, 12 reptiles and amphibians, 90 birds, and 28 mammals (Table A 13.7). Many of these species rely on a variety of habitat types to complete their life history. Two reptiles, nine birds, and three mammals are considered at risk primarily as a result of habitat loss.[16]

Of the 140 insects that feed on Garry oak, 48 species rely on it as their only source of food. At least 15 invertebrates that use Garry oak ecosystems are considered to be threatened or endangered (Table A 9.8).[16] The red-listed Propertius Duskywing inhabits open oak woodlands, forest openings and edges, meadows, and fields near oaks on the south coast, but it does not occur on interior grasslands. This butterfly feeds exclusively on Garry oak in British Columbia but it may use other species over its entire range that extends to Baja California.[36] Several other insects, with localized distributions, feed on understory species in Garry oak woodlands. For example, Bremner's Silverspot larvae feed on early blue violets in Garry oak meadows on Saltspring Island, while Taylor's Checkerspot feeds on plantain, and is mostly limited to Hornby Island. The Perdiccas Checkerspot butterfly is now locally extinct in Garry oak habitats in British Columbia.[18]

Reptiles and amphibians use a variety of specialized habitats in Garry oak associations. Characteristic species that inhabit warm, dry ecosystems include the Western Garter Snake, Northwestern Garter Snake and Northern Alligator Lizard, whereas the red-listed Sharp-tailed Snake mostly occupies dry, south-facing habitats (Table A 13.7).[29,37] Several amphibians such as the Rough-skinned Newt, Long-toed Salamander, Pacific Treefrog, and Red-

Photo: J. Hobbs

The Western Terresterial Garter Snake is a common reptile in Garry oak communities.

legged Frog require wetlands, while the Red-backed Salamander and the Ensatina Salamander occupy upland terrestrial habitats.[16,37]

The Georgia Depression has a rich avifauna supporting 90% of all bird species known to occur in B.C., and 60% of the breeding birds in the province.[7] More than 355 bird species are found on southern Vancouver Island,[1] but not all of these species use Garry oak communities. Some of the resident and migratory species that use Garry oak habitats for foraging, hiding cover, resting, and nesting include the Cooper's Hawk, Western Screech-owl, Brown Creeper, Downy Woodpecker, Orange-crowned Warbler, Yellow Warbler, and Chipping Sparrow (Table A 13.7). Several species that rely mostly on Garry oak grasslands and savannahs, such as the Vesper Sparrow, Western Meadowlark, and Western Bluebird, are near extirpation because of habitat loss, while the Streaked Horned Lark has already vanished.[5,16] The status of the Lewis's Woodpecker in Garry oak habitats is somewhat uncertain, but this species is either locally extirpated, or population levels are very low.[5,15]

Lewis's Woodpecker, blue listed in the southern interior, was also found in Garry oak habitat in the past.

Photo: J. Hobbs

Many common bird species in Garry oak savannahs and grasslands also occur on interior grasslands and open forests including the Vesper Sparrow, Western Meadowlark, Cooper's Hawk, Turkey Vulture, Mourning Dove, Western Screech-owl, Rufous Hummingbird, Spotted Towhee, Bushtit, Black-throated Gray Warbler, and Red-winged Blackbird.[18] Most of these species are separated from interior grasslands by dense forest and the Coast and Cascade mountains, and are more closely allied to arid ecosystems in Washington, Oregon and California.

No large mammal depend solely on Garry oak communities to complete their life cycle, but several species use these associations periodically throughout the year. The Black-tailed Deer is the most prominent large mammal in the Garry oak community, but the Black Bear and Roosevelt Elk often use these habitats for foraging, and as travel corridors among other habitat types (Table A 13.7). Small mammals, including the White-footed Deer Mouse, Townsend's Vole, Vagrant Shrew, and Vancouver Island Water Shrew, are found more frequently in Garry oak ecosystems than are large mammals. The blue- listed Townsend's Big-eared Bat is among 10 species of listed bats that use open woodlands and grassland openings for foraging, roosting, and breeding.[37]

Numerous non-native animal species are common inhabitants of Garry oak associations. Specific impacts of these species on plants and other animal species have not been studied, but competition, displacement of other species, foraging impacts, and dispersal of non-native plants are often cited as possible effects.[16,37]

Some species, such as the European Wall Lizard, remain localized in their distribution, while others like the Gray

Black-tailed Deer are one of the most common mammals using Garry oak habitats.

Photo: J. Hobbs

Squirrel, Eastern Cottontail, European Starling, and House Sparrow are widespread. The Gray Squirrel, which was introduced to Vancouver Island about 25 years ago, now occurs across the southern end and east side of Vancouver Island north to Duncan. It uses Garry oak savannahs for foraging and nesting. The Eastern Cottontail uses shrubby coastal bluffs for hiding cover and for foraging. This species was introduced near Sooke on Vancouver Island in 1964,[28] and since then, has dispersed along the east side of the island to Campbell River and beyond.[31]

The European Starling has a cosmopolitan distribution in British Columbia, and occupies a wide range of habitat types. This species is thought to be largely responsible for the decline of other songbird populations due to competition for nest sites. It is specifically responsible for declining populations of the Western Bluebird, Lewis's Woodpecker, and Purple Martin in Garry oak communities.[37] The House Sparrow is non-migratory, and widespread on Vancouver Island and elsewhere in the province. This species nests in cavities, often near human habitation, but it can compete with some native birds such as the Tree Swallow and Cliff Swallow for food and nest sites. Other species that occupy Garry oak communities irregularly include the Norway Rat, Black Rat, House Mouse, and Virginia Opossum.[16]

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4. Protected Area Status and Range Reference Areas

Grasslands in British Columbia are scarce, biologically rich, highly complex and variable, and generally poorly understood. The total area of grassland (740,000 ha) represents less than 1% of the land base but supports nearly 30% of the rare and endangered species in the province.[2] Additionally, nearly 5% of the provincial flora is restricted to grasslands, and 42% of all plant species that occur in B.C. are found in grassland habitats.[1] Until 1994, only about 1% of the grasslands in British Columbia south of Quesnel were protected in some form.[5] Since then, the proportion of grasslands contained within provincial parks, protected areas, ecological reserves and properties acquired by environmental non-government organizations has risen to nearly 8%.[2]

Most of our understanding of grassland ecosystems in British Columbia results from research initiated by the federal government in the 1930s. The intent of this research was to help restore rangelands that had deteriorated from overuse during the period of early European settlement. These studies provided valuable information on soils, forage production, grazing impacts, and livestock production, but few opportunities existed to study undisturbed grasslands.[5] Relatively less attention was devoted to gaining a broader ecological understanding of grasslands so that their long-term sustainability could be maintained. The establishment of protected areas provides the opportunity for grasslands to recover from past disturbances, and ensures that representative areas exist so that our knowledge of these ecosystems improve in the future.

Protected areas exist in many forms including national parks, ecological reserves, wilderness areas, provincial parks, bird sanctuaries, wildlife management areas,[4] and private properties acquired by environmental non-government organizations. These areas have been set aside to protect and preserve representative and special natural ecosystems, plant and animal species, and special physical features. In addition, ecological reserves are intended to be used principally for scientific research and education.[4]

Range Reference Areas are permanent exclosures that are constructed to monitor primarily the effects of livestock and wildlife grazing. These sites also serve as protected areas that can be used to classify plant communities and determine successional pathways that result from grazing. Some of the earliest exclosures that were installed by the federal government date back to the 1930s. Since then, other groups have constructed exclosures periodically to meet specific needs. The Range Reference Area Program was initiated in the early 1990s, and resulted in the construction of over 360 exclosures in representative plant communities throughout the province.[6] Nearly 200 of these are located in grassland or open forest habitats.

4.1 East Kootenay Trench

Only 1% (550ha) of the total grassland area in the East Kootenay Trench is protected by Crown protected areas, ecological reserves, or range reference areas. A further 5% (1760 ha) is protected in properties under land trusts (Table A 16.1). Virtually all of the Crown protected grassland areas occur in the Interior Douglas-fir and Ponderosa Pine zones. None exist in the Interior Cedar-Hemlock or Sub-Boreal Spruce zones (Table A 14.1). Grasslands, meadows and subalpine parklands are present in Height of the Rockies Provincial Park in the Engelmann Spruce-Subalpine Fir and Alpine Tundra zones. Although the park comprises nearly 6800 ha, the total area covered by grasslands and meadows in the alpine zone is less than 100 ha; the extent of meadow habitats in the subalpine parklands is unknown.

Sixteen grassland exclosures have been installed or re-sampled through the Range Reference Area Program since 1990. All of these exclosure are located in the Ponderosa Pine and Interior Douglas-fir zones between the U.S. border and Invermere (Table A 15.1). Some of these exclosures exclude livestock but allow access by wild ungulates. Others are ‘three-way exclosures’ where one part excludes all large herbivores, a second part excludes cattle but allows wildlife access, and the third part permits grazing by cattle and wildlife.

Except for a few of the older exclosures, most of the new installations are in early seral stage communities (Table A 15.1). Opportunities for installing new exclosures on climax or late-seral grassland appear to be limited in the Ponderosa Pine and Interior Douglas-fir zones, but may be better on higher elevation grasslands. No range reference areas have been established in grassland associations from Montane Spruce to the Alpine Tundra, or in the Interior Cedar-Hemlock zone.

4.2 Okanagan

Numerous grassland protected areas have been created in the Northern and Southern Okanagan Basins and Okanagan Range ecosections, mainly in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones. Few representative grassland areas have been protected in the Montane Spruce and Engelmann Spruce-Subalpine Fir zones (Table A 14.2). About 10% of the grasslands in the region have been protected in parks, ecological reserves and protected areas, while over 60% of the grasslands in the Okanagan Valley are privately owned, or on Indian Reserves. Nearly 2000 ha of grassland in the Okanagan have been acquired in land trusts (Table A 16.2).

Most of the parks and protected areas in this region are less than 100 ha, and most are located in the Okanagan and Similkameen valleys (Table A 14.2). Some of these, such as White Lake Grasslands and Long’s Ranch, are held in trust by non-government organizations to protect specific habitats or species at risk. Kalamalka Lake Provincial Park contains about 3200 ha of grasslands and supports a high diversity of fauna and flora, some of which occur at their northern range limit in the province and North America. Vaseux Protected Area and the South Okanagan Grasslands Protected Area each comprise more than 1000 ha of grassland and a variety of habitats that support endangered flora and fauna (Table A 14.2). Okanagan Mountain Park is the only protected area that contains grasslands in the Northern Okanagan Highland. Virtually no grasslands are protected in the Southern Okanagan Highlands.

Twenty-nine range reference exclosures are distributed throughout the Okanagan, Similkameen and Kettle valleys (Table A 15.2). These exclosures provide a good representation of grassland communities from the driest conditions in the Bunchgrass zone to the Alpine Tundra.

Very few long-term exclosures exist in the area except for those in the Ashnola and one at Johnstone Creek near Bridesville, which date back to the 1960s. Most of the new reference areas were built between about 1992 and 1997, and are in early seral stages (Table A 15.2). Very few large areas of undisturbed climax grassland remain in the Okanagan, Similkameen and Kettle valleys making classification based on climax or potential natural communities difficult.

4.3 Thompson-Pavilion

Nearly 8% of the grasslands in the Thompson-Pavilion region are in protected areas (Table A 16.3). Twenty-four provincial parks contain grasslands, but Lac du Bois Grassland Protected Area comprises nearly 65% of the protected grasslands in the region. Elephant Hill and Edge Hills Provincial Parks also include large areas of grassland, while the remaining 22 parks each contain less than 500 ha of grassland (Table A 14.3).

Most of the grassland protected areas are in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones in the Thompson Basin, but Cornwall Hill and Edge Hills Provincial Parks include small areas of grassland in the Montane Spruce and Engelmann Spruce-Subalpine Fir zones (Table A 14.3).

Range Reference Area exclosures are widely distributed among 44 locations throughout the Thompson-Pavilion region, and are located mainly in the Bunchgrass (87%), and Interior Douglas-fir (13%) zones. No reference areas occur in the Ponderosa Pine, Montane Spruce, or Engelmann Spruce-Subalpine Fir zones (Table A 15.3). Additionally, no exclosures or provincial parks exist with a sizable area of grassland in the very driest parts of the Bunchgrass zone in the Ashcroft Basin, or on the dry, cool Interior Douglas-fir grasslands in the Pavilion Ranges.

Except for the East and West Mara exclosures, which are approximately 65 years old, all other exclosures in the region are less than 35 years old (Table A 15.3). Like the Okanagan, large areas of climax grassland are difficult to find in Thompson-Pavilion region but smaller relic sites can be found in isolated patches.

4.4 Southern Thompson Upland

About 80% of the grasslands in the Southern Thompson Upland are privately owned or on Indian reserves, while 20% occur on Crown land (Table A 16.4). Less than 1% (about 960 ha) occurs in Crown protected areas (Table A 16.4). Twenty-three Range Reference Area exclosures are distributed among the Bunchgrass (4%), Ponderosa Pine (13%), and Interior Douglas-fir (83%) zones. Some of these exclosures are the oldest in the province dating back to the 1920s and 1930s,[3] but more than half have been constructed since 1990 (Table A 15.4). No references areas occur in the Montane Spruce or Engelmann Spruce-Subalpine Fir zones, or in the Bunchgrass zone between Merritt and Spences Bridge.

4.5 Cariboo-Chilcotin and Central Interior

Grassland protected areas are slightly better represented in the Cariboo-Chilcotin than in other parts of the province. About 12.5% of the total grassland area in this region, occurs in protected areas ranging from parks to ecological reserves (Table A 16.5). Fifteen parks, varying in size from 27 to 506,000 ha, contain some area of grassland. Churn Creek Provincial Park contains the largest area of grassland in the province (36,100 ha) including representative communities of the Lower, Middle and Upper Grasslands in the Bunchgrass and Interior Douglas-fir zones (Table A 14.5). Other parks such as Nunsti, Itcha-Ilgachuz, and Kluskoil Lake include grasslands in the Sub-Boreal Pine-Spruce, Engelmann Spruce-Subalpine Fir, and Alpine Tundra zones.

Seventy-nine range reference exclosures have been constructed on grasslands throughout the Central Interior from the south Cariboo to the west Chilcotin (Table A 15.5). Most of these exclosures were built in the Bunchgrass (9%), Interior Douglas-fir (80%), and Sub-Boreal Pine-Spruce (9%) zones. Single exclosures have been constructed in the Montane Spruce and Engelmann Spruce-Subalpine Fir zones, but none exist in the Sub-Boreal

Spruce and Alpine Tundra zones. Although the earliest exclosure dates back to 1925, about 15 % were constructed between the mid-1960s and the late-1980s, and more than 80% were installed after 1990 (Table A 15.5).

4.6 Sub-Boreal Interior and Northern Boreal Mountains

Fourteen provincial parks and protected areas contain grasslands more than 22,000 ha (nearly 28%) of the total grassland area in the region (Table A 14.6). Protected grasslands are dispersed over five biogeoclimatic zones, and are representative of most of the grassland associations north of 52^{o} N latitude.

Seven range reference areas have been established on grassland sites in the Northern Boreal Mountains Ecoprovince, mostly in the Spruce-Willow-Birch and Boreal White and Black Spruce zones in the Muskwa Foothills (Table A 15.6). Most of these exclosures were constructed after 1996 to assess the effects of bison on the shrub-steppe communities.[7]

4.7 Boreal And Taiga Plains

Slightly less than 65% of the total grassland area in these ecoprovinces are in protected areas (Table A 16.6). Five provincial parks have been established in the Peace River region covering over 90,000 ha. Although Muncho Lake Class A Park comprises over 88,000 ha, the grassland component is small, but it does contain representative areas of alpine and subalpine grassland (Table A 14.7).

All of the parks in the Boreal Plains are found in the Boreal White and Black Spruce zone (Table A 14.7). The Clayhurst Ecological Reserve is the largest protected area covering slightly more than 2000 ha of open grassland and aspen groves along the Peace River. No range reference areas have been installed in the Boreal or Taiga Plains Ecoprovinces.

4.8 Georgia Depression

Over 2575 ha of Garry oak communities and associated ecosystems in the Georgia Depression are included in 23 provincial parks, ecological reserves, and non-government owned protected areas (Table A 14.8). These sanctuaries range in size from 0.4 ha at Esquimalt Garry Oak Park to over 1200 ha at Gowlland Tod Provincial Park in Victoria (Table A 14.8). These protected areas contain a wide range of habitats including open grassland, grassy meadows, savannah woodland, moss covered rocky knolls, and old-growth forest.

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5. Status Of Grassland Classification

5.1 History of Grassland Classification

The classification of grassland plant communities in British Columbia has gone through several iterations since the first descriptions of these ecosystems were published early in the 20th century.[7,43] Each change in classification has reflected differences in approach, changes in sampling methodology, and a growing understanding of the ecology of grassland ecosystems.

The earliest classification, published in 1918, simply divided the grasslands into two broad types: the Sage-brush Type dominated by big sagebrush, and the Grass Type that extended to higher elevations above the big sagebrush associations.[43] Eight years later, the *Naturalist's Guide to the Americas* described steppe and shrub-steppe vegetation in the Columbia-Kootenay semi-arid area, the Okanagan-Similkameen, and the 'Fraser area', which included the Thompson Valley, and north to 53^{o} N latitude.[7] Vegetation associations in these geographic areas were differentiated primarily on the presence and absence of antelope-brush and brittle prickly-pear cactus. They also classified grasslands into three vegetation associations over an elevational gradient: the lowest elevation zone dominated by sagebrush and bunchgrass; a second zone dominated by grasses; and the third, or 'meadow' zone, at the highest elevation where sedges were the dominant grasslike plant.[7] It was also acknowledged that steppe communities occurred in forested areas, and these were classified as yellow pine (ponderosa pine), Douglas-fir and cottonwood grasslands.[7]

Grassland associations were more rigorously studied and classified in the 1930s and 1940s. Lower, Middle and Upper Grassland communities were described in detail, and divisions were largely determined by variations in climate, topography and elevation.[38,42] Most of the inventory and research was conducted in the Thompson and Nicola valleys, although some sites were sampled in the Okanagan Valley as well. Data were collected based on modified methods used by European ecologists such as Braun-Blanquet, and plant cover was rated from rare to most dominant on an abundance scale of 1 to 5.[38,42]

East of the Rocky Mountains, E.H. Moss classified the grasslands of the Northern Great Plains in Alberta and in the Peace River area in British Columbia. His classification was based on ecological records of community structure and floristic composition using species cover, abundance and frequency ratings.[29,30] He also provided the first descriptions of seral stages that resulted from heavy livestock grazing in the region.[29,30]

Soil surveys during the 1950s and 1960s provided additional information on grassland plant communities as vegetation data were usually collected as part of the soil survey.[17,20,21,39,40] These surveys were conducted over a broad geographic area that included the North Okanagan, Kettle Valley, East Kootenay, Bulkley Valley, and the Peace River region. Some of these surveys were still ongoing in the 1970s and 1980s, covering the remaining important agricultural regions of the province.[18,24] Many of these areas coincided with grasslands.

From the mid-1960s to early-1980s, grassland classification in British Columbia was strongly influenced by the philosophy and methodology used by R. Daubenmire in classifying the steppe vegetation of Washington State and northern Idaho.[6] This approach classified grasslands based on habitat types using multiple small plots to estimate frequency and cover of vegetation.[5] These methods, and variations of the macro-plot method,[36] were broadly adopted for grassland inventory and research throughout the East Kootenay,[10,13] Similkameen Valley,[14,25] Nicola Valley,[31] lower Chilcotin ,[12,15] and the Peace River region.[11]Other studies were completed during the same period that classified open Douglas-fir forest and savannah types in the south Cariboo,[1] and open ponderosa pine and Douglas-fir forests in the Okanagan, Similkameen, Nicola, and Thompson valleys.[3]

In 1976, the B.C. Ministry of Forests initiated an ecosystem classification system based on the philosophy and principles developed by V.J. Krajina and his students in classifying forests in British Columbia into biogeoclimatic zones.[32] This hierarchial classification integrates climate, soil and floristic factors using a Braun-Blanquet approach whereby vegetation units are differentiated using ‘diagnostic combinations of species.’[34] This classification is still ongoing, but regional ecosystem guides have been produced which cover most of the province.[2,8,9,22,28,33,35,41]

During the early development of this program, grasslands were given a lower priority than forest ecosystems for developing a classification. Generally, grasslands were described as phases of other biogeoclimatic units based on variations in local topographic and soil features.[34] By 1981, however, it was apparent to some that the southern interior grasslands deserved a higher profile in the classification system. Additionally, grasslands that had been considered as part of the classification were not integrated into the system in a consistent manner. In 1982, a problem analysis was initiated by the Research Branch of the Ministry of Forests to evaluate North American grassland classification systems, and to provide insight into developing an appropriate grassland classification system for British Columbia.[32] The most significant outcome of this analysis was the general agreement that some grasslands in the province are climatic climax ecosystems, and that four grassland biogeoclimatic subzones were required to represent grasslands on a provincial level.[32] Three main recommendations, which comprised over a dozen comprehensive topics, were made for research and monitoring. Two of the most fundamental information gaps identified were the need for:

- complete descriptions of all climax ecosystem associations within each grassland biogeoclimatic subzone; and
- the identification of successional stages, grazing and fire effects, and recovery potential of ecosystem associations, especially in relation to the timing of various disturbances.[32]

Few of the research and inventory recommendations from the problem analysis have been addressed in the 20 intervening years, but some progress has been made on the classification issues of concern.

5.2 Classification of Grassland Seral Stages

Grassland seral stages originate from two main sources: relics of primary succession; and secondary succession resulting from disturbance caused by physiographic processes, climatic phenomena, or biotic agents.[5] More specifically, successional sequences in grassland vegetation arise from several sources including erosion by wind, water, and gravity; flooding (or draining); drought; fire; weed invasion; and grazing by livestock, wild ungulates, small mammals, and insects.

While all of these factors have periodically influenced grassland development in B.C., the most pervasive disturbances that cause change are associated with short-term climate patterns, fire, weed invasion, and grazing. Unfortunately, these events are often inseparable and confounded, resulting in multiple pathways of succession.[19]

No known information exists describing successional sequences that result from climate or fire in British Columbia, and only slightly more information is available on seral stages that arise from grazing. In the late 1960s, range condition classification guidelines were developed that described plant species that were expected to increase, decrease, or invade in response to cattle grazing.[26] These guidelines are most applicable to grasslands and savannahs in the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir zones in the Thompson, Nicola and Okanagan valleys, but they have been widely used throughout the province on other grasslands in these zones. No subsequent research has been conducted to modify the guidelines and define seral stages on other grasslands in the province.

Little research has been conducted in British Columbia that documents the time required for depleted grasslands to recover, or on the patterns of succession that result when these grasslands are protected from livestock grazing. Research conducted on exclosures during the 1970s revealed that plant communities in the Ponderosa Pine zone and on rough fescue grasslands recovered in 20 to 40 years following complete protection from grazing with exclosures.[27] These estimates were based on the best information available at the time, but may not accurately reflect recovery times on all grassland sites. For example, more recent data collected at one of these exclosures at Skookumchuck Prairie in the East Kootenay Trench indicates that changes are still occurring after 50 years of protection.[37] While scanty, the data collected in the East Kootenay Trench suggest that recovery times are longer than previously expected. Observations from other long-term exclosures indicate this may also be true elsewhere in the province.

5.3 Gap Analysis

The classification of grasslands in British Columbia is ongoing but at various stages of progress as summarized below.

5.3.1 East Kootenay Trench

Biogeoclimatic classification in this region has focused primarily on forests,[2] and grasslands have not received as much attention as in other parts of the province. Only four grassland biogeoclimatic units have been described for the Ponderosa Pine, Interior Douglas-fir and Montane Spruce zones (Table 3),[2] and these were classified based on existing plant communities. Grassland classification in all other biogeoclimatic zones in the East Kootenay Trench is scant, and no regional grazing guidelines presently exist. Similarly, plant communities associated with grasslands are poorly understood. Few large, representative relic sites, which could be used to classify climax grasslands in the region, remain in the Trench. Several old exclosures exist; however, that can provide preliminary information for the Ponderosa Pine and Interior Douglas-fir zones.

5.3.2 Southern Interior

Until 1990, most of the ecological classification in the Southern Interior Ecoprovince focused on forests, although grasslands were classified in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones.[22] Since 1990, 124 grassland site series have been classified in five biogeoclimatic zones and 22 biogeoclimatic units (Table 3). Nearly 80% of the site series occur in the Bunchgrass, Ponderosa Pine and Interior Douglas-fir zones where most of the significant grasslands are found. Other site series have been classified

TABLE 3. Status of grassland classification in British Columbia within biogeoclimatic units.

Ecoprovince/ Biogeoclimatic Unit	Total Site Units [1]	Zonal Sites Climax	Zonal Sites Seral	Azonal Sites Climax	Azonal Sites Seral
East Kootenay Trench					
IDFdm2	1	I [2]	I	L [3]	L
IDFunn	0	L	L	L	L
MSdk	1	I	L	L	L
PPdh2	2	I	I	L	L
Southern Interior Ecoprovince					
BGxh1	8	A [4]	A	I	I
BGxh2	8	A	A	I	I
BGxh3 [5]	7	A	A	I	I
BGxw1	11	A	A	I	I
ESSFxc	11	I	L	L	L
IDFdk1	11	A	A	I	I
IDFdk2	1	I	L	I	L
IDFdk3	0	L	L	L	L
IDFdm1	2	I	L	L	L
IDFmw1	0	L	L	L	L
IDFxh1	12	A	A	I	I
IDFxh2	6	A	A	I	I
IDFxm4	11	A	A	I	I
IDFxw4	2	I	L	L	L
MSdc2	6	I	L	L	L
MSdm1	1	I	L	L	L
MSdm2	1	I	L	L	L
MSxk	2	I	L	L	L
MSxv	1	I	L	L	L
PPdh1	2	I	I	L	L
PPxh1	14	A	A	I	I
PPxh2	7	A	A	I	I
Central Interior Ecoprovince					
BGxh2 [6]	8	A	A	A	I
BGxh3	16	A	A	A	I
BGxw2	12	A	A	A	I
ESSFxv2	0	L	L	L	L
IDFdk3	1	I	I	I	L
IDFdk4	2	I	I	I	L
Central Interior Ecoprovince					
IDFdw	0	L	L	L	L
IDFxm	11	A	A	A	I
IDFxw	2	I	I	L	L
MSxv [7]	0	L	L	L	L

Ecoprovince/ Biogeoclimatic Unit	Total Site Units [1]	Zonal Sites		Azonal Sites	
		Climax	Seral	Climax	Seral
SBPSdc	0	L	L	L	L
SBPSxc [7]	0	L	L	L	L
SBSdk [7]	0	L	L	L	L
SBSmc [7]	0	L	L	L	L
Sub-Boreal Interior Ecoprovince					
ESSFmv4	0	L	L	L	L
Northern Boreal Mountains Ecoprovince					
BWBSdk2	0	L	L	L	L
BWBSmw2	0	L	L	L	L
BWBSwk2	0	L	L	L	L
SWBmk	0	L	L	L	L
Boreal Plains Ecoprovince					
BWBSmw1	0	L	L	L	L
Taiga Plains Ecoprovince					
BWBSmw2	0	L	L	L	L
Georgia Depression Ecoprovince					
CDFmm [7]	0	L	L	L	L

[1] Total Site Units = The total number of 'site units' described for each biogeoclimatic subzone or variant.
[2] I = Incomplete – Classification based on existing plant communities.
[3] L = Lacking - Little or no classification.
[4] A = Available - Classification based on long-term studies of exclosures or relic sites.
[5] Based on ecological classification in the Southern Interior.
[6] Based on ecological classification in the Central Interior.
[7] Classification work has been done on these biogeoclimatic units, but is not part of ecological classification program.

in the Montane Spruce and Engelmann Spruce-Subalpine Fir zones. Wetlands, rock outcrops, talus, and aspen types have also been classified. Seral stages for most of these communities are not well understood, especially in some of the smaller and higher elevation variants. So far, this work is in a formative stage, and published results are not available.[23]

Grazing management guidelines exist for most of the main grasslands in the region,[26] but are of limited value for some of the smaller grassland areas in the Montane Spruce, Engelmann Spruce-Subalpine Fir, and Alpine Tundra zones. Similarly, successional pathways are poorly understood in these ecosystems, and in other communities in the grassland environment, such as aspen groves and wetland habitats.

5.3.3 Cariboo-Chilcotin and Central Interior

Before 1997, relatively little published information was available that described or classified grasslands in the Cariboo-Chilcotin.[41] Since then, considerable effort has gone into producing a preliminary classification and guide for 52 site associations found primarily in the Bunchgrass and Interior Douglas-fir zones (Table 3).[4] Classification of site series in other subzones of the Interior Douglas-fir zone, and for all other biogeoclimatic zones containing grassland, is incomplete or absent, especially at higher elevations.

The preliminary classification includes non-zonal sites, and proposes seral stages that result from livestock grazing.[4] Site series also have been described for shrublands, aspen groves, rock outcrops and talus, and some wetlands that occur within the grasslands.

Grazing management guidelines developed for grasslands in the Thompson-Pavilion region, Nicola Valley and Okanagan have some application in the Cariboo-Chilcotin, especially for the Lower and Middle Grasslands. These guidelines, however, need to be modified for Upper Grassland communities, and grasslands in other biogeoclimatic units in the region. No information is available regarding successional pathways for most plant communities above the Middle Grasslands, or for other communities in the grassland environment such as aspen copse and wetland habitats.

5.3.4 Northern Grasslands

Few studies have been conducted on grasslands north of 52^{o} N latitude on either side of the Rocky Mountains. Although generalized grassland types have been described in all regions, none are presently part of the biogeoclimatic classification system (Table 3). The few Range Reference Areas that have been established will provide cursory information that can be used to classify some of the northern grasslands, but additional inventories will be required to describe site series and document seral stages for all grasslands in the region.

5.3.5 Georgia Depression

A survey of Garry oak communities on Vancouver Island and the adjoining Gulf Islands produced descriptions of 43 plant communities.[16] This classification was based on existing plant communities, and had to contend with the high incidence of non-native species that occupied or dominated many sites. So far, results from this work have not been incorporated into the biogeoclimatic classification system (Table 3).

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APPENDIX 1. Brief description of the ecoregion classification system and biogeoclimatic classification system used in British Columbia.

INDEX TO TABLES

SOURCES

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The Ecoregion Classification system was developed in 1985 to organize terrestrial and marine ecosystems into geographic units based on climate, soils, vegetation, and fauna.[1] Five levels of classification exist including ecodomain, ecodivision, ecoprovince, ecoregion, and ecosection. Of these, this report relied on ecoprovinces and ecosections as geographic references for describing grassland distribution and extent. Ecoprovinces are large areas conforming to regional climates, relief and landforms (Table A 1.1). Ecosections are geographic units within the ecoprovince that have similar local climates, landforms, soils, flora, and fauna.[1]

Biogeoclimatic zones, subzones, variants, and site series occur within each ecosection, and are classified using the Biogeoclimatic Ecosystem Classification (BEC) system.[2] This system classifies ecosystems based on a combination of soils, vegetation, climate, site, and succession. The levels within this system range from broad units that encompass a wide range of vegetation types, to finely defined units which describe a single plant community growing under specific environmental conditions.

Classification of units in the BEC is based upon the zonal site or the ‘average’ condition for a number of factors such as soil moisture and fertility; slope; soil depth and texture; and topographic location. A second basic feature, common to most classification systems, is that biogeoclimatic units are classified based on ‘climax’ vegetation, however, not all sites are zonal or at climax.

Biogeoclimatic zones are the broadest vegetation complexes reflecting the same regional climate.[2] Zones are generally named after one or two dominant plants that are present over a wide range of conditions, such as ponderosa pine, Douglas-fir, or sub-boreal spruce (Table A 1.2).

Biogeoclimatic subzones and variants have less climatic variability and a narrower geographic distribution than zones. While subzones share characteristics of the zone, they are separated from other subzones by having a unique composition of plant species. Variants reflect minor changes in climate and geographic location that produce subtle differences in the composition of plant communities. Subzone names represent precipitation and temperature regimes, while variants are named to indicate their geographic location.[2] Site Series reflect highly specific climatic and edaphic conditions that produce similar ecosystems.

TABLE A 1.1. Summary of grassland ecoregions and biogeoclimatic units in British Columbia.

Ecoprovince	Ecoregion	Ecosections	Biogeoclimatic Unit Code
Southern Interior Mountains	Southern Rocky Mountain Trench	East Kootenay Trench	PPdh2
			IDFdm2
			MS
			ESSF
		Upper Fraser Trench	SBSdh
	Selkirk - Bitterroot Foothills	Selkirk Foothills	IDFunn
			ICHdw
			ICHmw2
			ICHmk1
			ESSFdc1
			ESSFwc4
	Columbia Highlands	Shuswap Highland	IDFmw 2
			ICHmw 2
			ICHmw 3
		Quesnel Highland	IDFmw 2
	Northern Continental Divide	Border Ranges	IDFdm 2
			MSdk
			ESSFdk
			ESSFwm
			ICHmk 1
		Crown of the Continent	MSdk
	Northern Columbia Mountains	Southern Columbia Mountains	ESSFwm
	Northern Columbia Mountains	McGillivray Range	IDFdm2
			MSdk
			ESSFdk
			ESSFwm
	Central Canadian Rocky Mountains	Eastern Purcell Mountains	IDFdm2
			MSdk

Ecoprovince	Ecoregion	Ecosections	Biogeoclimatic Unit Code
Southern Interior Mountains	Central Canadian Rocky Mountains	Eastern Purcell Mountains	ESSFdk
			AT
			IDFdm2
			ICHmk1
	Western Continental Ranges	Southern Park Ranges	MSdk
			ESSFdk
Southern Interior	Okanagan Highland	Southern Okanogan Basin	BGxh1
			PPxh1
			IDFxh1
		Southern Okanogan Highland	PPdh1
			IDFdm1
			IDFxh1
			ICHmk1
	Northern Cascade Ranges	Okanagan Range	BGxh1
			PPxh1
			IDFxh1
			IDFdk1
			IDFdk2
			MSxk
			MSdm2
			ESSFxc
			AT
	Thompson-Okanagan Plateau	Northern Okanagan Basin	BGxh1
			PPxh1
			IDFxh1
			IDFdk1
			IDFmw1
		Northern Okanagan Highland	PPxh1
			IDFxh1
			IDFdm1
			IDFmw1
			MSdm1
			ESSFdc1
			ICHmk1

Ecoprovince	Ecoregion	Ecosections	Biogeoclimatic Unit Code
Southern Interior	Thompson-Okanagan Plateau	Thompson Basin	BGxh2
			BGxw1
			PPxh2
			IDFxh2
			IDFxh1
			IDFxw
			IDFdk1
		Southern Thompson Upland	BGxh2
			BGxw1
			PPxh2
			IDFdk1
			IDFdk2
			IDFmw 1
			IDFxh1
			IDFxh2
			MSdm2
			MSxk
			ESSFdc2
			ESSFxc
			ICHmk2
		Northern Thompson Upland	PPxh2
			IDFdk1
			IDFdk2
			IDFdk3
			IDFmw1
			IDFmw2
			IDFxh1
			IDFxh2
			IDFxw
			MSdm2
			MSxk
			ESSFdc2
			ICHmw2
	Interior Transition Ranges	Pavilion Ranges	BGxh2
			BGxh3
			PPxh2
			IDFdk1
			IDFdk2
			IDFdk3
			IDFunk

APPENDIX 1. Continued

Ecoprovince	Ecoregion	Ecosections	Biogeoclimatic Unit Code
Southern Interior	Interior Transition Ranges	Pavilion Ranges	IDFxh1
			IDFxh2
			IDFxm
			IDFxw
			MSdm2
			MSxk
			ESSFxc
			ESSFxcp
			ESSFdc2
			AT
		Southern Chilcotin Ranges	PPxh2
			IDFdk1
			IDFdk2
			IDFunk
			IDFxh1
			IDFxh2
			MSdc
			MSunk
			MSxk
			ESSFdv
			ESSFxc
			AT
Central Interior	Chilcotin Ranges	Central Chilcotin Ranges	IDFdw
			IDFdk4
			MSxv
		Western Chilcotin Ranges	IDFdk 2
			IDFdk 3
		Western Chilcotin Ranges	IDFdw
			IDFunv
			IDFxm
			MSdc
			MSdc2
			MSdv
			MSxk
			MSxv
			ESSFdv
			ESSFxv1

APPENDIX 1. Continued

Ecoprovince	Ecoregion	Ecosections	Biogeoclimatic Unit Code
Central Interior	Chilcotin Ranges	Western Chilcotin Ranges	ESSFxv 2
			AT
			SBPSxc
	Fraser River Plateau	Chilcotin Plateau	IDFdk4
			IDFdw
			IDFxm
			MSdc2
			MSxv
			ESSFxv2
			SBPSxc
		Fraser River Basin	BGxh2
			BGxh3
			BGxw2
			IDFdk4
	Fraser River Plateau	Fraser River Basin	IDFdk3
			IDFxm
		Cariboo Basin	PPxh2
			IDFdk3
			IDFxm
			IDFxw
			SBPSmk
			SBSdw2
		Cariboo Plateau	IDFdk3
			IDFmw2
			SBPSmk
			SBSdw1
			SBSdw2
		Western Chilcotin Upland	MSxv
			ESSFxv1
			SBPSxc
		Nazko Upland	ESSFmv1
			SBPSdc
			SBPSmc
			SBPSmk
			SBSdk
			SBSdw2
			SBSmc2

APPENDIX 1. Continued

Ecoprovince	Ecoregion	Ecosections	Biogeoclimatic Unit Code
Central Interior	Fraser River Plateau	Nazko Upland	SBSmc3
		Quesnel Lowland	IDFxm
			SBSdw2
		Bulkley Basin	ESSFmv1
			SBSdk
			SBSdw3
			SBSmc2
Sub-Boreal Interior	Central Canadian Rocky Mountains	Peace Foothills	BWBSwk2
			BWBSmw1
			BWBSwk1
			ESSFmv2
			ESSFmv4
			ESSFwk2
			SBSwk2
			AT
		Misinchinka Ranges	ESSFmv4
			ESSFwk2
			SWBmk
		Hart Foothills	BWBSmw1
			BWBSwk1
			ESSFmv2
			SBSwk2
	Fraser Basin	Babine Upland	ESSFmv1
			SBSdk
			SBSdw3
			SBSmc2
			SBSwk3
		Nechako Lowland	SBSdw3
		Muskwa Foothills	BWBSdk 2
			BWBSmk
			BWBSmw2
			BWBSwk2
			SWBmk
			ESSFmv4
			AT

APPENDIX 1. Continued

Ecoprovince	Ecoregion	Ecosections	Biogeoclimatic Unit Code
Northern Boreal Mountains	Northern Canadian Rocky Mountains	Eastern Muskwa Ranges	BWBSmw2
			SWBmk
			AT
	Liard Basin	Hyland Highland	BWBSdk2
		Liard Plain	BWBSdk2
	Northern Mountains and Plateaus	Teslin Plateau	BWBSdk1
Boreal Plains	Peace River Basin	Peace Lowland	BWBSmw1
	Central Alberta Uplands	Halfway Plateau	BWBSmw1
			BWBSwk1
			BWBSwk2
		Clear Hills	BWBSmw1
	Southern Alberta Upland	Kiskatinaw Plateau	BWBSmw1
			BWBSwk1
Tiaga Plains	Muskwa Plateau	Muskwa Plateau	BWBSmw2
			BWBSwk3
			SWBmk
Georgia Depression	Georgia-Puget Basin	Nanaimo Lowland	CDFmm
		Southern Gulf Islands	CDFmm

TABLE A 1.2. Biogeoclimatic units containing grassland in British Columbia.

Biogeoclimatic Zone	Subzone	Variant	Label
Alpine Tundra	Parkland		ATp
Bunchgrass	Very Dry Hot	Okanagan	BGxh 1
	Very Dry Hot	Thompson	BGxh 2
	Very Dry Hot	Fraser	BGxh 3
	Very Dry Warm	Nicola	BGxw 1
	Very Dry Warm	Alkali	BGxw 2
Boreal White and Black Spruce	Dry Cool	Stikine	BWBSdk 1
	Dry Cool	Liard	BWBSdk 2
	Moist Warm	Peace	BWBSmw 1
	Moist Warm	Fort Nelson	BWBSmw 2
	Moist Cool		BWBSmk
	Wet Cool	Murray	BWBSwk 1
	Wet Cool	Graham	BWBSwk 2
	Wet Cool	Kledo	BWBSwk 3
Coastal Douglas-fir	Moist Maritime		CDF mm
Engelmann Spruce-Subalpine Fir	Dry Cold	Okanagan	ESSFdc 1
	Dry Cold	Thompson	ESSFdc 2
	Dry Cool		ESSFdk
	Dry Very Cold		ESSFdv
	Moist Very Cold	Nechako	ESSFmv 1
	Moist Very Cold	Bullmoose	ESSFmv 2
	Moist Very Cold	Graham	ESSFmv 4
	Wet Cold	Selkirk	ESSFwc 4
	Wet Cool	Misinchinka	ESSFwk 2
	Wet Mild		ESSFwm
	Very Dry Cold		ESSFxc
	Very Dry Very Cold		ESSFxv
Interior Cedar Hemlock	Dry Warm		ICHdw
	Moist Cool	Kootenay	ICHmk 1
	Moist Cool	Thompson	ICHmk 2
	Moist Warm	Columbia-Shuswap	ICHmw 2
	Moist Warm	Thompson	ICHmw 3
Interior Douglas-fir	Dry Cool	Thompson	IDFdk 1
	Dry Cool	Cascade	IDFdk 2
Interior Douglas-fir	Dry Cool	Fraser	IDFdk 3

APPENDIX 1. Continued

Biogeoclimatic Zone	Subzone	Variant	Label
Interior Douglas-fir	Dry Cool	Chilcotin	IDFdk 4
	Dry Mild	Kettle	IDFdm 1
	Dry Mild	Kootenay	IDFdm 2
	Dry Warm		IDFdw
	Moist Warm	Okanagan	IDFmw 1
	Moist Warm	Thompson	IDFmw 2
	Undifferentiated Kamloops Forest Region		IDFunk
	Undifferentiated Nelson Forest Region		IDFunn
	Undifferentiated Vancouver Forest Region		IDFunv
	Very Dry Hot	Okanagan	IDFxh 1
	Very Dry Hot	Thompson	IDFxh 2
	Very Dry Mild		IDFxm
	Very Dry Warm		IDFxw
Montane Spruce	Dry Cold		MSdc
	Dry Cool		MSdk
	Dry Mild	Okanagan	MSdm 1
	Dry Mild	Thompson	MSdm 2
	Undifferentiated Kamloops Forest Region		MSunk
	Very Dry Cool		MSxk
	Very Dry Very Cold		MSxv
Ponderosa Pine	Dry Hot	Kettle	PPdh 1
	Dry Hot	Kootenay	PPdh 2
	Very Dry Hot	Okanagan	PPxh 1
	Very Dry Hot	Thompson	PPxh 2
Sub-Boreal Pine-Spruce	Dry Cold		SBPSdc
	Moist Cold		SBPSmc
	Moist Cool		SBPSmk
	Very Dry Cold		SBPSxc
Sub-Boreal Spruce	Dry Hot		SBSdh
	Dry Cool		SBSdk
	Dry Warm	Horsefly	SBSdw 1
	Dry Warm	Blackwater	SBSdw 2
	Dry Warm	Stuart	SBSdw 3
	Moist Cold		SBSmc

APPENDIX 1. Concluded.

Biogeoclimatic Zone	Subzone	Variant	Label
Sub-Boreal Spruce	Moist Cold	Kluskus	SBSmc 3
	Wet Cool	Finlay-Peace	SBSwk 2
	Wet Cool	Takla	SBSwk 3
Spruce-Willow-Birch	Moist Cool		SWBmk

APPENDIX 2. Common and scientific names of selected non-vascular and vascular plants from grasslands and associated habitats.

Common Name	Scientific Name
Microbiotics	
cow pie lichen	*Diploschistes muscorum*
dog lichen	*Peltigera canina*
dog pelt	*Peltigera cana*
glow moss	*Aulacomnium palustre*
No common name	*Parmelia separata*
No common name	*Physconia muscigena*
pixie-cup	*Calydonia pyxidata*
rusty steppe moss	*Tortula ruralis*
Vascular Plants	
Alaska oniongrass	*Melica subulata*
alfalfa	*Medicago sativa*
alkali cordgrass	*Spartina gracilis*
alkali plantain	*Plantago eriopoda*
alkanet	*Anchusa officinalis*
alpine anemone	*Anemone drummondii* var. *drummondii*
alpine bistort	*Polygonum viviparum*
alpine bluegrass	*Poa alpina*
alpine buckwheat	*Eriogonum pyrolifolium*
alpine fescue	*Festuca brachyphylla*
alpine hedysarum	*Hedysarum alpinum*
alpine meadow-foxtail	*Alopecurus alpinus*
alpine sorrel	*Rumex paucifolius*
alpine sweetgrass	*Hierochloë alpina*
alpine timothy	*Phleum alpinum*
Altai fescue	*Festuca altaica*
American bulrush	*Schoenoplectus pungens*
American bush-cranberry	*Vibernum opulus* ssp. *trilobum*
American chamaerhodos	*Chamaerhodos erecta* ssp. *nuttallii*
American speedwell	*Veronica beccabunga*
American sweet-flag	*Acorus americanus*

Common Name	Scientific Name
American vetch	*Vicia americana*
Andean evening-primrose	*Camissonia andina*
androsace buckwheat	*Eriogonum androsaceum*
annual paintbrush	*Castilleja minor* ssp. *minor*
annual sow-thistle	*Sonchus oleraceus*
antelope-brush	*Purshia tridentata*
arbutus	*Arbutus menziesii*
Arctic bladderpod	*Lesquerella arctica*
Arctic lupine	*Lupinus arcticus*
Arctic rush	*Juncus arcticus*
Arkansas rose	*Rosa arkansana* var. *arkansana*
arnica	*Arnica* sp.
arrowleaf balsamroot	*Balsamorhiza sagittata*
arrow-leaved groundsel	*Senecio triangularis*
Atkinson's coreopsis	*Coreopsis tinctoria*
Austin's knotweed	*Polygonum douglasii* ssp. *austiniae*
autumn willow	*Salix serissima*
awned cyperus	*Cyperus squarrosus*
awned sedge	*Carex atherodes*
aaldhip rose	*Rosa gymnocarpa*
aalsam poplar	*Populus balsamifera*
Baltic rush	*Juncus balticus*
Baneberry	*Actaea rubra*
Barclay's willow	*Salix barclayi*
barren brome	*Bromus sterilis*
beaked sedge	*Carex utriculata*
beaked spike-rush	*Eleocharis rostellata*
bearded sedge	*Carex comosa*
Bebb's willow	*Salix bebbiana*
Bellard's kobresia	*Kobresia myosuroides*
big bluestem	*Andropogon gerardii*
big sagebrush	*Artemisia tridentata* var. *tridentata*
birdfoot buttercup	*Ranunculus pedatifidus*
bitterroot	*Lewisia rediviva*

Common Name	Scientific Name
black cottonwood	*Populus balsamifera* ssp. *trichocarpa*
black hawthorn	*Crataegus douglasii*
black huckleberry	*Vaccinium membranaceum*
black medic	*Medicago lupulina*
black spruce	*Picea mariana*
black twinberry	*Lonicera involucrata*
blackish locoweed	*Oxytropis nigrescens*
blue grama	*Bouteloua gracilis*
blue toadflax	*Linaria canadensis*
blue vervain	*Verbena hastata var. scabra*
blue wildrye	*Elymus glaucus*
bluebunch wheatgrass	*Pseudoroegneria spicata*
bluebunch wheatgrass	*Pseudoroegneria spicata* ssp. *inermis*
bluejoint reedgrass	*Calamagrostis canadensis*
blunt sedge	*Carex obtusata*
blunt-sepaled starwort	*Stellaria obtusa*
Booth's willow	*Salix boothii*
bracted lousewort	*Pedicularis bracteosa*
branched phacelia	*Phacelia ramosissima*
Brandegee's lomatium	*Lomatium brandegeei*
Brewer's monkey-flower	*Mimulus breweri*
bristly mousetail	*Myosurus apetalus* var. *borealis*
brittle prickly-pear cactus	*Opuntia fragilis*
broad-leaved shootingstar	*Dodecatheon hendersonii*
bromegrass	*Bromus* sp.
brown-eyed susan	*Gaillardia aristata*
buckbean	*Menyanthes trifoliata*
buffalo grass	*Buchloe dactyloides*
bull thistle	*Cirsium vulgare*
bulrush	*Schoenoplectus* sp.
bunchberry	*Cornus canadensis*
burdock	*Arctium* sp.
bushy cinquefoil	*Potentilla paradoxa*
bushy knotweed	*Polygonum ramosissimum* var. *ramosissimum*

Common Name	Scientific Name
Calder's wildrye	*Elymus calderi*
California brome	*Bromus carinatus*
California oatgrass	*Danthonia californica*
Canada anemone	*Anemone canadensis*
Canada goldenrod	*Solidago canadensis*
Canada thistle	*Cirsium arvense*
Canada violet	*Viola canadensis*
Canada wildrye	*Elymus canadensis*
capitate lousewort	*Pedicularis capitata*
Carolina draba	*Draba reptans*
Carolina meadow-foxtail	*Alopecurus carolinianus*
cheatgrass	*Bromus tectorum*
chocolate lily	*Fritillaria affinis*
choke cherry	*Prunus virginiana*
cleavers	*Galium aparine*
cliff paintbrush	*Castilleja rupicola*
clover	*Trifolium* sp.
clustered dodder	*Cuscuta approximata*
cockscomb cryptantha	*Cryptantha celosioides*
Colorado rush	*Juncus confusus*
Columbia bladderpod	*Lesquerella douglasii*
Columbia bower	*Clematis occidentalis*
Columbia needlegrass	*Achnatherum nelsonii*
Columbia River locoweed	*Oxytropis campestris* var. *columbiana*
Columbian goldenweed	*Pyrrocoma carthamoides*
common camas	*Camassia quamash*
common cattail	*Typha latifolia*
common chickweed	*Stellaria media*
common dandelion	*Taraxacum officinale*
common harebell	*Campanula rotundifolia*
common horsetail	*Equisetum arvense*
common hound's-tongue	*Cynoglossum officinale*
common juniper	*Juniperus communis*
common rabbit-brush	*Ericameria nauseosus*

Common Name	Scientific Name
common silverweed	*Potentilla anserina*
common snowberry	*Symphoricarpos albus*
common spike-rush	*Eleocharis palustris*
common tansy	*Tanacetum vulgare*
common timothy	*Phleum pratense*
common toadflax	*Linaria vulgaris*
common twinpod	*Physaria didymocarpa* var. *didymocarpa*
common velvet-grass	*Holcus lanatus*
common vetch	*Vicia sativa*
compact selaginella	*Selaginella densa*
cotton-batting cudweed	*Gnaphalium stramineum*
cow-parsnip	*Heracleum maximum*
creeping bentgrass	*Agrostis stolonifera*
creeping juniper	*Juniperus horizontalis*
curly sedge	*Carex rupestris* ssp. *drummondiana*
cushion fleabane	*Erigeron poliospermus* var. *poliospermus*
Cusick's bluegrass	*Poa cusickii*
Cutleaf evergreen blackberry	*Rubus laciniatus*
cut-leaved anemone	*Anemone multifida*
cut-leaved daisy	*Erigeron compositus*
Dalmatian toadflax	*Linaria genistifolia*
dark lamb's-quarters	*Chenopodium atrovirens*
Davis' locoweed	*Oxytropis jordalii* ssp. *davisii*
diffuse knapweed	*Centaurea diffusa*
diverse-leaved cinquefoil	*Potentilla diversifolia*
deer grass	*Muhlenbergia rigens*
dotted smartweed	*Polygonum punctatum*
Douglas maple	*Acer glabrum*
Douglas-fir	*Pseudotsuga menziesii*
dovefoot geranium	*Geranium molle*
Drummond's campion	*Silene drummondii var. drummondii*
dry-land sedge	*Carex xerantica*
dunhead sedge	*Carex phaeocephala*
dwarf blueberry	*Vaccinium caespitosum*

Common Name	Scientific Name
dwarf clubrush	*Trichophorum pumilum*
dwarf groundsmoke	*Gayophytum humile*
dwarf woolly-heads	*Psilocarphus brevissimus* var. *brevissimus*
early blue violet	*Viola adunca* var. *adunca*
elk sedge	*Carex geyeri*
Engelmann spruce	*Picea engelmannii*
Engelmann's knotweed	*Polygonum douglasii* ssp. *engelmannii*
English ivy	*Hedera helix*
Eurasian water-milfoil	*Myriophyllum spicatum*
Falkland Island sedge	*Carex macloviana*
false-agoseris	*Nothocalais troximoides*
falsebox	*Paxistima myrsinites*
feathermoss	*Pleurozium* sp.
Fee’s lipfern	*Cheilanthes feei*
fennel-leaved desert-parsley	*Lomatium foeniculaceum* var. *foeniculaceum*
fern-leaved desert-parsley	*Lomatium dissectum*
field bindweed	*Convolvulus arvensis*
field chickweed	*Cerastium arvense*
field goldenrod	*Solidago nemoralis*
field locoweed	*Oxytropis campestris*
field locoweed	*Oxytropis campestris* var. *varians*
field milk-vetch	*Astragalus agrestis*
field mint	*Mentha arvensis*
field sedge	*Carex praegracilis*
fireweed	*Epilobium angustifolium*
five-leaved cinquefoil	*Potentilla nivea* var. *pentaphylla*
flat-topped broomrape	*Orobanche corymbosa* ssp. *mutabilis*
flixweed	*Descurainia sophia*
four-angled mountain-heather	*Cassiope tetragona*
fowl bluegrass	*Poa palustris*
fowl mannagrass	*Glyceria striata*
fox sedge	*Carex vulpinoidea*
foxtail barley	*Hordeum jubatum*
freckled milk-vetch	*Astragalus lentiginosus*

Common Name	Scientific Name
fuzzy-spiked wildrye	*Leymus innovatus*
fuzzy-tongued penstemon	*Penstemon eriantherus* var. *eriantherus*
Garry oak	*Quercus garryana*
Gastony's cliff-brake	*Pellaea gastonyi*
Geyer's onion	*Allium geyeri* var. *tenerum*
giant helleborine	*Epipactis gigantea*
giant wildrye	*Leymus cinereus*
glacier lily	*Erythronium* sp.
glaucous bluegrass	*Poa glauca*
glaucous gentian	*Gentiana glauca*
globeflower	*Trollius albiflorus*
golden-aster	*Heterotheca villosa*
graceful cinquefoil	*Potentilla gracilis*
graceful mountain sedge	*Carex podocarpa*
Grand Coulee owl-clover	*Orthocarpus barbatus*
grassland lupine	*Lupinus arbustus* ssp. *neolaxiflorus*
great camas	*Camassia leichtlinii*
great mullein	*Verbascum thapsus*
green bristlegrass	*Setaria viridis*
green fescue	*Festuca viridula*
green needlegrass	*Nassella viridula*
green rabbit-brush	*Chrysothamnus viscidiflorus*
green wintergreen	*Pyrola chlorantha*
grey horsebrush	*Tetradymia canescens*
grey reindeer	*Cladina rangiferina*
grey-leaved willow	*Salix glauca*
haircap moss	*Polytrichum* sp.
hairgrass dropseed	*Sporobolus airoides*
hairstem groundsmoke	*Gayophytum ramosissimum*
hairy cat's-ear	*Hypochaeris radicata*
hairy honeysuckle	*Lonicera hispidula*
hairy vetch	*Vicia villosa*
hairy water-clover	*Marsilea vestita*
hairy wildrye	*Elymus hirsutus*

Common Name	Scientific Name
Hall's willowherb	*Epilobium halleanum*
hard-stemmed bulrush	*Schoenoplectus acutus*
Harkness' linanthus	*Linanthus harknessii*
harvest brodiaea	*Brodiaea coronaria*
hay sedge	*Carex siccata*
heart-leaved buttercup	*Ranunculus cardiophyllus*
hedgehog dogtail	*Cynosurus echinatus*
heterocodon	*Heterocodon rariflorum*
highbush-cranberry	*Viburnum edule*
hillside milk-vetch	*Astragalus collinus*
Himalayan blackberry	*Rubus discolor*
Holboell's rockcress	*Arabis holboellii*
Hood's phlox	*Phlox hoodii*
Hooker's onion	*Allium acuminatum*
Hooker's townsendia	*Townsendia hookeri*
Hudson Bay sedge	*Carex heleonastes*
Idaho fescue	*Festuca idahoensis*
Indian hellebore	*Veratrum viride*
Indian ricegrass	*Achnatherum hymenoides*
interior bluegrass	*Poa nemoralis* ssp. *interior*
Japanese brome	*Bromus japonicus*
Jordal's locoweed	*Oxytropis jordalii*
junegrass	*Koeleria macrantha*
Kellogg's knotweed	*Polygonum polygaloides* ssp. *kelloggii*
Kentucky bluegrass	*Poa pratensis*
Kincaid's lupine	*Lupinus oreganus* var. *kincaidii*
kinnikinnick	*Arctostaphylos uva-ursi*
knapweed	*Centaurea* sp.
Kruckeberg's holly fern	*Polystichum kruckebergii*
large-fruited desert-parsley	*Lomatium macrocarpum*
least bladdery milk-vetch	*Astragalus microcystis*
Leiberg's fleabane	*Erigeron leibergii*
Lemmon's needlegrass	*Achnatherum lemmonii*
lemonweed	*Lithospermum ruderale*

APPENDIX 2. Continued

Common Name	Scientific Name
lesser-panicled sedge	*Carex diandra*
lesser spearwort	*Ranunculus flammula*
licorice fern	*Polypodium glycyrrhiza*
Lindley's aster	*Aster ciliolatus*
linear-leaved daisy	*Erigeron linearis*
little bluestem	*Schizachyrium scoparium*
lodgepole pine	*Pinus contorta*
long-leaved aster	*Aster ascendens*
long-leaved mugwort	*Artemisia longifolia*
long-leaved phlox	*Phlox longifolia*
long-stalked starwort	*Stellaria longipes*
long-stoloned sedge	*Carex inops*
long-stoloned sedge	*Carex inops* ssp. *heliophila*
Lotus milk-vetch	*Astragalus lotiflorus*
Low pussytoes	*Antennaria dimorpha*
lupine	*Lupinus* sp.
Lyall's mariposa lily	*Calochortus lyallii*
Mackenzie willow	*Salix prolixa*
mallow ninebark	*Physocarpus malvaceus*
mannagrass	*Glyceria* sp.
manroot	*Marah oreganus*
many-headed sedge	*Carex sychnocephala*
mariposa lily	*Calochortus*
marsh cinquefoil	*Comarum palustre*
marsh muhly	*Muhlenbergia glomerata*
mat muhly	*Muhlenbergia richardsonis*
meadow arnica	*Arnica chamissonis* ssp. *incana*
meadow birds-foot trefoil	*Lotus denticulatus*
meadow death-camas	*Zigadenus venenosus*
meadow salsify	*Tragopogon pratensis*
meadow sedge	*Carex praticola*
meadow willow	*Salix petiolaris*
Menzies' larkspur	*Delphinium menziesii*
Michaux's mugwort	*Artemisia michauxiana*

Common Name	Scientific Name
milk-vetch	*Astragalus* sp.
miner's-lettuce	*Claytonia perfoliata*
mock-orange	*Philadelphus lewisii*
mock-pennyroyal	*Hedeoma hispida*
Montana larkspur	*Delphinium bicolor* ssp. *bicolor*
moss campion	*Silene acaulis*
mountain alder	*Alnus incana*
mountain death-camas	*Zigadenus elegans*
mountain forget-me-not	*Myosotis asiatica*
mountain harebell	*Campanula lasiocarpa*
mountain monkshood	*Aconitum delphiniifolium*
mountain prickly gooseberry	*Ribes montigenum*
mountain sagewort	*Artemisia norvegica*
mountain sneezeweed	*Helenium autumnale* var. *grandiflorum*
Munroe's globe-mallow	*Sphaeralcea munroana*
mutton grass	*Poa fendleriana*
narrow-leaf willow	*Salix exigua* ssp. *interior*
narrow-leaved brickellia	*Brickellia oblongifolia* ssp. *oblongifolia*
needle-and-thread grass	*Hesperostipa comata*
needlegrass	*Achnatherum* sp.
needle-leaved navarretia	*Navarretia intertexta*
nettle-leaved giant-hyssop	*Agastache urticifolia*
net-veined willow	*Salix reticulata*
Nevada birds-foot trefoil	*Lotus nevadensis* var. *douglasii*
Nevada bluegrass	*Poa secunda* ssp. *juncifolia*
Nevada bulrush	*Amphiscirpus nevadensis*
nine-leaved desert-parsley	*Lomatium triternatum* ssp. *platycarpum*
nodding onion	*Allium cernuum*
nodding wood-reed	*Cinna latifolia*
Nootka rose	*Rosa nutkana*
northern anemone	*Anemone parviflora*
northern bedstraw	*Galium boreale*
northern gooseberry	*Ribes oxyacanthoides* ssp. *cognatum*
northern linanthus	*Linanthus septentrionalis*

Common Name	Scientific Name
northern mannagrass	*Glyceria borealis*
northern sweet-vetch	*Hedysarum boreale*
northern tansy mustard	*Descurainia sophioides*
northern wormwood	*Artemisia campestris*
northwestern sedge	*Carex concinnoides*
Nuttall's alkaligrass	*Puccinellia nuttalliana*
Nuttall's orache	*Atriplex nuttallii*
Nuttall's sunflower	*Helianthus nuttallii* var. *nuttallii*
Nuttall's waterweed	*Elodea nuttallii*
obscure cryptantha	*Cryptantha ambigua*
oceanspray	*Holodiscus discolor*
Okanogan fameflower	*Talinum sediforme*
Okanogan stickseed	*Hackelia ciliata*
old man's whiskers	*Geum triflorum*
one-flowered cinquefoil	*Potentilla uniflora*
oniongrass	*Melica bulbosa var. bulbosa*
orange touch-me-not	*Impatiens aurella*
orange-red king devil	*Hieracium aurantiacum*
orchard-grass	*Dactylis glomerata*
Oregon checker-mallow	*Sidalcea oregana var. procera*
oxeye daisy	*Leucanthemum vulgare*
Pacific bleeding heart	*Dicentra formosa*
Pacific reedgrass	*Calamagrostis nutkaensis*
Pacific sanicle	*Sanicula crassicaulis*
paintbrush	*Castilleja* sp.
pale comandra	*Comandra umbellata* var. *pallida*
pale evening-primrose	*Oenothera pallida* ssp. *pallida*
paper birch	*Betula papyrifera*
parsnip-flowered buckwheat	*Eriogonum heracleoides*
pasture sedge	*Carex petasata*
peach-leaf willow	*Salix amygdaloides*
perennial sow-thistle	*Sonchus arvensis*
pine bluegrass (big bluegrass)	*Poa secunda [P. canbyi])*
pinegrass	*Calamagrostis rubescens*

Common Name	Scientific Name
pinewood peavine	*Lathyrus bijugatus*
pink fairies	*Clarkia pulchella*
pink twink	*Phlox gracilis* ssp. *humilis*
plains butterweed	*Senecio plattensis*
plains prickly-pear cactus	*Opuntia polyacantha*
plains reedgrass	*Calamagrostis montanensis*
poison ivy	*Toxicodendron rydbergii*
polar willow	*Salix polaris*
ponderosa pine	*Pinus ponderosa*
porcupine sedge	*Carex hystricina*
porcupinegrass	*Hesperostipa spartea*
poverty-weed	*Iva axillaris* ssp. *robustior*
prairie buttercup	*Ranunculus rhomboideus*
prairie crocus	*Anemone patens*
prairie gentian	*Gentiana affinis*
prairie pepper-grass	*Lepidium densiflorum*
prairie rose	*Rosa woodsii*
prairie sagewort	*Artemisia frigida*
prairie sandgrass	*Calamovilfa longifolia*
prairie wedgegrass	*Sphenopholis obtusata*
pretty cinquefoil	*Potentilla pulcherrima*
pretty shootingstar	*Dodecatheon pulchellum* ssp. *cusickii*
prickly phlox	*Leptodactylon pungens*
prickly rose	*Rosa acicularis*
pulse milk-vetch	*Astragalus tenellus*
pumpelly brome	*Bromus inermis* ssp. *pumpellianus*
puncture vine	*Tribulus terrestris*
purple loosestrife	*Lythrum salicaria*
purple needlegrass	*Stipa pulchra* (*Nassella pulchra*)
purple nutsedge	*Cyperus rotundus*
purple oniongrass	*Melica spectabilis*
purple peavine	*Lathyrus nevadensis*
purple rattlesnake-root	*Prenanthes racemosa* ssp. *multiflora*
purple reedgrass	*Calamagrostis purpurascens*

Common Name	Scientific Name
purple spike-rush	*Eleocharis atropurpurea*
purple-leaved willowherb	*Epilobium ciliatum*
purple-leaved willowherb	*Epilobium ciliatum* ssp. *watsonii*
pussy willow	*Salix discolor*
Pyrenean sedge	*Carex pyrenaica*
quackgrass	*Elymus repens*
Raup's willow	*Salix raupii*
red alder	*Alnus rubra*
red fescue	*Festuca rubra*
red glass	*Salicornia rubra*
red raspberry	*Rubus idaeus*
redstem ceanothus	*Ceanothus sanguineus*
red three-awn	*Aristida purpurea* var. *longiseta*
red-osier dogwood	*Cornus stolonifera*
red-rooted cyperus	*Cyperus erythrorhizos*
redtop	*Agrostis gigantea*
reed canarygrass	*Phalaris arundinacea*
Regel's rush	*Juncus regelii*
rigid fiddleneck	*Amsinckia retrorsa*
river bulrush	*Bolboschoenus fluviatilis*
rivergrass	*Scolochloa festucacea*
Rocky Mountain butterweed	*Senecio streptanthifolius*
Rocky Mountain clubrush	*Schoenoplectus saximontanus*
Rocky Mountain fescue	*Festuca saximontana*
Rocky Mountain juniper	*Juniperus scopulorum*
Roemer's fescue	*Festuca idahoensis* ssp. *roemeri*
rose	*Rosa* sp.
rosy pussytoes	*Antennaria rosea*
rough dropseed	*Sporobolus compositus* var. *compositus*
rough fescue	*Festuca campestris*
round-leaved alumroot	*Heuchera cylindrica*
rush aster	*Aster borealis*
russian olive	*Elaeagnus angustifolia*
russian thistle	*Salsola kali*

Common Name	Scientific Name
sagebrush buttercup	*Ranunculus glaberrimus*
sagebrush mariposa lily	*Calochortus macrocarpus*
saltwater cress	*Arabidopsis salsuginea*
sand dropseed	*Sporobolus cryptandrus*
Sandberg's bluegrass	*Poa secunda*
saskatoon	*Amelanchier alnifolia*
satin grass	*Muhlenbergia racemosa*
satinflower	*Olsynium douglasii* var. *inflatum*
scarlet ammannia	*Ammannia robusta*
scarlet gaura	*Gaura coccinea*
scarlet globe-mallow	*Sphaeralcea coccinea*
scarlet paintbrush	*Castilleja miniata*
Scotch broom	*Cytisus scoparius*
Scouler's willow	*Salix scouleriana*
Scouler's campion	*Silene scouleri* ssp. *grandis*
scouring-rush	*Equisetum hyemale*
scrub birch	*Betula nana*
seablite	*suaeda calceoliformis*
sea blush	*Plectritis congesta*
seacoast bulrush	*Bolboschoenus maritimus*
seagreen barley	*Hordeum marinum*
seaside arrow-grass	*Triglochin concinna*
seneca-snakeroot	*Polygala senega*
shaggy fleabane	*Erigeron pumilus*
sheep cinquefoil	*Potentilla ovina*
sheep sorrel	*Rumex acetosella*
short-awned porcupinegrass	*Hesperostipa curtiseta*
short-beaked agoseris	*Agoseris glauca*
short-beaked fen sedge	*Carex simulata*
short-flowered evening-primrose	*Camissonia breviflora*
short-flowered monkey-flower	*Mimulus breviflorus*
short-rayed aster	*Aster frondosus*
showy daisy	*Erigeron speciosus*
showy Jacob's-ladder	*Polemonium pulcherrimum*

Common Name	Scientific Name
showy locoweed	*Oxytropis splendens*
showy milkweed	*Asclepias speciosa*
showy phlox	*Phlox speciosa* ssp. *occidentalis*
shrubby cinquefoil	*Pentaphylloides floribunda*
shrubby penstemon	*Penstemon fruticosus*
shy gilia	*Gilia sinuata*
sickle-pod rockcress	*Arabis sparsiflora*
sideoats gramma	*Bouteloua curtipendula*
silky locoweed	*Oxytropis sericea*
silver hairgrass	*Aira caryophyllea*
silverberry	*Elaeagnus commutata*
silverleaf phacelia	*Phacelia hastata*
silvery cinquefoil	*Potentilla argentea*
silvery orache	*Atriplex argentea* ssp. *argentea*
silvery sagebrush	*Artemisia cana* ssp. *cana*
Sitka alder	*Alnus viridis* ssp. *sinuata*
Sitka valerian	*Valeriana sitchensis*
skeleton-weed	*Chondrilla juncea*
slender collomia	*Collomia tenella*
slender hawksbeard	*Crepis atribarba*
slender mannagrass	*Glyceria pulchella*
slender penstemon	*Penstemon gracilis*
slender popcornflower	*Plagiobothrys tenellus*
slender sedge	*Carex lasiocarpa*
slender wedgegrass	*Sphenopholis intermedia*
slender wheatgrass	*Elymus trachycaulus*
slender-beaked sedge	*Carex athrostachya*
slimstem reedgrass	*Calamagrostis stricta* ssp. *inexpansa*
small-awned sedge	*Carex microchaeta*
small bedstraw	*Galium trifidum* ssp. *trifidum*
small-flowered birds-foot trefoil	*Lotus micranthus*
small-flowered blue-eyed Mary	*Collinsia parviflora*
small-flowered bulrush	*Scirpus microcarpus*
small-flowered fringecup	*Lithophragma parviflorum*

Common Name	Scientific Name
small-flowered ipomopsis	*Ipomopsis minutiflora*
small-flowered lipocarpha	*Lipocarpha micrantha*
small-flowered paintbrush	*Castilleja parviflora*
small-flowered penstemon	*Penstemon procerus*
small-flowered ricegrass	*Piptatherum micranthum*
small-fruited willowherb	*Epilobium leptocarpum*
small-headed clover	*Trifolium microcephalum*
small yellow water-buttercup	*Ranunculus gmelinii*
smooth cliff fern	*woodsia glabella*
smooth sumac	*Rhus glabra*
snowl buckwheat	*Eriogonum niveum*
snowl cinquefoil	*Potentilla nivea*
snowlbrush	*Ceanothus velutinus*
soft brome	*Bromus hordeaceus*
soft-stemmed bulrush	*Schoenoplectus tabernaemontani*
soopolallie	*Shepherdia canadensis*
Spalding’s campion	*Silene spaldingii*
Spalding's milk-vetch	*Astragalus spaldingii* var. *spaldingii*
Spanish-clover	*Lotus unifoliolatus* var. *unifoliolatus*
spike trisetum	*Trisetum spicatum*
spiked wood-rush	*Luzula spicata*
spikelike goldenrod	*Solidago spathulata*
spike-oat	*Helictotrichon hookeri*
spotted knapweed	*Centaurea biebersteinii*
spotted saxifrage	*Saxifraga bronchialis* ssp. *austromontana*
spreading arctic sedge	*Carex supina*
spreading dogbane	*Apocynum androsaemifolium*
spreading needlegrass	*Achnatherum richardsonii*
spreading stickseed	*Hackelia diffusa*
spring gold	*Lomatium utriculatum*
spurge-laurel	*Daphne laureola*
squaw currant	*Ribes cereum*
St. John’s-wort	*Hypericum perforatum*
star-flowered false Solomon's-seal	*Maianthemum stellatum*

Common Name	Scientific Name
step moss	*Hylocomium splendens*
sticky purple geranium	*Geranium viscosissimum*
stiff needlegrass	*Achnatherum occidentale*
stoloniferous pussytoes	*Antennaria flagellaris*
strict buckwheat	*Eriogonum strictum*
subalpine daisy	*Erigeron peregrinus*
subalpine fir	*Abies lasiocarpa*
Suksdorf's lupine	*Lupinus bingenensis* var. *subsaccatus*
sulphur buckwheat	*Eriogonum umbellatum*
sulphur cinquefoil	*Potentilla recta*
summer-cypress	*Kochia scoparia*
swamp onion	*Allium validum*
sweet-cicely	*Myrrhis odorata*
sweet-cicely	*Osmorhiza* sp.
sweet vernalgrass	*Anthoxanthum odoratum*
tall annual willowherb	*Epilobium brachycarpum*
tall beggarticks	*Bidens vulgata*
tall bluebells	*Mertensia paniculata*
tall Jacob's-ladder	*Polemonium acutiflorum*
tall mannagrass	*Glyceria elata*
tall Oregon-grape	*Mahonia aquifolium*
tall tumble-mustard	*Sisymbrium altissimum*
tamarack	*Larix laricina*
tarragon	*Artemisia dracunculus*
The Dalles milk-vetch	*Astragalus sclerocarpus*
thick-headed sedge	*Carex pachystachya*
thick-leaved thelypody	*Thelypodium laciniatum* var. *laciniatum*
thin-leaved owl-clover	*Orthocarpus tenuifolius*
thread-leaved fleabane	*Erigeron filifolius*
thread-leaved phacelia	*Phacelia linearis*
thread-leaved sandwort	*Arenaria capillaris*
threadstalk milk-vetch	*Astragalus filipes*
three-spot mariposa lily	*Calochortus apiculatus*
threetip sagebrush	*Artemisia tripartita*

Common Name	Scientific Name
three-toothed saxifrage	*Saxifraga tricuspidata*
thyme-leaved spurge	*Chamaesyce serpyllifolia* ssp. *serpyllifolia*
timber milk-vetch	*Astragalus miser*
timber oatgrass	*Danthonia intermedia*
toothcup meadow-foam	*Rotala ramosior*
trailing fleabane	*Erigeron flagellaris*
trembling aspen	*Populus tremuloides*
tufted fleabane	*Erigeron caespitosus*
tufted hairgrass	*Deschampsia cespitosa*
tufted lovegrass	*Eragrostis pectinacea*
tufted phlox	*Phlox caespitosa*
tufted white prairie aster	*Aster ericoides*
tundra milk-vetch	*Astragalus umbellatus*
Tweedy's willow	*Salix tweedyi*
twinflower	*Linnaea borealis*
two-coloured lupine	*Lupinus bicolor*
two-flowered cinquefoil	*Potentilla biflora*
two-spiked moonwort	*Botrychium paradoxum*
umber pussytoes	*Antennaria umbrinella*
upland larkspur	*Delphinium nuttallianum*
valley sedge	*Carex vallicola var. vallicola*
Vassey’s big sagebrush	*Artemisia tridentata* var. *vaseyana*
veiny meadowrue	*Thalictrum venulosum*
viviparous fescue	*Festuca viviparoidea*
Wallace's selaginella	*Selaginella wallacei*
wapato	*Sagittaria latifolia*
water birch	*Betula occidentalis*
water sedge	*Carex aquatilis*
water smartweed	*Polygonum amphibium*
Watson's cryptantha	*Cryptantha watsonii*
wedgescale orache	*Atriplex truncata*
Weiser milk-vetch	*Astragalus beckwithii*
western blue flax	*Linum lewisii*
western bluegrass	*Pascopyrum smithii*

Common Name	Scientific Name
western buttercup	*Ranunculus occidentalis*
western centaury	*Centaurium exaltatum*
western cliff fern	*woodsia oregana*
western dogbane	*Apocynum x floribundum*
western fescue	*Festuca occidentalis*
western flowering dogwood	*Cornus nuttallii*
western Jacob's-ladder	*Polemonium occidentale* ssp. *occidentale*
western low hawksbeard	*Crepis modocensis* ssp. *modocensis*
western low hawksbeard	*Crepis modocensis* ssp. *rostrata*
western meadowrue	*Thalictrum occidentale*
western mugwort	*Artemisia ludoviciana*
western mugwort	*Artemisia ludoviciana* var. *incompta*
western pasqueflower	*Anemone occidentalis*
western redcedar	*Thuja plicata*
western snowberry	*Symphoricarpos occidentalis*
western stickseed	*Lappula occidentalis* var. *cupulata*
western trillium	*Trillium ovatum*
western witchgrass	*Dichanthelium acuminatum*
western wheatgrass	*Pascopyrum smithii (Agropyron smithii)*
Wheeler’s bluegrass	*Poa wheeleri*
white cinquefoil	*Potentilla arguta*
white clematis	*Clematis ligusticifolia*
white clover	*Trifolium repens*
white fawn lily	*Erythronium oregonum*
white mountain-avens	*Dryas octopetala*
white mountain-heather	*Cassiope mertensiana*
white pussytoes	*Antennaria microphylla*
white spruce	*Picea glauca*
white sweet-clover	*Melilotus alba*
white wintergreen	*Pyrola elliptica*
Whited's halimolobos	*Halimolobos whitedii*
whitish rush	*Juncus albescens*
wild bergamot	*Monarda fistulosa*
wild licorice	*Glycyrrhiza lepidota*

APPENDIX 2. Concluded.

Common Name	Scientific Name
wild oat	*Avena fatua*
wild sarsaparilla	*Aralia nudicaulis*
wild strawberry	*Fragaria virginiana*
wild tobacco	*Nicotiana attenuata*
willow	*Salix* sp.
winged combseed	*Pectocarya penicillata*
winged water-starwort	*Callitriche marginata*
woody-branched rockcress	*Arabis lignifera*
woolly cinquefoil	*Potentilla hippiana*
woolly clover	*Trifolium microcephalum*
woolly plantain	*Plantago patagonica*
woolly sedge	*Carex lanuginosa*
woollypod milk-vetch	*Astragalus purshii*
yarrow	*Achillea millefolium*
yellow bell	*Fritillaria pudica*
yellow buckwheat	*Eriogonum flavum*
yellow chamomile	*Anthemis tinctoria*
yellow columbine	*Aquilegia flavescens*
yellow gromwell	*Lithospermum incisum*
yellow montane violet	*Viola praemorsa*
yellow nutsedge	*Cyperus esculentus*
yellow rattle	*Rhinanthus minor*
yellow salsify	*Tragopogon dubius*
yellow sweet-clover	*Melilotus officinalis*

APPENDIX 3. Common and scientific names of grassland fauna in British Columbia.

Common Name	Scientific Name
Arthropods	
Alberta Arctic	*Oeneis alberta*
Aphrodite Fritillary	*Speyeria aphrodite* ssp. *manitoba*
Apiocerid Fly	*Apiocera barri*
Arctic Blue	*Agriades glandon* ssp. *lacustris*
Arctic White	*Pieris angelika*
Astarte Fritillary	*Clossiana astarte* ssp. *distincta*
Baird's Swallowtail	*Papilio bairdii* ssp. *pikei*
Behr's Hairstreak	*Satyrium behrii*
Beringian Alpine	*Erebia mackinleyensis*
Beringian Fritillary	*Clossiana natazhati*
Blackmore's Blue	*Icaricia icariodes blackmorei*
Bremner's Silverspot	*Speyeria zerene bremnerii*
Bronze Copper	*Lycaena hyllus*
Checkered Skipper	*Pyrgus communis*
Common Branded Skipper	*Hesperia comma* ssp. *assiniboia*
Common Ringlet	*Coenonympha california* spp. *Benjamini*
Common Woodnymph	*Cercyonis pegala* ssp. *incana*
Coral Hairstreak	*Satyrium titus* ssp. *titus*
Dione Copper	*Lycaena dione*
Draco Skipper	*Polites draco*
Dun Skipper	*Euphyes vestris vestris*
Eastern Pine Elfin	*Incisalia niphon*
Eastern Tailed Blue	*Everes comyntas*
Gillette's Checkerspot	*Euphydryas gillettii*
Great Spangled Fritillary	*Speyeria cybele* ssp. *Pseudocarpenteri*
Green Marble	*Euchloe naina*
Ground Mantid	*Litaneutria minor*
Hecla Sulphur	*Colias hecla*
Immaculate Green Hairstreak	*Callophrys affinis*
Island Blue	*Plebejus saepiolus insulanus*
Island Marble	*Euchloe ausonides*

Common Name	Scientific Name
Jumping Gall Wasp	*Neuroterus saltatorius*
Jutta Arctic	*Oeneis jutta* ssp. *alaskensis*
Leaf Bug	*Ceratocapsus downesi*
Margined White	*Pieris marginalis* ssp. *guppyi*
Mormon Metalmark	*Apodemia mormo*
Moss' Elfin	*Icisalia mossi mossi*
Mountain Alpine	*Erebia pawlowskii*
Nez perce Dancer	*Argia emma*
Oak Phylloxera	*Phylloxera glabra*
Perdiccas Checkerspot	*Euphydryas chalcedona perdiccas*
Phoebus Appolo	*Parnassius phoebus*
Polixenes Arctic	*Oeneis polixenes* ssp. *yukonensis*
Porowan Tiger Beetle	*Cicindela parowana*
Propertius Ducky Wing	*Erynnis propertius*
Robber Fly	*Megaphorus willistoni*
Robber Fly	*Nicocles rufus*
Robber Fly	*Sceropogon bradleyi*
Rosov's Arctic	*Oeneis rosovi*
Scentless Plant Bug	*Harmostes dorsalis*
Scoliid Wasp	*Campsomeris pilipes*
Shield-Backed Bug	*Camirus porosus*
Sooty Hairstreak	*Satyriumfuliginosum*
Striped Hairstreak	*Satyrium liparops*
Sun Scorpion	*EremoBates gladiolus*
Tawny Crescent	*Phyciodes Batesii*
Taylor's Checkerspot	*Euphydryas editha taylori*
Uhler's Arctic	*Oeneis uhleri*
Vancouver Island Ringlet	*Coenonympha california insulana*
Vivid Dancer	*Argia vivida*
White-veinedAarctic	*Oeneis bore edwardsi*
Reptiles and Amphibians	
Boreal Chorus Frog	*Pseudacis maculata*
Clouded Salamander	*Aneides ferreus*
Common Garter Snake	*Thamnophis sirtalis*
European Wall Lizard	*Podarcis muralis*
Gopher Snake	*Pituophis catenifer deserticola*

Common Name	Scientific Name
Great Basin Spadefoot	*Spea intermontana*
Leopard Frog	*Rana pipiens*
Long-toed Salamander	*Ambystoma macrodactylum*
Night Snake	*Hypsiglena torquata*
Northern Alligator Lizard	*Gerrhonotus coeruleus*
Northern Rough-skinned Newt	*Taricha granulosa*
Northwestern Garter Snake	*Thamnophis ordinoides*
Oregon Ensatina	*Ensatina eschscholtzii*
Pacific Treefrog	*Hyla regilla*
Painted Turtle	*Chrysemys picta*
Racer	*Coluber constrictor* spp.*mormon*
Rubber Boa	*Charina bottae*
Sharp-tailed Snake	*Contia tenuis*
Spotted Frog	*Rana pretiosa*
Tailed Frog	*Ascaphus truei*
Tiger Salamander	*Ambystoma tigrinum*
Western Garter Snake	*Thamnophis elegans*
Western RattleSnake	*Crotalus viridis*
Western Red-backed Salamander	*Plethodon vehiculum*
Western Skink	*Eumeces skiltonianus*
Western Toad	*Bufo boreas*
Wood Frog	*Rana sylvatica*
Birds	
American Avocet	*Recurvirostra americana*
American Bittern	*Botaurus lentiginosus*
American Coot	*Fulica americana*
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Carduelis tristis*
American Kestrel	*Falco sparverius*
American Peregrine Falcon	*Falco peregrinus anatum*
American Robin	*Turdus migratorius*
American White Pelican	*Pelecanus erthrorhynchus*
Bald Eagle	*Haliaeetus leucocephalus*
Band-tailed Pigeon	*Columba fasciata*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*

APPENDIX 3. Concluded.

Common Name	Scientific Name
Barrow’s Goldeneye	*Bucephala islandica*
Bewick’s Wren	*Thryomanes bewickii*
Black-billed Cuckoo	*Coccyzus erythrophthalmus*
Black-billed Magpie	*Pica pica*
Black-capped Chickadee	*Parus atricapillus*
Black-chinned Hummingbird	*Archilochus alexandri*
Black-throated Warbler	*Dendroica nigrescens*
Blue Grouse	*Dendragapus canadensis*
Blue-winged Teal	*Anas discors*
Bobolink	*Dolichonyx oryzivorus*
Bohemian Waxwing	*Bombycilla garrulus*
Boreal Chickadee	*Parus hudsonicus*
Boreal Owl	*Aegolius funereus*
Brewer’s Sparrow ssp. breweri	*Spizella breweri* ssp. *breweri*
Brewer's Blackbird	*Euphagus cyanocephalus*
Brown Creeper	*Certhia americana*
Bufflehead	*Bucephala albeola*
Burrowing Owl	*Athene cunicularia*
Bushtit	*Psaltriparus minimus*
California Gull	*Larus californicus*
California Quail	*Callipepla californica*
Calliope Hummingbird	*Stellula calliope*
Canada Goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Canyon Wren	*Catherpes mexicanus*
Caspian Tern	*Sterna caspia*
Cedar Waxwing	*Bombycilla cedrorum*
Chestnut-backed Chickadee	*Parus rufescens*
Chipping Sparrow	*Spizella passerina*
Cinnamon Teal	*Anas cyanoptera*
Clark's Nutcracker	*Nucifraga columbiana*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Goldeneye	*Bucephala clangula*
Common Loon	*Gavia immer*
Common Merganser	*Mergus merganser*
Common Nighthawk	*Chordeiles minor*
Common Poorwill	*Phalaenoptilus nuttallii*

APPENDIX 3. Concluded.

Common Name	**Scientific Name**
Common Raven	*Corvus corax*
Common Yellow-throat	*Geothlypis trichas*
Cooper's Hawk	*Accipiter cooperii*
Dark-eyed Junco	*Junco hyemalis*
Downy Woodpecker	*Picoides pubescens*
Dusky Flycatcher	*Empidonox oberholseri*
Eared Grebe	*Podiceps nigricollis*
Eastern Kingbird	*Tyrannus tyrannus*
European Starling	*Sturnus vulgaris*
Evening Grossbeak	*Coccothraustes vespertinus*
Ferruginous Hawk	*Buteo regalis*
Flammulated Owl	*Otus flammeolus*
Fox Sparrow	*Passerella iliaca*
Golden Eagle	*Aquila chrysaetos*
Golden-crowned Kinglet	*Regulus satrapa*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray Flycatcher	*Empidonax wrightii*
Great Blue Heron	*Ardea herodias herodias*
Great Gray Owl	*Strix nebulosa*
Great horned Owl	*Bubo virginianus*
Greater Scaup	*Aythya marila*
Greater Yellowlegs	*Tringa melanoleuca*
Green Heron	*Butorides virescens*
Gyrfalcon	*Falco rusticolus*
Hairy Woodpecker	*Picoides villosus*
Hammond's Flycatcher	*Empidonax hammondii*
Harris's Sparrow	*Zonotrichia querula*
Hermit Thrush	*Catharus guttatus*
Horned Lark	*Eremophila alpestris*
House Sparrow	*Passer domesticus*
House Wren	*Troglodytes aedon*
Hutton's Vireo	*Vireo huttoni*
Killdeer	*Charadrius vociferus*
Lapland Longspur	*Calcarius lapponicus*
Lark Sparrow	*Chondestes grammacus*
Least Sandpiper	*Calidris minutilla*

APPENDIX 3. Concluded.

Common Name	Scientific Name
Le Conte's Sparrow	*Ammodrammus leconteii*
Lesser Golden Plover	*Pluvialis dominica*
Lesser Scaup	*Aythya affinis*
Lewis's Woodpecker	*Melanerpes lewis*
Lincoln's Sparrow	*Melospiza lincolnii*
Long-billed Curlew	*Numenius americanus*
Mallard	*Anas platyrhynchos*
Marsh Wren	*Cistothorus palustris*
Merlin	*Falco columbarius*
Mountain Bluebird	*Sialia currucoides*
Mountain Chickadee	*Parus gambeli*
Mourning Dove	*Zenaidura macroura*
Northern Flicker	*Colaptes aurtus*
Northern Harrier	*Circus cyaneus*
Northern Pintail	*Anas acuta*
Northern Pygmy Owl	*Glaucidium gnoma* ssp. *swarthi*
Northern Saw-whet Owl	*Aegolius acadicus*
Northwestern Crow	*Corbus caurinus*
Orange-crowned Warbler	*Vermivora celata*
Pileated Woodpecker	*Dryocopus pileatus*
Pine Grosbeak	*Pinicola enuchleator*
Pine Siskin	*Carduelis pinus*
Prairie Falcon	*Falco mexicanus*
Purple Finch	*Carpodacus purpureus*
Pygmy Nuthatch	*Sitta pygmaea*
Red-breasted Nuthatch	*Sitta canadensis*
Red-breasted Sapsucker	*Sphyrapicus ruber*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Rock Ptarmigan	*Lagopus mutus*
Rock Wren	*Salpinctes obsoletus*
Rosy Finch	*Leucosticte arctoa*
Rough-legged Hawk	*Buteo lagopus*
Ruby-crowned Kinglet	*Regulus calendula*
Ruffed Grouse	*Bonasa umbellus*
Rufous Hummingbird	*Selasphorus rufus*
Spotted towhee	*Pipilo erythrophthalmus*

APPENDIX 3. Concluded.

Common Name	Scientific Name
Sage Thrasher	*Oreoscoptes montanus*
Sandhill Crane	*Grus americana*
Savannah Sparrow	*Passerculus sandwichensis*
Say's Phoebe	*Sayornis nigricans*
Sharp-shinned Hawk	*Accipiter striatus*
Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*
Sharp-tailed Sparrow	*Ammodramus nelsoni*
Short-eared Owl	*Asio flammeus*
Skylark	*Alauda arvensis*
Smith's Larkspur	*Calcarius pictus*
Snow Bunting	*Plectrophenax nivalis*
Sprague's Pipit	*Anthus spragueii*
Song Sparrow	*Melospiza melodia*
Sora	*Porzana carolina*
Spotted Towhee	*Pipilo maculatus*
Steller's Jay	*Cyanocitta stelleri* ssp. *carlottae*
Streaked Horned Lark	*Eremophila alpestris strigata*
Swainson's Thrush	*Catharus ustulatus*
Swainson's Hawk	*Buteo swainsoni*
Townsend's Solitaire	*Myadestes townsendi*
Tree Swallow	*Tachycineta bicolor*
Trumpeter Swan	*Cygnus buccinator*
Tundra Swan	*Cygnus columbianus*
Turkey Vulture	*Cathartes aura*
Upland Aandpiper	*Bartramia longicauda*
Varied Thrush	*Ixoreus naevius*
Vaux's Swift	*Chaetura vauxi*
Vesper Sparrow	*Pooecetes gramineus* ssp. *affinis*
Warbling Vireo	*Vireo gilvus*
Water Pipit	*Anthus spinoletta*
Western Bluebird	*Sialia mexicana*
Western Grebe	*Aechmophorus occidentalis*
Western Kingbird	*Tyrannus verticalis*
Western Meadowlark	*Sturnella neglecta*
Western Screech-owl	*Otus kennicottii macfarlanei*
Western Tanager	*Piranga ludoviciana*
Western Wood-peewee	*Contopus sordidulas*

Common Name	Scientific Name
White-breasted Nuthatch	*Sitta carolinensis*
White-crowned Sparrow	*Zonotrichia leucophrya*
White-headed Woodpecker	*Picoides albolarvatus*
White-tailed Ptarmigan	*Lagopus leucurus*
White-throated Swift	*Aeronautes saxatalis*
Willow Ptarmigan	*Lagopus lagopus*
Wilson’s Warbler	*Wilsonia canadensis*
Winter Wren	*Troglodytes troglodytes*
Yellow Warbler	*Dendroica petechia*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Yellow-billed Cuckoo	*Coccyzus americanus*
Yellow-breasted Chat	*Icteria virens*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Mammals	
Arctic Ground Squirrel	*Spermophilus undulatus plesius*
Badger	*Taxidea taxus*
Big Brown Bat	*Eptesicus fuscus*
Bison	*Bison bison athabasca*
Black Bear	*Ursus americanus*
Black Rat	*Rattus rattus*
Black-tailed Deer	*Odocoileus hemionus columbianus*
Bobcat	*Lynx rufus*
Brown Lemming	*Lemmus trimucronatus*
California Bighorn Sheep	*Ovis canadensis californiana*
California Myotis	*Myotis californicus*
Caribou	*Rangifer tarandus*
Columbian Ground Squirrel	*Spermophilus columbianus*
Common Shrew	*Sorex cinereus*
Cougar	*Pumus concolor*
Coyote	*Cnus latrans*
Dall Sheep	*Ovis dalli dalli*
Deer Mouse	*Peromyscus maniculatus*
Dusky Shrew	*Sorex monicolus*
Eastern Cottontail	*Sylvilagus floridanus*
Eastern Gray Squirrel	*Sciurus carolinensis*
European Rabbit	*Oryctolagus cuniculus*

APPENDIX 3. Concluded.

Common Name	Scientific Name
Fringed Myotis	*Myotis thysanodes*
Gray Wolf	*Canis lupus*
Great Basin Pocket Mouse	*Perognathus parvus*
Grizzly Bear	*Ursus arctos*
Hoary Bat	*Lasiurus cinereus*
Hoary Marmot	*Marmota caligata*
House Mouse	*Mus musculus*
Least Chipmunk	*Eutamias minimus*
Little Brown Myotis	*Myotis lucifugus*
Long-eared Weasel	*Mestela frenata*
Long-legged Myotis	*Myotis volans*
Long-tailed Vole	*Microtus lingicaudus*
Long-tailed Weasel	*Mustela frenata* ssp. *altifrontalis*
Lynx	*Lynx canadensis*
Meadow Jumping Mouse	*Zapus hudsonius* ssp. *alascensis*
Meadow Vole	*Microtus pennsylvanicus*
Montane Vole	*Microtus montanus*
Mountain Goat	*Oreamnos americanus*
Mule Deer	*Odocoileus hemionus*
Muskrat	*Ondatra zibethicus*
Northern Bog Lemming	*Synaptomys borealis* ssp. *borealis*
Northern Pocket Gopher	*Thomonys talpoides*
Norway Rat	*Rattus norvengicus*
Nuttall’s Cottontail	*Sylivalagus nuttallii*
Pallid Bat	*Antrozous pallidus*
Preble’s Shrew	*Sorex preblei*
Raccoon	*Procyon lotor*
Red Fox	*Vulpes fluva*
Red Squirrel	*Tamiasciurus hudsonicus*
Rocky Mountain Bighorn	*Ovis canadensis canadensis*
Rocky Mountain Elk	*Cervus elephus*
Silver-haired Bat	*Lasionycteris noctivagans*
Snowshoe Hare	*Lepus americanus*
Spotted Bat	*Euderma maculatum*
Stone Sheep	*Ovis dallis stonei*
Striped Skunk	*Mephitis mephitis*
Townsend’s Mole	*Scapanus townsendii*

APPENDIX 3. Concluded.

Common Name	**Scientific Name**
Townsend’s Vole	*Microtus townsendii tetramerus*
Townsend's Big-eared Bat	*Corynorhinus townsendii*
Tundra Shrew	*Sorex tundrensis*
Tundra Vole	*Microtus oeconomus*
Vagrant Shrew	*Sorex vagrans*
Virginia Opossum	*Didelphis virgiana*
Western Harvest Mouse	*Reithrodontomys megalotis*

APPENDIX 4. Glossary of technical terms.

Abiotic. The non-living components of the environment, such as air, rocks, soil, water, peat, and plant litter.

Above-ground biomass. The total amount or mass of living plant material in a given area.

Abundance. The total number of individuals of a species in an area, population, or community.

Accelerated erosion. Erosion that is often induced by disturbance that exceeds the natural levels of erosion that occur within the prevailing topography, soils type and vegetative cover.

Aeolian. Produced by, or carried by wind.

Alien. A species occurring in an area to which it is not native. A plant or animal species introduced very recently, and usually by humans.

Alluvium (Alluvial deposit). Sands, gravels and silts deposited by flowing water.

Alpine. Those parts of mountains that rise above the treeline.

Apical (Apical bud). Buds that form at the terminal point of plant tissues.

Arctic. Pertaining to unforested areas that lie mostly north of the Arctic Circle.

Arthropod. A large group of invertebrate animals having segmented bodies and legs, including insects, spiders, mites, scorpions, and crustaceans.

Aspect. The direction towards which a slope faces.

Associate. A plant that is characteristic of a given plant community but has low to moderate abundance.

Association, plant. A kind of plant community represented by stands that occur in places where environments are so similar that there is a high degree of floristic uniformity in all layers of the plant community.

Avifauna. The birds of a particular region, environment, or time.

Azonal. (1) Soils and vegetation determined predominantly by factors other than local climate and vegetation. (2) Soils without distinct genetic horizons that form on steep slopes, coarse textured parent material or highly disturbed sites.

Barrier. (1) Any expanse of inhospitable space larger than the probable range of plant or animal dispersal that prevents a species from extending its range. (2) A physiographic feature that prevents or impedes the movement of air masses.

Bedrock. Solid rock exposed or overlain by unconsolidated material.

Biodiversity (Biological diversity). The diversity of plants, animals, and other living organisms in all their forms and levels of organization, including genes, species, ecosystems, and the evolutionary and functional processes that link them.

Biogeoclimatic classification system. A hierarchical classification system of ecosystems that integrates regional, local and chronological factors, and combines climatic, vegetation and site factors.

Biogeoclimatic unit. A part of the biogeoclimatic ecosystem classification system that is recognizable from other units by unique features of climate, vegetation and soils. Units can be zones, subzones, variants, or sites.

Biogeoclimatic zone. A geographic area having similar patterns of energy flow, vegetation, and soil as a result of a broad, regional climate.

Biomass. See above-ground biomass.

Biome. A broad region whose climate produces a characteristic climax community of plants and animals such as the coniferous forest region or taiga of North America.

Biotic. The living components of the environment including plants and animals.

Bog. A class of wetland characterized by a thick layer of sphagnum-based peat, and which receives its water primarily from direct precipitation. Bogs are acidic and nutrient poor.

Boundary layer. A thin layer of humid air surrounding living tissues that acts as insulation.

Browse. (1) That part of the leaf and twig growth of shrubs and trees that is available for animal consumption. (2) Act of consuming stems and other woody materials.

Brunisol. Brown soils that occur under dry, relatively open coniferous and sometimes deciduous forest. They are well drained but little weathered.

Bunchgrass. A perennial herbaceous grass lacking rhizomes or stolons, and which has a characteristic growth habit of forming a bunch.

Canopy. The vertical projection downward of the aerial portion of vegetation, usually expressed as percent of ground covered.

Canopy closure. The progressive reduction of space between tree or shrub crowns as they spread laterally, increasing canopy cover.

Chernozem. Well- to imperfectly-drained mineral soils with a very dark brown or black A horizon. Formed on grasslands under conditions of high summer temperatures and low rainfall.

Climate. The average weather conditions of a place over a period of years.

Climatic climax. The apparently stable vegetation that terminates succession on zonal soils.

Climax. The highest ecological development of a plant community capable of perpetuation in dynamic equilibrium under the prevailing climatic, edaphic and biotic conditions. The final or stable biotic community in a successional series.

Co-dominant. Two or more species that are dominant in the same plant community.

Colluvium (Colluvial deposit). Materials that accumulate from mass wastage such as downhill movement, mudflows, landslides, and shattering of bedrock from frost action.

Community. Any group of organisms interacting among themselves.

Competition. The influence of one organism on another that results from both drawing on one or more resources that are in short supply.

Coniferous (Conifer). Cone-bearing trees having needles or scale-like leaves, usually evergreen.

Continental climate. Any climate in which the difference between summer and winter temperatures is greater than average for that latitude because of distance from a sea or ocean.

Copse. Small thickets of small trees and shrubs.

Corridor. A band of vegetation or strip of land that serves to connect distinct patches of habitat on the landscape, and permits the movement of plant and animal species between what would otherwise be isolated patches.

Cosmopolitan. Animals or plants that are found almost everywhere. As related to diets, comprised of almost all foods available.

Cover. (1) The plants or plant parts, living or dead, on the surface of the ground. It includes living plants and litter. (2) Shelter and protection for animals and birds.

Crown. (1)The permanent base of a perennial plant. (2)The live branches and foliage of a tree.

Crown closure. The condition when the crowns of trees touch and effectively block sunlight from reaching the forest floor.

Crown land. Land that is owned by the federal or a provincial government. Referred to as federal Crown land when it is owned by Canada, and as provincial Crown land when owned by a province.

Cryptogam. Any plant reproducing sexually without forming seeds. Includes mosses, lichens and ferns.

Deciduous. Perennial plants that normally shed their leaves for some time during the year.

Decreaser. Plant species of the original or climax vegetation that will decrease in relative amount with continued overuse by grazing animals.

Decumbent. Low-growing with stems or branches lying or trailing on the ground.

Derived. Plant communities that are created and maintained by disturbances such as fire, grazing, logging, or other extraneous influences.

Desert. Very hot ecosystems with insufficient rainfall to support a significant cover of perennial grass on zonal soils.

Dicot (Dicotyledon). A flowering plant having two seed leaves (cotyledons) in the embryo. Includes most broadleaf plants.

Disjunct. Two or more potentially interbreeding populations separated by a distance that precludes genetic exchange.

Dispersal. The scattering of seeds or spores of a plant, or movement of an animal to a new habitat.

Disturbance. A discrete event, either natural or human-induced, that causes a change in the existing condition of an ecological system.

Dominance. The collective size or bulk of the individuals of a group of organisms as it determines their relative influence on other components of the ecosystem.

Dominant. Plant species or species groups, which by means of their number, coverage, or size, has considerable influence or control upon the conditions of existence of associated species.

Drumlin. A ridge or oval hill formed by glacial deposits.

Ecological classification. An approach to categorizing and delineating, at different levels of resolution, areas of land and water which have similar characteristic combinations of the physical environment (such as climate, geomorphic processes, geology, soils, and hydrologic function), biological communities (plants, animals, microorganisms, and potential natural communities), and the human dimension (such as social, economic, cultural and infrastructure).

Ecological reserve. Areas of Crown land that are representative of natural ecosystems; contain rare or endangered native plants or animals in their natural habitat; or are unique geological phenomena.

Ecology. The study of the interrelationships of organisms with their environment.

Ecoregion classification. The ecoregion classification system in British Columbia is used to stratify terrestrial and marine ecosystems into discrete geographical units at five different levels. Ecodomains and Ecodivisions are very broad, while Ecoprovinces, Ecoregions and Ecosections, are progressively more detailed. The geographic units describe areas of similar climate, physiography, oceanography, hydrology, vegetation, and wildlife potential.

Ecosystem. Organisms together with their physical environment, forming an interacting system, inhabiting an identifiable space.

Ecotone. A transition area between two adjacent ecological communities having characteristics of both kinds of neighboring vegetation as well as characteristics of its own.

Ecotype. A race within a species which is genetically adapted to a habitat type that is different from the habitat types of other races of that species.

Edaphic. Refers to the soil.

Edaphic climax. Any distinctive type of stable community that develops on soils different from those which support a climatic climax.

Effective precipitation. That portion of total precipitation that is available for plant growth. It does not include precipitation lost to percolation below the root zone of plants, runoff, or losses resulting from evaporation.

Endangered species. Any indigenous species, or sub-species, threatened with imminent extinction throughout all, or most of its range.

Environment. The sum of all external conditions that affect an organism or community and influence its development or existence.

Erosion. Detachment and movement of soil or rock fragments by water, wind, ice, or gravity.

Esker. A winding ridge of sand and gravel deposited by meltwater streams flowing inside retreating glaciers.

Evapotranspiration. The combined water lost from evaporation from soils and water bodies, and transpiration from vegetation over a given area and time.

Exotic. An organism or species that is not native to the region in which it is found.

Exposure. Direction of slope with respect to the points of a compass.

Fauna. The animal life of a region.

Fen. Wetland containing more than 15 cm of non-sphagnum peat. Its water comes mainly from groundwater or runoff from adjacent uplands. Vegetation can include sedges, shrubs and mosses.

Feral. Escaped from cultivation or domestication and exists in the wild.

Fibrous roots. A root system consisting of a large number of small, finely divided, widely spreading roots, but no large taproots. Typified by grass root systems.

Floodplain. A level, low-lying area adjacent to streams that is periodically flooded during the spring freshet or extreme rainfall events.

Flora. (1) The plant species of an area. (2) A list of plant species or a taxonomic manual.

Fluvial. Processes by which sediment is transferred along the stream channel by the force of flowing water.

Fluvial deposit. Materials transported and deposited by streams and rivers. They consist of sorted sands, silts or gravels.

Fluvioglacial deposit. Materials deposited by glacial meltwater either directly from glacier ice or as outwash from beyond the ice margin. They consist of sands and gravels that may be sorted and stratified.

Forage. Grasses, herbs and small shrubs that can be used as feed for livestock or wildlife.

Forb. Any broad-leaved herbaceous plant other than those in the grass, sedge or rush families.

Forest. An area of closely spaced trees that is relatively extensive (i.e., larger than a grove).

Forestland. Land on which the native vegetation is forest.

Formation. A region dominated by plants of the same 'life form' or physiognomy as a result of the prevailing climate.

Fragmented. The process of transforming large continuous patches of vegetation into one or more smaller patches surrounded by disturbed areas. This occurs naturally through such agents as fire, landslides, wind throw, and insect attack.

Geomorphic. Having to do with the shape or the surface features of the earth.

Glacial till. Non-stratified sediments ranging in size from clay particles to boulders that were directly deposited by glaciers.

Glaciolacustrine. Sedimentary deposits from lakes formed around the time of deglaciation. They vary in texture from silt and fine sand to coarser sand and gravel.

Gleysol. Mineral soils of medium to heavy texture that are saturated for much of the year.

Grasslike. Same as graminoid.

Graze. The consumption of standing forage by livestock or wildlife.

Grove. A stand of forest or woodland of small extent, surrounded by lower vegetation or bare soil.

Growing season. That portion of the year when temperature and moisture are favorable for plant growth.

Growth form. The characteristic shape or appearance of an organism.

Gully. A furrow or channel, usually with steep sides, through which water periodically flows.

Habitat. The natural abode of a plant or animal, including all biotic, climatic, and edaphic factors affecting life.

Habitat type. A collective term for all parts of the land surface supporting, or capable of supporting, the same kind of climax plant association.

Heath. Low shrublands primarily consisting of shrub species in the Ericaceae family.

Herb. Any flowering plant that dies back to the ground surface each year.

Herbaceous. Vegetation lacking persistent woody stems; can refer to graminoids or forbs.

Horizon, soil. A visually observable horizontal component of a soil profile in which weathering and/or plant influences have had a distinctive influence.

Hummock. A very small, rounded hill or knoll often formed from deposition of glacial debris.

Increaser. Plant species of the original or climax vegetation that initially become more abundant and widespread with grazing, and then decrease in relative abundance with continued overuse by grazing animals.

Introduced species. A species that is not a part of the original fauna or flora of a region.

Invader. Plant species that are absent, or present in very small numbers, in the undisturbed original vegetation, and which become more abundant and widespread following disturbance.

Invasion. The entrance of an organism into an area where it was not formerly represented.

Kame. A small hill or ridge deposited by retreating glaciers.

Krummholz. The belt of discontinuous scrub at alpine timberlines; composed of species that have the genetic potential of the tree life form, but in the cold climate, are strongly dwarfed.

Landform. A landscape unit that denotes origin and shape, such as a floodplain, river terrace, or till plain.

Landscape. The fundamental characteristics of a specific geographic area, including its biological composition and physical environment.

Layer. A structural component of a community that may be recognized as consisting of plants with approximately uniform and distinctive stature. Often described as a tree layer, shrub layer, or herb layer.

Life-form. Characteristic form or appearance of a species at maturity such as tree, shrub or herb.

Litter. Organic debris, mainly bark, twigs, and leaves, on the soil surface; essentially freshly fallen or slightly decomposed vegetative material.

Livestock. Domestic animals such as cattle, horses, mules, asses, sheep, and goats.

Loess. Wind deposited sand and silts. A thin mantle of fine soil particles that results from settling of sediments carried by winds associated with deglaciation.

Luvisol. Soils that form under forest canopies or forest-grassland transition zones in areas of moderate precipitation. They have a clay accumulation in the subsoil caused from leaching from above.

Marsh. An ecosystem dominated by herbaceous plants such as bulrush or cattail, and with the soil saturated for long periods if not permanently, but without surface accumulations of peat.

Meadow. Openings in forests and grasslands of exceptional productivity in arid regions, usually resulting from high water content of the soil.

Meadow-steppe. Steppe occurring in climates almost moist enough for forest, and containing an abundance of perennial forbs.

Meristem(atic). (1) The tip of a stem or root where cells divide and grow. (2) Tissues containing cells that divide and grow.

Mesic. Slightly moist, neither very dry nor very moist.

Microbiotic crust. An association of mosses and lichens that form a crust on the soil surface. (Often used synonymously for cryptogam crust).

Microclimate. Any set of climatic conditions differing from the macroclimate due to closeness to the ground, vegetation influences, aspect, and cold air drainage.

Mineral soil. Soils consisting predominately of inorganic materials and usually containing less than 20% organic matter.

Mixed stand. A stand composed of two or more tree species.

Moisture deficit. A measure of the dryness of soil expressed as the depth of rainfall that would be required to return soils to their maximum water-holding capacity. The soil moisture deficit increases when evapotranspiration exceeds precipitation.

Montane. Pertaining to mountain slopes below the alpine belt.

Monocot (monocotyledon). Flowering plants having one seed leaf (cotyledon) in the embryo. Includes grasses, sedges, rushes and lilies.

Moraine (Morainal deposit). Unsorted materials deposited directly from glacier ice. They lie below rock and colluvial slopes and above valley floor areas affected by recent fluvial activity.

Mulch. A layer of dead plant matter (or other material such as rock) that covers the soil surface as a protective layer.

Native species. Species that are part of the original fauna or flora of an area.

Naturalized. An alien species that continues to perpetuate itself after being introduced into a new area.

Noxious weed. Any plant species so designated by the Weed Control Act of British Columbia.

Nunatak. An isolated mountain peak or hill rising above the surrounding glacial ice.

Organic soil. Soils containing a high proportion (greater than 20%) of organic matter.

Outwash terrace. A relatively small, flat, or gently sloping tract of land that lies above the valley of a modern stream or river, which was formed by sediments deposited by water flowing away from a melting glacier.

Overgrazing. Continued overuse that exceeds the recovery capacity of the community and results in degradation of an ecosystem.

Overuse. Utilization of the current annual growth exceeding the capacity of plants to store carbohydrates or reproduce. Repeated overuse will result in overgrazing and a deterioration of the ecosystem.

Parkland. A landscape dominated by openings of grassland mixed with forest.

Phenology. The study of periodic biological phenomena that are recurrent, such as flowering, seeding, etc., especially as related to climate.

Physiognomy. The superficial appearance of vegetation.

Physiography. The study of physical features of the earth’s surface.

Pioneer plant. The first species or community to colonize, or recolonize, barren or disturbed areas in primary or secondary succession.

Pond. A body of water with negligible current that has vegetation extending without interruption from the surrounding elevated land into the water (i.e., lacks a beach).

Potential natural community. The final or stable biotic community in a successional series including some species that may be non-native but naturalized.

Prairie. An extensive tract of level or rolling land that was originally treeless and grass-covered.

Profile. The sequence of visually distinguishable horizons in a soil, or layers in a plant community, seen in a vertical section. In a soil profile there is usually an upper (A) horizon that has been leached of solutes or colloids that were deposited in a B horizon below, with the relatively unweathered material still deeper referred to as the C horizon.

Proper use. A degree of utilization of current year’s growth that, if continued, will achieve management objectives and maintain or improve the long-term productivity and ecological integrity of the site.

Rain shadow. The region of diminished rainfall on the lee side of a mountain range, where the rainfall is noticeably less than on the windward side.

Range. Any land supporting vegetation suitable for wildlife or domestic livestock grazing, including grasslands, woodlands, shrublands and forest lands.

Rangeland. A broad category of land characterized by native plant communities that are often associated with grazing. Includes natural grasslands, savannahs, shrublands, deserts, tundra, alpine, coastal marshes, wetlands and some forest communities.

Recovery. Movement of a site toward a higher successional status after disturbance within its ecological potential.

Refugia. A small area in which organisms have survived when most of their former range became uninhabitable due to climatic change or glaciation.

Regosol. Immature, poorly developed soils that develop under conditions of recent disturbance such as floodplains, or where harsh conditions restrict soil development such as on steep slopes and alpine areas.

Relic. A remnant or fragment of a flora that remains from a former period when it was more widely distributed.

Retrogression. The degradation of a site cause by biotic or abiotic factors that results in movement of the site to a lower successional status.

Rhizome. A horizontal underground stem, usually sending out roots and above-ground shoots from nodes.

Rhizomatous. Plant species that reproduce by sending out roots and underground stems.

Riparian. Land adjacent to a stream, river, lake, or wetland containing vegetation that is distinctly different from the vegetation of adjacent upland areas because of the presence of water.

Riparian habitat. Vegetation growing close to a watercourse, lake, wetland, or spring that is important for wildlife cover and for organisms that provide food for fish.

Ruderal. Plant species that are usually herbs and characterized by having a short lifespan and high seed production. They usually occupy the earliest stages of plant succession.

Saline. Pertaining to soil or water that contains sufficient soluble salts to be detrimental to most plants.

Savannah. A physiognomic type of vegetation in which tall, widely spaced plants, especially trees, are scattered individually over land otherwise covered with low-growing plants and especially graminoids. Often a transitional type between true grassland and forest.

Scarp slope. A steep slope often formed by erosion or faulting.

Semi-arid. Regions or climates where moisture is normally greater than under arid conditions but still limits the production of vegetation. The upper limit of average annual precipitation in the cold, semiarid regions is as low as 380 mm, whereas in tropical regions it is as high as 1100 to 1300 mm.

Seral. Non-climax, or a species or a community demonstrably susceptible to replacement by another species or community, usually within a few centuries at most.

Seral stage. Any stage of development of an ecosystem from a disturbed, unvegetated state to a climax plant community. Seral stages are often called early, mid, late, and climax.

Shallow open water. Wetlands with a mid-season water depth less than 2 m. They support little or no emergent vegetation. Bottom soils may be mineral or organic.

Shrub. A plant that has persistent, woody stems and a relatively low growth habit, and which generally produces several basal shoots instead of a single stem.

Shrub-carr. A hummocky wet meadow in which shrubs grow on the hummocks while sedges, grasses and forbs grow in the wet depressions between the hummocks.

Shrubland. Any land where shrubs dominate the vegetation.

Shrub-steppe. Grassland in which scattered shrubs form an open overstory above the grass layer and often co-dominate with the main grass species.

Site. An area described or defined by its biotic, climatic, and soil conditions in relation to its capacity to produce vegetation.

Slope. A slant or incline of the land surface, measured in degrees from the horizontal, or in percent (defined as the number of feet or meters change in elevation per 100 of the same units of horizontal distance), and characterized by direction (exposure).

Soil. The naturally occurring, unconsolidated mineral or organic material at the surface that supports plant growth, and is formed by the interactions between climate, living organisms, and relief acting on soil and soil parent material.

Soil erosion. The wearing away of the earth's surface by water, gravity, wind, and ice.

Soil texture. The nature of soil as determined by the proportions of sand, silt and clay particles.

Species composition. The proportions of various plant species in relation to the total on a given area; may be expressed in terms of cover, density, or weight.

Stand. An existing plant community with defined bounds that is relatively uniform in age, composition, structural, and site conditions.

Steppe. Temperate zone vegetation dominated by grasses and occurring in climates where zonal soils are too dry to support trees.

Subalpine. The first distinctive type of vegetation, usually forest, below the alpine tundra, or a plant growing in such a location.

Sublimation. The process of passing directly from a solid state (e.g., snow) to a vapor.

Succession. The progressive replacement of plant communities on a site which leads to the climax or potential natural plant community. Primary succession involves the simultaneous successions of soils (from parent material) and vegetation. Secondary succession occurs following disturbances on sites that previously supported vegetation, and entails plant succession on a more mature soil.

Swale. Depressions on the landscape where water accumulates.

Swamp. A wetland dominated by trees or tall shrubs, which has soils saturated for long periods, if not permanently. The substrate consists of a mix of mineral sediments and organic materials.

Tectonic. Changes in the earth's crust resulting from the forces that cause them, and the structures that result.

Temperate. Climates with regular winter seasons of freezing weather, alternating with summer seasons that are either hot, or only warm but of long duration.

Terrain. The physical features of a tract of land.

Threatened species. Plant or animal species that likely are to become endangered if factors limiting their survival are not reversed.

Timberline. Any altitudinal or latitudinal limit of forest growth. Where high mountains rise from an arid basal plain there is both a lower and upper timberline.

Tolerate. The ability of an organism or biological process to subsist under a given set of environmental conditions. The range of these under which it can subsist, representing its limits of tolerance, is termed its ecological amplitude.

Topography. The physical features of a geographic area, such as those represented on a map, taken collectively; especially, the relief and contours of the land.

Tundra. Ecosystems of areas beyond the cold limits of tree growth.

Understory. Plants growing beneath the canopy of other plants. Usually refers to grasses, forbs, and low shrubs under a tree or shrub canopy.

Ungulate. A hoofed mammal, including ruminants such as cattle, sheep, deer and elk, but also including horses and swine.

Uplands. Terrain not affected by water tables or surface water, or else affected only for short periods so that riparian vegetation or aquatic processes do not persist.

Vegetation. Plant life considered in mass.

Vegetation type. A plant community with distinguishable characteristics.

Watershed. The total area of land above a given point on a waterway that contributes runoff water to the flow at that point.

Weed. A plant growing where it is unwanted.

Wet meadow. A meadow where the surface remains wet or moist throughout the summer but is rarely inundated. It has mineral soils and is usually characterized by sedges and rushes, grasses and various forbs.

Wetland. A swamp, marsh, or other similar area supporting natural vegetation that is distinct from adjacent upland areas. Its soils are usually saturated or ponded.

Wetland complex. An association of adjacent wetland types such as a shallow open water-marsh-wet meadow complex.

Wildlife. Undomesticated vertebrate animals considered collectively, except fish.

Wildlife habitat. Areas of land and water that support specific wildlife or groups of wildlife.

Winter range. A range, usually at lower elevation, used by migratory deer, elk, caribou, moose, etc., during the winter months and typically better defined and smaller than summer range.

Woodland. Lands dominated by a closed stand of trees of short stature.

Zonal site. Sites that represent the soil and vegetation conditions determined by the climate, and of such widespread distribution that they are considered regional in extent.

Zootic. Of, or relating to, animals.

Zootic climax. Any type of stable vegetation whose continued existence depends upon continued stress from heavy use by animals. The animal components of all ecosystems play important roles as subordinates, but only in a zootic climax is an animal so influential as to be clearly a dominant influence.

APPENDIX 5. Climate of grassland areas in British Columbia.

INDEX OF TABLES

SOURCES

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KEY TO CLIMATE PARAMETERS

Precipitation = Mean annual precipitation (rain + snow).
Snowfall = Total annual snowfall.
July Temp. = Mean maximum daily temperature in July.
Extreme High = Highest summer temperature recorded.
January Temp. = Mean minimum daily temperature in January.
Extreme Low = Lowest winter temperature recorded.
Frost-Free Days = Total number of days without frost over the year.

TABLE A 5.1. Climatic data for selected locations in the East Kootenay Trench.[1]

Parameter	Grasmere	Cranbrook	Wasa
Elevation (m)	869	939	930
Precipitation (mm)	552	383	439
Snowfall (cm)	101	140	100
July Temp. (ºC)	27.5	25.6	25.8
Extreme High (ºC)	39.4	36.6	37.0
January Temp. (ºC)	-2.0	-3.2	-2.4
Extreme Low (ºC)	-42.8	-40.0	-35.5
Frost Free Days	200	189	184

[1] Environment Canada. 2004.

TABLE A 5.2. Climatic data for selected locations in the Okanagan, Similkameen and Kettle valleys.[1]

Parameter	Armstrong	Oliver	Keremeos	Grand Forks
Elevation (m)	373	315	435	516
Precipitation (mm)	448	305	310	420
Snowfall (cm)	135	60	60	44
July Temp. (ºC)	19.2	23.0	20.0	20.0
Extreme High (ºC)	40.5	43.9	41.0	42.7
January Temp. (ºC)	-6.4	-2.0	1.0	-6.0
Extreme Low (ºC)	-35.0	-29.4	-29.0	-38.9
Frost Free Days	196	257	181	120

[1] Environment Canada. 2004.

TABLE A 5.3. Climatic data for selected locations in the Thompson-Pavilion.

Parameter	Ashcroft	Lower [1]	Middle	Upper	Chase
Elevation (m)	300	335	700	850	340
Precipitation (mm)	193	242	328	379	280
Snowfall (cm)	51	75	100	128	126
July Temp. (ºC)	30.0	22.7	21.1	18.9	22.2
January Temp. (ºC)	-2.2	-10.0	-11.8	-13.4	-6.0
Frost Free Days	165	163	114	92	130

[1] Lower, Middle and Upper Grassland zones (van Ryswyk et al. 1966) are equivalent to the BGxh2, BGxw1, IDFxh2 (Lloyd et al. 1990).

TABLE A 5.4. Climatic data for selected locations in the Southern Thompson Upland[1.]

Parameter	Princeton	Merritt	Highland Valley
Elevation (m)	700	609	1268
Precipitation (mm)	356	322	387
Snowfall (cm)	147	83.3	155.8
July Temp. (ºC)	26.2	26.4	20.8
Extreme High (ºC)	41.7	39.5	35.0
January Temp. (ºC)	-10.1	-8.6	-10.2
Extreme Low (ºC)	-42.8	-42.8	-43.9
Frost Free Days	85[2]	250	195

[1]Environment Canada. 2004.

[2]Green and Lord. 1979.

TABLE A 5.5. Climatic data for selected locations in the Cariboo-Chilcotin and Central Interior.[1]

Parameter	100 Mile House	Williams Lake Airport	Tatlayoko Lake	Quesnel	Vanderhoof
Elevation (m)	1060	940	853	545	674
Annual Precipitation (mm)	453.3	450.3	434.1	540.3	495.9
Annual Snowfall (cm)	159.0	197.2	121.9	177.9	165.3
July Temp. (ºC)	23.0	22.0	22.3	24.0	23.4
Extreme maximum (ºC)	36.0	35.8	37.8	36.7	36.0
January Temp. (ºC)	-13.5	-12.4	-11.7	-12.8	-13.9
Extreme minimum (ºC)	-48.0	-42.8	-43.3	-46.7	-47.0
Frost Free Days	165	120	57	104	53

[1] Environment Canada. 2004.

TABLE A 5.6. Climatic data for selected the Bunchgrass zone in the Cariboo-Chilcotin and Central Interior.

Parameter[1]	BGxh3	BGxw2
Elevation (m)	400-650	650-900
Annual Precipitation (mm)	330	345
Annual Snowfall (cm)	71	180
July Temp. (ºC)	19.0	17.3
January Temp. (ºC)	-10.6	19.9
Frost Free Days	182	169

[1] Adapted from Steen and Coupé (1997).

TABLE A 5.7. Climatic data for selected the Interior Douglas-fir zone in the Cariboo-Chilcotin and Central Interior.

Parameter[1]	IDFdk3	IDFdk4	IDFdw	IDFxm	IDFxw
Elevation (m)	750-1200	1050-1350	1050-1400	800-1200	600-1000
Annual Precipitation (mm)	433	355	412	392	No data
Annual Snowfall (cm)	231	138	142	145	No data
July Temp. (ºC)	14.7	13.6	14.0	16.0	15.4
January Temp. (ºC)	-10.3	-10.3	-8.5	-11.0	-10.2
Frost Free Days	151	122	148	163	No data

[1] Adapted from Steen and Coupé (1997).

TABLE A 5.8. Climatic data for selected the Sub-Boreal Pine-Spruce and Sub-Boreal Spruce zones in the Cariboo-Chilcotin and Central Interior.[1]

Parameter	SBPSdc	SBSPxc	SBSdk	SBSmc2
Elevation (m)	900-1280	1100-1500	700-1050	1200-1500
Annual Precipitation (mm)	508	389	481	575
Annual Snowfall (cm)	178	179	188	237
July Temp. (ºC)	13.9	12.3	no data	12.3
January Temp. (ºC)	-13.5	-11.8	no data	-12.6
Frost Free Days	152	93	70	151

[1] Adapted from Steen and Coupé (1997) and DeLong et al. (1990)

TABLE A 5.9. Climatic data for selected biogeoclimatic units in the Sub-Boreal Interior, Northern Boreal Mountains, Boreal Plains, and Taiga Plains.

Parameter	ESSFmv4	BWBSdk2	BWBSmw[1]	BWBSwk2	SWBmk[2]
Precipitation (mm)	No data	460	485	No data	580
Snowfall (cm)	No data	195	185	No data	270
Annual Temp.(ºC)	No data	-2.1	-1.6	No data	-1.9
Frost-Free Days	No data	75	105	No data	35

[1] Data for BWBSmw2 (DeLong et al. 1990).

[2] Data for SWBb (MacKinnon et al. 1990).

TABLE A 5.10. Climatic data for selected locations in the Sub-Boreal Interior, Northern Boreal Mountains, Boreal Plains, and Taiga Plains.[1]

Parameter	Smithers	Cassiar	Dawson Creek	Fort Nelson
Elevation (m)	523	1078	655	382
Precipitation (mm)	513	750	504	452
Snowfall (cm)	204	414	188	178
July Temp. (ºC)	21.6	17.3	15.1	23.0
Extreme maximum (ºC)	35.8	30.0	34.5	36.7
January Temp. (ºC)	-12.7	-19.0	-18.2	-18.6
Extreme minimum (ºC)	-43.9	-47.2	-49.2	-51.7
Frost-Free Days	100	37	78	105

[1] Environment Canada. 2004.

TABLE A 5.11. Climatic data for selected locations in the Georgia Depression.[1]

Parameter	Victoria	Comox
Elevation (m)	19 m	26 m
Precipitation (mm)	883	1179
Snowfall (cm)	44	74
July Temp. (ºC)	21.9	22.4
Extreme maximum (ºC)	36.1	34.4
January Temp. (ºC)	6.9	5.6
Extreme minimum (ºC)	-15.6	-21.1
Frost-Free Days	313	308

[1] Environment Canada. 2004.

APPENDIX 6. Grassland soils subgroups in British Columbia.

Soil Subgroup	Elevation (m)	Location	Comment
Chernozem			
Brown	275-600	Southern Okanagan Basin	Confined to driest valley bottoms and lower slopes.
	980-1250	Okanagan Range	Valley bottoms and lower slopes from Hedley south to US border.
	300-1000	Thompson Basin	Characteristic of Lower Grasslands in valley bottoms and on lower slopes; also in pine savannah.
	300-550	Southern Thompson Upland	Dry sites at low elevations.
	650-900	Fraser Basin	Characteristic of Lower Grasslands in valley bottoms and on lower slopes.
Dark Brown	345-1065	Southern Okanagan Basin	Lower slopes and well-drained sites, Osoyoos to Oyama; band between brown below and black above; occasionally merge with brunisols or podzols on north-facing slopes.
	500-600	Southern Okanagan Highland Northern Okanagan Highland	South-facing slopes from valley bottom in the Kettle Valley.
	400-1000	Thompson Basin	Characteristic of Middle Grasslands; also occurs in ponderosa pine savannah and lower elevations of Upper Grasslands.

Soil Subgroup	Elevation (m)	Location	Comment
Dark Brown	700-1130	Southern Thompson Upland	Characteristic of grasslands of this region; also in Ponderosa Pine savannah.
		East Kootenay Trench	Intergrades with Eutric Brunisols.
	600-1350	Fraser Basin Caribou Basin Caribou Plateau Chilcotin Plateau	Characteristic of Middle Grasslands, but also found on dry sites at higher elevations
Black	400-1370	Southern Okanagan Basin Northern Okanagan Basin	Limited areas from Osoyoos to Armstrong; most prevalent north of Kelowna in the Northern Okanagan Basin where they extend down to the valley bottoms.
	600-900	Okanagan Range	High elevations on steep south-facing slopes from Princeton to Keremeos; merge with Douglas-fir forest.
	600-1280	Southern Okanagan Highland Northern Okanagan Highland	Steep south-facing slopes and terraces; Rock Creek to Grand Forks and to Anarchist Mountain.
	900-1460	Thompson Basin	Characteristic soil of Upper Grasslands
	850-1460	Thompson Uplands	Characteristic soil of higher elevation open grasslands in this region.
	750-1050	Peace Lowlands Halfway Plateau	Limited occurrence on steep, south-facing slopes.
	1000-1550	Misinchinka Ranges	Shallow soils on coarse parent materials; immature soils Rego Black.
Dark Gray	400-1370	Okanagan Range	Scattered among Black Chernozems where open grassland intergrades with open tree stands; Princeton to Keremeos.
	500-640	Westbridge to Cascade Rock Creek to Grand Forks	Smooth to gently rolling slopes; open ponderosa pine; Westbridge to Cascade Rock Creek to Grand Forks.

Soil Subgroup	Elevation (m)	Location	Comment
	400-1130	Thompson Basin	Grasslands that merge with open stands of ponderosa pine or Douglas-fir.
	560-1260	Southern Thompson Upland	Grasslands influenced with needle cast from open Douglas-fir forest.
	750-1050	Halfway Plateau Peace Lowlands	Steep, south-facing slopes; immature soils (Rego Dark Gray).
Brunisol			
Eutric	450-950	Thompson Basin	Open ponderosa pine or Douglas-fir forest at grassland edge where canopy begins to close.
	700-1260	Thompson Upland	Open ponderosa pine or Douglas-fir forest at grassland edge where canopy begins to close.
	800-1200	East Kootenay Trench	Characteristic soil of ponderosa pine savannah; also where grasslands intergrades with Douglas-fir forest.
	600-1200 1050-1350	Cariboo Basin Cariboo Plateau	Dry soils on steep, south slopes; grassland soils in drier types.
Eutric		Peace Foothills Misinchinka Ranges	Coarse-textured, dry soils of cold regions on steep, south slopes.
	800-1850	Muskwa Foothills	Coarse-textured, dry soils on south slopes.
Orthic Sombric	1400-1700	Western Chilcotin Upland	Coarse-textured, acidic soils with a thick, mineral-organic surface layer, found in dry, cold areas.
Sombric		Georgia Depression	Loamy, acidic soils with thick mineral-organic surface layer, common in CDFmm
Dystric	750-1200 1050-1400 1400-1700	Cariboo Basin Cariboo Plateau Western Chilcotin Upland	Acidic soils in moister types influenced by forest cover, lacks mineral-organic surface layer.

APPENDIX 6. Continued

Soil Subgroup	Elevation (m)	Location	Comment
Dystric		Georgia Depression	Acidic soils influenced by forest cover and lacking a thick mineral-organic surface layer, common in CDFmm
Regosol			
	250-2000 700-1650 500-2100 300-1050	Southern Interior Southern Interior Mountains Central Interior Boreal and Taiga Plains	Immature soils formed where there is active fluvial action (floodplain), dry sites with steep, unstable slopes, or exposed, weathered bedrock.
	350-1900	Sub-Boreal Interior and Northern Boreal Mountains	Immature soils formed where there are steep, unstable slopes, exposed bedrock, or cold climates; some resemble Chernozem soils with a thick organically-enriched surface horizon, but the cold climate retards soil development processes.
Solonetzic			
		Southern Interior Central Interior	Localized on wetlands with fine-textured, poorly drained soils and high evaporation rates that cause salts to accumulate near the soil surface.
		Boreal Plains Peace Lowland	High salinity results from parent materials that were once part of an ancient sea-bed.
Luvisol			
Gray		Central Interior	Associated with openings in forested sites on medium-textured soils.
		Taiga Plains	Associated with aspen parkland and aspen forests on medium-textured soils.

APPENDIX 6. Concluded.

Soil Subgroup	Elevation (m)	Location	Comment
Gleysol		All regions	Associated with wetlands where fine-textured, mineral soils are saturated much of the time so that soil-forming processes lack oxygen.
Organic		All regions	Associated with wetlands where soils are cool and saturated most of the time and where organic material accumulates faster than it can decompose.

APPENDIX 7. Area of grassland within geographic regions and ecosections in British Columbia.

INDEX TO TABLES

SOURCE

Grasslands Conservation Council of B.C. (GCC). 2003. B.C. Grasslands mapping project: A conservation risk assessment. 3rd Year Annual, Grasslands Conserv. Counc. of B.C., Kamloops, B.C. 51pp.

TABLE A 7.1. Distribution and area of grassland in the East Kootenay Region by ecosection.

Ecosection	Area (ha)
East Kootenay Trench	41,260
Selkirk Foothills	1,855
Shuswap Highland	165
Border Ranges	970
McGillivray Ranges	380
Eastern Purcell Ranges	1,105
Southern Park Ranges	565
Total	46,415

TABLE A 7.2. Distribution and area of grassland in the Okanagan by ecosection.

Ecosection	Area (ha)
Southern Okanagan Basin	33,290
Southern Okanagan Highland	12,570
Okanagan Range	19,635
Northern Okanagan Basin	39,905
Northern Okanagan Highland	9,375
Total	117,275

TABLE A 7.3. Distribution and area of grassland in the Thompson-Pavilion by ecosection.

Ecosection	Area (ha)
Thompson Basin	98,840
Northern Thompson Upland	4,300
Pavilion Range	38,175
Southern Chilcotin Range	2,660
Total	143,975

TABLE A 7.4. Distribution and area of grassland in the Cariboo-Chilcotin and Central Interior by ecosection.

Ecosection	Area (ha)
Chilcotin Plateau	39,100
Central Chilcotin Ranges	8,440
Western Chilcotin Ranges	6,765
Western Chilcotin Upland	1,315
Fraser River Basin	125,275
Cariboo Basin	43,860
Cariboo Plateau	1,460
Nazko Upland	1,940
Bulkley Basin	5,030
Quesnel Lowland	150
Total	233,335

TABLE A 7.5. Distribution and area of grassland in the Sub-Boreal Interior and Northern Boreal Mountains by ecosection.

Ecosections	Area (ha)
Sub-Boreal Interior Ecoprovince	
Peace Foothills	5,450
Misinchinka Ranges	3,660
Hart Foothills	485
Babine Upland	770
Nechako Lowland	20
Total	10,385
Northern Boreal Mountains Ecoprovince	
Muskwa Foothills	36,910
Eastern Muskwa Ranges	5,765
Hyland Highland	6,725
Kechika Mountains	No data
Liard Plain	No data
Liard Basin	No data
Southern Boreal Plain	No data
Stikine Plateau	No data
Teslin Plateau	No data
Total	49,400

TABLE A 7.6. Distribution and area of grassland in Boreal and Taiga Plains by ecosection.

Ecosections	Area (ha)
Boreal Plains Ecoprovince	
Peace Lowland	7,720
Halfway Plateau	6,285
Kiskatinaw Plateau	1,140
Clear Hills	15
Total	15,160
Taiga Plains Ecoprovince	
Muskwa Plateau	3,360
Total	3,360

APPENDIX 8. Distribution and area of grasslands within biogeoclimatic units.

INDEX TO TABLES

SOURCE

Grasslands Conservation Council. 2003. B.C. Grasslands mapping project: A conservation risk assessment. 3rd Year Annual, Grasslands Conserv. Counc. of B.C., Kamloops, B.C. 51pp.

TABLE A 8.1. Distribution and area of grassland in the East Kootenay by biogeoclimatic unit.

Biogeoclimatic Unit		**Area (ha)**
Ponderosa Pine Zone		15,900
PPdh2	15,900	
Interior Douglas-fir Zone		26,950
IDFunn	3,500	
IDFdm2	23,450	
Montane Spruce Zone		2,100
MSdk	2,100	
Others		1,465
Total		46,415

TABLE A 8.2. Distribution and area of grassland in the Okanagan by biogeoclimatic unit.

Biogeoclimatic Unit	**Area (ha)**	
Bunchgrass Zone		22,780
BGxh1	22,780	
Ponderosa Pine Zone		33,810
PPxh1	28,660	
PPdh1	5,150	
Interior Douglas-fir Zone		56,045
IDFdk1	2,870	
IDFdk2	365	
IDFdm1	6,640	
IDFmw1	1,835	
IDFxh1	44,335	
Montane Spruce Zone		2,745
MSdm1	945	
MSdm2	175	
MSxk	1,625	
Engelmann Spruce-Subalpine Fir Zone		565
ESSFdc1	20	
ESSFxc	545	
Interior Cedar-Hemlock Zone		915
ICHmk1	915	
Other Zones		395
Total		117,275

TABLE A 8.3. Distribution and area of grassland in the Thompson-Pavilion by biogeoclimatic unit.

Biogeoclimatic Unit	**Area (ha)**	
Bunchgrass Zone		78,615
BGxh2	45,560	
BGxh3	3,475	
BGxw1	29,580	
Ponderosa Pine Zone		22,010
PPxh2	22,010	
Interior Douglas-fir Zone		40,220
IDFxh1	970	
IDFxh2	25,220	
IDFdk1	5,885	
IDFdk2	1,525	
IDFdk3	1,150	
IDFmw	1,700	
IDFunk	15	
IDFxm	1,325	
IDFxw	2,430	
Montane Spruce Zone		2,445
MSdc	360	
MSdm2	290	
MSunk	40	
MSxk	1,755	
Engelmann Spruce-Subalpine Fir Zone		635
ESSFdc2	30	
ESSFxc	520	
ESSFdv	85	
Others		50
Total		143,975

TABLE A 8.4. Distribution and area of grassland in the Southern Thompson Upland by biogeoclimatic unit.

Biogeoclimatic Unit	**Area (ha)**	
Bunchgrass Zone		28,750
BGxh2	1,100	
BGxw1	27,650	
Ponderosa Pine Zone		4,235
PPxh2	4,235	
Interior Douglas-fir Zone		99,120
IDFxh1	8,115	
IDFxh2	39,635	
IDFdk1	48,280	
IDFdk2	2,385	
IDFmw1	705	
Montane Spruce Zone		1,735
MSdm2	615	
MSxk	1,120	
Engelmann Spruce-Subalpine Fir Zone		485
ESSFdc2	190	
ESSFxc	295	
Total		134,325

TABLE A 8.5. Distribution and area of grassland in the Cariboo-Chilcotin and Central Interior by biogeoclimatic unit.

Biogeoclimatic Unit	Area (ha)	
Bunchgrass Zone		61,950
BGxh3	20,225	
BGxw2	41,695	
Interior Douglas-fir Zone		139,185
IDFdk3	30,860	
IDFdk4	23,790	
IDFdw	5,185	
IDFxm	74,200	
IDFxw	5,150	
Montane Spruce Zone		5,245
MSdc	975	
MSxv	4,270	
Engelmann Spruce-Subalpine Fir Zone		1,910
ESSFxv 2	1,910	
Sub-Boreal Pine-Spruce Zone		16,620
SBPSdc	1,010	
SBPSxc	15,610	
Sub-Boreal Spruce Zone		1,315
SBSdk	4,695	
SBSmc2	205	
SBSmc3	535	
Alpine Tundra Zone		50
Others		2,940
Total		233,335

TABLE A 8.6. Distribution and area of grasslands in the Northern Boreal Mountains and Sub-Boreal Interior by biogeoclimatic unit.[1]

Biogeoclimatic Unit	Area (ha)	
Sub-Boreal Interior Ecoprovince		
Alpine Tundra Zone		40
Boreal White and Black Spruce Zone		975
BWBSmw 1	445	
BWBSwk 1	15	
BWBSwk2	515	
Engelmann Spruce-Subalpine Fir Zone		8,460
ESSFmv2	50	
ESSFmv4	8,040	
ESSFwk2	370	
Spruce-Willow-Birch Zone		905
SBSdk	220	
SBSdw3	90	
SBSmc2	335	
SBSwk2	115	
SBSwk3	145	
Total		10,380
Northern Boreal Mountains Ecoprovince		
Alpine Tundra Zone		625
Boreal White and Black Spruce Zone		12,770
BWBSdk2	6,745	
BWBSmk	225	
BWBSmw	3,255	
BWBSwk2	2,545	
Spruce-Willow-Birch Zone		35,790
SWBmk	35,790	
Other Zones		215
Total		49,400

[1]Areas within biogeoclimatic units do not include grasslands in the Kechika Mountains, Liard Plain, Liard Basin, Southern Boreal Plain, Stikine Plateau, and Teslin Plateau ecosections.

TABLE A 8.7. Distribution and area of grassland in the Boreal Plains and Taiga Plains by biogeoclimatic unit.

Biogeoclimatic Unit	Area (ha)	
Boreal Plains Ecoprovince		
Boreal White and Black Spruce Zone		15,160
BWBSmw1	14,245	
BWBSwk1	320	
BWBSwk2	595	
Total		15,160
Taiga Plains Ecoprovince		
Boreal White and Black Spruce Zone		3,345
BWBSmw2	3,255	
BWBSwk3	90	
Spruce -Willow-Birch Zone	15	
SWBmk	15	
Total		3,360

APPENDIX 9. Number of red- and blue-listed elements on British Columbia grasslands by geographic region.

INDEX TO TABLES

SOURCES

Conservation Data Center (CDC). 2003. Rare and endangered database. Victoria, B.C.

TABLE A 9.1. Number of listed grassland elements in the East Kootenay.

Element	Red	Blue
Vascular Plants	20	20
Plant Communities	6	0
Insects	3	2
Reptiles and Amphibians	0	2
Birds	3	12
Mammals	1	3
Total Elements	33	39

TABLE A 9.2. Number of listed grassland elements in the Okanagan.

Element	Red	Blue
Vascular Plants	73	39
Plant Communities	27	11
Insects	5	6
Reptiles and Amphibians	4	7
Birds	15	25
Mammals	5	10
Total Elements	129	98

TABLE A 9.3. Number of listed grassland elements in the Thompson-Pavilion.

Element	Red	Blue
Vascular Plants	37	18
Plant Communities	18	7
Insects	0	0
Reptiles and Amphibians	0	5
Birds	3	8
Mammals	1	4
Total Elements	59	42

TABLE A 9.4. Number of listed grassland elements in the Southern Thompson Upland.

Element	Red	Blue
Vascular Plants	16	5
Plant Communities	14	6
Insects	0	0
Reptiles and Amphibians	0	6
Birds	5	14
Mammals	1	1
Total Elements	36	32

TABLE A 9.5. Number of listed grassland elements in the Cariboo-Chilcotin and Central Interior.

Element	Red	Blue
Vascular Plants	27	39
Plant Communities	16	4
Insects	0	0
Reptiles and Amphibians	0	6
Birds	10	21
Mammals	2	6
Total Elements	55	76

TABLE A 9.6. Number of listed grassland elements in the Sub-Boreal Interior and Northern Boreal Mountains.

Element	Red	Blue
Vascular Plants	17	27
Plant Communities	4	0
Insects	0	16
Reptiles and Amphibians	0	0
Birds	5	5
Mammals	1	1
Total Elements	27	49

TABLE A 9.7. Number of listed grassland elements in the Boreal and Taiga Plains.

Element	Red	Blue
Vascular Plants	16	16
Plant Communities	2	0
Insects	1	14
Reptiles and Amphibians	0	0
Birds	5	8
Mammals	3	3
Total Elements	27	41

TABLE A 9.8. Number of listed grassland elements in the Georgia Depression.

Element	Red	Blue
Vascular Plants	30	17
Plant Communities	2	0
Insects	10	5
Reptiles and Amphibians	1	0
Birds	7	5
Mammals	0	3
Total Elements	50	30

APPENDIX 10. Red- and blue-listed grassland vascular plants by biogeoclimatic unit within geographic regions of British Columbia.

INDEX TO TABLES

SOURCE

Conservation Data Center. 2003. Rare and endangered database. Victoria, B.C.

PLANT STATUS

R = Red, Endangered or threatened; B = Blue, Sensitive or vulnerable; X = Present.

TABLE A 10. 1. Red- and blue-listed grassland vascular plants in the East Kootenay Trench by biogeoclimatic unit.

Life-Form/Common Name	Status	PPdh2	IDFdm2	MSdk
Trees/Shrubs				
Western mugwort		X		
Herbaceous Monocots				
Blue grama	R	X	X	
Dry-land sedge	R	X		
Elk sedge	B			X
Little bluestem	R		X	
Many-headed sedge	B		X	X
Marsh muhly	B			X
Rivergrass	R	X	X	X
Herbaceous Dicots				
Alkali plantain	R		X	
Annual paintbrush	R		X	
Austin's knotweed	B			X
Blunt-sepaled starwort	B		X	
Common twinpod	B		X	X
Dark lamb's-quarters	R		X	X
Drummond's campion	B			X
Elk thistle	B			X
Engelmann's knotweed	B			X
Flat-topped broomrape	R	X		
Giant helleborine	B		X	
Grassland lupine	R		X	
Hairstem groundsmoke	R		X	
Heterocodon	B		X	
Hooker's townsendia	R		X	
Meadow arnica	B		X	
Mock-pennyroyal	R	X	X	
Montana larkspur	B		X	X
Mountain sneezeweed	B	X		
Nine-leaved desert-parsley	R	X	X	X

APPENDIX 10. Continued

Life-Form/Common Name	Status	PPdh2	IDFdm2	MSdk
Northern linanthus	B	X	X	X
Obscure cryptantha	R		X	X
Pinewood peavine	R		X	
Prairie gentian	B		X	
Prairie wedgegrass	R		X	
Saltwater cress	R		X	
Scarlet gaura	B		X	X
Scarlet globe-mallow	R		X	
Short-flowered monkey-flower	R		X	
Spreading stickweed	B	X		
Western dogbane	B		X	
Wild licorice	R	X	X	

TABLE A 10. 2. Red- and blue-listed grassland vascular plants in the Okanagan by biogeoclimatic unit.

Common Name	**Status**	**BG**	**BGxh1**	**PP**	**PPdh1**	**PPxh1**	**IDF**	**IDFdk1**	**IDFdm1**	**IDFmw1**	**IDFmw2**	**IDFxh1**	**IDFxh2**	**MSxk**	**ESSFxc**
Trees/Shrubs															
Booth’s willow	B							X					X		
Long-leaved mugwort	R		X												
Mountain prickly gooseberry	R				X										
Northern gooseberry	R				X										
Peach-leaf willow	R		X									X			
Silvery sagebrush	R	X						X							
Tweedy’s willow	B													X	X
Western dogbane	B		X												
Herbaceous Monocots															
American sweet-flag	B										X				
Awned cyperus	B		X												
Beaked spike-rush	B					X									
Bearded sedge	B		X								X				
Colorado rush	R		X									X			
Dry-land sedge	R	X						X				X	X		
Fox sedge	B		X							X		X			
Giant helleborine	B		X			X						X	X		
Hairgrass dropseed	R		X												
Lyall's mariposa lily	R				X							X			
Many-headed sedge	B		X		X			X							
Marsh muhly	B		X				X								
Oniongrass	R			X					X			X			
Porcupine sedge	B												X		
Porcupinegrass	R	X								X					
Purple spike-rush	R		X												
Red-rooted cyperus	R		X									X			

Common Name	Status	BG	BGxh1	PP	PPdh1	PPxh1	IDF	IDFdk1	IDFdm1	IDFmw1	IDFmw2	IDFxh1	IDFxh2	MSxk	ESSFxc
Regel's rush	B		X					X							
River bulrush	B		X												
Rocky mountain clubrush	R	X									X				
Satinflower	R										X				
Slender mannagrass	B	X													
Small-flowered lipocarpha	R		X												
Swamp onion	R		X	X											
Tufted lovegrass	R		X												
Valley sedge	R											X			
Herbaceous Dicots															
Alpine sorrel	B														X
Andean evening-primrose	R		X												
Annual paintbrush	R		X												
Atkinson's coreopsis	R		X												
Birdfoot buttercup	B														X
Blue vervain	R		X									X			
Branched phacelia	R		X									X			
Brewer’s monkeyflower	B								X						
Bristly mousetail	R		X					X							
Bushy cinquefoil	R		X			X									
Bushy knotweed	R	X													
Cockscomb cryptantha	R		X				X								
Columbia river locoweed	B	X						X				X		X	
Columbian goldenweed	R		X		X	X		X				X		X	
Common twinpod	B		X												
Cup clover	R				X				X						
Cushion fleabane	B		X												
Cusick's paintbrush	R							X				X			
Cut-leaved water-parsnip	R		X									X			
Dotted smartweed	B		X				X								

Common Name	Status	BG	BGxh1	PP	PPdh1	PPxh1	IDF	IDFdk1	IDFdm1	IDFmw1	IDFmw2	IDFxh1	IDFxh2	MSxk	ESSFxc
Dwarf groundsmoke	B											X		X	
False-pimpernel	B		X									X			
Field dodder	B		X									X			
Flat-topped broomrape	R		X					X				X		X	
Freckled milk-vetch	R											X			
Grand coulee owl-clover	R		X			X									
Hairstem groundsmoke	R	X		X			X								
Hairy water-clover	R		X	X							X	X			
Hall’s willowherb	B		X												
Hutchinsia	R		X												
Leiberg's fleabane	R											X			
Long-leaved pondweed	R	X													
Montana larkspur	B		X					X							
Munroe's globe-mallow	R		X			X									
Narrow-leaved brickellia	R		X		X	X						X			
Needle-leaved navarretia	R									X			X		
Nettle-leaved giant-hyssop	B		X			X		X	X			X		X	X
Nine-leaved desert-parsley	R		X			X		X				X			
Northern linanthus	B		X		X	X						X			
Nuttall's waterweed	B		X												
Obscure cryptantha	R		X		X	X						X			
Okanagan fameflower	B											X			
Orange touch-me-not	B	X											X		
Pale evening-primrose	B		X												
Pink fairies	B		X		X							X			
Poverty-weed	R						X								
Prairie gentian	B		X	X								X			
Prairie pepper-grass	R		X						X						
Rigid fiddleneck	R			X								X			
Scarlet ammannia	R		X												

Common Name	Status	BG	BGxh1	PP	PPdh1	PPxh1	IDF	IDFdk1	IDFdm1	IDFmw1	IDFmw2	IDFxh1	IDFxh2	MSxk	ESSFxc
Scarlet gaura	R		X												
Scarlet globe-mallow	R		X			X									
Short-rayed aster	R		X												
Showy phlox	R		X												
Shy gilia	R		X												
Sickle-pod rockcress	R											X			
Silvery orache	R		X				X								
Slender hawksbeard	R											X			
Small-flowered ipomopsis	R		X			X		X							
Spalding's milk-vetch	R		X												
Stoloniferous pussytoes	R											X			
Strict buckwheat	R							X							
The dalles milk-vetch	R		X			X									
Thick-leaved thelypody	B		X			X						X			
Threadstalk milk-vetch	B		X					X					X		
Thyme-leaved spurge	B		X								X				
Toothcup meadow-foam	R		X												
Watson’s cryptantha	R					X					X				
Wedgescale orache	R		X												
Western centaury	R		X												
Western jacob's-ladder	B		X												
Western stickseed	R		X		X										
Whited's halimolobos	R		X			X						X			
Wild tobacco	R		X												
Winged combseed	R		X												
Woody-branched rockcress	R			X								X			

TABLE A 10. 3. Red- and blue-listed grassland vascular plants in the Thompson-Pavilion by biogeoclimatic unit.

Common Name	Status	BG	BGxh2	BGxh3	BGxw1	PP	PPxh2	IDF	IDFdk1	IDFdk2	IDFdk3	IDFxh1	IDFxh2	IDFxm	IDFxw	MSxk	ESSFxc
Trees/Shrubs																	
Western dogbane	B			X										X			
Herbaceous Monocots																	
Awned cyperus	B		X														
Blue grama	R		X														
Colorado rush	R											X					
Geyer's onion	R					X				X			X	X			
Hooker's onion	B						X										
Many-headed sedge	B		X						X								
Mutton grass	R										X						
Oniongrass	R					X						X					
Porcupine sedge	B			X			X						X				
Rivergrass	R				X												
Rough dropseed	R		X														
Satin grass	R		X														
Slender mannagrass	B	X						X									
Valley sedge	R											X					
Herbaceous Dicots																	
Blue vervain	R											X					
Bristly mousetail	R		X				X						X				
Bushy cinquefoil	R												X				
Dotted smartweed	B		X					X									
False-pimpernel	B											X					
Freckled milk-vetch	R		X				X					X	X				
Geyer’s Onion	R												X				
Hairy water-clover	R					X						X					
Harkness' linanthus	R	X															
Howell's quillwort	R	X						X									

Common Name	Status	BG	BGxh2	BGxh3	BGxw1	PP	PPxh2	IDF	IDFdk1	IDFdk2	IDFdk3	IDFxh1	IDFxh2	IDFxm	IDFxw	MSxk	ESSFxc
Hutchinsia	R				X								X				
Low hawksbeard	R												X				
Mock-pennyroyal	R		X														
Montana larkspur	B		X														
Mountain sneezeweed	B	X															
Needle-leaved navarretia	R												X				
Nine-leaved desert-parsley	R						X					X	X				
Northern linanthus	B											X					
Okanagan fameflower	B		X										X				
Oregon checker-mallow	R				X								X				
Poverty-weed	R		X		X		X	X									
Purple-leaved willowherb	B		X			X							X				
Rabbitbrush goldenweed	R		X					X									
Scarlet gaura	R				X												
Scarlet globe-mallow	R		X														
Sickle-pod rockcress	R											X					
Silvery orache	R		X					X									
Small-flowered ipomopsis	R		X				X										
Snow cinquefoil	B																X
Stoloniferous pussytoes	R									X		X					
Suksdorf's lupine	R				X			X									
Tall beggarticks	R		X														
Threadstalk milk-vetch	B		X		X		X						X				
Thyme-leaved spurge	B		X														
Toothcup meadow-foam	R		X														
Wedgescale orache	R				X								X				
Western hawksbeard	R	X															
Western jacob's-ladder	B									X							
Woody-branched rockcress	B				X	X						X					

TABLE A 10. 4. Red- and blue-listed grassland vascular plants in the Southern Thompson Upland by biogeoclimatic unit.

Common Name	Status	BG	BGxw1	PP	PPxh2	IDF	IDFdk2	IDFxh1	IDFxh2	ESSF
Trees/Shrubs										
Booth’s willow	B								X	
Silvery sagebrush	R						X			
Herbaceous Monocots										
Colorado rush	R							X		
Mutton grass	R									X
Oniongrass	R			X				X		
Porcupine sedge	B				X				X	
Rivergrass	R		X							
Herbaceous Dicots										
Cut-leaved daisy	R				X					
Freckled milk-vetch	R				X			X	X	
Hairy water-clover	R			X				X		
Harkness' linanthus	R	X								
Holboell's rockcress	B					X				X
Hutchinsia	R		X						X	
Obscure cryptantha	R				X			X	X	
Poverty-weed	R		X		X	X				
Sickle-pod rockcress	R							X		
Silvery orache	R					X				
Suksdorf's lupine	R		X			X				
Threadstalk milk-vetch	B		X		X				X	
Wedgescale orache	R		X						X	

TABLE A 10. 5. Red- and blue-listed grassland vascular plants in the Cariboo-Chilcotin and Central Interior by biogeoclimatic unit.

Common Name	Status	BGxh3	BGxw2	IDFdk3	IDFdk4	IDFdw	IDFxm	IDFxw	MSxv	ESSFxv 2	SBPSdc	SBPSxc	SBS
Trees/Shrubs													
Autumn willow	B						X						
Booth's willow	B						X	X					
Herbaceous Monocots													
Awned cyperus	B	X											
Blue grama	R	X											
Dry-land sedge	R						X	X	X				
Dwarf clubrush	B				X							X	
Geyer's onion	R						X						
Many-headed sedge	B				X							X	
Marsh muhly	B											X	
Mutton grass	R			X									
Porcupine sedge	B	X										X	
Porcupinegrass	R						X						
Purple oniongrass	B									X			
Regel's rush	B											X	
Rivergrass	R		X		X		X					X	
Rocky mountain sedge	B			X			X			X			
Rough dropseed	R	X											
Satin grass	R	X	X	X									
Short-beaked fen sedge	B			X	X		X					X	
Spangle top	B												
Whitish rush	B									X		X	
Herbaceous Dicots													
Alpine sorrel	B												X
American chamaerhodos	B		X		X		X						
Birdfoot buttercup	B								X			X	
Bristly mousetail	R	X											
Carolina draba	R		X										

APPENDIX 10. Continued

Common Name	**Status**	**BGxh3**	**BGxw2**	**IDFdk3**	**IDFdk4**	**IDFdw**	**IDFxm**	**IDFxw**	**MSxv**	**ESSFxv 2**	**SBPSdc**	**SBPSxc**	**SBS**
Chamisso's montia	B											X	
Dark lamb's-quarters	R							X					
Dotted smartweed	B	X											
Drummond's campion	B		X		X		X						
Elegant Jacob's-ladder	B									X			
Five-leaved cinquefoil	B		X		X								
Freckled milk-vetch	R	X											
Gastony's cliff-brake	R		X										
Great Basin nephophilia	B	X	X										
Hairy owl-clover	R	X	X				X						
Holboell’s rockcress	B						X						
Hood’s pholx	B	X	X										
Least moonwort	B											X	
Low hawksbeard	R	X	X										
Meadow arnica	B		X		X								
Mock-pennyroyal	R	X											
Montana larkspur	B	X											
Mousetail	R	X	X										
Hood’s phlox	B	X	X										
Poverty-weed	R	X											
Purple-leaved willowherb	B	X					X						
Scarlet globe-mallow	R	X											
Sheep cinquefoil	B								X				
Sickle-pod rockcress	R		X										
Silvery orache	R	X	X										
Slender hawksbeard	R		X										
Small bedstraw	B			X	X	X	X	X					
Small-flowered ipomopsis	R	X											
Small-fruited willowherb	B									X			
Smooth draba	B									X		X	
Smooth spike-primrose	R	X											
Tall beggarticks	R	X											

Common Name	Status	BGxh3	BGxw2	IDFdk3	IDFdk4	IDFdw	IDFxm	IDFxw	MSxv	ESSFxv 2	SBPSdc	SBPSxc	SBS
Tall Jacob's-ladder	B						X						
Threadstalk milk-vetch	B	X											
Thyme-leaved spurge	B	X		X									
Toothcup meadow-foam	R	X											
Umbellate starwort	B												X
Western dogbane	B	X					X						
Western hawksbeard	R	X	X										
Wind river draba	B									X			

TABLE A 10. 6. Red- and blue-listed grassland vascular plants in the Northern Boreal Mountains, Sub-Boreal Interior, Boreal Plains, and Taiga Plains.

Common Name	Status	BWBSmw1	BWBSmw2	BWBSwk1	SWBmk	ESSFmv4	SBSdk	SBSmc2	SBSwk2
Trees/Shrubs									
Arkansas rose	B	X							
Autumn willow	B	X							
Meadow willow	B	X	X						
Herbaceous Monocots									
Alpine meadow-foxtail	B	X							
Dry-land sedge	R	X							
Plains reedgrass	R	X							
Rivergrass	R	X							
Rocky mountain sedge	B	X							
Sheathed cotton-grass	B	X							
Short-leaved sedge	B				X				
Slender mannagrass	B	X							
Slender wedgegrass	R	X							
Spike-oat	B	X							
Herbaceous Dicots									
Alpine draba	B				X				
American sweet-flag	B						X		X
Arctic bladderpod	B		X		X				
Canada anemone	B	X	X	X		X	X	X	X
Common pitcher-plant	B	X							
Davis locoweed	B	X	X		X				
Edwards wallflower	B				X				
Entire-leaved daisy	B				X				
European water-hemlock	B	X	X						
Fennel-leaved desert-parsley	R	X							
Fernald's false manna	R						X		
Fragrant white rein orchid	B						X		

Common Name	Status	BWBSmw1	BWBSmw2	BWBSwk1	SWBmk	ESSFmv4	SBSdk	SBSmc2	SBSwk2
Heart-leaved buttercup	R	X							
Holboell's rockcress	B						X		
Iowa golden-saxifrage	B	X							
Long-leaved mugwort	R	X							
Milky draba	B				X				
Nuttall's orache	R	X							
Nuttall's sunflower	R	X							
Plains butterweed	B						X		
Prairie buttercup	R	X							
Purple rattlesnake-root	R	X							
Rock selaginella	R	X							
Seneca-snakeroot	R	X							
Siberian polypody	R	X							
Sickle-pod rockcress	R	X							
Slender penstemon	R	X							
Small-fruited willowherb	B								X
Tundra milk-vetch	B				X				
Western Jacob’s-ladder	B	X	X		X				
White wintergreen	B	X							

TABLE A 10. 7. Red- and blue-listed grassland vascular plants in the Georgia Depression.

Common Name	Status
Trees/Shrubs	
Poison oak	R
Herbaceous Monocots	
Awned cyperus	B
Dune bentgrass	B
Elegant rein orchid	B
Foothill sedge	R
Geyer’s onion	R
Hooker’s onion	B
Pointed rush	B
Slimleaf onion	B
White-lip rein orchid	R
Herbaceous Dicots	
Brook spike-primrose	R
California-tea	B
Chaffweed	B
Coast microseris	R
Contorted-pod evening-primrose	R
Cup clover	R
Deltoid balsamroot	R
Dense spike-primrose	R
Dense-flowered lupine	R
Farewell-to-spring	B
Farewell-to-spring	B
Fern-leaved desert-parsley	R
Field dodder	B
Golden paintbrush	R
Gray’s desert-parsley	R
Howell’s triteleia	R
Hutchinsia	R
Incaid’s lupine	R

Common Name	Status
Lindley’s microseris	R
Macoun’s groundsel	B
Macrae’s clover	B
Manroot	B
Poverty clover	B
Prairie lupine	R
Purple sanicle	R
Redstem springbeauty	R
Rough-leaved aster	R
Slender popcorn flower	R
Small-flowered tonella	R
Snake-root sanicle	R
Spanish clover	B
Streambank lupine	R
Washington springbeauty	R
Western pearlwort	B
White meconella	R
White-top aster	R
Yellow montane violet	R

APPENDIX 11. Red- and blue-listed grassland plant communities by biogeoclimatic unit within geographic regions of British Columbia.

PLANT COMMUNITY STATUS

R = Red, Endangered or threatened; B = Blue, Sensitive or vulnerable; X = Present.

Location / Plant Community Name	BEC Unit	Status
East Kootenay Trench		
Antelope-brush – Bluebunch Wheatgrass	IDFdm2	Red
Saltgrass – Foxtail Barley	IDFdm2	R
Western Snowberry – Idaho Fescue	IDFdm2	R
Antelope-brush – Bluebunch Wheatgrass	PPdh2	R
Bluebunch Wheatgrass – Junegrass	PPdh2	R
Ponderosa Pine – Bluebunch Wheatgrass – Lupine	PPdh2	R
Rough Fescue – Bluebunch Wheatgrass	PPdh2	R
Okanagan		
Antelope brush – Needle-and-thread Grass	BGxh1	R
Big sage – Bluebunch Wheatgrass	BGxh1	R
Black Cottonwood – Water birch	BGxh1	R
Bluebunch wheatgrass – Junegrass	BGxh1	R
Hairy Water-clover – American Bulrush	BGxh1	R
Ponderosa Pine – Black Cottonwood – Poison Ivy	BGxh1	R
Ponderosa Pine – Red Three-awn	BGxh1	B
Ponderosa Pine – Smooth Sumac	BGxh1	R
Sandbar Willow – Peach-leaf Willow	BGxh1	R
Water Birch – Red-osier Dogwood	BGxh1	R
Bluebunch Wheatgrass – Pasqueflower	ESSFxc	R
Vasey's Big Sagebrush – Pinegrass	ESSFxc	R

Location / Plant Community Name	BEC Unit	Status
Okanagan (continued)		
Bluebunch Wheatgrass – Junegrass	IDFdk1	R
Rough Fescue – Bluebunch Wheatgrass	IDFdk1	R
Spreading Needlegrass	IDFdk1	B
Trembling Aspen – Snowberry – Kentucky Bluegrass	IDFdk1	R
Douglas-fir – Ponderosa Pine – Bluebunch Wheatgrass [Balsamroot]	IDFdk2	B
Douglas-fir – Ponderosa Pine – Pinegrass	IDFdk2	B
Hybrid White Spruce – Douglas-fir – Gooseberry	IDFdk2	B
Bluebunch Wheatgrass – Junegrass	IDFdm1	R
Big Sagebrush – Bluebunch Wheatgrass – Balsamroot	IDFxh1	R
Bluebunch Wheatgrass – Balsamroot	IDFxh1	R
Idaho Fescue – Bluebunch Wheatgrass	IDFxh1	R
Prairie Rose – Idaho Fescue	IDFxh1	R
Trembling Aspen – Snowberry – Kentucky Bluegrass	IDFxh1	R
Common Juniper – Bluebunch Wheatgrass	MSdm2	B
Bluebunch Wheatgrass – Junegrass	MSxk	R
Vasey's Big Sagebrush – Pinegrass	MSxk	R
Bluebunch Wheatgrass – Balsamroot	PPdh1	R
Ponderosa Pine – Bluebunch Wheatgrass – Lupine	PPdh1	R
Selaginella – Bluebunch Wheatgrass – Blue-eyed Mary	PPdh1	B
Big Sagebrush – Bluebunch Wheatgrass – Balsamroot	PPxh1	R
Bluebunch Wheatgrass – Balsamroot	PPxh1	R
Douglas-fir – Common Snowberry – Pinegrass	PPxh1	B
Ponderosa Pine – Bluebunch Wheatgrass – Idaho Fescue	PPxh1	B
Ponderosa Pine – Bluebunch Wheatgrass – Rough Fescue	PPxh1	B
Ponderosa Pine – Red Three-awn	PPxh1	B
Threetip Sagebrush – Bluebunch Wheatgrass – Balsamroot	PPxh1	R
Thompson-Pavilion-Southern Thompson Upland		
Big Sagebrush – Bluebunch Wheatgrass	BGxh2	R
Black Cottonwood – Common Snowberry – Red-osier Dogwood	BGxh2	R
Ponderosa Pine – Bluebunch Wheatgrass	BGxh2	B
Ponderosa Pine – Red Three-awn	BGxh2	B

Location / Plant Community Name	BEC Unit	Status
Thompson-Pavilion-Southern Thompson Upland (Continued)		
Rough Fescue – Bluebunch Wheatgrass	BGxh2	R
Wooly Sedge – Arctic Rush	BGxh2	R
Big Sagebrush – Bluebunch Wheatgrass	BGxh3	R
Bluebunch Wheatgrass – Junegrass	BGxh3	R
Sand Dropseed – Needle-and-thread Grass	BGxh3	R
Scrub Birch – Northern Gooseberry	BGxh3	R
Big Sagebrush – Bluebunch Wheatgrass	BGxw1	R
Bluebunch Wheatgrass – Junegrass	BGxw1	R
Giant Wildrye	BGxw1	R
Ponderosa Pine – Bluebunch Wheatgrass	BGxw1	B
Ponderosa Pine – Bluebunch Wheatgrass – Rough Fescue	BGxw1	B
Rough Fescue – Bluebunch Wheatgrass	BGxw1	R
Saltgrass – Sedge	BGxw1	R
Trembling Aspen – Snowberry – Kentucky Bluegrass	BGxw1	R
Common Juniper – Bluebunch Wheatgrass	ESSFdc2	B
Bluebunch Wheatgrass – Junegrass	IDFxh2	R
Rough Fescue – Bluebunch Wheatgrass	IDFxh2	R
Trembling Aspen – Snowberry – Kentucky Bluegrass	IDFxh2	R
Big Sagebrush – Bluebunch Wheatgrass	PPxh2	R
Ponderosa Pine – Bluebunch Wheatgrass	PPxh2	B
Ponderosa Pine – Bluebunch Wheatgrass – Rough Fescue	PPxh2	B
Cariboo-Chilcotin-Central Interior		
Baltic Rush – Silverweed	BGxw2	R
Big Sagebrush – Bluebunch Wheatgrass	BGxw2	R
Bluebunch Wheatgrass – Junegrass	BGxw2	R
Sand Dropseed – Needle-and-Thread Grass	BGxw2	R
Scrub Birch – Northern Gooseberry	BGxw2	R
Spreading Needlegrass	BGxw2	B
Trembling Aspen – Spreading Needlegrass – Old Man's Whiskers	BGxw2	R
Bluebunch Wheatgrass – Junegrass	IDFdk3	R

APPENDIX 11. Concluded.

Location / Plant Community Name	BEC Unit	Status
Cariboo-Chilcotin-Central Interior (continued)		
Douglas-Fir – Bluebunch Wheatgrass – Needlegrass	IDFdk3	B
Saltgrass – Alkaligrass	IDFdk3	R
Spreading Needlegrass	IDFdk4	B
Baltic Rush – Silverweed	IDFxm	R
Bluebunch Wheatgrass – Balsamroot	IDFxm	R
Bluebunch Wheatgrass – Junegrass	IDFxm	R
Pacific Sagebrush – Short-awned Porcupinegrass	IDFxm	R
Sand Dropseed – Needle-and-thread Grass	IDFxm	R
Spreading Needlegrass	IDFxm	B
Trembling Aspen – Spreading Needlegrass – Old Man's Whiskers	IDFxm	R
Sand Dropseed – Needle-and-thread Grass	IDFxw	R
Saltgrass – Alkaligrass	SBPSxc	R
Sub-Boreal Interior and Northern Boreal Mountains		
Bluegrass – Slender Wheatgrass	SBSdk	R
Saskatoon – Slender Wheatgrass	SBSdk	R
Taiga and Boreal Plains		
Arctic Rush – Nuttall's Alkaligrass – Seablite	BWBSmw1	R
Mat Muhly – Arctic Rush – Sandberg's Bluegrass (ssp. *juncifolia*)	BWBSmw1	R
Georgia Depression		
Garry Oak – California Brome	CDFmm	R
Garry Oak – Arbutus	CDFmm	R
Garry Oak – Oceanspray	CDFmm	R
Idaho Fescue – Junegrass	CDFmm	R

APPENDIX 12. Floral comparisons of selected grassland areas in British Columbia.

VASCULAR PLANT STATUS

R = Red, Endangered or threatened; B = Blue, Sensitive or vulnerable; X = Present;
P = Present but very infrequent.

Common Name	Status	East Kootenay Trench	South Okanagan Valley	North Okanagan Valley	Thompson - Valley	Southern Thompson Upland	Pavilion	Cariboo-Chilcotin	Chilcotin Upland	Sub-boreal Mountains	Northern Boreal Mountains	Taiga and Boreal Plains	Georgia Depression
Shrubs													
antelope-brush		X	X										
big sagebrush		P	X	X	X	X	X	X	X				
common rabbit-brush		X	X	X	X	X	X	X					
green rabbit-brush			X										
grey horsebrush			X	X	X	X							
mallow ninebark		X	X	P									
mock-orange		X	X	X	P								
prairie sagewort		X	X	X	X	X	X	X	X	X	X	X	X
saskatoon		X	X	X	X	X	X	X	X	X	X	X	X
Herbaceous Monocots													
Altai fescue									X	X	X	X	
blue grama	R	X		X		X		X					
bluebunch wheatgrass		X	X	X	X	X	X	X					X
fuzzy-spiked wildrye		X	X							X	X	X	
Idaho fescue		X	X	X									X

Common Name	Status	East Kootenay Trench	South Okanagan Valley	North Okanagan Valley	Thompson - Valley	Southern Thompson Upland	Pavilion	Cariboo-Chilcotin	Chilcotin Upland	Sub-boreal Mountains	Northern Boreal Mountains	Taiga and Boreal Plains	Georgia Depression
Interior bluegrass									X			X	
junegrass		X	X	X	X	X	X	X	X	X	X	X	X
little bluestem	R	X											
long-stoloned sedge			X							X	X	X	
needle-and-thread grass		X	X	X	X	X	X	X	X	X	X	X	
plains reedgrass	R	X										X	
porcupinegrass	R		X	X	X			X				X	
prairie sandgrass		X										X	
pumpelly brome		X	X					X	X	X	X	X	
purple reedgrass		X	X		X		X	X	X	X	X	X	
rough fescue		X	X	X	X								
Sandberg's bluegrass		X	X	X	X	X	X	X	X	X	X	X	X
short-awned porcupinegrass		X										X	
slender wheatgrass		X	X	X	X	X	X	X	X	X	X	X	X
spreading needlegrass		X			X		X						
timber oatgrass		X	X	X				X	X	X	X	X	X
viviparous fescue		X											
Herabaceous Dicots													
alpine buckwheat			X										
Andean evening-primrose	R		X										
Androsace buckwheat	B	X											
arrowleaf balsamroot		X	X	X	X	X	X	X	X				
Atkinson's coreopsis	R		X										
bitter-root		X	X	X	P								
brittle prickly-pear cactus			X	X	X		X	X	X			X	X
cockscomb cryptantha	R		X										
Columbia river locoweed	B	X	X										
Columbia bladderpod		X	X	X									
Columbian goldenweed	R		X										
compact selaginella		X	X	X	X	X	X	X					
cotton-batting cudweed			X	X									
false-agoseris			X	X									

Common Name	Status	East Kootenay Trench	South Okanagan Valley	North Okanagan Valley	Thompson -Valley	Southern Thompson Upland	Pavilion	Cariboo-Chilcotin	Chilcotin Upland	Sub-boreal Mountains	Northern Boreal Mountains	Taiga and Boreal Plains	Georgia Depression
fennel-leaved desert-parsley	R											X	
Harkness' linanthus	R		X										
Hood's phlox		X	X										
Leiberg's fleabane	R		X										
lemonweed		X	X	X	X	X	X	X	X				
long-leaved phlox			X				X						
Lyall's mariposa lily	R	X	X										
meadow saxifrage		X	X	X									
mock-pennyroyal	R	X			X								
mountain sagewort				X	X	X	X	X	X	X	X		
northern wormwood		X	X	X	X	X	X	X			X	X	X
Okanogan stickseed	R		X										
old man's whiskers		X	X	X	X	X	X	X	X			X	
parsnip-flowered buckwheat		X	X	X	X	X	X						
pink fairies	B		X	X									
plains prickly-pear cactus			X		X								
prairie crocus		X								X	X	X	
prairie pepper-grass		X	X		P								
pretty cinquefoil		X	X	X	X								
prickly phlox			X	X									
purple peavine		X					X	X	X	X			X
sagebrush mariposa lily		X	X	X	X	X	X	X					
scarlet gaura	R	X	X		X								
shaggy daisy		X	X	X	X	X							
sheep cinquefoil	B	X							X				
short-flowered evening-primrose	R		X										
showy phlox	R		X	X									
silky lupine		X	X	X	X	X							
slender penstemon	R											X	
snow buckwheat		P	X	X	P								
Spalding's campion	R	X											

APPENDIX 12. Concluded.

Common Name	Status	East Kootenay Trench	South Okanagan Valley	North Okanagan Valley	Thompson -Valley	Southern Thompson Unland	Pavilion	Cariboo-Chilcotin	Chilcotin Upland	Sub-boreal Mountains	Northern Boreal Mountains	Taiga and Boreal Plains	Georgia Depression
strict buckwheat	R		X										
three-spot mariposa lily		X											
tufted phlox		X			X								
two-flowered cinquefoil	B										X		
Watson's cryptantha	R		X	X									
white dryas		X	X				X		X	X	X	X	
whited's halimolobos	R		X										
wild tobacco	R		X										
yarrow		X	X	X	X	X	X	X	X	X	X	X	X
yellow buckwheat		X											

APPENDIX 13. Biogeoclimatic units and habitats of characteristic grassland fauna and species at risk.

INDEX TO TABLES

SOURCE

Stevens, V. 1995. Wildlife diversity in British Columbia: Distribution and habitat use of amphibians, reptiles, birds, and mammals in biogeoclimatic zones. B.C. Minist. of For. and B.C. Minist. of Environ. Lands, and Parks, Victoria, B.C. 287pp.

FAUNAL STATUS

R = Red, Endangered or threatened; B = Blue, Sensitive or vulnerable; X = Present.

TABLE A 13.1. Habitats and biogeoclimatic units used by characteristic and listed grassland fauna in the East Kootenay.

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Grassland	PPdh2	IDFdm2	MSdk
Arthropods								
Common Ringlet	B				X			
Dione Copper	R							
Eastern Tailed Blue	B		X		X			
Gillette Checkerspot	R		X					
Vivid Dancer	R			X			X	
Reptiles and Amphibians								
Common Garter Snake		X		X	X	X	X	
Long-toed Salamander		X		X		X	X	X
Painted Turtle	B			X		X	X	
Rubber Boa	B		X	X	X	X		
Western Garter Snake		X		X	X	X	X	
Western Toad				X		X	X	X
Birds								
American Avocet	R			X		X	X	
American Bittern	B			X		X	X	
American Coot				X		X	X	
American Crow		X	X	X	X	X	X	X
American Kestrel		X	X	X	X	X	X	X
American Robin		X			X	X	X	X
Bald Eagle	B	X		X	X	X	X	X
Barn Swallow		X		X	X	X	X	X
Barrow’s Goldeneye		X		X	X	X	X	X
Black-billed Cuckoo		X			X	X	X	
Black-billed Magpie			X		X	X	X	X
Black-chinned Hummingbird	B	X	X				X	
Blue Grouse		X	X		X	X	X	X
Bobolink	B				X		X	

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Grassland	PPdh2	IDFdm2	MSdk
Bohemian Waxwing			X		X	X	X	X
Brewer's Blackbird			X		X	X	X	
Brewer’s Sparrow ssp. *breweri*					X	X	X	
Brown Creeper			X			X	X	X
Brown-headed Cowbird			X		X	X	X	X
Calliope Hummingbird		X	X		X	X	X	
Canada Goose				X	X	X	X	
Canvasback				X		X	X	
Cassin’s Finch		X	X	X		X	X	
Chipping Sparrow		X	X		X	X	X	
Cinnamon Teal				X		X	X	
Clark’s Nutcracker		X	X			X	X	X
Cliff Swallow				X	X	X	X	
Common Goldeneye		X		X		X	X	X
Common Loon				X		X	X	
Common Merganser				X		X	X	X
Common Nighthawk			X	X	X	X	X	X
Common Poorwill			X		X	X	X	
Common Raven		X	X	X	X	X	X	X
Cooper’s Hawk		X	X	X	X	X	X	X
Dark-eyed Junco		X	X	X	X	X	X	X
Downy Woodpecker		X	X			X	X	
Eared Grebe				X		X		
Eastern Kingbird		X		X	X	X	X	X
Flammulated Owl	B	X	X				X	X
Golden Eagle		X		X	X	X	X	X
Grasshopper Sparrow	R				X		X	
Great Blue Heron	B	X		X	X	X	X	X
Great Horned Owl		X	X	X	X	X	X	X
Harris’s Sparrow		X	X		X	X	X	
Hairy Woodpecker		X	X			X	X	X
Horned Lark					X	X	X	X
Killdeer				X	X	X	X	X

Lark Sparrow	R				X	X	X	
Least Sandpiper				X	X	X	X	
Lesser Scaup				X		X	X	
Lewis's Woodpecker	B	X	X		X	X	X	X
Long-billed Curlew	B				X	X	X	
MacGillivray’s Warbler		X		X		X	X	X
Mallard				X	X	X	X	
Marsh Wren				X		X	X	X
Merlin		X		X		X	X	X
Mountain Bluebird					X	X	X	X
Mountain Chickadee			X			X	X	X
Mourning Dove		X	X		X	X	X	
Northern Pintail				X	X	X	X	
Northern Pygmy Owl		X	X	X	X	X	X	
Orange-crowned Warbler		X	X			X	X	X
Peregrine Falcon	R			X	X	X	X	X
Pileated Woodpecker		X	X			X	X	
Pine Siskin		X	X		X	X	X	
Prairie Falcon	R			X	X	X	X	
Pygmy Nuthatch		X	X			X	X	
Red-breasted Nuthatch		X	X			X	X	X
Red-tailed Hawk		X	X	X	X	X	X	
Red-winged Blackbird				X		X	X	X
Rosy Finch		X	X			X	X	X
Rough-legged Hawk				X	X	X	X	X
Ruby-crowned Kinglet		X			X	X	X	X
Ruddy Duck				X				
Ruffed Grouse		X		X		X	X	X
Rufous Hummingbird			X		X	X	X	X
Sandhill Crane	B			X	X	X	X	
Savannah Sparrow			X	X	X	X	X	X
Say’s Phoebe					X	X	X	
Sharp-shinned Hawk			X	X	X	X	X	X
Sharp-tailed Grouse	B	X		X	X	X	X	X
Short-eared Owl	B		X	X	X	X	X	
Song Sparrow		X	X	X		X	X	X
Sora				X		X	X	

Tundra Swan				X		X	X	
Turkey Vulture					X	X	X	X
Vaux's Swift		X	X	X	X	X	X	
Vesper Sparrow			X		X	X	X	X
Warbling Vireo		X			X	X	X	X
Western Bluebird			X	X		X	X	X
Western Meadowlark			X		X	X	X	X
Western Screech Owl		X	X		X	X	X	
White-breasted Nuthatch		X	X			X	X	
White-throated Swift	B			X	X	X		
Wilson's Warbler		X		X		X	X	X
Yellow-headed Blackbird				X	X	X	X	X
Yellow Warbler		X	X			X	X	
Mammals								
Badger	R		X		X	X	X	
Beaver		X		X		X	X	X
Big Brown Bat			X	X		X	X	X
Black Bear		X	X	X	X	X	X	X
Bobcat		X		X		X	X	X
Bushy-tailed Woodrat		X				X	X	X
Common Shrew		X	X	X	X	X	X	X
Cougar		X	X		X	X	X	X
Coyote		X	X	X	X	X	X	X
Deer Mouse		X	X	X	X	X	X	X
Dusky Shrew		X	X	X		X	X	X
Ermine subsp. *anguinea*	B	X	X	X		X	X	
Gray Wolf		X	X	X	X	X	X	X
Grizzly Bear				X		X	X	
Hoary Bat			X	X	X	X	X	X
Little Brown Myotis			X	X	X	X	X	X
Long-tailed Vole		X	X	X	X	X	X	X
Long-tailed Weasel subsp. *altifrontalis*		X	X	X	X	X	X	X
Meadow Jumping Mouse				X	X		X	
Meadow Vole		X	X	X	X	X	X	X
Mule Deer		X	X	X	X	X	X	X
Muskrat				X		X	X	X

APPENDIX 13. Continued

Northern Bog Lemming				X			X	
Northern Pocket Gopher			X	X		X	X	X
Rocky Mountain Bighorn	B		X		X		X	
Rocky Mountain Elk			X	X	X	X	X	X
Silver-Haired Bat		X			X	X	X	X
Snowshoe Hare		X		X	X	X	X	X
Striped Skunk		X	X	X		X	X	X
Vagrant Shrew		X		X		X	X	X
Western Jumping Mouse		X		X		X	X	X
Western Long-eared Myotis		X	X			X	X	X
White-tailed Deer		X	X	X	X	X	X	X

TABLE A 13.2. Habitats and biogeoclimatic units used by characteristic and listed grassland fauna in the Okanagan.

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh1**	**PPxh1**	**PPdh1**	**IDFdk1**	**IDFdm1**	**IDFxh1**	**MSxk**	**ESSFxc**	**AT**
Arthropods														
Apiocerid Fly	B			X	X	X								
Behr’s Hairstreak	R				X	X	X							
Ground Mantid	B				X	X								
Immaculate Green Hairstreak	B				X	X	X	X						
Mormon Metalmark	R		X		X	X					X			
Nez Perce Dancer- coastal	B			X	X	X								
Parowan Tiger Beetle	R			X		X	X							
Robber Fly	B				X	X	X							
Scoliid Wasp			X		X	X								
Sooty Hairstreak	R				X	X								
Sun Scorpion	R				X	X								
Vivid Dancer	R			X		X								
Reptiles and Amphibians														
Common Garter Snake		X		X	X	X	X	X	X	X	X			
Gopher Snake	B	X	X		X	X	X	X						
Great Basin Spadefoot	B			X	X	X	X	X		X	X			
Long-toed Salamander		X		X	X	X	X	X	X			X	X	
Night Snake	R				X	X	X							
Northern Alligator Lizard			X		X	X	X				X			
Painted Turtle	B			X		X	X			X	X			
Racer	B		X		X	X	X	X	X		X		X	
Rubber Boa	B	X	X		X	X	X	X			X			
Sharp-tailed Snake	R	X		X		X								
Short-horned Lizard	R		X		X	X								
Spotted Frog				X	X	X	X	X	X	X	X	X	X	
Tiger Salamander	R			X		X	X			X	X			
Western Garter Snake		X	X	X	X	X	X	X		X	X			
Western Rattlesnake	B		X		X	X	X	X			X			
Western Skink	B		X		X	X	X				X			

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh1**	**PPxh1**	**PPdh1**	**IDFdk1**	**IDFdm1**	**IDFxh1**	**MSxk**	**ESSFxc**	**AT**
Western Toad			X	X	X	X	X	X	X	X	X	X	X	
Birds														
American Avocet	R			X		X	X	X	X					
American Bittern	B			X		X	X	X		X	X			
American Coot				X		X	X	X	X	X	X			
American Crow		X	X		X	X	X	X	X	X	X	X	X	
American Kestrel		X	X	X	X	X	X	X	X	X	X	X	X	
American Robin		X	X		X	X	X	X	X	X	X	X	X	
American White Pelican	R			X		X	X							
American Wigeon		X		X		X	X			X	X		X	
Arctic Tern				X	X	X								
Bald Eagle	B	X	X	X	X	X	X	X	X	X	X	X	X	
Band-tailed Pigeon			X			X								
Barn Swallow		X		X	X	X	X	X	X	X	X	X		
Barrow's Goldeneye		X	X	X	X	X	X			X	X		X	X
Black-billed Magpie			X		X	X	X	X	X	X	X	X		
Black-capped Chickadee		X	X			X	X	X	X	X	X	X		
Black-chinned Hummingbird	B	X			X	X	X							
Blue Grouse		X	X	X	X	X	X	X	X	X	X	X	X	
Blue-winged Teal			X	X	X	X	X			X	X		X	X
Bobolink	B				X	X	X	X	X	X	X			
Bohemian Waxwing			X		X	X	X	X	X	X	X	X		
Brewer’s Sparrow	R				X	X	X				X			
Brewer's Blackbird		X	X		X	X	X	X	X	X	X	X		
Brown Creeper			X		X	X	X	X	X	X	X	X		
Brown-headed Cowbird			X		X	X	X	X	X	X	X	X		
Bufflehead		X		X		X	X			X	X		X	X
Burrowing Owl	R				X	X	X	X			X			
California Quail		X	X		X	X	X				X			
Calliope Hummingbird		X	X		X	X	X	X	X	X	X			
Canada Goose			X	X	X	X	X	X	X	X	X		X	
Canvasback				X		X	X	X	X	X	X			

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh1	PPxh1	PPdh1	IDFdk1	IDFdm1	IDFxh1	MSxk	ESSFxc	AT
Canyon Wren	B				X	X	X	X			X			
Cassin's Finch		X	X	X	X	X	X	X	X	X	X			
Caspian Tern	B			X	X	X	X				X			
Cinnamon Teal				X		X	X	X	X	X	X		X	
Clark's Nutcracker			X		X	X	X	X	X	X	X	X	X	
Cliff Swallow				X	X	X	X	X	X	X	X	X	X	
Common Goldeneye		X	X	X		X	X	X	X	X	X	X	X	
Common Loon				X		X	X	X		X	X		X	
Common Merganser		X	X	X		X	X	X	X	X	X	X		
Common Nighthawk			X	X	X	X	X	X	X	X	X	X	X	
Common Poorwill			X		X	X	X	X	X	X	X			
Common Raven		X	X	X	X	X	X	X	X	X	X	X	X	
Cooper's Hawk		X	X	X	X	X	X	X	X	X	X	X	X	
Dark-eyed Junco		X	X	X	X	X	X	X	X	X	X	X	X	
Downy Woodpecker		X	X		X	X	X	X	X	X	X			
Eared Grebe				X	X	X	X	X			X			
Eastern Kingbird		X		X	X	X	X	X	X	X	X	X		
Eurasian Wigeon				X		X	X			X	X			
Ferruginous Hawk	R	X			X	X	X				X			
Flammulated Owl	B	X	X			X	X	X	X	X	X			
Forster's Tern	R			X	X	X					X			
Fox Sparrow		X	X				X	X	X	X	X	X		
Gadwall				X	X	X	X			X	X			
Golden Eagle		X		X	X	X	X	X	X	X	X	X	X	
Grasshopper Sparrow	R				X		X			X	X			
Gray Flycatcher	B		X				X							
Gray Partridge			X		X	X	X				X			
Great Blue Heron	B	X		X	X	X	X	X	X	X	X			
Great Horned Owl		X	X	X	X	X	X	X	X	X	X	X	X	
Greater Scaup				X		X	X	X	X	X	X	X		
Green-winged Teal			X	X		X	X			X	X			X
Gryfalcon	B		X	X	X	X	X			X	X			X
Hairy Woodpecker		X	X			X	X	X	X	X	X	X		

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh1**	**PPxh1**	**PPdh1**	**IDFdk1**	**IDFdm1**	**IDFxh1**	**MSxk**	**ESSFxc**	**AT**
Harlequin Duck				X		X	X			X	X		X	X
Hooded Merganser		X	X	X		X	X			X	X		X	X
Horned Lark					X	X	X	X	X	X	X	X	X	
Killdeer				X	X	X	X	X	X	X	X	X		
Lark Sparrow	R				X	X	X	X	X	X	X			
Least Sandpiper				X	X	X	X	X	X	X	X		X	
Lesser Golden-plover	B				X	X	X			X	X			X
Lesser Scaup				X		X	X	X	X	X	X	X	X	X
Lewis's Woodpecker	B		X		X	X	X	X	X	X	X			
Long-billed Curlew	B				X	X	X	X	X	X	X		X	
MacGillivray’s Warbler		X		X	X	X	X	X	X	X	X	X		
Mallard		X		X	X	X	X	X	X	X	X		X	
Marsh Wren				X		X	X	X	X	X	X	X		
Merlin		X	X	X	X	X	X	X	X	X	X	X	X	
Mountain Bluebird					X	X	X	X		X	X		X	
Mountain Chickadee			X			X	X	X	X	X	X	X	X	
Mourning Dove		X	X		X	X	X	X	X		X			
Northern Flicker		X	X		X	X	X	X	X	X	X			
Northern Goshawk		X			X	X	X	X	X	X	X		X	
Northern Pintail			X	X	X	X	X	X	X	X	X			
Northern Pygmy Owl		X	X	X	X	X	X	X	X	X	X			
Northern Saw-whet Owl		X		X										
Northern Shoveler			X	X	X	X	X			X	X			X
Northern Shrike		X		X										
Oldsquaw	B			X		X	X			X	X		X	X
Orange-crowned Warbler		X	X			X	X	X	X	X	X	X	X	
Osprey				X	X	X	X			X	X			
Palm Warbler	B	X		X	X		X							
Peregrine Falcon	R			X	X	X	X			X	X			
Pileated Woodpecker		X	X	X		X	X	X	X	X	X			
Pine Siskin		X	X		X		X	X	X	X	X	X	X	
Prairie Falcon	R			X	X	X	X	X	X	X	X			
Pygmy Nuthatch		X	X			X	X	X	X	X	X			

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh1	PPxh1	PPdh1	IDFdk1	IDFdm1	IDFxh1	MSxk	ESSFxc	AT
Red-breasted Merganser				X		X	X			X	X			X
Red-breasted Nuthatch		X	X			X	X	X	X	X	X	X	X	
Redhead				X		X	X			X	X			
Red-necked Phalarope	B			X	X	X	X			X	X		X	X
Red-tailed Hawk		X	X	X	X	X	X	X	X	X	X		X	
Red-winged Blackbird				X		X	X	X	X	X	X	X		
Ring-necked Duck				X		X	X			X	X		X	X
Rock Ptarmigan				X										X
Rock Wren					X	X	X	X	X	X	X			
Rosy Finch		X	X		X	X	X	X	X	X	X	X	X	
Rough-legged Hawk			X	X	X	X	X	X	X	X	X	X	X	
Ruby-crowned Kinglet		X			X	X	X	X	X	X	X	X	X	
Ruddy Duck				X		X	X			X	X			
Ruffed Grouse		X	X	X	X	X	X	X	X	X	X	X		
Rufous Hummingbird			X		X	X	X	X	X	X	X	X	X	
Spotted Towhee		X	X			X	X	X	X	X	X	X		
Sage Thrasher	R				X	X	X							
Sandhill Crane	B			X	X	X	X	X	X	X	X			
Savannah Sparrow			X	X	X	X	X	X	X	X	X	X		
Say’s Phoebe					X	X	X	X	X	X	X			
Sharp-shinned Hawk			X	X	X	X	X	X	X	X	X	X	X	
Sharp-tailed Grouse	B	X		X	X	X	X	X	X					
Short-billed Dowitcher	B			X		X	X			X	X			X
Short-eared Owl	B		X	X	X	X	X	X	X					
Song Sparrow		X	X	X		X	X	X	X	X	X	X	X	
Sora				X			X	X						
Steller’s Jay		X	X		X	X	X	X	X	X	X	X		
Swainson's Hawk	B			X	X	X	X	X	X	X	X	X		
Three-toed Woodpecker		X	X		X	X	X			X	X		X	
Townsend’s Solitaire			X		X	X	X	X	X	X	X	X	X	
Tree Swallow		X		X	X	X	X	X	X	X	X	X		
Trumpeter Swan	B			X		X	X			X	X			
Tundra Swan				X		X	X	X	X	X	X			

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh1**	**PPxh1**	**PPdh1**	**IDFdk1**	**IDFdm1**	**IDFxh1**	**MSxk**	**ESSFxc**	**AT**
Turkey Vulture			X		X	X		X	X	X	X	X		
Vaux's Swift		X	X	X	X	X	X	X	X	X	X			
Vesper Sparrow			X		X	X	X	X	X	X	X	X		
Warbling Vireo		X			X	X	X	X	X	X	X	X		
Western Bluebird			X		X	X	X							
Western Grebe	R			X		X	X			X	X			
Western Meadowlark			X		X	X	X	X	X	X	X	X		
Western Screech-Owl	R	X	X		X	X	X	X	X					
White-breasted Nuthatch		X	X			X	X	X	X		X			
White-headed Woodpecker	R		X			X	X			X	X			
White-tailed Ptarmigan	B		X	X									X	X
White-throated Swift	B			X	X	X	X	X						
White-winged Scoter				X		X	X			X	X		X	X
Williamson's Sapsucker	B	X	X						X	X	X			
Willow Ptarmigan			X	X									X	X
Wilson's Warbler		X		X	X	X	X	X	X	X	X	X	X	
Wood Duck		X				X	X			X	X			
Yellow-breasted Chat	R				X									
Yellow-headed Blackbird				X	X	X	X	X	X	X	X	X		
Mammals														
Badger	R		X		X	X	X	X	X	X	X	X		
Beaver		X		X		X	X	X	X	X	X	X		
Big Brown Bat		X		X	X	X	X	X	X	X	X	X		
Black Bear		X	X	X	X	X	X	X	X	X	X	X	X	
Bobcat		X	X	X		X	X	X	X	X	X	X	X	
Bushy-tailed Woodrat		X	X	X	X	X	X	X	X	X	X	X	X	
California Bighorn Sheep	B		X		X	X	X	X	X		X	X	X	
Columbian Ground Squirrel			X		X	X	X	X	X	X	X	X		
Common Shrew		X		X	X	X	X	X	X	X	X	X	X	
Cougar		X	X		X	X	X	X	X	X	X	X	X	
Coyote		X	X	X	X	X	X	X	X	X	X	X	X	
Deer Mouse		X	X	X	X	X	X	X	X	X	X	X	X	

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh1	PPxh1	PPdh1	IDFdk1	IDFdm1	IDFxh1	MSxk	ESSFxc	AT
Dusky Shrew		X	X	X		X	X	X	X	X	X	X	X	
Ermine	B	X	X	X		X	X	X	X	X	X			
Great Basin Pocket Mouse	B				X	X	X	X						
Hoary Bat			X	X	X	X	X	X	X	X	X	X	X	
Least Chipmunk			X		X	X	X	X	X	X	X	X		
Little Brown Myotis			X	X	X	X	X	X	X	X	X	X	X	
Long-tailed Vole		X		X	X	X	X	X	X	X	X	X	X	
Long-tailed Weasel		X	X	X	X	X	X	X	X			X	X	
Meadow Jumping Mouse				X	X	X	X		X	X	X			
Meadow Vole		X	X	X	X	X	X	X	X	X	X	X	X	
Mountain Goat			X										X	
Mule Deer		X	X	X	X	X	X	X	X	X	X	X	X	
Muskrat				X		X	X	X	X	X	X	X	X	
Northern Bog Lemming				X	X	X	X		X	X	X		X	
Northern Long-eared Myotis	R	X	X	X										
Northern Pocket Gopher			X		X	X	X	X	X	X	X	X	X	
Nuttall’s Cottontail	B	X			X	X	X							
Pallid Bat	R		X		X	X								
Red Fox		X	X	X	X	X	X	X	X	X	X	X	X	
Red Squirrel		X	X			X	X	X	X	X	X	X		
Red-tailed Chipmunk	R		X		X								X	
Rocky Mountain Bighorn	B		X		X		X			X	X		X	X
Rocky Mountain Elk			X	X	X		X	X	X	X	X	X		
Snowshoe Hare		X		X	X	X	X	X	X	X	X	X		
Spotted Bat	B		X	X	X	X	X							
Striped Skunk		X		X	X	X	X	X	X	X	X	X		
Townsend's Big-eared Bat	B		X		X	X	X	X	X	X	X			
Vagrant Shrew		X		X	X	X	X	X	X	X	X	X	X	
Western Harvest Mouse	B			X	X	X								
Western Jumping Mouse		X		X	X	X	X	X	X	X	X	X		
Western Long-eared Myotis			X	X		X	X	X	X	X	X	X		
Western Red Bat	R	X		X		X								
Western Small-footed Myotis	B				X	X	X							

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh1	PPxh1	PPdh1	IDFdk1	IDFdm1	IDFxh1	MSxk	ESSFxc	AT
White-tailed Deer		X	X	X	X	X	X	X	X	X	X	X	X	
Yellow-bellied Marmot			X		X		X	X	X	X	X			
Yellow-pine Chipmunk		X	X		X	X	X	X	X	X	X	X		
Yuma Myotis		X	X	X	X	X	X	X	X	X	X	X		

TABLE A 13.3. Habitats and biogeoclimatic units used by characteristic and listed grassland fauna in the Thompson-Pavilion.

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh2**	**BGxw1**	**PPxh2**	**IDFdk1**	**IDFxh1**	**IDFxh2**	**MSxk**	**ESSFxc**
Reptiles and Amphibians													
Common Garter Snake		X		X	X	X	X	X	X	X			
Gopher Snake	B	X	X		X		X	X					
Great Basin Spadefoot	B			X	X	X		X		X	X		
Long-toed Salamander		X		X	X	X	X	X	X			X	X
Northern Alligator Lizard			X		X	X	X			X			
Painted Turtle	B			X			X			X			
Racer	B		X		X					X			
Rubber Boa	B	X	X		X	X							
Spotted Frog				X	X	X	X	X	X	X		X	X
Western Garter Snake		X	X	X	X	X	X	X		X	X		
Western Rattlesnake	B		X		X	X	X	X					
Western Skink	B		X		X	X	X			X			
Western Toad			X	X	X	X	X	X	X	X		X	X
Birds													
American Coot				X		X	X	X	X	X			
American Crow		X	X	X	X	X	X	X	X	X		X	X
American Kestrel		X	X	X	X	X	X	X	X	X		X	X
American Robin		X			X	X	X	X	X	X		X	X
American Wigeon		X		X		X	X			X			X
Barn Swallow		X		X	X	X	X	X	X	X		X	
Barrow's Goldeneye		X	X	X	X	X	X			X			X
Black-billed Magpie			X		X	X	X	X	X	X		X	
Blue Grouse		X	X	X	X	X	X	X	X	X		X	X
Bobolink	B				X	X		X		X			
Brewer's Blackbird		X	X		X	X	X	X	X	X		X	
Brown-headed Cowbird			X		X	X	X	X	X	X		X	
Bufflehead		X		X	X	X	X			X			X
Burrowing Owl	R				X	X					X		
Canada Goose		X	X	X	X	X	X	X	X	X			X

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh2	BGxw1	PPxh2	IDFdk1	IDFxh1	IDFxh2	MSxk	ESSFxc
Canvasback				X		X	X	X	X	X			
Clark’s Nutcracker			X		X	X	X	X	X	X		X	X
Cliff Swallow				X	X	X	X	X	X	X		X	X
Common Goldeneye		X	X	X		X	X	X	X	X		X	X
Common Loon				X		X	X	X		X			X
Common Nighthawk			X	X	X	X	X	X	X	X		X	X
Common Poorwill			X		X	X	X	X	X	X			
Common Raven		X	X	X	X	X	X	X	X	X		X	X
Cooper’s Hawk		X	X	X	X	X	X	X	X	X		X	X
Eared Grebe				X	X	X	X	X		X			
Eastern Kingbird		X		X	X	X	X	X	X	X		X	
Flammulated Owl	B	X	X					X	X	X	X		
Golden Eagle		X		X	X	X	X	X	X	X		X	X
Great Blue Heron	B	X			X	X		X					
Great Horned Owl		X	X	X	X	X	X	X	X	X		X	X
Greater Scaup				X		X	X	X	X	X		X	
Hairy Woodpecker		X	X			X	X	X	X	X		X	
Horned Lark					X		X	X	X	X	X	X	X
Killdeer				X	X	X	X	X	X	X		X	
Least Sandpiper				X	X	X	X	X	X	X			X
Lesser Scaup				X		X	X	X	X	X		X	X
Lewis's Woodpecker	B		X		X	X	X	X		X			
Long-billed Curlew	B				X		X						
Mallard		X		X	X	X	X	X	X	X			X
Marsh Wren				X		X	X	X	X	X		X	
Merlin		X	X	X	X	X	X	X	X	X		X	X
Mountain Bluebird					X	X	X	X		X			X
Mourning Dove		X	X		X	X	X	X	X	X			
Northern Flicker		X	X		X	X	X	X	X	X			
Northern Pygmy Owl		X	X	X	X	X	X	X	X	X			
Northern Saw-whet Owl		X		X				X		X			
Osprey			X	X	X	X	X			X			
Pileated Woodpecker		X	X			X	X	X	X	X			

APPENDIX 13. Continued

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh2	BGxw1	PPxh2	IDFdk1	IDFxh1	IDFxh2	MSxk	ESSFxc
Prairie Falcon	R			X	X						X		X
Pygmy Nuthatch		X	X		X	X	X	X	X	X			
Red-breasted Nuthatch		X	X		X	X	X	X	X	X		X	X
Redhead				X		X	X			X			
Red-tailed Hawk		X	X	X	X	X	X	X	X	X			X
Red-winged Blackbird				X		X	X	X	X	X		X	
Rock Wren					X	X	X	X	X	X			
Ruddy Duck				X						X			
Ruffed Grouse		X	X	X	X			X	X	X		X	
Rufous Hummingbird			X		X			X	X	X		X	X
Spotted Towhee		X	X					X	X	X		X	
Sharp-tailed Grouse	B				X		X		X		X	X	
Sora		X		X	X			X					
Swainson's Hawk	B			X	X			X	X	X		X	
Tundra Swan				X				X	X	X			
Turkey Vulture			X		X			X	X	X		X	
Vaux’s Swift		X	X	X	X			X	X	X			
Vesper Sparrow					X			X	X	X		X	
Western Bluebird			X		X								
Western Kingbird			X		X								
Western Meadowlark			X		X			X	X	X		X	
Western Screech-Owl	R	X	X		X			X					
White-breasted Nuthatch		X	X					X	X	X			
White-throated Swift	B			X	X	X				X			
Yellow-headed Blackbird				X	X			X	X	X		X	
Mammals													
Badger	R		X		X	X	X	X			X		
Beaver		X		X				X	X	X		X	
Big Brown Bat		X		X	X			X	X	X		X	
Black Bear		X	X		X			X	X	X		X	X
California Bighorn Sheep	B					X	X	X			X		
Coyote		X	X	X	X			X	X	X		X	X

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh2**	**BGxw1**	**PPxh2**	**IDFdk1**	**IDFxh1**	**IDFxh2**	**MSxk**	**ESSFxc**
Deer Mouse		X	X	X	X			X	X	X		X	X
Hoary Bat			X	X	X			X	X	X		X	X
Little Brown Myotis			X	X	X			X	X	X		X	X
Long-tailed Vole		X		X	X			X	X	X		X	X
Long-tailed Weasel		X	X	X	X			X	X			X	X
Meadow Jumping Mouse				X	X				X	X			
Meadow Vole		X	X	X	X			X	X	X		X	X
Mule Deer		X	X	X	X			X	X	X		X	X
Muskrat				X				X	X	X		X	X
Northern Bog Lemming				X	X				X	X			X
Red Fox		X	X	X	X			X	X	X		X	X
Red Squirrel		X	X					X	X	X		X	
Rocky Mountain bighorn	B		X		X					X			X
Rocky Mountain Elk			X	X	X			X	X	X		X	
Striped Skunk		X		X	X			X	X	X		X	
Western Long-eared Myotis			X	X				X	X	X		X	
White-tailed Deer		X	X	X	X			X	X	X		X	X
Yellow-bellied Marmot			X		X			X	X	X			
Yellow-pine Chipmunk		X	X		X			X	X	X		X	
Yuma Myotis		X	X	X	X			X	X	X		X	

TABLE A 13.4. Habitats and biogeoclimatic units used by characteristic and listed grassland fauna in the Southern Thompson Upland.

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh2**	**BGxw1**	**PPxh2**	**IDFdk1**	**IDFdk2**	**IDFxh1**	**IDFxh2**	**MSxk**
Reptiles and Amphibians													
Common Garter Snake		X		X	X	X	X	X	X	X	X	X	
Gopher Snake	B	X	X		X		X	X					
Great Basin Spadefoot	B		X	X	X	X		X	X	X	X	X	
Long-toed Salamander		X		X	X	X	X	X	X	X	X	X	X
Northern Alligator Lizard			X		X	X	X				X	X	
Northwest Salamander				X						X			
Painted Turtle	B			X			X				X	X	
Racer	B		X		X	X	X	X			X	X	
Rubber Boa	B	X	X		X	X					X	X	
Spotted Frog				X	X	X	X	X	X	X	X	X	X
Western Garter Snake		X	X	X	X	X	X	X	X	X	X	X	
Western Skink	B		X		X	X	X				X	X	
Western Toad			X	X	X	X	X	X	X	X	X	X	X
Wood Frog		X		X					X	X	X	X	
Birds													
American Avocet	R			X			X	X			X		
America Bittern	B			X			X	X			X		
American Coot				X		X	X	X	X	X	X	X	
American Crow		X	X		X	X	X	X	X	X	X	X	X
American Kestrel		X	X	X	X	X	X	X	X	X	X	X	X
American Robin		X			X	X	X	X	X	X	X	X	X
American Wigeon		X		X		X	X			X	X	X	
Barrow's Goldeneye		X		X	X	X	X			X	X	X	
Black-billed Magpie			X		X	X	X	X	X	X	X	X	X
Blue Grouse		X	X	X	X	X	X	X	X	X	X	X	X
Bobolink	B				X	X	X	X			X		
Brewer's Blackbird		X	X		X	X	X	X	X	X	X	X	X
Brewers' Sparrow	R		X		X						X		

APPENDIX 13. Continued

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh2	BGxw1	PPxh2	IDFdk1	IDFdk2	IDFxh1	IDFxh2	MSxk
Brown-headed Cowbird			X		X	X	X	X	X	X	X	X	X
Bufflehead		X		X		X	X		X	X	X	X	X
Burrowing Owl	R				X	X	X				X	X	
Canada Goose			X	X	X	X	X	X	X	X	X	X	
Canvasback				X		X	X	X	X	X	X	X	
Clark’s Nutcracker			X		X	X	X	X	X	X	X	X	X
Cliff Swallow				X	X	X	X	X	X	X	X	X	X
Common Goldeneye		X	X	X		X	X	X	X	X	X	X	X
Common Loon				X		X	X	X	X	X	X	X	
Common Nighthawk			X	X	X	X	X	X	X	X	X	X	X
Common Poorwill			X		X	X	X	X	X	X	X	X	
Common Raven		X	X	X	X	X	X	X	X	X	X	X	X
Cooper’s Hawk		X	X	X	X	X	X	X	X	X	X	X	X
Eared Grebe				X	X	X	X	X		X	X	X	
Eastern Kingbird		X		X	X	X	X	X	X	X	X	X	X
Ferruginous Hawk	R	X			X	X	X	X	X	X	X	X	
Flammulated Owl	B	X	X						X	X	X	X	
Golden Eagle		X		X	X	X	X	X	X	X	X	X	X
Grasshopper Sparrow	R		X		X	X	X	X	X	X	X	X	
Great Blue Heron	B	X		X	X	X	X	X	X	X	X	X	
Great Horned Owl		X	X	X	X	X	X	X	X	X	X	X	X
Hairy Woodpecker		X	X			X	X	X	X	X	X	X	X
Horned Lark					X		X	X	X	X	X	X	X
Killdeer				X	X	X	X	X	X	X	X	X	X
Least Sandpiper				X	X	X	X	X	X	X	X	X	
Lewis's Woodpecker	B	X	X		X	X	X	X		X	X	X	
Long-billed Curlew	B				X		X				X	X	
Mallard		X		X	X	X	X	X	X	X	X	X	
Marsh Wren				X		X	X	X	X	X	X	X	X
Merlin		X	X	X	X	X	X	X	X	X	X	X	X
Mountain Bluebird					X	X	X	X		X	X	X	
Mourning Dove		X	X		X	X	X	X	X	X	X	X	
Northern Flicker		X	X		X	X	X	X	X	X	X	X	

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh2**	**BGxw1**	**PPxh2**	**IDFdk1**	**IDFdk2**	**IDFxh1**	**IDFxh2**	**MSxk**
Northern Pygmy Owl		X	X	X	X	X	X	X	X	X	X	X	
Northern Saw-whet Owl		X		X				X			X	X	
Osprey			X	X	X	X	X				X	X	
Prairie Falcon	R			X	X	X	X				X	X	
Pygmy Nuthatch		X	X			X	X	X	X	X	X	X	
Red-breasted Nuthatch		X	X			X	X	X	X	X	X	X	X
Redhead				X		X	X			X	X	X	
Red-tailed Hawk		X	X	X	X	X	X	X	X	X	X	X	
Red-winged Blackbird				X		X	X	X	X	X	X	X	X
Rock Wren					X	X	X	X	X	X	X	X	
Ruddy Duck				X						X	X	X	
Ruffed Grouse		X	X	X	X		X	X	X	X	X	X	
Rufous Hummingbird			X		X			X	X	X	X	X	X
Spotted Towhee		X	X					X	X	X	X	X	X
Sandhill Crane				X	X		X		X	X		X	
Savannah Sparrow			X		X		X	X	X		X	X	
Sharp-shinned Hawk			X	X	X			X	X	X	X	X	X
Sharp-tailed Grouse	B	X	X	X	X		X		X	X	X	X	X
Sora				X				X		X			
Swainson's Hawk	R			X	X			X	X	X	X	X	X
Tundra Swan				X				X	X		X		
Turkey Vulture			X		X			X	X	X	X	X	X
Vaux’s Swift		X	X	X	X			X	X	X	X	X	
Vesper Sparrow					X			X	X	X	X	X	X
Western Bluebird			X		X					X			
Western Grebe				X			X				X		
Western Kingbird			X		X								
Western Meadowlark			X		X			X	X	X	X	X	X
Western Screech-Owl	R	X	X		X			X					
White-breasted Nuthatch		X	X		X			X	X	X	X	X	
White-throated Swift	B			X	X	X		X					
White-winged Scoter				X							X	X	
Yellow-headed Blackbird				X	X			X	X	X	X	X	X

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh2	BGxw1	PPxh2	IDFdk1	IDFdk2	IDFxh1	IDFxh2	MSxk
Mammals													
Badger	R		X		X	X	X	X		X		X	
Beaver		X		X		X	X	X	X	X	X	X	X
Big Brown Bat		X		X	X	X	X	X	X	X	X	X	X
Black Bear		X	X	X	X	X	X	X	X	X	X	X	X
Bobcat		X	X	X	X	X	X	X	X	X	X	X	X
Common Shrew		X		X	X	X	X	X	X	X	X	X	X
Coyote		X	X	X	X	X	X	X	X	X	X	X	X
Deer Mouse		X	X	X	X	X	X	X	X	X	X	X	X
Dusky Shrew		X	X	X		X	X	X	X	X	X	X	X
Fringed Myotis	B	X	X	X	X	X	X	X					
Hoary Bat			X	X	X	X	X	X	X	X	X	X	X
Little Brown Myotis			X	X	X	X	X	X	X	X	X	X	X
Long-tailed Vole		X		X	X	X	X	X	X	X	X	X	X
Long-tailed Weasel		X	X	X	X	X	X	X	X	X	X	X	X
Meadow Jumping Mouse				X	X	X	X		X	X	X	X	
Meadow Vole		X	X	X	X	X	X	X	X	X	X	X	X
Mule Deer		X	X	X	X	X	X	X	X	X	X	X	X
Muskrat				X		X	X	X	X	X	X	X	X
Northern Bog Lemming				X	X	X	X	X	X	X	X	X	X
Northern Pocket Gopher			X		X	X	X	X	X	X	X	X	X
Rocky Mountain Elk			X	X	X			X	X		X		X
Spotted Bat	B	X	X	X	X	X	X	X	X	X	X	X	
Striped Skunk		X		X	X	X	X	X	X	X	X	X	
Western Long-eared Myotis			X	X		X	X	X	X	X	X	X	X
White-tailed Deer		X	X	X	X	X	X	X	X	X	X	X	X
Yellow-bellied Marmot			X		X			X	X	X	X	X	
Yellow-pine Chipmunk		X	X		X	X	X	X	X	X	X	X	X
Yuma Myotis		X	X	X	X	X	X	X	X	X	X	X	X

TABLE A 13.5. Habitats and biogeoclimatic units used by characteristic and listed grassland fauna in the Cariboo-Chilcotin and Central Interior.

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh3**	**BGxw2**	**IDFdk3**	**IDFdk4**	**IDFdw**	**IDFxm**	**IDFxw**	**MSxv**	**ESSFxv 2**	**SBPSdc**	**SBPSxc**	**SBS**
Reptiles and Amphibians																	
Gopher Snake	B	X	X		X	X	X				X						
Great Basin Spadefoot	B		X	X	X	X	X				X						
Long-toed Salamander		X		X	X	X	X	X	X		X	X	X	X		X	X
Painted Turtle	B			X		X	X				X						
Racer	B	X	X		X	X	X										
Rubber Boa	B	X	X		X	X	X				X						
Spotted Frog				X	X	X	X	X	X		X	X	X	X		X	X
Western Garter Snake		X	X	X	X	X	X				X	X	X	X		X	X
Western Rattlesnake	B		X		X	X											
Western Toad			X	X	X	X	X	X	X	X	X	X					
Woodfrog		X		X							X	X					
Birds																	
American Avocet	R			X			X	X									
American Bittern	B			X				X									
American Coot				X		X	X	X	X		X	X					
American Kestrel		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
American White Pelican	R			X							X				X	X	
American Wigeon		X		X		X					X	X					
Bald Eagle	B		X	X	X												
Bank Swallow				X	X	X	X				X	X					
Barrow's Goldeneye		X	X	X	X	X					X	X					
Black-billed Magpie			X		X	X	X	X	X		X	X	X				
Blue Grouse		X	X	X	X	X	X	X	X		X	X	X				
Bobolink	B			X	X	X	X	X			X						
Brewer's Blackbird		X	X		X	X	X	X	X	X	X	X	X				
Brewer's Sparrow ssp. *breweri*	R				X	X	X										
Brown-headed Cowbird			X		X	X	X	X	X	X	X	X	X				
Bufflehead		X		X		X					X	X	X	X	X	X	X
California Gull	B			X	X				X		X						

Life-Form/Common Name	**Status**	**Aspen**	**Parkland**	**Wetland**	**Steppe**	**BGxh3**	**BGxw2**	**IDFdk3**	**IDFdk4**	**IDFdw**	**IDFxm**	**IDFxw**	**MSxv**	**ESSFxv 2**	**SBPSdc**	**SBPSxc**	**SBS**
Canada Goose				X	X	X	X	X	X	X	X			X	X	X	X
Canvasback				X		X	X	X	X	X	X						
Caspian Tern	B			X	X			X			X						
Clark's Nutcracker			X		X	X	X	X	X	X	X	X	X	X	X	X	X
Cliff Swallow				X	X	X	X	X	X	X	X	X	X	X	X	X	X
Common Goldeneye		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Common Nighthawk			X	X	X	X	X				X	X					
Common Poorwill			X		X	X	X	X	X		X	X					
Common Raven		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cooper's Hawk		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Eared Grebe				X		X	X				X	X					X
Eastern Kingbird		X		X	X	X	X	X	X	X	X	X	X				X
Flammulated Owl	B	X	X					X	X	X	X	X					
Golden Eagle		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Great Blue Heron	B	X		X	X			X									
Great Horned Owl		X	X	X	X	X	X	X	X	X	X	X	X	X			X
Gryfalcon	B		X	X	X	X	X	X									
Hairy Woodpecker		X	X		X	X	X	X	X		X	X	X				
Horned Lark					X	X	X	X	X	X	X	X	X	X	X	X	X
Killdeer				X	X	X	X	X	X	X	X	X	X				X
Lark Sparrow	B		X		X	X	X		X		X						
Least Sandpiper				X	X	X	X	X	X	X	X	X					
Lesser Golden Plover	B			X	X		X	X	X		X						
Lewis's Woodpecker	B	X	X		X	X	X				X						
Long-billed Curlew	B				X	X	X				X						
Mallard		X		X	X	X	X	X	X	X	X	X		X	X	X	X
Marsh Wren				X		X	X	X	X	X	X	X	X		X	X	X
Merlin		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mountain Bluebird					X	X	X	X	X	X	X	X	X				
Mourning Dove		X	X		X						X	X					
Northern Flicker		X	X		X	X	X	X	X	X	X	X					
Northern Saw-whet Owl		X		X		X	X	X			X	X					
Northern Shoveler			X	X	X	X					X	X					

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh3	BGxw2	IDFdk3	IDFdk4	IDFdw	IDFxm	IDFxw	MSxv	ESSFxv 2	SBPSdc	SBPSxc	SBS
Osprey				X	X	X	X	X	X		X	X	X				
Peregrine Falcon	R			X	X	X	X										
Prairie Falcon	R			X	X		X	X			X						
Pygmy Nuthatch		X	X			X	X	X	X	X	X						
Red-breasted Nuthatch		X	X			X	X	X	X	X	X		X	X			X
Redhead				X						X	X				X	X	X
Red-necked Phalarope	B			X													
Red-tailed Hawk		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-winged Blackbird				X		X	X	X	X	X	X	X	X		X	X	X
Rock Ptarmigan			X		X									X	X	X	
Rock Wren					X	X	X	X	X		X	X					
Ruffed Grouse		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Rufous Hummingbird			X		X	X	X	X	X	X	X	X	X		X	X	X
Spotted Towhee		X	X			X	X	X	X	X	X	X					
Sandhill Crane	B			X	X	X	X	X			X		X			X	
Savannah Sparrow			X		X	X	X			X	X						
Sharp-tailed Grouse	B	X	X	X	X		X	X			X						
Short-eared Owl	B		X	X	X	X	X	X			X						
Sora				X		X	X	X			X	X					
Sprague’s Pipit	R				X	X	X				X						
Surf Scoter	B			X	X		X	X			X						
Swainson's Hawk	R			X	X		X										
Trumpeter Swan	B			X	X				X		X						
Tundra Swan				X		X	X			X	X						
Upland Sandpiper	R			X	X	X					X						
Vaux's Swift		X	X	X	X	X	X	X	X		X	X					X
Vesper Sparrow			X		X	X	X	X	X		X	X	X		X	X	X
Western Grebe	R			X													
Western Kingbird			X		X	X	X				X	X					
Western Meadowlark			X		X	X	X	X	X	X	X	X	X		X	X	X
Western Screech-Owl	B	X	X		X	X	X	X	X	X	X						
White-breasted Nuthatch		X	X			X	X	X	X	X	X						
White-tailed Ptarmigan	B		X											X			

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh3	BGxw2	IDFdk3	IDFdk4	IDFdw	IDFxm	IDFxw	MSxv	ESSFxv 2	SBPSdc	SBPSxc	SBS
White-throated Swift	B			X	X	X	X				X						
Willow Ptarmigan			X	X										X	X	X	
Yellow-breasted Chat	R			X	X	X											
Yellow-headed Blackbird				X	X	X	X	X	X	X			X		X	X	
Mammals																	
Badger	R		X		X	X	X				X						
Beaver		X		X		X	X	X	X		X	X					
Big Brown Bat		X		X	X	X	X	X	X		X	X	X		X	X	
Black Bear		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
California Bighorn Sheep	B		X		X	X	X				X						
Caribou			X	X										X		X	
Columbian Ground Squirrel			X		X	X	X				X						
Coyote		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Deer Mouse		X	X	X	X	X	X	X	X	X	X	X	X				
Grizzly Bear	B	X	X	X	X			X	X		X		X	X	X	X	X
Hoary Bat			X	X	X	X	X	X	X	X	X	X	X				
Little Brown Myotis			X	X	X	X	X	X	X	X	X	X	X		X	X	X
Long-tailed Weasel		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Montane Vole				X	X	X	X	X	X	X	X	X					
Moose				X							X	X		X	X	X	X
Mule Deer		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Muskrat				X		X	X	X	X	X	X	X	X	X	X	X	X
Northern Bog Lemming				X	X	X		X	X	X	X	X		X	X	X	X
Red Fox		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red Squirrel		X	X			X	X	X	X	X	X	X	X		X	X	X
Spotted Bat	B		X	X	X	X	X				X						
Striped Skunk		X	X	X	X	X	X	X	X	X	X						
Townsend's Big-eared Bat	B		X	X	X	X	X				X						
Western Jumping Mouse					X	X	X	X	X	X	X	X	X		X	X	X
Western Long-eared Myotis			X		X	X	X	X	X	X	X	X	X				X
Western Small-footed Myotis	B				X	X	X				X						
Yellow-bellied Marmot			X		X			X	X		X	X					

APPENDIX 13. Continued

Life-Form/Common Name	Status	Aspen	Parkland	Wetland	Steppe	BGxh3	BGxw2	IDFdk3	IDFdk4	IDFdw	IDFxm	IDFxw	MSxv	ESSFxv 2	SBPSdc	SBPSxc	SBS
Yellow-pine Chipmunk		X	X		X	X	X	X	X	X	X	X	X				
Yuma Myotis		X	X	X	X	X	X	X	X	X	X	X	X				

TABLE A 13.6. Habitats and biogeoclimatic units used by characteristic and listed grassland fauna in the Sub-Boreal Interior, Northern Boreal Mountains, Boreal Plains and Taiga Plains.

Life-Form/Common Name	Status	Parkland	Wetland	Subalpine Meadow	Subalpine Grass	Steppe	ESSFmv	AT	BWBSdk	BWBSmw	BWBSwk	SBSmc	SWBmk
Arthropods													
Alberta Arctic	B					X				X			
Aphrodite Fritillary	B	X				X				X			
Arctic Blue	B					X				X			
Arctic White	B												
Astarte Fritillary	B												
Baird's Swallowtail	B					X				X			
Beringian Alpine	B												
Beringian Fritillary	B												
Bronze Copper	B		X			X				X			
Checkered Skipper	B	X				X				X			
Common Branded Skipper	B	X				X				X			
Common Ringlet	B					X				X			
Common Woodnymph	B					X				X			
Coral Hairstreak	B					X				X			
Draco Skipper	B		X	X									
Eastern Pine Elfin	R	X								X			
Great Spangled Fritillary	B	X				X				X			
Green Marble	B												
Hecla Sulphur	B				X		X	X					
Jutta Arctic, Alaskensis	B				X		X	X					
Margined White	B	X											
Mountain Alpine	B		X										
Phoebus Appolo	B			X	X		X	X					
Polixenes Arctic	B				X		X	X					
Rosov's Arctic	B												
Striped Hairstreak	B	X								X			

Life-Form/Common Name	**Status**	**Parkland**	**Wetland**	**Subalpine Meadow**	**Subalpine Grass**	**Steppe**	**ESSFmv**	**AT**	**BWBSdk**	**BWBSmw**	**BWBSwk**	**SBSmc**	**SWBmk**
Tawny Crescent	B	X								X			
Uhler's Arctic	B					X				X			
White-veined Arctic	B				X		X	X					
Reptiles and Amphibians													
Boreal Chorus Frog		X	X						X	X	X		
Common Garter Snake									X	X	X		
Long-toed Salamander		X	X				X		X	X	X	X	X
Spotted Frog			X				X		X	X	X	X	X
Western Garter Snake		X	X						X	X	X	X	
Western Toad			X				X		X	X	X	X	X
Wood Frog			X						X	X	X	X	X
Birds													
American Avocet	R		X						X	X	X	X	
American Bittern	B		X									X	
American Coot			X						X	X	X	X	
American Crow		X				X	X		X	X	X	X	
American Kestrel		X	X	X		X	X		X	X	X	X	X
American Wigeon			X					X	X	X	X	X	X
Bald Eagle	B	X	X	X	X	X	X		X	X	X	X	X
Barrow's Goldeneye		X	X	X				X	X	X	X	X	
Black-billed Magpie		X				X			X	X	X	X	
Blue Grouse		X		X	X	X	X		X	X	X	X	X
Blue-winged Teal			X	X	X	X	X	X	X	X	X	X	X
Brewer’s Sparrow ssp. *breweri*	R			X					X	X	X		
Brewer's Blackbird		X				X			X	X	X	X	X
Brown-headed Cowbird		X				X			X	X	X	X	
Bufflehead		X	X					X	X	X	X	X	X
Calliope Hummingbird		X		X					X	X	X	X	

Life-Form/Common Name	Status	Parkland	Wetland	Subalpine Meadow	Subalpine Grass	Steppe	ESSFmv	AT	BWBSdk	BWBSmw	BWBSwk	SBSmc	SWBmk
Canada Warbler	B	X											
Canada Goose			X	X	X	X	X		X	X	X	X	X
Canvasback			X						X	X	X	X	
Cinnamon Teal			X				X		X	X	X	X	X
Clark’s Nutcracker		X					X		X	X	X	X	
Cliff Swallow						X	X		X	X	X	X	X
Common Goldeneye			X				X		X	X	X	X	X
Common Loon			X				X		X	X	X	X	X
Common Merganser		X	X						X	X	X	X	X
Common Nighthawk			X				X		X	X	X	X	
Common Poorwill						X						X	
Common Raven		X	X			X	X		X	X	X	X	X
Connecticut Warbler	R	X							X	X	X		
Cooper’s Hawk		X		X			X					X	
Eared Grebe			X						X	X	X	X	
Eastern Kingbird						X			X	X	X	X	
Eurasian Wigeon			X					X	X	X	X	X	
Gadwall			X					X	X	X	X	X	
Golden Eagle		X	X	X	X	X	X		X	X	X	X	X
Great Horned Owl			X				X					X	
Greater Scaup			X						X	X	X	X	X
Green-winged Teal			X					X	X	X	X	X	X
Gryfalcon	B		X	X	X	X		X	X	X	X		X
Hooded Merganser			X					X	X	X	X	X	X
Horned Lark				X		X	X	X	X	X	X	X	X
Killdeer			X			X			X	X	X	X	X
Lark Sparrow	R					X							
Least Sandpiper			X				X		X	X	X	X	X
Le Conte’s Sparrow	B	X	X							X			
Lesser Scaup			X				X	X	X	X	X	X	X

Life-Form/Common Name	**Status**	**Parkland**	**Wetland**	**Subalpine Meadow**	**Subalpine Grass**	**Steppe**	**ESSFmv**	**AT**	**BWBSdk**	**BWBSmw**	**BWBSwk**	**SBSmc**	**SWBmk**
Lewis's Woodpecker	B	X				X						X	
Long-billed Curlew	B					X						X	
MacGillivray’s Warbler		X	X						X	X	X	X	
Mallard			X			X	X		X	X	X	X	X
Marsh Wren			X						X	X	X	X	X
Merlin		X	X	X	X		X		X	X	X	X	X
Mountain Bluebird		X		X		X	X		X	X	X	X	X
Mourning Dove		X						X	X	X	X	X	X
Northern Flicker		X							X	X	X	X	
Northern Goshawk		X	X	X			X		X	X	X	X	X
Northern Pintail			X	X	X	X			X	X	X	X	X
Orange-crowned Warbler		X					X		X	X	X		X
Osprey			X					X	X	X	X	X	X
Palm Warbler	B	X	X			X			X	X	X		
Peregrine Falcon subsp. *anatum*	R		X	X				X	X	X	X	X	X
Pileated Woodpecker		X							X	X	X	X	
Redhead			X					X	X	X	X	X	X
Red-necked Phalarope	B		X					X	X	X	X	X	X
Red-tailed Hawk		X	X	X	X	X	X		X	X	X	X	X
Red-winged Blackbird			X			X			X	X	X	X	
Ring-necked Duck			X					X	X	X	X	X	X
Rock Ptarmigan				X		X		X					
Rough-legged Hawk			X	X	X	X	X		X	X	X	X	X
Ruby-crowned Kinglet		X				X	X		X	X	X	X	X
Ruddy Duck			X					X	X	X	X	X	X
Ruffed Grouse		X	X						X	X	X	X	
Rufous Hummingbird				X			X		X	X	X	X	X
Sandhill Crane	B		X			X			X	X	X	X	
Savannah Sparrow			X			X			X	X	X	X	X
Sharp-shinned Hawk							X		X	X	X	X	X

Life-Form/Common Name	Status	Parkland	Wetland	Subalpine Meadow	Subalpine Grass	Steppe	ESSFmv	AT	BWBSdk	BWBSmw	BWBSwk	SBSmc	SWBmk
Sharp-tailed Grouse	B	X	X			X			X	X	X	X	
Short-eared Owl	B		X	X	X	X			X	X	X	X	X
Smith's Longspur	B	X	X	X	X	X		X	X	X	X		X
Snow Bunting		X		X	X		X		X	X	X	X	X
Sora			X						X	X	X	X	
Townsend’s Solitaire		X		X		X	X		X	X	X	X	X
Tundra Swan			X						X	X	X	X	
Upland Sandpiper	R					X				X			
Varied Thrush		X	X						X	X	X	X	
Vaux’s Swift		X							X	X	X	X	
Vesper Sparrow		X				X			X	X	X	X	
Western Grebe	R		X									X	
Western Meadowlark		X				X			X	X	X	X	
Willow Ptarmigan		X	X	X	X	X	X						X
Wilson’s Warbler		X	X	X			X		X	X	X	X	X
Yellow Warbler		X	X						X	X	X		
Yellow-bellied Sapsucker		X							X	X	X		
Yellow-headed Blackbird			X			X						X	
Mammals													
Arctic Ground Squirrel				X				X					X
Arctic Shrew		X	X						X	X	X		X
Beaver		X	X	X		X		X	X	X	X	X	X
Big Brown Bat									X	X	X	X	
Bison subsp. *athabascae*	R	X			X	X			X	X	X		
Black Bear		X	X	X	X	X	X		X	X	X	X	X
Bushy-tailed Woodrat		X					X		X	X	X	X	X
Caribou (northern populations)		X	X	X	X	X		X	X	X	X	X	
Common Shrew		X	X			X	X		X	X	X	X	X

Life-Form/Common Name	**Status**	**Parkland**	**Wetland**	**Subalpine Meadow**	**Subalpine Grass**	**Steppe**	**ESSFmv**	**AT**	**BWBSdk**	**BWBSmw**	**BWBSwk**	**SBSmc**	**SWBmk**
Coyote		X	X	X	X	X	X		X	X	X	X	X
Dall Sheep	B			X	X	X			X	X	X		X
Deer Mouse		X	X			X	X		X	X	X	X	X
Dusky Shrew		X	X			X	X		X	X	X	X	X
Gray Wolf		X	X	X	X	X	X		X	X	X	X	X
Grizzly Bear	B	X	X	X	X	X	X		X	X	X	X	X
Little Brown Myotis						X	X		X	X	X	X	X
Long-tailed Vole		X	X			X	X		X	X	X		X
Long-tailed Weasel		X	X	X	X	X	X		X	X	X	X	X
Meadow Jumping Mouse			X	X					X	X	X	X	X
Meadow Vole		X	X	X		X	X		X	X	X	X	X
Moose			X				X		X	X	X	X	X
Mountain Goat		X		X	X		X	X	X	X	X	X	X
Mule Deer		X	X	X	X	X	X		X	X	X	X	X
Muskrat			X				X		X	X	X	X	X
Northern Bog Lemming			X	X			X	X	X	X	X	X	X
Northern Long-eared Myotis	R		X						X	X	X	X	
Red Fox		X		X	X	X	X		X	X	X	X	X
Rocky Mountain Elk		X	X	X	X	X			X	X	X		X
Snowshoe Hare		X	X						X	X	X	X	X
Striped Skunk		X	X			X			X	X	X	X	
Thinhorn Sheep subsp. *dalli*	R			X	X	X		X	X	X	X		X
Thinhorn Sheep subsp. *stonei*	B			X	X	X		X	X	X	X	X	X
Tundra Shrew	R					X		X					X
Tundra Vole				X	X								X
Western Jumping Mouse		X	X			X			X	X	X	X	
Western Long-eared Myotis		X										X	
White-tailed Deer		X	X		X	X	X		X	X	X	X	
Yellow-pine Chipmunk		X				X						X	

TABLE A 13.7. Habitats and biogeoclimatic units used by characteristic and listed grassland fauna in the Georgia Depression.

Life-form/Common Name	Status	Wetland	Steppe	Savannah
Arthropods				
Blackmore’s Blue	B		X	X
Bremner’s Silverspot	B		X	X
Dun Skipper	R	X		
Island Blue	R	X	X	
Island Marble	R		X	X
Leaf Bug	R			X
Moss’ Elfin	B		X	
Perdiccas Checkerspot	R		X	X
Propertius Ducky Wing	B		X	X
Robber Fly (*Nicocles rufus*)	R		X	X
Robber Fly (*Sceropogon bradleyi*)	R		X	X
Scentless Plant Bug	R			
Shield-backed Bug	R			
Taylor’s Checkerspot	R		X	X
Vancouver Island Riglet	B		X	X
Reptiles and Amphibians				
Clouded Salamander		X		X
Common Garter Snake		X	X	X
Long-toed Salamander		X		X
Northern Alligator Lizard			X	
Northern Rough-skinned Newt				X
Northwestern Garter Snake		X	X	X
Oregon Ensatina		X	X	X
Pacific Treefrog				X
Sharp-tailed Snake	R			X
Western Garter Snake		X	X	X
Western Red-backed Salamander				X
Western Toad		X		X

Life-form/Common Name	Status	Wetland	Steppe	Savannah
Birds				
American Goldfinch		X	X	X
American Kestrel		X	X	X
American Robin			X	X
Bald Eagle	B	X	X	X
Band-tailed Pigeon				X
Barn Swallow		X	X	X
Barred Owl		X		X
Bewick's Wren			X	X
Black-throated Warbler				X
Brewer's Blackbird		X	X	X
Brown Creeper				X
Brown-headed Cowbird		X	X	X
Bushtit			X	X
California Quail			X	X
Cedar Waxwing				X
Chestnut-backed Chickadee				X
Chipping Sparrow			X	X
Cliff Swallow			X	
Common Nighthawk			X	X
Common Raven		X	X	X
Common Yellow-throat		X		
Cooper's Hawk				X
Dark-eyed Junco		X	X	X
Downy Woodpecker				X
European Starling		X	X	X
Evening Grosbeak				X
Fox Sparrow			X	X
Golden-crowned Kinglet				X
Golden-crowned Sparrow			X	X
Great Blue Heron	B	X	X	X
Great Horned Owl		X	X	X
Hairy Woodpecker				X

Life-form/Common Name	Status	Wetland	Steppe	Savannah
Hammond’s Flycatcher			X	X
Hermit Thrush			X	X
House Wren				X
Hutton's Vireo	B			X
Killdeer		X	X	
Least Sparrow			X	X
Lewis's Woodpecker	B			X
Lincoln’s Sparrow			X	X
MacGillivray’s Warbler		X		X
Mallard		X		
Merlin		X		X
Mountain Bluebird			X	
Mourning Dove			X	X
Northwestern Crow		X	X	X
Orange-crowned Warbler				X
Osprey				X
Pacific Slope Flycatcher			X	X
Pileated Woodpecker				X
Pine Grosbeak				X
Pine Siskin			X	X
Purple Finch				X
Purple Martin	R	X		X
Red-breasted Nuthatch				X
Red-breasted Sapsucker				X
Red-tailed Hawk		X	X	X
Red-winged Blackbird				X
Ruby-crowned Kinglet			X	
Rufous Hummingbird			X	X
Savannah Sparrow		X	X	
Sharp-shinned Hawk		X	X	X
Skylark			X	X
Song Sparrow		X	X	X
Spotted Towhee			X	X

Life-form/Common Name	Status	Wetland	Steppe	Savannah
Steller's Jay			X	X
Streaked Horned Lark	R	X	X	
Swainson's Thrush				X
Townsend's Solitaire			X	X
Townsend's Warbler				X
Tree Swallow				X
Turkey Vulture			X	X
Varied Thrush		X		X
Vaux's Swift		X	X	X
Vesper Sparrow	(R)		X	X
Violet-green Swallow				X
Warbling Vireo			X	
Western Bluebird	R		X	X
Western Kingbird			X	
Western Meadowlark	(R)		X	X
Western Screech Owl subsp. *kennicottii*	B			X
Western tanager		X		X
Western Wood-peewee				X
White-Crowned Sparrow			X	X
Wilson's Warbler		X	X	X
Winter Wren		X	X	X
Yellow Warbler		X		X
Yellow-billed Cuckoo	R			X
Yellow-breasted Chat	R	X		X
Yellow-rumped Warbler		X		X
Mammals				
Beaver		X		
Big Brown Bat		X	X	X
Black Bear			X	X
Black-tailed Deer		X	X	X
California Myotis		X	X	X

Life form/Common Name	Status	Wetland	Steppe	Savannah
Cougar			X	X
Deer Mouse		X	X	X
Dusky Shrew		X		X
Eastern Cottontail			X	X
Eastern Gray Squirrel				X
Ermine subsp. *anguinea*	B	X	X	X
European rabbit			X	X
Hoary Bat		X	X	X
House Mouse		X	X	X
Little Brown Myotis		X	X	X
Long-legged Myotis		X	X	X
Norway Rat		X	X	X
Raccoon		X	X	X
Red Squirrel				X
Roosevelt Elk	B	X	X	X
Silver-Haired Bat		X	X	X
Townsend’s mole				X
Townsend’s Vole		X	X	X
Townsend's Big-eared Bat	B	X	X	X
Vagrant Shrew		X		X
Virginia Opossum				X
Western Long-eared Myotis		X	X	X
Yuma Myotis		X	X	X

APPENDIX 14. Provincial parks, protected areas and non-government tenures containing grassland in British Columbia.

INDEX OF TABLES

SOURCES

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TABLE A 14.1. Protected areas containing grassland in the East Kootenay.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
East Kootenay Trench	Columbia Lake Park and Ecological Reserve	32	IDFdm2 (13) MSdk (16)	Bunchgrass grasslands and dry Douglas-fir and ponderosa pine forests; established to protect ecosystems representing calcareous soils and the Interior Douglas-fir zone.
East Kootenay Trench	Columbia Lake Park	257	IDFdm2 (237) MSdk (7)	Bunchgrass grasslands and dry Douglas-fir and ponderosa pine forests.
East Kootenay Trench	Elko Park	25	IDFdm2 (25)	Bunchgrass grasslands and dry Douglas-fir and ponderosa pine forests; at risk from infestation of noxious weeds.
East Kootenay Trench	Height of the Rockies Park	68,000	Atunp (23,308) ESSFdk (19,254) ESSFdkp (10,228) MSdk (926)	Lower elevations forested; Engelmann Spruce-Subalpine Fir parkland, alpine grassland, alpine meadows, and alpine tundra at higher elevations; high concentrations of Rocky Mountain Elk, Mule Deer, Rocky Mountain Bighorn Sheep, and Mountain Goat.
East Kootenay Trench	Kikomun Creek Park	682	IDFdm2 (682)	Bunchgrass grasslands and dry Douglas-fir and ponderosa pine forests; habitat restoration underway to restore grassland.
East Kootenay Trench	Norbury Lake Park	103	IDFdm2 (103)	Bunchgrass grasslands and dry Douglas-fir and ponderosa pine forests; habitat restoration projects underway to restore grasslands and open forest.
East Kootenay Trench	Premier Lake Park	838	IDF dm2 (770) MSdk (17)	Bunchgrass grasslands; dry Douglas-fir forests with ponderosa pine or lodgepole pine; Douglas-fir spruce forests at higher elevations.
East Kootenay Trench	Wasa Lake Park	144	PPdh2 (144)	Open ponderosa pine forest; habitat restoration projects underway to restore grasslands and open forest.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
East Kootenay Trench	Windermere Lake Park	205	IDFun (1) IDFdm2 (204)	Bunchgrass grassland and dry Douglas-fir forest; fenced to restrict access by horses, cows and ATV's.
East Kootenay Trench	Elizabeth Lake Land Trust	5	IDFdm2 (5)	Mostly forest with less than 1 ha grassland; transitional wetland; no red-listed species.
East Kootenay Trench	Annis Covenant Land Trust	24	IDFun (24)	Formerly grassland; now mostly ingrowth forest with about 15 ha grassland; no red-listed species.
East Kootenay Trench	Newhouse Land Trust	0.8	IDFdm2 (<1)	Mostly wetland, no red-listed species.
East Kootenay Trench	Wasa Slough Land Trust	79	PPdh2 (79)	5% grassland (4 ha), 20% shallow open water, 75% wetlands; no red-listed species.
East Kootenay Trench	Wycliffe Wildlife Land Trust	1051	PPdh2 (1051)	30% grassland (307 ha), 65% forest, 5% unspecified; red-listed species - Badger.
East Kootenay Trench	RCMP Flats\Land Trust	379	IDFdm2	4 ha grassland
East Kootenay Trench	West Columbia Lake Land Trust	1919	IDFun	612 ha grassland
East Kootenay Trench	Bull River Land Trust	79	IDFdm2	23 ha grassland
East Kootenay Trench	Sheep Mountain Land Trust	608	PPdh2 IDF dm2	393 ha grassland; bunchgrass grasslands and dry Douglas-fir and ponderosa pine forests.
East Kootenay Trench	Cherry Creek Land Trust	679		30 ha grassland
East Kootenay Trench	Musil/Big Ranch Land Trust	363		10 ha grassland
East Kootenay Trench	Wilmer Land Trust	461	PPdh2	57 ha grassland; mostly marsh along the Columbia River with cottonwood and aspen stands along rivers.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
East Kootenay Trench	Mt. Broadwood Land Trust	9084	IDFdm2 ICHmk ESSFdk ESSFwm	Variable terrain with a wide elevational range and several forest types; about 4 ha of grassland; important habitat for large mammals such as Rocky Mountain Bighorn Sheep, Mule Deer, Rocky Mountain Elk, Mountain Goats, Grizzl Bear, Black Bear, Cougar, and the Gray Wolf.
East Kootenay Trench	Three Sons Land Trust	392		66 ha grassland
East Kootenay Trench	Newgate Land Trust	421	PPdh2	85 ha grassland
East Kootenay Trench	Wolf Creek Land Trust	166	IDFdm2	7 ha grassland

TABLE A 14.2. Protected areas containing grassland in the Okanagan.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
Northern Okanagan Basin	Kalamalka Lake Park	978	IDFxh1a IDFxh1	Bunchgrass grasslands, ponderosa pine savannah and groves of Douglas-fir; high floristic diversity including red-listed flat-topped broom-rape; many endangered fauna such as Western Harvest Mouse, Townsend's Big-eared Bat, Canyon Wren, White-throated Swift, Pacific Rubber Boa, Western Rattlesnake, Northern Alligator Lizard and Immaculate Green Hairstreak.
Northern Okanagan Basin	Kalamalka Lake Protected Area	3231	IDFxh1a (663) IDFxh1 (1143) IDFmw1 (1073) ICHmk1 (230)	Elevational gradient from valley bottom to forested upland slopes; provides a link between Kalamalka Lake Provincial Park and Cougar Canyon Ecological Reserve; habitat for Black Bear, Cougar and Western Rattlesnake.
Northern Okanagan Basin	Okanagan Lake Park	98	BGxh1 (48) PPxh1 (17)	Campsite area greatly altered; lakeshore with riparian cottonwoods; most bunchgrass and ponderosa pine uplands undisturbed.
Northern Okanagan Basin/ Northern Okanagan Highland	Okanagan Mountain Park	10,462	BGxh1 (89) PPxh1 (2875) IDFxh1 (3283) IDFdm1 (4174) MSdm1 (238)	Parks spans natural lakeshore to mountain tops encompassing the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir zones; canyons and rugged outcrops provide habitat for Western Rattlesnake, Racer, and Gopher Snake.
Northern Okanagan Basin	Trout Creek Ecological Reserve	68	PPxh1 (68)	Established to conserve semi-arid vegetation in the southern interior; contains bunchgrass grassland, ponderosa pine savannah, and open ponderosa pine-Douglas-fir forests.
Southern Okanagan Basin	Field's Lease Ecological	4	BGxh3 (4.2)	Established to protect antelope-brush shrub-steppe.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
	Reserve			
Southern Okanagan Basin	Hayne's Lease Ecological Reserve	101	BGxh1 (101)	Established to protect Antelope-brush shrub-steppe.
Southern Okanagan Basin	Inkaneep Park	21	BGxh1 (21)	Established to protect Antelope-brush shrub-steppe, old-growth cottonwood, and red three-awn communities; birds present include the Black-headed Grosbeak, Northern Oriole, Warbling Vireo, Yellow-breasted Chat, and Lewis's Woodpecker.
Southern Okanagan Highland	Johnstone Creek Park	38	PPdh1 (31) IDFxh1 (14)	Ponderosa pine-Douglas-fir forests with a small area of bunchgrass grassland; mature trees provide habitat for woodpeckers and other cavity nesting bird species; White-tailed Deer frequent.
Southern Okanagan Basin	White Lake Grasslands Protected Area	3741	BGxh1 PPxh1 IDFxh1	Protects the very hot and dry grassland, open ponderosa pine forest, alkali ponds, and rock outcrops over an elevational gradient from lakeshore to mountaintop; contiguous with other protected areas around Vaseux Lake; supports 10 red-listed wildlife species, 20 blue-listed species, and 3 endangered plants.
Southern Okanagan Basin	Sandy’s Oxbow Land Trust	6		Oxbow and riparian area on the Okanagan River floodplain with adjacent upland; protects water birch-red osier dogwood woodland along with 3 red-listed species- Tiger Salamander, Pallid Bat, and Yellow-breasted Chat.
Southern Okanagan Basin	Mahoney Lake Ecological Reserve	30	PPxh1(30)	Big sagebrush shrub-steppe (about 65%) and Ponderosa Pine forest (about 35%); established to conserve a saline lake that has unique limnological features.
Southern Okanagan	Vaseux	2015	BGxh1 (124)	Bunchgrass grassland,

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
Basin	Protected Area		PPxh1 (1385) IDFdm1 (12) IDFxh1 (474)	antelope-brush shrub-steppe, big sagebrush shrub-steppe, ponderosa pine, Douglas-fir and lodgepole pine forests; established to protect low- to mid-elevation winter range for California Bighorn Sheep and old-growth larch stands for White-headed Woodpecker and Williamson's Sapsucker; red- and blue-listed plants include bristly mousetail and bearded sedge; Douglas-fir-Ponderosa Pine-Idaho Fescue is a blue-listed plant community; area supports two red- and seven blue-listed mammals (including the Pallid Bat and the Western Red Bat), 11 red-, and nine blue-listed bird species (including the White-headed Woodpecker) and one red- and five blue-listed reptiles (including the Night Snake).
Okanagan Range	Keremeos Columns Park	57	IDFxh1 (4) IDFdk1 (17)	Big sagebrush shrub-steppe on lower slopes, Ponderosa pine and Douglas-fir forests above; good display of bitterroot in spring.
Okanagan Range	Snowy Protected Areas	25,889	BGxh1 (21) PPxh1 (203) IDFxh1 (1429) IDFdk1 (3471) MSxk (5755) ESSFxc (9299)	Established to provide representation of ecosystems in the Okanogan Ranges Ecosection from low-elevation grasslands to alpine meadows; supports a herd of California Bighorn Sheep.
Okanagan Range	Harper Property Land Trust	51	BGxh1 PPxh1	Floodplain and riparian vegetation along Similkameen River including willow and cottonwood ecosystems; variable amounts of forest cover.

TABLE A 14.3. Protected areas containing grassland in the Thompson-Pavilion region.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
Thompson Basin	Arrowstone Protected Area	6203	BGxw1 (29) IDFdk1 (2622) IDFxw (1049) MSxk (1944) PPxh2 (517)	Established to protect one of the largest undisturbed watersheds in the southern interior; includes old-growth Douglas-fir forest, Ponderosa pine forest and grasslands; critical winter range for Mule Deer and habitat for rare species including the Burrowing Owl and Western Rattlesnake; trees are encroaching on the grasslands.
Thompson Basin	Buse Lake Protected Area	228	PPxh2 (26) IDFxh2 (177)	A mix of upper grassland, and open ponderosa pine and Douglas-fir forests; diffuse knapweed infestation, tree encroachment, and cattle grazing could threaten grasslands.
Thompson Basin	Elephant Hill Park	995	BGxh2 (376) BGxw1 (592)	Established to protect grassland, big sagebrush shrub-steppe and associated wildlife species and plants on both Elephant and Rattlesnake Hills; the south-facing slopes are some of the driest conditions in province; some diffuse knapweed present along the road to the micro-wave tower; fauna include the Western Rattlesnake, Gopher Snake, Mule Deer, Coyote, Sharp-tailed Grouse, Common Merganser, Chukar, Belted Kingfisher, and Rosy Finch.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
Thompson Basin	Juniper Beach Park	255	BGxh2 (230) BGxw1 (18)	The grasslands and big sagebrush shrub-steppe communities are in fairly good condition, but diffuse and spotted knapweed are present along road edges; some fauna present include the Western Rattlesnake, Mule Deer, Western Tanager, Mountain Bluebird, and Northern Oriole.
Thompson Basin	Lac du Bois Grassland Park	15,500	BGxh2 (2075) BGxw1 (5016) IDFxh2 (3738) IDFxh2a (673) PPxh2 (2173)	Established to protect representative grassland communities in this area; contains lower, middle and upper grasslands, ponderosa pine and Douglas-fir forests, and various wetlands; numerous noxious weed species present including spotted knapweed, diffuse knapweed, Russian knapweed, and dalmatian toadflax; forest encroachment is occurring on some sites; California Bighorn Sheep, White-tailed Deer, Mule Deer, Moose (occasional), Black Bear, Western Rattlesnake, Sharp-tail Grouse, Short-eared Owl, Burrowing Owl, Long-billed Curlew, and a variety of waterfowl and shorebirds inhabit the park.
Thompson Basin	McQueen Creek Ecological Reserve	35	BGxw1 (16) PPxh2 (19)	Established to protect representative middle grasslands and big sagebrush shrub-steppe in the Thompson Basin.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
Thompson Basin	North Thompson Oxbows Jensen Island Park	30	PPxh2 (14)	Very small area containing grassland; contains oxbow, marsh, and wetland habitat for waterfowl, otter, and Beaver; a migration stop for American White Pelicans, Tundra Swan, Trumpeter Swan, passerines, and waterfowl.
Thompson Basin	Painted Bluffs Park	100	BGxh2 (90) PPxh2 (1)	Low-elevation big sagebrush shrub-steppe and ponderosa pine on the shore of Kamloops Lake; small infestation of diffuse knapweed.
Thompson Basin	Paul Lake Park	670	IDFxh2(649)	Small area of grassland in a mostly forested park; Coyote, Peregrine Falcon, White-throated Swift, Bald Eagle, Osprey, and swallows among the park's fauna.
Thompson Basin	Pritchard Park	42	BGxh2 (12) BGxw1 (19) PPxh2 (4)	Contains big sagebrush shrub-steppe, ponderosa pine forest, and cottonwood riparian areas; grassland area is small and linked to riparian habitats on the South Thompson River; plant species include trembling aspen, black cottonwood, ponderosa pine, Douglas-fir, willows, Russian olive, black hawthorn, saskatoon, numerous grasses and sedges; Trumpeter and Tundra Swan, a variety of waterfowl, shorebird, and passerine bird species, Beaver, Muskrat, and Otter are present.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
Thompson Basin	Steelhead Park	51	BGxh2 (51)	Small park containing big sagebrush, brittle prickly-pear cactus and bluebunch wheatgrass; knapweed and baby's breath present.
Thompson Basin	Tranquille Ecological Reserve	235	PPxh2 (170) IDFdk1 (4) IDFxh2 (79)	Established to protect representative ponderosa pine and Douglas-fir communities.
Thompson Basin	Walhachin Oxbows Park	37	BGxh2 (29)	Established to protect riparian habitat on the Thompson River; big sagebrush shrub-steppe and riparian habitats; leafy spurge present.
Thompson Basin	Soap Lake Ecological Reserve	884	IDFdk1 (426) IDFxh2 (470) PPxh2 (1)	Established to protect flora and fauna surrounding an alkaline lake and representative ecosystems in the Ponderosa Pine and Interior Douglas-fir zones.
Thompson Basin	Cornwall Hills Park	1188	IDFxh2 (198) IDFdk1 (139) MSxk (424) ESSFxc (475)	Contains Engelmann Spruce-Subalpine Fir parkland, Montane Spruce grassland on south slopes at lower elevations; tree encroachment common in the park; Mule Deer, Cougar, Blue Grouse, and a variety of upland bird species are present
Thompson Basin	Epsom Park	75	BGxh2 (55)	Contains riparian habitat of ponderosa pine and black cottonwood along Thompson River; big sagebrush shrub-steppe occupies terraces above the river; diffuse knapweed present in park.
Thompson Basin	Goldpan Park	5	PPxh2 (5)	A very small park with a grassland component.
Pavilion Ranges	Bedard Aspen Park	183	IDFdk1 (30) MSxk (133)	Primarily aspen-willow forests with some grassland and old-growth Douglas-fir and spruce.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
Pavilion Ranges	Edge Hills Park	11,500	BGxh2 (15) BGxh3 (1453) IDFdk3 (3347) IDFxw (2139) MSxk (4509)	Park contains riparian habitat along the Fraser River, big sagebrush shrub-steppe, Douglas-fir forests and spruce and lodgepole pine forests at high elevation; forest encroachment and diffuse knapweed present on some sites; California Bighorn Sheep, Mule Deer, Moose, Black Bear, Spotted Bat, Long-billed Curlew, and Flammulated Owl present.
Pavilion Ranges	Harry Lake Aspen Park	330	IDFdk1 (241) IDFdk1a (80) IDFxh2 (7)	Established to protect grassland and mixed Douglas fir-aspen forest in the Pavilion Ranges; contains two ponds with associated wetlands; some forest ingrowth and encroachment occurring.
Pavilion Ranges	Marble Range Park	550	IDFdk3 (1259) MSxk (7538) ESSFxc (6657) ATunp (1550)	Grasslands not extensive.
Pavilion Ranges	Talking Mountain Ranch	404	BGxh2 IDFxm IDFdk3 MSxk	Grasslands comprise 85% of the area; contains a diversity of habitats from shrub-steppe, to riparian, wetland, and subalpine forest; rare and endangered fauna include Lewis's Woodpecker, Prairie Falcon, and Western Rattlesnake.

Ecosection	Name	Area (ha)	BEC Unit (Area in ha)	Comments
Southern Chilcotin Ranges	Stein Valley Nlaka'pamux Park	108,435	PPxh2 (329) IDFdk2 (1567) IDFdk2b (2231) IDFun (2884) IDFxh1 (1645) IDFxh2 (27) MSdc1 (572) MSun (7060) CWHms1 (712) ESSFdv (6931) ESSFmw (27,926) ATunp (56,086)	Contains a diversity of ecosystems from low- to high-elevation including grasslands; forest ingrowth and weeds present on grassland areas; high diversity of mammals and birds over the entire park.

TABLE A 14.4. Protected areas containing grassland in the Southern Thompson Upland.

Ecosection	Park	Area (ha)	BEC Unit (Area in ha)	Comments
Southern Thompson Upland	Tunkwa Park	5100	IDFdk1 (4920)	Park protects mid-elevation grasslands, forests, lakes, and various wetlands; Moose, Mule Deer, White-tailed Deer, and birds such as the Mallard, Common Snipe, Vesper Sparrow, and Mountain Bluebird are present; ATV damage and forest encroachment are potential threats to grasslands.
Southern Thompson Upland	Mount Savona Park	382	IDFxh2 (87) IDFdk1 (163) MSxk (183)	Park contains cliffs, canyons, dry ridges, old-growth Douglas-fir, pockets of high elevation grassland, a small lake and marshland; the park has the highest (elevational) known occurrence of Okanagan fameflower that grows on Kamloops lavas.
Southern Thompson Upland	Greenstone Mountain Park	124	MSxk (99) ESSFxp (25)	High elevation grasslands support late-succession communities dominated by bluebunch wheatgrass and forbs; at 1790 m, this is one of the highest elevations where Vasey's big sagebrush has been found growing.
Southern Thompson Upland	Monck Park	87	PPxh2 (69)	Park contains big sagebrush shrub-steppe and open ponderosa pine forest with volcanic rock cliffs; diffuse knapweed has established; the grasslands of this park are very small and threatened by forest ingrowth.
Southern Thompson Upland	Whipsaw Creek Ecological Reserve	32	IDFdk2 (32)	Established to maintain representative stands of Douglas-fir and ponderosa pine in the IDF zone; savannah on moderately steep slopes.

TABLE A 14.5. Protected areas containing grassland in the Cariboo-Chilcotin and Central Interior.

Ecosection	Park	Area (ha)	BEC Units (Area in ha)	Comments
Cariboo Basin	Cariboo Nature Park	98	IDFdk3 (82)	Contains grassland, aspen and wetland communities; Mule Deer are common along with Black Bear, Coyote, Red Fox, Muskrat, and Marten; diffuse knapweed and Canada thistle are present.
Cariboo Basin	Lac la Hache Park	24	IDFdk3 (24)	Bunchgrass grassland, Douglas-fir and Douglas-fir/lodgepole pine forest; diffuse knapweed present, but control measures have been implemented.
Cariboo Basin	Moose Valley Park	2389	IDFdk3 (1998)	Contains wetlands, dry forests and grassland communities; no noxious weeds present.
Cariboo Basin	Westwick Lake Ecological Reserve	28	IDFxm	Mosaic of bunchgrass grassland, aspen parkland vegetation and Douglas-fir forests at the northern extent of the Interior Douglas-fir zone.
Cariboo Basin	Green Lake Multi Site Park	331	IDFdk3 (187) SBPSmk (83)	Habitats include Bunchgrass grassland and Douglas-fir-Lodgepole pine forests; no noxious weeds reported on grasslands.
Chilcotin Plateau	Big Creek Ecological Reserve	257	BGxw2 (194) IDFxm (272)	Contains climax grassland for the Chilcotin area; no noxious weeds presently in the park.
Chilcotin Plateau	Bull Canyon Park	369	IDFxm (272) IDFdk4 (43)	Bunchgrass grassland and Douglas-fir forest; diffuse knapweed present, but a control program has been implemented; Douglas-fir encroachment occurring on grassland.

Ecosection	Park	Area (ha)	BEC Units (Area in ha)	Comments
Chilcotin Plateau	White Pelican Park	2763	SBPSdc (437) SBPSxc (2769)	Grasslands, parklands and dry lodgepole pine forests surround Stum Lake, the only breeding colony in the province of the American White Pelican.
Fraser River Basin	Churn Creek Protected Area	36,100	BGxh3 (4355) BGxw2 (7189) IDFdk3 (1042) IDFdk4 (5535) IDFxm (16,274) MSxv (480) SBPSxc (1643)	Many habitats including a representation of lower, middle, and upper grasslands and ponderosa pine forests; diffuse knapweed, burdock, leafy spurge, and hound's-tongue are present; excellent representation of numerous red- and blue-listed wildlife species including Lewis's Woodpecker, Brewer's Sparrow, Sage Thrasher, Peregrine Falcon, Swainson's Hawk, Bobolink, Flammulated Owl, Pallid Bat, Fringed Myotis, Rubber Boa, and Gopher Snake; also includes winter range for about 2500 Mule Deer, and year-round habitat for Black Bear, Cougar, Bobcat, small mammals, and 300-500 California Bighorn Sheep.
Central Chilcotin Ranges	Ts-ly-os Park	235,880	IDFdw (15,416) CWH un (1289) MSdc2 (9053) MSdv (7574) MSxv (38) ESSFxv1 (52,483) Atunp (131,362)	Many diverse habitats including bunchgrass grassland, dry Douglas-fir forest, subalpine parkland, alpine heath, tundra and meadows; no evidence of noxious weeds.

Ecosection	Park	Area (ha)	BEC Units (Area in ha)	Comments
Nazko Upland	Itcha Ilgachuz Park	111,977	MSxv (33,185) ESSFxv1 (38,097) Atunp (36,912)	Park set aside to protect alpine and subalpine grasslands, wetlands, and wildlife habitat, including the largest herd of Woodland Caribou in southern B.C.; some alpine species are at their northernmost limit, and some arctic species are at their southern limit; cattle and horse grazing occurs on park grasslands; Park supports unique grasslands near Itcha Lake; northern limits of California Bighorn Sheep in North America.
Fraser River Basin	Doc English Bluff Ecological Reserve	52	BGxw2 (48)	Established for conservation of rare plants and cliff-nesting birds associated with limestone cliffs.
Fraser River Basin	Junction Sheep Range Park	4589	BGxh3 (1548) BGxw2 (2983) IDFxm (52)	Rolling grassland, steep rugged cliffs along the river breaks, and pockets of Douglas-fir forest; home to 11 blue-listed species including Long-billed Curlew, Rubber Boa, and large herd of non-migratory California Bighorn Sheep.
Nazko Upland	Kluskoil Lake Park	15,548	SBPSdc (14,855) SBSmc2 (66)	Lodgepole pine and pine/spruce forests; grasslands grazed by cattle; ATV use on grasslands in undesignated areas.

Ecosection	Park	Area (ha)	BEC Units (Area in ha)	Comments
Nazko Upland	Tweedsmuir South Park	506,000	ATunp (137, 213) CWH (18,349) ESSFmc (49,804) ESSFmw (55, 760) ESSFxv1 (32, 989) IDFdw (3627) IDFww (28,004) MH (1990) MSdc2 (560) MSun (8658) MSxv (10,822) SBPSmc (74,108)	Trembling aspen, Douglas-fir, or lodgepole pine interspersed with natural meadows at low elevations; alpine and grass meadows at higher elevations provide habitat for Grizzly Bear, Black Bear, Mountain Goat, Woodland Caribou, and Gray Wolf, and summer range for Moose and Mule Deer; horses graze the grasslands in the area.
Bulkley Basin	Uncha Mountain/ Red Hills Park	9327	SBSdk (7032) SBSmc2 (1921)	Red Hills contains south-facing shrub-steppe scrub, grassland, and deciduous and coniferous forest ecosystems.
Bulkley Basin	Wistaria Park	35	SBSdk (35)	Small grassy opening around lake edge.
Central Chilcotin Ranges	Tatlayoko Lake Ranch Land Trust	324	IDFdw MSdc2	Held by Nature Conservancy of Canada; Valley important to migratory birds, Gray Wolf, Grizzly Bear, Cougar, Mountain Goat, and California Bighorn Sheep; "sagebrush south slopes" are a conservation target.

TABLE A 14.6. Protected areas containing grassland in the Northern Boreal Mountains and Sub-Boreal Interior.

Ecosection	Park	Area (ha)	BEC Unit (Area in ha)	Comments
Cassiar Ranges	Dall River Old Growth Denetiah Multi Class Park	64	BWBSdk1	Contains very small grassland communities and important habitat for Grizzly Bear and furbearers.
Eastern Muskwa Ranges Muskwa Foothills Muskwa Plateau	Northern Rocky Mountains Park	665,709	BWBSmw2 (38,293) SWBmk (300,298) ATunp (325,843)	Contains alpine grassland, alpine meadows, subalpine grassland, subalpine meadows, and subalpine shrub/grassland; also has numerous wetlands and native grasslands; area provides habitat for Moose, Rocky Mountain Elk, Stone Sheep, and Mountain Goats; year-round horse grazing occurs on grasslands.
Eastern Muskwa Ranges	Stone Mountain Park	25,690	ATunp (18,520) SWBmk (6,570)	Contains alpine grasslands, alpine meadows, and subalpine shrub/grasslands; Lapland rosebay shrub reaches its southern limit in alpine meadows of park; Woodland Caribou, Stone Sheep, and Mountain Goat winter in park, and two lakes are important congregation sites for migratory birds.
Liard Plain	Horneline Creek Park	298	BWBSdk1 (298)	Grassland component of the park is small but provides habitat for Mountain Goats; pockets of grasslands and stands of aspen line the canyon.

Ecosection	Park	Area (ha)	BEC Unit (Area in ha)	Comments
Liard Plain	Liard River Hot Springs Park	1082	BWBSdk2 (1,082)	No inventory of park conducted; cottonwood-spruce riparian zone and spruce-pine forests.
Liard Plain	Liard River Corridor Park and Protected Area	83,159	BWBSdk2 (49,798) BWBSmw2 (33,806) BWBSwk3 (186) SWBmk (291) ATunp (264)	Contains large areas of subalpine grassland; supports a herd of wood bison that use forested habitat north of the Liard River; Moose, Grizzly Bear, Rocky Mountain Elk, furbearers, and Northern Long-eared Bats also present.
Stikine Plateau Southern Boreal Plateau	Stikine River Park	217,000	BWBSdk1 (127,118) SWBun (72,800) ATunp (10,459)	Contains alpine grassland, montane shrub/grassland, subalpine meadows, and large areas of subalpine shrub/grassland; five rare boreal steppe ecosystems occur in BWBSdk1 on steep, warm aspects, and small patches of grassland at Boya Lake near Telegraph Creek are considered a rare habitat in park ; horse grazing is permitted in selected areas; more than 300 Mountain Goats reside in the canyon; other fauna include Black Bear, Grizzly Bear, Stone Sheep, Moose, Woodland Caribou, Gray Wolf, Coyote, and numerous bird species.

Ecosection	Park	Area (ha)	BEC Unit (Area in ha)	Comments
Southern Boreal Plateau	Todagin Mountain Park	3490	BWBSdk1 (235) SWBun (2,392) ATunp (862)	Contains two rare boreal steppe ecosystems; Prairie Sagewort-Wheatgrass in BWBSdk1 on steep, warm aspects, and the Glaucous bluegrass-Alaskan wildrye ecosystem in the Alpine Tundra.
Southern Boreal Plateau Eastern Skeena Mountains	Tatlatui Park	103,446	SWBun (48,372) ESSFmc (50) ATunp (55,024)	Contains a large area of alpine grassland including the rare Glaucous wildrye grassland ecosystem.
Southern Boreal Plateau	Spatsizi Plateau Wilderness Park	88,420	BWBSdk1 (34,912) ESSFmc (159) SWBun (299,233) ATunp (300,964)	Contains montane shrub/grassland, and large areas of alpine grassland and subalpine shrub/grassland including the rare Glaucous bluegrass-Alaskan wildrye grassland ecosystem; wildlife include Grizzly Bear, Black Bear, Hoary Marmot, and Arctic Ground Squirrel, and more than 140 species of birds.
Southern Boreal Plateau	Gladys Lake Ecological Reserve	42,432	SWBun (12,202) ATunp (30,230)	Created to study Stone Sheep and Mountain Goats in undisturbed habitat; 3 alpine communities contain grassland including the rare Glaucous bluegrass-Alaskan wildrye ecosystem.

Ecosection	Park	Area (ha)	BEC Unit (Area in ha)	Comments
Stikine Plateau Southern Boreal Plateau	Mount Edziza Park	230,000	BWBSdk1 (52,482) SBSun (10,139) ESSFwv (39,759) SWBun (36,807) ATunp (83,360)	Contains alpine grassland and subalpine meadows; four rare grassland or grass/steppe ecosystems; 3 in BWBSdk1, 1 in Alpine Tundra; Telegraph Creek to Buckley Lake is characterized by a mosaic of shrub fields, wet grasslands, and peat meadows; Caribou utilize subalpine and alpine vegetation; Mountain Goats and Stone Sheep use rocky terrain on slopes of Mt. Edziza.
Babine Upland	Sutherland River Park and Protected Area	18,400	SBSdk (12,105) SBSmc2 (4,934) ESSFmv1 (943) ATunp (151)	Located east end of Babine Lake; contains large inland river delta with extensive wetlands; habitat for Moose, Grizzly Bear, and the Gray Wolf.
Teslin Plateau	Atlin Park and Recreation Area	301,140	BWBSdk1 (35,017) SBSun (14,263) ESSFwv (9,298) ATunp (98,984) SWBun (21,456)	Habitats include large areas of subalpine meadow, small amount of subalpine shrub-steppe; Grizzly and Black Bear, Mountain Goat, Caribou, Moose, Stone Sheep, Hoary Marmot, Arctic Ground Squirrel, Pika, Beaver, and Otter present; Blue Grouse, Ruffed-Grouse, Rock Ptarmigan, Willow Ptarmigan, and White-tailed Ptarmigan are representative grassland bird species.

TABLE A 14.7. Protected areas containing grassland in the Taiga Plains and Boreal Plains.

Ecoprovince/ Ecosection	Park	Area (ha)	BEC Units (Area in ha)	Comments
Taiga Plains				
Muskwa Plateau	Muncho Lake Park	88,420	BWBSmw2 (525) SWB (55,023) ATunp (28,709)	Small areas of alpine grassland and subalpine shrub-steppe; the grassland component is very small, and is used by Stone Sheep.
Boreal Plains				
Peace Lowland	Clayhurst Ecological Reserve	316	BWBSmw1 (316)	Established to conserve grassland and aspen grove communities on rugged slopes along the Peace River; also contains montane shrub-steppe.
Peace Lowland	Peace River Corridor Park	2014	BWBSmw1	Contains open aspen stands and south-facing grasslands on steep slopes; various red- and blue-listed species have been identified within the corridor including fennel-leaved desert parsley and slender penstemon; prickly-pear cactus is abundant throughout the area; grasslands and aspen savannah wildlife include Mule Deer, White-tailed Deer, Moose, Coyote, Red Fox, and other small mammals; common raptors such as Bald Eagle, Red-tailed Hawk, and American Kestrel are also present in the area.

Ecoprovince/ Ecosection	Park	Area (ha)	BEC Units (Area in ha)	Comments
Peace Lowland	Kiskatinaw Protected Area	180	BWBSmw1 (159)	Contains a mosaic of grassland, aspen groves, and open pine forests on the river breaks; conserves rare grassland vegetation in the region, and species such as the red- listed fennel-leaved desert parsley; Mule Deer, White-tailed Deer, and a diversity of songbirds use the open hillsides.
Peace Lowland	Pine River Breaks Park	614	BWBSmw1 (614)	Contains open grasslands and mixed forests of aspen and spruce along the steep banks of the Pine River; wildlife includes Mule Deer, White-tailed Deer, Moose, Coyote, and Black Bear.

TABLE A 14.8. Protected areas containing grassland in the Georgia Depression.

Ecosection	Name	Area (ha)	BEC Unit	Comments
Southern Gulf Islands	Bodega Ridge Nature Preserve (Galiano Island)	147	CDFmm	Grassy open area on west-facing upper slopes and crest of ridge with dry Douglas-fir forest beneath; Bald Eagle, Turkey Vulture, and Peregrine Falcon use high cliffs.
Southern Gulf Islands	Gowlland Tod Park (Greater Victoria)	1219	CDFmm	Preserves a dry coastal Douglas-fir habitat that features grassy meadows, moss covered rocky knolls, and old-growth forest.
Southern Gulf Islands	Winter Cove Park (Saturna Island)	91	CDFmm	Broad beaches are backed by forested uplands with numerous open areas.
Southern Gulf Islands	Ruckle Park (Saltspring Island)	486	CDFmm	Over 7 km of shoreline lined with grassy headlands; popular recreation site including camping on headlands.
Southern Gulf Islands	Bellhouse Park (Galiano)	2	CDFmm	Garry oak meadows and rocky shoreline; popular day-use area.
Strait of Georgia	Mitlenatch Island Nature Park	155	CDFmm	Meadows give impressive flower display in spring; prickly-pear cactus is present; limited amounts of shore pine present in meadows, and large aspen copse on upland; large seabird colony.
Nanaimo Lowland	Drumbeg Park (Gabriola Island)	20	CDFmm	Garry oak ecosystems and undeveloped Douglas-fir forests.
Southern Gulf Islands	Oak Bay Islands Ecological Reserve	205	CDFmm	Established to protect nesting seabirds, uncommon meadow communities, showy and rare early spring wildflowers, and representative shallow-water marine habitat.
Strait of Georgia	Helliwell Park (Hornby Island)	79	CDFmm	Mature Douglas-fir forest and Garry oak woodlands are fringed with grassy meadows on the thin soils of the rocky bluffs; high diversity of wildflowers in spring.

APPENDIX 14. Continued

Ecosection	Name	Area (ha)	BEC Unit	Comments
Southern Gulf Islands	Brooks Point Land Trust (S. Pender Island)	4.5	CDFmm	Contains 50% grassland, 30% forest, 20% beach; open grasslands of bluff adjoin Douglas-fir/grand fir forest; blue-listed tiny mousetail on grassland; five species of red-listed birds attracted to intertidal zone.
Nanaimo Lowland	Mill Hill Regional Park (Greater Victoria)	8	CDFmm	Rock outcrops are dominated by mosses, grasses, and wildflowers; stands of Garry oak and arbutus fringe many of these outcrops; extends a 1000 ha regional park complex; these ecosystems have been invaded by non-native grasses and Scotch broom; contains red-listed white-top aster.
Nanaimo Lowland	Cowichan Garry Oak Preserve Land Trust (Cowichan Valley)	10.8	CDFmm	Contains 60% forest, and 40% grassland; preserve may have the best remaining intact example of Garry Oak ecosystem; red-listed Sharp-Tailed Snake, white-top aster, yellow montane violet, and golden paintbrush,. blue-listed Howell's triteleia, Western Bluebird, Coopers Hawk, Band-tailed Pigeon, Taylor's Checkerspot Butterfly; many introduced species threaten reserve.
Southern Gulf Islands	Mt. Sutil Land Trust (Galiano Island)	17	CDFmm	Contains 60% forests and 40% grassland; features the dry, southwest exposed face of Mt. Sutil with Garry oak grassland.
Nanaimo Lowland	Quamichan Garry Oak Site Land Trust (Cowichan Valley)	16	CDFmm	Contains a unique complex of ecosystems including wetland, riparian, Garry Oak, and older second-growth coniferous (Douglas fir/Grand fir) habitats.

Ecosection	Name	Area (ha)	BEC Unit	Comments
Southern Gulf Islands	C. Cunningham Nature Reserve and Covenant Lands Land Trust (Salt Spring Island)	15.7	CDFmm	Garry oak woods; provides a buffer for the Ecological Reserve.
Southern Gulf Islands	Galiano Island Land Trust	12	CDFmm	Steep coastal bluffs; important nesting habitat for seabirds.
Southern Gulf Islands	Retreat Island Fee Simple and Covenant Land Trust (Galiano Island)	3.6	CDFmm	The upland supports healthy Garry Oak woodlands and older Douglas-fir forest; grassy openings at shore line.
Southern Gulf Islands	Burgoyne Bay Land Trust (Saltspring Island)	64	CDFmm	Includes all of Burgoyne Bay including the estuary and a portion of Mt. Tuam.
Nanaimo Lowland	Christmas Hill Nature Sanctuary (Greater Victoria)	7.8	CDFmm	Garry Oak meadow containing 70% forest and 20% grassland.
Nanaimo Lowland	Esquimalt Garry Oak Land Trust (Greater Victoria)	0.4	CDFmm	A Garry oak ecosystem in Esquimalt.
Southern Gulf Islands	Gowlland Point Land Trust (S. Pender Island)	0.9	CDFmm	The grassy headland supports an abundance of rare native plants including one of the most profuse shows of chocolate lilies on the Gulf Islands; adjacent to Brooks Point.
Southern Gulf Islands	Matthews Point Land Trust (Galiano Island)	14.7	CDFmm	Features of the property include Coastal Douglas-fir-Garry oak ecosystems, rare dry-zone vegetation, migratory bird habitat, Bald Eagle nesting zone, and intertidal and beach areas.

APPENDIX 15. Grassland Range Reference Areas in British Columbia.

INDEX TO TABLES

SOURCE

Ministry of Forests, Forest Practices Branch. The Range Reference Areas of British Columbia. 2002. Available at: http://www/for.gov.bc.ca/hfp/range/rra/rra.htm

TABLE A 15.1. Grassland Range Reference Areas in the East Kootenay.

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Cranbrook					
Bagley's Pasture	PPdh2 (02B)	1997	800 m 0%	None given (1998)	Open Ponderosa pine stand.
Bronze Lake	IDFdm2 (02)	1960s	940 m 15% S	Antelope Brush-Kentucky Bluegrass-Spreading Dogbane (1993)	Wildlife-proof exclosure.
Buck Lake Ridges	IDFdm2/ PPdh2 (01,04)	1995	860m 4% SE	Kentucky Bluegrass-Silky Lupine-Hop Clover (1996)	Three-way exclosure; elk and deer winter range.
Cherry Ta-Ta	IDFdm2/ PPdh2 (06,06)	1995	900 m 0%	Bluejoint-Silverweed-Rosy Pussytoes (1996)	Includes riparian zone around lake and upland.
Old Kimberly Airport	PPdh2 (01,02B)	1936	900-930 m 0%	Rough Fescue-Kinnikinnick-Kentucky Bluegrass (1995)	Partially enclosed 1936; completely enclosed 1974.
Pickering Hills	IDFdm2 (03)	1991	975 m	Stiff Needlegrass-Kentucky Bluegrass-Antelope Brush (1994)	
Wigwam Flats	IDFdm2 (03)	1966	990 m 0%	Rough Fescue-Douglas-fir – Chokecherry (1993)	No livestock use. Forest encroachment.
Bull River	IDFdm2 (03)	1966	855 m 3% SW	Spreading Needlegrass-Kentucky Bluegrass-Antelope Brush (1993)	Wildlife-proof to exclude bighorn sheep, elk, and deer.
Invermere					
Columbia Lake East	IDFunn	1996	860 m 5% W	Douglas-fir – Rabbitbrush – Junegrass (1997)	No livestock use; wildlife winter range.
Height of Land	IDFunn	1950s	1010 m 10% SW	Rough Fescue-Idaho Fescue-Kentucky Bluegrass (1993)	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Lavington Flats	IDFdm2 (06)	1996	1150 m 1% S	Scrub Birch – Shrubby Cinquefoil-Kinninnick (1997)	Saline grassland on uplands next to wetland
Old Premier Ridge	IDFdm2 (02)	1983	1200 m 23% W	Pinegrass – Soopolallie-Rough Fescue (1987)	Prescribed fire in 1998 did not burn exclosure; forest encroachment.
Premier Ridge	IDFdm2 (03)	1991	920 m 11% SSW	Kentucky Bluegrass-Stiff Needlegrass-Antelope Brush (1994)	
Milroy	PPdh2 (02B)	1951	800 m 0%	Rough Fescue-Idaho Fescue-Ponderosa Pine (1994)	
Sagebrush	IDFunn	1997		Big Sagebrush-BluebunchWheatgrass-Junegrass (1999)	

TABLE A 15.2. Grassland Range Reference Areas in the Okanagan.

Forest District /Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Boundary					
Erickson Transect	PPdh1 (03)	1983	960 m 1-5% S	Kentucky Bluegrass-Diffuse Knapweed-Sulphur Cinquefoil (1998)	No exclosure; single transect.
Bunchgrass Hill	IDFdm1(03)	1997	800 m 32% SSW	None given (1998)	
David Creek	IDFdm1(02)	1997	910 m 23% W	None given (1998)	Heavily grazed; forest ingrowth.
Johnstone Creek	PPdh1/ IDFdm1(04)	1960s (old) 1995 (new)	950 m 10% SSW	Old- Kentucky Bluegrass -Silky Lupine- Junegrass (1995) New-Kentucky Bluegrass-Sticky Geranium- Junegrass (1995)	New exclosure established around old exclosure.
March Creek	IDFdm1(02)	1980s		Bluegrass- Big Sagebrush- Junegrass (1996)	Sampled in 1986 and 1996.
Murray Gulch	PPdh1 (01)	1995	920 m 12% SW	Columbia Needlegrass- Diffuse Knapweed- Silky Lupine (1995)	Three-way exclosure; elk and deer winter range.
Overton-Moody Range	PPdh1(01)	1975	600 m 4% SW	Columbia Needlegrass- Kentucky Bluegrass- Field Bindweed (1998)	Wildlife-proof fence; site burned 1998.
Upper Gilpin	PPdh1(01)	1973 (old) 1995 (new)	825 m 19% SSW	Old - Snowberry- Rose-St. John's-wort (1995) New - Cheatgrass- American Vetch- Tumble Mustard (1990)	New exclosure established around small exclosure.

Forest District /Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
West Midway Transect	PPdh1(03)	1986	670 m 10% W	Diffuse Knapweed-Bluebunch Wheatgrass-Cheatgrass (1998)	No exclosure; release site of biocontrol agent (*Sphenoptera*) for knapweed control.
Penticton					
Apex	ESSFxcp	1998	1950 m 30% SW	Alpine Timothy-Alpine Bluegrass-Leafy Aster (2000)	
Black Mountain	IDFxh1(02)	1997	1200 m 40% SE	Threetip Sagebrush-Bluebunch Wheatgrass-Sandberg's Bluegrass (2000)	
Chopaka	BGxh1	1995	510 m 5% NE	Big Sagebrush-Needle-and-thread Grass- Sandberg's Bluegrass (1997)	
Crater Alpine	ESSF	1994	2000 m 62% SW	Kinnikinnick-Arctic Lupine-Pinegrass (1994)	
Crater Aspen	IDFdk1(94)	1994	1375 m 16% NE	Trembling Aspen-Dandelion-Kentucky Bluegrass (2000)	
Crater South Bench	IDFdk1b	1976	1220 m 10% SW	Idaho Fescue-Bluebunch Wheatgrass – Junegrass (date not given)	
Crump	IDFxh1a(03)	1996	1050 m 23% SW	Kentucky Bluegrass-Threetip Sagebrush (date not given)	Aspen draw inside exclosure.
Chopaka East	BGxh1	1997	850 m 15% S	Needle-and-thread Grass- Sandberg's Bluegrass- Parsnip-flowered Buckwheat (2000)	

Forest District /Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Fairview	PPxh1(03)	1997	650 m variable slope variable aspect	Kentucky Bluegrass-Smooth Brome – Clovers (on flat 2000)	Variable topography includes flats, south slope, and riparian area.
Haynes	BGxh1	1994		Cheatgrass – Sand Dropseed-Prickly-pear Cactus (1997)	
Juniper South-Lower	IDFdk1	1961	1524 m 35% SE	None given (2000)	No livestock use; bighorn sheep and Mule Deer range.
Juniper South-Upper	IDFdk1	1979	1676 m	None given	No livestock use; bighorn sheep and Mule Deer range.
Joe Lake	AT	1993	2180 m 20% S	Timber Oatgrass – Subalpine Daisy-Western Meadowrue (1994)	
McClellan	PPxh1(01)	1997	510 m 5-10% W	Ponderosa Pine-Threetip Sagebrush-Cheatgrass (2000)	
Parker Mountain	PPxh1(02,03)	1997	800 m 44% SE	Bluebunch Wheatgrass- Idaho Fescue-Arrowleaf Balsamroot (2000)	
Bear Paw	MSdm2	1992	1700 m 16% E	Junegrass – Fireweed-Grouseberry (1994)	No exclosure; transects only.
Okanagan Falls	PPxh1	1993	465 m 5% NW	Cheatgrass – Bluebunch Wheatgrass- Diffuse Knapweed (1997)	No exclosure; transects only.
Vernon					
Eldorado Ranch	IDFxh1a	1996	470 m 14% W	Cheatgrass-Bluegrasses –Three-awn (1996)	Knapweed monitoring site; no exclosure.

Forest District /Name	**BEC Unit**	**Year Installed**	**Elevation Slope Aspect**	**Existing Plant Community (most recent year sampled)**	**Comments**
Pinaus	IDFxh2a	1994	583 m 6% N	Spotted Knapweed-Kentucky Bluegrass-Sandberg's Bluegrass (2001)	Knapweed monitoring site; no exclosure.
Westwold Station	IDFxh2a	1996	677 m 6% S	Sandberg's Bluegrass-Spotted Knapweed-Arrowleaf Balsamroot (2001)	Knapweed monitoring site; no exclosure.

TABLE A 15.3. Grassland Range Reference Areas in the Thompson-Pavilion.

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Kamloops					
Dewdrop East Field Deer Exclosure-West	BGxh2 (03,05)	1972	540 m 16% SW	Big Sagebrush-Needle-and-thread Grass- Pasture Sage (2000)	
Dewdrop East Field Deer Exclosure-East	BGxh2	1972	530 m 16% S	Big Sagebrush-Bluebunch Wheatgrass-Needle-and-thread-Grass (2000)	
Dewdrop Middle Field	BGxh2	1972	505 m 25% SW	Big Sagebrush-Bluebunch Wheatgrass (2000)	
Dewdrop Middle Field-East	BGxh2	1972	495 m 25% SW	Big Sagebrush-Bluebunch Wheatgrass (2000)	
Dewdrop West Field - West	BGxh2	1972	530 m 20% S	Big Sagebrush-Bluebunch Wheatgrass – Needle-and-thread Grass.(2000)	
Dewdrop West Field - East	BGxh2	1972	530 m 20% S	Big Sagebrush-Bluebunch Wheatgrass – Needlegrass.(2000)	
Frolek	IDFxh2a	1958	950 m 5%	Rough Fescue-Spreading Needlegrass-Northern Bedstraw. (2000)	Originally seeding trial, but has reverted to native vegetation.
East Mara	IDFxh2	1938	800 m 25% N	Rough Fescue – Arrowleaf Balsamroot – Big Sagebrush.1981).	
CDA Grazing Trial-BGxw1	BGxw1	1979	855 m 24% SE	Bluebunch Wheatgrass-Rough Fescue-Diffuse Knapweed. (2000).	
CDA Grazing Trial-BGxh2	BGxh2	1979	855 m 24% SW	Bluebunch Wheatgrass-Big Sagebrush..(2000).	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
CDA Middle Grassland-Burn	BGxh2	1979	755 m 15% SE	Kentucky Bluegrass-Bluebunch Wheatgrass – Big Sagebrush. (2000).	Most sagebrush killed in a pre-1989 fire.
CDA Middle Grassland-Control	BGxh2	1979	850 m 15% SE	Bluebunch Wheatgrass – Big Sagebrush-Diffuse Knapweed. (2000).	
CDA Grazing Trial Lower Grassland	BGxh2	1979	725 m 20% NE	Junegrass-Bluebunch wheatgrass – Big Sagebrush. (2000).	
CDA Lac du Bois Middle Grassland	BGxh2	1979	750 m 15% SE	Bluebunch Wheatgrass – Big Sagebrush-Junegrass (2000)	
CDA Lac du Bois Lower Grassland-Aspect 172^o	BGxh2	1979	645 m 22% S	Bluebunch Wheatgrass – Big Sagebrush-Pasture Sage. (2000).	
CDA Lac du Bois Lower Grassland-Aspect 228^o	BGxh2	1979	670 m 17% SW	Bluebunch Wheatgrass – Big Sagebrush-Kentucky Bluegrass. (2000).	
CDA Lac du Bois Lower Grassland-Aspect 360^o	BGxh2	1979	725 m 10% N	Bluebunch Wheatgrass – Pussytoes- Junegrass. (2000).	
CDA Lac du Bois Lower Grassland-Aspect 294^o	BGxh2	1979	608 m 10% NW	Bluebunch Wheatgrass – Big Sagebrush. (2000).	
CDA Lac du Bois Lower Grassland-Aspect 90^o	BGxh2	1979	615 m 10% E	None given. (2000).	
Lac du Bois CDA Grazing Trial-North	BGxh2	1979	625 m 25% S	None given.(2000).	
Lac du Bois CDA Grazing Trial-South	BGxh2	1979	585 m 15% SE	None given. (2000)	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Lac du Bois Pond 53	BGxw1 (07)	1979	925 m 10% NE	Kentucky Bluegrass-Stiff Needlegrass-Spreading Needlegrass (2000).	
Lac du Bois Pond 54-Fertilizer Trial	IDFxh2a	1981	1000 m 15% E	Rough fescue-Pussytoes. (2000).	
Lac du Bois Pond 54-Fertilizer Trial- Lower	IDFxh2a	1981	1000 m 20% NW	Bluegrasses-Rough fescue-Arrowleaf Balsamroot. (2000.	
Lac du Bois Pond 56	BGxw1	1979	840 m 10% NE	Rough Fescue-Kentucky Bluegrass. (2000).	
Lac du Bois Pond 64	BGxh2	1979	740 m 7% SE	Bluebunch Wheatgrass-Kentucky Bluegrass – Needlegrass. (2000).	Fence down since 1995.
Long Lake Lower – North	BGxw1	1979	750 m 10% SE	Junegrass – Diffuse Knapweed-Needlegrasses (2000)	
Long Lake Lower – South	BGxw1	1979	765 m 10% SW	Junegrass – Needlegrasses-Kentucky Bluegrass. (2000).	
Long Lake CDA Grazing Trial	BGxh2	1979	812 m 1 % SW	None given. (2000).	
Long Lake Upper-North	BGxw1	1979	505 m 10% S	Bluebunch Wheatgrass-Junegrass-Needlegrasses. (2000.	
Long Lake Upper-South	BGxw1	1979	800 m 13% W	Kentucky Bluegrass-Diffuse Knapweed-Spreading Needlegrass. (2000).	
Long Lake Upper-Riparian	BGxw1	1979	766 m 0% none	Bluebunch Wheatgrass-Junegrass-Kentucky Bluegrass. (2000).	
Rattlesnake Hills Aspect 16©	BGxh2(06)	1987	650 m 20% N	Bluebunch Wheatgrass-Big Sagebrush. (2000).	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Rattlesnake Hills Aspect 76^{o}	BGxh2(01)	1987	555 m 13% E	Crested Wheatgrass-Big Sagebrush-Pussytoes. (2000).	Monitor changes in crested wheatgrass seeding.
Rattlesnake Hills Aspect 360^{o}	BGxh2 (01)	1987	540 m 10% N	Bluebunch Wheatgrass-Pussytoes-Junegrass. (2000).	
Red Hill East	BGxh2	1959	700 m 2% NW	Diffuse Knapweed-Bluebunch Wheatgrass-Big sagebrush (date not given)	
Red Hill West	BGxh2	1959	700 m 10% NW	Diffuse Knapweed-Bluebunch Wheatgrass-Junegrass. (No date).	Originally, herbicide and date of seeding trial.
West Mara	BGxh2 (03,04)	1936	640 5% SW	Bluebunch Wheatgrass-Big Sagebrush – Junegrass. (No date).	
Batchelor	BGxw1	1993	635 m 15% W	Junegrass-Sandberg’s Bluegrass-Diffuse Knapweed. (2001).	Transects, no exclosure.
Dairy Two	BGxh2	1992	605 m 20% E	Needle-and-thread Grass- Bluebunch Wheatgrass – Junegrass. (2001).	Transects, no exclosure.
Long Lake	BGxw1	1992	748 m 15% E	Bluebunch Wheatgrass-Kentucky Bluegrass-Diffuse Knapweed. (2001).	Transects, no exclosure.
Walhachin	BGxh2	1993	540 m 17% SW	Needle-and-thread Grass- Sandberg’s Bluegrass- Pasture Sage. (2001).	Transects, no exclosure.

TABLE A 15.4. Grassland Range Reference Areas in the Southern Thompson Upland.

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Merritt					
Tunkwa Lake Old	IDFdk1	1963	1200 m 5% N	Rough Fescue-Kentucky Bluegrass-Field Chickweed. (1997).	Originally a variety trial.
Paxton	IDFxh2	1994	910 m 40% SW	Bluebunch Wheatgrass-Junegrass-Arrowleaf Balsamroot. (2001).	Transects, no exclosure.
Drum Lake	IDFdk1a	1920, 1994	1005 m 5% S	Junegrass-Kentucky Bluegrass-Silky Lupine (2000)	Larger exclosure built in 1994.
Foley Lake	IDFdk1	1980	1070 m 5% W	Rough Fescue Pasture Sage Kentucky Bluegrass (date not given)	
Goose Lake	IDFdk1a	1931	1188 m 5% SE	Rough Fescue (2000)	
Hamilton Bluegrass	IDFdk1a	1996	1140 m 0% 0	Kentucky Bluegrass-Dandelion-Red Clover (2000)	
Hamilton Fork	IDFdk1a	1990s	1188 m 25% SE	Stiff Needlegrass-Bluegrasses-Junegrass (2000)	
Hamilton Microwave Repeater	IDFdk1a (91)	1970s	1306 m 2% SW	Rough Fescue-Old Man's Whiskers-Brown-eyed Susan (2000)	
Hamilton (*Stipa nelsonii*)	IDFdk1a	1996	1216 m 5% N	Kentucky Bluegrass-Columbia Needlegrass- Yarrow (2000)	
Hamilton (*Stipa richardsonii*)	IDFdk1a	1996	1125 m 8% NE	Spreading Needlegrass-Kentucky Bluegrass-Stiff Needlegrass (2000)	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Lundbum Lake Fertilizer Trial	IDFdk1a	1983	1125 m 0% 0	Kentucky Bluegrass (1997)	Only one end fertilized.
Minnie Lake	IDFdk1a	1968	1105 m 5% E	Rough Fescue-Junegrass (2000)	
Muskrat Lake	IDFxh2a	1996	965 m 30% NW	Sandberg's Bluegrass- Rough Fescue-Pussytoes (2000)	
North Coutlee Flats	PPxh2 (01)	1997	800 m 5% S	Kentucky Bluegrass-Spotted Knapweed-Nootka Rose (1997)	
North Summit	IDFdk1a (91,92,93)	1968	1250 m 5% S	Rough Fescue-Kentucky Bluegrass (1996)	
Quilchena	BGxw1	1968	600 m 10% W	Bluebunch Wheatgrass-Sandberg's Bluegrass (2000)	
South Summit	IDFdk1a	1968	1250 m 5% S	Rough Fescue-Kentucky Bluegrass-Silky Lupine (2000)	
Toad Lake-East	IDFdk1a	1990's	1165 m 0% 0	Kentucky -Bluegrass-Stiff Needlegrass-Baltic Rush (2001)	
Toad Lake-West	IDFdk1a	1990's	1160 m variable	Bluegrasses-Rough Fescue-American Vetch (2001)	
Coldwater	PPxh2	1993	670 m 7% S	Kentucky Bluegrass-Cheatgrass-Spotted Knapweed (1997)	Transects only, no exclosure.
Goose Riparian	IDFdk1a (94)	1994	1125 m 0% 0	Fowl bluegrass-Dandelion-Cut-leaved Daisy (2000)	Transects only, no exclosure.
Hamilton Lake	IDFdk1a	1991	1150 m 10% E	Stiff Needlegrass-Junegrass-Bluegrasses (2001)	Transects only, no exclosure.

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Promontory	PPxh2	1993	810 m 13% SW	Bluegrasses- Spotted Knapweed- Timber Milk-vetch (2001)	Transects only, no exclosure.

TABLE A 15.5. Grassland Range Reference Areas in the Cariboo-Chilcotin and Central Interior.

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
100 Mile House					
Windmill	IDFdk3 (94)	1994	1120 m 13% W	Kentucky Bluegrass- Alkali Saltgrass- Junegrass. (1998).	
Cow Camp	IDFdk3	1962	1170 m 4% NW	Spreading Needlegrass- Bluebunch Wheatgrass- Dandelion (1998)	
China Lake	IDFxm	1996	1130 m 4% S	Sandberg's Bluegrass- Saltgrass- Cladonia. (1997).	
Upper China Lake	IDFxm	1996	1175 m 3% W	Sandberg's Bluegrass- Needle-and-thread Grass- Pussytoes (1997)	
Lower Sheep	BGxh3	1993	500 m 0% 0	Needle-and-thread Grass. (Not monitored).	Failed crested wheatgrass seeding; site not monitored.
Long Lake	IDFdk3	1995	1050 1% 0	Bluebunch Wheatgrass- Rocky Mountain Fescue- Needle-and-thread Grass. (1997).	
Wild Goose Lakes	IDFdk3	1993	1200 m 6% S	Kentucky Bluegrass- Spreading Needlegrass- Slender Wheatgrass. (1998).	
Long Run	IDFdk3	1994	1230 m 2% 0	Kentucky Bluegrass- Mat Muhly- Slender Wheatgrass. (1998).	
Onion Lake	IDFdk3	1993	1200 m 18% S	Kentucky Bluegrass- Spreading Needlegrass- Mat Muhly. (1998).	
Sting and Vert Lakes	IDFxm	1994	1120 m 1% S	Spreading Needlegrass- Sticky Geranium- Old man's Whiskers (1998)	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Vert Lake	IDFxm	1996	1160 m 2% SW	Spreading Needlegrass-Short-awned Porcupinegrass. (1997.	
Meason Creek Sheep/Cow	BGxh	1996	500 m 1% SW	Bluebunch Wheatgrass-Needle-and-thread Grass-Pasture Sage. (1998).	
Dry Farm	IDFxm/dk3	1985	1028 m 4% W	Spreading Needlegrass-Short-awned Porcupinegrass-Spikelike Goldenrod. (1998).	
Green Lake 6 Mile	IDFdk3	1996	900 m 3%	Spreading Needlegrass-Junegrass-Kentucky Bluegrass. (1997).	
Hart Ridge	IDFdk3	1996	1200 m 1% NE	Kentucky Bluegrass – Old man's Whiskers-Graceful Cinquefoil. (1997).	
Cavanagh Creek Sheep	BGxh3	1997	500 m 2%	Big Sagebrush – Bluebunch Wheatgrass-Sand Dropseed. (1998).	
Little White Lake/ Little White Roadside	IDFdk3	1996	1150 m 2% SE	Alkali Saltgrass. (1996).	
Upland Little White	IDFdk3	1995	1150 m 3%	Rocky Mountain Fescue-Pasture Sage-Cladonia.(1997).	
Five Mile Run	IDFdk3	1995	1150 m 1% NW	Alkali saltgrass-Junegrass-Cladonia (1997)	
Wild Rye	IDFdk3	1985	1150 m 0%	Kentucky Bluegrass-Spreading Needlegrass-Short-awned Porcupinegrass. (1998).	Visual assessment only; failed Altai wild rye seeding.
Alberta Lake	IDFdk3	1994	1130 m 17% SW	Bluebunch Wheatgrass-Short-awned Porcupinegrass-Pussytoes. (1998).	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Timian Creek	IDFdk3	1996	1150 m 5% SW	Kentucky Bluegrass- Sandberg's Bluegrass- Arrowleaf balsamroot.(1997).	
Mirage Lake	IDFdk3	1996	900 m 3% S	Kentucky Bluegrass- Woolly Cinquefoil- Field Chickweed (1997)	Riparian habitat also sampled.
Horse Lake Horn	IDFdk3	1996	1050 m 28% S	Needle-and-thread Grass- Kentucky Bluegrass- Timber Milk-vetch (1997)	
Williams Lake					
Green Field South	IDFxm	1986	1140 m 1%	Junegrass- Bluebunch Wheatgrass- Needle-and-thread Grass (1997)	
Wycott Goose Lake	IDFdk4	1990	1310 m 10% SW	Bluebunch Wheatgrass- Woolly Cinquefoil- Trailing Daisy (1997)	
Old Place Field	BGxw2 (01)	1986	7% SW	Junegrass- Bluebunch Wheatgrass- Pussytoes (1998)	
Green Field Split	IDFxm	1989	1130 m 0%	Needle-and-thread Grass- Kentucky Bluegrass- Bluebunch Wheatgrass (1997)	
Needlegrass Farwell	BGxh3	1986	620 m 5%	Needle-and-thread Grass- Bluebunch Wheatgrass- Brittle Prickly-pear Cactus (1997)	
Joes Lake	IDFxm	1995	1060 m 17% S	Kentucky Bluegrass- Needle-and-thread Grass- Spreading Needlegrass (1997)	
Alkali Creek	IDFxm	1995	850 m 8% S	Kentucky Bluegrass- Yarrow- Field Chickweed. (1997).	
Milk Ranch Lake	IDFdk3	1996	1100 m	Kentucky Bluegrass- Clovers- Dandelion.(1997).	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Forestry Last Chance	IDFxm	1996	1080 m 7% SW	Kentucky Bluegrass-Timber Milkvetch-Pussytoes. (1997).	
Dick Meadow	SBPSxc	1995	900 m 0% 0	Sandberg's Bluegrass-Foxtail Barley-Mat Muhly. (1997).	Also contains shrub-carr and wet meadow.
Big Flat	IDFxm	1990	1100 m 4% S	Junegrass-Sandberg's Bluegrass-Pussytoes. (1990).	
Cultus Lake	IDFxm	1994	1085 m 15% S	Junegrass-Stiff Needlegrass-Pussytoes (1995)	
Two Lakes High Pasture	IDFxm	1994	1150 m 0% 0	Alkali Saltgrass-Sandberg's Bluegrass-Foxtail Barley. (1995).	
Hungry Valley	MSxv	1996	690 m 5% S	Timber Oatgrass-Rocky Mountain Fescue- Field Chickweed (1997)	Exclosure also contains a shrub-carr and wet meadow.
Cow Lake	IDFdk4	1994	1100 m 11% W	Kentucky Bluegrass-Woolly Cinquefoil-Field Chickweed (1997)	
Jamieson	IDFdk4	1994-96	1100 m	None given. (1997)	
Alex Lake	IDFdk4	1993	1280 m 10% SW	Junegrass-Spreading Needlegrass-Wooly Cinquefoil. (1995).	
Long Lake Field	IDFdk3	1986	1050 m 0%	Short-awned Porcupinegrass – Stiff Needlegrass-Junegrass. (1997).	
North Long Lake	IDFxm	1990	1160 m 9% S	Kentucky Bluegrass-Salsify-Pussytoes. (1997).	
Thaddeus Lake	IDFdk4	1990	1170 m 3% S	Spreading Needlegrass-Junegrass-Bluebunch Wheatgrass. (1997).	
Breeding Pasture South	IDFdk4	1986	1300 m 1% SE	Junegrass-Rocky Mountain Fescue- Pussytoes. (1997).	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Green Field North	IDFxm	1986	1100 m 5% NW	Spreading Needlegrass-Slender Wheatgrass-Kentucky Bluegrass. (1997).	
Green Field West	IDFxm	1989	1160 m 0%	Bluebunch Wheatgrass-Junegrass- Kentucky Bluegrass. (1997).	
Breeding Pasture North	IDFdk4	1986	1150 m 4% S	Spreading Needlegrass-Dandelion. (1997).	
Bald Mountain Big B Road	IDFdk4	1993	1100 m 5% SW	Rocky Mountain Fescue- Kentucky Bluegrass- Blunt Sedge. (1998).	
Dog Lake	IDFdk4	1993	1245 m 7% S	Kentucky Bluegrass-Timber Oatgrass-Spreading Needlegrass. (1998).	
Bald Mountain Holding Ground	IDFxm	1993	1250 m 10% E	Spreading Needlegrass-Kentucky Bluegrass-Salsify (1998)	
Becher’s Prairie Loran C	IDFxm	1993	1000 m 0%	Spreading Needlegrass-Short-awned Porcupinegrass –Stiff Needlegrass.(1998).	
Snake Pit	IDFxm	1995	1000 m 0%	Spreading Needlegrass-Short-awned Porcupinegrass – Kentucky Bluegrass.(1998).	
Rock Lake	IDFxm	1995/96	980 m 0%	Kentucky Bluegrass-Wooly Cinquefoil-Pussytoes.(1997).	Riparian site.
Baseball Diamond	IDFxm	1995	950 m 9% W	None given. (1998).	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Toosey	IDFxm	1923	940 m 0%	Bluebunch Wheatgrass-Short-awned Porcupinegrass-Kentucky Bluegrass. (1998).	
Big Sage Farwell	BGxh3	1990	570 m 4% S	Needle-and-thread Grass- Bluebunch Wheatgrass-Prickly-pear Cactus. (1997).	
Deer Park	BGxw2	1990	750 m 2% S	Bluebunch Wheatgrass-Needle-and-thread Grass- Tarragon. (1997).	
Cotton Ranch Corrals	IDFxm	1994	990 m 5% E	Spreading Needlegrass-Junegrass- Pussytoes (1998)	
Company Cabin	IDFxm	1994	1030 m 6% S	Junegrass- Needle-and-thread Grass- Pussytoes. (1998.)	
Mile 35 Field	IDFxm	1994	1010 m 3% E	Junegrass- Rocky Mountain Fescue- Salsify. (1995).	
Cotton Lake	IDFxm	1994	980 m 4% W	Junegrass- Bluebunch Wheatgrass-Pussytoes. (1995).	
Skunk Flats	IDFdk3	1995	650 m 0%	Kentucky Bluegrass-Timothy- Dandelion. (1995).	Riparian site in meadow
Chilcotin					
Tsuh Lake	IDFdk4	1994	1000 m	Alkali Saltgrass-Sandberg's Bluegrass-Kentucky Bluegrass. (1995).	
Punti Lake	SBPSxc	1993	950 m 4% S	Junegrass – Bluebunch Wheatgrass-Stiff Needlegrass. (1997).	
Stone Pasture Lower	IDFxm	1996	800 m 1% NW	Kentucky Bluegrass-Alkali Cordgrass- Foxtail Barley. (1997).	

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Stone Pasture Upper	IDFxm	1996	800 m 3% N	Bluebunch Wheatgrass-Sand Dropseed-Prickly-pear Cactus. (1997).	Exclosure has 4 communities; upland and transitional.
Paxton Valley	SBPSxc	1998	1210 m 0%	None given. (1998).	Exclosure contains upland and riparian
Jones Flats	IDFxm	1997	1050 m 0 5	Junegrass-Pussytoes-Woolly Cinquefoil. (1998).	
Alexis Lakes	SBPSxc	1994	1000 m 2% SW	Kentucky Bluegrass-Mat Muhly-Field Sedge.(1998).	
Chilco-Taseko	IDFdk4	1994	800 m 3% S	Needle-and-thread Grass- Junegrass-Wooly Cinquefoil. (1998).	
Siwash Bridge	IDFxm	1994	800 m 0 %	Needle-and-thread Grass- Kentucky Bluegrass-Junegrass. (1998).	
Choelquoit Lake	IDFdk4	1994	1000 m 6% S	Bluebunch Wheatgrass-Junegrass-Pussytoes. (1998).	
Haines Lake	IDFdk4	1993	1000 m 0%	Kentucky Bluegrass-Alkali Saltgrass-Sandberg’s Bluegrass. (1995).	
Upper Haines	IDFdk4	1996	1000 m 7% S	Kentucky Bluegrass-Junegrass-Rocky Mountain Fescue (1997)	
Polywog Lake	SBPSxc	1994	900 m 5%	Alkali Saltgrass-Junegrass-Mat Muhly. (1998).	
Jim Holte	SBPSxc	1995	900 m 10% SE	Needle-and-thread Grass- Sandberg’s Bluegrass- Pussytoes. (1997).	

APPENDIX 15. Continued

Forest District/ Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Tatla Lake	SBPSxc	1995	900 m 10% SE	Needle-and-thread Grass- Junegrass- Bluebunch Wheatgrass. (1997).	
North Potatoes	ESSFxv2	1993	1900 m 2% S	None given. (1998).	

APPENDIX 15. Concluded.

TABLE A 15.6. Grassland Range Reference Areas in the Northern Boreal Mountains.

Forest District	Name	BEC Unit	Year Installed	Elevation Slope Aspect	Existing Plant Community (most recent year sampled)	Comments
Fort Nelson	Gathto	SWBmk	1998	1450 m 75% warm	Fuzzy-spiked-Wildrye-Fendler's Bluegrass (1997)	
Fort Nelson	Halfway Meadow	SWBmk	1998	1200 m 0%	Scrub Birch-Altai Fescue (1997)	
Fort St. John	Hammett	SWBmk	1997	1300 m 35% warm	Grey-leaved Willow- Fuzzy-spiked Wildrye (1997)	
Fort St. John	Jesson-Gorrie	ATp	1996	1700 m 5%	Grey-leaved Willow- Cow Parsnip-Altai Fescue (1996)	
Fort St. John	McQue Flats	SWBmk	1996	1200 m 2%	Grey-leaved Willow- Scrub Birch-Fuzzy-spiked Wildrye (1996)	
Fort St. John	Mount Bertha	SWBmk	1996	1200 m <5%	Shrubby Cinquefoil-Altai Fescue (1997)	
Fort St. John	Ross	BWBSmw1	1998	800 m variable	Fuzzy-spiked Wildrye-Fireweed-Showy Aster (1999)	Fire-maintained disclimax.

APPENDIX 16. Land status of grasslands in British Columbia by geographic region.

INDEX TO TABLES

SOURCES

Grasslands Conservation Council.2003. B.C. Grasslands mapping project: A conservation risk assessment. 3rd Year Annual, Grasslands Conserv. Counc. of B.C., Kamloops, B.C. 51pp.

Grasslands Conservation Council. 2004. Draft statistics for B.C. Grasslands Conservation Risk Assessment. Grasslands Conserv. Counc. of B.C., Kamloops, B.C.

TABLE A 16.1. Land status of grasslands in the East Kootenay.

Land Status	Area (ha)	Proportion of Total Grassland (%)
Crown grassland not in protected area	27,665	63.0
Crown grassland in protected areas	555	1.3
Private	10,035	22.8
Private Non-Government Owned (protected)	1,760	4.0
Federal Indian Reserve	3,915	8.9
Federal Non-Indian Reserve	10	0.0
Total	43,940	100.0

TABLE A 16.2. Land status of grasslands in the Okanagan.

Land Status	Area (ha)	Proportion of Total Grassland (%)
Crown grassland not in protected area	28,030	24.0
Crown grassland in protected areas	8,815	7.6
Private	56,235	48.2
Private Non-Government Owned (protected)	1,935	1.7
Federal Indian Reserve	21,625	18.5
Federal Non-Indian Reserve	0	0.0
Total	116,640	100.0

TABLE A 16.3. Land status of grasslands in the Thompson-Pavilion.

Land Status	Area (ha)	Proportion of Total Grassland (%)
Crown grassland not in protected area	60,740	43.7
Crown grassland in protected areas	11,170	8.0
Private	46,880	33.7
Private Non-Government Owned (protected)	35	0.0
Federal Indian Reserve	20,090	14.5
Federal Non-Indian Reserve	15	0.0
Total	138,930	100.0

TABLE A 16.4. Land status of grasslands in the Southern Thompson Upland.

Land Status	Area (ha)	Proportion of Total Grassland (%)
Crown grassland not in protected area	27,405	20.7
Crown grassland in protected areas	960	0.7
Private	91,995	69.4
Private Non-Government Owned (protected)	0	0.0
Federal Indian Reserve	12,140	9.2
Federal Non-Indian Reserve	0	0.0
Total	132,500	100.0

TABLE A 16.5. Land status of grasslands in the Cariboo-Chilcotin and Central Interior.

Land Status	Area (ha)	Proportion of Total Grassland (%)
Crown grassland not in protected area	106,100	48.2
Crown grassland in protected areas	24,985	11.3
Private	78,105	35.5
Private Non-Government Owned (protected)	265	0.1
Federal Indian Reserve	7,340	3.3
Federal Non-Indian Reserve	3,395	1.5
Total	220,190	100.0

TABLE A 16.6. Land status of grasslands in the Taiga Plains and Boreal Plains.

Land Status	Area (ha)	Proportion of Total Grassland (%)
Crown grassland not in protected area	9,935	61.5
Crown grassland in protected areas	190	1.2
Private	5,705	35.3
Private Non-Government Owned (protected)	0	0.0
Federal Indian Reserve	320	2.0
Federal Non-Indian Reserve	0	0.0
Total	16,150	100.0