Sensitive Ecosystems Inventory: Lake Country, 2005

Volume 1: Methods, Ecological Descriptions, Results, Conservation Analysis, and Management Recommendations

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THE REAL ESTATE FOUNDATION OF BRITISH COLUMBIA

DISTRICT of LAKE COUNTRY

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This project has adapted material from the reports for the Bella Vista – Goose Lake Range Sensitive Ecosystems Inventory[9] and Central Okanagan Sensitive Ecosystems Inventory[10].

We would like to thank the many landowners that gave us permission to access their lands for field sampling.

[1] The mission of the Real Estate Foundation is to support sustainable real estate and land use practices for the benefit of British Columbians.
[2] Iverson & MacKenzie Biological Consulting Ltd.
[3] District of Lake Country
[4] Iverson & MacKenzie Biological Consulting Ltd.
[5] Polar Geoscience
[6] Ophiuchus Consulting
[7] Artemis Wildlife Consultants
[8] Baseline Geomatics Inc.
[9] Iverson 2003
[10] Iverson and Cadrin 2003

Abstract

The Okanagan Basin of British Columbia has very high biodiversity, including many special concern, threatened, and endangered species and ecological communities. A high diversity of ecosystems occurs in close proximity, providing habitat for many species. The region has been subject to extensive agricultural conversion, intense human settlement pressure, noxious weed invasion, uncontrolled motorized recreation, and forest ingrowth and encroachment associated with fire exclusion.

The District of Lake Country is a vital portion of the north – south corridor in the Okanagan Valley and is facing further development pressures It has a wide variety of site conditions including many rare and unique elements.

The Lake Country SEI was initiated in 2004 to provide inventory information on rare and fragile ecosystems that can be used for ecologically sustainable land use and development planning. We used Terrestrial Ecosystem Mapping (TEM) as a base to develop a Sensitive Ecosystems theme map. The inventory was compiled through aerial photograph interpretation and field sampling in the summer of 2005. The project area covers private land, provincial parks, regional parks and provincial crown land. This technical report documents inventory methods and results, the conservation analysis, and provides management recommendations.

Twenty-eight percent of the study area is comprised of sensitive ecosystems (SE); eight percent of the area was included in the other important ecosystem (OIE) categories. Wetlands, old forests, riparian, sparsely vegetated, and broadleaf woodland ecosystems were extremely rare in the study area. Although greater areas of intact grasslands and coniferous woodland ecosystems remained, much of the area was covered by altered ecosystems including extensive agricultural fields, young forests, and some disturbed grasslands. Remaining grasslands are at risk to invasive plant species introduction or spread.

Many of the sensitive ecosystems are at high risk from human settlement, including loss, fragmentation, or further degradation by human use and invasion by non-native plants. Many forested areas have become thick with ingrowth and are at risk of loss to catastrophic wildfires.

Sensitive and other important ecosystems provide many social values including recreation opportunities and increased property values. With the study area supporting many remaining rare and fragile ecosystems, it is paramount to balance the retention and ecological sustainability of sensitive ecosystems with sustainable land development.

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Using the Report

This report presents information on sensitive ecosystems in the District of Lake Country of the central Okanagan Valley, and provides guidance regarding their conservation and management.

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Chapter 2: Ecosystems of concern outlines the importance of sensitive ecosystems, and the need for concern about them.

Chapter 3: Impacts of concern describes the types of impacts that threaten sensitive ecosystems.

Chapter 4: Methods and limitations explains how the mapping was completed and limitations of the mapping.

Chapter 5: Inventory results describes and shows a map of the status of sensitive ecosystems in the study area.

Chapter 6: Conservation analysis describes the methods used in the conservation analysis and the results of the analysis.

Chapter 7: Planning and management outlines conservation and land management planning options for the District of Lake Country and landowners.

The Central Okanagan Sensitive Ecosystems Inventory report[11] provides detailed information on conservation tools that are directly applicable to ecosystems in the District of Lake Country.

Chapters 8 through ***16*** profile each of the seven sensitive ecosystems and two other important ecosystems. Each chapter describes the specific ecosystem, and its status and importance in the study area. Impacts and management recommendations specific to the ecosystem are also discussed.

Chapter 17: Future directions presents recommendations for using the SEI, updating SEI products, and extending the inventory's coverage.

There are two companion volumes to this one for people who need or are interested in more technical information on ecosystem mapping (Volume 2) and wildlife habitat mapping (Volume 3).

Volume 2[12] provides detailed information on ***terrestrial ecosystem mapping*** (TEM) methods and gives descriptions of each of the ecosystems that occur within the sensitive ecosystems or

[11] Iverson and Cadrin 2003. Contact Todd Cashin at the Regional District of the Central Okanagan for more information.

other important ecosystems categories. Appendix B of Volume 1 provides tables that can be used to cross-reference between sensitive and other important ecosystems units and ecosystem mapping units in the ecosystem mapping report.

Volume 2 includes information on methods, results and recommendations for the ***terrain, terrain stability,*** and ***erosion potential mapping***. It is intended for use by professionals that require more detailed ecological and terrain information. It is recommended for use by people interested in developing other interpretive map themes from the ecosystem or terrain mapping.

Volume 3[13] contains wildlife habitat mapping themes developed from the terrestrial ecosystem mapping (TEM) for the following eleven species: Great Basin Spadefoot (*Spea intermontana*), Painted Turtle (*Chrysemys picta*), Western Rattlesnake (*Crotalus oreganus*), Gopher Snake (*Pituophis catenifer* ssp. *deserticola*), Western Screech-owl (*Megascops kennicottii* ssp. *macfarlanei*), Long-billed Curlew (*Numenius americanus*), Yellow-breasted Chat (*Icteria virens*), Grasshopper Sparrow (*Ammodramus savannarum*), Swainson's Hawk (*Buteo swainsonii*), Spotted Bat (*Euderma maculatum*), and Badger (*Taxidea taxus jeffersonii*). All of these species are considered at risk in the province of B.C. and most are listed under the federal Species at Risk Act. These species provide a cross-section of threatened or endangered amphibians, reptiles, birds, and mammals that depend on a range of different ecosystems in the study area. There are many other threatened and endangered species that likely occur in the study area and are listed in each ecosystem chapter of Volume 1.

Wildlife habitat mapping portrays the potential importance of each ecosystem to specific animal species through a species-habitat model. The model assigns ratings to different ecosystem units from the TEM based on the needs of the species for particular life requisites. These ratings are displayed on the wildlife habitat maps. Volume 3 is intended for professionals who require more detailed information on wildlife habitat values in the study area than Volume 1 provides.

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[12] Iverson and Uunila 2006
[13] Haney and Sarell 2006

1 Introduction

The Okanagan Valley is an area of tremendous biological, ecological and geological diversity. However, many ecosystems have been lost, significantly modified, or fragmented; these ecosystems continue to be primarily threatened by urban and agricultural development. The valley provides a vital north – south corridor connecting the Great Basin to the south with other dry interior valleys of British Columbia. The District of Lake Country encompasses the central portion of a ridge that extends from Kelowna to Vernon in the North Okanagan, and includes the slopes east of Wood Lake and Kalamalka Lake. The area is a significant portion of the central portion of the valley and has a diverse assemblage of relatively intact ecosystems that support many species at risk and other important species.

The District of Lake Country and Ministry of Environment initiated this project to develop an inventory information base and conservation analysis to support sound land management decisions and promote effective stewardship of sensitive ecosystems in the District of Lake Country of the central Okanagan. The project provides the District of Lake Country with data that can be used in revising their Official Community Plans and provides information to input into Neighbourhood and Parks Plans. This product contributes to the tools and information required to develop and assess broad conservation and development options for the study area.

This report describes inventory methods and results, rare and fragile ecosystems of the District of Lake Country, highlights their values and importance, and offers practical advice on how to best avoid or minimize damage to them.

The Lake Country SEI follows from the Vernon Commonage SEI[14], Bella Vista – Goose Lake Range SEI[15], Central Okanagan SEI[16], and Vancouver Island SEI[17]. Many of the materials in this report have been adapted from the reports of those SEI projects.

1.1 Study Area

The study area (Figure 1) lies within the central Okanagan Valley of south-central British Columbia. It is bounded by the boundaries of the District of Lake Country. It abuts the North Okanagan Regional District to the north, Okanagan Lake to the west, and the Central Okanagan Regional District and City of Kelowna in the south. The area covers 12,330 ha and includes private land, provincial parks, regional parks, and provincial crown land. The area covers 6,728 ha and includes private land, provincial parks, regional parks, and provincial crown land.

It lies within the Okanagan Very Dry Hot Ponderosa Pine (PPxh1) [18] and the Okanagan Very Dry Hot Interior Douglas-fir (IDFxh1), Shuswap Moist Warm Interior Douglas-fir (IDFmw1), and the Okanagan Dry Mild Montane Spruce (MSdm1) biogeoclimatic variants. The study area is located

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[14] Iverson 2005
[15] Iverson 2003
[16] Iverson and Cadrin 2003
[17] McPhee et al. 2000
[18] The BC Ministry of Forests ***Biogeoclimatic Ecosystem Classification*** (BEC) is a system of classifying vegetation based on climatic and topographic patterns. The BEC system was developed by the Ministry of Forests to provide a basis for natural resource management, particularly forest and range management. See Pojar et al. 1987 for further information.

within the Southern Interior ***Ecoprovince***[19], the northern extension of the Columbia Basin that extends south to Oregon and lies within the North Okanagan Basin ***Ecosection***[20], a wide trench formed by parallel fault lines and further carved out by multiple glaciations, and the North Okanagan Highland Ecosection (NOH), a cool, moist, transitional mountain area, dominated by a rolling upland.

The Okanagan Valley experiences some of the warmest and driest weather conditions in the province. The valley lies in the rain shadow of the Coast and Cascade Mountains; this results in low precipitation in both winter and summer. In summer, hot dry air moves in from the Great Basin to the south, and very hot temperatures are common; however, the presence of Okanagan, Kalamalka, and Wood Lakes (large, glacial-relic lakes), moderates these temperatures somewhat by cooling the air in summer and warming it in winter.

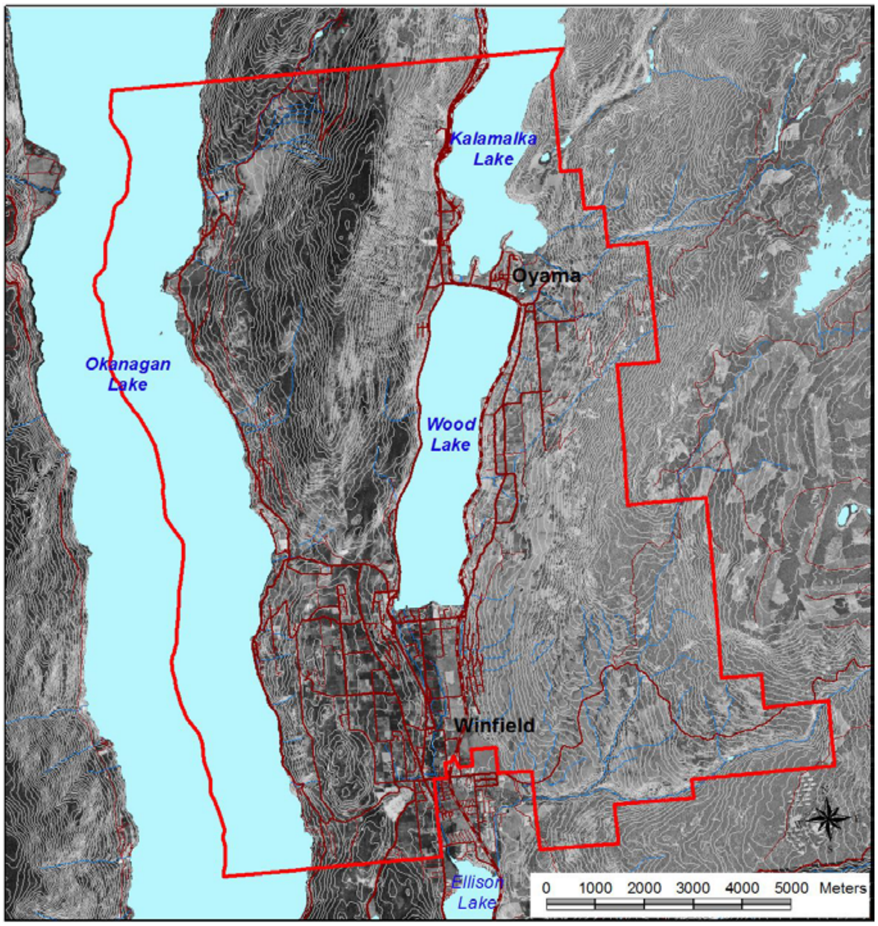

Figure 1. Lake Country SEI study area outlined in red.

[19] The ecoregional classification system was developed and adapted by the former Ministry of Environment, Lands & Parks, Wildlife Branch, to provide a systematic view of the small scale ecological relationships within British Columbia. An ***Ecoprovince*** is an area of consistent climate or oceanography, and physiography, of a size useful for provincial overview-planning. See Demarchi 1996 for further information.
[20] An ***Ecosection*** is a subdivision of an Ecoprovince and is an area with minor physiographic and macroclimatic or oceanographic differences.

1.2 Ecological Importance of the Study Area

The Okanagan Valley is a region of nearly unparalleled biological diversity within British Columbia, Canada, and North America. The complex terrain of the area, combined with a semi-arid climate moderated by the influence of Lake Okanagan and other large lakes has resulted in a wide diversity of ecosystems and organisms in relatively close proximity to one another. The terrain and presence of glacial-relict lakes distinguish the Okanagan Valley from the broad Columbia Basin to the south. Increasingly, scientists are finding that populations at the edge of their range, such as those in the Okanagan, are likely to persist longer than core populations during population declines. This phenomenon may allow these populations to adapt to future changes such as global warming[21].

The Okanagan Valley is a north to south corridor that connects the dry interior valleys of British Columbia to southern grassland ecosystems of the Columbia Basin in the U.S. The valley is a corridor for migrating birds and a point of entry for organisms entering into B.C.'s dry interior from the Columbia Basin.

The District of Lake Country has many remaining relatively large and natural areas, and has a great diversity of ecosystems, plant and wildlife species, landforms, and bedrock geology. With proper planning and management, the natural features of the study area provide the potential for long-term viability of many endangered species and sensitive ecosystems. The area may be an important area for the northward migration of species during global warming. Finally, the area provides many community values including aesthetics, hiking, and observing wildlife and nature.

Figure 2. Overview of central portion of study area.

[21] Scudder 1991

2 Ecosystems of Concern

2.1 What are Sensitive Ecosystems?

This sensitive ecosystems project recognises both ***sensitive ecosystems*** (SE) and ***other important ecosystems*** (OIE) in the study area. *Sensitive ecosystems* refer to seven ecosystem types (Table 1) that are ecologically fragile or are rare in the provincial landscape and are relatively unmodified by human influences[22] (Table 1). These sensitive ecosystems are generalised groupings of ecosystems that share many characteristics, particularly ecological sensitivities, ecological processes, rarity, and wildlife habitat values. These categories were adopted from the Central Okanagan SEI.

Other important ecosystems are partially modified ecosystems that provide many natural values including wildlife habitat, wildlife corridors, buffers between developed areas and sensitive ecosystems, and sources of potential recruitment for some sensitive ecosystems (Table 2).

Within developed landscapes, sensitive and other important ecosystems provide natural areas with intrinsic value and critical habitats for many species. They provide ecological functions that regulate the climate, clean freshwater, regulate and clean soils, maintain genetic diversity, maintain the water cycle, recycle nutrients, and pollinate crops. They are vital in creating healthy and attractive communities for people.

Table 1. Sensitive ecosystems mapped in the study area including the code, name and description.

Code	Sensitive Ecosystems	Ecosystem Description
WN	Wetlands	Non-forested ecosystems where the water table is at or near the surface; includes **wet meadows** (WN:md), **marshes** (WN:ms), and **shallow open water** (WN:sw) ecosystems including ponds
RI	Riparian	Streamside ecosystems in gullies with intermittent or permanent creeks (**gully**, RI:gu); and fringe ecosystems associated with pond and lake shorelines (**fringe**, RI:ff).
OF	Old Forest	Forest ecosystems dominated by large, old trees; excludes old riparian forests; includes old Coniferous Woodlands and old Broadleaf Woodlands.
GR	Grasslands	Ecosystems dominated by bunchgrasses (**grassland**; GR:gr) and **shrubland** (GR:sh) ecosystems that occur in a grassland matrix
BW	Broadleaf Woodlands	Ecosystems dominated by trembling aspen (BW:ac) occurring in depressions and moist areas in grasslands; old Broadleaf Woodlands are part of the Old Forest category.
WD	Coniferous Woodlands	Open stands of Douglas-fir or ponderosa pine, often on shallow soils, with typically grassy understories; old Coniferous Woodlands are part of the Old Forest category.
SV	Sparsely Vegetated	Shrubby rock outcrops (**shrub**; SV:sh), grassy or unvegetated **rock outcrops** (SV:ro), **talus** (SV:ta) slopes, and **cliffs** (SV:cl)

[22] Ward et al. 1998

Table 2. Other important ecosystems mapped in the study area including the code, name and description.

Code	Other Important Ecosystems	Ecosystem Description
MF	Mature Forest	Forests dominated by mature trees; includes **broadleaf** (MF:bd) forests, **coniferous** (MF:co) forests, and **mixed** (MF:mx) deciduous and coniferous forests; excludes mature riparian forests and mature coniferous and broadleaf woodlands
DG	Disturbed Grasslands	Disturbed grasslands are grasslands with some noxious or invasive plants (20 to 70% of the vegetation cover in the plant community)

2.2 Why are these ecosystems important?[23]

The ecological attributes and socio-economic values that are common to all SEI ecosystems are discussed below. Values and attributes unique to individual ecosystems are discussed in Chapters 8 – 16.

Ecological Attributes

Rarity is a primary feature of sensitive ecosystems. Rarity can be due to limited natural occurrence or the result of human activities since European settlement in the late 1800's. Most rare species or ecological communities in the study area are considered to be rare both because they are restricted in distribution or abundance, and because their extent and densities have been reduced and fragmented.

Rare ecological communities and vertebrate species are listed for each sensitive ecosystem (Chapters 8 – 16).

The Okanagan Valley provides habitat for many species that are nationally ranked by COSEWIC[24] as endangered (E), threatened (T) or of special concern (C), or are provincially ranked as red-listed or blue-listed[25]. The Species at Risk Act[26] provides protection for species ranked as threatened or endangered that occurring on Federal land. See Appendix C for a list of wildlife species with the potential to occur in the study area.

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[23] Adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.
[24] **COSEWIC,** the Committee on the Status of Endangered Wildlife in Canada, determines the national status of wild Canadian species, subspecies and separate populations suspected of being at risk. Endangered (E) denotes a species facing imminent extirpation or extinction. Threatened (T) denotes a species likely to become endangered if limiting factors are not reversed. (SC) denotes a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
[25] **Red-list**: The list of British Columbia's flora, fauna, and ecological communities that are rare and endangered. **Blue-list**: The list of British Columbia's flora, fauna and ecological communities that are at risk because of low or declining numbers.
[26] Government of Canada 2003.

Some ***red-listed*** vertebrate animals in the study area include[27]:

Badger (COSEWIC-E) (*Taxidea taxus* ssp. *jeffersonii*)
Swainson's Hawk (*Buteo swainsoni*)
Yellow-breasted Chat (COSEWIC-E) (*Icteria virens*)
Grasshopper Sparrow (*Ammodramus savannarum*)

Some ***blue-listed*** animals in the study area include:

Spotted Bat (COSEWIC-SC) (*Euderma maculatum*)
White-throated Swift (*Aeronautes saxatalis*)
Gopher Snake (COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Racer (COSEWIC-SC) (*Coluber constrictor*)
Western Rattlesnake (COSEWIC-T) (*Crotalus oreganus*)
Painted Turtle (*Chrysemis picta*)
Great Basin Spadefoot (COSEWIC-T) (*Spea intermontana*)

Conservation Data Centre

web site: http://srmwww.gov.bc.ca/cdc/

Check this web site for the current provincial conservation status of rare plants, animals, and ecological communities, since the status of these changes over time.

COSEWIC

web site: http://www.cosewic.gc.ca/

Check this web site for the current national status of rare plants and animals.

- **Fragility** is a measure of an ecosystem's sensitivity to a range of disturbance factors that can cause decline or loss of ecosystem health or integrity. Disturbances include direct physical impacts, introduction of invasive species, and fragmentation. Many of the SEI ecosystem types are fragile because they are vulnerable to invasion by invasive plants, they have erodable soils, and they depend on complex ecological processes that are easily disrupted.
- **High biodiversity** is a common feature of most SEI ecosystems, largely because of the proximity of the Okanagan Valley to grasslands and deserts to the south, and because of the close proximity of many different types of ecosystems in the landscape. This creates an ensemble of species at risk not found elsewhere in Canada.
- **Specialised habitats** occur throughout the SEI ecosystems. They support many species of plants and animals. Typically, these ecosystems are critical habitats for rare, threatened, endangered, or special concern species or ecological communities. Some of these occur in only a few places in British Columbia or Canada, and their loss in the Okanagan would result in the loss of biodiversity and species at risk.

[27] See Appendix D for a full list of known and potential threatened and endangered vertebrates in the study area.

Socio-economic Values

- **Ecosystem Services** including air and water filtration and purification, nutrient cycling, and crop pollination. Clean water, water retention, and groundwater infiltration are important values provided by natural areas.
- **Green Space** networks comprised of diverse ecosystems and species of the area will provide for human enjoyment and interaction with wildlife amidst development. The area provides an attractive and aesthetic backdrop for the City.
- **High scenic values** are provided by rock outcrops, grasslands, and cliffs that provide excellent views of the landscape. These areas are often targeted for recreational and residential development. The community's natural landscape attracts visitors and new residents, and contributes towards opportunities for nature-based tourism and the unique 'sense of place', and is a source of pride and pleasure for local residents.
- **Outdoor recreation** opportunities are provided by ecosystems in public parks, and on accessible crown land where low-impact activities will not damage the habitat. Wildlife viewing is very important to Canadians[28], and contributes to our quality of life. Bird watching is among the fastest growing leisure pursuits. Hunting, fishing, trapping and guide outfitting contribute to the economy and can occur where wildlife populations can sustain them.
- **Research and nature education** are important at all levels from early childhood through to university, plus continuing education programs. Many schools are now working with local groups (e.g., Streamkeepers and Wetlandkeepers); most focus on creating native plant communities and restoring wildlife habitat. Local nature centres provides opportunities for local and regional community ecosystem conservation efforts through displays, educational programs, hands-on workshops, and conservation-based volunteer activities.
- **Nature based tourism** is growing in economic importance, and can be very important in rural communities. Economic spin-offs can include benefits to local commercial services such as overnight accommodation, food concessions, and ventures such as guided nature trips and bird watching. Annual events such as the Meadowlark Festival in the South Okanagan make significant contributions to the local economy as they attract visitors from well beyond the host community.
- **Natural resource use** such as grazing and selection harvesting of forests have supported generations of Okanagan residents and continue to be important activities in the study area. The study area is also a source of many plants traditionally used by First Nations including food plants such as balsamroot and mariposa lily.
- **Increased property value** is provided by green space and wild lands. The beauty of the natural landscape is often a large part of what attracts people to the North Okanagan. Studies show that undeveloped green space measurably increases the value of nearby property[29] by 5 to 32%[30] and thus, contributes far more in property taxes than it costs in services[31].

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[28] Environment Canada 1999
[29] Meadows 1999
[30] U.S. National Parks Service 1990
[31] Fodor 1999

3 Impacts of Concern[32]

Within the central Okanagan Valley, the District of Lake Country has many of the remaining relatively intact natural ecosystems that are minimally fragmented. Human settlement pressures represent the greatest threat to sensitive ecosystems in the study area. Large-scale landscape concerns, which affect all ecosystems, include landscape fragmentation, disruption of natural disturbance regimes, edge effects, and invasive species introductions.

3.1 Landscape fragmentation

Fragmentation of the landscape often affects the functioning of ecosystems by disrupting connections between different ecosystems (e.g., between uplands and wetlands, resulting in changing water movement and water table levels). Fragmented ecosystems also are more susceptible to a variety of impacts, such as invasion by non-native species and increased access and inappropriate activities by people. In addition, disconnected islands of natural ecosystems often cannot provide the necessary habitat values for wildlife species, which may require a number of different ecosystems for breeding, wintering, and foraging. A network of corridors that connect habitats will help to maintain habitat access, gene dispersal, and the potential for distribution of wildlife species.

Within the study area, urban and agricultural developments have affected many edges and surroundings.

3.2 Disruption of Natural Disturbance Regime

The exclusion and suppression of natural fire has changed grassland and forest ecosystems in the study area. Ecosystems and species of the Okanagan Valley have evolved with natural fire as a major factor in ecosystem and habitat distribution. Frequent ***surface fires***[33] maintained open forests with largely grassy and shrubby understories. Fire exclusion has resulted in dense forests ingrown with Douglas-fir and ponderosa pine, and encroachment of these trees onto grasslands. Fire exclusion has affected both ecosystem processes and wildlife habitat values.

Field observations indicate that many of the forested areas of the District of Lake Country were likely a combination of grasslands and very open forests historically. Areas where there is little wind-deposited (aeolian) material on the soil surface tend to have more trees on them now than areas with aeolian deposits. Aeolian material is comprised of sands and silts with no rocks. Compared to trees, native bunchgrasses are better able to capture the surface moisture in wind-deposited materials. The lack of aeolian material may have allowed trees to establish more readily once fires began to be excluded with European settlement in the late 1800's.

[32] Adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

[33] Surface fires are fires that burn primarily through the understory or grass and herbaceous vegetation in an ecosystem and do not burn in the overstory trees. This is in contrast to the Kelowna fire of 2003 which was able to burn through the forest canopy because forests are now more closed than they were historically.

3.3 Invasive Species

Both the deliberate and accidental introduction of invasive non-native plant species (see below) has significantly altered the species composition of some ecosystems in the study area. Many grasslands have been altered by invasive plants. Some invasive animal species such as European starlings have altered wildlife populations by displacing native cavity nesting birds.

Invasive plant species reduce diversity by displacing native plant species, and by reducing vegetation diversity and soil stabilization. Invasion of non-native plants usually results in a loss of forage for domestic livestock and wildlife. Recreation vehicles such as all terrain vehicles (ATVs), bicycles, animals, and people can all spread invasive plants. Many invasive plants have seeds that can survive in the soil for decades; consequently, invasive plant control must always be considered to be a long-term process.

For this SEI, we define **invasive plant species** as non-native plants which, in the area they occur, lack the natural enemies necessary to restrict their distribution.

Noxious weeds are aggressive invasive plants that are designated under the provincial ***Weed Control Act***.

Grasslands, old forests, coniferous woodlands, and sparsely vegetated ecosystems are vulnerable to invasion by cheatgrass (*Bromus tectorum*) and other annual bromes (*Bromus* spp.), diffuse knapweed (*Centaurea diffusa*), and sulphur cinquefoil (*Potentilla recta*). Disturbed grasslands are very vulnerable to takeover by invasive plant species if they are disturbed further. Riparian ecosystems and broadleaf woodlands are vulnerable to invasion by common hound's-tongue (*Cynoglossum officinale*) and common burdock (*Arctium minus*). Wetland ecosystems can be completely altered if purple loosestrife (*Lythrum salicaria*) becomes established (it was not observed in the study area but is known from around Kelowna).

Some invasive plant species:

Diffuse knapweed (*Centaurea diffusa*)
Sulphur cinquefoil (*Potentilla recta*)
Cheatgrass (*Bromus tectorum*) and other annual bromes (*Bromus* spp.)
Dalmation toadflax (*Linaria genistifolia*)
Common hound's-tongue (*Cynoglossum officinale*)
Purple loosestrife (*Lythrum salicaria*)

Figure 3. Cheatgrass (left) and knapweed plant in its first year (right).

3.4 Edge effects

Fragmentation of ecosystems combined with adjacent development contributes to the creation of 'edges' where there is an abrupt rather than natural, gradual change from one ecosystem type to another. This edge effect can alter the habitat value of the original ecosystem by creating changes in microclimate elements such as air temperature, light level, and humidity[34]. Direct biological effects result when specific species cannot tolerate human activity nearby, or they are exposed to predation by other species including domestic pets. Increased non-native species invasion and competition for habitat are examples of indirect biological edge effects.

The study area is influenced by edge effects in developed areas such as Winfield, Oyama, and other rural roads and housing developments. The agricultural fields in the study area provide a much softer edge than urban development. These agricultural areas still provide some habitat values, including places for wildlife to traverse to other habitats. Additional urban growth, roads, and other land development within the study area have the potential to increase edge effects.

3.5 Direct Impacts

Direct impacts to ecosystems are those which occur on site, and which have the most immediate and visible effect. Vegetation removal or damage and soil removal or compaction are examples of immediate and visible effects. Ditching, diking, draining and filling of wetlands and riparian areas are visible effects that also result in long-term indirect effects on water movement and water levels. Disturbances to wildlife species, particularly during the breeding season can directly impact their survival. Although it may seem like large rural lots have the potential to retain many natural values, many owners choose to remove native vegetation and natural features, and intensely graze domestic animals (e.g., horses). Degradation and fragmentation of these areas also leaves them more vulnerable to weed invasion. All of these possible changes reduce the ecological integrity and natural values of these areas.

[34] Chen et al. 1995; Saunders et al. 1991

3.6 Indirect Impacts

Activities that occur adjacent to or at some distance from the ecosystem result in indirect impacts. Hydrological[35] changes due to roads, buildings, irrigation, deforestation, removal of vegetation, invasive plant species, increased impervious road surfaces, soil compaction and agricultural practices can all result in reduced groundwater infiltration and summer soil moisture, increased annual runoff, disrupted drainage patterns, and reduced soil moisture holding capacity. These hydrological changes can change the water quality and function, structure, and wildlife habitat values of adjacent wetlands and riparian areas.

Water pollution from both point and non-point sources contributes to reduced water quality, potential outbreaks of water-borne disease, and impacts to wildlife populations through the loss of habitat and disruption of the food chain. The use of pesticides associated with agriculture and landscaping has also caused degradation of natural ecosystems and wildlife habitat[36].

The presence of humans and their pets, even on private property can cause disturbances to wildlife. Recreational activities involving all terrain vehicles (ATVs), dirt bikes, off-road vehicles, and mountain bikes, create soil disturbances that allow rapid invasion and spread of invasive plant species. They can also disturb wildlife, and cause soil erosion and damage to plants. Similarly, domestic pets such as cats and dogs may predate or harass wildlife.

[35] Water-related features and processes.

[36] Cannings and Durance 1998

4 Methods and Limitations[37]

This chapter describes the methods that were used to generate the sensitive ecosystems map. These methods follow those used in the Central Okanagan SEI. The provincially recognised Terrestrial Ecosystem Mapping[38] (TEM) approach was used to create a base map. Ecosystems were evaluated for rarity and ecological sensitivity, and a sensitive ecosystems theme map was developed.

4.1 Terrestrial Ecosystem Mapping

Terrestrial Ecosystem Mapping (TEM) formed the foundation of the thematic sensitive ecosystems map that was created for this project. Polygons were drawn on 1:15,000 aerial photographs around areas of uniform vegetation, topography and terrain features. Ecosystem, terrain, and conservation evaluations were recorded in a polygon database. The polygons were digitized and compiled in a geographic information system (GIS), and linked to the polygon database.

Details on methods, results, limitations and management recommendations for Terrestrial Ecosystem Mapping and terrain mapping can be found in **Volume 2**[39].

Details on methods, results, limitations and management recommendations for wildlife capability and suitability mapping can be found in **Volume 3**[40].

4.2 Sensitive Ecosystems Mapping

For the Central Okanagan SEI[41], Bella Vista SEI[42], and Vernon Commonage SEI[43], TEM units were evaluated for rarity and ecological sensitivity and were assigned to sensitive ecosystems and other important ecosystems categories accordingly. For this project, TEM units were assigned to the same sensitive ecosystems as in the Central Okanagan, Bella Vista, and Vernon Commonage SEIs and any new TEM units were evaluated for rarity and ecological sensitivity.

The criteria used in the Central Okanagan, Bella Vista, and Vernon Commonage SEIs for ecological sensitivity included the presence of shallow soils, the susceptibility of the site to hydrological changes, erosion, and presence of invasive plant species, and sensitivity associated with human disturbance. Rarity was based on rankings and proposed rankings by the Conservation Data Centre (CDC), provincial distribution of those ecosystems (especially in an undisturbed state), and the threats to them.

If an ecosystem was determined to be ecologically fragile or rare, it was assigned to the applicable sensitive ecosystems category. In cases where a given ecosystem could be assigned to more than one Sensitive Ecosystems category, it was always assigned to the more sensitive category.

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37 Adapted from Iverson and Cadrin 2003.
38 Resources Inventory Committee 1998
39 Iverson and Uunila 2006
40 Haney and Sarell 2006
41 Iverson and Cadrin 2003
42 Iverson 2003
43 Iverson 2005

For example, old riparian forests were assigned to the 'riparian' rather than the 'old forest' category and old coniferous woodlands were assigned to the 'old forest' category rather than the 'coniferous woodland' category.

Ecosystems were grouped into sensitive ecosystems categories using the Ecosystem-based Resource Mapping (ERM) Ratings Table Tool[44]. This tool allows SEI categories to be assigned to each ecosystem. Detailed conversion tables can be found in Appendix B.

Each polygon can have up to three ecosystem components mapped in it. The three components are ordered by area of occupancy from largest to smallest. The final Sensitive Ecosystems map shows the first component of the polygon in a colour specific to that Sensitive or Other Important Ecosystem type (see Figure 5 in Section 5 Inventory Results). The presence of a second or third component is indicated by cross-hatching but does not specifically indicate which Sensitive or Other Important Ecosystem is present.

Field Sampling and Conservation Evaluation of Sensitive Ecosystems

Prior to fieldwork, landowners with larger holdings within the study were contacted by letter and phone (and sometimes in person) to request permission to sample their lands. Numerous landowners agreed to have their lands sampled, although several large landowners did not grant access.

I developed a sampling plan using forest cover maps to identify areas of potentially old forest, and used aerial photographs to identify accessible potentially sensitive ecosystems including grasslands, wetlands, ponds, aspen copses, riparian areas, rock outcrops, and talus slopes. Field sampling was completed in the summer of 2005, and a total of 180 sensitive ecosystems or other important ecosystems sites were field-checked (Table 3; an additional 102 plots were completed in non-sensitive ecosystems). A team of three scientists including a plant ecologist, terrain specialist, and wildlife biologist conducted the sampling.

Three types of sample plots were used to identify and assess ecosystems: detailed ecological plots, ground inspections, and visual inspections[45]. Sample plots were subjectively located within polygons to best represent the ecosystem(s) in that polygon. Samples sites were distributed to maximize sampling of sensitive ecosystems; other ecosystems were sampled along access routes to sensitive ecosystems. Sampling of private lands we did not have permission to access was limited to visual inspections with binoculars from accessible locations on adjacent properties. Sampling procedures for detailed ecological plots and ground inspections are outlined in *Field Manual for Describing Terrestrial Ecosystems*[46]. The *Standard for Terrestrial Ecosystem Mapping*[47] in British Columbia provides guidelines for visual inspection data collection. We also assessed the conservation values of each site.

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[44] See http://srmwww.gov.bc.ca/wildlife/whr/sta.html for more information on the ERM tools.
[45] See Volume 2: Iverson and Uunila 2006
[46] BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998
[47] Resources Inventory Committee 1998

Table 3. Number of sites field sampled by ecosystem type.

Sensitive Ecosystems	Full plots	Ground Inspections	Visuals	Total Plots
Broadleaf Woodland		1	4	5
Grasslands	2	10	14	26
Old Forest	3	4		7
Riparian		9	14	23
Sparsely Vegetated	1	8	14	23
Coniferous Woodland	3	11	43	57
Wetland		3	11	14
TOTAL	**9**	**46**	**100**	**154**
Other Important Ecosystems				
Disturbed Grasslands		6	9	15
Mature Forest		5	6	11
TOTAL	**0**	**11**	**15**	**26**

4.3 Mapping Limitations

The SEI information is intended to provide a broad planning base and to alert local and regional decision-makers, landowners, and development or planning consultants of the presence of important ecosystems and ecological features.

The SEI mapping does not replace the need for on-site assessments of areas where land use changes are proposed or contemplated.

The accuracy of polygon boundaries is limited by the scale (1:15,000) and date (1994) of the aerial photographs on which the sites are delineated.

It is recommended that digital data not be enlarged beyond the scale of the photos as this may result in unacceptable distortion and faulty registration with other data sets.

On-going land uses may have changed some polygons after the date that the aerial photographs were taken or the field sampling was conducted. Wherever possible, polygons reflect conditions that were noted during field sampling and on orthophotos from 2003, rather than when the aerial photographs were taken.

One of the primary limitations of aerial photograph interpretations is the ability to see disturbances such as cover of invasive plants. I applied information from field sampling data to adjacent areas. Disturbance levels may have changed in some areas after the field sampling was completed.

Often small sensitive ecosystems are captured as a small component of a larger polygon that is dominated by one or two other ecosystems. Many polygons contain a complex of up to three ecosystems, and sensitive ecosystems may only occupy a portion of a given polygon. While polygon delineation is much more detailed than in many 1:15,000 ecosystem-mapping projects, the landscape is complex, resulting in many complex polygons.

5 Inventory Results

This chapter provides a summary of the distribution and extent of sensitive ecosystems and other important ecosystems in the study area. Further details can be found in each of the ecosystem chapters.

SEI Summary Results

Seven types of sensitive ecosystems and two types of other important ecosystems were identified. Collectively the seven sensitive ecosystems (SE) covered 27.6% (4517 ha) of the study area), while modified landscapes covered the remaining 68.9% (Figure 4 and Table 4). The two other important ecosystems (OIE) mapped covered 8.4% (1371 ha) of the study area. Figure 5 shows the distribution of sensitive ecosystems in the study area. Each polygon can have up to three ecosystem components mapped in it. The three components are ordered by area of occupancy from largest to smallest; only the first component is shown in colour on the map.

Ecosystems that have not been included as sensitive ecosystems or other important ecosystems still have many important values, especially to provide connectivity and buffers between and around SE and OIEs. Some ecosystems such as younger forests may be recruitment sites for future SEs or OIEs. Many non-sensitive ecosystems provide important wildlife habitat. Also, the vegetation and soils help provide the safe capture, storage, and release of water that is critical to maintaining water quality, preventing soil erosion, and maintaining the hydrological function of wetland, riparian and other ecosystems.

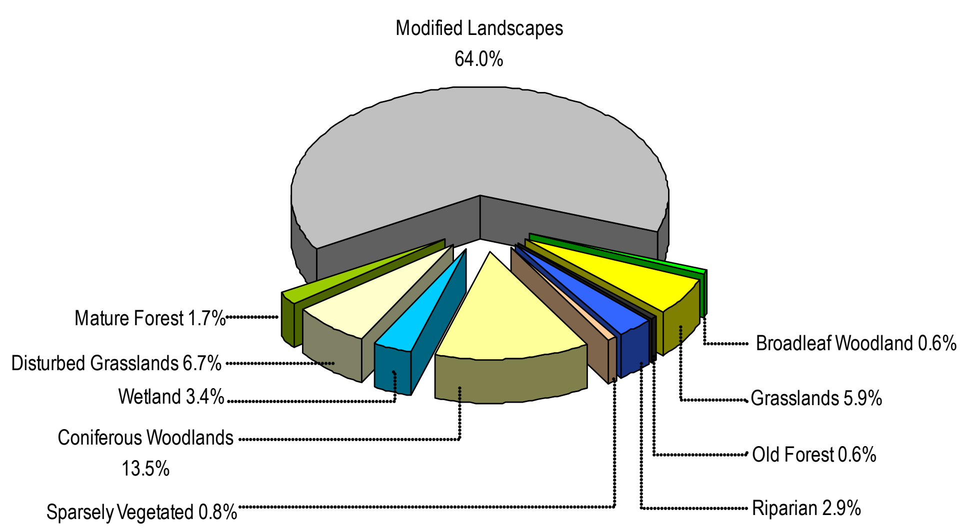

Figure 4. Relative proportion of sensitive ecosystems, other important ecosystems, and modified landscapes in the study area.

Table 4. Area of sensitive ecosystems and other important ecosystems in the study area.

	Area (ha)	Percent of Study Area
Sensitive Ecosystems (SE)		
Broadleaf Woodland	92	0.6
Grassland	966	5.9
Old Forest	90	0.6
Riparian	477	2.9
Sparsely Vegetated	129	0.8
Coniferous Woodland	2206	13.5
Wetland	558	3.4
Total SE	**4517**	**27.6**
Other Important Ecosystems (OIE)		
Disturbed Grassland	1091	6.7
Mature Forest	280	1.7
Total OIE	**1371**	**8.4**
TOTAL SE and OIE	**5888**	**36.0**

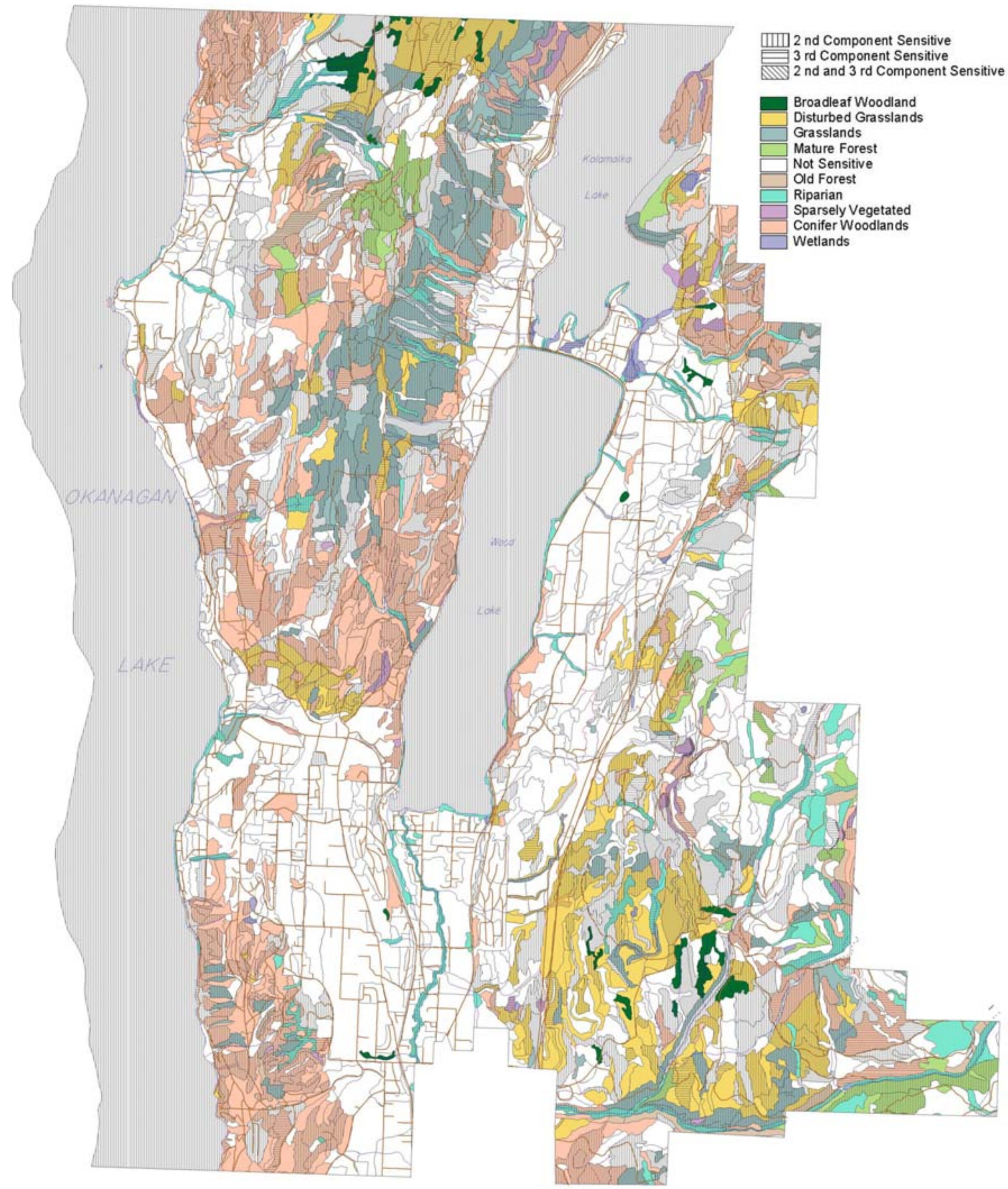

Figure 5. Map of Sensitive and Other Important Ecosystems map for the study area. The first component of each polygon is shown in colour and the presence of other sensitive components is shown with cross-hatching but does not specifically indicate which Sensitive or Other Important Ecosystem is present.

6 Conservation Analysis

The first stage in developing a Local Ecosystems Plan (see Section 7) is the systematic prioritization of ecosystems for protection. This can provide a basis for a strategy for parks designation and acquisition, other forms of protection, and sensitive development. This can be accomplished using the base mapping used to develop the Sensitive Ecosystems Inventory. This conservation analysis is intended to provide the prioritization of ecosystems. It follows methods developed for the conservation analysis in 'Balanced Growth for the Bella Vista – Goose Lake Range' (Clarke et al. 2004).

The primary goals of the conservation analysis are to identify areas within the study area that, if retained as intact ecosystems and properly managed, will:

- conserve representative high quality examples of all sensitive and important ecosystems;
- ensure the long-term existence of significant wildlife habitat and all native plant and wildlife species in the study area, especially rare and endangered species;
- maintain ecological linkages within the study area and to adjacent areas; and
- maintain all ecological functions and wildlife habitat needs within these areas.

To achieve these objectives, we used a broad scale planning approach based on GIS data from the Sensitive Ecosystems Inventory, Terrestrial Ecosystem Mapping[48], and Wildlife Habitat Mapping[49].

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[48] Iverson and Uunila 2006
[49] Haney and Sarell 2006

6.1 Conservation analysis methods[50]

Three stages were used to identify priority areas for conservation.

Stage 1: Cumulate Conservation Values

1. A rating scheme based on rarity, quality and condition of ecosystems, was developed to prioritize sensitive ecosystems mapped in the District of Lake Country.
   a. The relative value of sensitive and other important ecosystems in the study area was ranked in order of importance from 0 (minimal importance) to 10 (highest importance), and the results shown below (Table 5).[51]

Table 5. Relative ecosystem values for sensitive ecosystems.

SEI category	SEI subcategory	Relative Ecosystem Value	Rationale (% of study area)
Broadleaf Woodland	Aspen Copse	7	Sensitive & very rare within the study area (0.6%)
Disturbed Grassland		6	Disturbed but provide values for many grassland species including many rare and endangered species (6.7%)
Grassland	Grassland	9	Very Sensitive & provincially rare; moderately distributed in the study area (4.5%)
	Shrubland	9	Very Sensitive & provincially rare; very rare in the study area (1.4%)
Mature Forest	Coniferous	3	Rare, but less sensitive (1.7%)
	Mixed	3	Very rare, but less sensitive (0.02%)
Not a Sensitive or Other Important Ecosystem		0	Not sensitive (64%)
Old Forest	Coniferous	10	Very sensitive, very important wildlife habitat, very rare (0.6%)
Riparian	Fluvial Fringe	10	Very sensitive, very important wildlife habitat, very rare (1.2%)
	Bench	10	Very sensitive, very important wildlife habitat, very rare (0.4%)
	Gully	10	Very sensitive, very important wildlife habitat, rare (1.3%)
Sparsely Vegetated	Cliff	10	Sensitive, very important wildlife habitat, very rare (0.03%)
	Rock	9	Sensitive, important wildlife habitat, very rare (0.2%)
	Shrub	9	Sensitive, important wildlife habitat, very rare (0.3%)
	Talus	10	Sensitive, very important wildlife habitat, very rare (0.2%)
Coniferous Woodland	young	6	Sensitive, important wildlife habitat, common (13%)
	mature	8	Sensitive, very important wildlife habitat, rare
Wetland	Wet Meadow	10	Very sensitive, very important wildlife habitat, very rare (0.0005%)
	Marsh	10	Very sensitive, very important wildlife habitat, very rare (0.1%)
	Shallow Water	10	Very sensitive, very important wildlife habitat, uncommon (3%)
	Swamp	10	Very sensitive, very important wildlife habitat, very rare (0.04%)

   b. Each sensitive- or other important ecosystem was rated as to the quality and condition of the ecosystem in the original mapping. Values were assigned to these ratings from 0 (lowest value) to 1 (highest value) as shown below in Table 6.

[50] This section and these methods are adapted from Clarke et al. 2004

[51] Values are not intended to be absolute, instead only the relative ranking of ecosystems is important.

Table 6. Values assigned to each quality and condition rating.

Quality and Condition Rating	Assigned Value (from 0 to 1)
Excellent	1
Good	0.8
Marginal	0.5
Poor	0.1

c. The SEI and quality-condition values were multiplied together for each component of a polygon, to produce the combined ecosystem values.

2. Wildlife habitat values were examined for the most important life requisites of 10 of the 11[52] selected species whose habitats were mapped (Table 7). All ecosystems, including sensitive and non-sensitive ecosystems were rated for current habitat suitability for various life requisites for each of these 10 species. Each component of a polygon was assigned a value of 10 for a high rating, 6 for a moderate rating, 1 for a low suitability rating, and 0 for a nil rating. All of the values for each component of each polygon were averaged. The final value used for the polygon was the component with the highest value.

Table 7. Species and life requisites used to assign wildlife values to polygons.

Species	Map Theme (Life requisite)
Great Basin Spadefoot	Breeding
Western Rattlesnake	Basking/denning
Gopher Snake	Egg-laying
Swainson's Hawk	Nesting
Long-billed Curlew	Nesting
Western Screech-owl	Nesting
Yellow-breasted chat	General living (nesting and foraging)
Grasshopper Sparrow	General living (nesting and foraging)
Spotted Bat	Breeding/roosting
Badger	General living (denning and foraging)

3. For each polygon component, sensitive ecosystem and wildlife habitat values were combined into a single value giving a two to one weighting of ecosystems to wildlife (2 x ecosystem value + wildlife value). Ecosystems were weighted more heavily as they also represent values for a much broader range of species whose habitat was not mapped [53]. The final value used for the polygon was the component with the highest value.

The resulting map of combined and weighted SEI / habitat ratings is shown as the 'Conservation Value Map' (Figure 6).

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[52] Painted Turtle was excluded because of the habitat overlap with Great Basin Spadefoot.
[53] There is no guidance in scientific literature to guide the appropriate weighting of ecosystem and wildlife habitat values. We found that there was considerable overlap between conservation priorities for ecosystems and wildlife, thus maps produced with different weighting would be very similar.

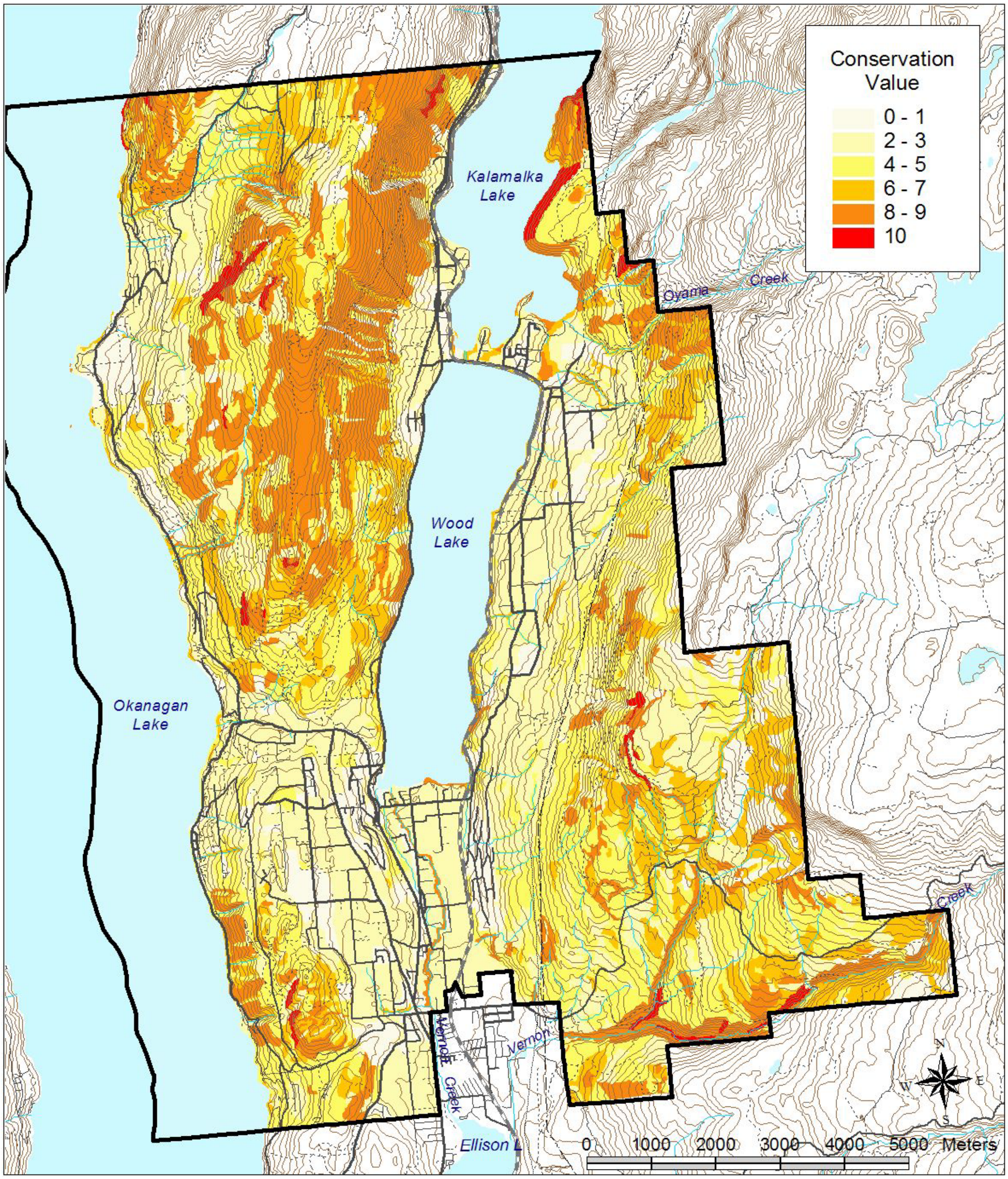

Figure 6. Conservation value map.

Stage 2: Identify Priority Conservation Areas

Using the conservation rating map, conservation areas including core areas, buffers, wildlife corridors, and other important conservation areas were identified based on size, concentration and connectivity of high value areas (see Figure 7). Additionally, the SEI map and wildlife habitat maps were cross-referenced to ensure that the most important ecosystem and wildlife habitat values were captured. The figure illustrates priorities for conservation, and could be used to develop a vision for a system of protected areas and resource lands connected across the landscape.

1. Core Conservation Areas

Areas with a large concentration of high and some moderate conservation values were identified as core conservation areas. These would be the areas of highest priority for conservation. Ideally, activities would be primarily directed towards maintaining ecological and wildlife habitat values in these areas. There may be small areas within the core areas that could be accessed and developed without compromising core values (e.g., by fragmentation); further larger scale mapping and wildlife inventory would be needed to identify these areas. Core areas are high priorities for acquisition by land trusts, conservation organizations, for Regional Parks, and should be zoned for environmental purposes.

2. Buffers

Core conservation areas need to be buffered from potential adverse effects of adjacent land uses. One hundred meter buffers around core areas were identified to conserve values in core conservation zones, and need to be managed for that purpose. The width and design of buffers also needs to be refined at larger scales to reflect the size of patches, ecosystem types, local landscape features and wildlife habitat values. Wetland and riparian buffers will likely need to be wider[54], but it is possible that buffers around some upland ecosystems may be narrower.

3. Wildlife Corridors

Wildlife corridors provide animals with an opportunity to move freely between two or more habitat patches or habitat types in an otherwise fragmented landscape. This movement is essential to provide genetic links between populations and prevent inbreeding, and to compensate for

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54 "It is generally acknowledged that terrestrial buffers or riparian strips (30 to 60 meters) wide will effectively protect water resources. However, terrestrial habitats surrounding wetlands are important to more than just the protection of water resources. They are also essential to the conservation and management of semi-aquatic species... Our data clearly indicates that buffers of 15-30 meters, used to protect wetland species in many states, are inadequate for amphibians and reptiles. We propose…three terrestrial zones of protection... an aquatic buffer 30-60 meters; a core habitat (which includes the aquatic buffer): 142 to 289 meters; and an additional terrestrial buffer of 50 meters"

"We propose…three terrestrial zones adjacent to core aquatic and wetland habitats (1) a first terrestrial zone immediately adjacent to the aquatic habitat, which is restricted from use and designed to buffer the core aquatic habitat and protect water resources (30 to 60 meters); (2) starting again from the wetland edge and overlapping with the first zone, a second terrestrial zone that encompasses the core terrestrial habitat defined by semi-aquatic focal-group use (e.g., amphibians 159 – 290m); and (3) a third zone, outside the second zone, that serves to buffer the core terrestrial habitat from edge effects from surrounding land use (e.g. 50 meters)"

From: Semlitsch, R. and J. Bodie. 2003. Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles. Cons. Biol. 17(5):1219-1228.

temporary population declines in one of the habitat patches. The habitat needs of all priority species should be incorporated into the design of the corridor. Corridors must be suitably wide, with appropriate habitat features to provide security cover during movement. Corridors usually consist of linear habitats such as gully or streamside riparian areas; they are often composed of two or more ecosystem types to provide complexity to the corridor. Development and roads should avoid these zones, and mitigation will be required where roads and other developments transect the corridor. Wildlife corridors were identified to connect core areas to each other and to outside the study area, including connections to Okanagan Lake, Kalamalka Lake, and Wood Lake.

In some cases, corridors have already been fragmented by roads and connections need to be restored. In particular, it will be challenging to restore connections across Highway 97.

Corridors, where possible, include riparian draws with adjacent warm aspect grasslands, and ridges. These habitat features are those most commonly used for travel between habitats. Larger scale mapping and additional wildlife inventory might identify some small areas that could be developed without compromising connectivity and other corridor values. This would depend upon the type and configuration of development, and site-specific issues.

4. Other Important Conservation Areas

Areas with a concentration of moderate conservation values were identified as other important conservation areas. Activities would be directed towards maintaining ecological and wildlife habitat values. There would be areas within that could be accessed and developed without compromising some ecological values; further larger scale mapping and wildlife inventory would be needed to identify these areas.

Stage 3: Refine Conservation Priorities

The conservation area design identified in Stage 2 was compared to the SEI map and each wildlife habitat map to ensure all high priority values were included in the appropriate zone. This ensured that core areas included old forests and wetlands, and that there was diversity within each core area.

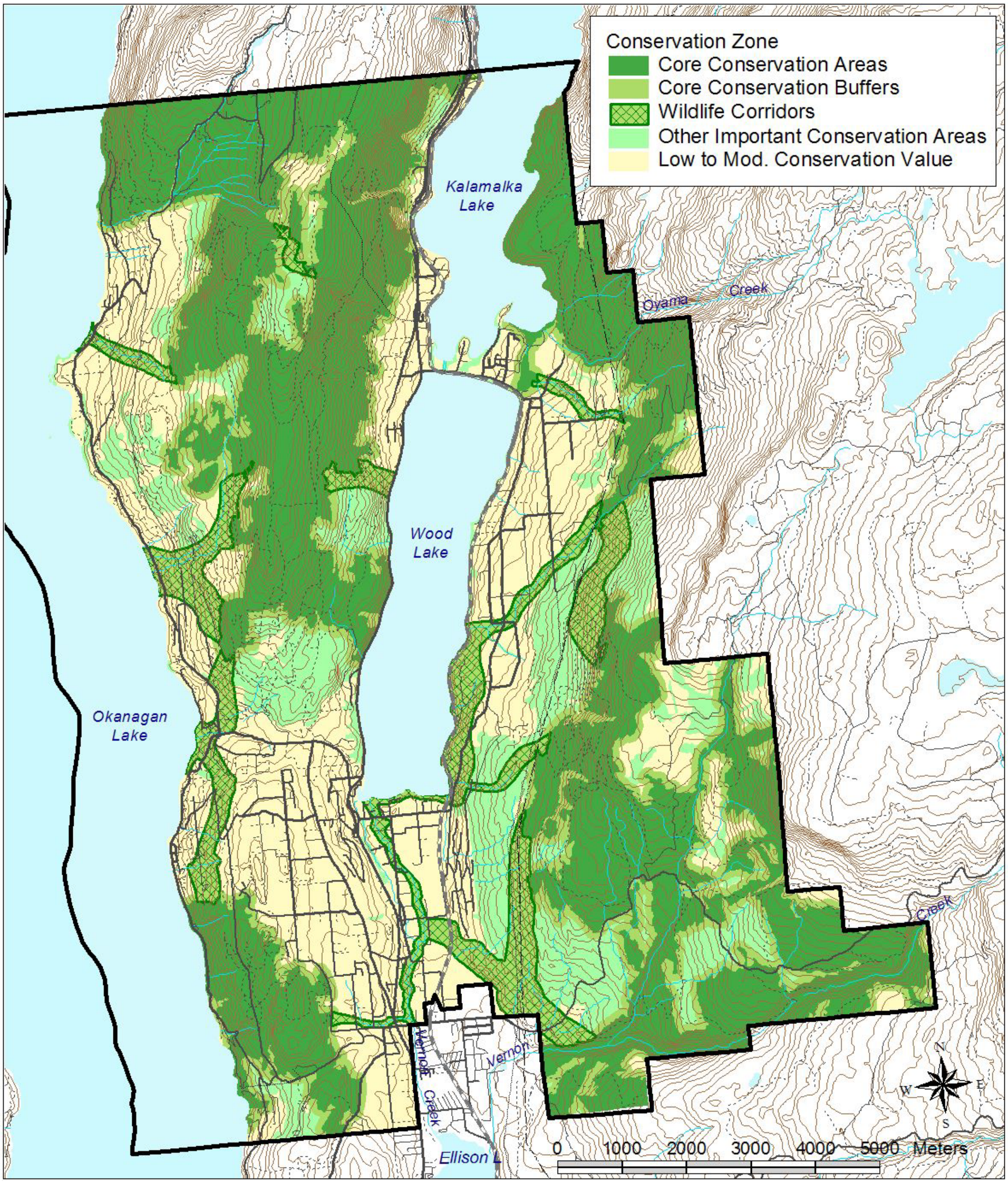

Figure 7. Conservation zones.

6.2 Management of Conservation Zones

Management of Core Conservation Areas (CCA)

Where CCAs occur in areas of rural land use, some managed resource uses (e.g., grazing and selection harvesting of ingrown coniferous forests) may be compatible with conservation values. Landowner contact programs, stewardship agreements, and other forms of stewardship activities could help landowners understand and care for biodiversity values on their property.

CCAs that are situated on properties subject to urban development should be a priority for protection. Core areas are recommended as a focus for conservation/parkland acquisition and should receive more detailed analysis to determine appropriate park boundaries, and to determine other potential means of land acquisition and other conservation options such as conservation covenants. Development Permit Areas (DPAs) can provide for protection of some of the features in and adjacent to these areas. Golf courses are not compatible with the objectives of CCAs, but depending on site conditions, may be compatible with buffer areas or wildlife corridors.

Classification of parks and conservation features should be determined and applied consistently throughout the region. The approved park classification system should be used in the Neighbourhood Planning process to avoid confusion regarding the purpose of green space areas.

Park planning should use zoning to identify areas and apply management objectives for conservation and recreational values.

Management of Buffers

Buffer widths and designs should be refined to better reflect the specific ecosystem and wildlife habitat values in the CCA that they surround. Higher quality and more sensitive ecosystems, important wildlife habitats, and more natural areas are higher priorities for inclusions in buffers. Where wetlands occur near the edge of a CCA, they will require significantly wider buffers and buffers should be designed to provide Painted Turtles and Spadefoots sufficient unrestricted access to other habitats they require. Other more sensitive areas may also require wider buffers, but, conversely, less sensitive edges of the CCA may have narrower buffers. The District of Lake Country should implement minimum setbacks from wetlands and watercourses.

Management of Corridors

Corridors for wildlife need to be established to provide secure movement opportunities between core conservation areas. Widths of 100 to several hundred metres are typically required. Recreational use is usually incompatible with maintaining effective corridors. The integrity of the ecosystem(s) within the corridor needs to be maintained, and often managed (and restored in some cases). Barriers may be required to keep domestic animals and unsuitable recreation activities out of the corridors, and keep potentially problem wildlife out of developed areas. Roads should avoid corridors but where this is not possible, should use underpasses or other techniques to eliminate traffic hazards to wildlife.

Management of Other Important Conservation Areas (OICA)

Some managed resource uses (e.g., grazing and selection harvesting of ingrown coniferous forests) are likely compatible with conservation values in OICA. OICAs that are situated on properties subject to urban or other development should be a priority for protection.

7 Planning and Management

7.1 Goals

The goals of the management guidelines differ between sensitive ecosystems and other important ecosystems:

- Sensitive ecosystem guidelines seek to conserve the seven sensitive ecosystems in a relatively natural state.
- Guidelines for other important ecosystems seek to maintain the resource values and minimise the loss of ecosystem functions.

7.2 City and Regional District Planning

Develop a 'Local Ecosystems Plan'[55]

A systematic plan for prioritization and protection, and stewardship of local sensitive and other important ecosystems should be developed. The conservation analysis provides priorities for conservation. The local ecosystems plan should consider known gaps in the system of provincial and regional protected areas, and be integrated across the study area, and with the City of Vernon, Regional District of North Okanagan, City of Kelowna, and Central Okanagan Regional District to ensure landscape level connectivity.

Recognizing and protecting environmentally sensitive areas early in the community planning process provides the best chance of protecting environmental values.

- Design initial road and utility layouts at a landscape scale to minimize impacts to sensitive and other important ecosystems.
- Integrate ecosystem retention and conservation with other land use planning considerations (such as parks and recreation) that are consistent with the preservation of sensitive ecosystems.
- Develop and implement a weed management strategy to minimize the spread and introduction of invasive plant species.
- Develop and implement a fire management plan that identifies forests that are a fire hazard and provides a strategy to reduce this hazard and return forests to historical stand densities.
- Develop a recreation use plan to avoid recreation in critical areas and designate appropriate types of recreation for other areas.

Aside from the ecosystems prioritized for protection in the ecosystem plan, other sensitive and other important ecosystems, and natural areas should be considered in all levels of planning and protection, and mitigation strategies should be developed in areas where development will occur. SEI maps are intended to be used for broad-level planning, however, on-site visits are needed to assess the site and develop site-specific management recommendations.

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[55] Refer to the Conservation Tools Section of Iverson and Cadrin 2003 for more detailed information.

On-site visits are needed to assess and develop site-specific management recommendations for neighbourhood plans and individual developments.

Develop a Conservation Strategy[56]

Most sensitive ecosystems in the Commonage are on private property, so voluntary stewardship by landowners is essential in the long-term. Various tools and mechanisms are available for ecosystem protection depending on the ownership and the management policies and practices of the existing land managers. Once land status is determined, appropriate measures may be taken including:

- **Designation as Environmentally Sensitive Areas** (ESA) – The seven sensitive ecosystems should be a priority in the identification and designation of local government ESAs. In some cases, site boundaries should reflect the dynamic nature of the ecosystem (see **Retain Natural Vegetated Buffers around Sensitive Ecosystems** below). These ESAs should be identified in the Official Community Plan.
- **Acquisition of privately owned lands for conservation and protected status** – The most undisturbed of these remaining ecosystem fragments should be considered for purchase as conservation areas where only activities that do not impact the ecosystem would be permitted. Grassland, wetland, old forest, riparian and broadleaf woodland together with the highest quality coniferous woodland and sparsely vegetated sites should all be priorities for receiving protected status. ***Sites where different sensitive ecosystems occur adjacent or in close proximity to one another should also be given priority with regards to protection***.
- **Stewardship** – Private landowners with Sensitive Ecosystems who wish to retain ownership could become involved in voluntary stewardship initiatives such as registering conservation covenants on their property to protect ecosystem values. Protection of grasslands and managing invasive plants should all be priorities for stewardship programs.
- **Use other protection techniques** such as cluster development, Development Permit Areas, restrictive covenants, purchase of development rights, and incentives to leave sensitive sites intact.

[56] Significant portions of this section have been adapted from McPhee et al. 2000.

Official Community Plan

*See **Local Government Act** sections 875-884 for more information*

The Official Community Plan (OCP) provides overall policy direction for the local government and establishes the basis for its regulations and development approvals. Below, we provide specific recommendations for integrating this SEI into the District of Lake Country's OCP.

- Designate sensitive and other important ecosystems as ***Development Permit Areas***[57] (DPAs) in the OCP. DPA boundaries may go beyond ESA boundaries.
    - Ensure that every effort shall be made to maintain or enhance the ecological integrity of these areas.
    - Ensure that the vegetation, wildlife, and ecological functions of these areas are maintained or enhanced.
    - Ensure that water balance and hydrologic functions are maintained and stormwater planning is integrated with other ecological planning.
    - Limit landscaping to restoration of removed or altered native vegetation or habitat. Use native plants adapted to on-site conditions. Control invasive plant species.
    - Adopt the recommendations for Environmental Impact Assessments in this report.
- Designate sensitive and other important ecosystem DPAs as areas for which ***Development Approval Information*** is required.
- Use the local ecosystems plan to ***determine areas for natural open space*** and develop conservation strategies for those areas. Create a natural open space designation for such areas.
- Ensure that ***only developments and other activities*** compatible with the preservation, protection, restoration, and enhancement of sensitive ecosystems occur in DPAs.
- Ensure ***neighbourhood plans are consistent with the local ecosystems plan*** and conservation strategies. At the development scale, maintain appropriate buffers, determined by qualified professionals, around sensitive ecosystem areas and provide connectivity between sensitive and other important ecosystems.
- Provide for ***greater incentives for density bonuses*** in developments in exchange for the retention of sensitive ecosystems:
    - Ecosystems identified for conservation in the local ecosystems plan should be the highest priority for retention.
    - Ecosystems must be retained in such a way that natural values are maintained or enhanced.

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[57] Development Permits can be used by local governments to establish special requirements for developments including the protection, restoration or enhancement of natural ecosystems and biological diversity. Development Permit guidelines can be specified in the OCP or in the zoning bylaw, as provided in Section 919.1(1)(a) of the Local Government Act (Iverson and Cadrin 2003).

- Provide buffers and connectivity to other natural ecosystems within and beyond the development (See Retain Natural Vegetated Buffers Around and Corridors Between Sensitive Ecosystems page 31).
- Do not limit the maximum density bonus to 20% in cases where density bonuses are granted in exchange for the secured conservation of sensitive ecosystems.
- Retained natural ecosystems should be covenanted to ensure that future uses are compatible with the protection, restoration, and enhancement of sensitive ecosystems.

- ***Eliminate large lot zoning designations*** in favour of cluster development zones where the net number of housing units remains the same. ***Reduce minimum lot size to permit cluster development*** if more than 20% natural open space is retained and is not disturbed. ***Consider the development of cluster housing as a zoning designation***.
- ***Plan and manage recreational access*** to minimize impacts to sensitive ecosystems, especially during wildlife breeding and nesting seasons. Uncontrolled motorized recreation is of particular concern.
- Add a goal into the OCP to ***acquire high priority sensitive ecosystems*** to add to protected natural areas.
- Add a goal into the OCP to ensure that ***trail and other recreation development*** is consistent with broader level conservation priorities and ecological integrity of sensitive ecosystems.
- Ensure that subdivision plans along Lake Okanagan, Kalamalka Lake, and Wood Lake have provisions for maintaining all foreshore vegetation and ecosystems and provide connectivity to upland ecosystems for wildlife.

Additional Policies for Wetland and Riparian Ecosystems

- Protect water quality from pollutants, sediments, and changed nutrient loads
- Determine and consider the overall water balance affecting wetland and riparian ecology and protect from disturbance.
    - Maintain natural surface, groundwater and nutrient regimes.

Other Local Government Policies and Plans

Use a Regional Growth Strategy and Parks and Recreation Master Plan to establish community goals and policies for ecosystem protection and to establish urban containment boundaries. Revise other policies and zoning bylaws[58] as direction is established for ecosystem protection.

[58] Refer to Sensitive Ecosystems Inventory: Central Okanagan Volume 1 (Iverson and Cadrin 2003) pp 135-143 for additional suggestions on zoning and bylaws.

7.3 Landowners

Plan Land Development Carefully

Landowners who wish to develop their land can use various tools outlined below to protect sensitive ecosystems. Landowners who do not wish to develop their land can use many of these same tools to provide long-term protection of the ecosystems on their property.

Tools for the Protection of Sensitive Ecosystems

- Have a qualified professional conduct an environmental impact assessment[59] to provide wildlife inventory information and verify and map sensitive ecosystems at an appropriate scale for development planning. Work collaboratively with professional biologists in designing the development.
- Consider using cluster style developments to provide opportunities for development while retaining sensitive ecosystems. Work with city planners to obtain density bonuses in exchange for retention of sensitive ecosystems.
- Where golf courses are a desired component of a development, consider a links style golf course where retention of natural areas within the course is maximized.
- Where a development has been designed to ensure the long-term retention and function of sensitive ecosystems, consider an alternate niche marketing strategy to promote it as an 'ecosystem friendly' development.
- Consider conservation covenants on sensitive lands:
    - They can protect certain values while allowing other uses.
    - They are registered in the Land Title Office.
    - They can provide a tax advantage if they have reduced the property value through restrictions on its use. The covenanting organization can provide a charitable receipt for the difference in land value.
- Consider donating land:
    - Lands can be donated to a land trust, stewardship organization or government.
    - Owners may want to establish conservation covenants prior to donating to ensure the donated land is protected.
    - Land donations can provide tax benefits.
    - Owners may want to donate the portions of their land designated for retention of sensitive ecosystems.
    - Owners may want to consider providing for the donation of their land in their will.

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[59] See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

Further Information:

Stewardship Options for Private Landowners in British Columbia[60]

Here Today, Here Tomorrow: Legal Tools for the Voluntary Protection of Private Land in British Columbia[61]

The Land Conservancy of British Columbia
www.conservancy.bc.ca (250) 479-8053

The Nature Trust of B.C.
info@naturetrust.bc.ca (250) 924-9771

The Canadian Ecological Gifts Program, Environment Canada
www.cws-scf.ec.gc.ca/ecogifts 1-800-668-6767

7.4 General Management Recommendations[62]

This section provides general recommendations to avoid negative impacts to sensitive ecosystems. These recommendations reflect the principles of biodiversity conservation, which apply to all sensitive ecosystems identified in the study area. For other important ecosystems (disturbed grasslands and mature forests), broader conservation-oriented management practices are discussed.

Retain Natural Vegetated Buffers Around and Corridors Between Sensitive Ecosystems

In order to achieve adequate protection, sensitive ecosystems must be buffered from potentially adverse effects of land use practices in adjacent areas. A natural vegetated buffer zone can absorb and avoid negative edge effects that result from animal and human access and disturbance. Buffers also play a role in maintaining microclimate conditions such as temperature and humidity, particularly for wetlands and riparian areas. A vegetated buffer is established by retaining or restoring natural ecosystems that surround sensitive or other important ecosystems. The size of the buffer zone varies by ecosystem type, and by constraints of the surrounding landscape. Fencing may be necessary along some buffers to delineate and protect the buffer from encroaching land uses and inappropriate activities. In planning for protection of a particular site, assessments and recommendations should be made by a qualified professional[63] to ensure that conservation options are effective.

In addition to buffering core high priority areas, corridors are needed to connect conservation areas. As with buffers, corridors are vegetated zones established by retaining or restoring natural ecosystems to connect sensitive or other important ecosystems. They are usually longer and

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[60] Ministry of Environment, Lands and Parks 1996
[61] Findlay and Hillyer 1994
[62] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.
[63] See: Incorporating SEI Information into Environmental Impact Assessments, page 32, step 1 for guidelines on qualified professionals.

narrow than buffers and must be designed to provide sufficient width and natural vegetation cover for the species that use them.

Avoid Direct and Indirect Impacts

Minimizing negative impacts to sensitive ecosystems can be achieved through the following principles:

- ***Discourage settlement and other development within or adjacent to sensitive ecosystems*** unless only insignificant negative impacts can be demonstrated;
- ***Manage access to land and water***: Seasonal use-restrictions (e.g., during wildlife breeding seasons), fencing, designated trails, and signage can be used to help avoid the negative effects of access to sensitive areas. Designating trails and areas for limited used (e.g., restricting motorized recreation or mountain bikes) are another access management tool;
- ***Prevent disturbance of nesting or breeding areas*: ** Known and potential breeding sites, (especially for threatened or endangered species where the Species at Risk Act (SARA) designates them as residences) should be protected from any activity that would disturb breeding wildlife;
- ***Control invasive species*: ** A broad weed management plan may be necessary to control and limit the spread of invasive plants such as diffuse knapweed (*Centaurea diffusa*), sulphur cinquefoil (*Potentilla recta*) and cheatgrass (*Bromus tectorum*). Reclaim disturbed sites using native vegetation species adapted to the site to reduce the potential for weed invasion; and
- ***Restore natural disturbance regimes*** wherever possible. Consider some planned thinning and prescribed burning to restore open forests, restore some encroached grassland habitat, and reduce wildfire hazard in interface areas. Consult a qualified professional to develop and implement a restoration and prescribed burning plan.

Plan Land Development Carefully

Where it is not possible to limit settlement or other developments within or immediately adjacent to a sensitive ecosystem, activities should be carefully planned to minimize adverse effects to the ecosystem. An environmental impact assessment should be completed (see below) and inventories of wildlife, vegetation, including wildlife trees and the extent of tree root systems, terrain features such as cliffs and talus, adjacent water bodies, and other important microhabitats are necessary to determine and minimize the full impact of development on biodiversity at the site.

7.5 Incorporating SEI Information into Environmental Impact Assessments[64]

These are guidelines for people planning land developments according to local government regulations. This information can be helpful in developing an Environmental Impact Assessment under provincial or federal guidelines, which are specified under the following acts:

Canadian Environmental Assessment Act

BC Environment Assessment Act

[64] This section comes directly from Iverson and Cadrin (2003).

Environmental Impact Assessments (EIAs) may by necessary where rezoning, subdivision, or other land development occurs within a Development Permit Area or areas where development approval information is required.

EIAs should be conducted early in the development process to allow for more flexibility in creating a development proposal that conserves sensitive ecosystems and wildlife habitat, while meeting the needs of the proponent. The process may be iterative – the consultant(s) conducting the assessment will be given information about the proposed or conceptual development layout, and then will provide specific suggestions on how to make the development reduce impacts to environmental values (e.g., changes in siting, onsite practices or design). Depending on the zoning of the site, the proponent should contact the District of Lake Country about the possibility of cluster development and density bonuses.

Sensitive ecosystems mapping can provide information about the environmental impacts of housing and other developments on these ecosystems. The following procedure provides a guide to incorporating SEI information into EIAs.

1. The EIA must be prepared by a registered professional biologist together with other professionals[65] of different expertise, as the project warrants. Hydrologists and hydrogeologists should be consulted where wetlands, riparian areas, and broadleaf woodlands exist within the development area to ensure that proper hydrological function is maintained within these ecosystems. A professional geoscientist should be consulted where there are erosion potential or slope stability hazards. The consultant or team of consultants must have an understanding of wildlife biology, especially for species at risk, geomorphology, environmental assessment, and development planning in British Columbia. Specific expertise in Okanagan Valley wildlife species, wildlife habitat, and ecosystems is highly preferred.
2. Digital Sensitive Ecosystems and Wildlife Habitat mapping files should be used to generate a sensitive ecosystems map and wildlife habitat maps for the proposed development area plus a surrounding adjacent area that is at least equal in width to the development area. The soil erosion and slope stability maps should be used to determine if any risks exist in the development area.
3. A field assessment should be conducted:
    a. For those SEI polygons where field data has not been collected, ground-truthing, including an assessment of the quality and condition of the ecosystems, should be conducted. For complex polygons, sensitive ecosystems should be mapped at a larger scale than used in the SEI to show specific locations;
    b. Where potential significant wildlife habitat is indicated by wildlife habitat maps, verify the presence of wildlife or their habitats by completing detailed species inventories. The inventories should take place during the time(s) of year when wildlife species of interest are expected to be present. It will be difficult to verify the presence of some species. It may be necessary to assume the presence of these species based on habitat suitability and forgo expensive inventories efforts. Each

[65] A collaborative team of consultants often provides the best combination of experience and expertise in the broad range of fields necessary to complete an effective Environmental Impact Assessment.

sensitive ecosystem chapter has a list of the potential red- and blue-listed wildlife that could occur in that ecosystem in the North Okanagan. All of these species should be addressed in the assessment; and

   c. Verify any potential soil erosion (ratings of Moderate, High, or Very High) or slope stability (Class III and up) problems in the field assessment.

4. The sensitive ecosystems and wildlife habitat mapping will need to be revised to reflect the field verification work. This may require independent verification prior to inclusion into the local government's digital warehouse.
5. Adverse long and short-term and cumulative effects that the proposed development is likely to have on sensitive ecosystems and wildlife habitat (direct and indirect impacts) should then be identified and mitigated or compensated[66].
6. A site plan that incorporates the management recommendations found below for each sensitive ecosystems category and which optimizes conservation of sensitive ecosystems and wildlife habitat, maintains connectivity and buffers around them and corridors between them, and avoids erosion potential or slope stability risks should be generated. The plan should seek to maintain connectivity with sensitive ecosystems and important wildlife habitats in adjacent areas, wherever possible.
7. The construction schedule and type of equipment that will minimize or avoid adverse environmental effects should be determined.
8. Opportunities for restoration or enhancement of sensitive ecosystems and wildlife habitat should be identified and the criteria used to prioritize these opportunities should be documented.
9. The assessment should identify how the proposed development will affect sensitive ecosystems and wildlife habitat, and should provide recommendations to reduce negative impacts and mitigate unavoidable impacts (e.g., restoration or enhancement).

[66] The occurrence of nationally or provincially special concern, threatened, or endangered species and ecological communities should be given high priority for conservation management.

8 Wetland

8.1 What are wetland ecosystems?[67]

Wetlands occur on sites where the water table is at, near, or above the soil surface for a sufficient period of time to influence soil and vegetation development[68]. Wetland ecosystems have plants that are adapted to growing on saturated soils with low oxygen levels.

Wetlands were divided into distinct classes according to their environmental and vegetation characteristics. These classes included marshes, shallow water, swamps, and wet meadow ecosystems; they are described below.

Marsh ecosystems

Marsh wetland ecosystems occur at the edge of shallow open water, ponds, and lakes, on the edges of larger wetlands, and in depressions where the water table is above or near the soil surface. Rushes, cattails, or occasionally sedges usually dominate marshes, and some floating aquatics such as duckweed were often present.

Shallow water ecosystems

Shallow water ecosystems are either areas of open water that are intermittently or permanently flooded up to 2 m in depth at midsummer[69], or are ponds that are greater than 2m in depth, but are less than 50 ha in area. Vegetation is limited to submerged or floating aquatic plants with less than 10% cover of vegetation emerging above the water surface. Shallow water ecosystems often occur in association with marshes.

Swamp wetland ecosystems

In this study area, swamp wetland ecosystems occurred at the edges of ponds and wetlands, forming a shrubby fringe around them. Willows dominated these sites, and sometimes sedges were present where the swamp occurred at the edge of a wetland. Many swamps have subsurface water flow associated with them (subirrigation).

Wet meadow ecosystems

Wet meadow ecosystems occur at the edge of shallow open water or marshes and sometimes on their own in depressions. Sedges, baltic rush, and some grasses tolerant of a high water table occur on these sites. These sites may have surface water in the spring but are dry at the surface by early summer.

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[67] Adapted from Iverson and Cadrin 2003.
[68] MacKenzie and Banner 1999
[69] Voller 1998

Vegetation

	Marsh	Shallow Water	Swamp	Wet Meadow	
Shrubs					
willows			***		*Salix* spp.
Grasses, Sedges & Rushes					
rushes	***				*Schoenoplectus* spp.
common spike-rush					*Eleocharis palustris*
baltic rush				**	*Juncus balticus*
sedges	*		**	**	*Carex* spp.
Forbs					
cattail	**				*Typhus latifolia*
duckweed	**	**			*Lemna minor*

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

8.2 Why are they important?[70]

Ecological attributes and socio-economic values of wetland ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

Rare[71] ecological communities of wetland ecosystems
Baltic rush – common silverweed (R)(*Juncus balticus - Potentilla anserina*)
Common cattail marsh (B)(*Typha latifolia*)
Common spike-rush (B)(*Eleocharis palustris*)

Natural ecological communities recommended for the red- or blue- list
Great bulrush (*Schoenoplectus acutus*)

Rare vertebrates of wetlands
Peregrine Falcon (R, COSEWIC-T) (*Falco peregrinus* ssp. *anatum*)
American Avocet (R) (*Recurvirostra americana*)

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Western Toad (COSEWIC-SC) (*Bufo boreus*)
Painted Turtle (B) (*Chrysemys picta*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
American Bittern (B) (*Botaurus lentiginosus*)
Great Blue Heron (B) (*Ardea herodias*)
Sandhill Crane (B) (*Grus canadensis*)
California Gull (B) (*Larus californicus*)
Short-eared Owl (B, COSEWIC-SC) (*Asio flammeus*)
Bobolink (B) (*Dolichonyx oryzivorus*)
Western Small-footed Myotis (B) (*Myotis ciliolabrum*)
Fringed Myotis (B, COSEWIC-SC) (*Myotis thysanodes*)
Townsend's Big-eared Bat (B)(*Corynorhinus townsendii*)

- **Rarity**: Most wetland ecological communities are rare or have been recommended for rare status (see above).

[70] Adapted from Iverson and Cadrin 2003.
[71] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).

- **High biodiversity**: Ponds and marshes are focal points for wildlife because of their infrequent occurrence in this landscape. Wetlands provide wildlife and biodiversity values that are disproportionate to the area they occupy on the land base. Wetland vegetation provides food, shelter, breeding habitat, and cover for many species of amphibians, reptiles, mammals, birds, and insects. Wetland vegetation provides food for many aquatic organisms. Ponds are important watering sites for many species, and in the study area provides Painted Turtle and spadefoot habitat. Wetlands are also sources of insects that provide food to many different species of birds and bats.
- **Fragility**: Wetlands are vulnerable to a range of human disturbances such as vegetation removal, dredging, diking, filling, and trampling by livestock. Small changes in hydrology such as reduced flows or lowered water tables, irrigation run-off, and urban run-off (including stormwater drainage) and other sources of nutrients including fertilizers and livestock manure can change and reduce the diversity of wetland communities. Such changes may occur away from the wetland, but can still influence it. Intensive recreational activities in and near wetlands can reduce plant cover, compact soil, and disturb nesting birds.

  Wetlands are vulnerable to overuse by livestock, but can still be extremely valuable and may recover quickly with improved livestock management.
- **Maintenance of water quality**: Properly functioning wetlands store and filter water, and maintain water quality. They reduce the levels of sediment, nutrients, and toxic chemicals in outflow water.
- **Social values**: Wetlands provide water storage and filtration and opportunities for wildlife viewing, education, and aesthetic enjoyment. They are focal points in the arid landscape of the Okanagan. They can add to real estate values in adjacent areas and can provide a tourist attraction.

8.3 Status

We found that wetland ecosystems were rare in the study area; they occupied 558 ha or 3.4% of the study area land base. Many wetlands in the Okanagan Valley have been filled in, or their hydrology has been altered through changes in land use in the surrounding area. For example, in the area between Penticton and Osoyoos, 85-90% of large marshes have been lost[72]. Because of the more gently rolling terrain, the study area has an unusually high proportion of wetlands remaining relative to other parts of the Okanagan Valley. Some wetlands have been influenced by irrigation run-off resulting in unnaturally high nutrient loads and different hydrology, and by domestic cattle grazing in the study area, together reducing plant cover and changing species on many sites. Such sites are still extremely valuable for wildlife and can recover quickly with effective range management. Future housing and other developments in the study area may alter, isolate, or cause losses of wetlands.

Shallow water (531 ha) was by far the most common wetland type in the study area; marshes (20 ha), wet meadows (0.08 ha), and swamps (7 ha) were all very rare.

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[72] Voller 1998

8.4 Management Recommendations[73]

The ecological functions that wetlands provide, specifically water storage and maintenance of water quality, are provided free of charge. When these functions are removed through the loss or degradation of wetlands, it can be an exorbitant cost to replace them through technological means or re-create wetlands. The ecological functions and rarity of wetlands requires conservation of all remaining wetlands, including the maintenance of buffers to preserve the hydrologic regime, wetland functions, and connectivity to other ecosystems. Community leaders and local governments should be diligent in promoting the protection of every wetland in their area whether the wetland is on private or public lands.

Retain Natural Vegetated Buffers around Wetland Ecosystems

Wetlands can be negatively affected by adjacent land use that alters wetland hydrology. Natural vegetated buffers should be retained or established with native vegetation to reduce edge effects and protect points of water inflow and outflow locations around the wetland. All native vegetation should be maintained in the wetland and the associated riparian ecosystem around the wetland. Wetland ecologists should be consulted when delineating vegetation buffers around wetlands.

Avoid Direct and Indirect Impacts

- **Prevent human settlement and other land developments within, or adjacent to, wetland areas**. It is strongly recommended that such activities in and around wetlands be avoided. Roads should not be built near wetlands as they can alter hydrology and lead to extensive mortality of wildlife species that use wetlands. Roads should never encircle wetlands and should be set back as far as possible (more than 50m; distance depends on local conditions; many should provide opportunities for painted turtle nesting along with special fencing to prevent road mortality).

- **Maintain wetland hydrology**. Draining or ditching in or around wetlands, the filling in of wetlands, irrigation run-off, and the discharge of stormwater into such sites should be avoided. Vegetation cover should not be removed as this increases surface runoff and reduces the amount of groundwater infiltration, thus reducing available summer moisture. Additionally, areas of impervious ground surfacing (i.e., pavement) should be minimized. Hydrologists familiar with wetland function should be consulted to determine how to protect wetland hydrology.

- **Maintain water quality***.* Wetlands store and filter water, and maintain water quality; therefore, the addition of urban storm drainage, agricultural runoff, and sediment from road building into wetlands should be prevented. Wetlands that have artificially high nutrient levels may experience algal blooms, and vegetation in some marshes may convert from sedges or rushes to cattails.

- **Restrict recreational access***.* Intensive recreational use of shoreline areas can reduce plant cover, compact soil, and disturb wildlife. Roots of trees and shrubs can be easily damaged by trampling and trail development in the moist soils of wetlands. Trails often become wide in wet, muddy areas, and sediments from trail damage may affect amphibians and insects. Motorized recreation, mountain biking, and horseback riding should be excluded

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[73] Many of the recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

from wetlands. In areas where trails to viewpoints in wetlands are desired, raised boardwalks should be used (avoid using rock or bark mulch on trails).

- **Manage livestock access**. Livestock use of many wetlands and ponds for water has significantly altered these sites. Overuse of wetlands by livestock can lead to soil compaction, damage and loss of vegetation cover and structure, and introductions of invasive plant species. Vegetation on many sites can quickly recover, however, when cattle use is reduced. Alternative watering sites, and fencing to allow a single access point to the water source can be used to maintain wetland functions and values while allowing some cattle use.
- **Prevent disturbance of nesting or breeding areas**. Recreational activities along wetland edges and canoeing in wetlands can impact amphibians, nesting waterfowl, and other birds, and thus, should be avoided during the breeding season (May through August). Disturbance of soils around wetlands, especially sandy soils that might be used by Painted Turtles for egg-laying or spadefoots for burrowing, should also be avoided.
- **Restrain pets near wetlands during spring and summer**. Pets should be controlled to avoid disturbances to turtles, amphibians, waterfowl, and other birds during the breeding season (May through August).
- **Allow natural wetland processes to maintain wetland functions and values**. Beaver activity, flooding, seasonal drawdown, and groundwater recharge and discharge should be maintained. Inflow or outflow streams should not be diked or channelized.
- **Avoid use of pesticides and fertilizers in or near wetlands**. Follow the restrictions for each pesticide and ensure that winds do not cause sprays to drift and contaminate the water body. Roundup (glyphosate) is particularly toxic to amphibians[74].

[74] Relvea 2005

9 Riparian

9.1 What are riparian ecosystems?[75]

Riparian simply refers to areas adjacent to water bodies such as lakes, rivers, streams, and ponds[76]. In this study, riparian ecosystems were defined as ecosystems that are adjacent to, and significantly influenced by a water body. That is, these sites are moister than and have a plant community that is distinct from the surrounding upland. Riparian ecosystems are typically linear in nature. Wetlands are riparian in nature but were described separately because of their distinct ecological nature.

Riparian ecosystem
vs.
Riparian zone

'Riparian ecosystems' vary in width and are delineated by site-specific vegetation, soil, and topographic features.

The term 'riparian zone' is often used to describe a fixed width management area surrounding streams and wetlands.

For this SEI, riparian ecosystems were classified into structural stages (Table 8) in order to identify different habitat values.

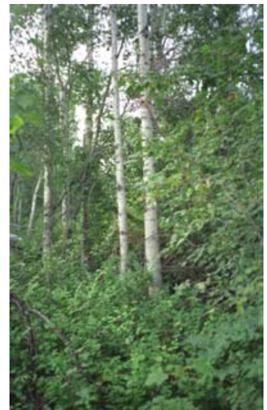
Table 8. Structural stages of riparian ecosystems

Code	Name	Definition
RI:1	Unvegetated or sparsely vegetated	Less than 10% cover of vegetation
RI:2	Herb	Herb dominated, shrub cover <20%, tree cover less than 10%
RI:3	Shrub/herb	Shrub cover 20% or greater, tree cover less than 10%
RI:4	Pole sapling	Trees are >10m tall and have 10% or greater cover, dense stands, generally 10-40 years old
RI:5	Young forest	Trees are >10m tall and have 10% or greater cover, dominated by young trees about 40-80 years old
RI:6	Mature forest	Trees are >10m tall and have 10% or greater cover, dominated by mature trees about 80-250 years old; trees may be younger in broadleaf forests.
RI:7	Older forest	Trees are >10m tall and have 10% or greater cover, many tree ages, many trees are 250 years or older; trees may be younger in broadleaf forests.

For this study, riparian ecosystems were also divided into distinct classes (gully, bench, and fringe) according to their environmental and vegetation characteristics; these are described below.

[75] Adapted from Iverson and Cadrin 2003.
[76] MacKenzie and Banner 1999; Voller 1998

Gully riparian

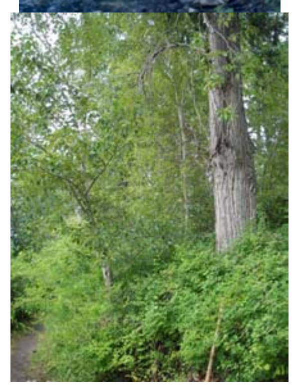


Gully riparian ecosystems occurred at the base and lower slopes of moderate to steep-sided linear sites (small valleys or ravines) with significant moisture. These ecosystems had either permanent or intermittent surface water flow, or significant subsurface flow, but were usually not subject to flooding. These were also rich and productive sites, providing habitat that is distinctly different from the surrounding landscape. These ecosystems usually had a mixed coniferous and deciduous overstory with shrubby understories.

Bench riparian ecosystems

Bench riparian ecosystems are flood or fluvial ecosystems that are associated with moving water such as creeks and rivers and are influenced by flooding and subsurface irrigation. Typically, these ecosystems occurred as a band on either side of a creek and often formed natural corridors through the landscape.

Fringe riparian ecosystems



Ponds, marshes, and Okanagan Lake typically had fringe riparian ecosystems associated with their shorelines. This class also includes sites with significant seepage that are sensitive to soil and hydrological disturbances. These ecosystems usually had trembling aspen overstories with shrubby understories.

Vegetation

		Gully	Fringe	Bench	
Trees					
	black cottonwood		*	***	*Populus balsamifera* ssp. *trichocarpa*
	Douglas-fir	**	*	*	*Pseudotsuga menziesii*
	trembling aspen	***	***	*	*Populus tremuloides*
Shrubs					
	common snowberry	***	***	**	*Symphoricarpos albus*
	red-osier dogwood	**	**	**	*Cornus stolonifera*
	Douglas maple	**	**	**	*Acer glabrum*
	water birch	**	**	**	*Betula occidentalis*
	Nootka rose	**	**	**	*Rosa nutkana*
Forbs					
	Star-flowered false Solomon's seal	**	*	*	*Maianthemum stellatum*
	Horsetail	*		*	*Equisetum* spp.

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

9.2 Why are they important?[77]

Ecological attributes and socio-economic values of riparian ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

Rare[78] ecological communities of riparian ecosystems

Black cottonwood – Douglas-fir – common snowberry – red-osier dogwood (R) (*Populus balsamifera* ssp. *trichocarpa - Pseudotsuga menziesii - Symphoricarpos albus - Cornus stolonifera*)

Douglas-fir / Douglas maple - red-osier dogwood (R) (*Pseudotsuga menziesii / Acer glabrum - Cornus stolonifera*)

Douglas-fir / common snowberry – birch-leaved spirea (R) (*Pseudotsuga menziesii / Symphoricarpos albus - Spiraea betulifolia*)

Douglas-fir - water birch / Douglas maple (R) (*Pseudotsuga menziesii - Betula occidentalis / Acer glabrum*)

Hybrid white spruce / black gooseberry (B) (*Picea engelmannii x glauca / Ribes lacustre*)

Rare vertebrates of riparian ecosystems
Western Screech-Owl (R, COSEWIC-E) (*Megascops kennicottii* ssp. *macfarlanei*)
Yellow-breasted Chat (R, COSEWIC-E) (*Icteria virens*)
Brewer's Sparrow (R) (*Spizella breweri* ssp. *breweri*)

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Great Blue Heron (B) (*Ardea herodias*)
Lewis's Woodpecker (B, COSEWIC-SC) (*Melanerpes lewis*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- **Rarity**: Their conservation status (B.C. Conservation Data Centre) lists most riparian ecological communities as rare (see above).
- **High biodiversity**: Riparian ecosystems support disproportionately high numbers of species relative to the area they occupy on the land base. They provide wildlife with water, cover, breeding habitat, and food. The wide diversity of plants, invertebrate organisms, and structural complexity of these ecosystems provide many habitat niches. Riparian vegetation provides food for many aquatic organisms. Gullies generally lack surface water flow but often have lush, productive vegetation that provides significant cover and food for wildlife.
- **Fragility**: Riparian ecosystems are strongly influenced by adjacent water bodies and, thus, they are sensitive to disturbance and changes in hydrology.
- **Aquatic habitat protection and water quality**: Riparian vegetation supplies most of the organic matter and plays a large role in determining the composition of the aquatic invertebrate community. Riparian vegetation also provides a source of large organic debris (e.g., logs). Riparian areas are important for trapping sediments and maintaining water quality. The root systems of riparian vegetation stabilize stream banks, thus reducing erosion and sediment

[77] Adapted from Iverson and Cadrin 2003.
[78] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).

inputs to the water. Riparian vegetation plays a key role in controlling water temperatures by reducing incoming radiation.

- **Wildlife corridors**: Within the study area, gullies form natural wildlife corridors connecting lower and upper slopes of the study area and connect different types of ecosystems.
- **Social values**: Riparian areas provide water retention and filtration, prevent erosion, and provide green space, and opportunities for education, bird watching, wildlife viewing, and walking and hiking. They are cooler places to enjoy nature on hot summer days. Retention of riparian corridors can enhance and maintain property values and attract tourists by retaining the natural beauty that many people seek out.

9.3 Status

Riparian ecosystems are naturally rare in the study area and occupied only 2.9% (477 ha) of the study area – predominantly gully (212 ha) and fringe (193 ha) ecosystems with some bench ecosystems (72 ha).

Only 7% of riparian ecosystems in the study area were in the old forest structural stage. Another 29% was mature forest and 43% was young forest, indicating that many riparian ecosystems had been altered by human disturbance. Historically, riparian ecosystems would have been predominantly old and mature structural stages.

Conservation of all riparian ecosystems should be a priority. In all structural stages, it is important to retain all riparian vegetation to preserve stream bank and soil stability, water temperature and quality, and wildlife habitat values.

9.4 Management Recommendations[79,80]

Riparian ecosystems have attracted considerable attention in the last decade because of increased awareness of their value in stream and river protection. Most protection has focussed on fisheries or wildlife values, with less emphasis on the diversity and ecology of riparian plant communities.

Efforts should be made to maintain connections with adjacent upland ecosystems and to reduce fragmentation in order to preserve wildlife corridors. Where possible, vegetation and ecological functions of altered riparian ecosystems should be restored.

The following recommendations will aid in the site management of riparian ecosystems:

Retain Natural Vegetated Buffers around Riparian Ecosystems

Wherever possible, natural vegetated buffers should be retained or established with native vegetation around riparian ecosystems. Buffers help maintain the integrity of riparian areas. Buffers need to be large enough to protect the core ecosystem from edge effects such as increased invasive plant species, increased temperature, decreased humidity, and increased noise and disturbance to wildlife.

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[79] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

[80] Additional management recommendations for riparian ecosystems where fish may be present can be found in Iverson and Cadrin 2003.

Maintain wildlife corridors and connectivity between riparian areas and adjacent habitats by retaining both riparian and adjacent habitats.

Avoid Direct and Indirect Impacts

- **Prevent human settlement or other development** within or adjacent to riparian areas.
- **Riparian vegetation should be maintained where it is present, and restored where it has been lost**. Vegetation maintains the cohesive nature of banks and provides inputs of organic matter into soils, which increases their capacity to adsorb and store water. Additionally, riparian vegetation moderates water temperatures, provides an important source of food for many aquatic organisms, and provides important wildlife cover for nesting and feeding.
- **Plan for controlled recreational access** to some areas, and access restrictions (e.g., with fencing and railings) to sensitive areas in order to manage the effects of recreation and other human uses.
- Where practical or necessary, **restrict livestock access** by using fencing. To allow safe wildlife access, fences should be top-railed, and bottom wires should be 45cm (18") above ground level (this height is for cattle, lower bottom wires are needed for sheep and other livestock).
- **Control pets**. Pets should be restrained and hunting dogs should be trained away from riparian areas during the spring and summer. Other disturbances to waterfowl during the nesting season should also be avoided.
- **Protect structural features**: Large trees, snags, and logs provide critical nesting habitat for many species of birds and animals. Large, old trees and snags are especially important for birds, bats and other animals. Maintain structures such as rocks and logs within streams. They provide important habitat and prevent erosion.
- **Avoid use of insecticides in or near water and important foraging areas for wildlife**. Insecticide use near foraging habitat for animals that feed on insects (e.g., Western Screech-Owl, spadefoots, Townsend's Big-eared Bat and amphibians) should be avoided.
- **Allow natural disturbances to occur**. Flooding, windthrow, and channel changes are recognised as important factors in the creation and maintenance of high diversity riparian habitats and provide important habitat attributes for fish. Leave sufficient buffers to allow these events and processes to occur wherever possible.

Plan Land Development Carefully

Where human settlement or other development is permitted adjacent to a riparian area, the following guidelines apply:

- **Require an environmental impact assessment conducted by a qualified professional**[81].
- **Plan, design, and implement land development activities to avoid adversely affecting or disturbing:**
    - riparian vegetation;

[81] See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

- large old trees;
- threatened, endangered or special concern species or ecological communities;
- natural processes such as stream flow, flooding, and stream channel movement;
- wildlife nesting or denning sites;
- standing dead trees, and downed trees and logs; and
- riparian corridors, and connectivity with upland communities.

- **Design roads carefully**. Roads should be narrow and set back from the riparian ecosystem to ensure that both the riparian vegetation and bank stability are maintained. If roads must cross riparian ecosystems, bridges are recommended to minimize disturbance of soil and vegetation and to provide a wildlife corridor below. Where roads encroach upon riparian ecosystems, narrow the width of the road and avoid side-casting material into the riparian area.
- **Design trails carefully**. Trails should provide a direct route to a viewing area or crossing, and should avoid sensitive vegetation, seepage areas and wetlands, and stream banks or gully side walls with easily eroded soils.
- **Protect endangered, threatened, or special concern species or ecological communities** by addressing the following recommendations:
    - avoid disturbance to sites where rare plants are growing and where rare ecologcial communities occur;
    - maintain habitat structures such as trees with cavities, large old trees, and snags; and
    - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities around features including dens, raptor nest or perch trees, woodpecker cavities, and bat roosts from May through August.
- **Ensure adequate sediment and erosion control measures** are implemented.

10 Old Forest

10.1 What are old forest ecosystems?[82]

Old forest ecosystems are forests that are dominated by large, old trees. Old forests historically would have dominated the forested patches in the study area. Throughout the study area, historical harvesting of large, old ponderosa pine and Douglas-fir has greatly reduced the area of old forest ecosystems. Old forests were mapped where polygons included old structural stage ecosystems except for old riparian forests, which were included in the Riparian Forest category.

Historically, most forests had frequent surface fires that killed most regeneration and allowed few new trees into the overstory. Overstories were generally multi-aged with a largely single-layered canopy, and understories were open and dominated by grasses and shrubs. Frequent fire also limited the occurrence of dead wood to scattered large snags and large, downed wood.

The exclusion of fires has caused formerly open, park-like forests to infill with waves of smaller trees (this is referred to as forest ingrowth; historically, most of these small trees would have been killed by periodic fires). Old forests still occur where large, old trees have not been selectively harvested. In most cases these stands have undergone some forest ingrowth and, thus, are not fully representative of the historical forests. Old trees, however, are structurally very important for wildlife, and old forest sites have the best potential for restoration to historical stand structure.

Vegetation

Trees			
	ponderosa pine	**	*Pinus ponderosa*
	Douglas-fir	**	*Pseudotsuga menziesii*
Shrubs			
	common snowberry	**	*Symphoricarpos albus*
	tall oregon-grape	**	*Mahonia aquifolium*
	saskatoon	**	*Amelanchier alnifolia*
Grasses			
	bluebunch wheatgrass	***	*Pseudoroegneria spicata*
	rough fescue	**	*Festuca campestris*
	pinegrass	**	*Calamagrostis rubescens*
	blue wildrye	*	*Elymus glaucus*
Forbs			
	arrowleaf balsamroot	**	*Balsamorhiza sagittata*
	heart-leaved arnica	*	*Arnica cordifolia*

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

82 Adapted from Iverson and Cadrin 2003.

10.2 Why are they important?[83]

Ecological attributes and socio-economic values of old forest ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

Rare[84] ecological communities of old forests

Douglas-fir – ponderosa pine / bluebunch wheatgrass (B) (*Pseudotsuga menziesii - Pinus ponderosa / Pseudoroegneria spicata*)

Douglas-fir - ponderosa pine / bluebunch wheatgrass – pinegrass (B) (*Pseudotsuga menziesii - Pinus ponderosa / Pseudoroegneria spicata - Calamagrostis rubescens*)

Douglas-fir - ponderosa pine / pinegrass (B) (*Pseudotsuga menziesii - Pinus ponderosa / Calamagrostis rubescens*)

Douglas-fir - ponderosa pine / snowbrush (B) (*Pseudotsuga menziesii - Pinus ponderosa / Ceanothus velutinus*)

Douglas-fir / shrubby penstemon – pinegrass (B) (*Pseudotsuga menziesii / Penstemon fruticosus - Calamagrostis rubescens*)

Ponderosa pine / red three-awn (B) (*Pinus ponderosa / Aristida purpurea* var. *longiseta*)

Rare vertebrates of old forests
Swainson's Hawk (R) (*Buteo swainsonii*)
White-headed Woodpecker (R, COSEWIC-E) (*Picoides albolarvatus*)
Badger (R, COSEWIC-E) (*Taxidea taxus*)

Racer (B, COSEWIC-SC) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Ferruginous Hawk (B, COSEWIC-SC) (*Buteo regalis*)
Great Blue Heron (B) (*Ardea herodias*)
Flammulated Owl (B, COSEWIC-SC) (*Otus flammeolus*)
Lewis's Woodpecker (B, COSEWIC-SC) (*Melanerpes lewis*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- **Rarity**: Old forest ecological communities are rare (in addition to the ecological communities listed above, all other old forest ecological communities have been recommended for rare status).
- **High biodiversity:** Old forests provide habitat for a wide variety of wildlife, plant, and invertebrate species. Old forest ecosystems have many unique and important structural attributes. Typically these forests are open, and, thus, provide good visibility from predators for ungulates. Large old trees provide good snow interception, enabling animals such as mule deer to move easily through old forests in the winter.
- **Specialised habitats:** Many species depend on features found only in old forests. The large, old trees in these forests provide cavities for many bird and small mammal species. Additionally, these ecosystems usually have scattered large snags and large woody debris which provide critical habitats for many species, including some species at risk.

[83] Adapted from Iverson and Cadrin 2003.
[84] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).

- **Social values**: Old forests provide opportunities for education, and wildlife viewing. Large old trees provide attractive and aesthetic views that can raise real estate values in adjacent areas, and can draw tourists into the area.

10.3 Status

Historically, old forests likely dominated the majority of the forested portion of the landscape (about 33% of the study area) but now there are only small remnants. Most old forests had been lost to selection logging. The inventory showed that only 0.6% (90 ha) of the study area was old forests; these occurred in very small and fragmented patches, mostly in very rocky places not readily accessible for logging. There is a need to conserve all remaining old forests, and retain and restore stand structure in some mature forests for recruitment to old forests.

10.4 Management Recommendations[85]

Loss of old forest ecosystems and forest ingrowth in remaining old forest areas has resulted in the loss of many habitat features (e.g., grassy understory vegetation) and increased fire hazard.

The following recommendations will aid in the site management of old forest ecosystems.

Retain Natural Vegetated Buffers around Old Forest Ecosystems

Wherever possible, natural vegetated buffers should be retained or established with native vegetation around each old forest ecosystem. Buffers help prevent edge effects such as invasive weed colonisation and reduce indirect disturbances. When they are present, mature forests form excellent buffers around old forest ecosystems, especially when they have been thinned. Many species that are reliant on old forests also use other habitats; it is important to maintain connectivity with other ecosystems.

Avoid Direct and Indirect Impacts

- **Discourage human settlement or other development** within or adjacent to old forest ecosystems.
- **Manage access** to minimise vehicular and livestock access. Where trails can be safely established, the appropriate recommendations listed below under “Plan Land Development Carefully” should be followed.
- **Protect large old trees and snags**. Old trees and snags provide critical nesting habitat for many species of birds, bats, and other wildlife.
- **Reduce ingrowth.** Cut down and remove small ingrowth trees.
- **Prevent disturbance of nesting sites and breeding areas** (e.g., large trees with cavities).
- **Control invasive species**. Managing human and livestock access, and treating existing invasive plant species will help maintain the ecological integrity of old forest sites. Invasive plant control can include hand-pulling, and native species can be planted to help prevent the establishment of more invasive plants. Herbicides and biological control agents are other

[85] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

possible treatments. The BC Ministry of Forests or BC Ministry of Agriculture and Lands can be consulted to determine the appropriate method and timing of treatment for invasive plant species.

- **Avoid use of insecticides in, or near, important foraging areas for wildlife**. Insecticide use near foraging habitat for animals that feed on insects (e.g., Flammulated Owl and Lewis's Woodpecker) should be avoided.
- **Recruit new old forests.** Given that old forests are extremely limited within the study area, new old forests should be encouraged by proper management of mature forests (see Management Recommendations for mature forests on page 74).

Plan Land Development Carefully

Where development is allowed near old forest ecosystems, the following guidelines apply:

- **Require an environmental impact assessment conducted by a qualified professional**[86].
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimize impacts to old forest ecosystems** by addressing the following recommendations:
  - protect large, old trees and snags, and understory vegetation;
  - locate settlements and other developments away from existing large, old trees and snags;
  - design linear corridors to be as narrow as possible, and configure them to allow wildlife crossing; and
  - restore native vegetation where it has been disturbed. Seed or plant native species from nurseries, or plant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free.
- **Design trails carefully**. Ensure that trails do not affect the root systems of trees, and will not create soil erosion problems. Trails should be designed to discourage use by vehicles (e.g., ATVs and dirt bikes), horses, and mountain bikes. Fences may be necessary in some places to prevent access. Trails should be closely monitored for noxious and invasive plants. If invasive plants are present, trails should be closed until the invasive plants have been treated and are under control to avoid spreading them.
- **Protect endangered, threatened, or special concern species or ecological communities** by addressing the following recommendations:
  - avoid disturbance to sites where rare plants are growing and where rare ecological communities occur;
  - maintain habitat structures such as large old trees and snags; and
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.

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[86] See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

- **Protect nesting and denning sites that were identified in the environmental impact assessment**. Such features include dens, cavities, and perch trees.

11 Grasslands

11.1 What are grassland ecosystems?[87]

Grasslands in the study area were dominated by bunchgrasses with scattered forbs and a microbiotic crust. The grasslands of the North Okanagan represent a portion of the Pacific Northwest bunchgrass grasslands that are centred in south-east Washington, north-east Oregon and Idaho[88].

Areas where grasslands occurred are generally too hot and dry for forests to establish. Often, grasslands occurred on medium and finer textured soils where they are better able to capture the surface moisture than trees. Moisture is effectively funnelled by the conical shape of bunchgrasses and captured by extensive grass roots in the upper portions of the soil (generally the top 30cm), leaving little moisture available for tree seedlings. In comparison, trees are usually able to establish on moist sites, and on coarse soils (sandy, gravely) where moisture is available at depth. Additionally, grasslands are favoured in environments where frequent, low-severity fires historically occurred and most young trees were killed by fire.

Much of the diversity within grasslands is found in the microbiotic crust that covers the soil surface between plants. The microbiotic crust is composed of lichens, mosses, algae, bacteria and cyanobacteria. Crusts slow evaporation, prevent wind and water erosion, and contribute nutrients through nitrogen fixation. The microbiotic crust is, however, sensitive to disturbance by vehicles, people, mountain bikes, and livestock.[89]

Arrowleaf balsamroot is a common grassland and open forest plant. The underground parts of the plant were an important food for First Nations.

Bluebunch wheatgrass is a common bunchgrass in warm and dry grasslands and open forests. It is shown here with yarrow (white flowers) and brown-eyed susan (yellow flowers).

[87] Adapted from Iverson and Cadrin 2003.
[88] Tisdale 1947
[89] Williston 1999

For this SEI, grassland ecosystems were divided into distinct classes (grassland and shrubland) according to their environmental and vegetation characteristics; these are described below.

Grassland ecosystems

Bunchgrasses, most commonly bluebunch wheatgrass, rough fescue, and Idaho fescue dominated healthy grassland ecosystems in the study area. Bunchgrasses are designed to funnel moisture to the center of the plant, and have extensive fine roots to capture moisture in the upper horizons of the soil. Grassland soils are usually fine- or medium-textured, and soils are topped by a thick, dark-coloured horizon enriched by organic matter from the decomposition of grass roots.

Shrubland ecosystems

Shrubs, most commonly snowberry and roses, dominated shrubland ecosystems in the study area. Shrublands occurred in grassland areas, but were moister than the surrounding grasslands as they occurred in depressions and moist pockets that tended to collect snow and some run-off. Soils were dark (organic rich), typically medium-textured, and very rich.

Vegetation

	Grassland	Shrubland	
Shrubs			
common snowberry		***	*Symphoricarpos albus*
roses		***	*Rosa* spp.
Grasses			
bluebunch wheatgrass	**		*Pseudoroegneria spicata*
rough fescue	**		*Festuca campestris*
Idaho fescue	**		*Festuca idahoensis*
Forbs			
arrowleaf balsamroot	**	*	*Balsamorhiza sagittata*
parsnip-flowered buckwheat	**		*Eriogonum heracleoides*
daisies or fleabanes	**	*	*Erigeron* spp.
silky lupine	**	*	*Lupinus sericeus*
lemonweed	**	*	*Lithospermum ruderale*
Mosses and Lichens			
sidewalk moss	**		*Tortula ruralis*
clad lichens	**		*Cladonia* spp.

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

11.2 Why are they important?[90]

Ecological attributes and socio-economic values of grassland ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

> Many of the forbs that grow in grasslands, including arrowleaf balsamroot (*Balsamorhiza sagittata*) and mariposa lily (*Calochortus macrocarpus*) were important food sources for aboriginal peoples.

Rare[91] ecological communities of grasslands:

Bluebunch wheatgrass – balsamroot (R) (*Pseudoroegneria spicata - Balsamorhiza sagittata*)

Idaho fescue – bluebunch wheatgrass (R) (*Festuca idahoensis - Pseudoroegneria spicata*)

Prairie rose – Idaho fescue (R) (*Rosa woodsii / Festuca idahoensis*)

Rare vertebrates of grasslands
Swainson's Hawk (R) (*Buteo swainsonii*)
Ferruginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
Prairie Falcon (R) (*Falco mexicanus*)
Upland Sandpiper (R) (*Bartramia longicauda*)
Burrowing Owl (R, COSEWIC-E) (*Athene cunicularia*)
Grasshopper Sparrow (R) (*Ammodramus savannarum*)
Brewer's Sparrow (R) (*Spizella breweri* ssp. *breweri*)
Lark Sparrow (R) (*Chondestes grammacus*)
Preble's Shrew (R) (*Sorex preblei*)
Merriam's Shrew (R) (*Sorex merriami*)
Badger (R, COSEWIC-E) (*Taxidea taxus*)
Pallid Bat (R, COSEWIC-T) (*Antrozous pallidus*)

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Painted Turtle (B) (*Chrysemys picta*)
Racer (B, COSEWIC-SC) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Sharp-tailed Grouse[92] (B) (*Tympanuchus phasianellus* ssp. *columbianus*)
Long-billed Curlew (B, COSEWIC-SC) (*Numenius americanus*)
Short-eared Owl (B, COSEWIC-SC) (*Asio flammeus*)
Lewis's Woodpecker (B, COSEWIC-SC) (*Melanerpes lewis*)
Fringed Myotis (B, COSEWIC-SC) (*Myotis thysanodes*)
Great Basin Pocket Mouse (B) (*Perognathus parvus*)
Western Harvest Mouse (B, COSEWIC-SC) (*Reithrodontomys megalotis*)
Nuttall's Cottontail (B, COSEWIC-SC) (*Sylvilagus nuttallii* ssp. *nuttallii*)

- **Highly threatened**: Grasslands commonly occur on sites that are very amenable to development – both for agriculture and housing – and many grasslands have already been lost to agricultural or urban development. Overuse by domestic livestock and invasive plants also

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[90] Adapted from Iverson and Cadrin 2003.
[91] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).
[92] Thought to be extirpated from the area.

threaten remaining grasslands. Grasslands are recognised as one of British Columbia's most threatened ecosystems[93]. Only 8% of the grasslands in the province are protected[94].

- **Rarity**: All grassland ecological communities are listed by the B.C. Conservation Data Centre (see above).
- **High biodiversity**: Grasslands and shrublands support a unique assemblage of species that includes a high proportion of endangered species. Grasslands, in combination with other ecosystems, are used by many species.
- **Sensitivity to disturbance**: Grasslands are very sensitive to disturbances including off-road vehicle use and mountain biking, and recovery can take many decades. Disturbance to grassland soils can damage the fragile microbiotic crust, and can allow noxious weed invasions, which can slow or limit recovery.
- **Social values**: Grasslands provide opportunities for education, wide open spaces for walking and hiking, wildlife viewing, and aesthetic enjoyment. Grasslands are particularly attractive in spring with their vibrant display of wildflowers. The open, natural spaces that grasslands provide can add to real estate values in adjacent areas, and can draw tourists into the area.

11.3 Status

We found that grassland ecosystems covered 5.9% (966 hectares) of the study area. The majority of these were grassland (742 ha) with some shrubland (224 ha) ecosystems. The proportion of grasslands in the study area reflects the importance of the study area to the conservation of grasslands in the Okanagan Valley.

All grassland ecosystems are a high priority for conservation considering that many have been lost to agricultural and urban settlement, especially outside of the study area, and non-native plants have invaded many sites. Grasslands with 20-50% non-native vegetation were included in the Disturbed Grasslands category.

11.4 Management Recommendations[95]

The following recommendations will aid in the site management of grassland ecosystems.

Retain Natural Vegetated Buffers around Grassland Ecosystems

Site assessments should be conducted to delineate natural vegetated buffers that should be retained or established with native vegetation such that the buffer will maintain continuity with adjacent sensitive ecosystems and wildlife habitat and protect the grassland ecosystem from edge effects. Buffers are particularly important around grassland ecosystems because of their vulnerability to disturbance and susceptibility to weed invasions.

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[93] Canadian Parks and Wilderness Society 1996
[94] Grasslands Conservation Council of B.C. 2002
[95] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

Avoid Direct and Indirect Impacts

- **Discourage human settlements or other developments** within or adjacent to all grassland ecosystems.
- **Manage access**. All motorized vehicles should be restricted to existing roads. Mountain bikes should be restricted to existing or carefully planned trails that are weed free, and not subject to erosion; otherwise, these trails should be closed until weed problems have been controlled. Trails can create erosion problems, disturb fragile vegetation, and spread or introduce invasive weed species. Existing trails with erosion problems need to be rehabilitated and restored.
- **Prevent disturbance of nesting sites and breeding areas**. Many grassland birds are ground-nesters.
- **Protect large old trees and snags.** Scattered trees or snags are extremely important for wildlife in grassland areas. These trees can be isolated structures in grassland areas.
- **Manage livestock use**. Livestock grazing needs to be carefully managed to ensure that ecological values associated with grassland ecosystems are maintained. Bunchgrasses are damaged by season-long grazing. Careful monitoring should be implemented to ensure that grazing levels and timing meet management objectives for the site.
- **Control invasive species**. Managing human and livestock access and treating existing invasive species will help maintain the ecological integrity of grassland ecosystems. Invasive plants can be sprayed or hand-pulled, and native species can be planted to help prevent the establishment of more invasive plants. Herbicides and biological control agents are other possible treatments. It is important that the right treatment method is used to ensure it is effective. The BC Ministry of Forests or BC Ministry of Agriculture and Lands can be consulted to determine the appropriate method and timing of treatment for invasive plant species.
- **Remove encroaching trees**. Large old trees are important habitat features that should be protected where they occur in grassland areas, but young trees should be removed by cutting, or other mechanical means. Prescribed fire can also be used to remove encroachment, but it must be planned and conducted by a qualified professional and requires careful management of invasive plant species to prevent their spread.
- **Avoid use of insecticides in, or near, important foraging areas for wildlife**. Insecticide use near foraging habitat for animals that feed on insects (e.g., Lewis's woodpecker) should be avoided.

Plan Land Development Carefully

Where development is allowed near grassland ecosystems, the following guidelines apply:

- **Require an environmental impact assessment conducted by a qualified professional[96].**
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimize impacts to grassland ecosystems** by addressing the following recommendations:

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[96]See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

- protect native grasses, microbiotic crusts, and other native vegetation;
- protect large old trees, and snags;
- protect soils, and other terrain features such as bedrock; and
- restore native vegetation where it has been disturbed. Seed or plant native species from nurseries, or plant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free.

- **Maintain native grassland ecosystems and their wildflowers** by encouraging landowners and developers to maintain natural sites, and landscape with native species adapted to local conditions. Native plant gardening can help create wildlife habitat, and minimize the need to water or irrigate.
- **Protect endangered, threatened, or special concern species or ecological communities**, **and habitat features** that were identified during the planning and inventory stages by addressing the following recommendations:
  - avoid disturbance to sites where rare plants are growing and where rare ecological communities occur;
  - maintain habitat structures such as large old trees and snags; and
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Protect nesting and denning sites** that were identified in the environmental impact assessment. Such features include dens, raptor nest or perch trees, owl roosts, woodpecker cavities, and bat roosts.

12 Broadleaf Woodlands

12.1 What are broadleaf woodland ecosystems?[97]

Broadleaf woodland ecosystems occurred on sites where conditions resulted in a broadleaf overstory in the climax stage of succession. Because these ecosystems are moister than surrounding areas, they have many similarities to riparian ecosystems, but are generally not found near standing or running water.

In the study area broadleaf woodland ecosystems included only aspen copse ecosystems. Aspen copse ecosystems occurred in broad, moist depressions in grassland areas. They were typically small ecosystems with trembling aspen overstories and shrubby understories dominated by common snowberry and roses. Soils were typically medium-textured. These sites were rich as the yearly input of leaf litter is quickly decomposed and mixed into the upper soil horizon by soil organisms.

Vegetation

Trees			
	trembling aspen	***	*Populus tremuloides*
Shrubs			
	common snowberry	***	*Symphoricarpos albus*
	Nootka rose	**	*Rosa nutkana*
	Douglas maple	**	*Acer glabrum*
	saskatoon	*	*Amelanchier alnifolia*
	tall oregon-grape	*	*Mahonia aquifolium*
Grasses			
	blue wildrye	*	*Elymus glaucus*
Forbs			
	star-flowered false Solomon's-seal	*	*Maianthemum stellatum*

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

[97] Adapted from Iverson and Cadrin 2003.

12.2 Why are they important?[98]

Ecological attributes and socio-economic values of broadleaf woodland ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

Rare[99] ecological communities of broadleaf woodlands

Trembling aspen / snowberry / Kentucky bluegrass (R) (*Populus tremuloides / Symphoricarpos albus / Poa pratensis*)

Rare vertebrates of broadleaf woodlands:
Ferruginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
Western Screech-Owl (R, COSEWIC-E) (*Megascops kennicottii* ssp. *macfarlanei*)
Yellow-breasted Chat (R, COSEWIC-E) (*Icteria virens*)
Brewer's Sparrow (R) (*Spizella breweri* ssp. *breweri*)

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Lewis's Woodpecker (B, COSEWIC-SC) (*Melanerpes lewis*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)
Western Harvest Mouse (B, COSEWIC-SC) (*Reithrodontomys megalotis*)

- **Rarity**: Broadleaf woodland ecological communities are listed as rare by the B.C. Conservation Data Centre (see above).
- **High biodiversity**: Broadleaf woodland ecosystems have diverse ecological communities that support a rich assemblage of species. Deciduous litter fall results in an organically enriched upper layer of soil.
- **Specialised habitats**: Aspen copse ecosystems are structurally diverse, and provide cover, food, and nesting habitat for many species. Aspen trees are very important for cavity nesting birds and animals. Many species that feed in adjacent grasslands require aspen trees for nesting and denning.
- **Social values**: Broadleaf woodland ecosystems provide opportunities for education, wildlife viewing, cover from the heat and sun, walking and hiking, and aesthetic enjoyment. They provide water filtration, soil stability and can add to real estate values in adjacent areas and draw tourists into the area.
- **Fragility**: These ecosystems are sensitive to soil disturbances because of their moist soils.

12.3 Status

Broadleaf woodland ecosystems were rare in the study area; they covered 0.6% of the study area (92 ha). All broadleaf woodland ecosystems are a high priority for conservation.

[98] Adapted from Iverson and Cadrin 2003.
[99] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).

12.4 Management Recommendations[100]

The following recommendations will aid in the site management of broadleaf woodland ecosystems.

Retain Natural Vegetated Buffers around Broadleaf Woodland Ecosystems

Wherever possible, natural vegetated buffers should be retained or established with native vegetation around each broadleaf woodland ecosystem to maintain ecological viability and prevent the introduction and spread of invasive weed species. Connectivity should be maintained with surrounding ecosystems. Historically, broadleaf woodland ecosystems likely occurred as small to medium-sized patch sizes with a high level of interconnectedness with grassland and other ecosystems. Many wildlife values associated with these ecosystems are reliant on their connections with other ecosystems.

Avoid Direct and Indirect Impacts

- **Discourage human settlement or other development** within or adjacent to broadleaf woodland ecosystems.
- **Plan for controlled recreational access** to some areas, and access restrictions (e.g., with fencing and railings) to sensitive areas in order to manage the effects of recreation and other human uses. **Avoid road access wherever possible**.
- **Prevent disturbance or nesting of breeding areas**. Avoid development activities from May through August.
- **Avoid road access wherever possible**.
- **Control invasive species**. Managing human and livestock access will help prevent the spread of invasive plants. Treat existing invasive species to maintain ecological integrity of the site. Herbicides and biological control agents are other possible treatments. The BC Ministry of Forests and Range or BC Ministry of Agriculture and Lands can be consulted to determine the appropriate method and timing of treatment. Plant native shrubs on disturbed sites to establish a healthy, weed-resistant natural plant community.
- **Avoid use of insecticides in or near important foraging areas for wildlife**. Insecticide use near foraging habitat for animals that feed on insects (e.g., Western Screech-Owl and Townsend's Big-eared Bat) should be avoided.

Plan Land Development Carefully

Where development is allowed near broadleaf woodland ecosystems, the following guidelines apply:

- **Require an environmental impact assessment conducted by a qualified professional**[101].
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimise impacts to broadleaf woodland ecosystems** by addressing the following recommendations:

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[100] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

[101] See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

- ♦ protect mature and old trees and understory vegetation (especially shrubs);
- ♦ protect live and dead trees with cavities;
- ♦ protect standing dead and declining trees, downed trees and logs, and leaf litter;
- ♦ protect the root systems of trees;
- ♦ protect soil conditions and hydrologic regimes; and
- ♦ restore native vegetation where it has been disturbed. Plant cuttings of shrubs, or plant native species from nurseries, or plant native species have been rescued from other development sites. Make sure any native plant material used is weed-free.

- **Design roads carefully**. Roads should be narrow and set back from the ecosystem to ensure that vegetation is maintained. Where roads encroach upon broadleaf woodland ecosystems, narrow the width of the road and avoid sidecasting material into the ecosystem.
- **Design trails carefully**. Ensure that trails do not affect the root systems of trees, and will not create soil erosion problems. Trails should be designed to discourage use by vehicular traffic (ATV's), horses, and mountain bikes. Fences may be necessary in some places to control access.
- **Protect endangered, threatened, or special concern species or ecological communities, and habitat features** that were identified during the planning and inventory stages, by including the following recommendations:
    - ♦ avoid disturbance to sites where rare plants are growing and where rare ecological communities occur;
    - ♦ maintain habitat structures such as trees with cavities, large old trees, and snags, and limbs, leaf litter and soil; and
    - ♦ where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree. Large diameter felled trees should be left on the ground.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Protect nesting and denning sites** that were identified in the environmental impact assessment. Such features include dens, raptor nest or perch trees, owl roosts, woodpecker cavities, and bat roosts.
- **Maintain hydrologic regimes**. Changes to surface and ground water flow can negatively impact broadleaf woodland ecosystems. Trails, roads, and housing developments must be designed to maintain hydrology of these ecosystems.
- **Ensure adequate sediment and erosion control measures** are implemented.

13 Coniferous Woodlands

13.1 What are coniferous woodland ecosystems?[102]

Coniferous woodland ecosystems in the study area had open coniferous tree canopies. They occurred on rocky knolls and shallow soils where limited moisture or shallow soil limited tree establishment. These ecosystems had scattered ponderosa pine and Douglas-fir trees, and saskatoon growing in rock fractures with patches of grasses and forbs in shallow soil pockets.

Coniferous woodland ecosystems were classified into five structural stages for this SEI. Structural stages are important to identify different habitat values and the quality of the site (Table 9). Generally, older structural stages are of higher conservation priority than younger structural stages. Younger sites are important for buffers, and they provide recruitment for older structural stages.

Table 9. Structural stages of coniferous woodland ecosystems.

Code	Name	Definition
WD:3	Shrub/herb	Shrub cover 20% or greater, tree cover less than 10%
WD:4	Pole sapling	Trees are >10m tall and have 10% or greater cover, dense stands, generally 10-40 years old
WD:5	Young forest	Trees are >10m tall and have 10% or greater cover, dominated by young trees about 40-80 years old
WD:6	Mature forest	Trees are >10m tall and have 10% or greater cover, dominated by mature trees about 80-250 years old

Vegetation

Trees			
	ponderosa pine	**	*Pinus ponderosa*
	Douglas-fir	**	*Pseudotsuga menziesii*
Shrubs			
	saskatoon	**	*Amelanchier alnifolia*
Grasses			
	bluebunch wheatgrass	***	*Pseudoroegneria spicata*
	rough fescue	**	*Festuca campestris*
Forbs			
	arrowleaf balsamroot	**	*Balsamorhiza sagittata*
	selaginella	*	*Selaginella* spp.

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

[102] Adapted from Iverson and Cadrin 2003.

13.2 Why are they important?

Ecological attributes and socio-economic values of coniferous woodland ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

Rare[103] ecological communities of coniferous woodlands

Douglas-fir – ponderosa pine / bluebunch wheatgrass (B) (*Pseudotsuga menziesii - Pinus ponderosa / Pseudoroegneria spicata*)

Douglas-fir - ponderosa pine / bluebunch wheatgrass – pinegrass (B) (*Pseudotsuga menziesii - Pinus ponderosa / Pseudoroegneria spicata - Calamagrostis rubescens*)

Ponderosa pine / bluebunch wheatgrass - rough fescue (B) (*Pinus ponderosa / Pseudoroegneria spicata - Festuca campestris*)

Ponderosa pine / bluebunch wheatgrass - Idaho fescue (B) (*Pinus ponderosa / Pseudoroegneria spicata - Festuca idahoensis*)

Ponderosa pine / red three-awn (B) (*Pinus ponderosa / Aristida purpurea* var. *longiseta*)

Rare vertebrates of coniferous woodlands
Swainson's Hawk (R) (*Buteo swainsoni*)
Ferriginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
White-headed Woodpecker (R, COSEWIC-E) (*Picoides albolarvatus*)
Badger (R, COSEWIC-E) (*Taxidea taxus*)

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Painted Turtle (B) (*Chrysemys picta*)
Racer (B, COSEWIC-SC) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Western Skink (B, COSEWIC-SC) (*Eumeces skiltonianus*)
Lewis' Woodpecker (B, COSEWIC-SC) (Melanerpes lewis)
Flammulated Owl (B, COSEWIC-SC) (*Otus flammeolus*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- **Rarity**: Coniferous woodland ecological communities have rare status (see above).
- **High biodiversity**: Coniferous woodland ecosystems are diverse and support a rich assemblage of species. The open nature of these forests provides good visibility from predators for ungulates, and provides habitat for many grassland species that do not tolerate closed forests. Coniferous woodland ecosystems on shallow soil sites with exposed bedrock often provide habitat for snakes.
- **Specialised habitats**: Scattered large, old trees and cracks and crevices in ecosystems with exposed bedrock provide a range of habitat niches.
- **Fragility**: Coniferous woodland ecosystems commonly have shallow soils that are very sensitive to disturbance.

[103] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).

- **Social values**: Coniferous woodland ecosystems provide opportunities for education, wildlife viewing, landscape viewpoints, walking and hiking, and aesthetic enjoyment. They can add to real estate values in adjacent areas and draw tourists into the area.

13.3 Status

The types of coniferous woodland ecosystems found in the study area have a limited distribution in the dry interior valleys of southern British Columbia. Historically, these ecosystems likely occurred in lower elevation ponderosa pine forests and higher areas with warm aspects or shallow soils. Most coniferous woodland ecosystems have been altered by disturbances such as logging, forest ingrowth, and weed invasion. Coniferous woodland ecosystems were the most common sensitive ecosystem in the study area (13.5% of study area; 2206 ha).

Old coniferous woodland ecosystems are included within the old forest category because of their extreme rarity.

Most coniferous woodland ecosystems were young forests (75%). Mature coniferous woodlands (14%) should be a higher priority for conservation.

13.4 Management Recommendations[104]

The following recommendations will aid in the site management of coniferous woodland ecosystems.

Retain Natural Vegetated Buffers around Coniferous Woodland Ecosystems

Wherever possible, natural vegetated buffers should be retained or established with native vegetation around coniferous woodland ecosystems. Buffers help to reduce the spread and introduction of invasive weed species, and help to maintain ecological viability and connectivity to other ecosystems. It is also important to maintain corridors to further ensure connectivity to other ecosystems. Many of the wildlife values associated with coniferous woodland ecosystems are reliant on their connections with other ecosystems.

Avoid Direct and Indirect Impacts

- **Discourage human settlement or other developments** within or adjacent to coniferous woodland ecosystems.
- **Manage access** to minimize vehicular and livestock access. Where trails can be safely established, follow the appropriate recommendations listed below under "Plan Land Development Carefully".
- **Control invasive species**. Managing human and livestock access, and treating existing invasive species will help maintain the ecological integrity of coniferous woodland sites. Retaining a healthy natural plant community and avoiding soil disturbance will help prevent weed invasions. Herbicides and biological control agents are other possible treatments. The BC Ministry of Forests and Range or BC Ministry of Agriculture and Lands can be consulted to determine the appropriate method and timing of treatment for invasive plant species.

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[104] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

- **Prevent soil disturbances**. Coniferous woodlands typically have shallow soils that are sensitive to disturbance. Soil disturbance can allow invasive plants to establish and spread and can make it difficult for native plants to re-establish.
- **Reduce ingrowth.** Cut down and remove small ingrowth trees.

Plan Land Development Carefully

Where development is allowed in or near coniferous woodland ecosystems, the following guidelines apply:

- **Require an environmental impact assessment conducted by a qualified professional**[105].
- **Design and implement land development activities** (including trails and recreation access) **to minimise impacts to coniferous woodland ecosystems** by addressing the following recommendations:
    - protect mature and old trees, and native vegetation;
    - protect large diameter (>30cm) dead and declining trees;
    - protect the root systems of trees;
    - protect soils by avoiding activities that cause erosion or compaction; and
    - restore native vegetation where it has been disturbed. Seed or plant native species from nurseries, or plant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free.
- **Design trails carefully**. Ensure that trails do not affect the root systems of trees, and will not create soil erosion problems. Trails should be designed to discourage use by vehicles (ATV's), horses, and mountain bikes. Fences may be necessary in some places to prevent access. Trails should be closely monitored for noxious and invasive plants. If invasive plants are present, trails should be closed until the invasive plants have been treated and are under control to reduce spread.
- **Protect endangered, threatened, or special concern species or ecological communities, and habitat features** that were identified during the planning and inventory stages by addressing the following recommendations:
    - avoid disturbance to sites where rare plants are growing and where rare ecological communities occur;
    - maintain habitat structures such as trees with cavities, large old trees, and snags; and
    - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Protect large old trees, and snags**. Old trees and snags provide critical nesting habitat for many species of birds and small mammals.

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105 See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

- **Protect nesting and denning sites** that were identified in the environmental impact assessment. Such features include dens, raptor nest or perch trees, owl roosts, woodpecker cavities, and bat roosts.
- **Ensure adequate sediment and erosion control measures** are implemented.

14 Sparsely Vegetated

14.1 What are sparsely vegetated ecosystems?

Sparsely vegetated ecosystems in the study area occurred on sites where rock or talus limited vegetation establishment. Vegetation cover was discontinuous, and was interspersed with bedrock or blocks of rock.

Sparsely vegetated ecosystems were subdivided into four subtypes: shrub, talus, cliff, and rock outcrop ecosystems; these are described below.

Shrub

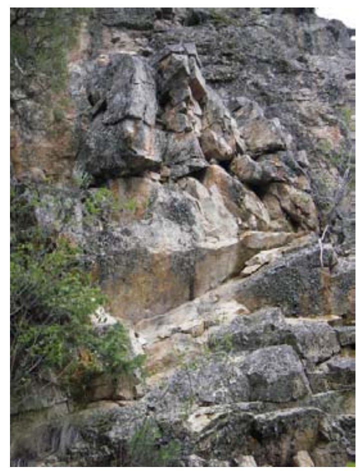
In the study area, shrub ecosystems occurred on small rock outcrops with cracks and crevices in grassland areas. Soils were restricted to small pockets. Scattered shrubs grew in cracks and crevices.

Talus

Talus ecosystems occurred on steep slopes covered with angular rock fragments. They usually occurred below rock outcrops or cliffs. Vegetation included scattered trees, shrubs, and cliff ferns.

Cliff

In the study area, sparsely vegetated cliff ecosystems were steep, vertical cliffs. Cliffs had minimal vegetation that was restricted to cracks and crevices, narrow ledges and small soils pockets.



Rock Outcrops

Rock outcrop ecosystems occurred on areas of exposed rock that had very little soil development and sparse vegetation cover. Vegetation cover typically consisted of bunchgrasses, selaginella and scattered shrubs.

Vegetation

	Shrub	Talus	Cliff	Rock outcrop	
Trees					
ponderosa pine		*			*Pinus ponderosa*
Douglas-fir		*		*	*Pseudotsuga menziesii*
Shrubs					
saskatoon	**	*	*	**	*Amelanchier alnifolia*
choke cherry	*	*	*		*Prunus virginiana*
mock orange		**	*		*Philadelphus lewisii*
Grasses					
bluebunch wheatgrass	*	*	*	**	*Pseudoroegneria spicata*
Forbs					
arrowleaf balsamroot	*			*	*Balsamorhiza sagittata*
selaginella				**	*Selaginella* spp.
cliff fern		*	*	*	*Woodsia* spp.
shrubby penstemon	*	*		*	*Penstemon fruticosus*

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

14.2 Why are they important?

Ecological attributes and socio-economic values of sparsely vegetated ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

Sparsely vegetated ecological communities recommended for the red- or blue- list:

Antelope-brush – selaginella (*Purshia tridentata*)[106]

Choke cherry – bluebunch wheatgrass (*Prunus virginiana – Pseudoroegneria spicata*)

Saskatoon – mock orange (*Amelanchier alnifolia – Philadelphus lewisii*)

Selaginella – bluebunch wheatgrass (*Selaginella - Pseudoroegneria spicata*)

Rare[107] vertebrates of sparsely vegetated ecosystems
Ferruginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
Peregrine Falcon (R, COSEWIC-SC) (*Falco peregrinus* ssp. *anatum*)
Prairie Falcon (R) (*Falco mexicanus*)
Pallid Bat (R, COSEWIC-T) (*Antrozous pallidus*)

Racer (B, COSEWIC-SC) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Western Skink (B, COSEWIC-SC) (*Eumeces skiltonianus*)
Canyon Wren (B) (*Catherpes mexicanus*)
Fringed Myotis (B, COSEWIC-SC) (*Myotis thysanodes*)
Western Small-footed Myotis (B) (*Myotis ciliolabrum*)
Spotted Bat (B, COSEWIC-SC) (*Euderma maculatum*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- **Rarity**: Most sparsely vegetated ecological communities have been recommended for rare status (see above).
- **Specialised habitats**: A variety of specialised habitats are found in sparsely vegetated ecosystems. A number of species, including many threatened- or endangered-species are dependant on these habitats. Deep crevices and some talus slopes are used for shelter and hibernacula for over-wintering snakes such as Western Rattlesnakes, Gopher Snakes, and Racers. Some shrub, rock outcrop and cliff ecosystems with deep crevices provide roosting or hibernacula sites for a variety of bat species. Isolated trees provide important roosting or nesting sites for Lewis' woodpeckers and raptors.
- **Fragility**: Sparsely vegetated sites are sensitive to disturbance. They can take very long periods of time to recover, or never if soil is removed or eroded.

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[106] Although Antelope-brush does not occur in the North Okanagan, this ecological community is still considered to occur here. Some ecological communities have a broad range of vegetation species and ecological community names do not always reflect the dominant species at a particular site.
[107] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).

- **Social values**: Sparsely vegetated ecosystems often provide focal points in the landscape for scenic viewpoints, wildlife viewing, and aesthetic enjoyment. They can add to real estate values in adjacent areas, and can draw tourists into the area.

14.3 Status

Sparsely vegetated ecosystems were rare in the study area and covered only 0.8% (129 ha) of the study area land base. In the study area, shrub, talus, and rock outcrop ecosystems were the most common ecosystem types (52 ha, 40 ha, and 32 ha); cliffs were very rare (5 ha).

14.4 Management Recommendations[108]

The following recommendations will aid in the site management of sparsely vegetated ecosystems.

Retain Natural Vegetated Buffers around Sparsely Vegetated Ecosystems

Wherever possible, natural vegetated buffers should be retained or established with native vegetation around each sparsely vegetated ecosystem and connectivity should be maintained between sparsely vegetated ecosystems and adjacent habitats. Many of the species that use sparsely vegetated ecosystems are also reliant on other types of ecosystems.

Avoid Direct and Indirect Impacts

- **Discourage human settlement and other land development** within or adjacent to sparsely vegetated ecosystems.
- **Manage access** to minimise vehicular and livestock access on and near sparsely vegetated ecosystems. Vehicle traffic, including bicycles, causes mortality to wildlife species that rely on these ecosystems. Road access should be avoided and rock climbing should be carefully managed on cliffs. ***Do not develop trails*** on sparsely vegetated ecosystems. Trails can create erosion problems, disturb fragile vegetation, and spread or introduce invasive weed species.
- **Prevent disturbance of snake hibernacula**. If snake hibernacula are found, they should not be disturbed and should not be made known to the public unless they occur in an area where public use may disturb snakes. Use snake fences around higher density developments.
- **Control invasive species***.* Managing human and livestock access, and treating existing invasive species will help maintain ecological integrity of the site. Invasive plants can be hand-pulled, and native species can be planted to help prevent the establishment of more invasive plants. Retention of a healthy natural plant community will also help prevent weed invasions. Sparsely vegetated ecosystems are very sensitive and it is important not to cause further disturbance when treating invasive plants. Herbicides and biological control agents are other possible treatments. The BC Ministry of Forests and Range or BC Ministry of Agriculture and Lands can be consulted to determine the appropriate method and timing of treatment for invasive plant species.

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108 Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

- **Prevent soil disturbances**. Sparsely vegetated have sensitive pockets of shallow soils, and they frequently occur on steep slopes. Soil disturbance can allow invasive plants to establish or spread and can make it difficult or impossible for native plants to re-establish. Disturbance of talus or bedrock may destabilize remaining rocks.

Plan Land Development Carefully

Where development is allowed in or near sparsely vegetated ecosystems, the following guidelines apply:

- **Require an environmental impact assessment conducted by a qualified professional**[109].
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimise impacts to sparsely vegetated ecosystems** by addressing the following recommendations:
    - protect talus that occurs at the base of rock outcroppings and protect the steep faces of rock outcrops and cliffs;
    - protect mature and old trees and all native vegetation;
    - protect large diameter (>30cm) standing dead and declining trees and downed logs;
    - protect soil conditions and hydrologic regimes; and
    - restore native vegetation where it has been disturbed. Seed or plant native species from nurseries, or plant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free.
- **Protect endangered, threatened, or special concern species or ecological communities, and habitat features** that were identified during the planning and inventory stages by addressing the following recommendations:
    - avoid disturbance of rock debris;
    - do no permit rock climbing without determining which areas must be avoided to protect denning, nesting, and roosting habitats;
    - avoid disturbance to sites where rare plants are growing and where rare ecological communities occur;
    - maintain habitat structures such as trees with cavities, large old trees, and snags; and,
    - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Avoid roads near hibernacula**. Determine locations of snake hibernacula prior to planning site layouts, including roads. Roads should not be located within 750m of a hibernaculum and barriers and underpasses or snake fences may be required to prevent snake mortality.

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[109] See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

- **Protect nesting and denning sites that were identified in the environmental impact assessment**. Such features include dens, hibernacula, raptor nest or perch trees, woodpecker cavities, and bat roosts.
- **Ensure adequate sediment and erosion control measures** are implemented.

15 Mature Forest

15.1 What are mature forest ecosystems?

Mature forest ecosystems were mapped where polygons included structural stage 6 forests[110] (mature forest), except for mature riparian, broadleaf woodland, and coniferous woodland forests, which were included in the riparian, broadleaf woodland, and coniferous woodland categories respectively.

Historically, most forests had frequent surface fires that killed most small trees and allowed few trees into the overstory. Overstories were generally open, multi-aged, and had a largely single-layered canopy of mostly large, old trees. The understory of mature forests was open and dominated by grasses and shrubs. Frequent fire also limited the occurrence of dead wood; only scattered large snags and large, downed wood occurred.

The exclusion of fires has caused formerly open, park-like forests to infill with smaller trees (forest ingrowth). Mature forests occurred where there are mature trees and a few large old trees. These stands typically had a history of selection logging and had some forest ingrowth, but the mature and old trees they contained are structurally important for wildlife. Mature forest sites provide excellent buffers for old forests and have good potential for restoration to historical stand structure.

Coniferous mature forest ecosystems

Coniferous mature forests in the study area were dominated by ponderosa pine and Douglas-fir. These forests occurred on sites with a wide range of ecological conditions. Most sites had a Douglas-fir overstory, with scattered grasses, forbs, and shrubs in the understory.

Mixed mature forest ecosystems

In the study area, mixed mature forests had both Douglas-fir and broadleaf tree species, including trembling aspen and paper birch. These ecosystems occurred on moister sites than coniferous mature forest ecosystems and had shrubby understories with scattered grasses and forbs.

[110] Refer to Volume 2 (Iverson and Uunila 2006) for details on structural stage 6.

Vegetation

	Coniferous	Mixed	
Trees			
ponderosa pine	**		*Pinus ponderosa*
Douglas-fir	***	**	*Pseudotsuga menziesii*
paper birch		**	*Betula papyrifera*
trembling aspen		**	*Populus tremuloides*
Shrubs			
common snowberry	**	***	*Symphoricarpos albus*
tall oregon-grape	**	**	*Mahonia aquifolium*
Nootka rose	*	**	*Rosa nutkana*
Douglas maple		**	*Acer glabrum*
Grasses			
bluebunch wheatgrass	**		*Pseudoroegneria spicata*
rough fescue	**		*Festuca campestris*
blue wildrye		*	*Elymus glaucus*
Forbs			
arrowleaf balsamroot	*		*Balsamorhiza sagittata*
heart-leaved arnica	*	**	*Arnica cordifolia*

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

15.2 Why are they important?

Ecological attributes and socio-economic values of mature forest ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

Rare[111] ecological communities of mature forests

Douglas-fir / common snowberry - birch-leaved spirea (B) (*Pseudotsuga menziesii / Symphoricarpos albus - Spiraea betulifolia*)

Douglas-fir - ponderosa pine / pinegrass (B) (*Pseudotsuga menziesii - Pinus ponderosa / Calamagrostis rubescens*)

Rare vertebrates of mature forests
Swainson's Hawk (R) (*Buteo swainsonii*)
White-headed Woodpecker (R, COSEWIC-E)
Badger (R, COSEWIC-E) (*Taxidea taxus*)

Racer (B, COSEWIC-SC) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Great Blue Heron (B) (*Ardea herodias*)
Flammulated Owl (B, COSEWIC-SC) (*Otus flammeolus*)
Lewis's Woodpecker (B) (*Melanerpes lewis*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- **Future old forest ecosystems**: The extent of old forest ecosystems was extremely limited. With proper restoration, mature forests can, over time, become old forest ecosystems. However, removal of forest ingrowth is required to develop old forest ecosystems.

[111] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).

- **Biodiversity**: Mature forest ecosystems have many important structural attributes, including some remaining large, old trees. They provide habitat for many species, and, where they occur, broadleaf trees are important for many cavity-nesting species.
- **Landscape connectivity:** Mature forests provide buffers, and connectivity between other ecosystems.
- **Social values**: Mature forests provide opportunities for education, recreation, wildlife viewing, and aesthetic enjoyment. The green space that mature forests provide can add to real estate values in adjacent areas. Mature forests provide opportunities for selective logging.

15.3 Status

Mature forest ecosystems covered 1.7% (280 ha) of the study area. Most mature forest ecosystems in the study area were ingrown and required thinning to restore them to high quality sites that could become old forests.

Coniferous mature forests were the most common type (276ha); only 4 ha were mixed mature forest.

15.4 Management Recommendations[112]

Avoid Direct and Indirect Impacts

- **Discourage human settlement or other developments** within or adjacent to mature forest ecosystems.
- **Manage access** to minimize vehicular and livestock access. Where trails can be safely established, the appropriate recommendations listed below under "Plan Land Development Carefully" should be followed.
- **Restore and maintain ecological structures and functions**. Restoration requires understanding of historical disturbance regimes (particularly fire), and of the structure of these forests prior to fire exclusion and logging. A qualified professional should develop a detailed restoration plan.

  Restoration should include the retention of larger trees, plus thinning and removal of other trees to restore forest densities to the low tree densities of the late 1800's. Following thinning, initial prescribed burns should be conducted to consume unnaturally heavy fuels. Prescribed burning should be planned and conducted by qualified professionals.

  Prescribed fire may be too dangerous to conduct on small, private lots. Landowners can reduce the risk of wildfire and maintain some of the ecological functioning of mature forest ecosystems on their land by raking and removing fuels from beneath trees, and by cutting and removing small trees.
- **Prevent disturbance of nesting sites and breeding areas** (e.g., cavities in large trees).

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[112] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

- **Protect large old trees, and snags**. Old trees and snags provide critical nesting habitat for many species of birds and den sites for mammals.
- **Control invasive species**. Managing human and livestock access, and treating existing invasive species (e.g., cheatgrass, knapweed, sulphur cinquefoil) will help maintain the ecological integrity of old forest sites. Retention or restoration of a healthy natural plant community will also help prevent weed invasions. Herbicides and biological control agents are other possible treatments. The BC Ministry of Forests and Range or BC Ministry of Agriculture and Lands can be consulted to determine the appropriate method and timing of treatment for invasive plant species.
- **Avoid use of insecticides in, or near, important foraging areas for wildlife**. Insecticide use near foraging habitat for animals that feed on insects (e.g., Flammulated Owl and Lewis's Woodpecker) should be avoided.

Plan Land Development Carefully

Where development is allowed in mature forest ecosystems, the following guidelines apply:

- **Require an environmental impact assessment conducted by a qualified professional**[113].
- **Design and implement land development activities** (including trails and recreation access) **to minimise impacts to the mature forest ecosystems** by addressing the following recommendations:
  - protect large, old trees, and understory vegetation;
  - locate the development away from existing large, old trees and snags; and
  - restore native vegetation where it has been disturbed. Seed in or plant native species from nurseries or transplant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free.
- **Design trails carefully**. Ensure that trails do not affect the root systems of trees, and will not create soil erosion problems. Trails should be designed to discourage use by vehicular traffic (ATV's), horses, and mountain bikes. Fences may be necessary in some places to prevent access. Trails should be closely monitored for noxious and invasive plants. If invasive plants are present, trails should be closed until the invasive plants have been treated and are under control to prevent spread.
- **Protect endangered, threatened, or special concern species and habitat features** that were identified during the planning and inventory stages by addressing the following recommendations**:**
  - avoid disturbance to sites where rare plants are growing and where rare natural plant communities occur;
  - maintain habitat structures such as large old trees and snags; and
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.

[113] See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Protect nesting and denning sites that were identified in the environmental impact assessment**. Such features include dens, raptor nest or perch trees, owl roosts, woodpecker cavities, and bat roosts.

16 Disturbed Grasslands

16.1 What are disturbed grassland ecosystems?

Disturbed grasslands, once intact grasslands, had a mixture of native bunchgrasses and forbs, and 20-70% invasive plant species including cheatgrass and other invasive annual bromes, diffuse knapweed (*Centaurea diffusa*), and sulphur cinquefoil (*Potentilla recta*). Grasslands now dominated by big sagebrush are also included as disturbed grasslands.

In the study area, some grassland ecosystems had been invaded by invasive plants that covered more than 70% of the plant community. These ecosystems would be extremely challenging to restore, were excluded from the disturbed grasslands category, and were considered not sensitive. They do, however, still provide many important wildlife habitat values.

Vegetation

Grasses			
	bluebunch wheatgrass	**	*Pseudoroegneria spicata*
	junegrass	**	*Koeleria macrantha*
	Columbia needlegrass	**	*Achnatherum nelsonii*
Forbs			
	arrowleaf balsamroot	**	*Balsamorhiza sagittata*
	parsnip-flowered buckwheat	**	*Eriogonum heracleoides*
	daisies or fleabanes	*	*Erigeron* spp.
	silky lupine	*	*Lupinus sericeus*
Non-native Plants			
	cheatgrass or Japanese brome	**	*Bromus tectorum* or *B. japonicus*
	diffuse knapweed	**	*Centaurea diffusa*
	sulphur cinquefoil	**	*Potentilla recta*

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species.

16.2 Why are they important?

Ecological attributes and socio-economic values of disturbed grassland ecosystems are listed below. Values common to most SEI ecosystems are discussed in Chapter 2.

- **Rarity**: Disturbed grasslands represent the best potential to recover part of the extent of rare grassland ecological communities.
- **Biodiversity**: Disturbed grasslands provide important habitat for many species, including many red- and blue-listed species (see below).
- **Landscape connectivity:** Disturbed grasslands provide buffers, and connectivity between other ecosystems.

Rare[114] vertebrates of disturbed grasslands
Swainson's Hawk (R) (*Buteo swainsonii*)
Ferruginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
Prairie Falcon (R) (*Falco mexicanus*)
Upland Sandpiper (R) (*Bartramia longicauda*)
Burrowing Owl (R, COSEWIC-E) (*Athene cunicularia*)
Grasshopper Sparrow (R) (*Ammodramus savannarum*)
Brewer's Sparrow (R) (*Spizella breweri* ssp. *breweri*)
Lark Sparrow (R) (*Chondestes grammacus*)
Preble's Shrew (R) (*Sorex preblei*)
Merriam's Shrew (R) (*Sorex merriami*)
Pallid Bat (R, COSEWIC-T) (*Antrozous pallidus*)
Badger (R, COSEWIC-E) (*Taxidea taxus*)

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Painted Turtle (B) (*Chrysemys picta*)
Racer (B, COSEWIC-SC) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Long-billed Curlew (B, COSEWIC-SC) (*Numenius americanus*)
Lewis's Woodpecker (B, COSEWIC-SC) (*Melanerpes lewis*)
Fringed Myotis (B, COSEWIC-SC) (*Myotis thysanodes*)
Western Small-footed Myotis (B) (*Myotis ciliolabrum*)
Great Basin Pocket Mouse (B) (*Perognathus parvus*)
Western Harvest Mouse (B, COSEWIC-SC) (*Reithrodontomys megalotis*)

16.3 Status

Grassland ecosystems cover only 0.8% of British Columbia's land area and many of these grasslands have been lost or disturbed[115]. The SEI showed that disturbed grasslands covered 6.7% (1091 ha) of the study area. Although these sites had up to 70% non-native plants, they could provide a source of grassland ecosystems through restoration. In particular, disturbed grassland ecosystems that occur in association with other sensitive and important ecosystems are higher priorities for preservation and restoration.

16.4 Management Recommendations[116]

Although 6% of the study area is covered by undisturbed grassland; disturbed grasslands covered a slightly higher proportion. These disturbed grassland ecosystems need to be restored to replace invasive plants with native vegetation. Where disturbed grasslands occur in association with other sensitive ecosystems, they have a higher preservation value and should be a higher priority for restoration. Disturbed grasslands can also form buffers, corridors, and provide wildlife habitat, but require a plan to control invasive plants.

Avoid Direct and Indirect Impacts

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114 Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of June 2005 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2005, are noted as endangered (E), threatened (T), or of special concern (SC).
115 Grasslands Conservation Council of B.C. 2002
116 Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

- **Discourage human settlement or other land developments** within or adjacent to disturbed grassland ecosystems that are required for wildlife habitats or are identified as environmentally sensitive areas (ESAs).
- **Minimise vehicular access**. Vehicles are very effective at spreading invasive plants. Ensure roads are weed-free.
- **Carefully plan new trails** on disturbed grassland ecosystems. Trails can create erosion problems, disturb fragile vegetation, and spread invasive weed species. All motorised vehicles should be restricted to existing roads. Mountain bikes should be restricted to existing trails where such trails are weed-free, sustainable, and are not subject to erosion; otherwise these trails should be closed. Trails with invasive plants (and no erosion problems) can be reopened once weed problems have been controlled.
- **Prevent disturbance of nesting sites and breeding areas**. Many grassland birds are ground-nesters.
- **Manage livestock use**. Livestock grazing needs to be carefully managed to ensure that ecological values associated with grassland ecosystems can be maintained and to avoid spreading invasive plant species. Careful monitoring should to be implemented to ensure that grazing levels and timing meet management objectives for the site. Grazing levels may need to be reduced to effectively restore these sites.
- **Protect large old trees and snags**. Scattered trees or snags are extremely important for wildlife in grassland areas. These trees can be isolated structures in grassland areas.
- **Control invasive species**. Managing human and livestock access and treating existing invasive plant species will help restore the ecological integrity of disturbed grassland ecosystems. Invasive plants can be sprayed or hand-pulled, and native species can be planted to help prevent the establishment of more invasive plants. Restoring a healthy natural plant community will also help prevent future weed invasions. Herbicides and biological control agents are other possible treatments. It is important that the right treatment method is used to ensure it is effective. The BC Ministry of Forests and Range or BC Ministry of Agriculture and Lands can be consulted to determine the appropriate method and timing of treatment for invasive plant species.
- **Remove encroaching trees**. Young trees should be removed by cutting. All large old trees (and some mature trees for recruitment) should be retained.
- **Avoid use of insecticides in, or near, important foraging areas for wildlife**. Insecticide use near foraging habitat for animals that feed on insects (e.g., Lewis's woodpecker) should be avoided.

Plan Land Development Carefully

Where development is allowed in or near disturbed grassland ecosystems, the following guidelines apply:

- **Require an environmental impact assessment conducted by a qualified professional**[117].
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimise impacts to disturbed grassland ecosystems** by addressing the following recommendations:
  - protect native grasses, microbiotic crusts, and other native vegetation,
  - protect large, old trees;
  - protect soils and other terrain features such as bedrock;
  - do not create trails unless invasive plants have been controlled; and
  - restore native vegetation where it has been disturbed. Seed or plant native species from nurseries, or plant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free or contaminated with the same invasive plants present on site.
- **Protect endangered, threatened, or special concern species**, **and habitat features** that were identified during the planning and inventory stages by addressing the following recommendations:
  - avoid disturbance to sites where rare plants are growing and where rare ecological communities occur;
  - maintain habitat structures such as large old trees and snags; and
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Protect nesting and denning sites that were identified in the environmental impact assessment**. Such features include dens, raptor nest or perch trees, owl or woodpecker cavities, and bat roosts.

[117] See: Incorporating SEI Information into Environmental Impact Assessments, page 32.

17 Future Directions

The District of Lake Country SEI provides an essential planning tool for the study area, and an important source of information for similar ecosystems that occur elsewhere in the Okanagan.

For the study area, this information should be used to develop a landscape level ‘local ecosystems plan’ and conservation strategy, which could tie into a broader ‘ecosystem plan’ for the Okanagan Valley including the protected areas on crown lands. Conservation priorities identified in the conservation analysis can provide the basis of a property acquisition strategy.

As development proceeds within the study area, this inventory should be used as the basis for more detailed information gathering (at a finer scale) for development of neighbourhood area plans and Environmental Impact Assessments.

This SEI should be used to provide specific input to a ‘local ecosystems plan’ for the District of Lake Country and could be a component of the Parks and Recreation Master Plan.

This SEI and the landscape level ecosystem plan for this area should be used to modify the District of Lake Country’s Official Community Plan, and to provide input into a Growth Management Strategy. Sensitive and Other Important Ecosystems should be designated as Development Permit Areas within the Official Community Plans. The SEI map and conservation analysis can be used to guide zoning designations within the study area.

Existing mapping can provide a baseline to monitor changes in sensitive and other important ecosystems in the study area. As new housing, agricultural, and land developments, disturbances, and ecological succession occur in the study area, they will change components of the sensitive ecosystems map. The mapping should be updated every ten years to reflect and measure such changes.

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Appendix A: SEI Data

Spatial and non-spatial data for the Terrestrial Ecosystem Mapping (TEM) component are available for download at the former Ministry of Sustainable Resource Management's Terrestrial Ecosystem Mapping Data Warehouse at http://lrdw.ca/ under Region 3.

The following are available:

- project metadata
- Non-Spatial Polygon Attributes
- TEM Map Legend Files
- TEM report with expanded legend (Volume 2)[118]
- Wildlife Species Accounts
- Wildlife Ratings Tables
- Wildlife Report (Volume 3)[119]
- Arc/Info *.E00 Export Files includes two spatial coverages: ECI field sampling points and a ECP TEM polygon coverage

[118] Iverson and Uunila 2006

[119] Haney and Sarell 2006

Appendix B: Sensitive Ecosystems (SEI) Units[120] and related Terrestrial Ecosystem Mapping (TEM) units

Sensitive Ecosystems

SEI Unit	Code	TEM Unit	Code[121]	Subzone / Site Series
Wetland, marsh	WN:ms	Bulrush marsh	BM	IDFxh1 /00
		Baltic rush marsh-meadow	BR	IDFxh1 /00
		Common spikerush marsh	CS	IDFxh1 /00
		Cattail marsh	CT	IDFmw1 /00 IDFxh1/00 PPxh1 /00
Wetland, meadow	WN:md	Nuttall's alkaligrass – Foxtail barley graminoid meadow	AB	IDFxh1 /00
Wetland, swamp	WN:sp	Willow – Sedge wetland	WS	IDFmw1 /00 IDFxh1 /09 PPxh1 /00
Wetland, shallow open water	WN:sw	Shallow open water	OW, OWx	IDFmw1 /00 IDFxh1 /00 PPxh1 /00
Riparian, bench	RI:fp	Black cottonwood – Douglas-fir – Common snowberry – Red-osier dogwood riparian	CDa, CDt	IDFmw1 /00 IDFxh1 /00 PPxh1 /00
		Western redcedar – Devil's club - Foamflower	RDt	IDFmw1 /06
		Hybrid white spruce – Douglas-fir – Douglas maple – Dogwood	SDa, SDt	IDFxh1 /08
Riparian, fringe	RI:ff	Black cottonwood – Douglas-fir – Common snowberry – Red-osier dogwood riparian	CD	IDFxh1 /00 PPxh1 /00
		Douglas-fir – Water birch – Douglas maple	DM, DMf, DMw	PPxh1 /08
		Western redcedar – Devil's club - Foamflower	RD	IDFmw1 /06
		Western redcedar/Douglas-fir – Dogwood	RR, RRw	IDFmw1 /05
		Hybrid white spruce – Douglas-fir – Douglas maple – Dogwood	SD	IDFxh1 /08
		Hybrid white spruce – Gooseberry	SG	MSdm1/06
Riparian, gully	RI:gu	Douglas-fir – Water birch – Douglas maple	DMg, DMgx	PPxh1 /08
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DSg, DSgk, DSgs, DSgw,	IDFxh1 /07 PPxh1 /07
		Western redcedar – Devil's club - Foamflower	RDg, RDgw	IDFmw1 /06
		Western redcedar/Douglas-fir – Dogwood	RRg, RRgk, RRgw	IDFmw1 /05
		Hybrid white spruce – Douglas-fir – Douglas maple – Dogwood	SDcg, SDg, SDgw	IDFxh1 /08
		Hybrid white spruce – Gooseberry	SGgw	MSdm1 /06
		Hybrid white spruce – Trapper's tea - Horsetail	SHg	MSdm1 /07
Old Forest, coniferous	OF:co	Douglas-fir – Ponderosa pine – Pinegrass	DP 7C	IDFxh1 /01
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DS 7C (except those with 'a', 'g', or 't' modifiers)	IDFxh1 /07
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Pinegrass	DW 7C	IDFxh1 /03

[120] See page 4 for SEI unit descriptions.

[121] All site modifier combinations, structural stages, and seral associations are included unless otherwise noted. Seral stages are indicated by the two letters following a '$' (e.g., $kw). Structural stages are indicated by a number (e.g. '7'). Structural stage stand composition modifiers are indicated by a capital letter after the number (e.g., 'C' in '7C'). See Volume 2 (Iverson and Uunila 2006) for descriptions of site modifiers, structural stages, seral associations, and TEM units.

SEI Unit	Code	TEM Unit	Code[121]	Subzone / Site Series
		Douglas-fir – Ponderosa pine – Saskatoon – Mock orange	FO 7C	IDFxh1 /00
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Balsamroot	PB 7C	IDFxh1/02
		Douglas-fir – Penstemon – Pinegrass	PP 7C	IDFmw1 /03
		Ponderosa pine – Red three-awn	PT 7C	PPxh1 /02
		Antelope brush - Selaginella	SA 7C	IDFxh1 /00
		Hybrid white spruce – Falsebox – Feathermoss	SF 7C	MSdm1 /01
		Saskatoon – Mock orange talus	SO 7C	PPxh1 /00
		Douglas-fir – Ponderosa pine – Snowbrush – Pinegrass	SP 7C	IDFxh1 /04
Grassland, grassland	GR:gr	Rough fescue – Bluebunch wheatgrass	FB (no seral association)	PPxh1 /00
		Idaho fescue – Bluebunch wheatgrass	FW (no seral association)	IDFxh1 /91
		Bluebunch wheatgrass – Balsamroot	WB (no seral association)	IDFxh1 /93 PPxh1 /00
Grassland, shrubland	GR:sh	Prairie Rose – Idaho fescue	RF	IDFxh1 /97
		Snowberry – Rose – Kentucky bluegrass	SR	PPxh1 /00
Broadleaf woodland, aspen copse	BW:ac	Trembling aspen – Snowberry – Kentucky bluegrass	AS (structural stage 3-6)	IDFxh1 /00 PPxh1 /00
Coniferous Woodland	WD	Douglas-fir/Ponderosa pine – Snowberry – Bluebunch wheatgrass	DS (structural stage 5-6)	IDFmw1 /02
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Pinegrass	DW (structural stage 5-6)	IDFxh1 /03
		Douglas-fir – Ponderosa pine – Saskatoon – Mock orange	FO (structural stage 3-6)	IDFxh1 /00
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Balsamroot	PB (structural stage 3-6)	IDFxh1 /02
		Ponderosa pine – Bluebunch wheatgrass – Cheatgrass	PC (structural stage 4-6)	PPxh1 /04
		Ponderosa pine – Bluebunch wheatgass – Rough fescue	PF (structural stage 4-6)	PPxh1 /05
		Lodgepole pine – Grouseberry – Cladonia	PG (structural stage 5-6)	MSdm1 /03
		Douglas-fir – Penstemon – Pinegrass	PP (structural stage 5-6)	IDFmw1 /03
		Ponderosa pine – Red three-awn	PT (structural stage 3-6)	PPxh1 /02
		Ponderosa pine – Bluebunch wheatgrass – Idaho fescue	PW (structural stage 4-6)	PPxh1 /01
Sparsely Vegetated, cliff	SV:cl	Cliff	CL	IDFxh1 /00 PPxh1 /00
Sparsely Vegetated, rock outcrop	SV:ro	Rock outcrop	RO	IDFxh1 /00 MSdm1 /00 PPxh1 /00
		Selaginella – Bluebunch wheatgrass rocky bluff	SB (no seral association)	IDFxh1 /00 PPxh1 /00
Sparsely Vegetated, shrub	SV:sh	Choke cherry – Bluebunch wheatgrass rocky bluff	CW	IDFxh1 /00 PPxh1 /00
		Antelope brush - Selaginella	SA	IDFxh1 /00 PPxh1 /00
Sparsely Vegetated, talus	SV:ta	Saskatoon – Mock orange talus	SO	IDFmw1 /00 IDFxh1 /00 PPxh1 /00
		Talus	Taw	IDFmw1 /00 IDFxh1 /00 MSdm1 /00 PPxh1 /00

Other Important Ecosystems

SEI Unit	Code	TEM Unit	Code[122]	Subzone / Site Series
Mature Forest, coniferous	MF:co	Douglas-fir/Western redcedar – Falsebox – Prince's pine	DF 6C	IDFmw1
		Douglas-fir – Ponderosa pine – Pinegrass	DP 6C	IDFmw1 / IDFxh1 /01
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DS 6C (except those with 'a', 'g', or 't' modifiers)	IDFxh1 /07 PPxh1 /07
		Hybrid white spruce – Falsebox - Feathermoss	SF 6C	MSdm1 /01
		Douglas-fir – Ponderosa pine – Snowbrush – Pinegrass	SP 6C	IDFxh1 /04
Mature Forest, mixed	MF:mx	Douglas-fir/Western redcedar – Falsebox – Prince's pine	DF 6M	IDFmw1 /01
		Douglas-fir – Ponderosa pine – Pinegrass	DP 6M	IDFxh1 /01
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DS 6M (except those with 'a', 'g', or 't' modifiers)	IDFxh1 /07
Disturbed Grassland	DG	Idaho fescue – Bluebunch wheatgrass	FB:$nc, $wk	PPxh1 /00
		Idaho fescue – Bluebunch wheatgrass	FW:$fc, $nc, $wk	IDFxh1 /91
		Bluebunch wheatgrass – Balsamroot	WB:$wk	IDFxh1 /93 PPxh1 /00

122 All site modifier combinations, structural stages, and seral associations are included unless otherwise noted.

Appendix C. Known and potential threatened and endangered vertebrate animals in the study area

Common Name	Scientific Name	Occurrence in Study Area	Prov. Status	COSEWIC Status
Amphibians				
Tiger Salamander	*Ambystoma tigrinum*	unknown	Red	Endangered
Great Basin Spadefoot	*Spea intermontana*	southeast, likely throughout	Blue	Threatened
Western Toad	*Bufo boreus*	unknown but likely	-	Special Concern
Reptiles				
Painted Turtle	*Chrysemis picta*	unknown but likely	Blue	-
Western Skink	*Eumeces skiltonianus*	unknown but possible	Blue	Special Concern
Western Rattlesnake	*Crotalus oreganus*	two locations, likely throughout	Blue	Threatened
Gopher Snake	*Pituophis catenifer*	two locations, likely throughout	Blue	Threatened
Racer	*Coluber contrictor*	northern portion, likely throughout	Blue	Special Concern
Rubber Boa	*Charina bottae*	unknown but likely	-	Special Concern
Birds				
Great Blue Heron	*Ardea herodias* ssp. *herodias*	unknown but possible	Blue	-
California Gull	*Larus californicus*	unknown but possible	Blue	-
American Avocet	*Recurvirostre americana*	unknown and unlikely	Red	-
Long-billed Curlew	*Numenius americanus*	unknown but possible	Blue	Special Concern
Upland Sandpiper	*Bartramia longicauda*	unknown but possible	Red	-
Swainson's Hawk	*Buteo swainsoni*	northern edge, possibly throughout	Red	-
Ferruginous Hawk	*Buteo regalis*	unknown but possible	Red	Special Concern
Western Screech-owl	*Megascops kennicotti* ssp. *macfarlanei*	one location	Red	Endangered
Flammulated Owl	*Otus flammeolus*	unknown but likely	Blue	Special Concern
Short-eared Owl	*Asio flammeus*	unknown but possible	Blue	Special Concern
White-throated Swift	*Aeronautes saxatalis*	forage throughout, poor breeding	Blue	-
Lewis' Woodpecker	*Melanerpes lewis*	unknown but likely	Blue	Special Concern
Yellow-breasted Chat	*Icteria virens*	unknown but possible	Red	Endangered
Brewer's Sparrow	*Spizella breweri breweri*	unknown and unlikely	Red	-
Grasshopper Sparrow	*Ammodramus savannarum*	unknown but possible	Red	-
Lark Sparrow	*Chondestes grammacus*	unknown but possible	Red	-
Mammals				
Merriam's Shrew	*Sorex merriami*	unknown but possible	Red	-
Preble's Shrew	*Sorex prebeii*	unknown but possible	Red	-
Townsend's Big-eared Bat	*Corynorhinus townsendii*	unknown but likely	Blue	-
Spotted Bat	*Euderma maculatum*	unknown but possible	Blue	Special Concern
Pallid Bat	*Antrozous pallidus*	unknown but possible	Red	Threatened
Fringed Myotis	*Myotis thysanodes*	unknown but likely	Blue	Special Concern
Western Small-footed Myotis	*Myostis ciliolabrum*	unknown but likely	Blue	-
Western Harvest Mouse	*Reinthrodontomys megalotis*	unknown but possible	Blue	Special Concern
Great Basin Pocket Mouse	*Perognathus parvus*	unknown but possible	Blue	-
Nuttall's Cottontail	*Sylvilagus nuttallii* ssp. *nuttallii*	unknown and unlikely	Blue	Special Concern
Badger	*Taxidea taxus*	one location, likely rare throughout	Red	Endangered

Sensitive Ecosystems Inventory: Lake Country, 2005

Volume 2: Terrestrial Ecosystem, Terrain, Terrain Stability, and Surface Erosion Mapping, and Expanded Legend

February 2006

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Polly Uunila, Polar Geoscience

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This project has adapted material from the reports for the Bella Vista – Goose Lake Range Sensitive Ecosystems Inventory and Central Okanagan Sensitive Ecosystems Inventory.

We would like to thank the many landowners that gave us permission to access their lands for field sampling.

[1] The mission of the Real Estate Foundation is to support sustainable real estate and land use practices for the benefit of British Columbians.
[2] Iverson & MacKenzie Biological Consulting Ltd.
[3] District of Lake Country
[4] Polar Geoscience
[5] Ophiuchus Consulting
[6] Artemis Wildlife Consultants
[7] Baseline Geomatics Inc.

Introduction

This report presents detailed information on ecosystems in the Lake Country of the Central Okanagan. It is the second volume in a series of three volumes.

Volume 2, this report, provides detailed information on terrestrial ecosystem mapping (TEM) methods and gives descriptions of each of the ecosystems that occur within the sensitive ecosystems or other important ecosystems categories described in Volume 1. Appendix B of Volume 1 provides tables that can be used to cross-reference between sensitive and other important ecosystems units and terrestrial ecosystem map units in this report.

This report describes the natural setting of the study area and details methods, results and recommendations for bioterrain mapping and ecosystem mapping. It is intended for use by professionals that require more detailed ecological and terrain information. It is recommended for use by people interested in developing other interpretive map themes from the ecosystem or terrain mapping.

Volume 1[8] is intended for people and organizations that need information to help conserve and protect remaining sensitive and important ecosystems in the Vernon Commonage and other similar areas. It is also intended to provide information and advice to landowners and developers on how to minimize and avoid possible degradation of sensitive ecosystems due to land use and development activities.

Volume 3[9] contains wildlife habitat mapping themes developed from the terrestrial ecosystem mapping (TEM) for the following ten species: Great Basin Spadefoot (*Spea intermontana*), Painted Turtle (*Chrysemys picta*), Western Rattlesnake (*Crotalus oreganus*), Gopher Snake (*Pituophis catenifer* ssp. *deserticola*), Western Screech-owl (*Otus kennicottii* ssp. *macfarlanei*), Long-billed Curlew (*Numenius americanus*), Yellow-breasted Chat (*Icteria virens*), Grasshopper Sparrow (*Ammodramus savannarum*), Swainson's Hawk (*Buteo swainsonii*), Spotted Bat (*Euderma maculatum*) and Badger (*Taxidea taxus jeffersonii*). All of these species are considered at risk in the province of B.C. and most are listed under the federal Species at Risk Act. These species provide a cross-section of threatened or endangered amphibians, reptiles, birds, and mammals that depend on a range of different ecosystems in the study area. There are many other threatened and endangered species that likely occur in the study area and are listed in each ecosystem chapter of Volume 1.

Wildlife habitat mapping portrays the potential importance of each ecosystem to specific animal species through a species-habitat model. The model assigns ratings to different ecosystem units from the TEM based on the needs of the species for particular life requisites. These ratings are displayed on the wildlife habitat maps. Volume 3 is intended for professionals who require more detailed information on wildlife habitat values in the study area than Volume 1 provides.

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[8] Iverson 2006

[9] Haney and Sarell 2006

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1 Study Area

The study area (Figure 1) lies within the central Okanagan Valley of south-central British Columbia. It is bounded by the boundaries of the District of Lake Country. It abuts the North Okanagan Regional District to the north, Okanagan Lake to the west, and the Central Okanagan Regional District and City of Kelowna in the south. The area covers 12,330 ha and includes private land, provincial parks, regional parks, and provincial crown land.

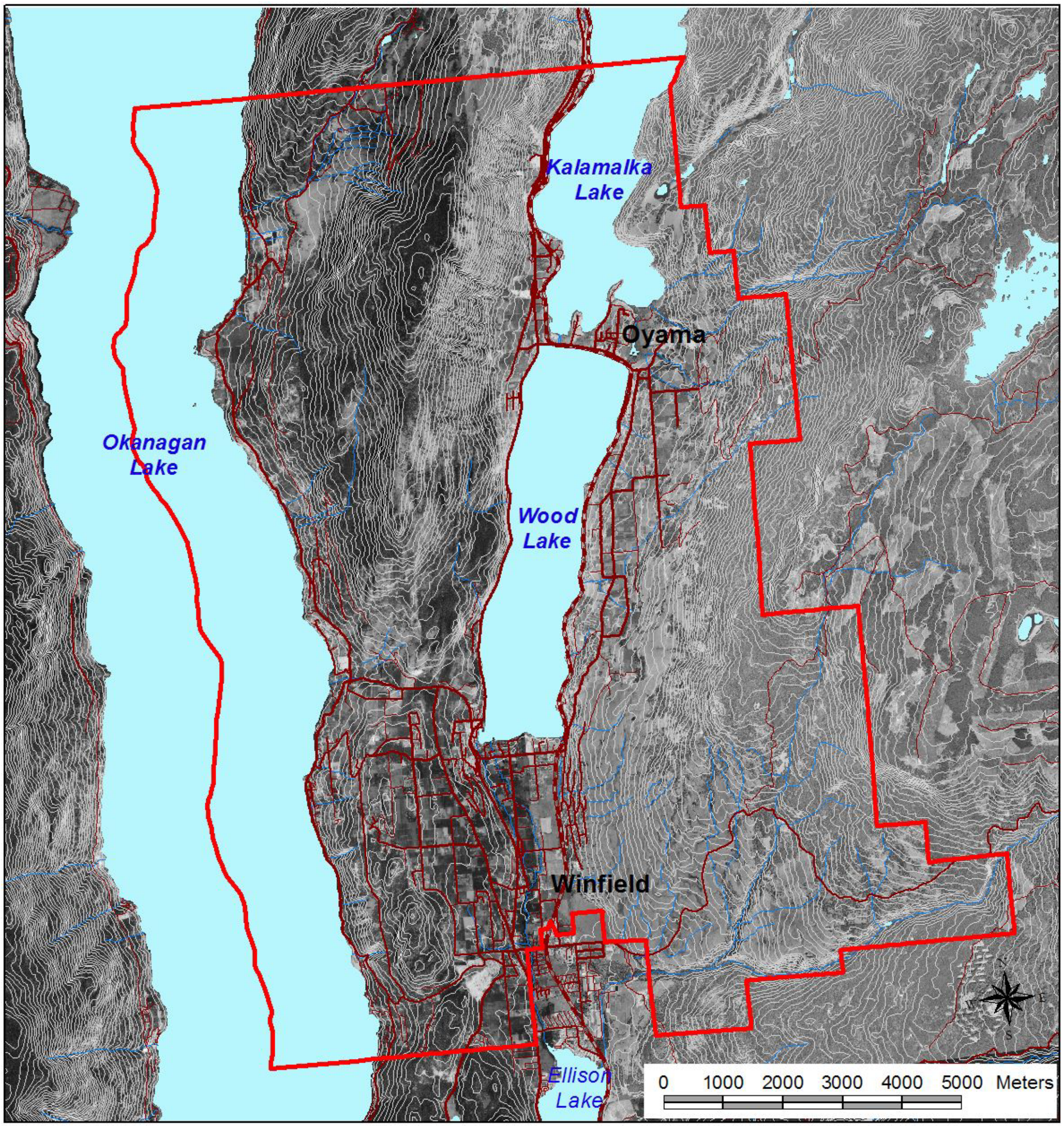

Figure 1. Map of study area. Study area boundary is shown in red.

1.1 Landscape Setting

The District of Lake Country includes the ridge between Okanagan Lake and the valley containing Kalamalka and Wood Lakes, Winfield, and the west-facing slopes above Winfield and Wood Lake. This area lies within the Thompson Plateau, a subdivision of the Interior Plateau Physiographic Region. The Thompson Plateau is characterized by a gentle, undulating upland surface, separated by large valleys.[10]

Bedrock Geology

A fault known as the Vernon Fault follows the valley bottom through Duck, Wood and Kalamalka Lakes. The bedrock geology of the study area[11] is quite different on either side of Vernon Fault. In general, the west side of the fault is underlain by younger intrusive rocks (Coryell Syenite (locally referred to as Oyama shale), the Okanagan Plutonic Suite, and Eocene – aged volcanic rock[11] (see Table 1).

Table 1. Bedrock Assemblages located on the west side of Vernon Fault.

Age	Bedrock Group or Suite	General Bedrock Type	Specific Rock Types	Location
Eocene	Andesitic Volcanic facies	Volcanic	Andesite	Two inclusions along NE edge of the study area
Paleocene	Coryell syenite	Intrusive	Syenite	Southern portion of the study area
	Coryell volcanic	Volcanic	Rhyolite porphyry and tuff	
Jurassic	Okanagan Plutonic Suite	Intrusive	Monzonite, quartz monzonite, diorite, quartz diorite, granodiortie and granite	Central portion of the study area
Permian	Harper Ranch Group (sedimentary and volcanic rocks)	Sedimentary and volcanic rocks partially metamorphosed	Siltstone, sandstone, argillite, conglomerate, breccia, phyllite, quartzite, limestone, tuff, andesite, minor marble, hornfels, skarn	Northern portion of the study area
	Harper Ranch Group (limestone)	Sedimentary	Limestone	

[10] Holland 1976
[11] Glombick et al. 2004

The east side of the fault is underlain by older metamorphic rocks (Chase Formation, Tsuius Schist, and Calc-silicate Gneiss) and younger intrusive rocks (Wood Lake Pluton and Cosens Bay Pluton) and capped by young sedimentary (Clark Creek Conglomerate) and volcanic rock (Thompson Plateau Basalt)[11].

Table 2. Bedrock Assemblages located on the east side of Vernon Fault.

Age	Bedrock Group or Suite	General Bedrock Type	Specific Rock Types	Location
Miocene	Thompson Plateau Basalt	Volcanic	Basalt	East-central portion of study area
Miocene	Clark Creek Conglomerate	Sedimentary	Conglomerate	East-central portion of study area
Cretaceous	Cosens Bay Pluton	Intrusive	Foliated biotite-granodiorite, granodiorite and granite	NE edge of study area
Jurassic	Wood Lake Pluton	Intrusive	Monzonite, quartz monzonite, diorite, quartz diorite, granodiortie and granite	Central portion of the study area
Devonian	Chase Formation	Metamorphic	Quartzite	Southern edge of study area
Paleo- and/or Mesoproterazoic	Tsuius Schist	Metamorphic	schist, gneiss, quartzite	East-central edge of study area
Paleo- and/or Mesoproterazoic	Calc-silicate Gneiss	Metamorphic	gneiss, marble, schist, amphilbolite	East-central edge of study area

Characteristics of bedrock such as mineral composition and structure determine the shape and texture of the weathered material that forms from it. These characteristics influence the shape and size of clasts and the matrix texture of soils that are created.

Intrusive bedrock and coarse-grained metamorphic rocks such as gneiss and quartzite tend to break down into sand and coarse silt. Thus, till and colluvium derived from these types of bedrock typically have a silty sand matrix. Well-jointed intrusive bedrock and coarse-grained metamorphic rocks break into large blocks and boulders.

Fine-grained metamorphic and sedimentary rocks such as schist weather to create a silty soil matrix. This bedrock typically fractures along foliation planes and jointing to create pebble-sized rubble and slabs. Finer sedimentary and metamorphic rock types that weather into silt create more erodible soil and are more susceptible to cut-slope slumping than rock types that weather to sand.

Non-siliceous volcanic bedrock typically breaks down into rubble and blocks, which weather into silt and clay. Silt and clay that weathers from volcanic bedrock and the finer sedimentary and metamorphic rock types create more erodible soil which is more susceptible to cut-slope slumping than rock types that weather to sand.

Landscape Evolution

The present physiography dates back two hundred million years ago (early Jurassic) when plate tectonics welded the former Pacific Ocean to the margin of the North American continent. This created ridges of metamorphic and plutonic bedrock orientated in a north-south direction. About 50 million years ago (early Tertiary), plate tectonics caused uplift of the area accompanied by extensive volcanism. A long period of relative stability followed, during which erosion and deposition formed a low-relief landscape with gentle slopes and low hills. During late Tertiary, the area was subject to uplift again, followed by a renewed period of down cutting, with the stream valleys deeply incising into the old erosion surface.

Both the upland surface and the steep-sided valleys were completely buried by ice during the Pleistocene glaciation. However, glaciers effected only relatively minor modifications to the older topography. Most of the surficial materials date from the last glaciation.

At the beginning of the last major glacial episode (Fraser Glaciation), ice accumulated in the high mountains and then gradually spread to valleys and lowlands. About 14,500 years ago, when the Cordilleran Ice Sheet was thickest and most extensive at the climax of Fraser Glaciation, ice flowed generally southward across the study area[12]. The rounded ridge tops suggest that the entire area was completely overridden by ice at this time, depositing till at the base of the ice sheet.

Deglaciation occurred between about 14,000 and 11,000 years ago. Deglaciation took place by downwasting so that the uplands emerged from beneath the ice while tongues of ice remained in the valley bottoms[13]. Stagnant ice in the valley bottoms impounded temporary glacial lakes in the Okanagan Valley (Glacial Lake Penticton). Downwasting ice often forms characteristic subglacial and ice-marginal landforms on gentle surfaces, such as, eskers, kames, and meltwater channels.

During post-glacial times, processes have re-worked some glacial sediments and weathered bedrock to redistribute them as colluvium (moved by gravity) and fluvial (moved by water) sediments. Some streams and rivers that have graded to the present day lake level have downcut into glacial deposits creating terraces, benches, and steep-sided scarps. Eolian sediments have been transported by wind and deposited on the gentler slopes on the eastern edge (lee side of the ridge) of the study area. Fine-grained sediments have accumulated in depressions due to slope wash.

Soils[14]

Soil forms the interface between surficial materials (parent materials) and the ecosystems they support. Ecosystems influence the formation of soils and soil affects what types of plants grow at a given site and the productivity of that site. Soil is defined as “naturally occurring, unconsolidated mineral or organic martial at least 10cm thick that occurs at the earth’s surface and is capable of supporting plant growth”[15]. The factors affecting soil formation include: parent material, climate, biota (including the vegetation, wildlife and organisms in the soil), topography (for example: slope, aspect, and slope morphology), and time. The following descriptions of the major soil groups present in the study area are derived from Wittneben (1986). Soil is not mapped in this project but

[12] Fulton 1965
[13] Fulton 1969
[14] This section is adapted from Iverson et al. 2004
[15] Soil Classification Working Group 1998

has been included as part of the field data collected to describe the site and the ecosystems at detailed ecological plot locations.

Chernozemic soils (Brown and Darkbrown Chernozems) have developed in the semi-arid lower valley grassland and open forest communities. These are characterized by the formation of an organic rich (Ah) upper mineral horizon. The Ah horizon forms primarily from the accumulation of organic material from the fine roots of grasses and herbaceous plants.

Brunisolic soils occur throughout the study area. They are common under forested communities on moister and cooler aspects. These soils are present on moderately- to rapidly-drained surficial materials that are medium- to coarse-textured. These are soils that have poorly developed horizons. They were often found in a complex with other soil types including chernozems, luvisols, and gleysols.

Luvisolic soils are present on moderately- to rapidly-drained, clay-rich parent materials such as muddy glaciolacustrine deposits and finer textured tills. The movement of clay particles from the upper horizons to a lower horizon of accumulation (Bt) characterizes these soils. Luvisols underlied some of both forested and grassland communities in the Interior Douglas-fir and Ponderosa Pine Biogeoclimatic Zones.

Organic soils develop under wet conditions where decomposition rates are relatively slow and a net accumulation of organic material (peat) occurs. Most organic soils are poor- to very poorly-drained and are saturated for prolonged periods of time. Organic soils occurred under wetland communities in depressions.

Gleysolic soils develop under moist to wet conditions usually in depressions, toe slopes and on valley bottoms. They are mineral soils formed under periodic, or sustained, reducing conditions caused by saturation, and result in gleyed colours (grey, blue and green). Gleysolic soils are imperfectly to very poorly drained and occurred under moist forest and wetland communities.

Regosolic soils are under-developed soils that lack defined horizonation. Regosols were common on floodplains and talus slopes throughout study area. They develop on recent parent materials such as landslide and river deposits; recently exposed materials such as landslide scarps and eroded banks; or under conditions that suppress soil formation, for example, extremely dry conditions (very rapidly drained, coarse textured soils on southerly aspects). Regosols are often associated with non-vegetated or early successional plant communities.

Solonetzic soils occur on saline parent materials in semiarid to subhumid regions of the British Columbia interior. These soils occur in small non-vegetated or sparsely vegetated pockets in depressions and toe slope positions. These soils are often used as salt licks by wildlife and thus have high wildlife values. They occur in association with chernozemic soils and to a lesser degree with gleysolic and luvisolic soils. A small salt lick was observed in the grasslands in the southeast corner of the study area.

Climate

The study area is located within the northern portion of a dry climatic system resulting in warm, dry conditions[16]. The Coast and Cascade Mountains create a rain shadow effect in the interior of

[16] Demarchi 1996

British Columbia, reducing summer and winter precipitation. In summers, hot dry air moves in from the Great Basin to the south.

Within British Columbia, the climate of this region has resulted in semi-arid steppe vegetation with unique geological and landscape features; this has resulted in a diverse and unique assemblage of species in the Okanagan Valley.

Ecoregional and Biogeoclimatic Classification

The study area is located within the Southern Interior Ecoprovince, the northern extension of the Columbia Basin that extends south to Oregon[17]. Situated within the southernmost region of the Interior Plateau of British Columbia, the region lies west of the Columbia Mountains and east of the Coast and Cascade Mountains within the North Okanagan Basin Ecosection (NOB), a wide trench formed by parallel fault lines and further carved out by multiple glaciations, and the North Okanagan Highland Ecosection (NOH), a cool, moist, transitional mountain area, dominated by a rolling upland.

The Ministry of Forests biogeoclimatic ecosystem classification is a system of classifying vegetation based on climatic and topographic patterns[18]. Four biogeoclimatic variants are represented within the study area: the Okanagan Very Dry Hot Ponderosa Pine (PPxh1) and the Okanagan Very Dry Hot Interior Douglas-fir Variant (IDFxh1), Shuswap Moist Warm Interior Douglas-fir Variant (IDFmw1), and the Okanagan Dry Mild Montane Spruce Variant (MSdm1).

The **PPxh1** is the driest forested zone in British Columbia[19]. Occurring only at lower elevations in the southern valleys of British Columbia, it is at the northern extent of a much larger range that runs south through eastern Washington and Oregon. Cool winters with low snowfall and hot dry summers with growing-season moisture deficits result in a mosaic of open forests and grasslands.

The **IDFxh1** is the driest variant of the Interior Douglas-fir zone[19]; it has a long growing season with warm, dry summers, and summer drought. Winters are cool with low to moderate snowfall. Most portions of the IDFxh1 are dominated by mixed open forests of Douglas-fir and ponderosa pine; the study area also has extensive areas of grasslands.

The **IDFmw1** has a warm, dry climatic regime (but is moister than the IDFxh1) and a relatively long growing season with summer drought[19]. It occurs above the IDFxh1 on the east side of the study area. Mature forests are dominated by Douglas-fir with some western redcedar and western larch.

The **MSdm1** occurs at the highest elevations at the eastern edge of the study area. It is characterized by cold winters and moderately short, warm summers[19]. Mature forests are dominated by lodgepole pine with some hybrid white-spruce and subalpine fir; Douglas-fir occurs on warm aspect slopes.

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[17] The ecoregional classification system was developed and adapted by the Ministry of Environment, Lands & Parks, Wildlife Branch, to provide a systematic view of the small scale ecological relationships within British Columbia . See Demarchi 1996 for further information.

[18] The Biogeoclimatic Ecosystem Classification system was developed by the Ministry of Forests to provide a basis for natural resource management, particularly forest management and range management. See Pojar et al. 1987 for further information.

[19] Lloyd et al. 1990

1.2 Ecology and Disturbance Processes

Historically, frequent low-intensity surface fires maintained grasslands and open Douglas-fir and ponderosa pine forests. Fires were likely ignited by both lightning and First Nations peoples. First Nations people used fire to improve wildlife habitat, root crops (for example, mariposa lily and balsamroot) and likely to fireproof their villages[20]. Most native grassland plants are well adapted to fire through perennating buds or seeds just at or below the ground surface where fire temperatures are cooler[21]. Figure 2 shows a prescribed fire similar to many historical fires.

Figure 2. Understory fire similar to how most historical fires burned.

Frequent fire maintained forest understories dominated by bunchgrasses and shrubs and promoted nutrient cycling. Most grasses, forbs, shrubs and mature trees survived most fires, but small trees likely often died[22]. Historically, forests were mostly very open with grassy, shrubby understories. Moister sites were more productive and likely more closed and shrubby. Fires also contribute to nutrient cycling, releasing nutrients that are otherwise very slowly released through decay processes.

The exclusion of most fires (dating back to the time of intensive grazing in the late 1800's) has lead to striking changes in these ecosystems. Some areas that were formerly grasslands have been encroached upon by trees and are now dominated by trees. Tree densities are now much higher in forests (Figure 3). Dense forests with accumulated fuels have lead to declines in grass and shrub productivity, increasing susceptibility to insect and disease outbreaks, and a shift from frequent low-severity fires to larger, more intense crown fires[23] such as the Okanagan Mountain fire in the summer of 2003.

Figure 3. Ingrown stand resulting from fire exclusion. In this stand, no remnant veteran trees are visible in the picture and the area was very open historically.

Moisture is very limiting in these dry forest ecosystems and available moisture is critical for the survival of ponderosa pine seedlings. Ponderosa pine seedlings, with a deeper taproot, are better able to survive moisture depletion than Douglas-fir seedlings.

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[20] Turner 1994; Pokotylo and Froese 1983; Daubenmire 1968
[21] Daubenmire 1968
[22] Agee 1993
[23] Moore et al. 1999; Fule et al. 1997; Daigle 1996

Historically, the principal grazing animals were likely deer and elk[24]. Domestic cattle grazing began in the late 1800's and many of the grasslands in the study area have reduced cover of the more grazing-sensitive species such as bluebunch wheatgrass, Idaho fescue, and rough fescue and have more grazing resistant native grasses such as Columbian needlegrass, junegrass and Sandberg's bluegrass[25]. Some grasslands have been overtaken by knapweed, sulphur cinquefoil and introduced annual brome grasses such as cheatgrass. Some of the grasslands along central ridge in the west-central portion of the study area are in late seral condition with abundant bunchgrasses and diverse mixes of native forbs.

1.3 Human History

The semi-arid climate of the central Okanagan, with its hot summers and mild winters, has long attracted human habitation. Archaeological evidence indicates that humans have been present in the Okanagan valley for at least 6000 years. The valley provided water, wildlife for hunting, fish, roots, berries, herbs, and other foods and medicines for First Nations peoples[26].

Following the discovery of gold in British Columbia, ranchers from western Oregon came and settled in the dry interior valleys of B.C. Cattle were turned loose on the unfenced range and by the late 1870's most grasslands had deteriorated due to overgrazing[27].

Early forest harvesting was localised but became industrial and more widespread by the mid-1900's[28]. We observed that all accessible areas of the study area had been selectively harvested, leaving very few large, old trees.

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[24] Tisdale 1947
[25] Dormaar et al.1989; McLean and Wikeen 1985; Daubenmire 1940
[26] Cannings and Durance 1998; Thomson 2000
[27] Mather 1996
[28] Cannings and Durance 1998

2 Methods and Limitations

This project has used the provincially recognised Terrestrial Ecosystem Mapping standard[29] to map terrain and ecosystems in the study area.

2.1 Terrestrial Ecosystem Mapping

Mapping at a scale of 1:20,000 and survey intensity level four was completed according to the methods in *Standard for Terrestrial Ecosystem Mapping in British Columbia*[30].

In addition to the required map attributes, the following map attributes were also recorded for each polygon:

- stand composition modifiers (e.g., coniferous, mixed or broadleaf stand),
- combined rating of quality and condition of the ecosystem (QUALCOND).

Preliminary Terrain Mapping

Terrain mapping is a method to categorize, describe and delineate characteristics of surficial materials (the loose materials on top of bedrock), landforms, and geomorphological processes (the active mechanism that continue to shape the landscape) within the natural landscape[31].

A terrain map is a map of surficial materials; it shows the surficial material type and thickness combined with surface expression or landform type (and geological processes if applicable). Each surficial material type is classified based on its genesis. It has its own characteristics of deposition and therefore physical properties such as texture and consolidation.

Terrain maps are the basis for many kinds of land use planning including terrain stability, ecosystem mapping, planning of urban roads and development, assessment of geological hazards, and aggregate mining. Terrain mapping with an ecological emphasis is called bioterrain mapping. Bioterrain mapping forms the basis of terrestrial ecosystem mapping (TEM) by delineating polygons with similar ecological conditions such as soil moisture, aspect, and vegetation characteristics.

Terrain mapping is based on air photo interpretation, which is then ground-truthed in the field. For this project, terrain mapping followed the standard British Columbia procedures for terrain classification[32], mapping methods[33], terrain stability mapping[34] (five-class system) and bioterrain mapping methods[35].

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[29] Resources Inventory Committee 1998
[30] Resources Inventory Committee 1998
[31] Ministry of Forests 1999
[32] Howes and Kenk 1997
[33] Resources Inventory Committee 1996
[34] Ministry of Forests 1999
[35] Resources Inventory Committee 1998

Project terrain mapping was more detailed than is typical as criteria for both bioterrain and terrain stability mapping were used during polygon delineation. Delineation was based on the following characteristics:

- terrain type;
- material depths;
- drainage;
- slope breaks;
- slope position;
- aspect: cool (from 285 to 135°) and warm (from135 to 285°);
- geomorphological processes;
- surface expression and slope morphology (e.g., concave or convex);
- terrain stability class;
- erosion potential class;
- vegetation changes;
- riparian zones and corridors; and
- any other ecologically significant areas such as cliffs, talus slopes, and ponds.

Preliminary terrain mapping was completed on colour aerial photographs at a scale of approximately 1: 15 000 (Table 3). Robert Maxwell, P.Ag. delineated the polygons and added terrain symbol and soil drainage class to each polygon. The linework was transferred to a digital map base by mono-restitution and the terrain labels were entered into the database.

At a later date, Polly Uunila, P.Geo. added slope gradient range (in percent), terrain stability class and soil erosion class to each polygon and entered the data the database. Appendix C: Terrain Legend provides a description of all materials and geological processes mapped. Figure 4 shows an example of a terrain polygon label.

Table 3. Mapsheets and aerial photographs used for mapping the study area.

TRIM Mapsheets	82L.003 82L.004 82L.013 82L.014
Flight Line and Air Photo Numbers	30BCC 94049: No. 96 – 102 30BCC 94052: No. 32 - 36 30BCC 94053: No. 60 – 66, 190 - 197 30BCC 94085: No. 32 – 40 30BCC 94089: No. 178 - 180 30BCC 94099: No. 73 - 78 30BCC 94152: No. 96 - 104

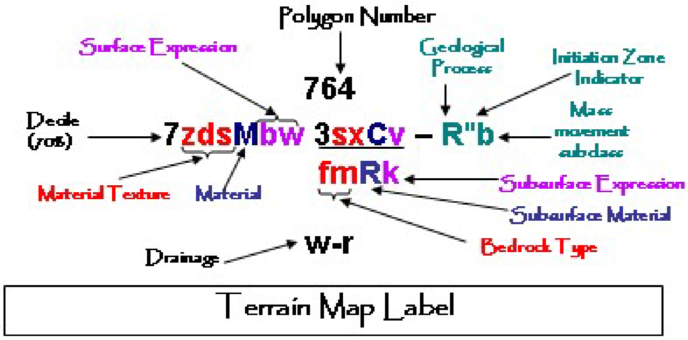

Figure 4. Sample terrain map label.

Field Sampling

A field-sampling plan was developed using aerial photographs and forest cover maps with the following objectives in mind:

- verify the presence, quality, and condition of sensitive ecosystems
- identify other ecosystems
- verify terrain labels
- verify ecosystems in at least 12% of the polygons
- gather detailed data for unclassified ecosystems

Landowners were contacted prior to fieldwork and many landowners granted us access to sample on their lands. Field sampling took place in June and July 2005. A team of three scientists conducted field sampling: a plant ecologist (Kristi Iverson, R.P.Bio.), a terrain and soil specialist (Polly Uunila, P.Geo.), and a wildlife habitat ecologist (Mike Sarell in June and Allison Haney in July).

Three types of sample plots were used to identify and assess ecosystems and terrain: detailed ecological plots (FS882), ground inspections, and visual inspections (Appendix A: Field Plot Forms). Field sampling procedures for detailed ecological plots and ground inspections are outlined in *Field Manual for Describing Terrestrial Ecosystems*[36]. We followed guidelines from the *Standard for Terrestrial Ecosystem Mapping* in British Columbia[37] for visual inspection data collection. Additionally, we collected the pertinent information from a site conservation evaluation form developed by the B.C. Conservation Data Centre to evaluate the quality and condition of all sensitive ecosystems.

Additional information regarding terrain stability and erosion potential was collected by Polly Uunila, P.Geo. including terrain stability and erosion potential classes, signs of instability or erosion, and any other pertinent information regarding stability and erosion potential classes. P. Uunila spent an extra day in the field to focus on refining the criteria for terrain stability and erosion potential.

The location of all detailed ecological plots, ground inspection plots, and visual inspections were either recorded by GPS or marked on project aerial photographs. Site locations were digitally captured and are shown on the terrestrial ecosystem map.

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[36] B.C. Ministry of Environment, Lands and Parks and B.C. Ministry of Forests 1998
[37] Resources Inventory Committee 1998

Forested and grassland ecosystems were identified using existing site series described in *A Field Guide for Site Identification and Interpretation for the Kamloops Forest Region*[38]. Non-forested units such as wetlands and rock outcrops and grassland seral associations were adopted from previous projects: the Bella Vista – Goose Lake Range SEI[39] and the Central Okanagan SEI[40]. These units were originally described based on field data and units were developed in conjunction with Dennis Lloyd, the Ministry of Forests and Range's Regional Ecologist in Kamloops.

Approximately 4% of the plots were detailed ecological plots (Table 4), 22% were ground inspections, and 74% were visual inspections. We checked a total of 11% of the polygons (TEM Survey Intensity 4, a total of 2553 polygons in 16,355 ha[41]). Detailed ecological field plots were used to sample representative sensitive ecosystems, unclassified ecosystems, and representative examples of each site series. Ground inspections were used to sample sensitive ecosystems and representative examples of site series. Visuals were primarily used to verify ecosystem units, structural stages, or terrain.

Table 4. Numbers and types of plots conducted at field sites.

FS882	Ground Inspections	Visuals	TOTAL
9	66	207	282

Final Terrain Mapping

Following fieldwork, revisions were made to the pre-typed polygon boundaries, terrain symbols and interpretative classes where necessary by Polly Uunila based on field observations and air photo interpretation. After the pre-typing was complete, the project objective changed to include interpretations for terrain stability and soil erosion in each polygon. Many of the polygons in the original terrain mapping contained areas of two or more terrain stability classes. In order to have polygons of internally uniform terrain stability class, several polygon boundaries were redrawn while maintaining an emphasis on important ecological elements such as surficial material, aspect and drainage. The database was updated to reflect any changes to polygon labels and the polygon boundaries were adjusted in the digital maps.

Expanded Legend Development

The expanded legend describes the terrain, soils, and vegetation of each ecosystem mapped in the study area. The vegetation and terrain descriptions in the expanded legend provided information for the wildlife biologists to develop wildlife habitat ratings (Volume 3; Haney and Sarell 2006).

The expanded legend also provides technical mapping information for each ecosystem unit: the map code, the ecosystem name, the site series number (if applicable), a listing of the assumed modifiers for each unit, and the modifier combinations that were mapped.

[38] Lloyd et al. 1990
[39] Iverson and Shypitka 2003
[40] Iverson and Cadrin 2003
[41] Survey intensity level 4 has 60-100 hectares per inspection or 15-25% polygon inspection. Although we only checked 11% of polygons, the detailed mapping resulted in a large number of polygons and our hectares per insection was only 58 hectares (survey intensity level 3).

Site Series and Site Unit Mapping

Ecosystem units were mapped according to the *Standard for Terrestrial Ecosystem Mapping in British Columbia*[42]. Site series were identified according to Lloyd et al. (1990). Two-letter codes have been assigned to all site series in the master list available at: ftp://ftp.env.gov.bc.ca/dist/wis/tem/mapcodes_jan2003.xls[43]. For ecosystems not included in current site series classifications, new ecosystem units were previously approved by the Ministry of Forests' Regional Ecologist. Sparsely vegetated, non-vegetated and anthropogenic units follow the two-letter codes and descriptions in Table 3.1 of the *Standard for Terrestrial Ecosystem Mapping in British Columbia*[42].

Core polygon attributes collected for all polygons are shown below in Table 5. Site modifiers were also used to describe ecosystems. Up to two site modifiers may be present with each ecosystem unit. Site modifiers represent different site conditions than those of the typical situation, as defined in the master list, for each site series. Each site series has a set of assumed site modifiers under the typical situation. Where a site series is mapped in its typical situation, site modifiers are not included in the map label.

The site series code and site modifier(s) are followed by a structural stage designation, one through seven. Structural stage modifiers were used to subdivide shrub and herb structural stages. Stand composition modifiers indicate the dominant stand composition and were mapped for all forested ecosystems. Seral associations were mapped for grassland ecosystems.

Definitions and descriptions for all site modifiers, structural stage, structural stage modifier, and stand composition modifiers can be found in the *Standard for Terrestrial Ecosystem Mapping in British Columbia*[44].

Up to three ecosystems units were noted for each polygon. The percentage of each ecosystem unit present is indicated by deciles ranging from 1 to 10 (1=10%; 10=100%; Figure 5).

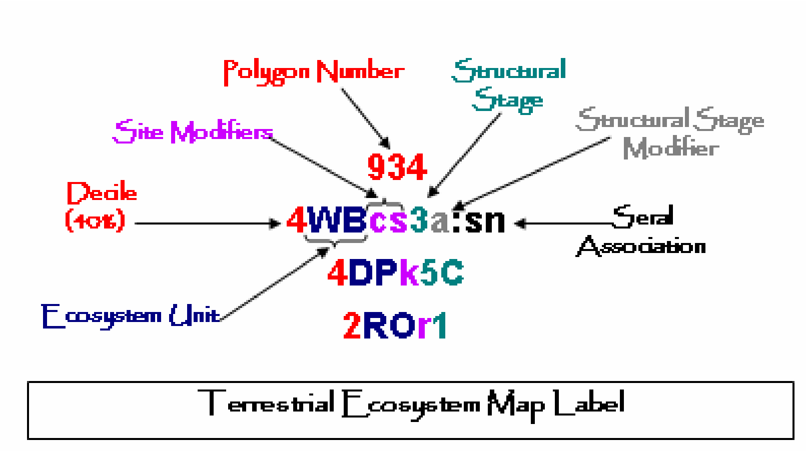

Figure 5. Example of a terrestrial ecosystem map label.

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[42] Resources Inventory Committee 1998
[43] Resources Inventory Committee 2000a
[44] Resources Inventory Committee 1998

Table 5. Core attributes collected for all polygons.

Project- or Mapsheet-Specific Attributes - repeated for all polygons

Project name
Ecosystem mapper
Terrain mapper
Survey intensity level

Polygon-Specific Attributes - unique for each polygon

Record one of each of the following elements or classes per polygon:

Mapsheet number
Polygon number
Data source
Ecosection unit
Biogeoclimatic unit (zone and subzone; variant and phase required if present)
Geomorphological processes (when present)
Soil drainages

Record up to three ecosystem and/or terrain units per polygon:

Ecosystem attributes
- Decile
- Site series
- Site modifier(s)
- Structural stage

Terrain attributes
- Decile
- Terrain texture (optional but should be done where possible; record up to three for each component)
- Surficial material (record one for each component; could include a surficial subtype)
- Qualifiers (when present, record one for each component)
- Surface expression (record up to three for each component)

Data Management

Non-spatial information includes field plot data and polygon attribute data. Spatial data includes polygon linework and locations of field verification sites.

Field Plot Data

Data from field plots were entered into a digital database using Resources Inventory Committee standard software (VENUS Version 5). Both manual and electronic quality assurance were completed for the VENUS database. This database was used to sort data into ecosystem units, create the project vegetation species list, and develop the expanded legend. The range of environmental conditions, terrain units, and vegetation communities over which ecosystem units were distributed is described in the expanded legend (Appendix D: Expanded Legend).

Non-spatial Data

We captured the core set of polygon attributes required to meet the provincially accepted *Standard for Terrestrial Ecosystem Mapping (TEM) - Digital Data Capture in British Columbia*[45] (Table 5). Table 6 lists the optional attributes we also applied in this project. We also applied two "user-defined" polygon attributes for all occurrences of sensitive ecosystems: Quality/condition and viability. We ran quality assurance error checking routines to ensure the attribute databases were free of errors.

Table 6. List of Optional Attributes

Attribute
Structural stage modifiers
Stand Appearance
Seral Stage
Disturbance Class and Subclass

Spatial Digital Data

Ecosystems were represented visually on maps and the digital data required to produce this representation were maintained according to standards outlined in the TEM Digital Data Capture Standards[46]. The Terrain Resource Information Management (TRIM) was used as the mapping base. The linework mapped by the bioterrain and ecosystem specialists was captured through monorestitution. Monorestitution is the digital transfer of features by digitising directly from aerial photos using TRIM control points to georeference the data, and TRIM digital elevation models to correct for slope. The process allows for adjustments in polygon shape and size related to the third dimension. Standard quality assurance routines were applied to ensure accurate mapping.

2.2 Terrain stability

Terrain stability refers to the susceptibility of a given slope to gravitationally-induced mass movement. Rotational slumps, debris slides, debris flows, rock fall and rockslides are some examples of mass movement. Terrain stability mapping provides a polygon-based rating system that indicates the potential for instabilities to exist or develop as a result of anthropogenic slope modifications (e.g. tree harvesting, road building, etc). This rating is based on surficial material type and texture, slope gradient range, drainage, as well as the presence and type of geomorphological processes.

A terrain stability map can be used as a planning tool for urban development, road building, or forest development. These maps identify areas that need further assessment prior to development and as such ***should not be considered an on-site assessment, but a tool for flagging areas needing further assessment***. Terrain stability maps also help planners anticipate or avoid areas that may cause environmental damage[47].

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[45] Resources Inventory Committee 2000b
[46] Resources Inventory Committee 2000b
[47] Ministry of Forests 1999

Terrain stability Criteria

Criteria used to assess terrain stability[48] are shown in Table 7. Definitions for terrain stability are shown in Table 8. Terrain stability is defined as the resistance of a slope to failure by landsliding[49] and the classes indicate the likelihood of instability resulting from development (i.e. tree removal and road building). Terrain stability ratings have a range of five classes for detailed terrain stability mapping from Class **I** (stable) to Class **V** (unstable).

Table 7. Guidelines for assessment of terrain stability classes.

Dominant texture	Typical surficial material	**Terrain Stability Class**				
		I	**II**	**III**	**IV**	**V**
fine s, z, zs, sz, c, m	LG, C1	<10 %	10-25 %	25-40 %	>40 %	all materials and landforms that are unstable, including rockfall; polygons with: -F”k, -F”m, -F”u, -R”s, -R”r, -R”d, -R”b
sm, dsm	LG, M	<15 %	15-30 %	30-55 %	>55 %	
dzs, zds, sg, a, x	M, F, FG, C	<20 %	20-40 %	40-60 %	>60 %	
resistant bedrock	R	<25 %	25-50 %	50-70 %	>70 %	

Numerical ranges in the table refer to the dominant range of slopes in percent. See Appendix C for definitions of texture and surficial material type.

Criteria are based chiefly on slope steepness, material type, texture, and the presence of geomorphological processes. The criteria were used as general guide with adjustments being made, as necessary, for specific conditions such as soil drainage and slope morphology. Each terrain polygon was rated individually in order to permit additional local factors to be taken into account when necessary. These additional local factors include:

- ***Slope smoothness/irregularity***: A slope morphology that includes irregular, near-surface bedrock may be rated as more stable than a similar slope with smooth underlying bedrock, because bedrock irregularities can reduce the likelihood of a landslide in surficial materials. The irregular bedrock acts to pin surficial materials in place, thus the potential for instability is less than on a slope of similar overall steepness but with a smoother profile.
- ***Drainage***: In general, wet slopes are more unstable than dry slopes. Wet slopes may be prone to slope failures through a reduction in normal stress due to high pore water pressure in the soil. Where imperfectly-drained areas are mapped on slopes with gradients that occur within the upper end of a slope steepness class range, the polygon may be rated one terrain stability class higher. Where rapidly drained areas are mapped on slopes with gradients that occur on the lower end of a slope steepness range, the polygon may be rated one stability class lower.
- ***Slope position***: In general, lower slopes and concavities are relatively wet because they receive moisture from a large area upslope; thus they may be classified as a terrain stability class higher than a similar slope that is located in a shedding slope position.

[48] ‘Terrain stability’ is sometimes also referred to as ‘slope stability’
[49] Bates and Jackson 1984

- ***Landslide deposits***: Large rockslide deposits (geomorphological process" –Fm") that initiated in the Thompson Plateau basalt located along the eastern edge of the study area have been rated as terrain stability class IV. These areas have be rated potentially unstable because other rockslide deposits from Tertiary-aged basalt in the region are experiencing local areas of on-going creep. Thus, these slopes need to be assessed in greater detail prior to any development.

Each terrain stability class has defined management implications that are described below in Table 8.

Table 8. Definitions and management implications for terrain stability classes.[50]

Stability Class	Interpretation
I	• No significant stability problems exist.
II	• There is a low likelihood of landslides following disturbance or development. • Minor slumping is expected along road cuts and excavations.
III	• Stability problems can develop. • Follow BMP to reduce the likelihood of causing slope failure. • Minor slumping is expected along road cuts and excavations. There is a low likelihood of landslide initiation following disturbance or road construction. • On-site inspection required by geotechnical professionals.
IV	• Expected to contain areas with a moderate likelihood of landslide initiation following development, disturbance or road construction. • These areas should be avoided. Use caution when planning intensive land use above or below these areas. • On-site inspection required by geotechnical professionals
V	• Expected to contain areas with a high likelihood of landslide initiation. Signs of existing instability present. • Avoid these areas. Do not plan intensive land use above or below these areas. • On-site inspection required by geotechnical professionals

When using these ratings, it is essential to bear in mind that conditions are locally variable. The ratings (and information on the terrain map) indicate the mapper's impression of typical conditions for each terrain polygon, but locally steeper slopes, wetter soils, and emergence of water from seepage zones give rise to areas that are potentially more unstable and/or more erodible than their surroundings. Consequently, ***persons using these maps for development should recognize and take account of these local conditions***.

In some cases, a polygon may contain more than one stability class, or be able to fit into two stability classes. In these cases, the higher of the two stability classes was used for a conservative rating.

[50] Adapted from Ministry of Forests 1999

2.3 Erosion Potential

For this study, erosion refers to the particle by particle removal of material from bare soil by running water. Erosion potential refers to the susceptibility of a bare surface of the soil (that is without vegetation, humus, or other protective layers) to erosion by water. This interpretation is based on the *in situ* surficial materials stripped bare of its protective vegetation but does not include deposits of excavated materials

Fine sediment production from soil erosion is from exposure of bare soil to rain. Exposed soil occurs on roads, road cutslopes, ditches, construction sites, excavation sites, landslide scars, active gullying, excessive cattle use, or a fire in which the vegetation and humus is destroyed. Sediment generated by erosion is generally transported from a source area to a depositional area.

Soil erosion potential ratings are based on surficial material type and texture, surficial material thickness, slope, drainage, slope morphology (e.g., concave vs. convex), and upslope catchment area.

Erosion is a natural process, but it may be accelerated by human activity. Each polygon is assigned an erosion potential rating which gives the degree of soil erosion potential expected if the vegetation and humus is removed. Erosion potential mapping can be used as a planning tool to anticipate or avoid development in areas that may cause environmental damage.

Erosion Potential Criteria

Erosion potential is based on a five-class rating scheme ranging from very low (VL) where no problems of erosion are expected to very high (VH) where there already exists the natural movement of sediments into adjacent creeks (Table 10). Ratings were assigned to each polygon through aerial photographic interpretation.

Criteria for assessing erosion potential are based on, soil texture, material thickness and slope gradient (Table 9).

Table 9. Guidelines for assessment of surface erosion potential.

SURFICIAL MATERIAL CHARACTERISTICS		DOMINANT GRADIENT RANGE (%) 0 – 40%	30 – 60%	> 50%	>40%
Dominant texture Decreasing erodibility	Typical surficial material	smooth, irregular, benched, terraced slopes	moderate to moderately steep slopes	single gullies and scarps	dissected slopes (-V)
fine s, z, c, m	LG, E, C1	H	H, VH	VH	VH
coarse s, ds, gs, sdm, sdz	FG, C, M, F	M	H	H, VH	VH
dzs, zds	M	L	M	H	VH
sg, sd, sr, sx	F, FG, C, M	VL	L	M	H
x, a	C	VL	VL	L	L
resistant bedrock	R	VL	VL	VL	VL
organics (peat bogs)	O	VL	-	-	-

The criteria were used as general guide with adjustments being made, as necessary, for specific conditions such as slope position and geomorphic processes. Each terrain polygon was rated individually in order to permit additional local factors to be taken into account when necessary. These local factors included:

- ***Soil drainage:*** Polygons with imperfectly drained soils (seepage present) is rated one class higher.
- ***Slope position***: Lower slopes and concavities tend to be more erodible because they generally receive more moisture compared to a middle slope. As a result a polygon may be rated one class higher if it is a receiving site. In contrast, upper slopes are generally less erodible as they receive less water as compared to a middle slope and may be rated one class lower;
- ***Slope morphology***: An irregular slope is generally less erodible than a smooth slope. A polygon may be rated one class lower if a slope is irregular enough to inhibit some erosion potential; and
- ***Geomorphic Processes***: If a polygon contains an active geomorphic process that is deemed to increase the erosion, such as gullying or slope failure, the erosion potential class may be rated one class higher.

Each soil erosion potential class has defined management implications that are shown below in Table 10.

Table 10. Definitions and management implications of soil erosion potential classes.[51]

Class	Rating	Definition and Implications
VL	Very low	• Negligible or very minor soil erosion.
L	Low	• Expect minor erosion of fines in ditch lines and disturbed soils.
M	Moderate	• Expect moderate erosion when water is channelled onto exposed soils.
H	High	• Significant erosion problems can be created when water is channelled onto or over exposed soil on these sites.
VH	Very high	• Severe surface and gully erosion problems can be created when water is channelled onto or over exposed soils on these sites.

When using these ratings, it is essential to bear in mind that conditions are locally variable. The ratings indicate the mappers impression of typical conditions for each terrain polygon, but local pockets of eolian sediments (or other materials consisting of fine sand and coarse silt) steeper slopes, wetter soils, interception of shallow groundwater and emergence of water from seepage zones give rise to areas that are potentially more erodible than their surroundings.

2.4 Mapping Limitations

TEM & SEI Mapping Limitations

The SEI and TEM information is intended for use in alerting local and regional decision-makers of the presence of important ecosystems and ecological features. The SEI and TEM do not replace the need for on-site assessments of areas where land use changes are proposed or contemplated.

The accuracy of polygon boundaries is limited by the scale (1:15,000) and date (1994) of the aerial photographs on which the sites are delineated. Orthophotos from 2003 were used to update the mapping where urban development had occurred since the date of the aerial photographs. ***Data should not be enlarged beyond the scale of the photos as this may result in unacceptable distortion and faulty registration with other data sets.***

Given the continuing land-uses within the study area, including human settlement and agricultural development, attributes of some polygons may have changed since the date of the aerial photographs or field work. Wherever possible, polygons were updated to reflect changes noted at the time of field work.

One of the primary limitations of aerial photograph interpretations is the limited ability to see disturbances such as grazing and invasion of noxious weeds. The mapper applies information based on extrapolation from adjacent areas or current land use, and based on the tone and texture seen on the aerial photographs. Some grasslands may be incorrectly assigned to either 'grasslands' or 'disturbed grasslands'.

[51] Adapted from Ministry of Forests 1999

There is limited ability to delineate polygons around small sensitive features or ecosystems. In most cases, these ecosystems are captured as a small component of a larger polygon dominated by another ecosystem. Many polygons are a complex of ecosystems and sensitive ecosystems may only occupy a portion of that polygon.

Field verification was limited by access. Not all private land owners granted permission to sample on their property. Finally, many important wildlife habitat features are difficult to capture in ecosystem maps unless they correlate well with certain ecosystems. It is likely that important habitat features such as snags, tree cavities, and coarse woody debris are present but are not included in SEI polygons.

Terrain Mapping Limitations

The accuracy of the terrain mapping and the reliability of the air photo interpretations are dependant on a number of factors. These factors are described below in Table 11.

Table 11. The factors affecting the reliability of terrain mapping.

Factors	Notes on this study
Skill and experience of the mapper	Pretyping was completed by Bob Maxwell, former Bioterrain Specialist for the Ministry of Environment and former resident of the Central Okanagan. Terrain stability and soil erosion and project completion by Polly Uunila, a resident of the North Okanagan, who has completed several terrain mapping projects locally and numerous projects throughout the province
Number of mappers	Two mappers
Continuity	Project started by one mapper and completed by another.
Quality control	Spot checked by Kristi Iverson
Vegetation cover	In general, the vast areas of grasslands and open forest allowed the mapper a good view of landform features while mapping.
Complexity of the landscape	Variable. The rock-controlled portion of the landscape is predictable and fairly straightforward. The thick valley fill on the lower slopes is more complex. Many of the smaller riparian corridors are not mapped.
Quality and scale of the airphotos	Colour photos. Appropriate photo scale for the scale of the final mapping. Generally of good quality, however many steep, west-facing slopes are shadowed and the air photos were 11 years old at the time of project completion.
Distribution of field checking	A majority of the study area is private land, and access to many properties was denied. Overall, the project team was able to check a representation of most ecosystems throughout the study area. Many steeper slopes were inaccessible.
Terrain Survey Intensity Level (TSIL)	TSIL D[52]/C[53] completed for project which is appropriate for mapping landforms and ecosystems, however a greater percentage of the checks on steeper slopes is ideal for Terrain Stability and Soil Erosion themes.
Interpretative criteria for Surface Erosion Potential and Slope Stability	Inadequate field data from this study but good data was available from comparable studies done in adjacent areas.

[52] TSIL D is defined as 1 - 20% of polygons inspected or 0 to 0.1 checks/ha

[53] TSIL C is defined as 20 - 50% of polygons inspected or 0.5 to 1.0 checks/ha

Factors	Notes on this study
Quality of the topographic base	Good.
Transfer of linework into digital format	Good. Checked during data entry.
Transfer of terrain symbols into digital format	The database is free of terrain coding errors. As every polygon was not checked against the original mapping on the airphotos, it is possible that data entry errors occurred. Spot-checking indicated that errors are not common.
Edit of final maps	No stand-alone bioterrain map was created so no final edit was done. The Soil Erosion Potential and Terrain Stability maps were spot checked against the original mapping on photos.

The terrain mapping was based on observations of land-surface conditions and current understanding of terrain and erosion. The following factors have not been taken into account by this study: subsurface conditions not detectable by air photo interpretation or field observations, events whose time of occurrence and severity cannot be predicted (e.g., storm events), management practices, and land-use.

Terrain Stability and Erosion Potential Mapping Limitations

The same limitations of terrain mapping also apply to terrain stability and erosion potential mapping. None of these previously listed limitations were found to be significant; however, terrain stability mapping and erosion potential mapping are also subject to additional limitations. These limitations include:

- ***Polygon based interpretations***: Both terrain stability and erosion potential classes have been assigned on a polygon basis. Even with small, fairly homogeneous polygons, these classes are not always continuous across the polygon. When assigning a terrain stability or erosion potential class, generally the most dominant class represented in the polygon is used. If there is a significant portion of a higher class in the polygon, then the higher class will be used for the most conservative rating. Sometimes within a polygon, a small portion of a higher class rating will be present, but deemed not significant enough in size to increase the rating. Many of the polygons from the pre-typing were refined after field checking to create as uniform polygons as possible at the scale of mapping.
- ***Field verification***: Terrain stability and erosion potential classes are assigned based on air photo interpretations and field verification. During field work, soil pits, root wads, and road cuts are used to interpret the subsurface conditions. No deeper subsurface investigations are carried out (i.e. test-pitting and drilling). Groundwater flow influences both terrain stability and erosion potential and can be adequately interpreted from the surface, but not as accurately as when subsurface investigations are carried out. Many of the areas mapped with higher classes of terrain stability are located on private land that denied access.
- ***Interpretations based on standard practices***: Interpretations are applied based on the use of standard forestry practices from the Forest Practices Code[54]. However, if inadequate culvert placing redirected drainage to an area that previously did not receive as much water, this area will be more susceptible to failure and erosion that it is rated. Extensive irrigation is another unnatural source of water that may increase erosion potential and the likelihood of a landslide.

[54] Ministry of Forests 1999

3 Results

3.1 Terrestrial Ecosystem Mapping

Table 12, Table 13, Table 14, and Table 15 below lists the ecosystems mapped in the study area fore each subzone, the area they covered, the percentage of the subzone, and the percentage of the study area landbase. Appendix B: Vegetation Species List provides a list of all plant species encountered during field sampling. Appendix D: Expanded Legend provides a complete description of each ecosystem.

Table 12. Ecosystem Units mapped, their area, and their percent of the study area in the IDFmw1.

IDFmw1				
Ecosystem Unit Code/ Number	Ecosystem Unit Name	Area (hectares)	% of IDFmw1	% of study area
CD /00	ActFd –Common Snowberry – Red-osier Dogwood Riparian	3.2	0.53	0.02
CT /00	Cattail Marsh	1.5	0.25	0.01
DF /01	Douglas-fir / Western redcedar – Falsebox – Prince's pine	276	45.6	1.69
DP /04	Douglas-fir – Pinegrass – Feathermoss	133	22.0	0.81
DS /02	Douglas-fir / Ponderosa pine – Snowberry – Bluebunch wheatgrass	4.7	0.78	0.03
ES /00	Exposed Soil	2.9	0.48	0.02
OW /00	Shallow Open Water	0.43	0.07	0.003
PP /03	Douglas-fir – Penstemon – Pinegrass	35.7	5.90	0.22
RD /06	Western redcedar – Devil's club – Foamflower	37.2	6.15	0.23
RR /05	Western redcedar / Douglas-fir - Dogwood	98.2	16.2	0.60
RZ /00	Road Surface	1.2	0.20	0.01
SO /00	Saskatoon – Mock orange Talus	1.0	0.17	0.01
TA /00	Talus	1.5	0.25	0.01
WB /00	Bluebunch wheatgrass – Balsamroot	7.8	1.29	0.05
WS /00	Willow – Sedge Wetland	0.43	0.07	0.003
TOTAL		**605**	**3.7**	**100**

Table 13. Ecosystem Units mapped, their area, and their percent of the study area in the IDFxh1.

IDFxh1				
Ecosystem Unit Code/ Number	Ecosystem Unit Name	Area (hectares)	% of IDFxh1	% of study area
AB /00	Nuttall's alkaligrass – Foxtail barley graminoid meadow	0.08	0.001	0.001
AS /98	At – Snowberry – Kentucky bluegrass	89.4	0.74	0.55
BM /00	Bulrush Marsh	3.21	0.03	0.02
BN /96	Kentucky bluegrass – Stiff needlegrass	17.4	0.14	0.11
BR /00	Baltic Rush Marsh-Meadow	2.97	0.02	0.02
CB /00	Cutbank	7.48	0.06	0.05
CD /00	ActFd –Common Snowberry – Red-osier Dogwood Riparian	19.0	0.16	0.12
CF /00	Cultivated Field	227	1.87	1.38
CL /00	Cliff	2.05	0.02	0.01
CO /00	Cultivated Orchard	464	3.82	2.84
CS /00	Common Spikerush Marsh	0.74	0.01	0.005
CT /00	Cattail Marsh	9.70	0.08	0.06
CW /00	Choke cherry – Bluebunch wheatgrass rocky bluff	1.59	0.01	0.01

IDFxh1				
Ecosystem Unit Code/ Number	Ecosystem Unit Name	Area (hectares)	% of IDFxh1	% of study area
DP /01	FdPy – Pinegrass	846	6.97	5.17
DS /07	FdPy – Snowberry – Spirea	784	6.46	4.79
DW /03	FdPy – Bluebunch wheatgrass – Pinegrass	1175	9.68	7.19
ES /00	Exposed Soil	8.05	0.07	0.05
FO /00	FdPy –Saskatoon – Mock orange	55.1	0.45	0.34
FW /91	Idaho fescue – Bluebunch wheatgrass	984	8.11	6.02
GP /00	Gravel Pit	17.4	0.14	0.11
LA /00	Lake	375	30.9	22.9
OW /00	Shallow Open Water	528	4.35	3.23
PB /02	FdPy – Bluebunch wheatgrass – Balsamroot	280	2.31	1.71
RF /97	Prairie Rose – Idaho fescue	207	1.70	1.26
RN /00	Railway	4.73	0.039	0.03
RO /00	Rock Outcrop	1.51	0.012	0.01
RW /00	Rural	308	2.54	1.88
RZ /00	Road Surface	92.3	0.76	0.56
SA/00	Antelope brush – Selaginella	37.2	0.31	0.23
SB /00	Selaginella – Bluebunch wheatgrass rock outcrop	21.3	0.18	0.13
SD /08	SxwFd – Douglas maple – Dogwood	78.8	0.65	0.48
SO /00	Saskatoon – Mock orange Talus	21.4	0.18	0.13
SP /04	FdPy – Snowbrush – Pinegrass	701	5.78	4.29
TA /00	Talus	8.57	0.07	0.05
UR /00	Urban/Suburban	74.9	0.62	0.46
WB /93	Bluebunch wheatgrass – Balsamroot	1300	10.7	7.95
WS /09	Willow – Sedge Wetland	5.17	0.04	0.03
TOTAL		**12136**	**100**	**74.2**

Table 14. Ecosystem Units mapped, their area, and their percent of the study area in the MSdm1.

MSdm1				
Ecosystem Unit Code/ Number	Ecosystem Unit Name	Area (hectares)	% of MSdm1	% of study area
PG /03	Lodgepole pine – Grouseberry – Cladonia	12.1	15.5	0.074
RO /00	Rock Outcrop	1.8	2.3	0.011
SF /01	Hybrid white spruce – Falsebox – Feathermoss	48.1	61.8	0.294
SG /06	Hybrid white spruce – Gooseberry	13.9	17.8	0.085
SH /07	Hybrid white spruce – Trapper's tea – Horsetail	0.8	1.1	0.005
TA /00	Talus	1.2	1.5	0.007
TOTAL		**77.8**	**100**	**0.48**

Table 15. Ecosystem Units mapped, their area, and their percent of the study area in the PPxh1.

PPxh1				
Ecosystem Unit Code/ Number	Ecosystem Unit Name	Area (hectares)	% of PPxh1	% of study area
AS /00	At – Snowberry – Kentucky bluegrass	2.5	0.07	0.02
CB /00	Cutbank	2.5	0.07	0.02
CD /00	ActFd –Common Snowberry – Red-osier Dogwood Riparian	45.9	1.30	0.28
CF /00	Cultivated Field	345.8	9.78	2.11
CL /00	Cliff	2.6	0.07	0.02
CO /00	Cultivated Orchard	670.1	18.95	4.10
CT /00	Cattail Marsh	2.0	0.06	0.01
CV /00	Cultivated Vineyard	4.7	0.13	0.03
CW /00	Choke cherry – Bluebunch wheatgrass rocky bluff	0.7	0.02	0.00
DM /08	Fd – Water birch - Douglas maple	40.0	1.13	0.24
DS /07	FdPy – Snowberry – Spirea	45.7	1.29	0.28
ES /00	Exposed Soil	3.3	0.09	0.02
FB /00	Rough fescue – Bluebunch wheatgrass	250.3	7.08	1.53
FO /00	FdPy –Saskatoon – Mock orange	3.3	0.09	0.02
GC /00	Golf Course	8.0	0.23	0.05
GP /00	Gravel Pit	33.8	0.96	0.21
OW /00	Shallow Open Water	2.3	0.07	0.01
PC /04	Py – Bluebunch wheatgrass – Cheatgrass	258.1	7.30	1.58
PF /05	Py – Bluebunch wheatgrass – Rough fescue	82.5	2.33	0.50
PT /02	Py – Red three-awn	132.8	3.76	0.81
PW /01	Py – Bluebunch wheatgrass – Idaho fescue	396.3	11.21	2.42
RO /00	Rock Outcrop	1.2	0.03	0.01
RW /00	Rural	447.6	12.66	2.74
RZ /00	Road Surface	49.7	1.41	0.30
SA/00	Antelope brush – Selaginella	13.1	0.37	0.08
SB /00	Selaginella – Bluebunch wheatgrass rock outcrop	9.5	0.27	0.06
SO /00	Saskatoon – Mock orange Talus	7.3	0.21	0.04
SP /06	FdPy – Snowberry – Pinegrass	61.5	1.74	0.38
SR /00	Snowberry – Rose – Kentucky Bluegrass	17.3	0.49	0.11
TA /00	Talus	3.5	0.10	0.02
UR /00	Urban/Suburban	343.7	9.72	2.10
WB /00	Bluebunch wheatgrass – Balsamroot	246.8	6.98	1.51
WS /00	Willow – Sedge Wetland	1.4	0.04	0.01
TOTAL		**3536**	**100**	**21.6**

3.2 Terrain, Terrain Stability, and Erosion Potential Results

In general, the landscape and surficial geology is quite variable and complex. A number of stability issues were identified during this project:

- slumps in glaciolacustrine sediments
- slumps in thick deposits of surficial materials in gully sidewalls
- slumps in bedrock
- tension cracks in bedrock
- rockfall
- debris flows
- debris slides
- debris flow fans

The following gives a brief and general description of the distribution of surficial geology, terrain stability, and erosion potential from the valley bottom adjacent to the lakes to the ridge tops.

- **Valley bottom**: Thin stretches of beach discontinuously lined the shores on the three major lakes (Okanagan, Kalamalka, and Wood Lakes) located in the study area. In Winfield, Vernon Creek has formed a large fan where the creek meets the valley bottom. The valley bottom between Duck and Wood Lakes consisted of a wide floodplain through which Winfield and Vernon Creeks flow northwards. Small fluvial fans were located at the mouths of the larger creeks and gullies throughout the area, for example on the west side and east side of Oyama.

  Stability issues in this area included the deposition zones of rapid and slow mass movements, such as debris flow fans, talus slopes and runout zone of slumps in glaciolacustrine sediments. The more erodible soils included fluvial silts and sands, lacustrine sands and glaciolacustrine sediments.

- **Lower slopes**: The lower slopes adjacent to the three major lakes and the Vernon/Winfield Creek floodplain consisted of deep valley fill (sloping benches dissected by gullies created by post-glacial streams and erosion). Areas of bedrock covered by little or no colluvium were scattered throughout these slopes. Located at the bottom of the valley fill were discontinuous outcrops of sediments pre-dating the most recent glaciation. These deposits were found at various locations, particularly in the Okanagan Centre area. For the most part, the surface of the benches consisted of thick deposits of glaciofluvial sediments, till, and glaciolacustrine sediments. Large deposits of glaciofluvial sediments were located at the mouths of the larger meltwater channels and gullies, for example, at the mouth of Cougar Canyon, in the Coral Beach and Commonage road area, on the west side and east side of Oyama, the vicinity of Pollard's Pond, along Okanagan Centre Road West in the south, and on either side of Vernon Creek upslope from its large fan. Thick till deposits were located in the Woodsdale area. Glaciolacustrine sediments deposited by Glacial Lake Penticton were found throughout much of the remainder of the lower slopes. Thin eolian sediments were found discontinuously on the surface on the east side of the study area.

  Stability issues in this area included rockfall, slumps in glaciolacustrine sediments, and debris flow fans. The more erodible soils included fluvial and glaciofluvial silts and sands, eolian silts and sands, and glaciolacustrine sediments. Slopes containing gullies incised through thick surficial materials were areas of high potential for erosion.

- **Mid to lower slopes**: Immediately upslope of the sloping benches were areas of thick till deposits separated by areas of bedrock-controlled terrain with thin partial covers of till and colluvium/weathered bedrock. Several meltwater channels were located on these slopes, many of which were ice-marginal streams. There was a high concentration of these channels located in the grasslands upslope and to the east of Winfield. At the outlets of these channels, most of which flowed southwards, glaciofluvial sediments were deposited over a large area. There were eskers located here as well. Thin eolian sediments were found discontinuously on the surface on the east side of the study area.

  The canyon portions of Clark and Vernon Creeks comprised the largest amount of potentially unstable terrain (terrain stability classes IV and IV) and unstable (terrain stability class V) within the study area. Other areas of potentially unstable and unstable terrain included single gullies in the Okanagan Centre area, moderate to steeply sloping glaciolacustrine sediments, and areas of rockfall.

  The more erodible soils included fluvial and glaciofluvial silts and sands, and eolian silts and sands. Slopes containing gullies incised through thick surficial materials were areas of high potential for erosion.

- **Mid to upper slopes**: These slopes were typically moderately steep to steep, bedrock-controlled terrain. The bedrock was discontinuously covered by thin till and colluvium. Talus slopes flanked bedrock cliffs. There were large bedrock slump deposits located below Wrinkly Face Cliff and at the edge of the plateau above Woodsdale. There was a smaller bedrock slump at the top of Spinekopje. Vernon Creek has incised a deep canyon through a thick sequence of sediments; either side of the canyon consisted of gentler slopes. At about 1100m south of Vernon Creek, there was an area of glaciolacustrine sediments. These were likely deposited when stagnating ice in the main valley bottom dammed Vernon Creek, temporarily forming a lake. Thin eolian sediments were found discontinuously on the surface of the gentler slopes on the east side of the study area.

  The single gullies, the canyon sections of Clark and Vernon Creeks, and rockfall comprised the largest amount of potentially unstable terrain and unstable within this area. In general, open slopes between about 60 % and 70 %, and some dissected slopes between 50 % and 70 %, were assigned terrain stability class IV. Steeper bedrock-controlled slopes with a partial veneer cover were rated as terrain stability class IV. The bedrock slumps and tension cracks located in the Thompson Plateau basalt along the eastern edges of the study area in volcanic bedrock at the peak of Spinekopje were mapped as potentially unstable and unstable.

  For the most part, the headscarps were rated as terrain stability class V. Slumps tend to occur when bedrock has failed on a weak layer of weathered bedrock below the surface. Elsewhere in the Shuswap and the North Okanagan, this type of failure is common in Kamloops Group volcanics. Although initial failure was likely prior to 10,000 years ago, there can be reactivation and secondary movement of portions of the slide masses along weak, weathered layers at the base. Thus the slump deposits have been rated as terrain stability class IV. At those sites visited there were no recent indicators of creep.

The more erodible soils included fluvial and glaciofluvial silts and sands, eolian silts and sands, and glaciolacustrine sediments. Slopes containing gullies incised through thick surficial materials were areas of high potential for erosion.

3.3 Terrain Recommendations

Some project-specific recommendations include:

- The extent and stability of the bedrock slumps needs to be further investigated prior to any development on or below these landforms.
- Many of the smaller riparian corridors were not completely mapped. A project similar to Sensitive Habitat Inventory and Mapping (SHIM)[55] being carried out in other areas of the Okanagan can provide complete inventory of watercourses in the District of Lake Country.

The following recommendations are standard for avoidance of problems during development in areas that are prone to erosion or instability:

- Best Management Practices as outlined in the document *Best Management Practices for Erosion and Sediment Control-Upland Works*[56] should be followed. In and adjacent to riparian zones, it is particularly critical to avoid disturbances of erodable soils. Best Management Practices as outlined in *Best Management Practices for Erosion and Sediment Control-Instream Works*[57] should be followed as well as all legal requirements outlined in the *Fisheries Act* and the provincial *Water Act*.
- Conscientious drainage planning is essential during road construction. Local drainage patterns have slowly been created since deglaciation. This process took thousands of years to evolve, and is in a sensitive equilibrium with the volume of water discharge. All natural drainage patterns, even minor ephemeral channels should be maintained. This is also important upslope of steeper areas as redirected drainage will affect the steep slopes below. Natural drainage patterns should be maintained through comprehensive stormwater planning that maintains natural water flow patterns by using stormwater source control strategies that return 90% of the precipitation to their natural drainage pathways.
- Sloughing of cut banks along roads may develop due to emergence of shallow subsurface water. Design road patterns to minimize cut and fills, and armour ditches with rock or vegetation where erosion is likely to occur. Ditches should be inspected regularly and cleaned or otherwise maintained when necessary.
- Ensure that culvert size is adequate and that the discharge points are properly armoured if necessary to reduce local erosion. Seeding together with geotextiles and armouring with rock are effective for controlling erosion.
- Minimize areas of soil disturbance for each development site or phase construction so that site clearing is minimized at any given time.
- Grass seeding may be an effective means of reducing erosion potential on bare surfaces such as cut banks and other disturbed areas. These areas could be lined with material such as

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[55] See http://www.shim.bc.ca/methods/SHIM_Methods.html
[56] City of Kelowna 1998b
[57] City of Kelowna 1998a

weed-free straw to control erosion until grass becomes established. Grass seed used must be weed-free.

- Road construction should be avoided during wet weather and when the ground is wet due to snowmelt.
- Bare, compacted surfaces, even on gentle slopes, are particularly vulnerable to erosion by running water. Minimize disturbance of soils by having equipment use designated trails. Avoid leaving tracks aligned in the downhill direction that will channel runoff water and increase erosion. On steeper areas, these trails may require armouring to prevent surface erosion. Trails that are not part of the permanent road network should be scarified and rehabilitated and planted with native vegetation species adapted to the specific site.
- On steep slopes, construction should be minimized, but where unavoidable, all appropriate measures should be used to prevent soil and site degradation.
- Qualified registered professionals should evaluate the risk of a debris flow/torrent impacting development on the fan.
- Areas down slope of unstable glaciolacustrine scarps are also areas that could be impacted by landslide runout. Stability of glaciolacustrine scarps can be affected by over-irrigation, redirection of water (ditches and watercourses) onto the scarp, and addition of weight at the edge of the scarp (i.e., buildings, pools, trees, fill etc.). The force of the wind on tall trees and buildings can increase the forces that contribute to rotational slumps in thick glaciolacustrine materials.
- Glaciolacustrine materials are also susceptible to piping and collapse. It is recommended that qualified registered professionals investigate ground conditions in areas of thick glaciolacustrine material even in class **I** and **II** terrain.
- Where development is planned within or near polygons containing terrain stability classes **III, IV** and **V**, on-site inspections is required by a qualified registered professional, such as a Geotechnical Engineer, to determine more precisely the nature and extent of the unstable areas.
- Where development is planned within polygons containing soil erosion potential **M, H** and **VH**, on-site inspections is required by a qualified registered professional.
- Class **V** terrain is unstable and should be avoided.

The information and analyses contained in this report are based on observations of land-surface conditions and current understanding of slope processes. However, because terrain stability is strongly influenced by subsurface conditions that are not apparent from surface observations or air photo interpretation (e.g., subsurface hydrologic conditions, characteristics of subsurface materials), by events whose time of occurrence cannot be predicted (e.g., extreme storms, earthquakes), and by land management practices, the results and recommendations provided in the report cannot guarantee that no landslides will occur in areas affected by land clearing and development. Appropriate use of terrain information and implementation of recommendations will, however, reduce the risk of landslides and erosion.

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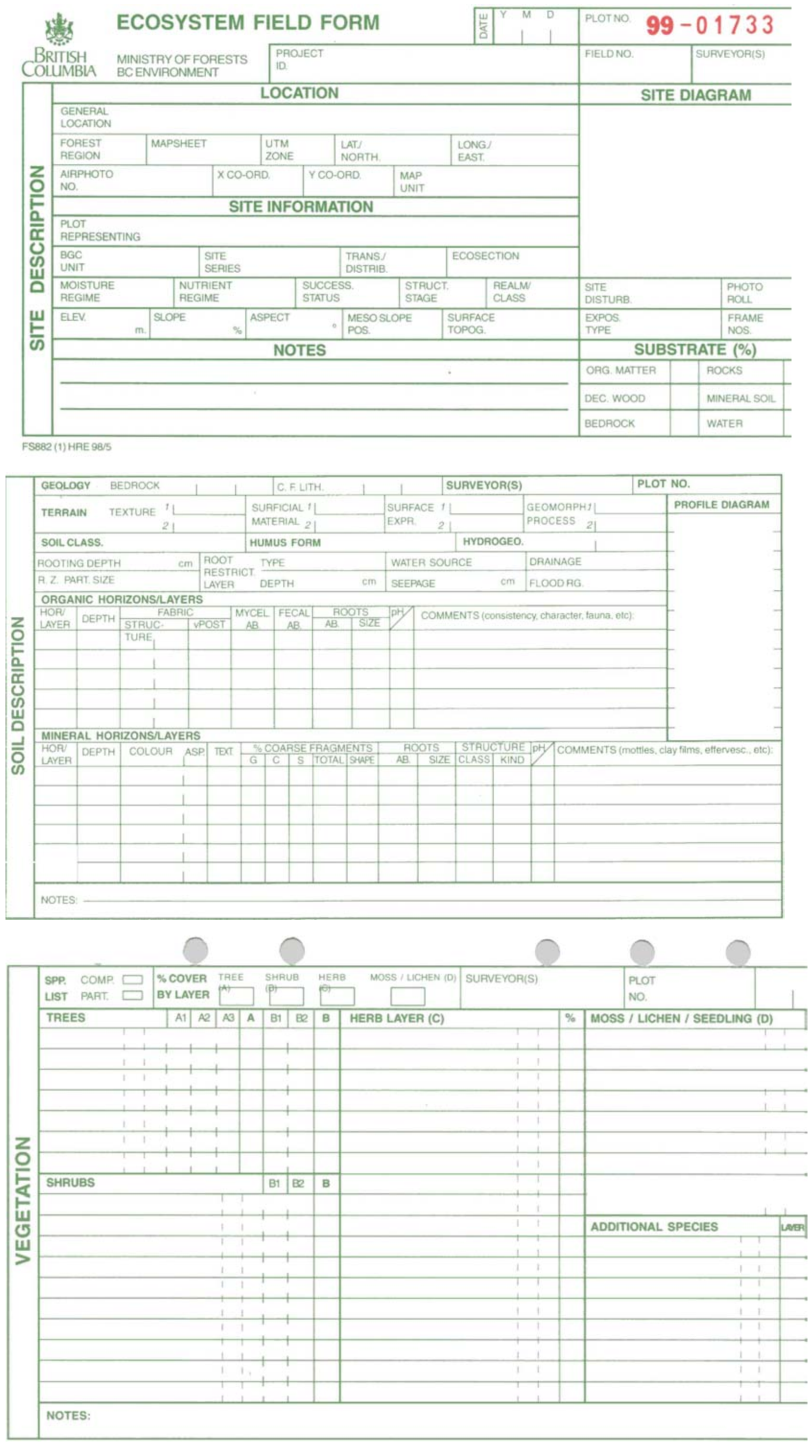
Appendix A: Field Plot Forms



ECOSYSTEM FIELD FORM

BRITISH COLUMBIA — MINISTRY OF FORESTS — BC ENVIRONMENT

DATE Y M D | PLOT NO. 99-01733

PROJECT ID. | FIELD NO. | SURVEYOR(S)

SITE DESCRIPTION

LOCATION

GENERAL LOCATION

FOREST REGION | MAPSHEET | UTM ZONE | LAT./NORTH. | LONG./EAST.

AIRPHOTO NO. | X CO-ORD. | Y CO-ORD. | MAP UNIT

SITE INFORMATION

PLOT REPRESENTING

BGC UNIT | SITE SERIES | TRANS./DISTRIB. | ECOSECTION

MOISTURE REGIME | NUTRIENT REGIME | SUCCESS. STATUS | STRUCT. STAGE | REALM/CLASS

ELEV. m. | SLOPE % | ASPECT ° | MESO SLOPE POS. | SURFACE TOPOG.

NOTES

SITE DIAGRAM

SITE DISTURB. | PHOTO ROLL

EXPOS. TYPE | FRAME NOS.

SUBSTRATE (%)

ORG. MATTER | ROCKS

DEC. WOOD | MINERAL SOIL

BEDROCK | WATER

FS882 (1) HRE 98/5

SOIL DESCRIPTION

GEOLOGY BEDROCK | C. F. LITH. | SURVEYOR(S) | PLOT NO.

TERRAIN TEXTURE 1 2 | SURFICIAL MATERIAL 1 2 | SURFACE EXPR. 1 2 | GEOMORPH. PROCESS 1 2 | PROFILE DIAGRAM

SOIL CLASS. | HUMUS FORM | HYDROGEO.

ROOTING DEPTH cm | ROOT RESTRICT. LAYER TYPE | DEPTH cm | WATER SOURCE | SEEPAGE cm | DRAINAGE | FLOOD RG.

R. Z. PART. SIZE

ORGANIC HORIZONS/LAYERS

HOR/LAYER | DEPTH | FABRIC STRUC-TURE | vPOST | MYCEL. AB. | FECAL AB. | ROOTS AB. SIZE | pH | COMMENTS (consistency, character, fauna, etc):

MINERAL HORIZONS/LAYERS

HOR/LAYER | DEPTH | COLOUR | ASP. | TEXT | % COARSE FRAGMENTS G C S TOTAL SHAPE | ROOTS AB. SIZE | STRUCTURE CLASS KIND | pH | COMMENTS (mottles, clay films, effervesc., etc):

NOTES:

VEGETATION

SPP. LIST COMP. PART. | % COVER BY LAYER TREE (A) SHRUB (B) HERB (C) MOSS / LICHEN (D) | SURVEYOR(S) | PLOT NO.

TREES | A1 | A2 | A3 | A | B1 | B2 | B | HERB LAYER (C) | % | MOSS / LICHEN / SEEDLING (D)

SHRUBS | B1 | B2 | B

ADDITIONAL SPECIES | LAYER

NOTES:

BRITISH COLUMBIA

GROUND INSPECTION FORM

G ☐ vs V ☐	PHOTO	X: / Y:	DATE
PROJECT ID.		SURV.	
MAP SHEET		PLOT	POLY.
UTM ZONE	LAT. / NORTH	LONG. / EAST	
ASPECT °		ELEVATION m	
SLOPE %	SMR	SNR	

MESO SLOPE POSITION ☐ Crest ☐ Upper slope ☐ Mid slope ☐ Lower slope ☐ Toe ☐ Depression ☐ Level

DRAINAGE - MINERAL SOILS ☐ Very rapidly ☐ Rapidly ☐ Well ☐ Mod. well ☐ Imperfectly ☐ Poorly ☐ Very poorly

MOISTURE SUBCLASSES - ORGANIC SOILS ☐ Aqueous ☐ Peraquic ☐ Aquic ☐ Subaquic ☐ Perhumid ☐ Humid

MINERAL SOIL TEXTURE ☐ Sandy (LS,S) ☐ Loamy (SL,L,SCL,FSL) ☐ Silty (SiL,Si) ☐ Clayey (SiCL,CL,SC,SiC,C)

ORGANIC SOIL TEXTURE ☐ Fibric ☐ Mesic ☐ Humic

SURF. ORGANIC HORIZON THICKNESS ☐ 0–40 cm ☐ > 40 cm

HUMUS FORM ☐ Mor ☐ Moder ☐ Mull

ROOT RESTRICTING LAYER Depth _______ cm Type _______

COARSE FRAGMENT CONTENT ☐ < 20% ☐ 20–35% ☐ 35–70% ☐ > 70%

TERRAIN

COMPONENT: TC1 ☐ TC2 ☐ TC3 ☐

TERRAIN TEXTURE	SURFICIAL MATERIAL	SURFACE EXPRESSION	GEOMORPH PROCESS
1	1	1	1
2	2	2	2

ECOSYSTEM

COMPONENT: EC1 ☐ EC2 ☐ EC3 ☐

BGC UNIT	ECOSECTION
SITE SERIES	SITE MODIFIERS
STRUCTURAL STAGE	CROWN CLOSURE %

ECOSYSTEM POLYGON SUMMARY	%	SS	SM	ST	TERRAIN POLYGON SUMMARY	%	Classification
EC1					TC1		
EC2					TC2		
EC3					TC3		

DOMINANT / INDICATOR PLANT SPECIES

TOTAL % A: B: C: D:

L.	SPECIES	%	L.	SPECIES	%	L.	SPECIES	%

COMPLETE ☐ PARTIAL ☐

Tree Mensuration

Spp.	DBH	Ht. Calculation to DBH: Top	Bot	SD	SL	HD	HT	Ht. to DBH	Total HT	BH Age	Path Y/N

NOTES (site diagram, exposure, gleying, etc.)

CONSERVATION EVALUATION & VISUAL INSPECTION FORM

PROJ. ID.	SURV.

POLY	AIR PHOTO #	DATE

ECOSYSTEM POLYGON SUMMARY						TERRAIN POLYGON SUMMARY		
	%	SS	SM	ST	CC		%	Classification
EC1						TC1		
EC2						TC2		
EC3						TC3		

PLOT #	GR. PHOTO #.	MAPSHEET
UTM ZONE	LAT./NORTH	LONG./EAST
ASPECT °	ELEVATION m	SLOPE %
MESO SLOPE	SOIL DRAINAGE	SOIL TEXTURE

ECOSYSTEM COMPONENT 1:	
TERRAIN COMPONENT 1	

DOMINANT / INDICATOR VEGETATION SPECIES

TOTAL	A:	B:	C:	D:

SPECIES	L	%	SPECIES	L	%	SPECIES	L	%

COMPLETE ❒ PARTIAL ❒

% Fragmentation (Plant Association)

- ❏ UNFRAGMENTED (< 5% of polygon)
- ❏ PARTLY FRAGMENTED (5 - 25 % of polygon)
- ❏ HIGHLY FRAGMENTED (> 25% of polygon)

SITE DISTURBANCE (e.g., L.c/F.I.b.b)

ADJACENT LAND USE:

KNOWN THREATS:

OTHER FACTORS:

EVALUATION SUMMARY:

QUALITY	❏ EXCELLENT	❏ GOOD	❏ MARGINAL	❏ POOR
CONDITION	❏ EXCELLENT	❏ GOOD	❏ MARGINAL	❏ POOR
VIABILITY	❏ EXCELLENT	❏ GOOD	❏ MARGINAL	❏ POOR
DEFENSIBILITY	❏ EXCELLENT	❏ GOOD	❏ MARGINAL	❏ POOR

NOTES (site diagram, exposure, gleying, etc.)

Appendix B: Vegetation Species List

Note: This is not a complete list of all plant species in the study area. It is a list of species that were encountered during field sampling and includes all species mentioned in this report.

*denotes introduced species. Please check the BC Conservation Data Centre web site for current provincial status of plant species (http://srmwww.gov.bc.ca/cdc/), and the COSEWIC web site (http://www.cosewic.gc.ca/) for national status of plant species. Although no rare plants were encountered during field sampling, the sampling methods did not include searches for rare plants and it is probable that many rare plants occur in the study area.

Common Name	Scientific Name
Alaska rein orchid	*Piperia unalascensis*
alfalfa*	*Medicago sativa*
alpine speedwell	*Veronica wormskjoldii*
alsike clover*	*Trifolium hybridum*
American speedwell	*Veronica beccabunga*
angelica	*Angelica* sp.
annual agoseris	*Agoseris heterophylla*
antelope-brush	*Purshia tridentata*
apple pelt	*Peltigera malacea*
arctic lupine	*Lupinus arcticus*
arrowleaf balsamroot	*Balsamorhiza sagittata*
aster	*Aster* sp.
awned haircap moss	*Polytrichum piliferum*
baldhip rose	*Rosa gymnocarpa*
balsam poplar	*Populus balsamifera*
Baltic rush	*Juncus balticus*
baneberry	*Actaea rubra*
Bebb's willow	*Salix bebbiana*
Bering chickweed	*Cerastium beeringianum*
birch-leaved spirea	*Spiraea betulifolia*
black elderberry	*Sambucus racemosa*
black gooseberry	*Ribes lacustre*
black huckleberry	*Vaccinium membranaceum*
black medic*	*Medicago lupulina*
bladderwort	*Utricularia* sp.
blue wildrye	*Elymus glaucus*
bluebunch wheatgrass	*Pseudoroegneria spicata*
bluejoint reedgrass	*Calamagrostis canadensis*
blunt-leaved sandwort	*Moehringia lateriflora*
brittle prickly-pear cactus	*Opuntia fragilis*
brown-eyed Susan	*Gaillardia aristata*
bull thistle*	*Cirsium vulgare*
bunchberry	*Cornus canadensis*
butterfly pelt	*Peltigera lepidophora*
California brome	*Bromus carinatus*

Common Name	Scientific Name
Canada thistle*	*Cirsium arvense*
Canada violet	*Viola canadensis*
cheatgrass*	*Bromus tectorum*
chocolate lily	*Fritillaria affinis*
choke cherry	*Prunus virginiana*
clad lichens	*Cladonia* sp.
cladonia lichen	*Cladonia gracilis*
clasping twistedstalk	*Streptopus amplexifolius*
claw-moss	*Hypnum* sp.
cleavers	*Galium aparine*
Columbia bower	*Clematis occidentalis*
Columbia brome	*Bromus vulgaris*
Columbia needlegrass	*Achnatherum nelsonii*
comandra	*Comandra umbellata*
common burdock*	*Arctium minus*
common cattail	*Typha latifolia*
common dandelion*	*Taraxacum officinale*
common duckweed	*Lemna minor*
common horsetail	*Equisetum arvense*
common hound's-tongue*	*Cynoglossum officinale*
common juniper	*Juniperus communis*
common mare's-tail	*Hippuris vulgaris*
common rabbit-brush	*Ericameria nauseosus*
common snowberry	*Symphoricarpos albus*
common spike-rush	*Eleocharis palustris*
common St. John's-wort*	*Hypericum perforatum*
common stork's-bill*	*Erodium cicutarium*
common timothy*	*Phleum pratense*
compact selaginella	*Selaginella densa*
corn gromwell*	*Lithospermum arvense*
cow-parsnip	*Heracleum maximum*
creamy peavine	*Lathyrus ochroleucus*
crested wheatgrass*	*Agropyron cristatum*
Dalmatian toadflax*	*Linaria genistifolia*
devil's club	*Oplopanax horridus*
diffuse fleabane	*Erigeron divergens*
diffuse knapweed*	*Centaurea diffusa*
dog pelt	*Peltigera canina*
Douglas' campion	*Silene douglasii*
Douglas maple	*Acer glabrum*
Douglas' water-hemlock	*Cicuta douglasii*
Douglas-fir	*Pseudotsuga menziesii*
early blue violet	*Viola adunca*
electrified cat's-tail moss	*Rhytidiadelphus triquetrus*
enchanter's-nightshade	*Circaea alpina*
European bittersweet*	*Solanum dulcamara*

Common Name	Scientific Name
false Solomon's-seal	*Maianthemum racemosum*
falsebox	*Paxistima myrsinites*
falseflax*	*Camelina sativa*
felt pelt	*Peltigera ponojensis*
felt pelt	*Peltigera rufescens*
fern-leaved desert-parsley	*Lomatium dissectum*
few-flowered shootingstar	*Dodecatheon pulchellum*
field filago*	*Filago arvensis*
field locoweed	*Oxytropis campestris*
field mint	*Mentha arvensis*
field pussytoes	*Antennaria neglecta*
fire-moss	*Ceratodon purpureus*
fireweed	*Epilobium angustifolium*
flixweed*	*Descurainia sophia*
floating-leaved pondweed	*Potamogeton natans*
foxtail barley	*Hordeum jubatum*
fragile fern	*Cystopteris fragilis*
freckle pelt	*Peltigera aphthosa*
glaucous bluegrass	*Poa glauca*
glow moss	*Aulacomnium palustre*
golden curl-moss	*Homalothecium aeneum*
golden-aster	*Heterotheca villosa*
great mullein*	*Verbascum thapsus*
greater bladderwort	*Utricularia macrorhiza*
green sorrel	*Rumex acetosa*
hairy vetch*	*Vicia villosa*
hard-stemmed bulrush	*Schoenoplectus acutus*
heart-leaved arnica	*Arnica cordifolia*
heron's-bill moss	*Dicranum sp.*
Himalayan blackberry	*Rubus discolor*
Holboell's rockcress	*Arabis holboellii*
Hooker's fairybells	*Prosartes hookeri*
hook-moss	*Drepanocladus sp.*
hybrid white spruce	*Picea engelmannii x glauca*
Idaho fescue	*Festuca idahoensis*
Japanese brome*	*Bromus japonicus*
junegrass	*Koeleria macrantha*
juniper haircap moss	*Polytrichum juniperinum*
Kentucky bluegrass*	*Poa pratensis*
kinnikinnick	*Arctostaphylos uva-ursi*
kneeling angelica	*Angelica genuflexa*
knotweed	*Polygonum douglasii*
lady fern	*Athyrium filix-femina*
large-fruited desert-parsley	*Lomatium macrocarpum*
large-leaved avens	*Geum macrophyllum*
lawn moss	*Brachythecium albicans*

Common Name	Scientific Name
leafy moss	*Mnium sp.*
leafy moss	*Plagiomnium sp.*
lemonweed	*Lithospermum ruderale*
lichen	*Fulgensia bracteata*
lichen	*Ochrolechia upsaliensis*
Lindley's aster	*Aster ciliolatus*
lipstick powderhorn	*Cladonia macilenta*
little buttercup	*Ranunculus uncinatus*
liverwort	*Riccia sp.*
lodgepole pine	*Pinus contorta*
Loesel's tumble-mustard*	*Sisymbrium loeselii*
long-leaved fleabane	*Erigeron corymbosus*
low pussytoes	*Antennaria dimorpha*
mannagrass	*Glyceria sp.*
marsh skullcap	*Scutellaria galericulata*
meadow birds-foot trefoil	*Lotus denticulatus*
meadow death-camas	*Zigadenus venenosus*
meadow saxifrage	*Saxifraga nidifica*
mealy pixie-cup	*Cladonia chlorophaea*
miner's funnel	*Cladonia cenotea*
miner's-lettuce	*Claytonia perfoliata*
mock-orange	*Philadelphus lewisii*
mountain alder	*Alnus incana*
mountain cliff fern	*Woodsia scopulina*
mountain lady's-slipper	*Cypripedium montanum*
mountain sweet-cicely	*Osmorhiza berteroi*
narrow-leaved collomia	*Collomia linearis*
needle-and-thread grass	*Hesperostipa comata*
Nootka rose	*Rosa nutkana*
northern bedstraw	*Galium boreale*
northern blackcurrant	*Ribes hudsonianum*
northern gentian	*Gentianella amarella*
northern mannagrass	*Glyceria borealis*
northern wormwood	*Artemisia campestris*
northwestern sedge	*Carex concinnoides*
Nuttall's pussytoes	*Antennaria parvifolia*
oak fern	*Gymnocarpium dryopteris*
oceanspray	*Holodiscus discolor*
one-leaved foamflower	*Tiarella trifoliata var. unifoliata*
one-sided wintergreen	*Orthilia secunda*
orange arnica	*Arnica fulgens*
orchard-grass*	*Dactylis glomerata*
Pacific willow	*Salix lucida*
pale alyssum*	*Alyssum alyssoides*
paper birch	*Betula papyrifera*
parsnip-flowered buckwheat	*Eriogonum heracleoides*

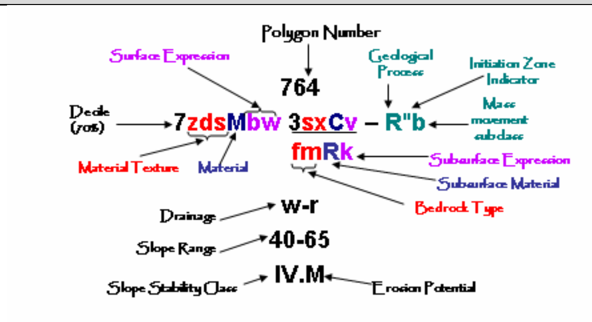
Common Name	Scientific Name
pasture sedge	*Carex petasata*
pathfinder	*Adenocaulon bicolor*
pearly everlasting	*Anaphalis margaritacea*
pebbled pixie-cup	*Cladonia pyxidata*
peg-leg soldiers	*Cladonia cariosa*
pelt lichens	*Peltigera sp.*
perennial sow-thistle*	*Sonchus arvensis*
Philadelphia fleabane	*Erigeron philadelphicus*
pinegrass	*Calamagrostis rubescens*
pink wintergreen	*Pyrola asarifolia*
plantain	*Plantago sp.*
poison ivy	*Toxicodendron rydbergii*
ponderosa pine	*Pinus ponderosa*
powdered trumpet	*Cladonia fimbriata*
prairie rose	*Rosa woodsii*
prairie sagewort	*Artemisia frigida*
prickly rose	*Rosa acicularis*
prince's pine	*Chimaphila umbellata*
purple sweet-cicely	*Osmorhiza purpurea*
purple-leaved willowherb	*Epilobium ciliatum*
quackgrass*	*Elymus repens*
queen's cup	*Clintonia uniflora*
ragged-moss	*Brachythecium sp.*
rattlesnake fern	*Botrychium virginianum*
rattlesnake-plantain	*Goodyera oblongifolia*
red raspberry	*Rubus idaeus*
red-osier dogwood	*Cornus stolonifera*
red-stemmed feathermoss	*Pleurozium schreberi*
reed canarygrass	*Phalaris arundinacea*
reed mannagrass	*Glyceria grandis*
Rocky Mountain juniper	*Juniperus scopulorum*
rose	*Rosa sp.*
Ross' sedge	*Carex rossii*
rough fescue	*Festuca campestris*
rough-fruited fairybells	*Prosartes trachycarpa*
rough-leaved ricegrass	*Oryzopsis asperifolia*
round-leaved alumroot	*Heuchera cylindrica*
sagebrush mariposa lily	*Calochortus macrocarpus*
salty-soil moss	*Pterygoneurum sp.*
Sandberg's bluegrass	*Poa secunda*
saskatoon	*Amelanchier alnifolia*
scarlet gilia	*Ipomopsis aggregata*
Scouler's hawkweed	*Hieracium scouleri*
scouring-rush	*Equisetum hyemale*
self-heal	*Prunella vulgaris*
sheep sorrel*	*Rumex acetosella*

Common Name	Scientific Name
shining starwort	*Stellaria nitens*
showy aster	*Aster conspicuus*
showy daisy	*Erigeron speciosus*
shrubby penstemon	*Penstemon fruticosus*
sidewalk moss	*Tortula ruralis*
silky lupine	*Lupinus sericeus*
silverleaf phacelia	*Phacelia hastata*
silver-moss	*Bryum argenteum*
silvery cinquefoil*	*Potentilla argentea*
Sitka columbine	*Aquilegia formosa*
six-weeks grass	*Vulpia octoflora*
skunk cabbage	*Lysichiton americanus*
slender hawksbeard	*Crepis atribarba*
small bedstraw	*Galium trifidum*
small-flowered blue-eyed Mary	*Collinsia parviflora*
small-flowered fringecup	*Lithophragma parviflorum*
small-flowered penstemon	*Penstemon procerus*
smooth brome*	*Bromus inermis*
smooth sumac	*Rhus glabra*
snowbrush	*Ceanothus velutinus*
soft brome*	*Bromus hordeaceus*
soft-leaved sedge	*Carex disperma*
soopolallie	*Shepherdia canadensis*
sow-thistle*	*Sonchus sp.*
spikelike goldenrod	*Solidago spathulata*
spotted knapweed*	*Centaurea biebersteinii*
spreading dogbane	*Apocynum androsaemifolium*
spring speedwell*	*Veronica verna*
star-flowered false Solomon's-seal	*Maianthemum stellatum*
step moss	*Hylocomium splendens*
sticky cinquefoil	*Potentilla glandulosa*
stinging nettle	*Urtica dioica*
stream violet	*Viola glabella*
sulphur cinquefoil*	*Potentilla recta*
swale desert-parsley	*Lomatium ambiguum*
sweet-scented bedstraw	*Galium triflorum*
tall annual willowherb	*Epilobium brachycarpum*
tall Oregon-grape	*Mahonia aquifolium*
tall tumble-mustard*	*Sisymbrium altissimum*
tarpaper lichens	*Collema sp.*
thatch soldiers	*Cladonia symphycarpia*
thimbleberry	*Rubus parviflorus*
Thompson's paintbrush	*Castilleja thompsonii*
thread-leaved fleabane	*Erigeron filifolius*
thread-leaved phacelia	*Phacelia linearis*
thread-moss	*Bryum sp.*

Common Name	Scientific Name
thyme-leaved sandwort	*Arenaria serpyllifolia*
timber milk-vetch	*Astragalus miser*
trembling aspen	*Populus tremuloides*
tufted thread-moss	*Bryum caespiticium*
twinflower	*Linnaea borealis*
umber pussytoes	*Antennaria umbrinella*
Utah honeysuckle	*Lonicera utahensis*
wall lettuce*	*Lactuca muralis*
water birch	*Betula occidentalis*
water smartweed	*Polygonum amphibium*
wavy-leaved thistle	*Cirsium undulatum*
western fescue	*Festuca occidentalis*
western groundsel	*Senecio integerrimus*
western larch	*Larix occidentalis*
western meadowrue	*Thalictrum occidentale*
western mountain-ash	*Sorbus scopulina*
western redcedar	*Thuja plicata*
western tansy mustard	*Descurainia pinnata*
Wheeler's bluegrass	*Poa wheeleri*
white clover*	*Trifolium repens*
white hawkweed	*Hieracium albiflorum*
white pussytoes	*Antennaria microphylla*
white sweet-clover*	*Melilotus alba*
white willow*	*Salix alba*
wild sarsaparilla	*Aralia nudicaulis*
wild strawberry	*Fragaria virginiana*
wood strawberry	*Fragaria vesca*
woolly sedge	*Carex lanuginosa*
worm-leaved stonecrop	*Sedum stenopetalum*
yarrow	*Achillea millefolium*
yellow monkey-flower	*Mimulus guttatus*
yellow pond-lily	*Nuphar lutea*
yellow salsify*	*Tragopogon dubius*
yellow sweet-clover*	*Melilotus officinalis*
yellow water-buttercup	*Ranunculus flabellaris*

Appendix C: Terrain Legend

Terrain Polygon Symbols



Terrain Map Label

Note: one or more letters may be used to describe any characteristic other than surficial material, or letters may be omitted if information is lacking.

Composite Units: Two or three groups of letters are used to indicate that two or three kinds of terrain are present within a map unit.

e.g., 7Mv 3Rs indicates that the polygons contains approximately 70% "Mv" and 30%"Rs".
e.g., 6Mb 3Cv 1Rs indicates that the polygons contains approximately 60% "Mb" , 30%"Cv", and 10% “Rs”.

Stratigraphic Units: Groups of letters are arranged one above the other where one or more kinds of surficial material overlie a different material or bedrock: e.g., $\frac{\text{Mv}}{\text{Rr}}$ indicates that "Mv" overlies "Rr".

Material	
Code	**Name**
A	Anthropogenic
C	Colluvium
C1	Slope wash
D	Weathered bedrock
E	Eolian
F	Fluvial materials
FA	"Active" fluvial materials
FG	Glaciofluvial materials
L	Lacustrine sediments
LG	Glaciolacustrine sediments
M	Till
O	Organic materials
R	Bedrock
U	Undifferentiated materials

Texture	
Code	**Name**
c	clay
z	silt
s	sand
p	pebbles
k	cobbles
b	boulders
a	blocks
d	mixed fragments
g	gravel
r	rubble
x	angular fragments
m	mud
y	shells
e	fibric
u	mesic
h	humic

Surface Expression	
Code	**Name**
a	moderate slope(s)
b	blanket (>1m thick)
c	cone
d	depression
f	fan
h	hummocky
j	gentle slope(s) (5-27%)
k	moderately steep slope (49-70%)
m	rolling topography
p	plain (0-5%)
r	ridges
s	steep slope(s) (>70%)
t	terrace(s)
u	undulating topography
v	veneer ($\leq$1m thick)
w	mantle of variable thickness
x	thin veneer (10-25cm)

Detailed Descriptions of Surficial Materials

Anthropogenic Material (A)

Anthropogenic materials are deposits that are sufficiently reworked or redistributed by human activities that their original character is lost. Examples include gravel pits and fill used for roads and other construction.

Colluvium (C)

Colluvium accumulated during post-glacial times as a result of gravity-induced slope movement, for example, rock fall and soil creep. The physical characteristics of colluvium are closely related to its source and mode of accumulation. Four processes generally create colluvial deposits; (1) rockfall from bedrock bluffs, (2) soil creep in weathered bedrock, (3) mass movement processes in surficial materials (debris flows and debris slides), and (4) rockslides and rock slumps.

Rockfall from bedrock bluffs typically forms talus slopes (Ck). Talus is loosely packed rubble or blocks with little interstitial silt and sand near the surface, and is rapidly drained. Within the study area talus was scattered throughout flanking bedrock cliffs.

Colluvial veneers (Cv) and blankets (Cb) develop where weathered bedrock or surficial materials have been loosened and moved downslope by gravitational processes such as soil creep. It is loosely packed and usually rapidly drained. Colluvial veneers and very thin veneers were most common on upper, moderately steep and steep gradient slopes and as discontinous, very thin veneers on bedrock-controlled terrain in the watershed. The matrix texture of the colluvium reflects the bedrock or surficial materials it is derived from. Within the study area, colluvium typically had a silty sand texture and was rapidly drained.

Colluvial fans (Cf) and cones (Cc) form at the base of steep gullies due to deposition by debris flows (-Rd). These deposits are generally compact, and sorting may range from poorly sorted to well sorted. The deposit may or may not be matrix supported, and the matrix is usually sand. Colluvial cones and fans are common at the mouths of the large single gullies. Debris flow deposits (levees) were observed in the canyon sections of Vernon Creek and Clark Creek.

Deep-seated slumps in bedrock and surficial materials result in hummocky, irregular colluvial deposits (Chu). Rock slumps contain blocks and rubble with little or no interstitial silt and sand. Rotational slumps have developed in some portions of the plateau basalt cliffs due to failure along vertical joints and horizontal weak layers. A couple of large slumps are located in the basalt along the eastern edge of the study area. The extent of the deposits was difficult to map without more field checking. The large deposit located below Wrinkly Face Cliff occurred prior to the end of the last glaciation as the deposit and portions of the headscarp are covered by till. The peak of Spinekopje is a slump.

Slope Wash (C1)

Slope wash is a result of rainfall events in which non-channellized overland flow carries surface material from a steeper area to a gentler area down slope. The material is generally derived from eolian sediments. Slope wash generally does not travel far and comes to rest on gentler slopes of 0 to 15 %. In the study area, it was commonly found as a partial veneer overlying till, fluvial or lacustrine deposits. The typical texture was silty sand or sandy silt with generally less than 5 %

coarse fragments. It commonly included some imperfect drainage as it accumulates in receiving sites.

Weathered Bedrock (D)

Weathered bedrock has been modified *in situ* by mechanical and chemical weathering. In the study area, weathered bedrock was found as a discontinuous very thin veneer (Dx) overlying gently sloping or undulating bedrock outcrops. It typically contained a high proportion of angular coarse fragments with varying amounts of interstitial silty sand. It was non-cohesive and rapidly to very rapidly drained.

Eolian Sediments (E)

Eolian sediments were transported and deposited by wind. They typically occur as a thin cap (Ev) over other materials, but may locally thicken into a blanket or dunes. Eolian veneers were found on the gentler slopes on the eastern side (lee side) of the study area. These deposits typically consisted of silt and fine sand.

Fluvial Materials (F, F^A)

Fluvial materials were deposited in post-glacial time by streams. Fluvial materials consist of loosely packed, non-cohesive sands and silt with some gravel. In the study area, fluvial materials were present mainly as small portions of a polygon that include a stream. Fluvial materials were generally mapped as floodplains (Fp, F^Ap) or gentle fluvial areas (Fj) with imperfect to poor drainage. There was a large floodplain mapped in the valley bottom in Winfield across which flow Vernon and Winfield Creeks. Narrow floodplains were mapped along Clark and Vernon Creeks. Fluvial fans (Ff) were mapped at the mouths of larger creeks and gullies throughout the study area.

Glaciofluvial Materials (F^G)

Glaciofluvial materials were deposited by glacial meltwater streams at the end of the Fraser Glaciation. Sands and gravels accumulated along ice margins and on top of melting ice (FGu) and downstream of melting ice (FGf and FGp). In some areas, rivers were made and quickly abandoned depositing blankets of sands and gravels over top of till (FGb). In a few areas, postglacial streams have incised into outwash plains and fans transforming them into terraces (FGt) and creating erosional slopes (FGk). In general, glaciofluvial materials created well-drained and relatively dry sites due to the highly porous and permeable sands and gravels. The material is non-cohesive and therefore erodible, and will tend to ravel when exposed on steep slopes and road cuts. Glaciofluvial sands and gravels are potential sources of aggregate.

In the study area, glaciofluvial materials consisted of gravely sands with minor amounts of silt. These deposits ranged from well stratified to unstratified and well-sorted to moderately-sorted. Large deposits of glaciofluvial sediments were located at the mouths of the larger meltwater channels and gullies, for example, at the mouth of Cougar Canyon, in the Coral Beach and Commonage road area, on the west side and east side of Oyama, the vicinity of Pollard's Pond, along Okanagan Centre Road West in the south, and on either side of Vernon Creek upslope from its large fan. There were large glaciofluvial deposits and some eskers located on either side of the Vernon Creek canyon

Lacustrine (L)

Lacustrine materials were deposited from standing bodies of water. Fine sand, silt, or clay that have been suspended in the water settle to the lake bed creating sediments that are commonly stratified and fine textured. These sediments may be exposed when the lake is drained. In the study area, lacustrine materials occurred in shallow ponds that were periodically inundated (szLp and szLv). Sediments were also deposited at the margins lakes by wave action, such as on the beaches of Okanagan, Wood and Kalamalka Lakes. These materials generally consisted of sand and gravel.

Glaciolacustrine (L^G)

Glaciolacustrine materials were deposited from glacial or ice-dammed lakes that were present during and shortly after glaciation. Glaciolacustrine materials generally consist of well to moderately well stratified fine sand, silt, or clay with occasional lenses of till or glaciofluvial material.

Glaciolacustrine materials are generally only slowly permeable, and so the presence of even a thin layer of this material is sufficient to cause impeded drainage, perched water tables, and surface seepage. These conditions may promote instability in some situations. These fine-textured materials are also susceptible to surface erosion by running water.

In the study area, glaciolacustrine materials resulting from glacial Lake Penticton were found on the gentler slopes adjacent to Okanagan, Wood, and Kalamalka Lakes. At about 1100m, south of Vernon Creek, there was a large area covered by glaciolacustrine sediments. These were likely deposited when stagnating ice in the main valley bottom dammed Vernon Creek, temporarily forming a lake.

Till (M)

Till was deposited directly by glacier ice and was the most common surficial material within the study area. The deposits typically consist of poorly sorted silt, sand and gravels. In general, till on slopes is well drained and moderately-well drained, and imperfectly drained in depressions.

Thick till deposits were found in the Woodsdale area and on the upper edges of the sloping benches. On the mid to upper slopes, discontinuous veneers and blankets of till covered much of the gentle to moderately steep slopes. Patches of very thin veneers of till covered areas of undulating bedrock.

Throughout the study area, the typical till was a noncohesive, silty sandy basal till (terrain texture label "zds" or "dzs"). A finer textured basal till (terrain texture label "smd") was observed in some soil pits and road cuts and appeared to be associated with the presence of basalt in the local area. The matrix texture was chiefly silt and contains some sand and trace amounts of clay, the till contained a coarse fraction typically between 30 to 40 %. These soils were generally found on the upper slopes along the eastern edge of the study area.

Organics (O)

Organic materials form where decaying plant material accumulates in poorly or very poorly drained areas. In the study area, organic materials were uncommon, but may occur as veneers (Ov) or very thin veneers (Ox) in some of the wetlands.

Bedrock (R)

Bedrock was mapped where it outcrops at the surface. Polygons mapped with thin or very thin material (Cv, Dx, Mv, Mx), may also have a small proportion of bedrock outcrops. Bedrock outcrops were scattered throughout the study area.

Undifferentiated Material (U)

This material type is used to describe material that is too complex to be represented by the usual terrain symbols. Undifferentiated material is a layered sequence of surficial materials that have been exposed on an erosional slope. There is usually a sequence of three or more layers.

In the study area, undifferentiated material were mapped in the Okanagan Centre area (between Tyndall Road and Okanagan Centre Road West) and in the canyon portions of Vernon and Clark Creeks. The Okanagan Centre area consists of several tens of metres of complex sequences of surficial materials, much of which pre-date the most recent glaciation. Fulton [58] has identified several distinct layers of sand and gravel, till, and laminated silt layers. The canyons in Clark and Vernon Creeks consisted of various layers of till, glaciolacustrine and glaciofluvial sediments.

Geological Processes	
Code	**Name**
-E	Glacial meltwater channels
-F	Slow mass movement (failing, slumps)
-F"	Slow mass movement initiation zone
-Fk	tension cracks
-Fm	slump in bedrock
-Fu	Slump in surficial material
-H	Kettled
-L	Surface seepage
-R	Rapid mass movement (slides and falls)
-R"	Rapid mass movement initiation zone
-Rb	Rockfall
-Rd	Debris flow
-Rs	Debris slide
-Ru	Slump in surficial materials
-V	Gully Erosion

Drainage	
Code	**Name**
x	very rapidly drained
r	rapidly drained
w	well drained
m	moderately well drained
i	imperfectly drained
p	poorly drained
v	very poorly drained

Where two drainage classes are shown:
- if the symbols are separated by a comma, e.g., “w,i”, then no intermediate classes are present;
- if the symbols are separated by a dash, e.g., "w-i", then all intermediate classes are present.

Description of Geological Processes

Channeled by Meltwater (-E, -EV)

Meltwater channels form alongside, beneath, or in front of a glacier or ice sheet. Glacial meltwater channels are typically sinuous in plan, flat-floored, and steep-sided in cross-section. The floors of the meltwater channel may contain glaciofluvial sediments, indicative of the water flow that once took place here.

[58] Fulton 1975

Many meltwater channels were located within the study area and ranged from large to small and incised through bedrock to incised through surficial materials. The largest and most prominent meltwater channel in the study area was Cougar Canyon located near Oyama. There were several small meltwater channels incised in till in the grasslands above Woodsdale. Many more of these landforms were scattered throughout the study area.

Slow Mass Movement (-F, -F"k, -F"m, -F"u)

Slow mass movement refers to slope failures where movement occurs slowly or where the displaced material moves only a short distance downslope. The double prime symbol (") indicates the initiation zone of slow mass movement. Tension cracks are indicated by the subclass "k" (-Fk). Failures occurring in bedrock are indicated by the subclass "m" (e.g. –Fm). Failures occurring in thick surficial materials are indicated by the subclass 'u' (e.g. -Fu).

Tension cracks (-Fk) are open fissures commonly located near ridge tops. They indicate slow slope spreading, and may be the precursor to catastrophic slope failure. Tension cracks were mapped along the eastern edge of the study area near cliff faces in the Thompson Plateau basalt.

A slump in bedrock (-Fm) refers to a rotational slump where portions of the slide mass remains internally cohesive. Rotational slumps develop due to failure along vertical joints and horizontal weak layers. In the study area, slumps were present along bluffs in the Thompson Plateau basalt. There were smaller rotational slumps that have occurred since the last glaciation. These deposits were at a gentler slope than the angle of repose and the planimetric width of the deposits were much wider than the bluff they originated from. There were a couple of larger slumps (i.e., at the base of Wrinkly Face Cliff) located in the Thompson Plateau basalt on the eastern edge of the study area. A portion of the Wrinkly Face Cliff slide was observed in the field, but the large slide located further north was not. Evans (1983) has classifies these types of slides as a complex block movements. His interpretation is that movement has occurred along a plane of weak sediments (weak pyroclastic rocks, or tuffaceous or poorly lithified sediments) located at depth. It is assumed that the slide occurred prior to or during the Fraser Glaciation as the headscarp and deposit is largely covered by till. Secondary flow in portions of the slide mass is common in these types of large slide deposits, although no recent movement was observed in the field. The extents of these deposits were difficult to determine by air photo interpretation.

Slumps in surficial materials (-Fu) consist of deep-seated, rotational failures along a zone of weakness within thick deposits. Slumping in fine-grained sediments, such as, glaciolacustrine materials are common. There was a slump in glaciolacustrine sediments in the escarpment above Pixie Beach on Pixton Road. This polygon was designated as terrain stability class **V** and erosion potential **VH** (very high).

Kettled (-H)

Kettled topography consists of hummocky undulating terrain, which developed when blocks of glacial ice buried by or surrounded by glaciofluvial gravels and ablation till melted. Kettled kame deposits were mapped along the Commonage Road in the north edge of the study area and along Okanagan Centre Road West between Glenmore Road and Tyndall Road.

Surface Seepage (-L)

Seepage is mapped where relatively wet soils are widespread in a polygon. This commonly occurs where soils are on slowly permeable materials such as till, where thin surficial materials overlie bedrock, and on lower slopes where shallow subsurface water is received from a relatively large catchment area further upslope. They may also occur where groundwater is concentrated at the surface by a physical conduit such as a geological fault. In the study area, areas of abundant surface seepage were uncommon and generally spread throughout the study area. However, there was abundant seepage throughout the Wrinkly Face Cliff landslide deposit.

Rapid Mass Movement (-R, -R”b, -R”d, -R”s, -R”u)

Rapid mass movement refers to downslope movement by falling, rolling or sliding of debris derived from surficial material or bedrock. Where a double prime symbol (”) is used with a mass movement process (e.g., -R”s), slope failure has initiated within the polygon. Mass movement symbols without the double prime symbol (e.g., -Rb) indicate a polygon that contains the transport or deposition zone of rapid mass movement. Transportation zones are generally not recognized as areas where landslides initiate; they may contribute additional volume of transported material to a failure. Transport and deposition zones represent hazardous areas downslope of slides or rockfall.

Rockfall (-Rb, -R”b) occurs when either a single block or a mass of bedrock falls, bounces and rolls downslope. In the study area, rockfall from local outcrops created talus slopes, colluvial veneers and blankets. Polygons with rockfall were scattered throughout the study area in association with local bedrock outcrops or cliffs.

Debris flows (-Rd) initiate in steep gullies and debris slides (-Rd) initiate on steep hillsides. They occur when a mass of surficial material slides rapidly downslope often as a result of the loss of soil strength due to high pore water pressure. Debris slides (non-channelized movement of debris) and debris flows (channelized movement of debris) are initiated on steep slopes where material slides along a shear plane. The shear plane often coincides with the boundary between more permeable and less permeable material (e.g., between weathered and unweathered material or between surficial material and bedrock). Debris flows and debris slides are triggered by heavy rain, water from snow melt, or rain on snow events, and result from loss of soil strength due to high pore water pressure. During wet conditions, slides are also triggered by wind stress on trees, tree throw, impact of falling rocks from up slope, and vibrations due to earthquakes or human activity. In logged areas, debris slides that occur several years after logging can be due to the loss of soil strength that results from root decay. Diverted drainage from roads commonly triggers failure of sidecast material and may initiate landslides some distance downslope. A debris flow may move downslope for several hundred metres or more before it is arrested by gentler terrain or by de-watering, or it may enter a trunk stream. Debris flows are effective agents of erosion, commonly increasing the volume of material as it progresses downslope. Debris slides and debris flows are significant potential sources of stream sediment and a hazard to activities or structures (roads, culverts) located in runout zones.

In the study area, most of the debris slides and flows were mapped in the canyon portions of Clark and Vernon Creeks. In the large gullies incised through the thick sequence of surficial materials in the Okanagan Centre area (below Tyndall Road), there was no recent evidence of debris slides. The presence of colluvial fans and cones at the mouths of these gullies indicated post-glacial mass movement.

Gully Erosion (-V)

Gullies are small ravines with V-shaped cross sections that can form in either glacial drift or bedrock. Gully erosion is mapped in two kinds of terrain: (i) slopes with several parallel shallow gullies in drift materials (dissected slope) and (ii) single gullies where streams have exploited joints in bedrock or have cut down into thick drift. Gullied terrain is an indicator of either former or active erosion, and the symbol serves to identify material that is potentially subject to erosion or mass movement (e.g., Uk-V). Gully sideslopes and steep headwalls are common sites of slope failures and are classed as potential unstable (Class IV) where there is no evidence of instability and unstable (Class V) where there is evidence of instability. In the study area, gully erosion was mapped in polygons scattered throughout the study area.

Slope Range
Slopes are given in percentages as a range. For example, ‘20-45’ indicates that the majority of the slopes in the polygon are between 20% and 45%.

Terrain stability Classes[59]	
Class	**Interpretation**
I	• No significant stability problems exist.
II	• There is a low likelihood of landslides following disturbance or development. • Minor slumping is expected along road cuts and excavations.
III	• Stability problems can develop. • Follow BMP to reduce the likelihood of causing slope failure. • Minor slumping is expected along road cuts and excavations. There is a low likelihood of landslide initiation following road construction. • On-site inspection required by geotechnical staff.
IV	• Expected to contain areas with a moderate likelihood of landslide initiation following development, disturbance or road construction. • These areas should be avoided. Use caution when planning intensive land use above or below these areas. • On-site inspection required by geotechnical staff
V	• Expected to contain areas with a high likelihood of landslide initiation. Signs of existing instability present. • Avoid these areas. Do not plan intensive land use above or below these areas. • On-site inspection required by geotechnical staff

Erosion Potential Classes[60]		
Class	**Rating**	**Management Implications**
VL	Very low	• Negligible or very minor soil erosion.
L	Low	• Expect minor erosion of fines in ditch lines and disturbed soils.
M	Moderate	• Expect moderate erosion when water is channelled down road surfaces or ditches and over exposed soils.
H	High	• Significant erosion problems can be created when water is channelled onto or over exposed soil on these sites.
VH	Very high	• Severe surface and gully erosion problems can be created when water is channelled onto or over exposed soils at these sites.

59 Adapted from Ministry of Forests 1999
60 Adapted from Ministry of Forests 1999

Appendix D: Expanded Legend

LAKE COUNTRY EXPANDED LEGEND – IDFmw1

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CD	**Black Cottonwood –Common Snowberry – Red-osier Dogwood Riparian**	**IDFmw1**	**00**

Typic unit occurs on level or very gently sloping sites with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is rare but was found along major creeks including Vernon Creek. Forests are often mixed black cottonwood with some western redcedar. The understory is typically rich and shrubby, often dominated by mountain alder. Forbs are sparse to moderately abundant and include lady fern, common horsetail, and scattered other species.

List of mapped units:

CDn fan

SITE INFORMATION

Common Terrain Types:

- colluvial slopewash , lacustrine, and fluvial

Slope position:	lower and toe
Slope (%):	0-5
Aspect:	none
Soil Moisture Regime:	hygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CD	Black cottonwood –Common Snowberry – Red-osier Dogwood Riparian	IDFmw1	00

	Structural Stage	3	4	5	6	7	
Trees	*Populus balsamifera* ssp. *trichocarpa*	**	***	***	***	***	black cottonwood
	Thuja plicata			*	**	**	western redcedar
Shrubs	*Alnus incana*	***	**	***	***	***	mountain alder
	Oplopanax horridus	*	**	***	***	***	devil's club
	Ribes lacustre	**	*	**	**	***	black gooseberry
	Cornus stolonifera	***	**	**	**	**	red-osier dogwood
Herbs	*Equisetum arvense*	**	*	*	*	**	common horsetail
	Athyrium filix-femina	**	*	**	***	***	lady fern
Mosses	*Plagiomnium* or *Mnium* spp.	**	*	**	**	**	leafy mosses
PLOTS						LCG003	

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CT	**Cattail Marsh**	**IDFmw1**	**00**

Typic unit occurs on level sites with deep, medium-textured soils (assumed modifiers are d, j, m).

This unit is equivalent to the *Cattail marsh* association in the provincial classification (MacKenzie and Shaw 2000).

This marsh wetland ecosystem occurs as a fringe on pond edges or in depressions, often adjacent to shallow open water (OW). This unit is rare in the study area. Water depths are typically up to 1 m in spring but draw down to the soil surface by late summer; soils remain saturated for most of the season. Some wetlands convert to cattail marshes when they are subject to nutrient loading. These sites are dominated by cattails with few other species. Soils are typically mineral, but may have a thin organic veneer on top.

List of mapped units:

CTp peaty materials, 40+cm of organic material overlaying mineral deposits

SITE INFORMATION

Common Terrain Types:

- thin organic veneer over lacustrine materials

Slope position:	depression
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	subhydric
Soil Nutrient Regime:	rich

	Structural Stage	2a	
Herbs	*Typha latifolia*	****	common cattail
	Lemna minor	**	common duckweed
Mosses	*Bryum* sp.	**	thread moss
PLOTS		LCG028	

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DF	**Douglas-fir/Western Redcedar – Falsebox – Prince's pine**	**IDFmw1**	**01**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is commonly associated with mesic gently sloping sites. Mature forests have an overstory dominated by western redcedar with a sparse understory.

List of mapped units:

DFc	coarse-textured soils (glaciofluvial)	DFf	fine-textured soils (glaciolacustrine)
DFk	cool aspect, slope >25%	DFks	cool aspect, slope >25%, shallow soils (50-100cm)
DFs	shallow soils (50-100cm)	DFw	warm aspect (often SE or NW), slope >25%

SITE INFORMATION

Common Terrain Types:

- deep morainal, glaciofluvial, and glaciolacustrine materials on level and gentle slopes
- moderate to steep cool aspect morainal and colluvial slopes

Slope position:	lower to middle
Slope (%):	0-30; steeper on cool aspects
Aspect:	all
Soil Moisture Regime:	mesic – submesic
Soil Nutrient Regime:	medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DF	Douglas-fir/Western Redcedar – Falsebox – Prince's pine	IDFmw1	01

	Structural Stage	3	4	5	6	7	
Trees	*Thuja plicata*	***	***	***	****	****	western redcedar
	Pinus contorta	***	***	**	*		lodgepole pine
Shrubs	*Paxi myr*	**	*	**	***	***	
Grasses	*Calamagrostis rubescens*	**	*	**	**	**	pinegrass
Herbs	*Epilobium angustifolium*	****	*				fireweed
	Linnaea borealis	*	*	**	**	**	twinflower
	Clintonia uniflora	*	*	**	**	**	queen's cup
Mosses and Lichens	*Pleurozium shreberi*		*	**	***	***	red-stemmed feathermoss
	Brachythecium sp.	**	*	*	*	*	
	Peltigera spp.	*	*	**	**	**	pelt lichens
PLOTS		LCG0047 LCV054		LCG002			

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DP	**Douglas-fir – Pinegrass – Feathermoss**	**IDFmw1**	**04**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is common on warm aspects. The overstory is dominated by Douglas-fir and the understory is dominated by pinegrass with showy aster, snowberry and other scattered shrubs and forbs.

List of mapped units:

DPcw	coarse-textured soils (generally glaciofluvial); warm aspect, slope >25%	DPks	cool aspect (NNW or ESE), slope >25%, shallow soils (50-100cm)
DPs	shallow soils (50-100cm)	DPsw	shallow soils (50-100cm); warm aspect, slope >25%
DPw	warm aspect, slope >25%		

SITE INFORMATION

Common Terrain Types:

- deep morainal or glaciolacustrine materials on moderate to steep warm aspect slopes

Slope position:	middle and upper
Slope (%):	35 – 85
Aspect:	southeast to west
Soil Moisture Regime:	subxeric to submesic
Soil Nutrient Regime:	poor to medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DP	**Douglas-fir – Pinegrass – Feathermoss**	**IDFmw1**	**04**

	Structural Stage	**3**	**4**	**5**	**6**	**7**	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	****	***	***	***	Douglas-fir
Shrubs	*Symphoricarpos albus*	****	*	**	**	**	common snowberry
	Spirea betulifolia	**	*	**	**	**	birch-leaved spirea
	Mahonia aquifolium	**	*	*	*	*	tall oregon-grape
Grasses	*Calamagrostis rubescens*	***	**	****	****	****	pinegrass
Herbs	*Aster conspicuus*	***	**	***	***	***	showy aster
	Lupinus sericeus	***	**	***	***	***	silky lupine
Mosses	*Brachythecium albicans*	*	*	*	**	**	lawn moss
and	*Peltigera* spp.	*		*	*	**	dog pelt
Lichens	*Dicranum* sp.	*	*	*	*	*	heron's bill moss
PLOTS				LCV089			

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DS	**Douglas-fir/Ponderosa pine – Snowberry – Bluebunch wheatgrass**	**IDFmw1**	**02**

Typic unit occurs on gentle slopes with deep, medium textured soils on ridges or crests (d, j, m and r are assumed modifiers).

This forest ecosystem occurs on very dry sites, often with some exposed bedrock.

List of mapped units:

DSv	very shallow soils (<20cm deep)	DSvw	very shallow soils (<20cm deep), warm aspect

SITE INFORMATION

Common Terrain Types:

- shallow till and colluvial slopes, rock

Slope position:	upper, crest
Slope (%):	0 – 60
Aspect:	none or warm
Soil Moisture Regime:	xeric
Soil Nutrient Regime:	poor to medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DS	**Douglas-fir/Ponderosa pine – Snowberry – Bluebunch wheatgrass**	**IDFmw1**	**02**

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	****	****	***	***	Douglas-fir
Shrubs	*Amelanchier alnifolia*	*	*	*	**	**	tall oregon-grape
Grasses	*Pseudoroegneria spicata*	**		*	*	**	bluebunch wheatgrass
Herbs	*Balsamorhiza sagittata*	**	**	***	***	***	arrow-leaved balsamroot
	Lupinus sericeus	***	**	***	***	***	silky lupine
	Achillea millefolium	**	*	**	**	**	yarrow

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
ES	**Exposed Soil**	**IDFmw1**	**N/A**

These are areas of exposed soils and typically include recent disturbances such as soil erosion.

List of mapped units:

ESw warm aspect; slope >25%

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
OW	**Shallow Open Water**	**IDFmw1**	**N/A**

These are areas of permanent open water that are less than 2m deep. There is less than 10% emergent vegetation but floating aquatics such as bladderwort are often present. Shallow open water commonly occurs in association with marsh ecosystems.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PP	**Douglas-fir – Penstemon – Pinegrass**	**IDFmw1**	**03**

Typic unit occurs on significant warm slopes with deep, medium textured soils (d, m, and w are assumed modifiers).

This forest ecosystem is characterized by an open Douglas-fir canopy with a mixed pinegrass – shrub – forb understory.

List of mapped units:

PPs shallow soils (50-100cm deep)

SITE INFORMATION

Common Terrain Types:

- moderate to steeply slope till and colluvium

Slope position:	middle and upper
Slope (%):	50-70
Aspect:	south – west
Soil Moisture Regime:	submesic – subxeric
Soil Nutrient Regime:	medium, poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PP	Douglas-fir – Penstemon – Pinegrass	IDFmw1	03

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	**	****	***	***	Douglas-fir
	Pinus contorta	**	***	***	**	*	lodgepole pine
Shrubs	*Spirea betulifolia*	***	*	***	***	***	birch-leaved spirea
	Symphoricarpos albus	**	*	**	**	**	common snowberry
Grasses	*Calamagrostis rubescens*	***	**	****	****	****	pinegrass
Herbs	*Aster conspicuus*	***	**	***	***	***	showy aster
	Arnica cordifolia	***	**	***	***	***	heart-leaved arnica
Mosses	*Brachythecium albicans*	*	*	*	**	**	lawn moss
and	*Peltigera* spp.	*		*	*	**	dog pelt
Lichens	*Dicranum* sp.	*	*	*	*	*	heron's bill moss
PLOTS					LCG006		

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RD	**Western redcedar – Devil's club – Foamflower**	**IDFmw1**	**06**

Typic unit occurs on gentle toe slopes or depressions with seepage and deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem occurs on moist sites with seepage. Mature forests are dominated by western redcedar and hybrid white spruce with an understory characterized by Devil's club and rich forbs. Seral forest are often deciduous and are dominated by paper birch and trembling aspen.

List of mapped units:

RDg	gully	RDgw	gully, warm aspect, slope >25%
RDt	fluvial terrace; adjacent to creek		

SITE INFORMATION

Common Terrain Types:

- Fluvial and slopewash colluvial materials on gentle toe slopes

Slope position:	toe
Slope (%):	0 – 10
Aspect:	none
Soil Moisture Regime:	hygric (subhygric)
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RD	Western redcedar – Devil's club – Foamflower	IDFmw1	06

	Structural Stage	3	4	5	6	7	
Trees	*Thuja plicata*	**	****	****	***	***	western redcedar
	Picea engelmannii x glauca	**	***	***	**	**	hybrid white spruce
	Betula papyrifera						paper birch
	Populus tremuloides						trembling aspen
Shrubs	*Oplopanax horridus*		*	**	***	***	Devil's club
	Symphoricarpos albus	***	*	**	**	**	common snowberry
	Cornus stolonifera	**	*	**	**	**	tall oregon-grape
Herbs	*Aralia nudicaulus*	**	*	*	*	**	wild sarsaparilla
	Equisetum arvense	**	*	*	*	*	common horsetail
Mosses	*Mnium* or *Plagiomnium* spp.			*	**	**	leafy mosses
	Brachythecium sp.	*	*	*	**	**	
PLOTS			LCG032		LCG005		

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RR	**Western redcedar/Douglas-fir – Dogwood**	**IDFmw1**	**05**

Typic unit occurs on gentle to level lower slopes, receiving sites with deep, medium textured soils (d, j and m are assumed modifiers).

This moist forest ecosystem is found on receiving sites and sometimes adjacent to small creeks. It has a rich understory characterized by abundant thimbleberry.

List of mapped units:

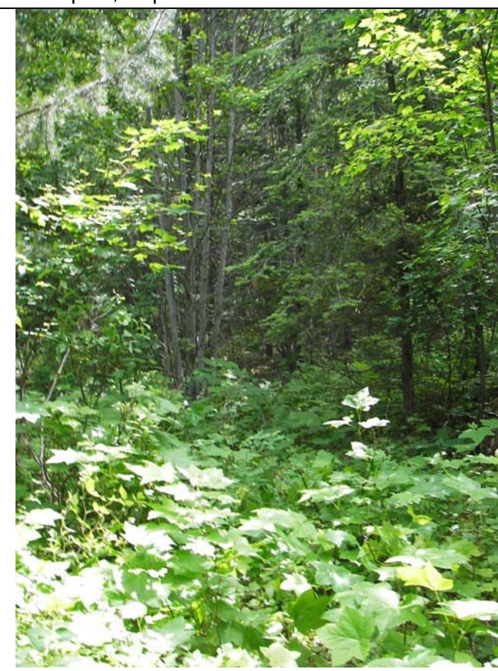
RRg	gully	RRgk	gully, cool aspect, slope >25%
RRgw	gully, warm aspect, slope >25%	RRw	warm aspect, slope >25%

SITE INFORMATION

Common Terrain Types:

- slopewash fluvial and till

Slope position:	toe (middle)
Slope (%):	0 – 20
Aspect:	none, all
Soil Moisture Regime:	subhygric (hygric)
Soil Nutrient Regime:	rich



Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RR	**Western redcedar/Douglas-fir – Dogwood**	**IDFmw1**	**05**

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	****	****	***	***	Douglas-fir
	Thuja plicata	**	***	***	**	**	Western redcedar
	Betula papyrifera	**	***	**	*	*	paper birch
Shrubs	*Rubus parviflorus*	****	***	****	*****	*****	thimbleberry
	Acer glabrum	**	*	**	**	**	Douglas maple
	Symphoricarpos albus	***	*	**	***	***	common snowberry
Herbs	*Osmorhiza berteroi*	**	*	**	**	**	mountain sweet-cicely
	Linnea borealis	**	*	**	**	**	twinflower
	Arnica cordifolia	***		**	**	**	heart-leaved arnica
Mosses	*Mnium* or *Plagiomnium* spp.	*	*	*	**	**	leafy mosses
	Brachythecium sp.	*	*	*	**	**	
PLOTS			LCG031	LCG009			

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RZ	**Road Surface**	**IDFmw1**	**N/A**

A gravel or paved road used for vehicular travel.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SO	**Saskatoon – Mock orange Talus**	**IDFmw1**	**00**

Typic unit occurs on both warm and cool steep slopes with deep, coarse textured soils (blocky) (c and d are assumed modifiers).

This ecosystem is commonly associated with steep, blocky talus slopes with minimal soil in pockets between blocks. This is an uncommon unit in the study area. Scattered trees (Douglas-fir or aspen) and scattered shrubs (snowberry, saskatoon) grow in soil pockets between blocks. Often cliff ferns (a very characteristic species) and scattered grasses are found growing in soil pockets. Vegetation cover is generally higher on sites with smaller blocks and more soil. Cool aspects more commonly have trees on them. Sites that are dominated by shrubs will not necessarily develop into a forested structural stage.

List of mapped units:

SOw warm aspect; slope >25%

SITE INFORMATION

Common Terrain Types:

- rubbly colluvial slopes

Slope position:	lower to upper
Slope (%):	60 – 70%
Aspect:	all
Soil Moisture Regime:	subxeric – xeric
Soil Nutrient Regime:	poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SO	Saskatoon – Mock orange Talus	IDFmw1	00

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	*	**	**	**	***	Douglas-fir
	Populus tremuloides	*	**	**	**	**	trembling aspen
Shrubs	*Amelanchier alnifolia*	**	**	**	**	**	saskatoon
	Symphoricarpos albus	**	**	**	**	**	common snowberry
	Prunus virginiana	*	*	*	*	*	choke cherry
Herbs	*Woodsia scopulorum*	*	*	*	*	*	cliff fern
	Calamagrostis rubescens	**	**	**	**	**	pinegrass
	Lomatium spp.	*	*	*	*	*	desert-parsely
PLOTS						9901758	

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WB	**Bluebunch wheatgrass – Balsamroot**	**IDFmw1**	**00**

Typic unit occurs on warm aspects with deep, medium-textured soils (assumed modifiers are d, m, and w)

This grassland ecosystem commonly occurs on moderately steep to steep warm slopes. Often surface soils are actively ravelling on steeper slopes. Bluebunch wheatgrass and balsamroot dominate these sites. Bunchgrasses are more widely spaced than on gentler slopes.

SITE INFORMATION

Common Terrain Types:

- morainal blankets and veneers and colluvial veneers

Slope position:	middle, upper, crest
Slope (%):	25 – 65%
Aspect:	south, southwest, west
Soil Moisture Regime:	subxeric – submesic
Soil Nutrient Regime:	medium – poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WB	**Bluebunch wheatgrass – Balsamroot**	**IDFmw1**	**00**

	Structural Stage **Seral Association**	**2b** **WB**	
Grasses	*Pseudoroegneria spicata*	****	bluebunch wheatgrass
	Koeleria macrantha	**	junegrass
Herbs	*Artemisia frigida*	**	pasture sage
	Balsamorhiza sagittata	***	arrowleaf balsamroot
	Lupinus sericeus	**	silky lupine
	Lithospermum ruderale	**	lemonweed
Mosses	*Cladonia* spp.	**	clad lichens
Lichens	*Tortula ruralis*	**	sidewalk moss
PLOTS		LCG027	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WS	**Willow - Sedge**	**IDFmw1**	**00**

Typic unit occurs on level sites with deep, organic soils (d, j and p are assumed modifiers).

This is a generalized wetland ecosystem that has variable site conditions and plant composition.

SITE INFORMATION

Common Terrain Types:

- Organic

Slope position:	depression
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	hygric - hydric
Soil Nutrient Regime:	medium - rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WS	**Willow – Sedge**	**IDFmw1**	**00**

	Structural Stage	3	
Shrubs	*Alnus incana*	***	mountain alder
	Ribes hudsonianum	***	northern blackcurrant
Grasses	*Glyceria grandis*	***	reed mannagrass
Herbs	*Typha latifolia*	**	common cattail
	Ranunculus flabellaris	**	yellow water-buttercup
Mosses	*Drepanocladus spp.*	***	hook-moss
PLOTS		LCG029	

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites
Comments: Very limited data; other sites are likely dominated by different species.

LAKE COUNTRY EXPANDED LEGEND – IDFxh1

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
AB	**Nuttall's alkaligrass – Foxtail barley graminoid meadow**	**IDFxh1**	**00**

Typic unit occurs on gentle slopes with deep, fine-textured soils (assumed modifiers are d, f, and j)

This meadow ecosystem commonly occurs at the fringes of alkaline ponds and lakes. These sites often have a white crust of salts on the soil surface. Vegetation is limited to species like Nuttall's alkaligrass, saltgrass, and foxtail barley that can tolerate alkaline conditions. This unit is rare in the study area.

SITE INFORMATION	
Common Terrain Types: • lacustrine and morainal blankets	
Slope position:	depression, lower, toe
Slope (%):	0 – 5
Aspect:	none
Soil Moisture Regime:	hygric
Soil Nutrient Regime:	rich – very rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
AB	**Nuttall's alkaligrass – Foxtail barley graminoid meadow**	**IDFxh1**	**00**

	Structural Stage	2b	
Grasses	*Puccinellia* sp.	***	alkaligrass
	Hordeum jubatum	***	foxtail barley
	Distichlis spicata	**	seashore saltgrass
Herbs	*Ranunculus cymbalaria*	**	shore buttercup
	Chenopodium spp.	*	lamb's quarters / goosefoot

Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Notes: These are dynamic ecosystems and their location and vegetation composition can change over the years with changing water levels. Foxtail barley tends to increase on drier sites.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
AS	**Trembling aspen – Snowberry – Kentucky bluegrass**	**IDFxh1**	**98**

Typic unit occurs on gentle slopes with deep, medium-textured soils (assumed modifiers are d, j, and m)

This forest ecosystem commonly occurs in large, broad depressions in grassland areas. These sites collect moisture from surrounding grassland areas. They have an overstory of trembling aspen and a shrubby understory dominated by snowberry and roses.

List of mapped units:

ASk	cool aspect; slope >25%	ASw	warm aspect; slope >25%
ASx	drier than typical	ASy	moister than typical

SITE INFORMATION

Common Terrain Types:

- morainal blankets, colluvial slopewash and sometimes glaciofluvial blankets

Slope position:	lower, toe, depression, mid
Slope (%):	0 – 10 (20)
Aspect:	none
Soil Moisture Regime:	subhygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
AS	Trembling aspen – Snowberry – Kentucky bluegrass	IDFxh1	98

	Structural Stage	3	4	5	6	7	
Trees	*Populus tremuloides*	*	***	***	***	***	trembling aspen
Shrubs	*Amelanchier alnifolia*	***	*	*	*	*	saskatoon
	Acer glabrum	**	**	**	**	**	Douglas maple
	Mahonia aquifolium	*	*	*	*	*	tall Oregon-grape
	Prunus virginiana	*	*	*	*	*	choke cherry
	Symphoricarpos albus	*****	****	*****	*****	*****	common snowberry
	Rosa spp.	**	**	**	**	**	roses
Grasses	*Poa pratensis*	**	*	**	**	**	Kentucky bluegrass
Herbs	*Osmorhiza berteroi*	*	*	*	**	**	mountain sweet-cicely
	Thalictrum occidentalis	**	*	*	*	*	western meadowrue
Mosses	*Brachythecium* sp.		*	*	*	*	ragged moss
PLOTS					LCG018 LCV081		

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites
Wetter sites may have water birch, drier sites have more Oregon-grape and little or no Douglas maple.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
BM	**Bulrush Marsh**	**IDFxh1**	**00**

Typic unit occurs on level sites with deep, fine-textured soils (assumed modifiers are d, f, and j).

This unit is equivalent to the *Great bulrush marsh* association in the provincial classification (MacKenzie and Shaw 2000).

This marsh wetland ecosystem commonly occurs on small ponds adjacent to shallow open water as a fringe along the shoreline. This unit is uncommon in the study area. It typcially occurs as a complex with shallow open water (OW). Water depths are up to 1.5 m but water levels draw down significantly in the summer. These sites are most commonly dominated by hard-stemmed bulrush, with some floating aquatic plants (duckweed, bladderwort and water smartweed). Vegetation species diversity is typically low on these sites. Soils are typically mineral, sometimes with a thin organic veneer.

SITE INFORMATION

Common Terrain Types:

- lacustrine veneer over morainal blanket

Slope position:	depression
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	subhydric - hydric
Soil Nutrient Regime:	rich

	Structural Stage	2b	
Rushes	*Schoenoplectus acutus*	***	hard-stemmed bulrush
Herbs	*Lemna minor*	**	common duckweed
	Utricularia macrorhiza	*	greater bladderwort

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
BN	**Kentucky bluegrass – Stiff needlegrass**	**IDFxh1**	**96**

Typic unit occurs on gentle slopes with deep, medium-textured soils (assumed modifiers are d, j, and m)

This ecosystem commonly occurs in moisture-collecting swales and depressions in grasslands and grassland openings. These sites are generally quite small and are dominated by grasses with scattered forbs. All sites observed were disturbed and dominated by Kentucky bluegrass. This ecosystem is likely dominated by needlegrasses at climax but the presence of Kentucky bluegrass may prevent these ecosystems from returning to a climax state.

SITE INFORMATION

Common Terrain Types:

- thick morainal blankets

Slope position:	toe, depression
Slope (%):	0 – 15
Aspect:	none
Soil Moisture Regime:	subhygric
Soil Nutrient Regime:	medium – rich

	Stuctural Stage	2b	
Grasses	*Poa pratensis*	****	Kentucky bluegrass
	Elymus repens	**	quackgrass
Herbs	*Taraxacum officinale*	**	dandelion

Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Comments: no late seral or climax sites were observed so it is not known what climax vegetation is but may be dominated by Columbia needlegrass and forbs.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
BR	**Baltic Rush Marsh-Meadow**	**IDFxh1**	**00**

Typic unit occurs on level sites with deep, fine-textured soils (assumed modifiers are d, f, and j).

This unit is equivalent to the *Baltic rush – Field sedge marsh* association in the provincial classification (MacKenzie and Shaw 2000).

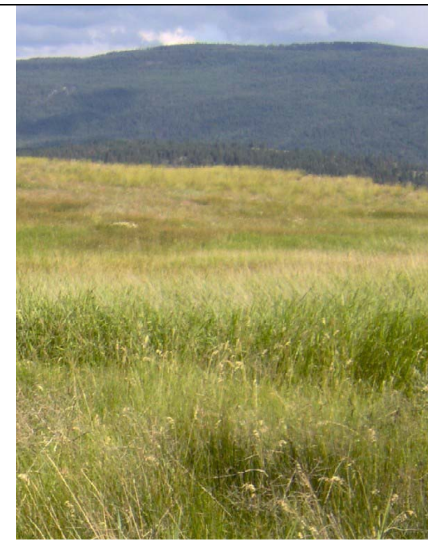
This marsh-meadow wetland ecosystem occurs in areas where water draws down below the soil surface most summers (seasonal flooding). This unit is rare in the study area. These sites are dominated by baltic rush. Field sedge may also occur in slightly drier situations. Soils are typically mineral.

SITE INFORMATION

Common Terrain Types:

- lacustrine veneer over thick morainal or glaciofluvial materials

Slope position:	toe, depression, (lower)
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	hygric
Soil Nutrient Regime:	rich



	Structural Stage	2b	
Rushes	*Juncus balticus*	***	baltic rush
Grasses	*Poa pratensis*	**	Kentucky bluegrass
	Elymus repens	***	quackgrass
PLOTS		LCV127	

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Comments: We only observed disturbed sites.
It is unknown if these sites will recover climax vegetation (baltic rush, common silverweed, and field sedge).

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CB	**Cutbank**	**IDFxh1**	**N/A**
Part of a road corridor which is created by excavation or erosion of the hillside.			

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CD	**Black cottonwood/Douglas-fir –Common Snowberry – Red-osier Dogwood**	**IDFxh1**	**00**

Typic unit occurs on level or very gently sloping sites with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is rare but was found along larger creeks including Vernon Creek and along the edge of Okanagan Lake and Kalamalka Lake. Forests are often mixed black cottonwood with Douglas-fir, and paper birch. The understory is typically rich and shrubby, often dominated by Nootka rose, mock orange, snowberry and red-osier dogwood. Forbs are uncommon and scattered.

List of mapped units:

Cda active floodplain

SITE INFORMATION

Common Terrain Types:

- glaciofluvial and colluvial slopewash

Slope position:	lower and toe
Slope (%):	0-15
Aspect:	none
Soil Moisture Regime:	subhygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CD	Black cottonwood/Douglas-fir –Common Snowberry – Red-osier Dogwood	IDFxh1	00

	Structural Stage	3	4	5	6	7	
Trees	*Populus balsamifera* ssp. *trichocarpa*	**	***	***	***	***	black cottonwood
	Betula papyrifera		**	**	**	**	paper birch
	Pseudotsuga menziesii var. *glauca*			*	**	**	Douglas-fir
Shrubs	*Symphoricarpos albus*	*****	****	****	****	****	common snowberry
	Acer glabrum	***	**	***	***	***	mock orange
	Amelanchier alnifolia	**	**	**	**	**	saskatoon
	Rosa nutkana	***	*	**	**	***	Nootka rose
	Cornus stolonifera	***	**	**	**	**	red-osier dogwood
Grasses	*Elymus glaucus*	**	*	*	*	*	blue wildrye
	Poa pratensis	**	*	*	*	*	Kentucky bluegrass
Herbs	*Equisetum arvense*	**	*	*	*	**	common horsetail
Mosses	*Brachythecium* sp.				*	*	ragged moss
PLOTS					LCG019 LCG040		

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CF	**Cultivated Field**	**IDFxh1**	**N/A**

These are agricultural fields with tilled soils and planted crops or ground cover.
Mapped units: CFcn – coarse-textured soils, fan; CFk – cool aspect, slope >25%

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CL	**Cliff**	**IDFxh1**	**N/A**

These are steep, vertical or overhanging rock faces. Typically there are scattered plants such as saskatoon and cliff ferns occurring in rock fractures or soil pockets. The non-standard modifier 'b' was used to indicate big cliffs large enough to support populations of spotted bats.

List of mapped units:

CLz very steep warm aspect

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CO	**Cultivated Orchard**	**IDFxh1**	**N/A**

Agricultural areas for growing fruit trees.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CS	**Common Spikerush Marsh**	**IDFxh1**	**00**

Typic unit occurs on level sites with deep, fine textured soils (assumed modifiers are d, f, and j).

This unit is equivalent to the *Common spike-rush marsh* association in the provincial classification (MacKenzie and Shaw 2000).

These marsh wetland ecosystems occur in standing water as a fringe around ponds, shallow open water and other marshes. This unit is rare in the study area. The water table often drops to the soil surface in late summer. These sites usually have shallower water than Bulrush marshes or Cattail marshes. Soils are typically mineral, but may have a thin organic veneer on top.

SITE INFORMATION

Common Terrain Types:

- lacustrine

Slope position:	depression
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	subhydric - hydric
Soil Nutrient Regime:	rich – very rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CS	**Common Spikerush Marsh**	**IDFxh1**	**00**

	Structural Stage	2b	
Rushes	*Eleocharis palustris*	***	common spike-rush
Herbs	*Polygonum amphibium*	*	water smartweed
PLOTS		LCV102	

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Comments: Vegetation may have more foxtail barley, oak-leaved goosefoot, and golden dock in drier years.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CT	**Cattail Marsh**	**IDFxh1**	**00**

Typic unit occurs on level sites with deep, medium-textured soils (assumed modifiers are d, j, m).

This unit is equivalent to the *Cattail marsh* association in the provincial classification (MacKenzie and Shaw 2000).

This marsh wetland ecosystem occurs as a fringe on pond edges or in depressions, often adjacent to shallow open water (OW). This unit is rare in the study area. Water depths are typically up to 1 m in spring but draw down to the soil surface by late summer; soils remain saturated for most of the season. Some wetlands convert to cattail marshes when they are subject to nutrient loading. These sites are dominated by cattails with few other species. Soils are typically mineral, but may have a thin organic veneer on top.

SITE INFORMATION

Common Terrain Types:

- thin organic veneer over lacustrine materials

Slope position:	depression
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	subhydric
Soil Nutrient Regime:	rich

	Structural Stage	2a	
Herbs	*Typha latifolia*	****	common cattail
	Lemna minor	**	common duckweed
Mosses	*Bryum* sp.	**	thread moss

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CW	**Choke cherry – Bluebunch wheatgrass rocky bluff**	**IDFxh1**	**00**

Typic unit occurs on gentle slopes with very shallow soils (assumed modifiers are j and v)

This ecosystem commonly occurs on bedrock bluffs where the bedrock is quite fractured. This unit is uncommon in the study area. Exposed bedrock usually occupies 30-50% of the area. Shrubs are common, typically occurring in cracks in the rocks. Grasses, forbs, lichens and mosses occur in small soil pockets scattered in amongst the bedrock.

List of mapped units:

CWz very steep warm aspect; slope >100%

SITE INFORMATION

Common Terrain Types:

- rock and very thin colluvial and morainal veneers

Slope position:	crest, upper
Slope (%):	0 – 100+
Aspect:	all
Soil Moisture Regime:	very xeric – xeric
Soil Nutrient Regime:	very poor – poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CW	**Choke cherry – Bluebunch wheatgrass rocky bluff**	**IDFxh1**	**00**

	Structural Stage	3	
Shrubs	*Amelanchier alnifolia*	**	saskatoon
	Symphoricarpos albus	**	common snowberry
	Philadelphus lewisii	**	mock-orange
	Prunus virginiana	**	choke cherry
Grasses	*Pseudoroegneria spicata*	**	bluebunch wheatgrass
Herbs	*Woodsia scopulina*	*	mountain cliff fern
	Selaginella densa	*	compact selaginella
	Balsamorhiza sagittata	*	arrowleaf balsamroot
Mosses	*Tortula ruralis*	*	sidewalk moss
PLOTS		LCG033	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DP	**Douglas-fir/Ponderosa pine – Pinegrass**	**IDFxh1**	**01**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is commonly associated with mesic gently sloping sites. This is the most common forest unit in the study area. Forests are moderately closed with mixed Douglas-fir and ponderosa pine overstories, although historically they would have been quite open. The understory has abundant pinegrass with scattered snowberry, birch-leaved spirea, tall Oregon-grape, grasses, herbs and mosses. This unit is also common on cool aspects (DPk) where there is usually more of a moss layer. Mature (structural stage 6) and old (structural stage 7) forests are uncommon because most of the large trees historically present on these sites have been logged. Because of fire exclusion, most sites have become ingrown with higher densities of smaller stems. Grazing and ingrowth have together reduced the presence of bunchgrasses which were likely historically common.

List of mapped units:

DPc	coarse-textured soils (glaciofluvial)	DPck	coarse-textured soils (glaciofluvial), cool aspect, slope >25%
DPfs	fine-textured soils, shallow soils (generally 50-100cm)	DPgw	gully, warm aspect, slope >25%
DPk	cool apsect, slope <25%	DPks	cool aspect (usually NW to E), shallow soils (generally 50-100cm)
DPs	shallow soils (generally 50-100cm)	DPw	warm aspect (usually SE or NW), slope usually 25-35%

SITE INFORMATION

Common Terrain Types:

- deep morainal materials on gentle slopes
- moderate to steep cool aspect morainal and colluvial slopes (deep or variable thickness)

Slope position:	level, middle
Slope (%):	0-30; up to 70% on cool aspects
Aspect:	all
Soil Moisture Regime:	mesic – submesic
Soil Nutrient Regime:	medium (poor)

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DP	Douglas-fir/Ponderosa pine – Pinegrass	IDFxh1	01

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	****	****	***	***	Douglas-fir
	Pinus ponderosa	**	***	***	**	**	ponderosa pine
Shrubs	*Symphoricarpos albus*	****	*	**	**	**	common snowberry
	Spirea betulifolia	***	*	**	**	**	birch-leaved spirea
	Mahonia aquifolium	**	*	*	*	*	tall oregon-grape
Grasses	*Calamagrostis rubescens*	***		**	***	***	pinegrass
	Festuca idahoensis	**		*	*	*	Idaho fescue
	Festuca campestris			*	**	**	rough fescue
Herbs	*Arnica cordifolia*	**	*	*	*	**	heart-leaved arnica
	Achillea millefolium	**	*	*	*	*	yarrow
	Fragaria virginiana	***		*	*	*	wild strawberry
Mosses and Lichens	*Rhytidiadelphus triquetrus*			*	**	**	electrified cat's tail moss
	Brachythecium albicans	*	*	*	**	**	lawn moss
	Peltigera canina	*		*	*	**	dog pelt
	Dicranum sp.	*	*	*	*	*	heron's bill moss
PLOTS		LCG001 LCG008			LCV100	LCG025	

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DS	**Douglas-fir/Ponderosa pine – Snowberry – Spirea**	**IDFxh1**	**07**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is commonly associated with gently sloping sites that are receiving some moisture. This is an uncommon forested ecosystem in the study area. These forests typically have moderately closed Douglas-fir overstories with very shrubby understories dominated by snowberry with some Oregon-grape, Douglas maple, and saskatoon. Often there is scattered Kentucky bluegrass with some heart-leaved arnica and other scattered forbs. There is a minimal moss layer with scattered patches of ragged mosses. Because these sites are moist, they may have had a longer fire-return interval than adjacent mesic and drier forests. These sites also tend to recover more quickly after disturbance (such as logging) because they are moister and more productive.

Although these sites are productive and vegetation recovers relatively quickly following disturbances such as logging, the moist soils on these sites are sensitive to disturbance and are difficult to find places for septic fields. Alterations in subsurface water flow present considerable risks to soil stability.

List of mapped units:

DSg	gully	DSgk	gully, cool aspect, slope >25%
DSgs	gully, shallow soils (generally 50-100cm)	DSgw	gully, warm aspect, slope >25%
DSk	cool aspect	DSks	cool aspect, shallow soil (50-100cm), slope >25%
DSs	shallow soils (generally 50-100cm)	DSsw	shallow soils (generally 50-100cm), warm aspect, slope >25%
DSw	warm aspect (usually SE or NW, sites with some compensating moisture)	DSy	moister than average

SITE INFORMATION

Common Terrain Types:

- gentle morainal slopes

Slope position:	lower and toe
Slope (%):	0-15% (up to 80% on cool aspects)
Aspect:	none, cool
Soil Moisture Regime:	subhygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DS	Douglas-fir/Ponderosa pine – Snowberry – Spirea	IDFxh1	07

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	*****	****	****	***	Douglas-fir
	Populus tremuloides	**	*	**	*		trembling aspen
Shrubs	*Symphoricarpos albus*	*****	***	****	****	****	common snowberry
	Acer glabrum	***	**	**	***	***	Douglas maple
	Mahonia aquifolium	**		*	**	**	tall oregon-grape
	Paxistima myrsinites	**	**	**	**	**	falsebox
	Spirea betulifolia	***	*	**	**	**	birch-leaved spirea
Grasses	*Calamagrostis rubescens*	**		*	*	**	pinegrass
	Elymus glaucus	**		*	*	**	blue wildrye
	Poa pratensis	**	*	*	*	*	Kentucky bluegrass
Herbs	*Osmorhiza berteroi*	***	*	**	**	**	mountain sweet-cicely
Mosses	*Brachythecium* sp.			*	**	**	ragged moss
PLOTS				LCG057	LCG017 LCG043 LCG054		

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites
Amount of trembling aspen varies from none to a significant part of the overstory (mixed); Douglas maple is often more abundant in mixed and deciduous overstories.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DW	**Douglas-fir/Ponderosa pine – Bluebunch wheatgrass - Pinegrass**	**IDFxh1**	**03**

Typic unit occurs on moderate to steep warm aspects with deep, medium textured soils (d, m and w are assumed modifiers).

This forest ecosystem is common on moderate to steep warm aspects (excluding southeast and west aspects which are usually /04 sites). This is an uncommon unit in the study area. It sometimes occurs on cooler aspects were soils are shallower and on ridges and crests where soils are not shallow enough to be the IDFxh1 /02 (PB). Mixed ponderosa pine – Douglas-fir forests are open and dominated by bunchgrasses, particularly bluebunch wheatgrass with scattered forbs (mostly balsamroot). Idaho fescue and sometimes rough fescue occur on sites that have not been heavily grazed. Mosses and lichens are scattered and uncommon. Ingrowth is commonly present, but drier conditions have helped keep most stands somewhat open.

List of mapped units:

DWc	coarse-textured soils (usually glaciofluvial)	DWck	coarse-textured soils, cool aspect (generally ESE or NW), slope >25%
DWcs	coarse textured soils (glaciofluvial), shallow soils (20-100cm deep)	DWj	gentle slope (generally 20-25% slope, warm aspect or slight ridge or crest)
DWjs	gentle slope (generally 20-25% slope, warm aspect or slight ridge or crest), shallow soils	DWjv	gentle slope (often a slight crest), very shallow soils <20cm deep, exposed bedrock present
DWks	cool aspect (generally NW or ESE), shallow soils (<20cm)	DWkv	cool aspect (generally NW or ESE), very shallow soils (<20cm); exposed bedrock present
DWqs	very steep cool aspect (slope >100%, aspect usually ESE or NW), shallow soils (20-100cm deep)	DWrs	ridge, shallow soils (20-100cm)
DWs	shallow soils (20-100cm)	DWv	very shallow soils (<20cm)

SITE INFORMATION

Common Terrain Types:

- steep warm aspect thin to thick colluvial and morainal slopes
- glaciofluvial and occasionally on glaciolacustrine slopes

Slope position:	middle and upper
Slope (%):	(30) 35 – 60%
Aspect:	south, southwest, west (also cool aspects on very shallow soils)
Soil Moisture Regime:	subxeric (submesic)
Soil Nutrient Regime:	poor – medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DW	**Douglas-fir/Ponderosa pine – Bluebunch wheatgrass - Pinegrass**	**IDFxh1**	**03**

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	***	***	***	***	Douglas-fir
	Pinus ponderosa	**	****	***	**	**	ponderosa pine
Shrubs	*Amelanchier alnifolia*	**	*	**	**	**	saskatoon
	Symphoricarpos albus	**	*	**	**	**	common snowberry
Grasses	*Pseudoroegneria spicata*	****	**	***	***	****	bluebunch wheatgrass
	Festuca campestris	**	*	**	**	**	rough fescue
	Koeleria macrantha	**	*	**	**	**	junegrass
	Bromus tectorum	*	*	*	*	*	cheatgrass
Herbs	*Balsamorhiza sagittata*	***	*	**	***	***	arrowleaf balsamroot
	Hieracium scouleri	*		*	*	*	Scouler's hawkweed
	Antennaria microphylla or *Antennaria parviflora* or *Antennaria umbrinella*	**	*	*	*	*	white pussytoes Nuttall's pussytoes umber pussytoes
Mosses and Lichens	*Cladonia* spp.	**	*	**	**	**	clad lichens
	Tortula ruralis	**	*	**	**	**	sidewalk moss
	Polytrichum piliferum	*		*	*	*	lawn moss
PLOTS				LCG021 LCG035 LCG059 LCV073 LCV115	LCG050 LCG064	9901759 9901764 LCG039	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
ES	**Exposed Soil**	**IDFxh1**	**N/A**

These are areas of exposed soils and typically include recent disturbances such as soil erosion.

List of mapped units:

ESk	cool aspect	ESw	warm aspect

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FO	**Douglas-fir / Ponderosa pine –Saskatoon – Mock orange**	**IDFxh1**	**00**

Typic unit occurs on steep slopes with deep, coarse-textured (rocky) soils (c, and d are assumed modifiers).

This forest ecosystem is commonly associated with steep colluvial sites with rocky soils. This is an uncommon unit in the study area. It occurs on both cool (FOk) and warm (FOw) aspects. The soil matrix is a mixture of both angular rocks and sandy, silty material. The overstory is generally open and dominated by Douglas-fir with scattered ponderosa pine. Understories are often quite shrubby with snowberry, saskatoon and mock orange. There is usually scattered bluebunch wheatgrass. Small rocks dominate a large portion of the soil surface.

List of mapped units:

FOj	gentle slope (20-25%)	FOk	cool aspect (>25%)
FOks	cool aspect (>25%), shallow soils (20-100cm deep)	FOsw	shallow soils (20-100cm deep), warm aspect (slope >25%)
FOw	warm aspect (slope >25%)		

SITE INFORMATION

Common Terrain Types:

- moderate and steep rocky colluvial slopes

Slope position:	lower to upper
Slope (%):	60-75%
Aspect:	all
Soil Moisture Regime:	submesic – subxeric
Soil Nutrient Regime:	medium, poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FO	**Douglas-fir / Ponderosa pine –Saskatoon – Mock orange**	**IDFxh1**	**00**

	Structural Stage	**3**	**4**	**5**	**6**	**7**	
Trees	*Pseudotsuga menziesii* var. *glauca*	*	***	***	***	***	Douglas-fir
Shrubs	*Symphoricarpos albus*	*****	***	***	****	****	common snowberry
	Spirea betulifolia	***	*	*	**	**	birch-leaved spirea
	Philadelphus lewisii	**		*	**	**	mock-orange
	Prunus virginiana	***		*	**	**	choke cherry
	Amelanchier alnifolia	****	**	**	***	***	saskatoon
Grasses	*Pseudoroegneria spicata*	***	**	**	***	***	bluebunch wheatgrass
	Calamagrostis rubescens	***	**	**	***	***	pinegrass
Herbs	*Lomatium dissectum*	*	*	*	*	*	fern-leaved desert parsley
Mosses	*Tortula ruralis*	*		*	*	*	sidewalk moss
PLOTS				LCV114	LCG061		

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FW	**Idaho fescue – Bluebunch wheatgrass**	**IDFxh1**	**91**

Typic unit occurs on gentle slopes with deep, medium-textured soils (assumed modifiers are d, j, m)

This grassland ecosystem occurs on gentle warm aspects, levels sites, and cool aspects. A mixture of Idaho fescue and bluebunch wheatgrass with balsamroot and other herbs dominates late seral sites, but late seral sites are uncommon in the study area and no climax sites were observed. Soils are typically dark brown or black chernozems. Most of these sites are highly disturbed and some have a significant component of weeds. These are described below.

FW:cn ***$Cheatgrass – Columbia needlegrass seral association***
This is an early seral association dominated by cheatgrass and other invasive annual bromes, weedy species, with scattered Columbia needlegrass and some native grassland forbs.

FW:fc ***$Idaho fescue – Cheatgrass seral association***
This is a mid- to late-seral asoociation dominated by Idaho fescue with significant cover of invasive annual bromes, especially cheatgrass, and a variety of native grassland forbs.

FW:kc ***$Knapweed – Cheatgrass seral association***
This is an early seral association dominated by knapweed, sulphur cinquefoil, and cheatgrass with few or no native bunchgrasses remaining on these sites.

FW:nc ***$Columbia needlegrass – Cheatgrass seral association***
This is an early seral association dominated by Columbia needlegrass with significant cover of invasive annual bromes, especially cheatgrass, and a variety of native grassland forbs.

FW:wk $***Bluebunch wheatgrass – Knapweed seral association***
This is a mid- to late-seral seral association. On these sites there is still a reasonable component of bluebunch wheatgrass with knapweed, sulphur cinquefoil, or cheatgrass.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FW	Idaho fescue – Bluebunch wheatgrass	IDFxh1	91

List of mapped units:

FWc	coarse-textured soils (generally glaciofluvial)	FWk	cool aspect (>25% slope)
FWks	cool aspect, shallow soils (20-100cm)	FWs	shallow soils (50-100cm)
FWw	warm aspect (generally SE or NW), slope >25%		

SITE INFORMATION

Common Terrain Types:

- morainal and glaciofluvial blankets, often with an aeolian veneer

Slope position:	lower to upper
Slope (%):	0-35% (up to 60% on cool aspects
Aspect:	all
Soil Moisture Regime:	mesic
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FW	**Idaho fescue – Bluebunch wheatgrass**	**IDFxh1**	**91**

	Structural Stage Seral Association	2b FW	2b FW:cn	2b FW:fc	2a FW:kc	2b FW:nc	2b FW:wk	
Shrubs	*Artemisia tridentata*							big sagebrush
Grasses	*Festuca idahoensis*	****		***				Idaho fescue
	Festuca campestris	**						rough fescue
	Pseudoroegneria spicata	***		*		*	***	bluebunch wheatgrass
	Koeleria macrantha	**		*		*		junegrass
	Achnatherum nelsonii		**	*	**	****	*	Columbian needlegrass
	Bromus tectorum or *Bromus japonicus*		****	***	****	***	***	cheatgrass or Japanese brome
Herbs	*Balsamorhiza sagittata*	***	*	**		**	**	arrowleaf balsamroot
	Lupinus sericeus	**	*	**	*	*	**	silky lupine
	Eriogonum heracleoides	**	**	**	*	*	*	parsnip-flowered buckwheat
	Lithospermum ruderale	*	*	*	*	*	*	lemonweed
	Calochortus macrocarpus	*						sagebrush mariposa lily
	Centaurea diffusa		*	*	***	**	**	diffuse knapweed
	Potentilla recta				***	*	*	sulphur cinquefoil
Mosses and Lichens	*Cladonia* spp.	**		*				clad lichens
	Tortula ruralis	**	*	*			*	sidewalk moss
	Peltigera rufescens or *Peltigera ponojensis*	**						felt pelt felt pelt
PLOTS		9901761 9901765 LCG042 LCG051		LCG056	LCV075 LCV098		LCG023 LCG055	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
GP	**Gravel Pit**	**IDFxh1**	**N/A**
These are areas of used for extraction of gravel and sand.			

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
LA	**Lake**	**IDFxh1**	**N/A**
These are areas of permanent open water that are greater than 2m deep and greater than 50ha.			

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
OW	**Shallow Open Water**	**IDFxh1**	**N/A**
These are areas of permanent open water that are less than 2m deep. There is less than 10% emergent vegetation but floating aquatics such as bladderwort are often present. Shallow open water commonly occurs in association with marsh ecosystems. **OWx** – drier than typical for a number of years – may only have water in spring and is dry by summer.			

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PB	**Douglas-fir/Ponderosa pine – Bluebunch wheatgrass – Balsamroot**	**IDFxh1**	**02**

Typic unit occurs on warm aspects with medium-textured shallow soils (m, s and w are assumed modifiers).

This forest ecosystem is commonly associated with shallow or very shallow soils and bedrock outcrops (PB, PBrv, PBv). This unit is uncommon in the study area. Forests are very open with scattered large trees, often growing in bedrock fractures. The understory is variable depending on soil depth with more vegetation occurring on deeper soil pockets. Scattered shrubs and bunchgrasses (usually bluebunch wheatgrass) dominate the understory. A lichen and moss crust may be present on soil pockets on undisturbed sites.

List of mapped units:

PBcd	coarse-textured soils (sandy glaciofluvial), deep soils, surface soils ravelling	PBjv	gentle slope (usually low crest), very shallow soils (<20cm), exposed bedrock present
PBkv	cool aspect (usually NW or ESE), slope >25%, very shallow soils (<20cm), exposed bedrock present	PBrv	ridge, very shallow soils (<20cm), exposed bedrock present
PBv	very shallow soils (<20cm), exposed bedrock present	PBvz	very shallow soils (<20cm), exposed bedrock present, very steep warm aspect (slope >100%)

SITE INFORMATION

Common Terrain Types:

- Thin and very thin colluvial, morainal, and weathered bedrock materials over bedrock
- Occasionally occurs on steep sandy glaciofluvial slopes

Slope position:	upper and crest
Slope (%):	0-70%
Aspect:	none, south, southwest
Soil Moisture Regime:	very xeric – subxeric
Soil Nutrient Regime:	poor (very poor, medium)

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PB	Douglas-fir/Ponderosa pine – Bluebunch wheatgrass – Balsamroot	IDFxh1	02

	Structural Stage	3	4	5	6	7	
Trees	*Pinus ponderosa*	**	****	***	***	***	ponderosa pine
	Pseudotsuga menziesii var. *glauca*	**	**	**	**	**	Douglas-fir
Shrubs	*Amelanchier alnifolia*	**	*	**	**	**	saskatoon
	Philadelphus lewisii	***	*	**	**	**	mock orange
	Mahonia aquifolium	*		*	*	*	tall oregon-grape
Grasses	*Pseudoroegneria spicata*	****	**	***	***	****	bluebunch wheatgrass
	Festuca campestris	**	*	**	**	**	rough fescue
	Bromus tectorum	*	*	*	*	*	cheatgrass
Herbs	*Balsamorhiza sagittata*	***	*	**	**	**	arrowleaf balsamroot
	Selaginella densa	*	*	*	*	*	compact selaginella
	Woodsia scopulina	*	*	*	*	*	mountain cliff fern
	Penstemon fruiticosa	*	*	*	*	*	shrubby penstemon
Mosses and Lichens	*Cladonia* spp.	**	**	**	**	**	clad lichens
	Tortula ruralis	**	**	**	**	**	sidewalk moss
	Polytrichum piliferum	**	**	**	**	***	awned haircap moss
PLOTS				LCG049	9901766 LCG034 LCV110		

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RF	**Prairie Rose – Idaho fescue**	**IDFxh1**	**97**

Typic unit occurs on gentle slopes with deep, medium-textured soils (assumed modifiers are d, j, and m)

This shrubland ecosystem commonly occurs in moisture collecting depressions, seepage slopes and swales in grassland areas. This unit sometimes occurs as patches on grassland slopes. These sites are dominated by shrubs, primarily snowberry and roses. Forbs and grasses are scattered in openings between shrubs. Soils are very rich black chernozems.

List of mapped units:

RFg	gully	RFk	cool aspect, slope >25%
RFs	shallow soils (usually 50-100cm)	RFsw	shallow soils (usually 50-100cm), warm aspect, slope >25%
RFw	warm aspect, slope >25%		

SITE INFORMATION

Common Terrain Types:
- morainal blankets

Slope position:	mid, toe, depression
Slope (%):	0-25
Aspect:	none, variable
Soil Moisture Regime:	subhygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RF	**Prairie Rose – Idaho fescue**	**IDFxh1**	**97**

	Structural stage	3a or 3b	
Shrubs	*Symphoricarpos albus*	*****	common snowberry
	Rosa woodsii	***	prairie rose
	Rosa nutkana	***	Nootka rose
Grasses	*Poa pratensis*	**	Kentucky bluegrass
	Achnatherum nelsonii	**	Columbian needlegrass
PLOTS		LCV077	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RN	**Railway Surface**	**IDFxh1**	**N/A**

A railway with fixed rails for single or multiple rail lines.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RO	**Rock Outcrop**	**IDFxh1**	**N/A**

These are areas of exposed bedrock with less than 10% vegetation cover. On sites with fractured bedrock, some plants may be growing out of rock cracks.

List of mapped units:

ROr	ridge	ROw	warm aspect

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RW	**Rural**	**IDFxh1**	**N/A**

Rural areas of human settlement with scattered houses intermingled with native vegetation or cultivated areas.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RZ	**Road Surface**	**IDFxh1**	**N/A**

A gravel or paved road used for vehicular travel.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SA	**Antelope Brush - Selaginella**[61]	**IDFxh1**	**00**

Typic unit occurs on gentle slopes with shallow soils (assumed modifiers are j, m and s).

However, in the study area, this unit more commonly occurs on steep slopes on rock outcrops with small ledges and pockets of soil. The bedrock is generally fractured. This is an uncommon unit in the study area. In contrast with areas in the South Okanagan, there is no antelope brush on these sites. Scattered ponderosa pine trees and saskatoon bushes occur in rock fractures. Soil pockets on ledges are dominated by bluebunch wheatgrass with balsamroot, selaginella, and a well-developed microbiotic crust on soil pockets.

List of mapped units:

SAkv	cool aspect, very shallow soils	SAqv	very steep cool aspect (>100% slope), very shallow soils
SArv	ridge, very shallow soils	SAvw	very shallow soils, warm aspect
SAvz	very shallow soils, very steep warm aspect (>100% slope)		

SITE INFORMATION

Common Terrain Types:

- rock, very thin morainal and colluvial veneers

Slope position:	crest, upper
Slope (%):	0 – 70
Aspect:	variable
Soil Moisture Regime:	very xeric – xeric
Soil Nutrient Regime:	very poor – poor

[61] Although the plant association name includes antelope brush, antelope brush does not occur in the study area.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SA	**Antelope Brush – Selaginella**	**IDFxh1**	**00**

	Structural Stage	2b	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*		*	**	**	**	**	Douglas-fir
	Pinus ponderosa		*	***	***	***	***	ponderosa pine
Shrubs	*Amelanchier alnifolia*	**	**	**	**	**	**	saskatoon
	Spirea betulifolia	*	*	*	*	*	*	birch-leaved spirea
Grasses	*Pseudoroegneria spicata*	***	***	***	***	***	***	bluebunch wheatgrass
	Festuca campestris	*	*	*	*	*	*	rough fescue
Herbs	*Selaginella densa*	**	**	**	**	**	**	compact selaginella
	Penstemon fruticosa	*	*	*	*	*	*	shrubby penstemon
	Woodsia scopulina	*	*	*	*	*	*	mountain cliff fern
Mosses	*Cladonia* spp.	**	**	**	**	**	**	clad lichens
Lichens	*Polytrichum piliferum*	**	**	**	**	**	**	awned haircap moss
PLOTS		LCV127	LCG044			LCG065		

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites
Comments: most sites do no progress through the structural stages. Some sites are more suitable for tree growth than others.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SB	**Selaginella – Bluebunch wheatgrass rock outcrop**	**IDFxh1**	**00**

Typic unit occurs on gentle slopes with very shallow soils (assumed modifiers are j and v)

This grassland ecosystem commonly occurs on bedrock outcrops. The bedrock is generally low relief and unfractured. This is an uncommon unit in the study area. Selaginella and rusty steppe moss with some grasses and forbs dominate these sites. This unit is commonly scattered as small sites in a grassland matrix.

SB:cg *Cheatgrass seral association*
This seral association is dominated by cheatgrass or sulphur cinquefoil with selaginella and rusty steppe moss.

List of mapped units:

SBk	cool aspect, slope >25%	SBr	ridge
SBw	warm aspect, slope >25%		

SITE INFORMATION

Common Terrain Types:

- rock, very thin morainal and colluvial veneers and weathered bedrock

Slope position:	crest, upper
Slope (%):	0 – 50
Aspect:	variable
Soil Moisture Regime:	xeric – very xeric
Soil Nutrient Regime:	poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SB	**Selaginella – Bluebunch wheatgrass rock outcrop**	**IDFxh1**	**00**

	Structural Stage Seral stage	2a SB	2a SB:$cg	
Shrubs	*Amelanchier alnifolia*	*	*	saskatoon
Grasses	*Pseudoroegneria spicata*	**	*	bluebunch wheatgrass
	Poa secunda	**	**	Sandberg's bluegrass
	Bromus japonicus or tectorum	*	***	Japanese brome or cheatgrass
Herbs	*Selaginella densa*	***	***	compact selaginella
	Eriogonum heracleoides	*	*	parsnip-flowered buckwheat
	Potentilla recta		**	sulphur cinquefoil
	Centaurea diffusa		**	diffuse knapweed
Mosses and Lichens	*Cladonia* spp.	**	*	clad lichens
	Tortula ruralis	***	**	sidewalk moss
	Polytrichum piliferum	***	*	awned haircap moss
PLOTS				

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SD	**Hybrid white spruce/Douglas-fir – Douglas maple – Dogwood**	**IDFxh1**	**08**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is commonly associated with gullies with intermittent or permanent streams or subsurface water flow. This is an uncommon unit in the study area. These are diverse, rich sites with mixed coniferous (Douglas-fir) and deciduous (paper birch and aspen) overstories. The understories are dominated by diverse mixture of shrubs. Forbs and mosses are scattered and uncommon on these sites. These moist sites likely had a longer fire return interval than adjacent upland areas.

Although these sites are productive and vegetation recovers relatively quickly following disturbances such as logging, the moist soils on these sites are sensitive to disturbance and septic fields would be difficult to locate on these sites. Alterations in subsurface water flow present considerable risks to soil stability.

List of mapped units:

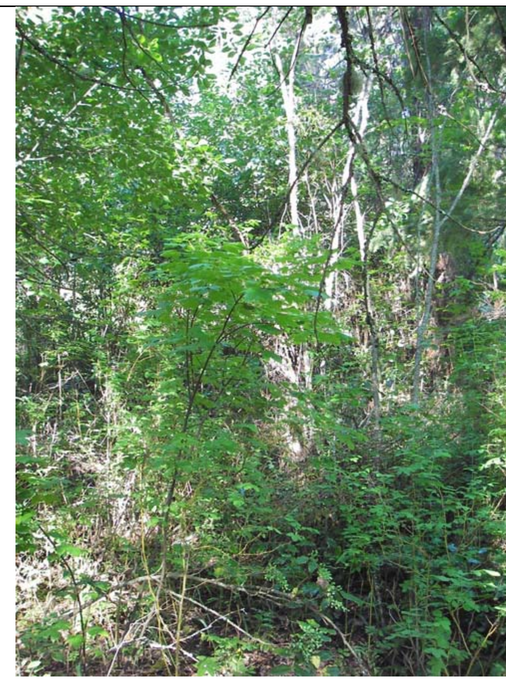
SDa	active flood-plain, usually a few cottonwood trees present	SDcg	coarse-textured soils, gully
SDg	gullies, usually associated with permanent or intermittent creeks	SDgw	occurs in gullies on warm aspects
SDt	occurs on fluvial terrace, often a few cottonwood trees present		

SITE INFORMATION

Common Terrain Types:

- gentle morainal, fluvial, and slopewash sites

Slope position:	lower, toe
Slope (%):	0-15%
Aspect:	none
Soil Moisture Regime:	hygric
Soil Nutrient Regime:	rich (medium)



Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SD	**Hybrid white spruce/Douglas-fir – Douglas maple – Dogwood**	**IDFxh1**	**08**

	Structural Stage	3	4	5	6	7	
Trees	*Betula paperifera*	****	***	***	***	**	paper birch
	Pseudotsuga menziesii var. *glauca*	*	****	***	***	***	Douglas-fir
	Populus tremuloides	**	**	***	***	*	trembling aspen
Shrubs	*Symphoricarpos albus*	****	***	***	****	***	common snowberry
	Acer glabrum var. *douglasii*	****	**	***	***	***	Douglas maple
	Rosa nutkana	**	**	**	**	**	Nootka rose
	Cornus stolonifera	**	*	**	**	**	red-osier dogwood
	Betula occidentalis	***	*	**	**	**	water birch
Grasses	*Elymus glaucus*	**	*	*	*	*	blue wildrye
Herbs	*Osmorhiza berteroi*	**	*	*	**	**	mountain sweet-cicely
	Galium triflorum	*	*	*	*	*	sweet-scented bedstraw
	Maianthemum stellata	*	*	*	*	*	star-flowered false Solomon's-seal
Mosses	*Brachythecium* sp.	*	*	*	*	*	ragged-moss
	Mnium spp.	*	*	*	*	*	leafy moss
PLOTS		LCG058		LCG022 LCG063	LCG020		

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SO	**Saskatoon – Mock orange Talus**	**IDFxh1**	**00**

Typic unit occurs on both warm and cool steep slopes with deep, coarse textured soils (blocky) (c and d are assumed modifiers).

This ecosystem is commonly associated with steep, blocky talus slopes with minimal soil in pockets between blocks. This is an uncommon unit in the study area. Scattered trees (Douglas-fir, ponderosa pine or aspen) and scattered shrubs (mock orange, snowberry, saskatoon) grow in soil pockets between blocks. Often cliff ferns (a very characteristic species) and scattered grasses are found growing in soil pockets. Vegetation cover is generally higher on sites with smaller blocks and more soil. Cool aspects more commonly have trees on them. Sites that are dominated by shrubs will not necessarily develop into a forested structural stage. Historically, these sites would not have had enough fuel to burn.

List of mapped units:

SOk	cool aspect	SOw	warm aspect

SITE INFORMATION

Common Terrain Types:

- rubbly colluvial slopes

Slope position:	lower to upper
Slope (%):	60 – 70%
Aspect:	all
Soil Moisture Regime:	subxeric – xeric
Soil Nutrient Regime:	poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SO	Saskatoon – Mock orange Talus	IDFxh1	00

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	*	**	**	**	***	Douglas-fir
	Pinus ponderosa	*	**	**	**	**	ponderosa pine
Shrubs	*Acer glabrum* var. *douglasii*	***	**	**	***	***	Douglas maple
	Philadelphus lewisii	**	**	**	**	**	mock-orange
	Amelanchier alnifolia	**	**	**	**	**	saskatoon
	Symphoricarpos albus	**	**	**	**	**	common snowberry
	Prunus virginiana	*	*	*	*	*	choke cherry
Herbs	*Woodsia scopulorum*	*	*	*	*	*	cliff fern
	Lomatium spp.	*	*	*	*	*	desert-parsely
PLOTS		LCG011 LCG045					

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SP	**Douglas-fir/Ponderosa pine – Snowbrush – Pinegrass**	**IDFxh1**	**04**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is associated with moderate to steep slopes on neutral aspects (SPk; northwest and east-southeast). This is a common unit in the study area. It is also found on gently sloping sites with shallow soils (SPs). Occasionally it is found on warm aspects, but generally these are moderately sloping (25-35%) or on 'barely' warm aspects (west-northwest, southeast). The overstory is moderately closed, although historically frequent surface fires would have kept these stands very open and bunchgrasses such as rough fescue were more abundant. Understories are usually a mixture of bunchgrasses (bluebunch wheatgrass and rough fescue) and other grasses with scattered shrubs, forbs and mosses.

List of mapped units:

SPc	coarse-textured soils (usually glaciofluvial)	SPck	coarse-textured soils, cool aspect (usually ESE or NW), slope >25%
SPk	cool aspect (usually ESE or NW), slope >25%	SPks	cool aspect (usually ESE or NW), shallow soils
SPs	shallow soils (20-100cm deep)	SPsw	shallow soils (20-100cm deep), warm aspect (usually WNW or SE), slope 25-35%
SPw	warm aspect (usually SE or WNW)		

SITE INFORMATION

Common Terrain Types:

- thin or thick colluvial and morainal slopes and ridges

Slope position:	middle and upper
Slope (%):	25 – 50%
Aspect:	east-southeast, west-northwest
Soil Moisture Regime:	submesic
Soil Nutrient Regime:	poor – medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SP	**Douglas-fir/Ponderosa pine – Snowbrush – Pinegrass**	**IDFxh1**	**04**

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	***	***	***	***	Douglas-fir
	Pinus ponderosa	*	**	**	**	**	ponderosa pine
Shrubs	*Spirea betulifolia*	***	**	**	**	**	birch-leaved spirea
	Symphoricarpos albus	***	**	**	**	**	common snowberry
	Amelanchier alnifolia	**	*	**	**	**	saskatoon
Grasses	*Calamagrostis rubescens*	**	*	**	*	*	pinegrass
	Pseudoroegneria spicata	***	*	**	**	**	bluebunch wheatgrass
	Festuca campestris	***	*	***	****	****	rough fescue
	Koeleria macrantha	**	*	**	**	**	junegrass
Herbs	*Balsamorhiza sagittata*	**	*	*	**	**	arrowleaf balsamroot
	Lupinus sericeus	**	*	**	**	**	silky lupine
Mosses Lichens	*Cladonia* spp.	**	*	*	*	*	clad lichens
	Tortula ruralis	**	*	**	**	**	sidewalk moss
	Dicranum sp.	*	*	*	*	*	heron's-bill moss
PLOTS			LCG060		LCG026	LCG037	

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
TA	**Talus**	**IDFxh1**	**N/A**

Steep colluvial deposits of angular rock fragments that result from rockfall. These sites have less than 10% vegetation cover.

List of mapped units:

TAw warm aspect, slope usually 60-70%

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
UR	**Urban/Suburban**	**IDFxh1**	**N/A**

Residential areas with concentrated houses and buildings that almost continuously cover the area. Urban areas are shown in the lower portion of the photo.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WB	**Bluebunch wheatgrass – Balsamroot**	**IDFxh1**	**93**

Typic unit occurs on warm aspects with deep, medium-textured soils (assumed modifiers are d, m, and w)

This grassland ecosystem commonly occurs on moderately steep to steep warm slopes. Often surface soils are actively ravelling on steeper slopes. Bluebunch wheatgrass and balsamroot dominate these sites. Bunchgrasses are more widely spaced than on gentler slopes. Disturbed sites are mapped as seral associations as described below.

WB:kc *$Knapweed - Cheatgrass seral association*
These are early and very early seral sites. Although there are native forbs, there are few or no native bunchgrasses remaining on these sites. Invasive weeds including knapweed, cheatgrass and sulphur cinquefoil dominate these sites.

WB:wk $***Bluebunch wheatgrass – Knapweed seral association***
This is a mid- to late-seral seral association. On these sites there is still a reasonable component of bluebunch wheatgrass with knapweed, sulphur cinquefoil, or cheatgrass.

List of mapped units:

WBc	coarse-textured soils (generally glaciofluvial or rocky colluvial)	WBck	coarse-textured soils (generally glaciofluvial or rocky colluvial), cool aspect (generally ESE or NW), slope usually 60-70%
WBk	cool aspect (generally ESE or NW), slope usually 60-70%	WBks	cool aspect (generally ESE or NW), slope usually 60-70%, shallow soils (20-100cm deep)
WBr	ridge	WBs	shallow soils (20-100cm)

SITE INFORMATION

Common Terrain Types:

- morainal and glaciofluvial blankets and veneers and colluvial veneers

Slope position:	middle, upper, crest
Slope (%):	25 – 65%
Aspect:	south, southwest, west
Soil Moisture Regime:	subxeric – submesic
Soil Nutrient Regime:	medium – poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WB	**Bluebunch wheatgrass – Balsamroot**	**IDFxh1**	**93**

	Structural Stage Seral Association	2b WB	2a WB:kc	2b WB:wk	
Shrubs	*Artemisia tridentata*				big sagebrush
Grasses	*Pseudoroegneria spicata*	***	*	**	bluebunch wheatgrass
	Koeleria macrantha	**		*	junegrass
	Bromus tectorum or *Bromus japonicus*	*	****	***	cheatgrass or Japanese brome
Herbs	*Artemisia frigida*	*		*	pasture sage
	Balsamorhiza sagittata	***	**	**	arrowleaf balsamroot
	Lupinus sericeus	**	*	**	silky lupine
	Eriogonum heracleoides	*	*	*	parsnip-flowered buckwheat
	Lithospermum ruderale	*	*	*	lemonweed
	Centaurea diffusa		****	**	diffuse knapweed
	Potentilla recta		***	**	sulphur cinquefoil
Mosses	*Cladonia* spp.	**		*	clad lichens
Lichens	*Tortula ruralis*	**		*	sidewalk moss
PLOTS		LCG007 LCG012 LCG024 LCG041 LCG062 LCG066 LCV113 LCV117	LCV076 LCV154	LCG036	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WS	**Willow – Sedge Wetland**	**IDFxh1**	**09**

Typic unit occurs in depressions with deep, medium-textured soils (assumed modifiers are d, j, and m)

This unit is a generalized wetland unit equivalent to several swamp associations in the provincial classification (MacKenzie and Shaw 2000).

This swamp wetland ecosystem occurs at the edges of ponds and wetlands, forming a shrubby fringe on mineral soils. This is a very rare unit in the study area. It is dominated by willows, usually with sedges where it occurs at the edge of a wetland. O

SITE INFORMATION

Common Terrain Types:

- lacustrine veneer over morainal or glaciofluvial blanket

Slope position:	level, depression
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	subhygric – hygric
Soil Nutrient Regime:	medium, rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WS	**Willow – Sedge Wetland**	**IDFxh1**	**09**

	Structural Stage	3	
Shrubs	*Salix planifolia*	*****	tea-leaved willow
	Cornus stolonifera	***	red-osier dogwood
	Ribes husonianum	**	northern blackcurrant
Sedges	*Carex* spp.	**	sedges

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Willow species likely vary from site to site.

LAKE COUNTRY EXPANDED LEGEND – MSdm1

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PG	**Lodgepole pine – Grouseberry – Cladonia**	**MSdm1**	**03**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem is common on warm slopes with shallow soils.

List of mapped units:

PGs	shallow soils (generally 20-50cm)	PGsw	shallow soils (20-100cm); warm aspect; slope >25%

SITE INFORMATION

Common Terrain Types:

- shallow colluvial and morainal

Slope position:	middle, upper
Slope (%):	20-70%
Aspect:	usually warm
Soil Moisture Regime:	2-3
Soil Nutrient Regime:	poor, medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PG	**Lodgepole pine – Grouseberry – Cladonia**	**MSdm1**	**03**

	Structural Stage	3	4	5	6	7	
Trees	*Pinus contorta*	**	*****	****	****	***	lodgepole pine
Herbs	*Arctostaphylos uva-ursi*	***	*	**	**	**	kinnikinnick
	Vaccinium scoparium	***	*	**	**	**	grouseberry
	Linnea borealis	*	**	**	**	**	twinflower
Lichens	*Cladonia* spp.	**	*	**	**	**	clad lichens

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

RO	**Rock Outcrop**	**MSdm1**	**N/A**

These are areas of exposed bedrock with less than 10% vegetation cover. On sites with fractured bedrock, some plants may be growing out of rock cracks.

List of mapped units:

ROk	cool aspect	ROw	warm aspect

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SF	**Hybrid white spruce – Falsebox – Feathermoss**	**MSdm1**	**01**

Typic unit occurs on gentle to moderate slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest ecosystem occurs on zonal and near zonal sites.

List of mapped units:

SFk	cool aspect; slope >25%	SFs	shallow soils (generally 50-100cm)
SFw	warm aspect (generally SE or NW); slope >25%		

SITE INFORMATION

Common Terrain Types:

-

Slope position:	
Slope (%):	
Aspect:	
Soil Moisture Regime:	
Soil Nutrient Regime:	

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SF	Hybrid white spruce – Falsebox – Feathermoss	MSdm1	01

	Structural Stage	3	4	5	6	7	
Trees	*Pinus contorta*	**	****	****	***	***	lodgepole pine
	Abies lasiocarpa			*	**	**	subalpine fir
	Picea engelmannii x glauca			*	**	**	hybrid white spruce
Shrubs	*Paxistima myrsinites*	***	*	**	**	**	falsebox
	Alnus viridis	****	*	**	**	**	Sitka alder
	Vaccinium membranaceum	***	*	**	**	**	black huckleberry
Grasses	*Calamagrostis rubescens*	***	*	**	**	**	pinegrass
Herbs	*Vaccinium scoparium*	***	*	**	**	**	grouseberry
	Epilobium angustifolium	****					fireweed
	Linnaea borealis	*	*	**	**	**	twinflower
	Cornus canadensis	***	**	**	**	**	bunchberry
Mosses	*Pleurozium schreberi*		*	**	***	***	red-stemmed feathermoss

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SG	**Hybrid white spruce – Gooseberry**	**MSdm1**	**06**

Typic unit occurs on gentle lower slope receiving sites with deep, medium textured soils (d, j and m are assumed modifiers).

List of mapped units:

SGgw gully, warm aspect, slope >25%

SITE INFORMATION

Common Terrain Types:

- morainal

Slope position:	lower, toe
Slope (%):	0 – 35%
Aspect:	none or warm
Soil Moisture Regime:	subhygric – hygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SG	Hybrid white spruce – Gooseberry	MSdm1	06

	Structural Stage	3	4	5	6	7	
Trees	*Abies lasiocarpa*			*	**	**	subalpine fir
	Picea engelmannii x glauca	**	***	***	***	***	hybrid white spruce
Shrubs	*Ribes lacustre*	***	*	**	**	**	black gooseberry
Herbs	*Vaccinium scoparium*	***	*	**	**	**	grouseberry
	Cornus canadensis	***	**	**	**	**	bunchberry
	Actaea rubra	**	*	*	*	*	baneberry
Mosses	*Pleurozium schreberi*		*	**	**	**	red-stemmed feathermoss

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SH	**Hybrid white spruce – Trapper's tea – Horsetail**	**MSdm1**	**07**

Typic unit occurs on level sites with high water tables and deep, medium textured soils (d, j and m are assumed modifiers).

List of mapped units:

SHg gully

SITE INFORMATION

Common Terrain Types:

- morainal

Slope position:	toe, level, depression
Slope (%):	0 – 10%
Aspect:	none
Soil Moisture Regime:	hygric - subhydric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SH	**Hybrid white spruce – Trapper's tea – Horsetail**	**MSdm1**	**07**

	Structural Stage	3	4	5	6	7	
Trees	*Pinus contorta*	**	****	****	***	***	lodgepole pine
	Abies lasiocarpa			*	**	**	subalpine fir
	Picea engelmannii x glauca	*	**	**	***	***	hybrid white spruce
Shrubs	*Alnus viridis*	****	*	**	**	**	Sitka alder
	Ledum glandulosum	**	**	**	**	**	trapper's tea
	Ribes lacustre	***	*	**	**	**	black gooseberry
Herbs	*Vaccinium scoparium*	*	*	**	**	**	grouseberry
	Equisetum arvense	****	**	***	***	***	common horsetail
	Carex spp.	**	*	**	**	**	sedges
Mosses	*Mnium spp.*	**	**	***	***	***	leafy mosses
	Aulacomnium paluste	**	**	**	**	**	glow moss

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

TA	Talus	MSdm1	N/A

Steep colluvial deposits of angular rock fragments that result from rockfall. These sites have less than 10% vegetation cover.

List of mapped units:

TAw warm aspect, slope >25%

LAKE COUNTRY EXPANDED LEGEND – PPxh1

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
AS	**Trembling aspen – Snowberry – Kentucky bluegrass**	**PPxh1**	**00**

Typic unit occurs on gentle slopes with deep, medium-textured soils (assumed modifiers are d, j, and m)

This ecosystem commonly occurs in large, broad depressions in grassland areas. These sites collect moisture from surrounding grassland areas. They have an overstory of trembling aspen and a shrubby understory dominated by snowberry and roses. This site unit was observed on the south-east side of the study area.

List of mapped units:

ASg	gully	ASk	cool aspect, slope >25%

SITE INFORMATION

Common Terrain Types:

- aeolian or slopewash veneer over morainal or glaciofluvial blankets

Slope position:	toe, depression
Slope (%):	0-15
Aspect:	none
Soil Moisture Regime:	subhygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
AS	**Trembling aspen – Snowberry – Kentucky bluegrass**	**PPxh1**	**00**

	Structural Stage	3	4	5	6	7	
Trees	*Populus tremuloides*	***	****	****	****	****	trembling aspen
Shrubs	*Symphoricarpos albus*	*****	****	****	****	****	common snowberry
	Rosa nutkana	***	**	**	**	**	Nootka rose
	Prunus virginiana	***	**	**	**	**	choke cherry
	Amelanchier alnifolia	**	*	*	*	*	saskatoon
	Mahonia aquifolium	**	*	*	*	*	tall Oregon-grape
Grasses	*Elymus glaucus*	*	*	*	*	*	blue wildrye
	Poa pratensis	*	*	*	*	*	Kentucky bluegrass
Herbs	*Cynoglossum officinale*	*	*	*	*	*	hound's tongue
	Arctium minus	*	*	*	*	*	burdock
	Maianthemum stellata	*	*	*	*	*	star-flowered false Solomon's-seal
Mosses	*Brachythecium* sp.	*	*	*	*	*	ragged moss

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CB	**Cutbank**	**PPxh1**	**N/A**

Edge of a road cut that is upslope or down slope of a road and was created by the excavation of a hillside.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CD	**Ponderosa pine / Black cottonwood – Snowberry Riparian**	**PPxh1**	**00**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest type is commonly associated with active floodplains and fluvial terraces with subsurface water. This unit is also found as a fringe along the Okanagan and Kalamalka Lake foreshore. Forests are often multi-layered with a mixture of black cottonwood, Douglas-fir, and Ponderosa pine. The understory is typically rich and shrubby, often dominated by snowberry and Douglas maple. Forbs (star-flowered false Solomon's seal), grasses (blue wildrye) and ragged mosses are uncommon and scattered.

List of mapped units:

CDa	active floodplain	CDt	fluvial terrace

SITE INFORMATION

Common Terrain Types:

- gentle and level fluvial sites and active floodplains
- lacustrine lake shores

Slope position:	level, lower and toe
Slope (%):	0-15%
Aspect:	none
Soil Moisture Regime:	subhygric – hygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CD	Ponderosa pine / Black cottonwood – Snowberry Riparian	PPxh1	00

	Structural Stage	3	4	5	6	7	
Trees	*Populus balsamifera* ssp. *trichocarpa*	**	****	***	***	***	black cottonwood
	Betula papyrifera	*	**	**	**	**	paper birch
	Pinus ponderosa			*	**	**	ponderosa pine
	Pseudotsuga menziesii var. *glauca*			*	*	*	Douglas-fir
Shrubs	*Symphoricarpos albus*	*****	****	****	****	****	common snowberry
	Acer glabrum var. *douglasii*	****	***	***	***	***	Douglas maple
	Amelanchier alnifolia	***	**	**	**	**	saskatoon
	Mahonia aquifolium	***	**	**	**	**	tall oregon-grape
	Prunus virginiana	***	**	**	**	**	choke cherry
	Rosa nutkana	***	**	**	**	**	Nootka rose
	Cornus stolonifera	**	*	*	*	*	red-osier dogwood
Grasses	*Elymus glaucus*	**	*	*	*	*	blue wildrye
Mosses	*Brachythecium* sp.			*	*	*	ragged moss
PLOTS					LCV143		

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Comments: some sites along the Okanagan Lake foreshore have low tree cover. Some pond fringes have higher Douglas-fir cover and may have tea-leaved willow and water birch as well on these sites.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CF	**Cultivated Field**	**PPxh1**	**N/A**

These are agricultural fields with tilled soils and planted crops or ground cover.

List of mapped units:

CFw	warm aspect, slope >25%

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CL	**Cliff**	**PPxh1**	**N/A**

These are steep, vertical or overhanging rock faces. Typically there are scattered plants such as cliff ferns occurring in pockets.

List of mapped units:

CLq	very steep (>100%) cool aspect	CLz	very steep (>100%) warm aspect

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CO	**Cultivated Orchard**	**IDFxh1**	**N/A**

Agricultural areas for growing fruit trees.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CT	**Cattail Marsh**	**PPxh1**	**00**

Typic unit occurs on level sites with deep, medium-textured soils (assumed modifiers are d, j, m)

This unit is equivalent to the *Cattail marsh* association in the provincial classification (MacKenzie and Shaw 2000)

This ecosystem commonly occurs as a fringe on ponds or in depressions, often adjacent to open water. Water depths are typically up to 1 m in spring but draw down to the soil surface by late summer; soils remain saturated for most of the season. Some wetlands convert to cattail marshes when they are subject to nutrient loading. These sites are dominated by cattails with few other species.

The photo below shows a cattail marsh in the spring before the new cattail leaves have grown above dead leaves from previous years' growth.

SITE INFORMATION

Common Terrain Types:

- lacustrine veneer over morainal or glaciofluvial blanket

Slope position:	depression
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	hygric - subhydric
Soil Nutrient Regime:	rich – very rich

	Structural Stage	2a	
Herbs	*Typha latifolia*	****	common cattail
	Lemna minor	**	common duckweed
PLOTS			

* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CV	**Cultivated Vineyard**	**PPxh1**	**N/A**

Agricultural areas for growing grape vines.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CW	**Choke cherry – Bluebunch wheatgrass rocky bluff**	**PPxh1**	**00**

Typic unit occurs on gentle slopes with very shallow soils (assumed modifiers are j and v)

This ecosystem commonly occurs on bedrock bluffs where the bedrock is quite fractured. This unit is uncommon in the study area. Exposed bedrock usually occupies 30-50% of the area. Shrubs are common, typically occurring in cracks in the rocks. Grasses, forbs, lichens and mosses occur in small soil pockets scattered in amongst the bedrock.

List of mapped units:

CWw warm aspect; slope >25%

SITE INFORMATION

Common Terrain Types:

- rock and very thin colluvial and morainal veneers

Slope position:	crest, upper
Slope (%):	0 – 100+
Aspect:	all
Soil Moisture Regime:	very xeric – xeric
Soil Nutrient Regime:	very poor – poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
CW	Choke cherry – Bluebunch wheatgrass rocky bluff	PPxh1	00

	Structural Stage	3	
Shrubs	*Amelanchier alnifolia*	**	saskatoon
	Symphoricarpos albus	**	common snowberry
	Philadelphus lewisii	**	mock-orange
	Prunus virginiana	**	choke cherry
Grasses	*Pseudoroegneria spicata*	**	bluebunch wheatgrass
Herbs	*Woodsia scopulina*	*	mountain cliff fern
	Selaginella densa	*	compact selaginella
	Balsamorhiza sagittata	*	arrowleaf balsamroot
Mosses	*Tortula ruralis*	*	sidewalk moss

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DM	**Douglas-fir – Water birch - Douglas maple**	**PPxh1**	**08**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest type is commonly associated with gullies with intermittent or permanent streams or subsurface water flow. These are diverse, rich sites with mixed coniferous (Douglas-fir) and deciduous (paper birch and aspen) overstories. The understories are dominated by diverse mixture of shrubs. Forbs are diverse but not abundant and mosses are scattered on these sites. These moist sites likely had a longer fire return interval than adjacent upland areas.

Although these sites are productive and vegetation recovers relatively quickly following disturbances such as logging, the moist soils on these sites are sensitive to disturbance and are difficult to find places for septic fields. Alterations in subsurface water flow present a considerable risk.

List of mapped units:

DMf	fine-textured soils	DMg	gullies, usually associated with permanent or intermittent creeks
DMgx	gully, drier than typic	DMt	fluvial terraces
DMw	warm aspect, slope >25%		

SITE INFORMATION

Common Terrain Types:

- gentle fluvial and morainal sites

Slope position:	toe (depression)
Slope (%):	0-15%
Aspect:	none
Soil Moisture Regime:	hygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DM	Douglas-fir – Water birch - Douglas maple	PPxh1	08

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	*	**	**	**	**	Douglas-fir
	Populus tremuloides	**	***	***	***	*	trembling aspen
	Betula paperifera	****	***	***	***	**	paper birch
Shrubs	*Symphoricarpos albus*	***	***	***	***	***	common snowberry
	Acer glabrum var. *douglasii*	****	***	***	***	***	Douglas maple
	Cornus stolonifera	**	**	**	**	**	red-osier dogwood
	Mahonia aquifolium	**	**	**	**	**	tall oregon-grape
	Philadelphus lewisii	**	**	**	**	**	mock-orange
	Rosa nutkana	**	*	*	*	*	Nootka rose
	Betula occidentalis	**	*	*	*	*	water birch
Grasses	*Elymus glaucus*	**	*	*	*	*	blue wildrye
Herbs	*Osmorhiza berteroi*	*	*	*	*	*	mountain sweet-cicely
	Galium triflorum	*	*	*	*	*	sweet-scented bedstraw
	Maianthemum stellatum	*	*	*	*	*	star-flowered false Solomon's-seal
Mosses	*Brachythecium* sp.	*	*	*	*	*	ragged moss
	Mnium sp.	*	*	*	*	*	leafy moss
PLOTS				LCG046	LCV136		

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DS	**Douglas-fir / Ponderosa pine – Snowberry – Spirea**	**PPxh1**	**07**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest type is commonly associated with gently sloping sites that are receiving some moisture. It is also found on receiving sites where there is some sub-surface moisture. These forests are typically have moderately closed Douglas-fir overstories with very shrubby understories dominated by snowberry with some Oregon-grape, birch-leaved spirea, and saskatoon. Often there is scattered pinegrass or Kentucky bluegrass with some heart-leaved arnica and other scattered forbs. There is a minimal moss layer with patches of ragged mosses. Because these sites are moist, they likely had a longer fire-return interval than adjacent mesic and drier forests. These sites also tend to recover more quickly after disturbance (such as logging) because they are moister and more productive.

List of mapped units:

DSc	coarse-textured soils	DSf	fine textured soils (usually glaciolacustrine)
DSg	gullied (usually associated with intermittent streams)	DSgw	gully, warm aspect, slope >25%
DSk	cool aspect (slope >25%)	DSs	shallow soils (generally 50-100cm)

SITE INFORMATION

Common Terrain Types:

- gentle morainal and glaciofluvial slopes

Slope position:	lower, toe
Slope (%):	0-15% (and sometimes up to 60%)
Aspect:	none
Soil Moisture Regime:	subhygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
DS	**Douglas-fir / Ponderosa pine – Snowberry – Spirea**	**PPxh1**	**07**

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	**	***	****	***	Douglas-fir
	Populus tremuloides	**	***	***	**		trembling aspen
Shrubs	*Symphoricarpos albus*	****	***	***	***	***	common snowberry
	Amelanchier alnifolia	**	**	**	**	**	saskatoon
	Mahonia aquifolium	**	**	**	**	**	tall oregon-grape
	Spirea betulifolia	***	**	**	**	**	birch-leaved spirea
	Acer glabrum	**	*				Douglas maple
Grasses	*Elymus glaucus*	**	*	*	*	*	blue wildrye
Herbs	*Maianthemum racemosa*	*	*	*	*	*	false Solomon's-seal
	Maianthemum stellata	*	*	*	*	*	star-flowered false Solomon's-seal
	Osmorhiza berteroi	*	*	*	*	*	mountain sweet-cicely
	Prosartes trachycarpa	**	*	*	*	*	rough-fruited fairy bells
Mosses	*Rhytidiadelphus triquetrus*	*	**	**	**	**	electrified cat's-tail moss
	Brachythecium sp.	**	**	**	**	**	ragged moss

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites

Comments: Douglas maple is more common on slightly moister sites; mixed and deciduous sites usually have a more diverse shrub layer; star-flowered false Solomon's seal, mountain sweet-cicely, and western meadowrue are often present on these mixed/pure deciduous sites as well

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
ES	**Exposed Soil**	**PPxh1**	**N/A**

These are areas of exposed soils and typically include recent disturbances such as soil erosion.

List of mapped units:

ESw warm aspect

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FB	**Fescue – Bluebunch wheatgrass**	**PPxh1**	**00**

Typic unit occurs on gentle slopes with deep, medium-textured soils (assumed modifiers are d, j, m)

This ecosystem commonly occurs on gentle and level sites and cool aspects (when they are non-forested). A mixture of Idaho fescue and bluebunch wheatgrass with balsamroot and other herbs dominate late seral sites. Many sites have significant pocket gopher digging in them. Unfortunately, most of these sites are highly disturbed and have a significant component of weeds. Sites with more than 10% weeds are mapped as seral associations.

FB:cn *$Cheatgrass – Columbia needlegrass seral association*
This is an early seral association dominated by cheatgrass and other invasive annual bromes, weedy species, with scattered Columbia needlegrass and native grassland forbs.

FB:kc *$Knapweed – Cheatgrass seral association*
This is an early seral association dominated by knapweed, sulphur cinquefoil, and cheatgrass with few or no native bunchgrasses remaining on these sites.

FB:nc *$Columbia needlegrass – Cheatgrass seral association*
This is an early seral association dominated by Columbia needlegrass with significant cover of invasive annual bromes, especially cheatgrass, and native grassland forbs.

FB:wk $*Bluebunch wheatgrass – Knapweed seral association*
This is a mid- to late-seral seral association. On these sites there is still a reasonable component of bluebunch wheatgrass with knapweed, sulphur cinquefoil, or cheatgrass.

List of mapped units:

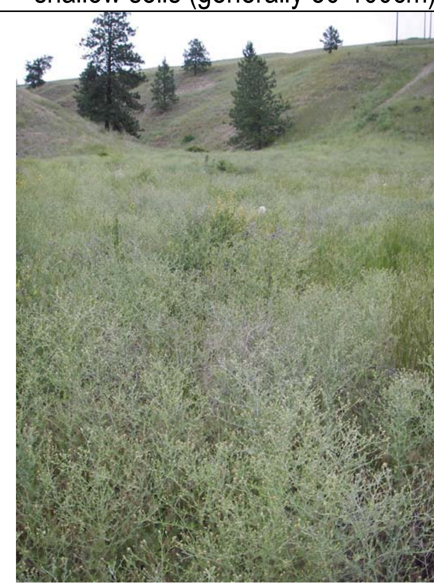
FBc	coarse-textured soils (glaciofluvial)	FBk	cool aspects, typically 25-35% slopes
FBks	cool aspects, shallow soils (generally 50-100cm)	FBs	shallow soils (generally 50-100cm)

SITE INFORMATION

Common Terrain Types:

- aeolian veneers overlying morainal or glaciofluvial blankets

Slope position:	Middle to upper
Slope (%):	0-35%
Aspect:	All
Soil Moisture Regime:	Submesic – mesic
Soil Nutrient Regime:	Medium – rich



Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FB	Rough fescue – Bluebunch wheatgrass	PPxh1	00

	Structural Stage Seral Association	2 FB	2 FB:cn	2 FB:kc	2 FB:nc	2 FB:wk	
Shrubs	*Artemisia tridentata*						big sagebrush
Grasses	*Festuca idahoensis*	****					Idaho fescue
	Festuca campestris	**					rough fescue
	Pseudoroegneria spicata	***			*	***	bluebunch wheatgrass
	Koeleria macrantha	**			*		junegrass
	Achnatherum nelsonii		**	**	****	*	Columbian needlegrass
	Bromus tectorum or *Bromus japonicus*		****	****	***	***	cheatgrass or Japanese brome
Herbs	*Balsamorhiza sagittata*	***	*		**	**	arrowleaf balsamroot
	Lupinus sericeus	**	*	*	*	**	silky lupine
	Eriogonum heracleoides	**	**	*	*	*	parsnip-flowered buckwheat
	Lithospermum ruderale	*	*	*	*	*	lemonweed
	Calochortus macrocarpus	*					sagebrush mariposa lily
	Centaurea diffusa		*	***	**	**	diffuse knapweed
	Potentilla recta			***	*	*	sulphur cinquefoil
Mosses and Lichens	*Cladonia* spp.	**					clad lichens
	Tortula ruralis	**	*			*	sidewalk moss
	Peltigera rufescens or *Peltigera ponojensis*	**					felt pelt felt pelt
PLOTS				LCV062		LCV063 LCV066	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FO	**Douglas-fir / Ponderosa pine –Saskatoon – Mock orange**	**PPxh1**	**00**

Typic unit occurs on steep slopes with deep, coarse-textured (rocky) soils (c, and d are assumed modifiers).

This forest ecosystem is commonly associated with steep colluvial sites with rocky soils. This is an uncommon unit in the study area. It occurs on both cool (FOk) and warm (FOw) aspects. The soil matrix is a mixture of both angular rocks and sandy, silty material. The overstory is generally open and dominated by Douglas-fir and ponderosa pine. Understories are often quite shrubby with snowberry, saskatoon and mock orange. There is usually scattered bluebunch wheatgrass. Small rocks dominate a large portion of the soil surface.

List of mapped units:

FOk cool aspect (>25%)

FOw warm aspect (slope >25%)

SITE INFORMATION

Common Terrain Types:

- moderate and steep rocky colluvial slopes

Slope position:	lower to upper
Slope (%):	60-75%
Aspect:	all
Soil Moisture Regime:	submesic – subxeric
Soil Nutrient Regime:	medium, poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
FO	Douglas-fir / Ponderosa pine –Saskatoon – Mock orange	PPxh1	00

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	*	***	***	***	***	Douglas-fir
	Pinus ponderosa	*	**	**	**	**	ponderosa pine
Shrubs	*Symphoricarpos albus*	*****	***	***	****	****	common snowberry
	Spirea betulifolia	***	*	*	**	**	birch-leaved spirea
	Philadelphus lewisii	**		*	**	**	mock-orange
	Prunus virginiana	***		*	**	**	choke cherry
	Amelanchier alnifolia	****	**	**	***	***	saskatoon
Grasses	*Pseudoroegneria spicata*	***	**	**	***	***	bluebunch wheatgrass
	Calamagrostis rubescens	***	**	**	***	***	pinegrass
Herbs	*Lomatium dissectum*	*	*	*	*	*	fern-leaved desert parsley
Mosses	*Tortula ruralis*	*		*	*	*	sidewalk moss

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
GC	**Golf Course**	**PPxh1**	**N/A**

Areas set aside for playing golf including grass-covered areas, and patches of trees or shrubs.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
GP	**Gravel Pit**	**PPxh1**	**N/A**

An area of exposed soil formed through the removal of sand and gravel

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
OW	**Shallow Open Water**	**PPxh1**	**N/A**

These are areas of permanent open water that are less than 2m deep. There is less than 10% emergent vegetation but floating aquatics such as bladderwort may be present.

OWx – drier than typical, may only have water in spring and is usually dry during summer.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PC	**Ponderosa pine – Bluebunch wheatgrass – Cheatgrass**	**PPxh1**	**04**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j, and m are assumed modifiers).

This forest type is most common on moderate to steep warm aspects. It sometimes occurs on cooler aspects where soils are shallow. Occasionally found on ridges and crests where soils are not shallow enough to be the PPxh1 /02 (PT). Forests are open and dominated by bunchgrasses, particularly bluebunch wheatgrass with scattered forbs. Mosses and lichens are scattered and uncommon.

List of mapped units:

PCc	coarse-textured soils	PCcr	coarse-textured soils, ridge or crest
PCcs	coarse-textured soils, shallow soils (20-100cm deep)	PCcw	coarse-textured soils, warm aspect (25-50% slopes)
PCks	cool aspect (35-60% slopes, typically southeast), shallow soils	PCr	ridge, crest
PCsw	shallow soils, warm aspect (25-50% slopes)	PCw	warm aspect (25-50% slopes)

SITE INFORMATION

Common Terrain Types:

- colluvial and morainal blankets and veneers
- moderate to steep glaciofluvial slopes

Slope position:	middle and upper
Slope (%):	(30) 40 – 60%
Aspect:	south, southwest, west (also southeast on glaciofluvial slopes and shallow soils)
Soil Moisture Regime:	subxeric – submesic
Soil Nutrient Regime:	medium - poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PC	**Ponderosa pine – Bluebunch wheatgrass - Cheatgrass**	**PPxh1**	**04**

	Structural Stage	**3**	**4**	**5**	**6**	**7**	
Trees	*Pinus ponderosa*	**	****	***	***	***	ponderosa pine
Shrubs	*Amelanchier alnifolia*	***	**	**	**	**	saskatoon
	Ceanothus velutinus	***					snowbrush
Grasses	*Pseudoroegneria spicata*	***	***	***	***	****	bluebunch wheatgrass
	Festuca campestris	*	*	**	**	**	rough fescue
Herbs	*Balsamorhiza sagittata*	**	**	**	**	**	arrowleaf balsamroot
	Antennaria spp.	**	*	*	*	*	pussytoes
	Achillea millefolium	**	*	*	*	*	yarrow
Mosses and Lichens	*Cladonia* spp.	**	**	**	**	**	clad lichens
	Tortula ruralis	**	**	**	**	**	sidewalk moss
	Brachythecium sp.	*	*	*	*	*	ragged moss
PLOTS		LCV121	LCV120		9901757		

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites
Snowbrush may only occur on sites that have been burned.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PF	**Ponderosa pine – Bluebunch wheatgrass – Rough fescue**	**PPxh1**	**05**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest type is commonly associated with moderate to steep slopes on cool aspects. It is also found on gently sloping sites with shallow soils. Occasionally it is found on warm aspects, but generally these are moderately sloping (25-35%) or on 'neutral' aspects (northwest, southeast). The overstory is moderately closed, although historically frequent surface fires would have kept these stands very open. Understories are usually a mixture of bluebunch wheatgrass, rough fescue, and pinegrass with scattered shrubs, forbs and mosses.

List of mapped units:

PFc	coarse-textured soils	PFck	coarse-textured soils, cool aspect (30-70% slopes)
PFfk	fine-textured soils (glaciolacustrine), cool aspect, slopes >25%	PFk	cool aspect (30-70% slopes)
PFks	cool aspect (30-70% slopes), shallow soils (50-100cm deep)		

SITE INFORMATION

Common Terrain Types:

- colluvial and morainal blankets and veneers
- moderate to steep glaciofluvial slopes

Slope position:	middle and upper
Slope (%):	30 – 75%
Aspect:	(northwest) north, northwest, east
Soil Moisture Regime:	mesic - submesic
Soil Nutrient Regime:	medium - poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PF	**Ponderosa pine – Bluebunch wheatgrass – Rough fescue**	**PPxh1**	**05**

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	**	***	***	***	***	Douglas-fir
	Pinus ponderosa	**	***	***	***	***	ponderosa pine
Shrubs	*Amelanchier alnifolia*	***	**	**	**	**	saskatoon
	Symphoricarpos albus	***	**	**	**	**	common snowberry
Grasses	*Festuca campestris*	**	**	***	***	***	rough fescue
	Pseudoroegneria spicata	**	*	**	**	**	bluebunch wheatgrass
	Koeleria macrantha	*	*	*	*	*	junegrass
Herbs	*Balsamorhiza sagittata*	**	*	**	**	**	arrowleaf balsamroot
	Achillea millefolium	**	*	*	*	*	yarrow
	Antennaria spp.	**	*	*	*	*	pussytoes
	Hieracium scouleri	*	*	*	*	*	Scouler's hawkweed
Mosses and Lichens	*Cladonia* spp.	**	*	*	**	**	clad lichens
	Tortula ruralis	*	*	*	**	**	rusty steppe moss
	Polytrichum juniperinum	*	*	*	*	*	juniper haircap moss

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PT	**Ponderosa pine – Red three-awn**	**PPxh1**	**02**

Typic unit occurs on warm aspects with deep, coarse-textured soils (c, d, and w are assumed modifiers).

This forest type most commonly occurs on moderate to steep warm aspects, with shallow or very shallow soils (PTs, PTv). It is also commonly found on moderate to steep slopes of all aspects and ridge crests where the soils are extremely shallow. Forests are very open with scattered large trees, often growing in bedrock fractures. The understory is variable depending on soil depth with more vegetation occurring on deeper soil pockets. Scattered shrubs and bunchgrasses (bluebunch wheatgrass and rough fescue) dominate the understory. A lichen and moss crust may be present on undisturbed sites. This ecosystem also occurs on steep glaciofluvial slopes with raveling, sandy surface soils (PT). Trees and other vegetation is usually widely spaced and scattered on these slopes.

List of mapped units:

PTjv	gentle slopes, very shallow soils, exposed bedrock present	PTkv	cool aspect, very shallow soils, exposed bedrock present
PTrv	ridge, very shallow soils, exposed bedrock present	PTs	shallow soils
PTv	very shallow soils, exposed bedrock present		

SITE INFORMATION

Common Terrain Types:

- Thin and very thin colluvial, morainal and glaciofluvial veneers over bedrock
- Steep glaciofluvial slopes

Slope position:	upper and crest (and middle slopes on steep glaciofluvial sites)
Slope (%):	0-70%
Aspect:	None (crest), south, southwest
Soil Moisture Regime:	Very xeric to subxeric
Soil Nutrient Regime:	poor (very poor, medium)

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PT	**Ponderosa pine – Red three-awn**	**PPxh1**	**02**

	Structural Stage	**3**	**4**	**5**	**6**	**7**	
Trees	*Pinus ponderosa*	**	***	***	***	***	ponderosa pine
	Pseudotsuga menziesii var. *glauca*			*	**	**	Douglas-fir
Shrubs	*Amelanchier alnifolia*	**	**	**	**	**	saskatoon
	Symphoricarpos albus	**	*	*	*	*	common snowberry
Grasses and Sedges	*Pseudoroegneria spicata*	***	***	***	***	***	bluebunch wheatgrass
	Bromus japonicus or tectorum	*	*	*	*	*	Japanese brome or cheatgrass
	Festuca campestris	*	*	*	*	*	rough fescue
Herbs	*Selaginella densa*	***	**	**	**	**	compact selaginella
	Balsamorhiza sagittata	**	**	**	**	**	arrowleaf balsamroot
	Penstemon fruiticosa	**	**	**	**	**	shrubby penstemon
Mosses Lichens	*Cladonia* spp.	**	**	**	**	**	clad lichens
	Tortula ruralis	**	**	**	**	**	sidewalk moss
PLOTS				LCV133			

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Comments: cover of Japanese brome or cheatgrass will usually increase with disturbance, spreading dogbane is often present on steep glaciofluvial sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PW	**Ponderosa pine – Bluebunch wheatgrass – Idaho fescue**	**PPxh1**	**01**

Typic unit occurs on gentle slopes with deep, medium-textured soils (d, j, and m are assumed modifiers).

This forest type is commonly associated with gently sloping glaciofluvial and morainal deposits. The overstory is generally open and dominated by ponderosa pine. Historically these sites would have been kept extremely open by frequent low-severity surface fires. Saskatoon, bluebunch wheatgrass, rough fescue and arrow-leaved balsamroot are most common in the understory. This ecosystem type been altered extensively by ingrowth of small trees into formerly open forests and loss to urban and agricultural development in the study area.

List of mapped units:

PWc	coarse-textured soils (typically glaciofluvial materials)	PWcw	coarse-textured soils, warm aspect (25-35% slopes, most often mid-lower slopes)
PWf	fine-textured soils (glaciolacustrine)	PWk	cool aspect, usually NW or ESE, slope 25-35%
PWks	cool aspect (25-35% slopes, usually mid-upper slopes), shallow soils (generally 50-100cm deep)	PWs	shallow soils (50-100cm deep)
PWw	warm aspect (usually WNW or SE, 25-35% slopes)		

SITE INFORMATION

Common Terrain Types:

- Gently sloping glaciofluvial and morainal slopes and terraces

Slope position:	Level, mid to upper
Slope (%):	0-15 (25)%
Aspect:	none
Soil Moisture Regime:	submesic – mesic
Soil Nutrient Regime:	poor – medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
PW	Ponderosa pine – Bluebunch wheatgrass – Idaho fescue	PPxh1	01

	Structural Stage	3	4	5	6	7	
Trees	*Pinus ponderosa*		**	***	**	**	ponderosa pine
Shrubs	*Amelanchier alnifolia*	**	**	*	*	*	saskatoon
	Rosa acicularis	**	*	*	*	*	prickly rose
	Ceanothus sanguineus or *velutinus*	***	**				redstem ceanothus or snowbrush
Grasses	*Festuca campestris*	***	**	***	***	***	Rough fescue
	Pseudoroegneria spicata	**	*	**	**	**	bluebunch wheatgrass
	Bromus tectorum	*	*	*	*	*	cheatgrass
Herbs	*Balsamorhiza sagittata*	***	**	**	**	**	arrow-leaved balsamroot
	Antennaria spp.	**	**	**	**	**	pussytoes
	Achillea millefolium	*	*	*	*	*	yarrow
	Hieracium scouleri	*	*	*	*	*	Scouler's hawkweed
Mosses	*Brachythecium* sp.	*	*	*	*	*	ragged moss
	Cladonia spp.	*		*	**	**	clad lichens
	Tortula ruralis	*	*	*	**	**	sidewalk moss
PLOTS				9901762 LCG015 LCG047			

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RO	**Rock Outcrop**	**PPxh1**	**N/A**

These are areas of exposed bedrock with less than 10% vegetation cover. On sites with fractured bedrock, some plants may be growing out of rock cracks. Generally rock outcrops on the east side of the study area had more fractures than those on the west side of the study area.

List of mapped units:

ROk	cool aspect	ROr	ridge

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RW	**Rural**	**PPxh1**	**N/A**

Rural areas of human settlement with scattered houses intermingled with native vegetation or cultivated areas.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
RZ	**Road Surface**	**PPxh1**	**N/A**

A gravel or paved road used for vehicular travel.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SA	**Antelope Brush - Selaginella[62]**	**PPxh1**	**00**

Typic unit occurs on gentle slopes with shallow soils (assumed modifiers are j, m and s).

However, in the study area, this unit more commonly occurs on steep slopes on rock outcrops with small ledges and pockets of soil. The bedrock is generally fractured. This is an uncommon unit in the study area. In contrast with areas in the South Okanagan, there is no antelope brush on these sites. Scattered ponderosa pine trees and saskatoon bushes occur in rock fractures. Soil pockets on ledges are dominated by bluebunch wheatgrass with balsamroot, selaginella, and a well-developed microbiotic crust.

List of mapped units:

SAkv	cool aspect, very shallow soils	SAqv	very steep cool aspect (>100% slope), very shallow soils
SArv	ridge, very shallow soils	SAv	very shallow soils
SAvw	very shallow soils, warm aspect	SAvz	very shallow soils, very steep warm aspect (>100% slope)

SITE INFORMATION

Common Terrain Types:

- rock, very thin morainal, weathered bedrock and colluvial veneers

Slope position:	crest, upper
Slope (%):	40 – 70
Aspect:	variable
Soil Moisture Regime:	very xeric – xeric
Soil Nutrient Regime:	very poor – poor

[62] Although the plant association name includes antelope brush, antelope brush does not occur in the study area.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SA	**Antelope Brush – Selaginella**	**PPxh1**	**00**

	Structural Stage	2b	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*		*	**	**	**	**	Douglas-fir
	Pinus ponderosa		*	***	***	***	***	ponderosa pine
Shrubs	*Amelanchier alnifolia*	**	**	**	**	**	**	saskatoon
	Spirea betulifolia	*	*	*	*	*	*	birch-leaved spirea
Grasses	*Pseudoroegneria spicata*	***	***	***	***	***	***	bluebunch wheatgrass
Herbs	*Selaginella densa*	**	**	**	**	**	**	compact selaginella
	Penstemon fruticosa	*	*	*	*	*	*	shrubby penstemon
	Woodsia scopulina	*	*	*	*	*	*	mountain cliff fern
Mosses	*Cladonia* spp.	**	**	**	**	**	**	clad lichens
Lichens	*Polytrichum piliferum*	**	**	**	**	**	**	awned haircap moss
PLOTS		LCG014						

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Comments: most sites do no progress through the structural stages. Rather some sites are more suitable for tree growth than others.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SB	**Selaginella – Bluebunch wheatgrass rock outcrop**	**PPxh1**	**00**

Typic unit occurs on gentle slopes with very shallow soils (assumed modifiers are j and v)

This ecosystem commonly occurs on bedrock outcrops with low relief, generally unfractured bedrock. Selaginella and rusty steppe moss with some grasses and forbs dominate these sites. Shrubs are sometimes present but are quite uncommon due to the lack of fractures in the bedrock.

SB:cg *Cheatgrass seral association*
This seral association is dominated by cheatgrass.

List of mapped units:

SBr	ridge	SBw	warm aspect (25-70% slope)

SITE INFORMATION

Common Terrain Types:

- Very thin morainal, glaciofluvial, weathered bedrock and colluvial veneers

Slope position:	crest
Slope (%):	0-20
Aspect:	all
Soil Moisture Regime:	very xeric
Soil Nutrient Regime:	poor, medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SB	Selaginella – Bluebunch wheatgrass rock outcrop	PPxh1	00

	Structural Stage Seral stage	2a SB	2a SB:cg	
Trees	*Pinus ponderosa*	*	*	ponderosa pine
Shrubs	*Amelanchier alnifolia*	*	*	saskatoon
Grasses	*Pseudoroegneria spicata*	**	*	bluebunch wheatgrass
	Bromus japonicus or tectorum	*	***	Japanese brome or cheatgrass
	Poa secunda	*	*	Sandberg's bluegrass
Herbs	*Selaginella densa*	***	***	compact selaginella
	Eriogonum heracleoides	**	*	parsnip-flowered buckwheat
	Achillea millefolium	*	*	yarrow
Mosses and Lichens	*Cladonia* spp.	**	*	clad lichens
	Tortula ruralis	**	*	sidewalk moss
	Peltigera rufescens or *Peltigera ponojensis*	*		felt pelt
PLOTS		LCG013 LCG053 LCV065		

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SO	**Saskatoon – Mock orange Talus**	**PPxh1**	**00**

Typic unit occurs on both warm and cool steep slopes with deep, coarse textured soils (blocky soils; c, and d are assumed modifiers).

This forest type is commonly associated with steep, blocky talus slopes with minimal soil in pockets between blocks. Scattered trees (Douglas-fir, ponderosa pine and/or aspen) and scattered shrubs (mock orange, snowberry, ocean spray) grow in soil pockets between blocks. Often cliff ferns (a very characteristic species) and scattered grasses are found growing in soil pockets. Vegetation cover is generally higher on sites with smaller blocks and more soil development, typically a mixture of both angular rocks and sandy, silty material. Cool aspects more commonly have trees on them. Sites that are dominated by shrubs will not necessarily succeed into a forested structural stage. Historically, these sites would not have enough fuel to burn. Thus they would be have been a seed source for some dry refugia species that are fire intolerant such as Rocky Mountain juniper.

List of mapped units:

SOk	cool aspect	SOw	warm aspect

SITE INFORMATION

Common Terrain Types:

- rubbly colluvium

Slope position:	Lower to upper
Slope (%):	60-75%
Aspect:	All
Soil Moisture Regime:	subxeric to very xeric
Soil Nutrient Regime:	poor to medium

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SO	**Saskatoon – Mock orange Talus**	**PPxh1**	**00**

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	*	**	**	**	**	Douglas-fir
	Pinus ponderosa	*	**	**	**	**	ponderosa pine
	Populus tremuloides		**	**	**	**	trembling aspen
Shrubs	*Philadelphus lewisii*	***	**	**	**	**	mock-orange
	Amelanchier alnifolia	**	**	**	**	**	saskatoon
	Acer glabrum var. *douglasii*	**	**	**	**	**	Douglas maple
	Symphoricarpos albus	**	**	**	**	**	common snowberry
	Prunus virginiana	**	*	**	**	**	choke cherry
Grasses	*Pseudoroegneria spicata*	*	*	*	*	*	bluebunch wheatgrass
Herbs	*Woodsia* sp.	*	*	*	*	*	cliff fern
PLOTS		LCV071					

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SP	**Douglas-fir / Ponderosa pine – Snowberry - Pinegrass**	**PPxh1**	**06**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

This forest type is commonly associated with gentle lower slopes and moderate to steep cool aspects that are receiving some subsurface moisture. Common on the lower slopes of gullies, adjacent to the wetter /08 (DM) unit mapped along the creeks and streams. Forests are moderately closed with mixed Douglas-fir and ponderosa pine overstories, although historically they would have been quite open, as fire would have been a frequent disturbance. The understory is dominated by snowberry and pinegrass. Mosses are prominent in the moss and lichen layer, especially on the cool aspects. Forbs are more abundant on the open sites that have been less subject to ingrowth (or have been thinned). This ecosystem also occurs on gentle glaciofluvial slopes or terraces where ponderosa pine is often more abundant than Douglas-fir but understories are very similar. Mature (structural stage 6) and old (structural stage 7) forests are uncommon because most of the large trees historically present on these sites have been logged. Because of fire exclusion, most sites have become ingrown with higher densities of smaller stems.

List of mapped units:

SPk	cool aspect	SPks	cool aspect, shallow soils (generally 50-100cm)
SPs	shallow soils	SPw	warm aspect (lower slopes, often south, southeast)

SITE INFORMATION

Common Terrain Types:

- gentle morainal and glaciofluvial slopes
- moderate to steep morainal and glaciofluvial slopes
- glaciofluvial terraces

Slope position:	lower or toe
Slope (%):	0-30%; up to 70% on cool aspects
Aspect:	All
Soil Moisture Regime:	Mesic – subhygric
Soil Nutrient Regime:	Medium – rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SP	**Douglas-fir / Ponderosa pine – Snowberry - Pinegrass**	**PPxh1**	**06**

	Structural Stage	3	4	5	6	7	
Trees	*Pseudotsuga menziesii* var. *glauca*	*	****	***	***	***	Douglas-fir
	Pinus ponderosa	*	**	**	**	**	ponderosa pine
Shrubs	*Symphoricarpos albus*	***	***	***	***	***	common snowberry
	Mahonia aquifolium	**	**	**	**	**	tall oregon-grape
	Spirea betulifolia	**	**	**	**	**	birch-leaved spirea
	Amelanchier alnifolia	**	*	*	*	*	saskatoon
	Ceanothus sanguineus or *velutinus*	****					redstem ceanothus or snowbrush
Grasses	*Calamagrostis rubescens*	***	***	****	****	****	pinegrass
	Festuca campestris	***	**	**	**	**	rough fescue
	Elymus glaucus	**	*	*	*	*	blue wildrye
Herbs	*Arnica cordifolia*	***	**	**	**	**	heart-leaved arnica
	Aster conspicuus	**	*	*	*	*	showy aster
Mosses	*Brachythecium* sp.	**	*	*	*	*	ragged moss
PLOTS				LCV074	LCV132		

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites
Comments: Fireweed seems to be common only after burning (as opposed to logging)

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SR	**Snowberry – Rose – Kentucky Bluegrass**	**PPxh1**	**00**

Typic unit occurs on gentle slopes with deep, medium textured soils (d, j and m are assumed modifiers).

Typically moist shrub dominated depressions in grassland mosaics (equivalent to the IDFxh1 RF /97 unit). Sites are dominated by snowberry and Nootka rose, with some Kentucky bluegrass in openings between the shrubs. These depressions are typically much smaller and shallower than those sites with trembling aspen.

List of mapped units:

SRw warm aspect

SITE INFORMATION

Common Terrain Types:

- gentle and level fluvial sites

Slope position:	level, lower and toe
Slope (%):	0-15%
Aspect:	none
Soil Moisture Regime:	subhygric
Soil Nutrient Regime:	rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
SR	**Snowberry – Rose - Kentucky bluegrass**	**PPxh1**	**00**

	Structural Stage	**3**	
Shrubs	*Symphoricarpos albus*	*****	common snowberry
	Amelanchier alnifolia	**	saskatoon
	Rosa nutkana or *gymnorcarpa* or *acicularis*	****	roses
Grasses	*Poa pratensis*	**	Kentucky bluegrass
PLOTS		LCV064	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
TA	**Talus**	**PPxh1**	**N/A**

Steep colluvial deposits of angular rock fragments that result from rockfall. These sites have less than 10% vegetation cover.

List of mapped units:

TAk	cool aspect	TAw	warm aspect

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
UR	**Urban/Suburban**	**PPxh1**	**N/A**

Residential areas with concentrated houses and buildings that almost continuously cover the area.

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WB	**Bluebunch wheatgrass – Balsamroot**	**PPxh1**	**00**

Typic unit occurs on warm aspects with deep, medium-textured soils (assumed modifiers are d, w, and m)

This ecosystem commonly occurs on moderately steep to steep warm slopes. Often surface soils are actively raveling. Bluebunch wheatgrass and balsamroot dominate these sites. Bunchgrasses are more widely spaced than on more gentle slopes. Many of these sites have been disturbed by grazing and have been invaded by weeds (see seral association descriptions below).

WB:kc *$Knapweed - Cheatgrass seral association*
These are early and very early seral sites. Although there are native forbs, there are few or no native bunchgrasses remaining on these sites. Invasive weeds including knapweed, cheatgrass and sulphur cinquefoil dominate these sites.

WB:wk $***Bluebunch wheatgrass – Knapweed seral association***
This is a mid- to late-seral seral association. On these sites there is still a reasonable component of bluebunch wheatgrass with knapweed, sulphur cinquefoil, or cheatgrass.

List of mapped units:

WBc	coarse-textured soils	WBcs	coarse-textured, shallow soils
WBk	cool aspect (usually NW or ESE)	WBrs	ridge, shallow soils
WBs	shallow soils		

SITE INFORMATION

Common Terrain Types:
- morainal and glaciofluvial blankets and veneers

Slope position:	middle, upper
Slope (%):	30-65%
Aspect:	south, southwest, west
Soil Moisture Regime:	subxeric
Soil Nutrient Regime:	medium – poor

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WB	Bluebunch wheatgrass – Balsamroot	PPxh1	00

	Structural Stage Seral Association	2 WB	2 WB:kc	2 WB:wk	
Grasses and Sedges	*Pseudoroegneria spicata*	****	*	**	bluebunch wheatgrass
	Bromus tectorum or *Bromus japonicus*	*	****	***	cheatgrass or Japanese brome
	Koeleria macrantha	*	*	*	junegrass
	Poa secunda	*	*	**	Sandberg's bluegrass
Herbs	*Balsamorhiza sagittata*	**	*	*	arrowleaf balsamroot
	Lupinus sericeus	**	*	**	silky lupine
	Artemisia frigida	*	*	*	pasture sage
	Eriogonum heracleoides	*	*	*	parsnip-flowered buckwheat
	Lithospermum ruderale	*	*	*	lemonweed
	Centaurea diffusa	*	***	**	diffuse knapweed
	Potentilla recta		***	**	sulphur cinquefoil
Mosses Lichens	*Cladonia* spp.	**			clad lichens
	Tortula ruralis	**		*	sidewalk moss
PLOTS		LCG010		LCG016	

Highlighted species – indicate important forage plants for ungulates
Species – non-native species
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WS	**Willow – Sedge Wetland**	**PPxh1**	**00**

Typic unit occurs in depressions with deep, medium-textured soils (assumed modifiers are d, j, and m)

This unit is a generalized wetland unit equivalent to several swamp associations in the provincial classification (MacKenzie and Shaw 2000).

This swamp wetland ecosystem occurs at the edges of ponds and wetlands, forming a shrubby fringe on mineral soils. This is a very rare unit in the study area. It is dominated by willows, usually with sedges where it occurs at the edge of a wetland.

SITE INFORMATION

Common Terrain Types:

- lacustrine veneer over morainal or glaciofluvial blanket

Slope position:	level, depression
Slope (%):	0
Aspect:	none
Soil Moisture Regime:	subhygric – hygric
Soil Nutrient Regime:	medium, rich

Site Unit Symbol	Site Unit Name	BGC	Site Series Number
WS	**Willow – Sedge Wetland**	**PPxh1**	**00**

	Structural Stage	3	
Shrubs	*Salix planifolia*	*****	tea-leaved willow
	Cornus stolonifera	***	red-osier dogwood
	Ribes husonianum	**	northern blackcurrant
Sedges	*Carex* spp.	**	sedges

Highlighted species – indicate important forage plants for ungulates
* incidental cover (less than 1% cover); used as indicator species
** 1-5% cover; occurs in 60% or more of sites
*** 6-25% cover; occurs in 60% or more of sites
**** 26-50% cover; occurs in 60% or more of sites
***** >50% cover; occurs in 60% or more of sites

Willow species likely vary from site to site.

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This project has adapted material from the reports for the Bella Vista – Goose Lake Range Sensitive Ecosystems Inventory[8] and Central Okanagan Sensitive Ecosystems Inventory[9].

We would like to thank the many landowners that gave us permission to access their lands for field sampling.

[1] The mission of the Real Estate Foundation is to support sustainable real estate and land use practices for the benefit of British Columbians.
[2] Iverson & MacKenzie Biological Consulting Ltd.
[3] District of Lake Country
[4] Polar Geoscience
[5] Ophiuchus Consulting
[6] Artemis Wildlife Consultants
[7] Baseline Geomatics Inc.
[8] Iverson 2003
[9] Iverson and Cadrin 2003

Abstract

The Okanagan Valley contains the northern-most extent of Great Basin shrub-steppe ecosystems. These are often bisected by species-rich riparian and wetland habitats, and flanked by open forests and rugged slopes. The ensemble of wildlife that depends on habitats in the valley is diverse, containing species from the boreal forests to the north and the deserts to the south. Many of the southern-associated species are considered at risk in British Columbia and in Canada, due to their rarity and declining populations in landscapes that are sought for human development. In the North Okanagan, grasslands and shrub-steppe ecosystems dominate the lower elevations, and form the northern extent of these ecosystems in the valley. Extensive land development is fragmenting and encroaching on important wildlife habitats, contributing to wildlife and habitat declines.

This report is **Volume 3** of a Sensitive Ecosystems Inventory (SEI) project, initiated by the District of Lake Country and Ministry of Environment. The report includes habitat summaries and species-habitat models for eleven wildlife species considered at risk in British Columbia. **Volume 1**[10] describes Sensitive Ecosystems, and offers practical advice on how to best avoid or minimize damage to them. **Volume 2**[11] provides details on the Terrestrial Ecosystem Mapping and terrain mapping.

The results of this habitat mapping indicate that abundant habitat exists for species that use open forest and grassland (e.g., Gopher Snake, Western Rattlesnake, Badger). Habitat for species preferring certain grassland conditions such as gently sloping, large contiguous areas (e.g., Grasshopper Sparrow) with low-profile vegetation (e.g., Long-billed Curlew) is scarcer. Limited wetland habitat is available for wildlife reliant on these habitats (e.g., Great Basin Spadefoot, Painted Turtle). Considering their natural rarity, a relatively large amount of healthy riparian habitat exists, including mature to old deciduous forest (e.g., Western Screech-owl habitat), and deciduous thickets with intact shrubby understory (e.g., Yellow-breasted Chat habitat). Overall, the mosaic of habitat types present in the study area leads to high habitat suitability for a wide range of wildlife species, and high biodiversity values.

Wildlife suitability models can be used to depict potential habitat values for individual species, or in conjunction with Sensitive Ecosystems Inventory to identify potential environmental values of areas for conservation purposes (i.e., natural parks), or to guide development proposals. Environmental assessments for development proposals, including on-site inventory, should be conducted to verify and revise the predictive suitability mapping. Revised environmental attributes, in a georeferenced format, can be returned to the planning staff at the District of Lake Country to revise in-house mapping. This would permit revisions to ecosystem and wildlife suitability mapping, updates of developed lands and areas retained as green space, and permit monitoring the efficacy of environmental planning and adaptive management.

Wildlife suitability models have also been incorporated into a Conservation Analysis that was developed to guide landscape-level planning.

[10] Iverson 2006
[11] Iverson and Uunila 2006

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1 Introduction

This report presents information on wildlife habitat mapping in the District of Lake Country which lies east of Okanagan Lake, including land north of Ellison Lake and surrounding Wood Lake and the south end of Kalamalka Lake. It is the third volume in the Sensitive Ecosystems Inventory reports for Lake Country.

Volume 1[12] describes the study area, inventory methods and results, rare and fragile ecosystems of Lake Country, highlights their values and importance, and offers practical advice on how to best avoid or minimize damage to them. **Volume 2**[13] provides details on the Terrestrial Ecosystem Mapping and terrain mapping.

1.1 What is Wildlife Habitat Mapping?

Habitat mapping portrays the potential importance of the land and its features to specific wildlife species through a species-habitat model. The model is used to generate a habitat map by assigning ratings to different habitat types, based on the needs of the species for particular life requisites. The ratings indicate the value of a habitat compared to the best habitat in the province[14]. Suitability is the ability of the habitat in its current condition to support a species. Capability is the ability of the habitat to support a species under optimal natural conditions, irrespective of the current condition of the habitat.

The following key elements and concepts summarize the Provincial standards for developing wildlife habitat ratings in British Columbia[14]:

1. There are three rating schemes; each reflects a different level of information available about the habitat requirements of a species (Table 1).
2. Ratings reflect a percentage of the provincial benchmark habitat. The provincial benchmark habitat has the highest suitability value for a given species in the province, against which all other habitats for that species must be rated. The benchmark is an actual location.
3. All ratings are a value for a specified season and activity, or life requisite.
4. A habitat rating is provided for each species for every occurring ecosystem unit (i.e., every site series / structural stage / site modifier combination).

Table 1 below shows the different habitat rating schemes.

[12] Iverson 2006
[13] Iverson and Uunila 2006
[14] Resources Inventory Committee 1999 (now Resources Information Standards Committee)

Table 1: Habitat rating schemes for different knowledge levels of habitat requirements.

<table>
<tr><th>Percent of Provincial Benchmark[15]</th><th colspan="2">6-class (Substantial Knowledge of Habitat Use)</th><th colspan="2">4-class (Intermediate Knowledge of Habitat Use)</th><th colspan="2">2-class (Limited Knowledge of Habitat Use)</th></tr>
<tr><td>76 - 100 %</td><td>High</td><td>1</td><td>High</td><td>H</td><td rowspan="4">Habitat Useable</td><td rowspan="4">U</td></tr>
<tr><td>51 - 75 %</td><td>Moderately High</td><td>2</td><td rowspan="2">Moderate</td><td rowspan="2">M</td></tr>
<tr><td>26 - 50 %</td><td>Moderate</td><td>3</td></tr>
<tr><td>6 - 25 %</td><td>Low</td><td>4</td><td rowspan="2">Low</td><td rowspan="2">L</td></tr>
<tr><td>1 - 5 %</td><td>Very Low</td><td>5</td><td rowspan="2">Likely No Value</td><td rowspan="2">X</td></tr>
<tr><td>0%</td><td>Nil</td><td>6</td><td>Nil</td><td>N</td></tr>
</table>

Habitat ratings are assigned to each ecosystem unit (e.g., habitat type) and then the values are projected onto the landscape where they are mapped. Habitat inventories assess the presence of available and potential habitat; they do not provide an indication of species presence or actual abundance. Much of the accuracy in predicting these habitat values is contingent on our understanding of how wildlife uses their habitats.

1.2 How does Wildlife Habitat Mapping interact with TEM and SEI?

Terrain and soil characteristics influence the vegetation of a site, within a given climate. Terrestrial Ecosystem Mapping (TEM) evaluates the specific ecological conditions (e.g. climate, terrain, vegetation community, and structural stage) for each polygon. All of these factors influence the wildlife assemblage and use within an area. TEM is used in a habitat model by assigning each ecosystem unit a wildlife habitat rating, indicating how useable (currently or potentially) the site is for a given wildlife species. These ratings are then applied to the TEM database and spatial data using GIS and portrayed as a habitat suitability or capability map of the study area.

In the field component of TEM, the terrain, vegetation, and wildlife aspects are assessed in the field and discussed with the other members of the field crew, contributing to a greater accuracy of interpreted habitat use for wildlife. Field sampling is used to extrapolate the occurrence of certain habitat features as well, such as snags and course woody debris, to the types of habitats they commonly occur in.

Sensitive Ecosystems Inventory (SEI) rates ecosystems based on their ecological rarity and sensitivity, but also considers critical habitat needs for select wildlife species. Often, sensitive ecosystems contain important habitats for many wildlife species.

1.3 How is Wildlife Habitat Mapping Used?

The Okanagan Valley is one of the most diverse wildlife areas in Canada, and contains many of the Province and Nation’s rare and endangered species. The area also has attracted considerable human settlement and associated land developments. Previous land use planning was limited in its ability to assess, identify, and conserve important wildlife habitats. This often led to the permanent loss of critical wildlife habitats, increasing the need to conserve those that remain. SEI and wildlife habitat mapping can

[15] The best habitat in the province. For example, High suitability (1 or H) is 76-100% as good as the best habitat in the province.

dramatically improve land use planning to ensure that critical habitats are not developed, or that appropriate mitigation activities are undertaken.

The effectiveness of wildlife habitat mapping is contingent on the information being portrayed in a manner that is easily interpreted by planners, developers, regulatory agencies, and the public. This can be a challenge considering the diverse array of wildlife species potentially present, and the variety of habitat types used. The values of ecosystems as habitat for wildlife have been considered in the SEI mapping, although 'Not Sensitive' ecosystems may still provide important habitat. Wildlife values for select species were given further consideration in the 'Conservation Analysis' provided in Volume 1[16], which should be consulted for landscape-level planning. For land-use planning at a finer scale (e.g., neighbourhood plans), each species model should be inspected to direct detailed inventories to avoid or mitigate impacts to crucial habitats.

Wildlife habitat mapping can also be used as a tool in wildlife management and recovery, a guide for wildlife viewing, and as a gauge of the loss of critical wildlife habitats.

1.4 Objectives

The objective of the wildlife habitat mapping is to provide input to land-use planning in the study area by providing estimated habitat values for wildlife species of management concern. The habitat mapping enables planners and managers to examine some of the wildlife values in order to guide development. Potential impacts can be identified and mitigation plans developed. ***Wildlife habitat mapping does not replace the need for development proponents to field-verify the presence or absence of wildlife species and the significance of identified habitats.***

2 Methods and Limitations

2.1 Project Wildlife Species

A vast number of rare or endangered wildlife potentially occur in the study area (Appendix B). Eleven of these wildlife species, all known to occur in the North Okanagan, were selected to demonstrate important wildlife habitats in the study area (Table 2). These species satisfy the following criteria[17] used to select wildlife species for habitat mapping:

- the level of knowledge of the species' use of habitat is adequate;
- the habitat required by selected species is also habitat required by other wildlife species;
- TEM is able to capture most of the habitat features required by the species;
- the species' habitat is present in the project area; and
- the species, or evidence of the species, is likely to be observed in the project area.

All of the selected species are considered at risk in the Province[18], and some of these species have also been designated through Federal listing[19]. Species designated Threatened or Endangered are protected under the federal Species at Risk Act.

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[16] Iverson 2006

[17] Resources Inventory Committee 1999 (now Resources Inventory Standards Committee)

[18] Conservation Data Centre (CDC) 2005: http://srmwww.gov.bc.ca/cdc/

Table 2: Wildlife species modelled in this project, their status, and rating scheme used.

Common Name	Scientific Name	Prov. Status[20]	COSEWIC Status[21]	Rating Scheme
Great Basin Spadefoot	*Spea intermontana*	Blue	Threatened	4-class
Painted Turtle	*Chrysemis picta*	Blue	-	4-class
Western Rattlesnake	*Crotalus oreganus*	Blue	Threatened	4-class
Gopher Snake	*Pituophis catenifer*	Blue	Threatened	4-class
Swainson's Hawk	*Buteo swainsoni*	Red	-	4-class
Long-billed Curlew	*Numenius americanus*	Blue	Special Concern	4-class
Western Screech-owl	*Megascops kennicottii macfarlanei*	Red	Endangered	4-class
Yellow-breasted Chat	*Icteria virens*	Red	Endangered	4-class
Grasshopper Sparrow	*Ammodramus savannarum*	Red	-	4-class
Spotted Bat	*Euderma maculatum*	Blue	Special Concern	4-class
Badger	*Taxidea taxus jeffersonii*	Red	Endangered	4-class

2.2 Species-Habitat Models

Wildlife habitat was modeled for the Lake Country TEM according to the standards in the *BC Wildlife Habitat Ratings Standards - Version 2.0*[22].

There are two basic components to a species-habitat model: the species account and the ratings table. The model is then applied to the ecosystem mapping to generate the spatial depiction of suitable habitat.

The species account summarizes the knowledge about a species and how it will be modeled. The account describes the distribution of the species in the province and in the project area, provides an overview of its ecology, and includes a detailed description of the critical life requisites and habitat uses of the species. The ratings section outlines the rating scheme (2, 4, or 6-class), the life requisites, and habitat uses that are modeled (map themes), and assumptions used to rate habitat characteristics. A section on map interpretation is also included, which describes how map themes were layered on the map, how the ratings were applied to the polygons, and provides information needed to correctly interpret each map.

Preliminary ratings tables, developed before field sampling, consist of an abbreviated table that provides habitat values for representative ecosystem units likely to occur in the project area. Our tables were modified to present assumptions used for rating ecosystems, which were incorporated into each species account. These assumptions, after being field-verified, guided development of the final ratings tables.

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[19] Committee on the Status of Wildlife in Canada (COSEWIC) 2005: http://www.cosewic.gc.ca/

[20] Red List: indigenous species or subspecies (taxa) considered *Extirpated*, *Endangered*, or *Threatened* in BC.
Blue List: indigenous taxa considered *Vulnerable* (Special Concern) in BC.

[21] Endangered = facing imminent extirpation in Canada or extinction.
Threatened = likely to become endangered in Canada if limiting factors are not reversed.
Special Concern = particularly sensitive to human activities or natural events.

[22] Resources Inventory Committee 1999 (now Resources Information Standards Committee)

2.3 Field Sampling

Field assessments occurred in conjunction with field sampling for ecosystem mapping. Survey intensity level 4 was used[23]. Fieldwork took place in June and July of 2005. During field sampling, habitat values were recorded on Wildlife Habitat Assessment (WHA) forms (FS 882HRE 98/5). An example of the form is presented in Appendix C. Data was entered into Venus 5.0 data capture software. Table 3 lists and briefly describes the life requisites and habitat-uses rated in the field.

Table 3: Life requisites and habitat-uses rated during fieldwork

Species	Life Requisite and Habitat Use	Rating Code
Great Basin Spadefoot	Security/thermal habitat for reproducing (breeding ponds). Security/thermal habitat and food for general living, all year (terrestrial sites).	RE LIA
Painted Turtle	Security/thermal habitat for reproducing (egg-laying sites). Security/thermal habitat and food for general living, all year (ponds).	RE LIA
Western Rattlesnake	Security/thermal habitat for general living all year (basking/denning sites). Food and security/thermal habitat for general living, summer.	LIA LIS
Gopher Snake	Food and security/thermal habitat for general living, growing season. Security/thermal habitat for reproducing (egg-laying sites).	LIG RE
Swainson's Hawk	Security habitat for reproducing. Food for general living, growing season.	RE LIG
Long-billed Curlew	Security habitat for reproducing. Food for general living, growing season.	RE LIG
Western Screech-owl	Security/thermal habitat for reproducing.	RE
Yellow-breasted Chat	Security/thermal habitat and food for general living, growing season.	LIG
Grasshopper Sparrow	Security/thermal habitat and food for general living, growing season.	LIG
Spotted Bat	Security/thermal habitat for reproducing and roosting	RB
Badger	Security/thermal habitat and food for general living, all year.	LIA

2.4 Wildlife Habitat Mapping

A final habitat ratings table was developed after field inspections were completed, and after a final list of ecosystem units was developed. Values were assigned using information from the species accounts, including assumptions, and from the wildlife report generated from field data in Venus 5.0.

We generated wildlife habitat maps by applying the ratings table values for each map theme (i.e., habitat use / life requisites for each species) to the TEM spatial and non-spatial data. An Ecosystem-based Resource Mapping (ERM) tool[24], developed by the former Ministry of Sustainable Resource Management, was used to apply the ratings tables to the TEM map in ArcView GIS software.

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[23] Resources Inventory Committee 1998 (now Resources Inventory Standards Committee)

[24] http://srmwww.gov.bc.ca/wildlife/whr/sta.html

Multiple map themes were displayed on the habitat-use map for some species, using a hierarchy of critical habitat requirements and life requisites. As habitat uses may overlap, we ensured that the most critical habitat uses overlaid less critical habitat uses. Each map was assigned a set of colours that identify the theme and values mapped.

Ratings were assigned to polygons with multiple ecosystem components (i.e., deciles) using one of the following four methods; based on which one best demonstrates the relative importance of that map theme:

- Highest-value – the highest rating within each polygon is displayed, regardless of the area it represents. The highest-value method exaggerates the amount of high value habitat because the whole polygon may be coloured high even if only a small part of it is actually high value.
- Averaged – the average rating within each polygon is displayed. Some parts of a polygon may be coloured as having some value, even if those parts have little or no habitat value. Similarly, some parts of a polygon may be rated as having low value, although the habitat in those parts has high value.
- Largest area – the rating for the ecosystem unit that covers the largest area of a polygon is displayed.
- Dot density – ratings for all of the ecosystems units are displayed, based on the percent area of the polygon they occupy. The dominant ecosystem unit provides the background colour, while dots of different colours or shades show the relative amount of other units occurring in the polygon.

2.5 Mapping Limitations

Limitations to Terrestrial Ecosystem Mapping are described in detail in Volume 1[25], including:

- Scale of the aerial photographs (1:15,000). It is recommended that digital data not be enlarged beyond the scale of the photos as this may result in unacceptable distortion and faulty registration with other data sets.
- Date of the aerial photographs (1994) and field sampling (2005). On-going land uses may have changed some polygons after the date that the aerial photographs were taken or the field sampling was conducted.
- Ability to see disturbances such as cover of invasive plants on aerial photographs. Information from field sampling was applied to adjacent areas.
- Complex landscape, resulting in many complex polygons. Small ecosystems are often captured as a small component of a larger polygon that may contain up to three ecosystems.

For wildlife modelling purposes, additional limitations include:

- High variability of some ecosystem units (e.g., slope, soil depth, and, in a few units, vegetation composition). A given ecosystem unit may be described as having 'moderate to steep slopes', and some wildlife will use moderate slopes but are less likely to use steep slopes. Soil depth can also be highly variable; a shallow-soiled unit may have large pockets of deep soil suitable for burrowing.
- Condition of the habitat (e.g., understory fragmentation, forest ingrowth, invasive plants) is not accounted for in TEM, except for seral association in grasslands. This information is available in SEI as a condition value, and, while not incorporated into wildlife models, it was included in the Conservation Analysis[26], where the sensitivity/rarity of the ecosystem, the condition of the ecosystem, and the wildlife values were all considered.

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[25] Iverson 2006
[26] Volume 1: Iverson 2006

3 Results

3.1 Species Accounts

Complete species accounts, including citations, are available as described in Appendix A. Each species account also includes the final habitat suitability map for the species. Brief summaries of some important habitat requirements for the project species are included in the Wildlife Habitat Maps section below.

3.2 Field Sampling

A total of 282 plots were visited and assessed during Terrestrial Ecosystem Mapping and Sensitive Ecosystem Inventory, with 9 full plots, 66 ground inspections, and 207 visual inspections completed in the field (Figure 1). Only cursory investigations, if any, for evidence of wildlife use was conducted in some of the visual plots.

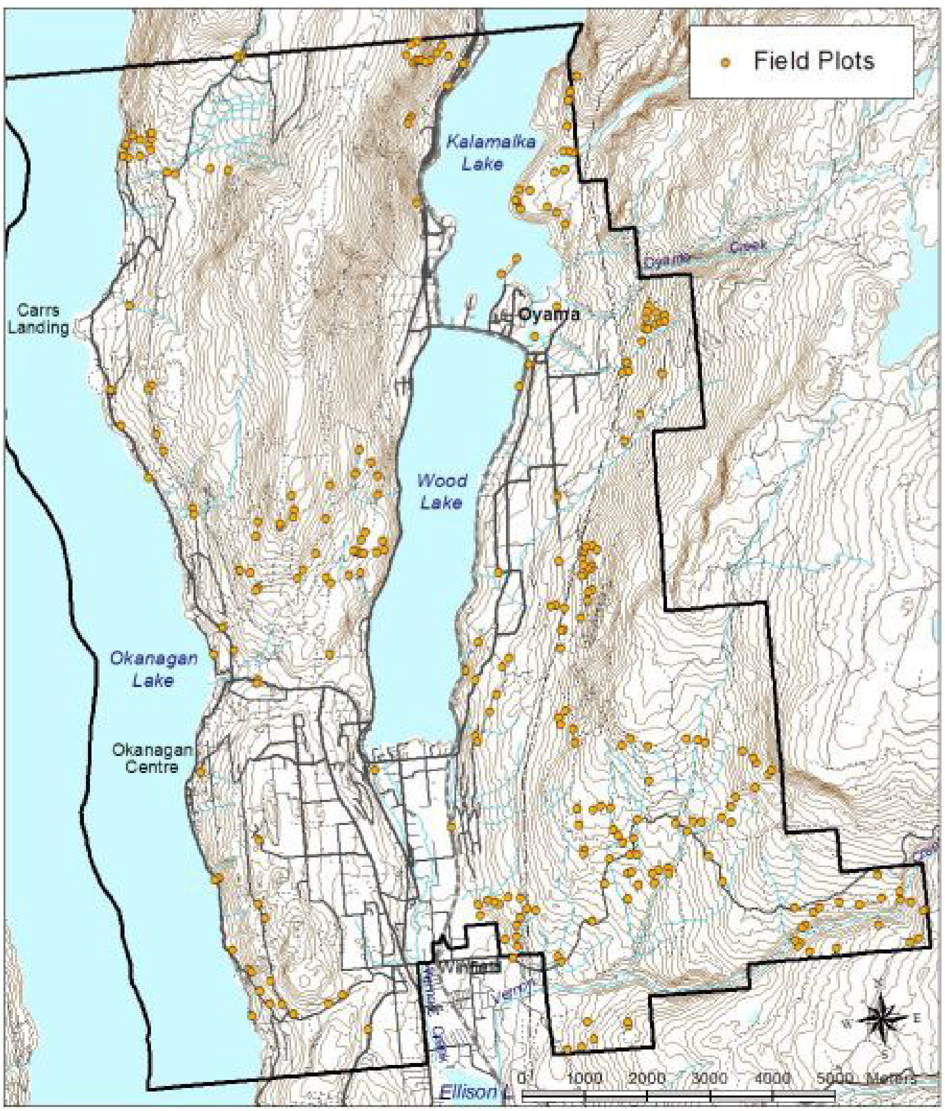

Figure 1: Location of plots assessed during ecosystem mapping fieldwork.

For many of the project wildlife species, we did not observe evidence of use during fieldwork. This is not surprising, as most of them are rare, elusive, or nocturnal, and fieldwork was intended as a habitat inventory rather than a wildlife survey.

Few, if any, wildlife inventories appear to have been conducted in this area. Previous observation records for the project species were amalgamated from all known sources[27], and are summarized in Table 4. Records obtained during fieldwork for this study are included in Table 4 as well. Details of these observations are provided by species in Section 3.4.

Table 4: Observations of project wildlife species or evidence of their use in the study area.

Species	Previous Observations in Study Area	Observations During SEI
Great Basin Spadefoot	None	Two breeding locations, southeast portion
Painted Turtle	None	None
Gopher Snake	None	Two roadkills
Western Rattlesnake	One location, near Winfield	One location, east Kalamalka
Swainson's Hawk	None	One location, north boundary
Western Screech-owl	One location, near Winfield	None
Long-billed Curlew	None	None
Grasshopper Sparrow	None	None
Yellow-breasted Chat	None	None
Spotted Bat	None	None
Badger	None	One location, near Winfield

Other red- or blue-listed species recorded from the study area include Racer and White-throated Swift.

3.3 Final Ratings Table

The final ratings table lists all of the mapped ecosystem units, including every combination of site series, site modifier, structural stage, stand modifier and seral association. See the expanded legend in Volume 3[28] for a description of all ecosystem units. Each ecosystem unit was assigned a rating for each of the 16 habitat uses for the eleven wildlife species. An example of the format of the ratings table is provided in Appendix D.

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[27] CDC 2005, Ministry of Environment 2005

[28] Iverson and Uunila 2006.

3.4 Wildlife Habitat Maps

By applying the habitat ratings to the TEM database and spatial data, seventeen map themes were created (Table 5) including a duplication of one map theme (Gopher Snake denning uses the ratings from Western Rattlesnake denning).

Table 5: Map themes of habitat uses and life requisites modelled.

Species	Species Code	Map Themes	Rating Code
Great Basin Spadefoot	A-SPIN	Breeding General Living (foraging and burrowing)	RE LIA
Western Rattlesnake	R-CROR	Basking/denning Foraging	LIA LIS
Gopher Snake	R-PICA	Basking/denning[29] Foraging Reproducing (egg-laying)	LIW LIG RE
Swainson's Hawk	B-SWHA	Nesting Foraging	RE LIG
Long-billed Curlew	B-LBCU	Nesting Foraging	RE LIG
Western Screech-owl	B-WSOW	Nesting	RE
Yellow-breasted Chat	B-YBCH	General Living (nesting and foraging)	LIG
Brewer's Sparrow	B-BRSP	Nesting Foraging	RE LIG
Grasshopper Sparrow	B-GRSP	General Living (nesting and foraging)	LIG
Badger	M-TATA	General Living (denning and foraging)	LIA

The Species Accounts (see Appendix A) provide descriptions of how the map themes were rated and presented, as well as full-page maps for each species. Smaller versions of each map are presented in the following sections with an interpretation of each model. We discuss the distribution of habitats and the accuracy of the model based on past sightings and wildlife observations during fieldwork.

[29] Rattlesnake general living, all year (R-CROR_LIA) ratings are used for this map theme.

Great Basin Spadefoot

The Great Basin Spadefoot requires wetlands for courting, egg-laying, and development of eggs and larvae. The development of young spadefoots from egg to tadpole to adult is relatively quick, so temporary water bodies that dry up in summer are commonly used. Ephemeral wetlands may actually be preferred due to the absence of fish or other aquatic predators.

Other than during spring breeding, adult spadefoots spend the rest of the year in nearby terrestrial habitats. These habitats must have deep, friable soils for burying themselves to avoid desiccation during dry weather and over-wintering.

No previous observation records exist for the study area, but tadpole spadefoots were detected during fieldwork at two locations in the south-eastern portion of the study area. High suitability breeding ponds (Figure 2) appear to occur sparsely throughout the study area.

Figure 2: Small wetlands provide excellent breeding habitat for Great Basin Spadefoot.

The suitability model generated two map themes: aquatic breeding habitats and terrestrial living habitats (Figure 3). Breeding habitats overlay living habitats. Both themes were displayed using the highest-value method.

Suitable breeding sites predicted by the model occur throughout the study area. However, spadefoots do not generally breed in large lakes, due to the presence of fish. Breeding has been depicted as suitable within 150 m of shoreline on the main lakes, although it is unlikely that it would occur. High value breeding ponds appear scarce in the area.

Terrestrial habitats near breeding ponds are more valuable to spadefoots, but very small, temporary 'wetlands' may not have been identified in the TEM.

Spadefoots are well adapted to desert conditions, with a hardened 'spade' on their hind foot for burrowing into soils, and skin secretion that prevents dehydration while buried.

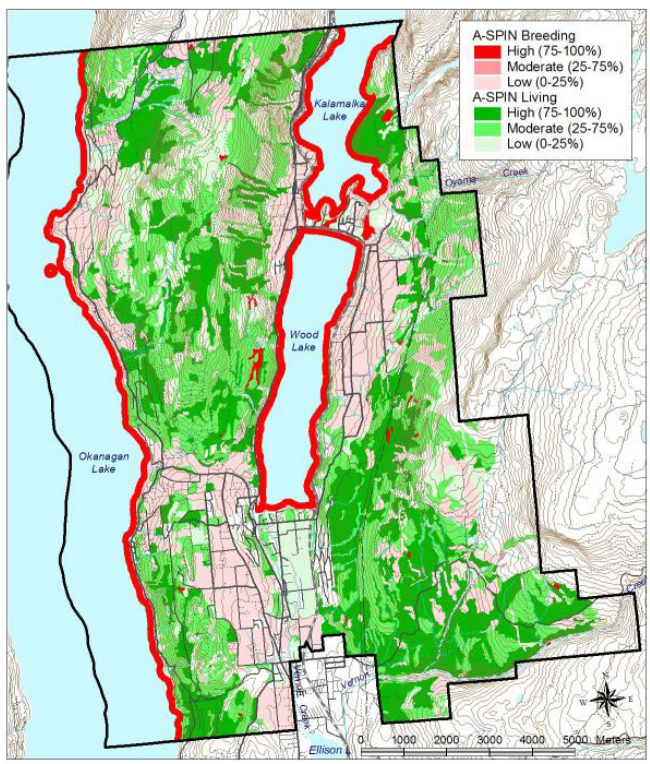

Figure 3: Distribution of suitable breeding and terrestrial habitats for Great Basin Spadefoot.

Painted Turtle

Turtles require wetlands throughout the year for foraging and over-wintering. Females leave the ponds to lay eggs in nearby terrestrial habitats with coarse, well-drained soils and sparse vegetation.

Turtles only leave their ponds when females lay eggs during the summer, and the occasional dispersal, particularly if their pond dries up during a dry spell.

Painted Turtles have not been recorded from the Lake Country study area, although they likely occur in the main lakes (Kalamalka and Wood Lake). Smaller, suitable ponds are scarce in the study area but high suitability ponds (Figure 4) occur sporadically throughout the study area.

Figure 4: Ponds provide living habitat for Painted Turtle.

The suitability model generates two map themes: aquatic living habitats and terrestrial nesting habitats (Figure 5). Both themes are displayed using the highest-value method. Only nesting habitats within 150 m of suitable ponds are portrayed. Living is depicted as suitable only within 150 m of shoreline of large lakes.

The model predicts abundant suitable living habitat, but the majority of shoreline along the main lakes appears unsuitable for nesting. Mortality from roads along the lakeshores is potentially very high as well.

Turtles spend the winter in the mud at the bottom of ponds. During this period of inactivity, turtles respire by absorbing oxygen from water they take into their pharynx and cloaca (i.e., both ends of the digestive tract).

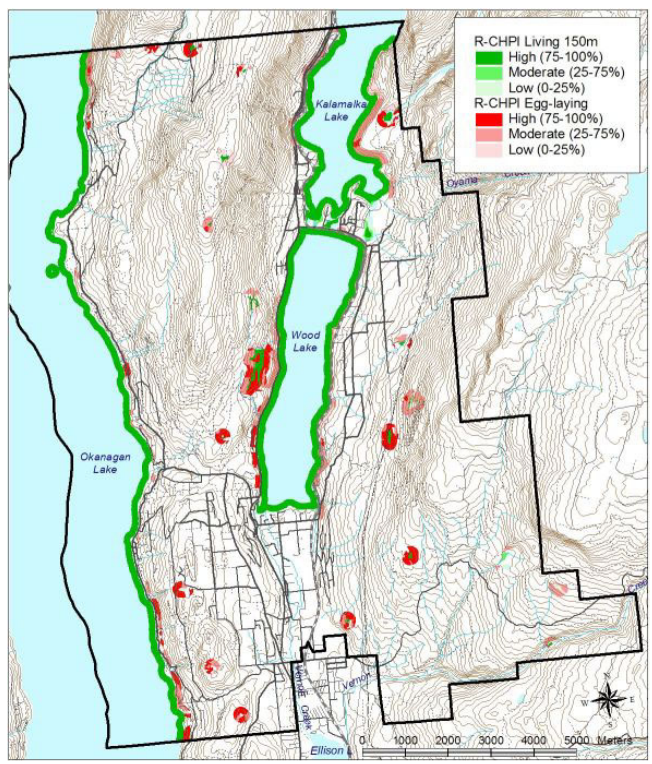

Figure 5: Distribution of suitable living and nesting habitats for Painted Turtle.

Western Rattlesnake

Western Rattlesnakes require sparsely vegetated ecosystems such as rock outcroppings for hibernating. Riparian areas, broadleaf woodlands, grasslands, or open forests are used for foraging. High-value denning and basking habitats on south-facing rocky hillsides (Figure 6) were observed at 13 of the field plots.

Figure 6: Denning and basking habitat for rattlesnakes.

High-value foraging habitats include riparian areas and broadleaf woodlands, which support dense prey populations and have more moderate summer temperatures (Figure 7).

Figure 7: Foraging habitat for rattlesnakes in the heat of summer.

Suitability was modeled for two map themes for rattlesnakes; both were displayed by the highest-value method (Figure 8). The denning theme (top map layer) consists of security/thermal habitats potentially used all year, including denning during winter, basking in spring and fall, and throughout the summer for gravid females. Foraging includes habitats that likely provide security and thermal shelter as well as food.

The map depicts suitable habitat throughout the study area, particularly the northern portion.

Rattlesnakes are the only dangerously venomous snake species in BC, but will rarely bite unless threatened.

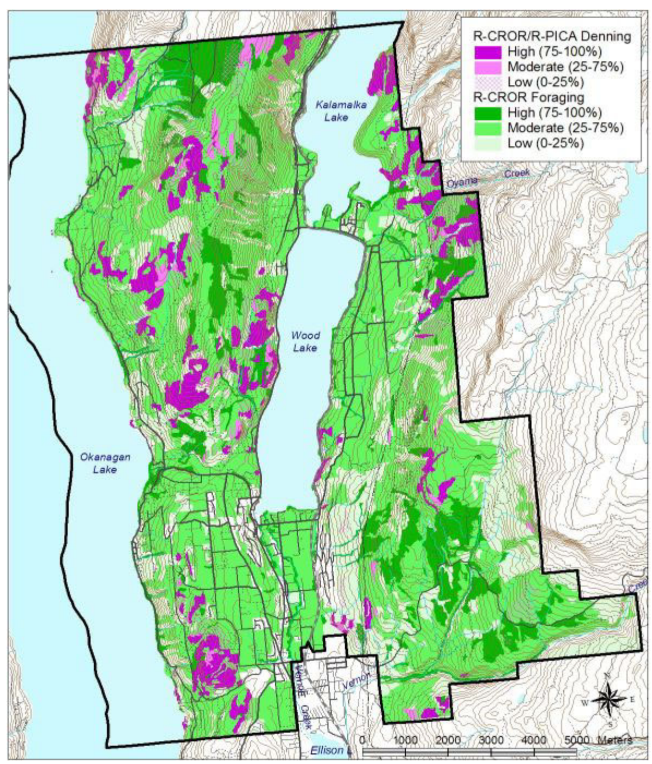

Figure 8: Distribution of suitable denning and foraging habitats for Western Rattlesnake.

Gopher Snake

Gopher Snakes den in either deep-soiled grasslands or sparsely vegetated ecosystems (rocky habitats). Deep-soiled den sites were not modeled for this project, as they are very difficult to predict. Because of the similarities in rocky den sites to rattlesnake suitability, ratings were not assigned separately for Gopher Snake.

High value foraging habitat occurs in deep-soiled grasslands, broadleaf woodlands and riparian areas.

Unlike Western Rattlesnakes, Gopher Snakes lay eggs. Egg-laying habitat is frequently associated with warm-aspect grasslands with deep soils (Figure 9). We assessed seven plots of the 282 with high-value egg-laying habitat.

The only known records of Gopher Snakes from the study area are from fieldwork for this project: a road-kill near Winfield and another near Oyama.

Figure 9: Warm aspect slopes with sparse tree cover and deep soils are important for egg laying and foraging for Gopher Snakes.

The Gopher Snake habitat-suitability model generated three map themes. Denning is the top map layer and overlays egg-laying, which overlays general living (Figure 10). Denning was derived from the rattlesnake denning theme, and predicts only rocky den sites. This model does not attempt to predict earthen burrows that may also be used by Gopher Snakes for over-wintering. Deep-soiled, warm aspect sites were used to predict egg-laying habitat, which may also capture some den sites. The living theme depicts areas potentially rich in prey that also provide security and thermal cover.

Suitable habitat is predicted to occur throughout the study area, although the best habitat is in the grasslands southeast of Wood Lake.

Although they resemble the rattlesnake, Gopher Snakes are constrictors, and non-venomous.

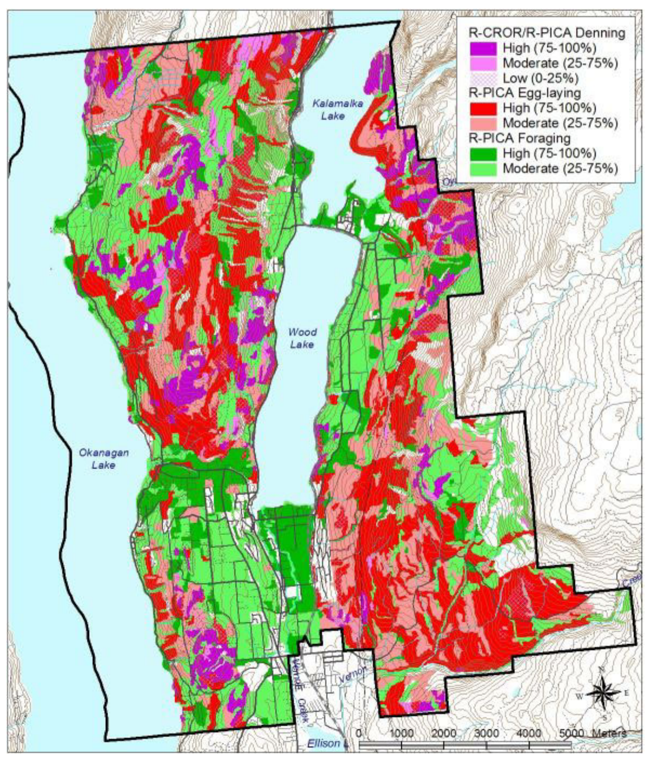

Figure 10: Distribution of suitable denning, egg-laying, and living habitats for Gopher Snake.

Swainson's Hawk

These hawks require expansive, open areas for foraging, and scattered large trees in or adjacent to grasslands for nesting (Figure 11).

Swainson's Hawks were not previously known from the study area, but were observed foraging and nesting near the northern edge during fieldwork.

Eight of 282 plots were assessed as having high value nesting habitat, and 18 as high-suitability for foraging, indicating that abundant habitat exists.

Figure 11: Expansive grasslands for foraging and sporadic trees for nesting are critical for Swainson's Hawks.

Both the nesting (top layer) and foraging theme generated by the model were displayed using the highest-value method (Figure 12).

Most of the nesting habitat depicted occurs in the northern portion of the study area. However, very small stands of trees and isolated trees near grasslands are valuable for nesting as well.

Hawks are highly motile, hunting over a large area, and require a relatively large amount of suitable foraging habitat to support a nesting pair. Most of the best foraging areas were in the southeast portion of the study area.

The colouration of Swainson's Hawks, as well as the more common Red-tailed Hawk, is highly variable. They can be distinguished by their longer, narrower, and more pointed wings.

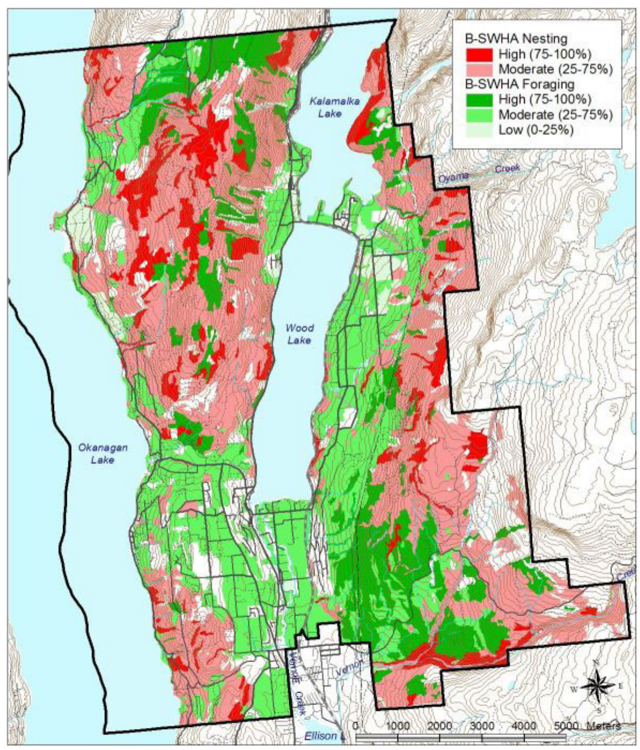

Figure 12: Distribution of suitable nesting and foraging habitats for Swainson's Hawk.

Long-Billed Curlew

Curlews require fairly large areas of level to gently sloping grassland with short vegetation and no trees for nesting. Families of curlews will often move to lush cultivated fields once the young have fledged. Foraging occurs in hayfields, pastures, meadows, and grasslands.

No sign of Long-billed Curlews was detected during fieldwork, and they have not been previously recorded from the study area.

High suitability nesting habitat (Figure 13) was encountered at only three plots during fieldwork. Expanses of gently sloping grasslands are typically the first areas to succumb to development pressures.

Figure 13: Long-billed Curlews only nest on flat or gently sloping grasslands.

The suitability model for curlews generates two map themes: nesting and foraging (Figure 14). Curlews generally avoid nesting near treed areas, so only polygons that contain 20% or less forested ecosystems are displayed.

High suitability habitat is predicted to occur in fairly restricted areas in the southeast and northern portion of the study area. Despite the availability of grasslands in the study area, optimum nesting conditions are scarce due to slope or proximity to trees.

Curlews are very tolerant of cattle grazing, except that they are vulnerable to trampling of the eggs and young.

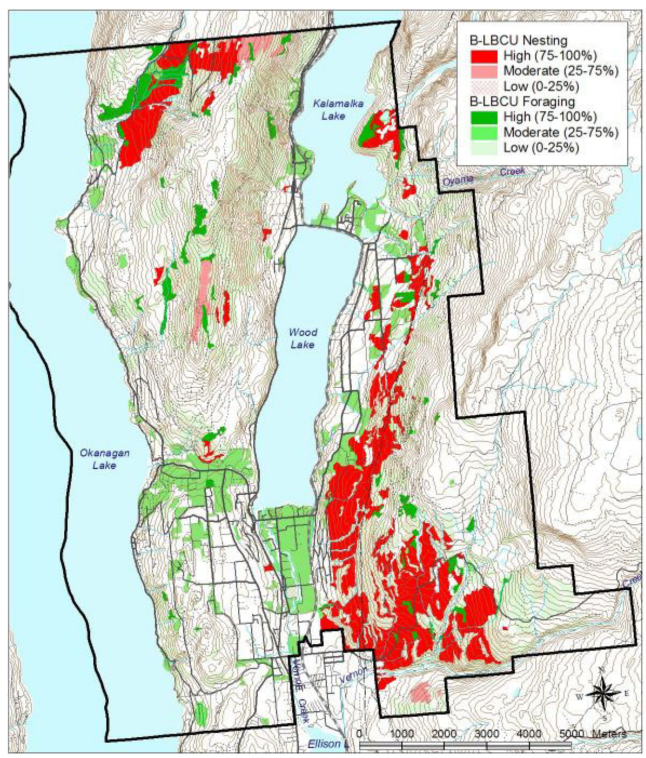

Figure 14: Distribution of suitable nesting and rearing habitats for Long-billed Curlew.

Western Screech-owl

Western Screech-owls are dependant on mature to old riparian forest and most often nest in cavities in large cottonwood trees. Nesting is known from the Okanagan valley floor as far north as Coldstream Creek, and also in the middle Shuswap (J. Hobbs, H. Davis pers. comms.).

We found no evidence of Western Screech-owls during fieldwork, but one previous record exists for the study area near Winfield.

Potential high-value nesting habitat was observed at three plots, all dominated by large cottonwood (Figure 15). A number of aspen or birch stands were assessed as moderate suitability (seven plots).

Figure 15: Mature cottonwood stands provide optimum nesting habitat.

The suitability model for Western Screech-owl generates only one map theme, nesting habitat, which is displayed using the highest-value method (Figure 16). Some foraging may occur in adjacent areas.

A relatively large amount of low suitable habitat is predicted to occur throughout the study areas. However, high suitability habitat consisting of mature cottonwood stands is scarce and generally restricted to remnant habitats along creeks in the southern portion of the study area.

The call of the Western Screech-owl is easily identified, described as a ‘bouncing ping-pong ball’.

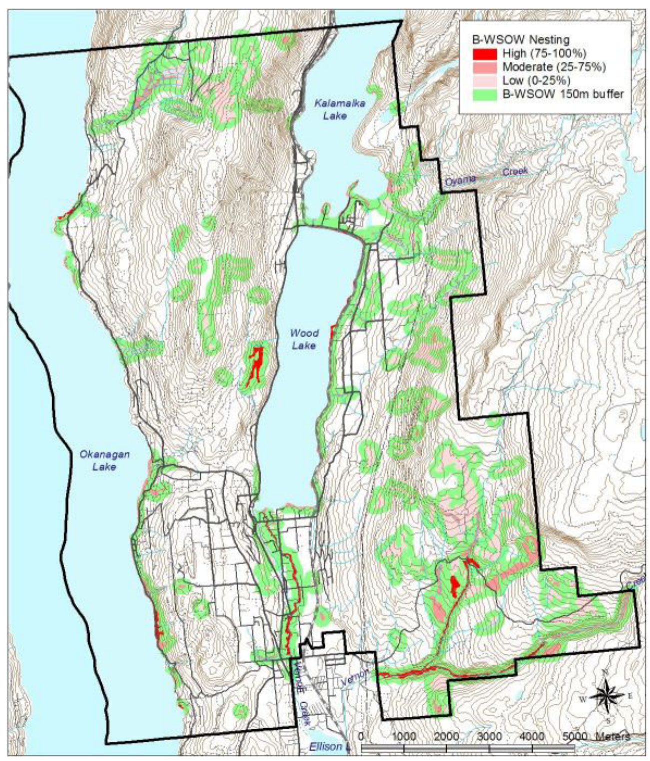

Figure 16: Distribution of suitable nesting habitat for Western Screech-owl.

Yellow-breasted Chat

These songbirds are dependant on riparian areas with a shrubby understory, preferably with dense wild rose and snowberry.

Yellow-breasted Chats were not observed during fieldwork, and no previous records are known from the study area. However, the lowlands south of Wood Lake would have been prime habitat at one time.

High suitability habitat for Yellow-breasted Chats (Figure 17) was recorded at only one plot. Some other sites would be of high value except that the amount of cattle use has resulted in degradation of the shrubby understory vegetation.

Figure 17: Dense stands of rose and other deciduous shrubs provide potential nesting habitat.

All chat activity is generally confined to a nesting territory. Therefore, there is only one map theme (living), which includes nesting and foraging (Figure 18). This theme is displayed using the highest-value method.

Chat habitat often occurs as small strips or pockets, and likely occupies only a portion of some of the polygons identified. These are usually located in gullies or around wetlands.

Chats earned their name because of their noisy and highly diverse range of calls, including a typical 'chat-chat-chat-chat'. They are one of the very few songbirds that are vocal at night.

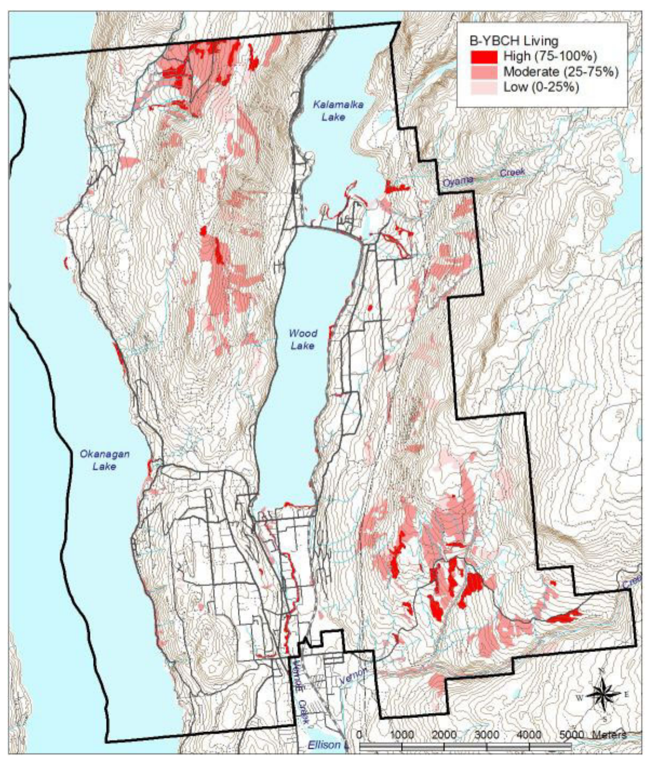

Figure 18: Distribution of suitable living (including nesting) habitat for Yellow-breasted Chat.

Grasshopper Sparrow

Grasshopper Sparrows generally occur in grasslands with little or no sagebrush or trees, which are flat or on gentle warm aspects.

Grasshopper Sparrows have not been recorded from the study area.

High suitability living habitat (Figure 19) was encountered at ten of the plots assessed.

Figure 19: Open grasslands are important nesting habitats for Grasshopper Sparrows.

Nesting and foraging by Grasshopper Sparrows generally occurs in the same type of habitat. Therefore, the model generated only one map theme: living (Figure 20). The theme is displayed using the dot-density method, as this bird prefers fairly large areas of suitable habitat. This allows the visualization of contiguity and where unsuitable habitats occur in otherwise suitable polygons.

Large areas of high-rated living habitats are concentrated in the southeast portion of the study area, and west of Kalamalka Lake. High and moderate rated living habitats should be the target of inventories.

Grasshopper Sparrows nest on the ground, usually at the base of bunchgrasses, and use the overhanging vegetation to build a dome with a side entrance. They received their name from a portion of their call that resembles the buzz of a grasshopper.

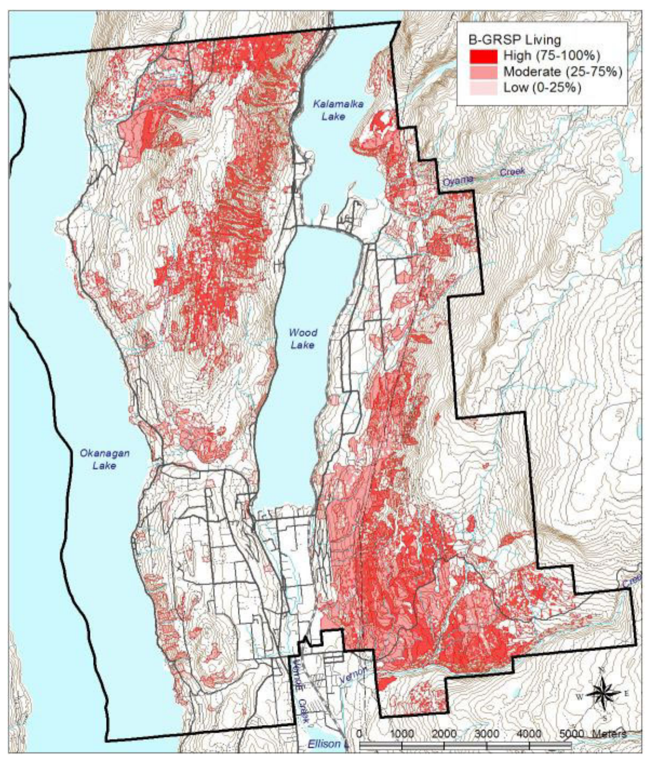

Figure 20: Distribution of suitable living habitat for Grasshopper Sparrow.

Spotted Bat

Spotted Bats roost in crevices in large, sheer cliffs, which are also used by maternal colonies where females give birth to young.

No roosts are known from the study area.

Only marginal habitat was encountered in the study area (Figure 21).

Figure 21: Crevices in large, sheer cliffs provide protection from predators.

The Spotted Bat suitability model generates just the one theme: breeding, which also includes non-maternity roosting (Figure 22).

The model predicts no high-suitable habitat, and very little moderate suitability, as verified by fieldwork. Because of the scarcity of suitable roosting habitat, the cliffs that do exist may be extremely important for this species.

Spotted Bats are the only bat species in BC whose echolocation calls are audible to the human ear, which sound like a series of high-pitched ticks.

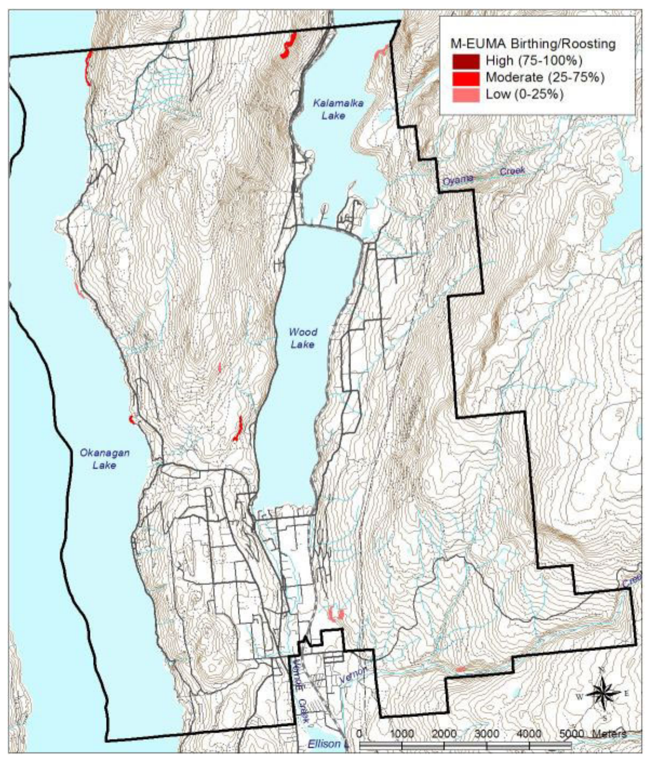

Figure 22: Distribution of suitable breeding habitat for Spotted Bat.

Badger

Badgers are usually residents of deep-soiled grasslands (Figure 23) although they will venture into a broad range of habitats. The north Okanagan has an abundance of deep-soiled grasslands that probably historically supported stable Badger populations.

We found old Badger burrows at one location east of Winfield.

Many plots were assessed as high-value habitat during fieldwork, including suitability for maternity dens.

Figure 23: Expansive, deep-soiled grasslands without road traffic are essential for Badger populations.

One map theme, living, is generated by the model, which includes foraging and denning (Figure 24). The dot density method is used to display habitat values, as this gives an indication of the proportion of the polygon suitable for use.

Suitable burrowing habitat may occur as small pockets within a polygon. The abundance of rodent prey could not be directly included in the habitat suitability model, but pocket gopher burrows often occurred in small pockets of deep soil throughout the rolling topography of much of the study area. However, badgers commonly forage for more colonial prey (i.e., marmots and ground squirrels), displaying patchy use of habitats.

Badger populations have likely declined from habitat loss, persecution and traffic mortality. Fragmentation of habitats has also likely contributed to their decline.

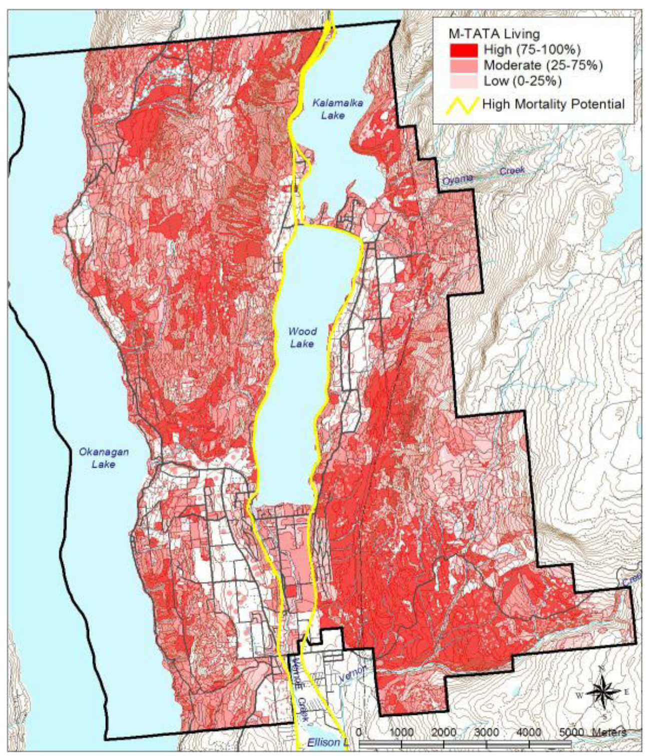

Figure 24: Distribution of suitable living habitat for Badger.

3.5 Composite Critical Habitat Map

Ten life requisites were chosen to represent the most limiting habitat requirements of the project wildlife species (Table 6). This does not imply that the species or life requisites omitted are not as important. Rather, their needs may be met if habitats for the remainder of the map themes are conserved.

Table 6: Map themes used in composite critical habitat map.

Species	Species Code	Map Theme	Rating Code
Great Basin Spadefoot	A-SPIN	Breeding	RE
Western Rattlesnake	R-CROR	Basking / denning	LIA
Gopher Snake	R-PICA	Egg-laying	RE
Swainson's Hawk	B-SWHA	Nesting	RE
Long-billed Curlew	B-LBCU	Nesting	RE
Western Screech-owl	B-WSOW	Nesting	RE
Yellow-breasted Chat	B-YBCH	General Living (nesting and foraging)	LIG
Grasshopper Sparrow	B-GRSP	General Living (nesting and foraging)	LIG
Spotted Bat	M-EUMA	Breeding/Roosting	RB
Badger	M-TATA	General Living (denning and foraging)	LIA

A composite critical habitat map of high- and moderate-value habitats for the ten critical map themes was generated and is presented in Figure 25. This map is displayed using the highest-value method. While this method is excellent for highlighting polygons containing important areas, it often tends to exaggerate the amount of valuable area, as entire polygons are shown by the highest value they contain.

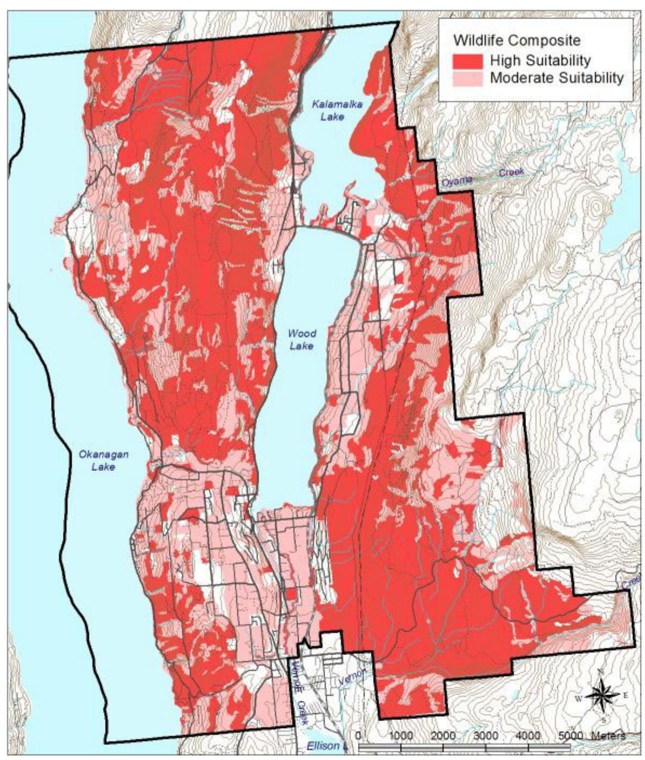

Figure 25: High and Moderate ratings for ten critical life requisites, displayed using highest value method.

The composite wildlife map portrays abundant high-suitability habitat, indicating that the majority of polygons in the study area contains valuable habitat for at least one of the project species. The map should be used to view important habitats on a landscape level. For areas of interest, refer to individual wildlife habitat models and investigate them in the field to assess values.

3.6 Habitat Values of Sensitive Ecosystems

Sensitive Ecosystem Inventory categories[30] are shown in Figure 26 by largest area, which portrays the dominant component of each polygon. Almost all polygons dominated by *sensitive ecosystems* have high suitability for at least one of the project wildlife species (see Figure 25). *Other important ecosystems*, particularly disturbed grasslands, often have high value for many of the project wildlife species as well. It should be noted that because the SEI categories are displayed using largest area, many of the polygons likely contain higher SEI values than shown.

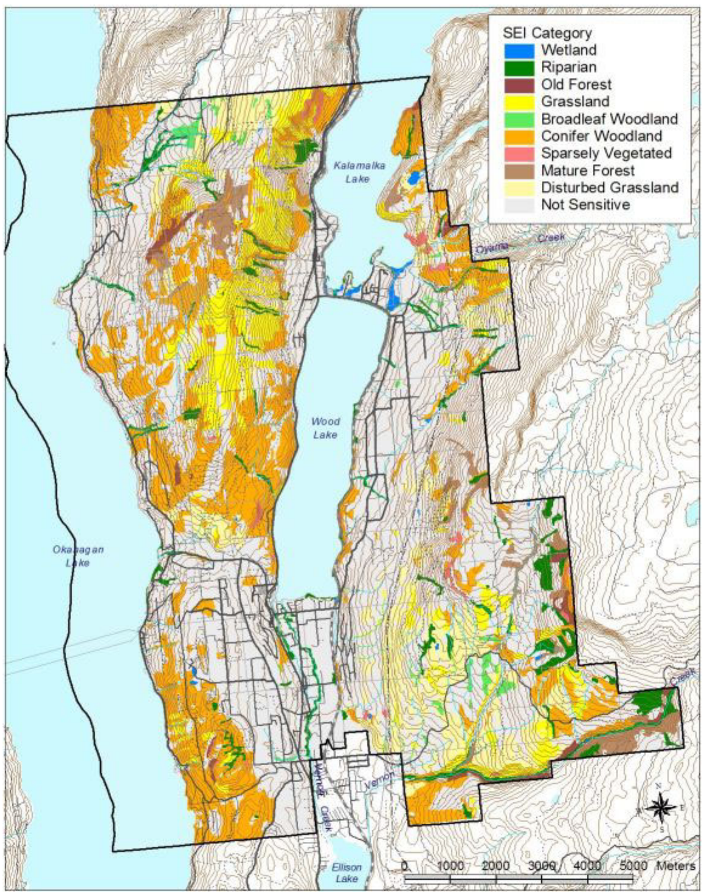

Figure 26: Sensitive ecosystem mapping, displayed using largest area method.

Many polygons without sensitive or other important ecosystems may still provide important wildlife habitat for species at risk, including rural and agricultural areas, and very weedy grasslands with little or no native vegetation.

30 Iverson 2006

The Conservation Analysis described in Volume 1[31] takes into account not only the rarity and fragility of ecosystems (sensitive ecosystems), but also the condition of the ecosystems and wildlife values (Figure 27). The Conservation Zones resulting from the Conservation Analysis appear to protect the bulk of critical habitat for all project species, including important wildlife corridors.

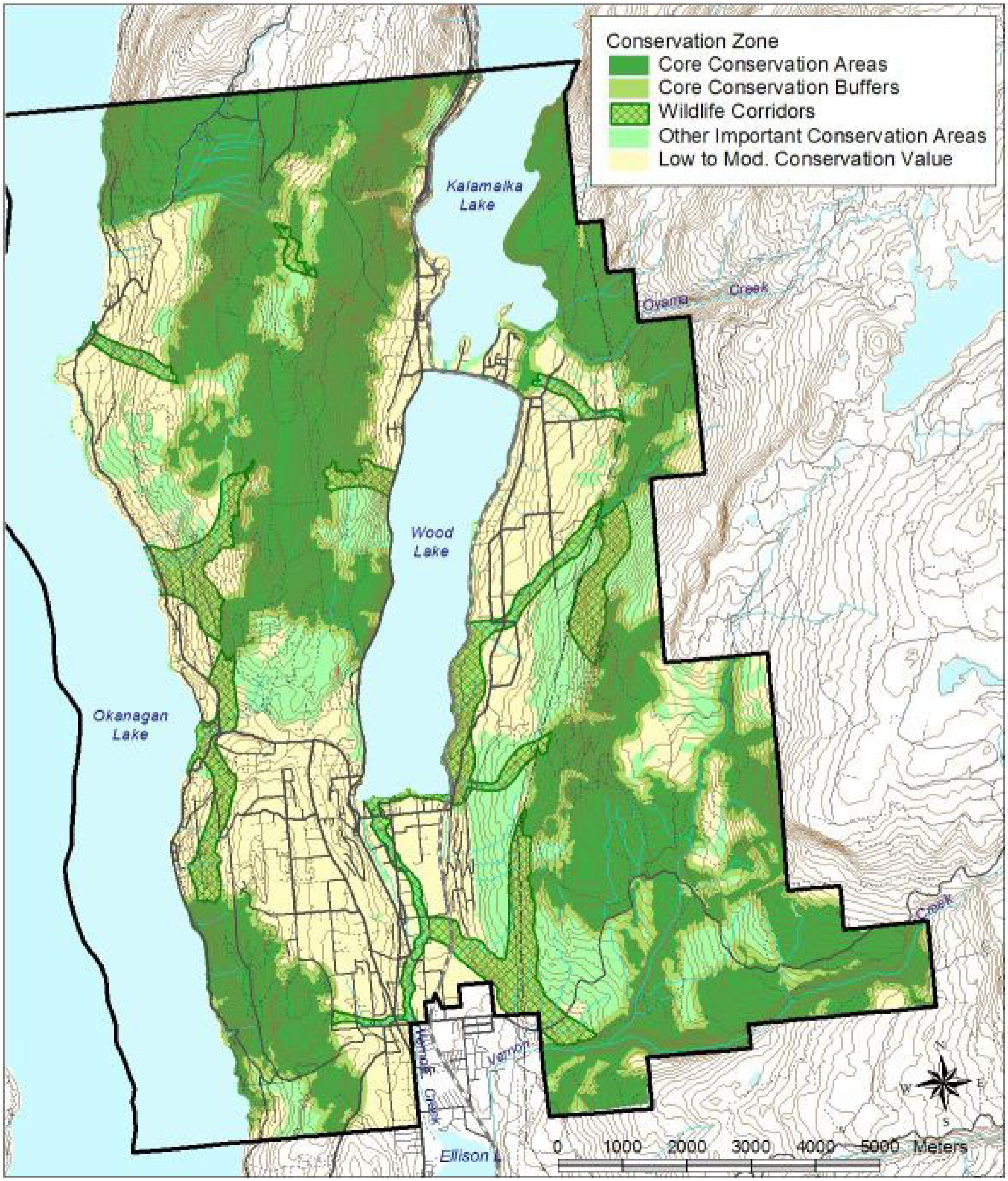

Figure 27: Conservation Zones resulting from the SEI Conservation Analysis.

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[31] Iverson 2006

4 Recommendations

Local government, BC Parks, landowners, consultants, and other interested groups can use the wildlife habitat mapping in a number of ways. As a management tool, the wildlife suitability maps can be used to direct broad wildlife management strategies, such as recovery of habitats for species at risk and ecosystem management practices, including prescribed burns. As a landscape-level planning tool, the Conservation Zones (Figure 27) resulting from the Conservation Analysis can be used to direct development towards less sensitive areas. The composite critical habitats map (Figure 25) should be used to identify potentially critical areas that should be considered for conservation unless an environmental impact assessment recommends adjustments to these boundaries. A development permit bylaw could restrict development on these areas until they are assessed. Assessments should address the relevancy of each of the wildlife suitability models within the area of interest, as a minimum standard. The Regional District of Central Okanagan's 'Terms of Reference: Professional Reports for Planning Services' should be used as a minimum standard for conducting environmental assessments[32]. Volume 1[33] of the Sensitive Ecosystem Inventory contains additional environmental impact assessment guidelines.

Due to the wildlife significance of the area, environmental impact assessments should not only concentrate on ground-truthing the results of these suitability models, but should also inventory for other species at risk and their critical habitats. Volume 1[33] provides lists of species at risk that may be associated with each sensitive or other important ecosystem.

Anyone conducting environmental impact assessments using this information should have a good understanding of each species' habitat requirements and associated threats when evaluating development impacts and establishing environmentally sensitive areas (ESA). Best Management Practices are being developed for many species at risk, and these should be consulted in addition to the management recommendations outlined here.

Many wildlife species require connectivity throughout their range, and this should be given consideration when assessing the lands of interest in context with the surrounding area. Priority areas should be secured for conservation.

The following are brief management guidelines for each of the project wildlife species.

4.1 Great Basin Spadefoot

Inventories are required to determine which ponds are used for breeding. This data can be used to adjust the suitability for terrestrial habitats. Generally, buffers around breeding sites should be at least 350 m[34] to protect both breeding and adjacent terrestrial habitats and to avoid road and other mortality. However, this could vary depending on the suitability of upland habitat. Spadefoots may travel several hundred metres from ponds, and up to 1.5 km, so buffers should be extended to encompass the highest-suitability surrounding habitat, attempting to capture at least 5 ha of terrestrial area[35].

Corridors must be maintained between ponds and foraging sites. Developments that pose a hazard or obstruction to spadefoots, including roads, retaining walls, and steep-sided trenches, should not occur

[32] Regional District of Central Okanagan 2005
[33] Iverson 2006
[34] Semlitsch and Bodie 2003
[35] Sarell 2004

between aquatic breeding habitats and nearby suitable terrestrial habitats. Management should also consider the connectivity between aquatic habitats, to maintain gene flow between spadefoot populations. Artificial breeding habitats can be created as part of mitigation programs.

4.2 Western Rattlesnake and Gopher Snake

Management of Low, Moderate and High potential denning habitats should include a no-development zone, unless an inventory has demonstrated that the depicted habitat(s) are not used. Recreational corridors should avoid these areas to minimize human-snake conflicts, including mortality from mountain bikes and vehicles. Summer foraging areas should be carefully assessed to determine whether any development is appropriate, and if so, what mitigation measures are required. Although corridors to allow snake movement from winter security/thermal habitats to summer foraging habitats have not been mapped, they should be interpreted and applied to project planning. Roads should not intersect any of these areas unless appropriate mitigation measures are employed to avoid traffic mortalities. Paved roads are a particularly large threat to snakes due to their habit of basking on the warm surface for thermoregulation. Snake exclusion fencing may be required to reduce encounters and mortality in developed areas.

4.3 Long-Billed Curlew

Conduct inventories in grassland habitats during the breeding season to determine whether Long-billed Curlews are present. Curlews require an expanse of level to gently sloping grasslands. Any development in these areas, including roadways and recreational corridors, will significantly impact these birds. Livestock should not access these areas during the breeding season to protect nests from trampling. Domestic cats should not be permitted in these areas as they may prey upon adults and nestlings.

4.4 Swainson’s Hawk

Inventories during the breeding season should be conducted to locate existing nest trees. Conserve wide grassland networks between nest trees and other suitable nesting habitats. Do not locate transportation or recreational corridors within 100 m of nest trees.

4.5 Western Screech-owl

Spring inventories are required to determine whether nesting occurs in riparian forests in the study area. Maintain deciduous and mixed stands, including wildlife trees, to provide nesting and foraging habitats. Incorporate surrounding natural habitats, particularly meadows, as a buffer to these areas. Nest boxes can help to mitigate small losses of nesting habitat.

4.6 Grasshopper Sparrow

Breeding season inventories are required to determine the extent to which they occur in grassland habitats, including weedy sites. They are semi-colonial but often shift their breeding territories between years. Therefore, additional suitable grassland habitats should be retained to accommodate breeding in subsequent years. A buffer to reduce disturbances is also recommended. Livestock should not access these areas during the breeding season to protect nests from trampling. Domestic cats should not be permitted in these areas as they may prey upon adults and nestlings.

4.7 Yellow-breasted Chat

Inventories during the breeding season are required to determine where they occur in the study area. Maintain deciduous stands and restore shrubby understory, particularly wild rose. Livestock should have limited access to these areas as they reduce the shrubby component of these ecosystems. Buffers should be incorporated to reduce disturbances to these areas. Domestic cats should not be permitted in these areas, as they may prey upon adults and nestlings.

4.8 Spotted Bat

Spotted Bats roost in large cliffs and may hibernate in these features as well. Generally there are few impacts to cliffs from human activities. Development and blasting should not be permitted within 200 m of a roost cliff. New developments should have shielded streetlights. Recreational rock climbing should not be permitted on roost cliffs.

4.9 Badger

Inventories should be conducted to locate burrows, particularly maternal burrows, although differentiating between maternal and other types of burrows is difficult. The most critical habitat sites for Badgers are their maternal dens and adjacent foraging areas. Burrows usually occur in deep soils on gentle to moderate sloping grasslands, often adjacent to significant populations of ground squirrels, marmots or pocket gophers. Management should ensure there is no disturbance to occupied or maternal burrow sites and that no activities significantly affect prey species or create barriers between suitable areas. Corridors or connectivity should be maintained with other natural areas to allow for their high degree of motility and dispersion. Road placement should avoid intersecting suitable badger habitat, as road mortality is the major cause of death for this species (Weir et al. 2005). Landowners may wish to conduct inventories to specifically identify important badger habitats.

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Appendices

Appendix A: Data Access

Spatial and non-spatial data for the Sensitive Ecosystems Inventory and Terrestrial Ecosystem Mapping (TEM), including wildlife mapping, are available for download at the former Ministry of Sustainable Resource Management's Terrestrial Ecosystem Mapping Data Warehouse at: http://srmwww.gov.bc.ca/ecology/tem/dataware.html

The following are available:

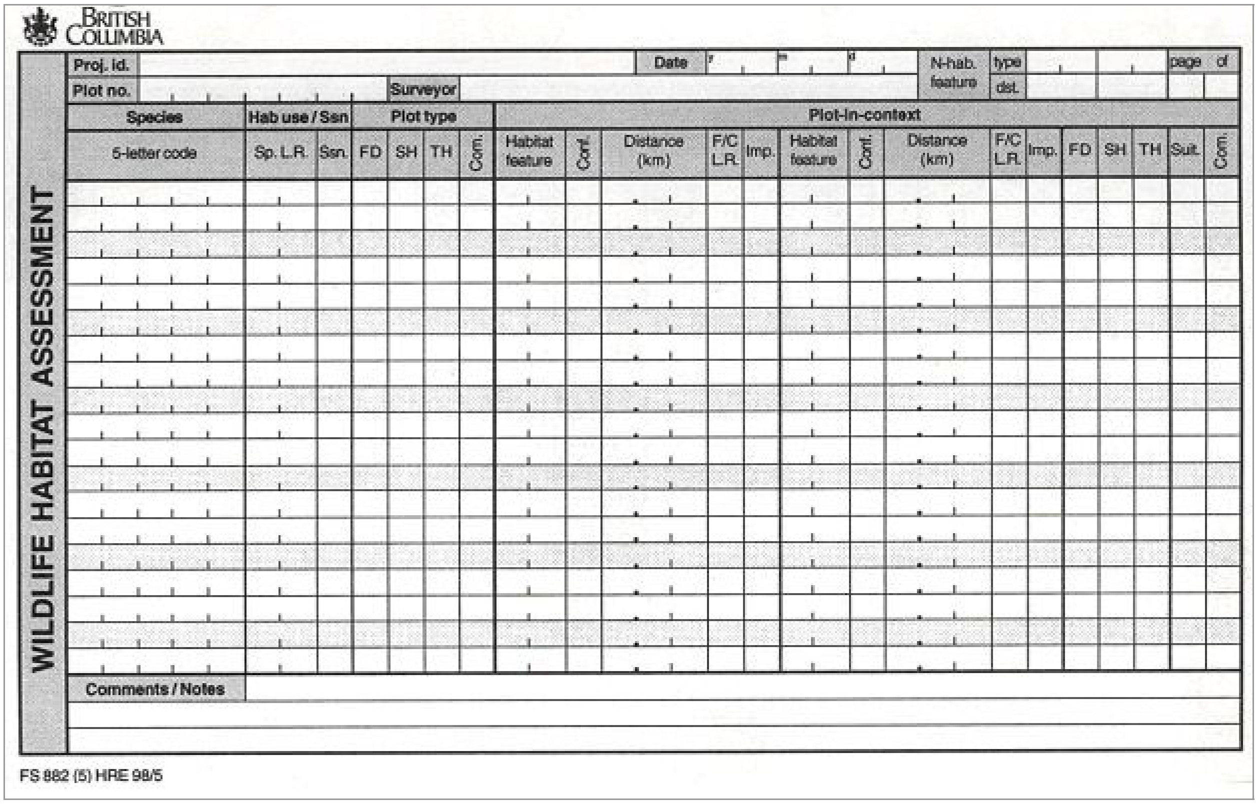
- Project metadata
- SEI report (Volume 1)[36]
- Arc/Info *.E00 Export Files includes two spatial coverages: ECI field sampling points and a ECP TEM polygon coverage
- TEM Polygon Attributes
- TEM Map Legend Files
- TEM report with expanded legend (Volume 2)[37]
- Wildlife Species Accounts
- Wildlife Ratings Tables
- Wildlife Report (Volume 3)

[36] Iverson 2006
[37] Iverson and Uunila 2006

Appendix B: Known and potential rare wildlife species in the study area.

Common Name	Scientific Name	Occurrence in Study Area	Prov. Status	COSEWIC Status
Amphibians				
Tiger Salamander	*Ambystoma tigrinum*	unknown	Red	Endangered
Great Basin Spadefoot	*Spea intermontana*	southeast, likely throughout	Blue	Threatened
Western Toad	*Bufo boreus*	unknown but likely	-	Special Concern
Reptiles				
Painted Turtle	*Chrysemis picta*	unknown but likely	Blue	-
Western Skink	*Eumeces skiltonianus*	unknown but possible	Blue	Special Concern
Western Rattlesnake	*Crotalus oreganus*	two locations, likely throughout	Blue	Threatened
Gopher Snake	*Pituophis catenifer*	two locations, likely throughout	Blue	Threatened
Racer	*Coluber contrictor*	northern portion, likely throughout	Blue	Special Concern
Rubber Boa	*Charina bottae*	unknown but likely	-	Special Concern
Birds				
Great Blue Heron	*Ardea herodias* ssp. *herodias*	unknown but possible	Blue	-
California Gull	*Larus californicus*	unknown but possible	Blue	-
American Avocet	*Recurvirostre americana*	unknown and unlikely	Red	-
Long-billed Curlew	*Numenius americanus*	unknown but possible	Blue	Special Concern
Upland Sandpiper	*Bartramia longicauda*	unknown but possible	Red	-
Swainson’s Hawk	*Buteo swainsoni*	northern edge, possibly throughout	Red	-
Ferruginous Hawk	*Buteo regalis*	unknown but possible	Red	Special Concern
Western Screech-owl	*Megascops kennicotti* ssp. *macfarlanei*	one location	Red	Endangered
Flammulated Owl	*Otus flammeolus*	unknown but likely	Blue	Special Concern
Short-eared Owl	*Asio flammeus*	unknown but possible	Blue	Special Concern
White-throated Swift	*Aeronautes saxatalis*	forage throughout, poor breeding	Blue	-
Lewis' Woodpecker	*Melanerpes lewis*	unknown but likely	Blue	Special Concern
Yellow-breasted Chat	*Icteria virens*	unknown but possible	Red	Endangered
Brewer’s Sparrow	*Spizella breweri breweri*	unknown and unlikely	Red	-
Grasshopper Sparrow	*Ammodramus savannarum*	unknown but possible	Red	-
Lark Sparrow	*Chondestes grammacus*	unknown but possible	Red	-
Mammals				
Merriam's Shrew	*Sorex merriami*	unknown but possible	Red	-
Preble's Shrew	*Sorex prebeii*	unknown but possible	Red	-
Townsend's Big-eared Bat	*Corynorhinus townsendii*	unknown but likely	Blue	-
Spotted Bat	*Euderma maculatum*	unknown but possible	Blue	Special Concern
Pallid Bat	*Antrozous pallidus*	unknown but possible	Red	Threatened
Fringed Myotis	*Myotis thysanodes*	unknown but likely	Blue	Special Concern
Western Small-footed Myotis	*Myostis ciliolabrum*	unknown but likely	Blue	-
Western Harvet Mouse	*Reinthrodontomys megalotis*	unknown but possible	Blue	Special Concern
Great Basin Pocket Mouse	*Perognathus parvus*	unknown but possible	Blue	-
Nuttall's Cottontail	*Sylvilagus nuttallii* ssp. *nuttallii*	unknown and unlikely	Blue	Special Concern
Badger	*Taxidea taxus*	one location, likely rare throughout	Red	Endangered

Appendix C: Wildlife Habitat Assessment Forms



BRITISH COLUMBIA

WILDLIFE HABITAT ASSESSMENT

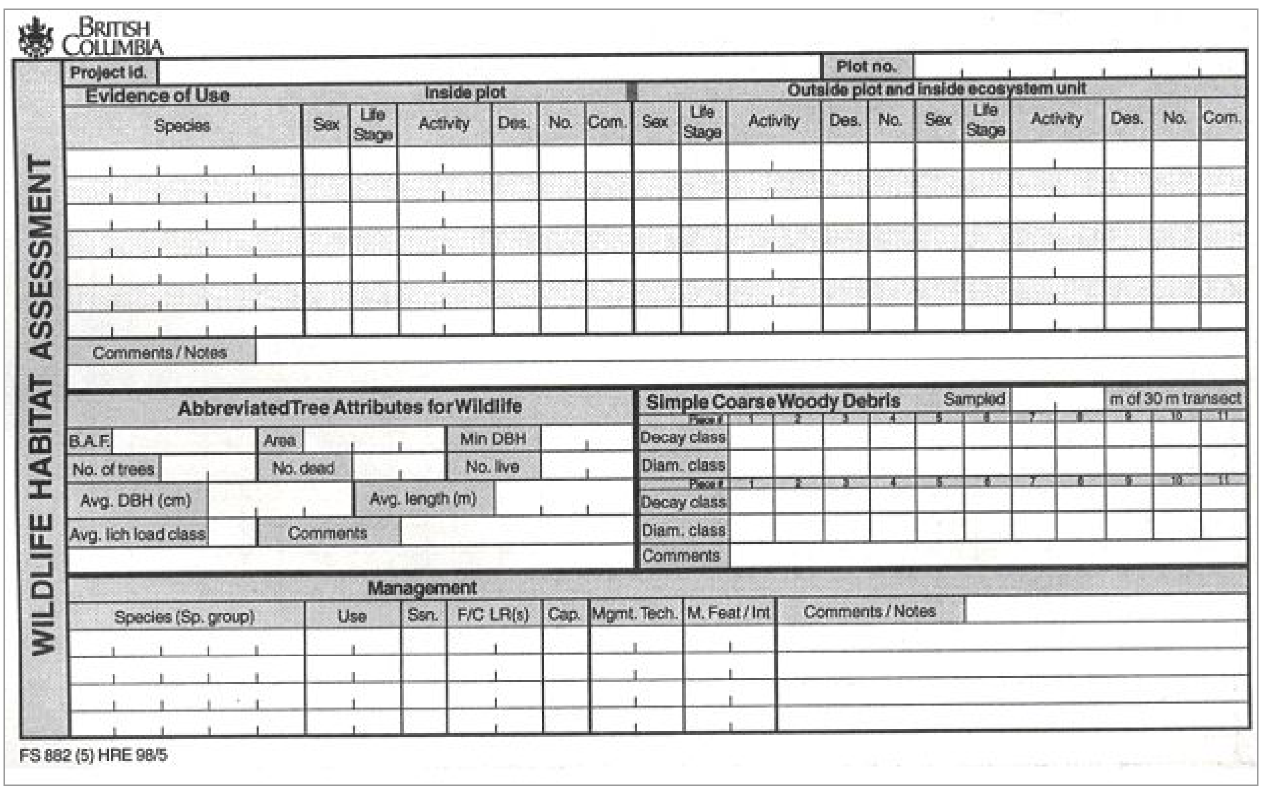
Proj. id. | Date | N-hab. feature | type | dst. | page of

Plot no. | Surveyor

Species	Hab use / Ssn		Plot type				Plot-in-context														
5-letter code	Sp. L.R.	Ssn.	FD	SH	TH	Com.	Habitat feature	Conf.	Distance (km)	F/C L.R.	Imp.	Habitat feature	Conf.	Distance (km)	F/C L.R.	Imp.	FD	SH	TH	Suit.	Com.

Comments / Notes

FS 882 (5) HRE 98/5



BRITISH COLUMBIA

WILDLIFE HABITAT ASSESSMENT

Project id. | Plot no.

Evidence of Use	Inside plot						Outside plot and inside ecosystem unit											
Species	Sex	Life Stage	Activity	Des.	No.	Com.	Sex	Life Stage	Activity	Des.	No.	Sex	Life Stage	Activity	Des.	No.	Com.

Comments / Notes

Abbreviated Tree Attributes for Wildlife

B.A.F. | Area | Min DBH

No. of trees | No. dead | No. live

Avg. DBH (cm) | Avg. length (m)

Avg. lich load class | Comments

Simple Coarse Woody Debris Sampled m of 30 m transect

Piece #	1	2	3	4	5	6	7	8	9	10	11
Decay class											
Diam. class											
Piece #	1	2	3	4	5	6	7	8	9	10	11
Decay class											
Diam. class											

Comments

Management

Species (Sp. group)	Use	Ssn.	F/C LR(s)	Cap.	Mgmt. Tech.	M. Feat / Int	Comments / Notes

FS 882 (5) HRE 98/5

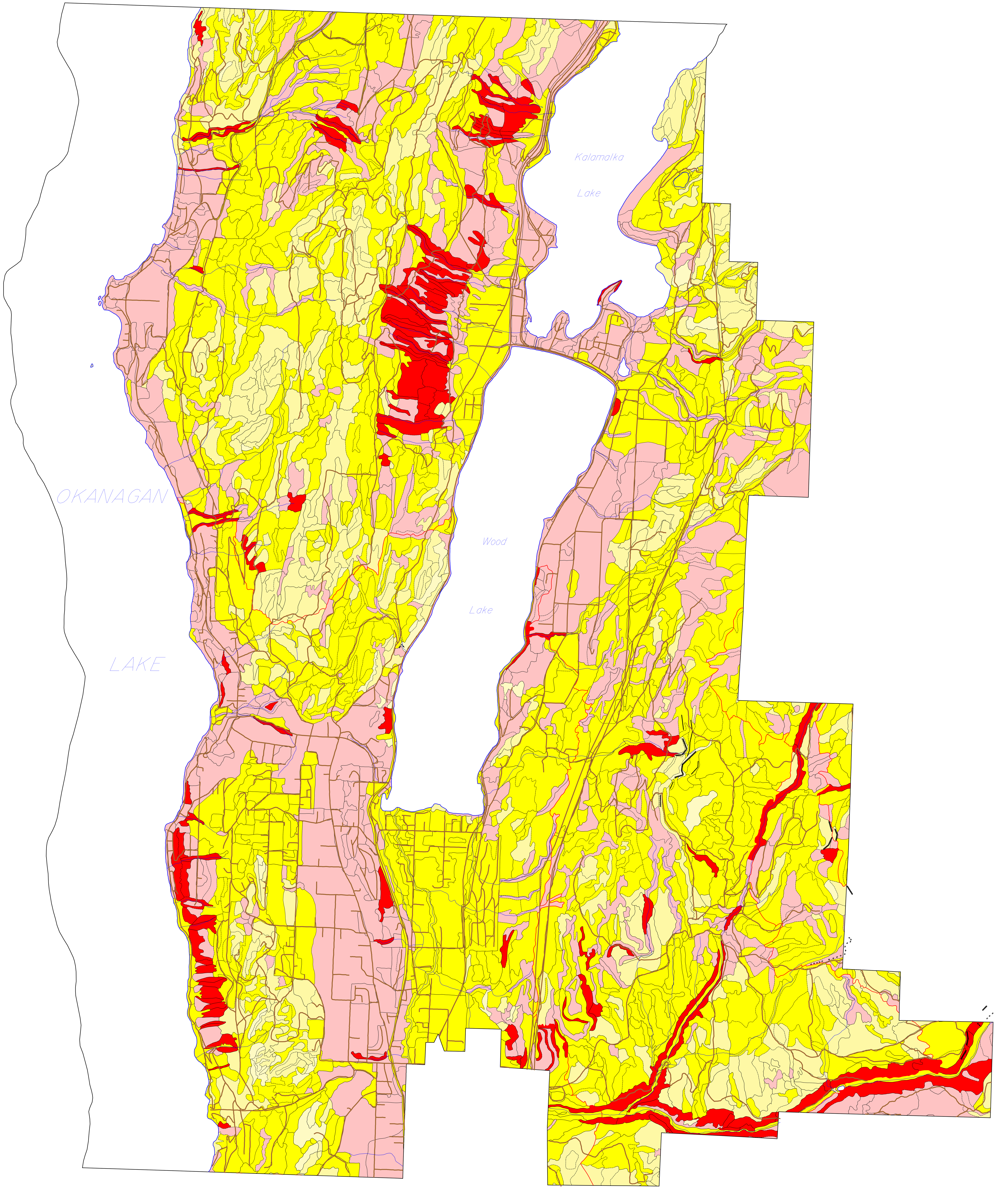
Completed data forms submitted to the Ministry of Environment.

Appendix D: Ratings Table

Ratings Table filename: lkc_wl-ratings_15Feb06.csv (See Appendix A for access)

Example of Ratings Table format:

ECO_SEC	BGC_ZONE	BGC_SUBZON	BGC_VRT	SITEMC_S	SITE_MA	SITE_MB	STRCT_S	STRCT_M	STAND_A	SERAL	A-SPIN_RE	A-SPIN_LIA	RCHPI_LIA	RCHPI_RE	R-CROR_LIS	R-CROR_LIA	R-PICA_LIG	R-PICA_RE	B-SWHA_RE	B-SWHA_LIG	B-LBCU_RE	B-LBCU_LIG	B-WSOW_RE	B-YBCH_LIG	B-GRSP_LIG	M-EUMA_RB	M-TATA_LIA
NOB	IDF	xh	1	AS			3				L	L	N	N	H	N	M	N	N	N	N	N	N	M	N	N	N
NOB	IDF	xh	1	AS			4		B		L	L	N	N	H	N	M	N	N	N	N	N	N	H	N	N	N
NOB	IDF	xh	1	AS			5		B		L	L	N	N	H	N	M	N	N	N	N	N	L	H	N	N	N
NOB	IDF	xh	1	AS			6		B		L	L	N	N	H	N	M	N	N	N	N	N	M	H	N	N	N
NOB	IDF	xh	1	AS			7		B		L	L	N	N	H	N	M	N	N	N	N	N	M	H	N	N	N
NOB	IDF	xh	1	AS	g		3				L	L	N	N	H	N	M	N	N	N	N	N	N	M	N	N	N
NOB	IDF	xh	1	AS	g		4		B		L	L	N	N	H	N	M	N	N	N	N	N	N	H	N	N	N
NOB	IDF	xh	1	AS	g		5		B		L	L	N	N	H	N	M	N	N	N	N	N	L	H	N	N	N
NOB	IDF	xh	1	AS	g		6		B		L	L	N	N	H	N	M	N	N	N	N	N	M	H	N	N	N
NOB	IDF	xh	1	AS	g		7		B		L	L	N	N	H	N	M	N	N	N	N	N	M	H	N	N	N
NOB	IDF	xh	1	AS	g	k	5		B		N	N	N	N	M	N	L	N	N	N	N	N	L	H	N	N	N
NOB	IDF	xh	1	AS	g	w	3				N	L	N	N	H	N	M	N	N	N	N	N	N	M	N	N	N
NOB	IDF	xh	1	AS	g	w	4		B		N	L	N	N	H	N	M	N	N	N	N	N	N	H	N	N	N
NOB	IDF	xh	1	AS	g	w	5		B		N	L	N	N	H	N	M	N	N	N	N	N	L	H	N	N	N
NOB	IDF	xh	1	AS	g	w	6		B		N	L	N	N	H	N	M	N	N	N	N	N	M	H	N	N	N
NOB	IDF	xh	1	AS	g	w	7		B		N	L	N	N	H	N	M	N	N	N	N	N	M	H	N	N	N
NOB	IDF	xh	1	AS	k		3				N	N	N	N	M	N	L	N	N	N	N	N	N	M	N	N	N
NOB	IDF	xh	1	AS	k		4		B		N	N	N	N	M	N	L	N	N	N	N	N	N	H	N	N	N
NOB	IDF	xh	1	AS	k		5		B		N	N	N	N	M	N	L	N	N	N	N	N	L	H	N	N	N
NOB	IDF	xh	1	AS	k		6		B		N	N	N	N	M	N	L	N	N	N	N	N	M	H	N	N	N
NOB	IDF	xh	1	AS	k		7		B		N	N	N	N	M	N	L	N	N	N	N	N	M	H	N	N	N
NOB	IDF	xh	1	AS	n		4		B		N	L	N	N	H	N	M	N	N	N	N	N	N	H	N	N	N
NOB	IDF	xh	1	AS	w		3				N	L	N	N	H	N	H	N	N	N	N	N	N	M	N	N	N
NOB	IDF	xh	1	AS	w		4		B		N	L	N	N	H	N	H	N	N	N	N	N	N	H	N	N	N
NOB	IDF	xh	1	AS	w		5		B		N	L	N	N	H	N	H	N	N	N	N	N	L	H	N	N	N
NOB	IDF	xh	1	AS	w		6		B		N	L	N	N	H	N	H	N	N	N	N	N	M	H	N	N	N



EROSION POTENTIAL MAPPING OF THE DISTRICT OF LAKE COUNTRY

For portions of map sheets **082L.003**, **082L.004**, **082L.013**, and **082L.014**

Scale 1:20,000

2005

DISTRICT of LAKE COUNTRY

Data Sources

This mapping project is based on 1:15,000 colour stereo aerial photography from Geographic Data BC taken in 1994 and updated based on field work in 2005. Base map is from Terrain Resource Inventory Mapping (TRIM) from Geographic Data BC. A total of 11% polygon inspection was achieved (Terrain Survey Intensity Level D).

Erosion Potential Classes

Class	Rating	Management Implications
VL	Very low	• Negligible or very minor soil erosion.
L	Low	• Expect minor erosion of fines in ditch lines and disturbed soils.
M	Moderate	• Expect moderate erosion when water is channelled down road surfaces or ditches and over exposed soils.
H	High	• Significant erosion problems can be created when water is channelled onto or over exposed soil on these sites.
VH	Very high	• Severe surface and gully erosion problems can be created when water is channelled onto or over exposed soils at these sites.

Credits

Erosion potential mapping: Polly Uunila, P. Geo. (Polar Geoscience, Coldstream, B.C.)

Digitizing and Cartography: Bon Lee (Baseline Geomatics Inc., Victoria, B.C.)

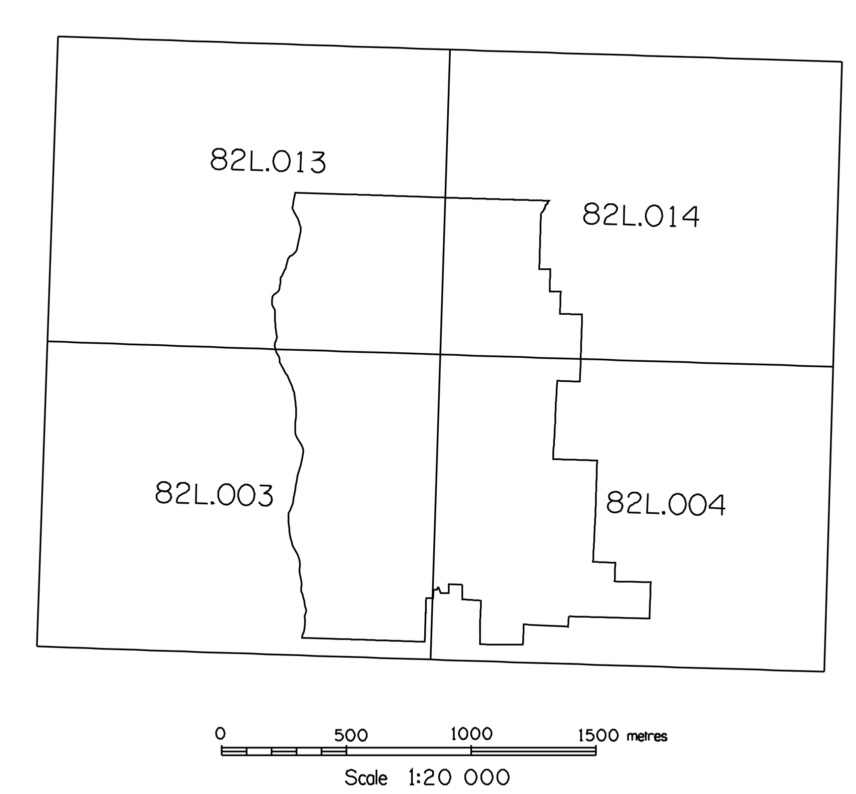
Funding: The District of Lake Country

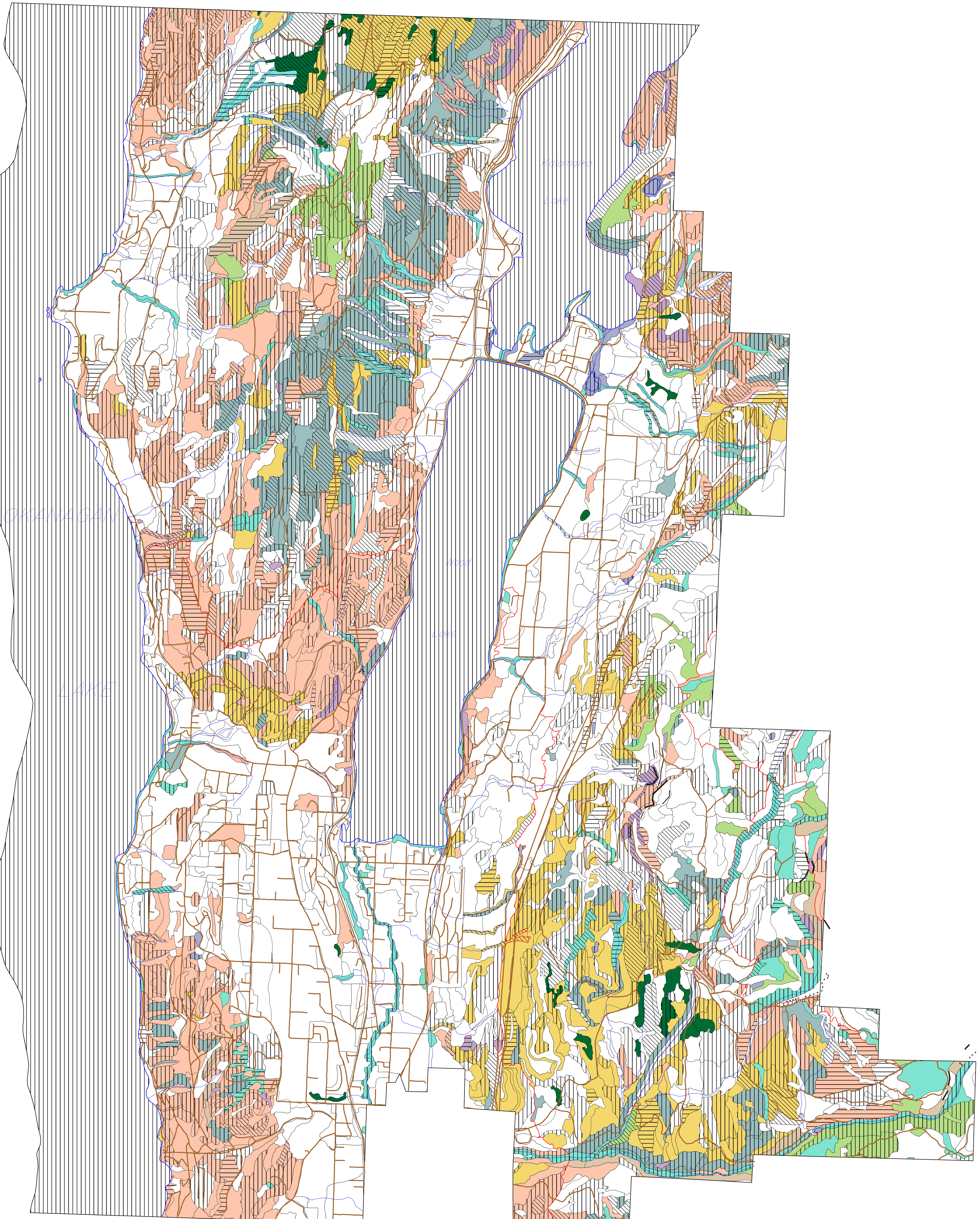
Accompanying Report

Iverson, K. and P. Uunila 2005. Sensitive Ecosystems Inventory: District of Lake Country, 2005. Volume 2: Terrestrial Ecosystem Mapping, Terrain, Terrain Stability, and Erosion Potential Mapping, and Expanded Legend.

Erosion Potential Classes

- VL
- L
- M
- H
- VH





SENSITIVE ECOSYSTEMS INVENTORY OF THE DISTRICT OF LAKE COUNTRY

For portions of map sheets
082L003, 082L004, 082L.013, 082L.014
Scale 1:20,000

2005

THE REAL ESTATE FOUNDATION OF BRITISH COLUMBIA · DISTRICT of LAKE COUNTRY · BRITISH COLUMBIA

Introduction

Sensitive Ecosystems are ecosystems that are ecologically sensitive and or rare in the landscape. These areas also have significant biodiversity values and provide many habitat features required by threatened and endangered plant and animal species.

Rationale

The Okanagan basin of British Columbia is an area of great ecological significance within both the province of B.C. and Canada as a whole. It is an area with high biodiversity values, and many rare and endangered ecosystems, plant and animal species. The warm dry climate of this valley has long attracted humans to live here. The Okanagan Valley is also the area with the highest population densities in the interior of British Columbia and has a rapidly growing population. This area has been subject to extensive agricultural conversion, significant changes to ecosystem structure and function through fire exclusion, and intense urban and rural development pressure. These pressures have resulted in the loss, fragmentation, and degradation of many of these natural areas.

This Sensitive Ecosystems Inventory (SEI) was initiated by the District of Lake Country and B.C. Ministry of Environment to provide an inventory of the remaining rare and fragile ecosystems and habitats for many wildlife species to support sustainable landscape level land-use decisions and to encourage private land stewardship.

Ecological Significance

These sensitive terrestrial ecosystems are ecologically significant because of their rarity and fragility and as a result of the great diversity of species they support, including habitat for many rare and endangered species.

Wetlands are extremely important because of their natural rarity in this area with few collecting sites and because many of them have been lost to development. They support a wide diversity of organisms including food, shelter, and breeding sites for ducks, songbirds, fish, amphibian, and invertebrate species. They have important hydrologic functions including filtering out pollutants, and safely storing and releasing water.

Riparian ecosystems include benches along streams, gullies with intermittent or permanent creeks, and fringes of lakes and ponds and sites with significant seepage. They support a rich diversity of species and have important hydrologic functions including filtering out pollutants, safely storing and releasing water (especially during peak flows), preventing stream bank erosion, and maintaining water quality and water temperatures..

Old forest ecosystems are ecosystems that are dominated by large, old trees. Most of these forests have been lost to selection logging of larger trees, ingrowth of dense trees resulting from fire exclusion, and development. Only small remnants of these forests remain today. Old forests and the old trees in them provide important habitat for many species including many woodpeckers, owls, and mule deer.

Grassland ecosystems are dominated by bunchgrasses but also have a wide diversity of forbs. Large areas of grasslands have been lost to agricultural and urban development and noxious weed invasion. Most of the remaining grasslands have been converted to disturbed grasslands (see Other Important Ecosystems) through partial invasion by noxious weeds.

Broadleaf woodland ecosystems are dominated by trembling aspen trees and include broad, moist basins in grassland areas. They are typically very shrubby and provide important habitat for many birds, reptiles and mammals. These ecosystems are quite rare and their moist nature makes their soils sensitive to disturbance.

Coniferous woodland ecosystems are like forests, but have very open canopies or only scattered ponderosa pine or Douglas-fir trees. They most commonly occur on very dry sites where soils are shallow or very shallow. Many sites have been lost to development and many areas have been altered by ingrowth of trees associated with fire exclusion, weed invasion, and other human disturbances.

Sparsely vegetated ecosystems occur on sites where exposed bedrock or rocks limit the places where vegetation can grow. They include cliffs, rock outcrops and talus slopes with sparse shrub or grass/herb cover. Many of these ecosystems are rare and their coarse or shallow soils make them sensitive to disturbance. They provide important habitat for bats, snakes, and raptor nests.

Other important ecosystems are not sensitive ecosystems but have many important values associated with them. They include mature forest and disturbed grassland ecosystems. **Mature forest ecosystems** provide important buffer sites, provide some of the values associated with old forest ecosystems and are recruitment sites for old forests. Similarly, **disturbed grassland ecosystems** still provide many of the important habitat values associated with grasslands, but they have some weeds (10 to 50% noxious weeds) or have lost many climax grassland species. Given the very limited extent of remaining grasslands, these are important sites for grassland restoration and maintenance of many grassland values including habitat for many rare and endangered species.

Methods

The study area was ecosystem mapped following provincial Resources Inventory Committee standards. Bioterrain and ecosystem polygons were delineated on 1:15,000 scale colour stereo aerial photographs from Geographic Data BC taken in 1994. Field sampling (survey intensity level 3) was used and a total of 11% of polygons were inspected in the field during the summer of 2005. Up to three ecosystems were mapped in each polygon and were assigned proportions of the polygon that they occupy (to the nearest 10%). Linework on photographs was digitized using the monorestitution method, databases were compiled, reviewed, and verified, and digital (ArcInfo) and hardcopy maps were produced.

All ecosystems mapped were evaluated for rarity and sensitivity and an algorithm was developed to create this Sensitive Ecosystem and Other Important Ecosystem theme. Each Sensitive Ecosystem and Other Important Ecosystem has been assigned a colour. The first component of each polygon has been colour-themed. Polygons with Sensitive or Other Important Ecosystems as a second or third component have cross-hatching.

Data Limitations

The map is intended to be used as a flagging tool to accompany planning processes and management of land resources in the study area. For site-specific evaluations, more detailed field assessments are needed. The accuracy of the boundaries of the mapping is limited by the scale of the aerial photographs used (1:15,000). *Enlargement of the data beyond the source scale may result in unacceptable distortion and faulty registration with other data sets.* Rapid changes are ongoing within the study area making it important to refer to the dates of information sources.

Credits

Participating Agencies: District of Lake Country and the BC Ministry of Environment.

Base Terrestrial Ecosystem Mapping: Kristi Iverson, R.P.Bio. (Iverson & MacKenzie Biological Consulting Ltd.)

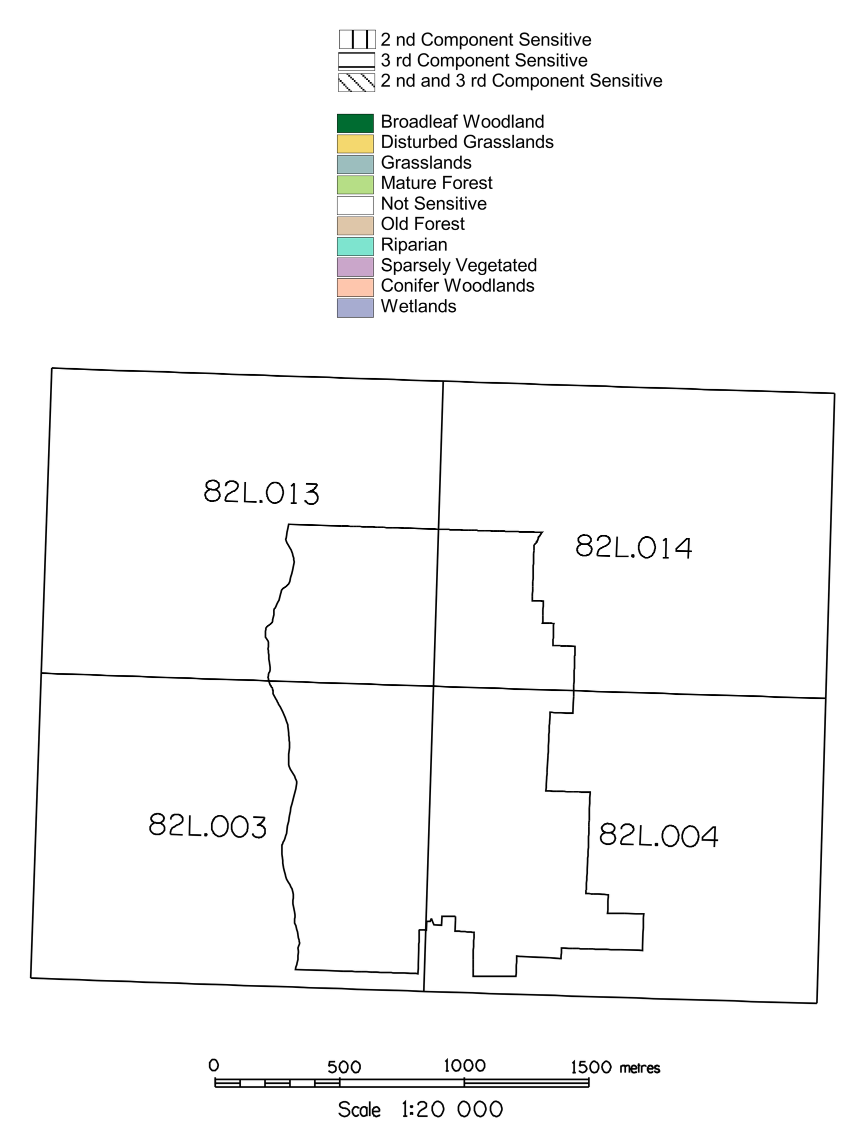
Base Bioterrain Mapping: Polly Uunila, P.Geo. (Polar Geoscience)

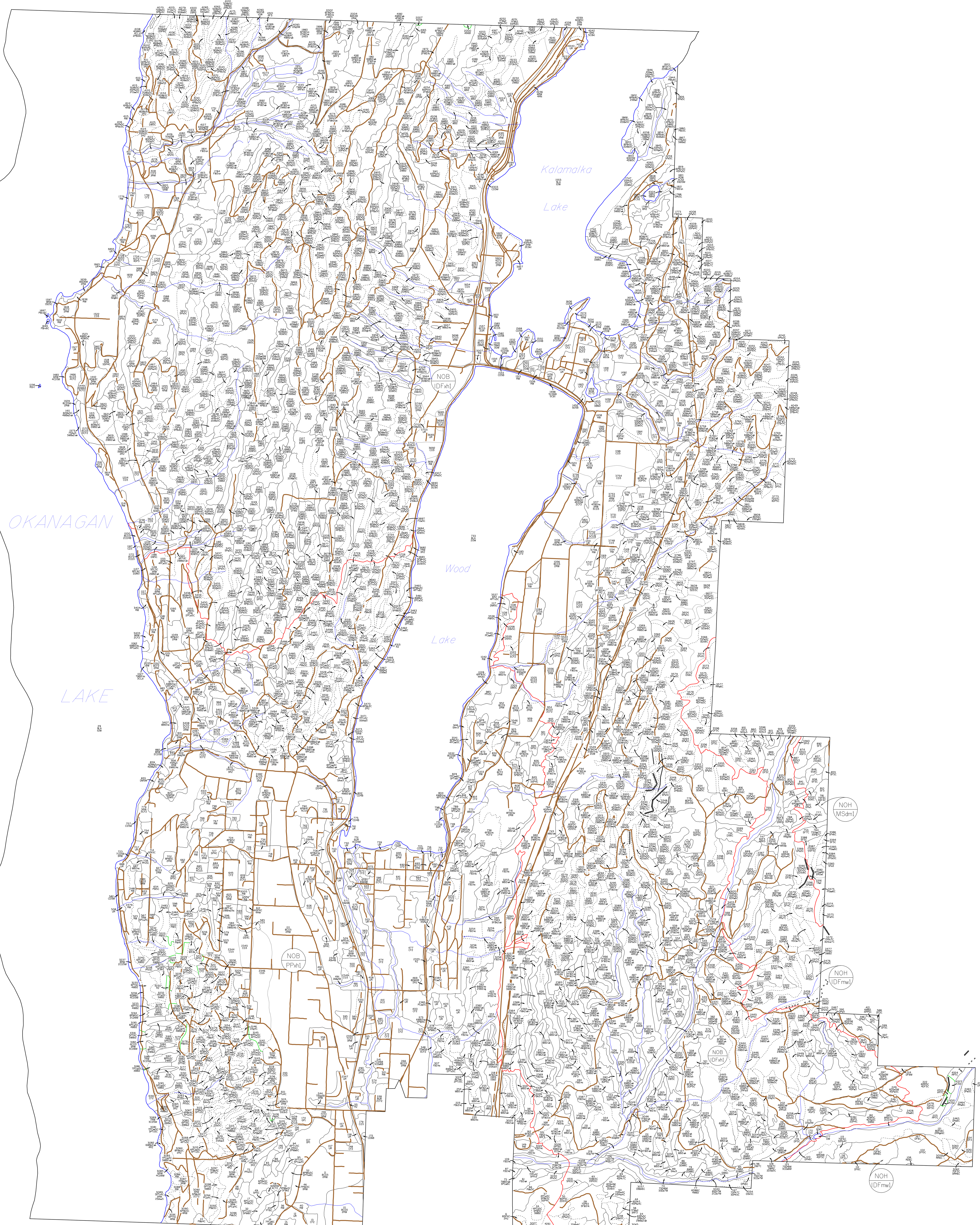
Sensitive Ecosystems Theme: Conversion tables were developed by Kristi Iverson, building upon tables used for the Central Okanagan and Vernon Commonage that were developed by Kristi Iverson, Carmen Cadrin and Corey Erwin (BC Ministry of Environment, Victoria, B.C.).

Base Mapping Data: Selected digital layers are from the Terrain Resources Information Management (TRIM) Program, Geographic Data BC.

Digitizing and Cartography: Bon Lee (Baseline Geomatics Inc., Victoria, B.C.)

Funding: The District of Lake Country, The Real Estate Foundation of BC, and the BC Ministry of Environment.





TERRESTRIAL ECOSYSTEM MAPPING OF THE DISTRICT OF LAKE COUNTRY

For portions of map sheets **082L.003, 082L.004, 082L.013, and 082L.014**

Scale 1:20,000

2005

THE REAL ESTATE FOUNDATION OF BRITISH COLUMBIA — DISTRICT of LAKE COUNTRY — BRITISH COLUMBIA

Introduction

This project provides detailed ecosystem mapping of the District of Lake Country. Project boundaries extend from the North Okanagan Regional District and City of Vernon in the north, west to Okanagan Lake, and south to the City of Kelowna and Regional District of the Central Okanagan.

This detailed ecosystem mapping will provide baseline information for land use planning products such as a Sensitive Ecosystem map. Wildlife habitat maps were produced for the following species: Great Basin Spadefoot, Painted Turtle, Great Basin Gopher Snake, Western Rattlesnake, Swainson's Hawk, Long-billed Curlew, Western Screech-owl, Yellow-breasted Chat, Grasshopper Sparrow, Spotted Bat, and Badger.

Mapping used the provincially recognised methodology in *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998). Fieldwork was completed in June 2005 to survey intensity level 3.

Map Unit Boundaries

Ecosection Map Unit
Biogeoclimatic Map Unit
Ecosystem Map Unit
Study area boundary
Plot location symbol +

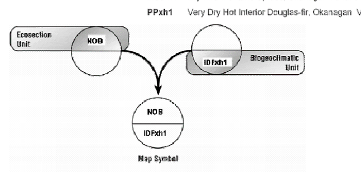
Ecosection and Biogeoclimatic Unit Symbols

Ecosections:

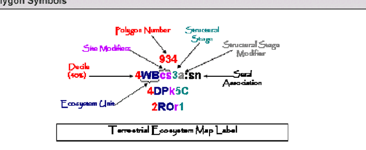
NOB North Okanagan Basin
NOH North Okanagan Highlands

Biogeoclimatic Units:

IDFmw1 Moist Warm Interior Douglas-fir, Okanagan Variant
IDFxh1 Very Dry Hot Interior Douglas-fir, Okanagan Variant
MSdm1 Dry Mild Montane Spruce, Okanagan Variant
PPxh1 Very Dry Hot Interior Douglas-fir, Okanagan Variant



Ecosystem Polygon Symbols



Site Modifiers

Code	Criteria
a	Active floodplain
c	Coarse-textured soils
f	Fine-textured soil
g	Site occurs in a gully
j	Gentle to moderate slope (<25%)
k	Cool aspect (25% - 100% slope, 285° - 135°)
q	Very steep cool aspect (>100% slope, 285° - 135°)
r	Ridged or ridge crest
s	Shallow soil (20 – 100cm to bedrock)
t	Terrace
v	Very shallow soil (<20 cm. to bedrock)
w	Warm aspect (>25% slope, 135° - 285°)
x	Drier than typical
y	Moister than typical
z	Very steep warm aspect (>100% slope, 135° - 285°)

Structural Stages

Code	Structural stage
1	Non-vegetated / sparsely vegetated
2	Herb
3	Shrub/Herb
3a	Low Shrub (less than 2m tall)
3b	Tall Shrub (between 2m and 10m tall)
4	Pole/Sapling; dense, single layered forests
5	Young Forest; more open than stage 4; may have a few mature trees
6	Mature Forest; dominated by mature trees with some scattered old trees
7	Old Forest (generally >250 years old); dominated by old trees; generally open forests

Ecosystem Units

IDFmw1 Interior Douglas-fir moist warm subzone Okanagan variant

Map Code	Site Series	Ecosystem Unit Name	Assumed Modifiers	Typical Conditions
CD	00	Black cottonwood / Douglas-fir – Snowberry –Dogwood	d, j, m	This forest ecosystem occurs on floodplains.
CT	00	Cattail Marsh	d, j, m	These marshes occur on ponds or in small depressions.
DF	01	Douglas-fir / Western redcedar – Falsebox – Prince's pine	d, j, m	This forest ecosystem is associated with mesic gently sloping sites.
DP	04	Douglas-fir – Pinegrass – Feathermoss	d, j, m	This forest ecosystem occurs on moderate warm aspects.
DS	02	Douglas-fir / Ponderosa pine – Snowberry – Bluebunch wheatgrass	d, j, m	This forest ecosystem occurs on very shallow soils.
PP	03	Douglas-fir – Penstemon – Pinegrass	d, m, w	This forest ecosystem occurs on steep warm aspects.
RD	06	Western redcedar – Devil's club – Foamflower	d, j, m	This forest ecosystem occurs on moist lower and toe slopes with subsurface seepage.
RR	05	Western redcedar / Douglas-fir - Dogwood	d, j, m	This forest ecosystem occurs on gentle receiving sites.
SO	00	Saskatoon – Mock orange Talus	c, d	This ecosystem is associated with steep, blocky talus slopes.
WB	00	Bluebunch wheatgrass – Balsamroot	d, m, w	This grassland ecosystem occurs on moderately steep to steep warm aspects with deep, medium-textured soils.
WS	00	Willow – Sedge Wetland	d, j, m	This swamp wetland ecosystem occurs at the edges of ponds and other wetlands.

Ecosystem Units

IDFxh1 Interior Douglas-fir very dry hot subzone Okanagan variant

Map Code	Site Series	Ecosystem Unit Name	Assumed Modifiers	Typical Conditions
AB	00	Nuttall's alkaligrass – Foxtail barley graminoid meadow	d, f, j	This wet meadow ecosystem commonly occurs at the fringes of alkaline lakes and ponds.
AS	98	Trembling aspen – Snowberry – Kentucky bluegrass	d, j, m	This ecosystem occurs in large, broad depressions in grassland areas.
BM	00	Bulrush Marsh	d, f, j	This ecosystem occurs as a fringe along ponds and wetlands.
BN	96	Kentucky bluegrass – Stiff needlegrass	d, j, m	This grassland ecosystem is found in small swales and depressions where moisture collects.
BR	00	Baltic Rush Marsh-Meadow	d, f, j	This marsh-meadow occurs along the edges of ponds and shallow open water and wet depressions.
CD	00	Black cottonwood / Douglas-fir – Snowberry –Dogwood	d, j, m	This forest ecosystem occurs on floodplains and as a fringe along the edge of ponds and lakes.
CS	00	Common Spikerush Marsh	d, f, j	A marsh that occurs at the edge of some ponds.
CT	00	Cattail Marsh	d, j, m	This marsh occurs as a fringe on ponds or in small depressions.
CW	00	Choke cherry – Bluebunch wheatgrass	j, v	This ecosystem occurs on gently sloping, fractured rock bluffs.
DP	01	Douglas-fir / Ponderosa pine – Pinegrass	d, j, m	This forest ecosystem is associated with mesic gently sloping sites.
DS	07	Douglas-fir / Ponderosa pine – Snowberry – Spirea	d, j, m	This forest ecosystem is associated with moist, gently sloping sites.
DW	03	Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Pinegrass	d, m, w	This forest ecosystem is common on moderate to steep warm aspects.
FO	00	Douglas-fir / Ponderosa pine – Saskatoon – Mock orange	c, d	This forest ecosystem occurs on rocky colluvial soils.
FW	91	Idaho fescue – Bluebunch wheatgrass	d, j, m	This ecosystem occurs on gentle slopes and cool aspects.
PB	02	Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Balsamroot	m, s, w	This forest ecosystem is typically associated with very shallow soils.
RF	97	Prairie Rose – Idaho fescue	d, j, m	This shrubby ecosystem commonly occurs in moisture collecting depressions in grassland areas.
SA	00	Antelope brush – Selaginella	j, m, s	This ecosystem commonly occurs on very shallow soil pockets on ledges of rock outcrops.
SB	00	Selaginella – Bluebunch wheatgrass	j, v	This grassland ecosystem commonly occurs on gently sloping, unfractured, low relief bedrock outcrops.
SD	08	Hybrid white Spruce – Douglas-fir – Douglas maple – Dogwood	d, j, m	This forest ecosystem is associated with gullies that have intermittent or subsurface water flow.
SO	00	Saskatoon – Mock orange Talus	c, d	This ecosystem is associated with steep, blocky talus slopes.
SP	04	Douglas-fir – Ponderosa pine – Snowbrush – Pinegrass	d, j, m	This forest ecosystem is associated with submesic sites.
WB	93	Bluebunch wheatgrass – Balsamroot	d, m, w	This grassland ecosystem commonly occurs on warm aspects.
WS	09	Willow – Sedge Wetland	d, j, m	This swamp wetland ecosystem occurs at the edges of ponds and other wetlands.

Ecosystem Units

MSdm1 Montane Spruce dry mild subzone Okanagan variant

Map Code	Site Series	Ecosystem Unit Name	Assumed Modifiers	Typical Conditions
PG	03	Lodgepole pine – Grouseberry – Cladonia	d, j, m	This forest ecosystem is common on moderate to steep warm aspects.
SF	01	Hybrid white spruce – Falsebox – Feathermoss	d, j, m	This forest ecosystem is associated with mesic gently sloping sites.
SG	06	Hybrid white spruce – Gooseberry	d, j, m	This forest ecosystem is associated with moist, gently sloping sites.
SH	07	Hybrid white spruce – Trapper's tea – Horsetail	d, j, m	This forest ecosystem occurs on sites with a high water table.

Ecosystem Units

PPxh1 Ponderosa pine very dry hot subzone Okanagan variant

Map Code	Site Series	Ecosystem Unit Name	Assumed Modifiers	Typical Conditions
AS	00	Trembling aspen – Snowberry – Kentucky bluegrass	d, j, m	This ecosystem commonly occurs in large, broad depressions in grassland areas.
CD	00	Black cottonwood / Douglas-fir – Snowberry – Dogwood	d, j, m	This forest ecosystem occurs on floodplains and as a fringe along the edge of ponds and lakes.
CT	00	Cattail Marsh	d, j, m	This marsh occurs as a fringe on ponds or in small depressions.
CW	00	Choke cherry – Bluebunch wheatgrass	j, v	This ecosystem occurs on gently sloping, fractured rock bluffs.
DM	08	Douglas-fir – Water birch – Douglas maple	d, j, m	This forest ecosystem is commonly associated with gullies that have intermittent or permanent streams or subsurface water flow.
DS	07	Douglas-fir – Ponderosa pine – Snowberry – Spirea	d, j, m	This forest ecosystem is commonly associated with gently sloping sites receiving some moisture.
FB	00	Fescue – Bluebunch wheatgrass	d, j, m	This ecosystem occurs on gentle slopes and cool aspects.
FO	00	Douglas-fir / Ponderosa pine – Saskatoon – Mock orange	c, d	This forest ecosystem occurs on rocky colluvial soils.
PC	04	Ponderosa pine – Bluebunch wheatgrass – Cheatgrass	d, j, m	This forest ecosystem is typically associated with moderate to steep slopes on warm aspects.
PF	05	Ponderosa pine – Bluebunch wheatgrass – Rough fescue	d, j, m	This forest type is typically associated with moderate to steep slopes on cool aspects.
PT	02	Ponderosa pine – Red three-awn	c, d, w	This forest type is typically associated with deep, coarse-textured materials on warm aspects or very shallow soils.
PW	01	Ponderosa pine – Bluebunch – Idaho fescue	d, j, m	This forest ecosystem is typically associated with mesic sites.
SA	00	Antelope brush – Selaginella	j, m, s	This ecosystem commonly occurs on very shallow soil pockets on ledges of rock outcrops.
SB	00	Selaginella – Bluebunch wheatgrass rock outcrop	j, v	This grassland ecosystem commonly occurs on gently sloping, unfractured, low relief bedrock outcrops.
SO	00	Saskatoon– Mock orange Talus	c, d	This ecosystem is commonly associated with steep, blocky talus slopes.
SP	06	Douglas-fir – Ponderosa pine – Snowberry – Pinegrass	d, j, m	This forest type is typically associated with gentle to moderate lower slopes that are receiving some moisture.
SR	00	Snowberry - Rose – Kentucky bluegrass	d, j, m	This shrubland ecosystem commonly occurs in moisture collecting swales and depressions in grassland areas.
WB	00	Bluebunch wheatgrass – Balsamroot	d, w, m	This ecosystem commonly occurs on moderately steep to steep warm slopes with deep, medium-textured soils.
WS	00	Willow – Sedge Wetland	d, j, m	This swamp wetland ecosystem occurs at the edges of ponds and other wetlands.

Ecosystem Units

Non-vegetated, sparsely vegetated, and anthropogenic units in all subzones

Map Code	Ecosystem Unit Name	Typical Conditions
CB	Cutbank	A part of a road corridor or river course situated upslope of the road or river, which is created by excavation and/or erosion of the hillside.
CF	Cultivated field	A flat or gently rolling, non-forested open areas that are subject to human agricultural practices.
CL	Cliff	A steep, vertical or overhanging rock face.
CO	Cultivated orchard	An agricultural area composed of single or multiple fruit bearing tree species planted in rows.
CV	Cultivated vineyard	An agricultural area composed of single or multiple species of grapes, usually supported by trellises.
ES	Exposed soil	An area of exposed soil that is not included in any of the other definitions.
GC	Golf course	Flat to gently rolling grass covered fairways, separated by rows of shrubs and trees, used for golf.
GP	Gravel Pit	An area exposed through the removal of sand and gravel.
LA	Lake	A body of fresh water > 2m deep > 5ha.
OW	Shallow open water	Permanent shallow open water < 2m deep, lacking emergent plant cover.
RI	River	A watercourse formed when water flows within continuous definable banks.
RN	Railway Surface	A railway with fixed rails for single or multiple rail lines.
RO	Rock outcrop	A sparsely vegetated, gentle to steep, bedrock escarpment or outcropping.
RW	Rural	An area where the residences are intermixed with forested or agricultural lands.
RZ	Road surface	An area cleared and compacted for the purposes of transporting goods and services by vehicle.
TA	Talus	Angular rock fragments of any size accumulated at the foot of steep rock slopes due to rock fall.
UR	Urban/Suburban	An area in which residences and other human developments cover the landscape.

Seral Associations

Ecosystem Unit	Code	Name	Description
FB or FW	cn	*Cheatgrass – Columbian needlegrass*	Early seral sites dominated by invasive annual bromes with scattered Columbia needlegrass and some native grassland forbs.
	fc	*Idaho fescue – cheatgrass*	Mid and late seral sites dominated by Idaho fescue and invasive annual bromes, especially cheatgrass, and a variety of native grassland forbs.
	kc	*Knapweed - Cheatgrass*	Early and very early seral sites. There are few or no native bunchgrasses remaining on these sites.
	nc	*Columbia needlegrass – cheatgrass*	Early seral sites dominated by Columbia needlegrass and invasive annual bromes and a variety of native grassland forbs.
	wk	*Bluebunch wheatgrass – Knapweed*	Mid- to late-seral sites dominated by bluebunch wheatgrass but also with some knapweed or cheatgrass.
SB	cg	*Cheatgrass*	Mid- to early-seral sites with cheatgrass, sulphur cinquefoil, selaginella, and rusty steppe moss.
WB	kc	*Knapweed - Cheatgrass*	Early and very early seral sites. There are few or no native bunchgrasses remaining on these sites.
	wk	*Bluebunch wheatgrass – Knapweed*	Mid- to late-seral sites dominated by bluebunch wheatgrass but also with some knapweed or cheatgrass.

Data Sources

This mapping project is based on 1:15,000 colour stereo aerial photography from Geographic Data BC taken in 1994 and updated based on field work in 2005. Base map is from Terrain Resource Inventory Mapping (TRIM) from Geographic Data BC. Survey Intensity 3 was used. A total of 11% polygon inspection was achieved. Nine full plots, 66 ground inspections, and 207 visual inspections were completed in the field.

Credits

Participating Agencies: District of Lake Country and the BC Ministry of Environment.

Ecosystem mapping: Kristi Iverson, R.P.Bio. (Iverson & MacKenzie Biological Consulting Ltd.)

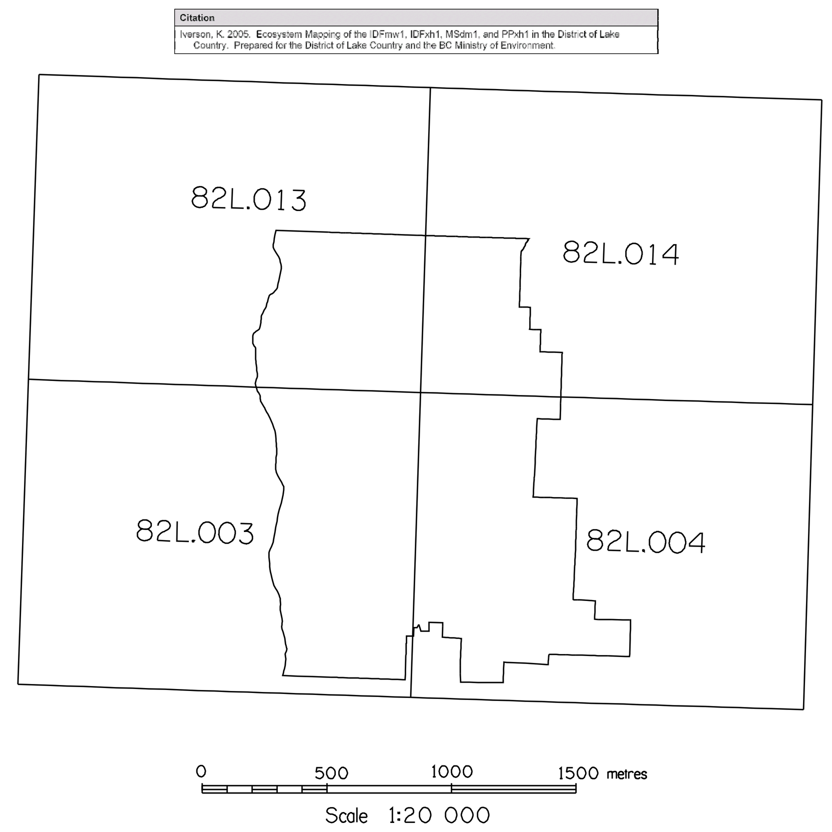
Bioterrain mapping: Polly Uunila (Polar Geoscience)

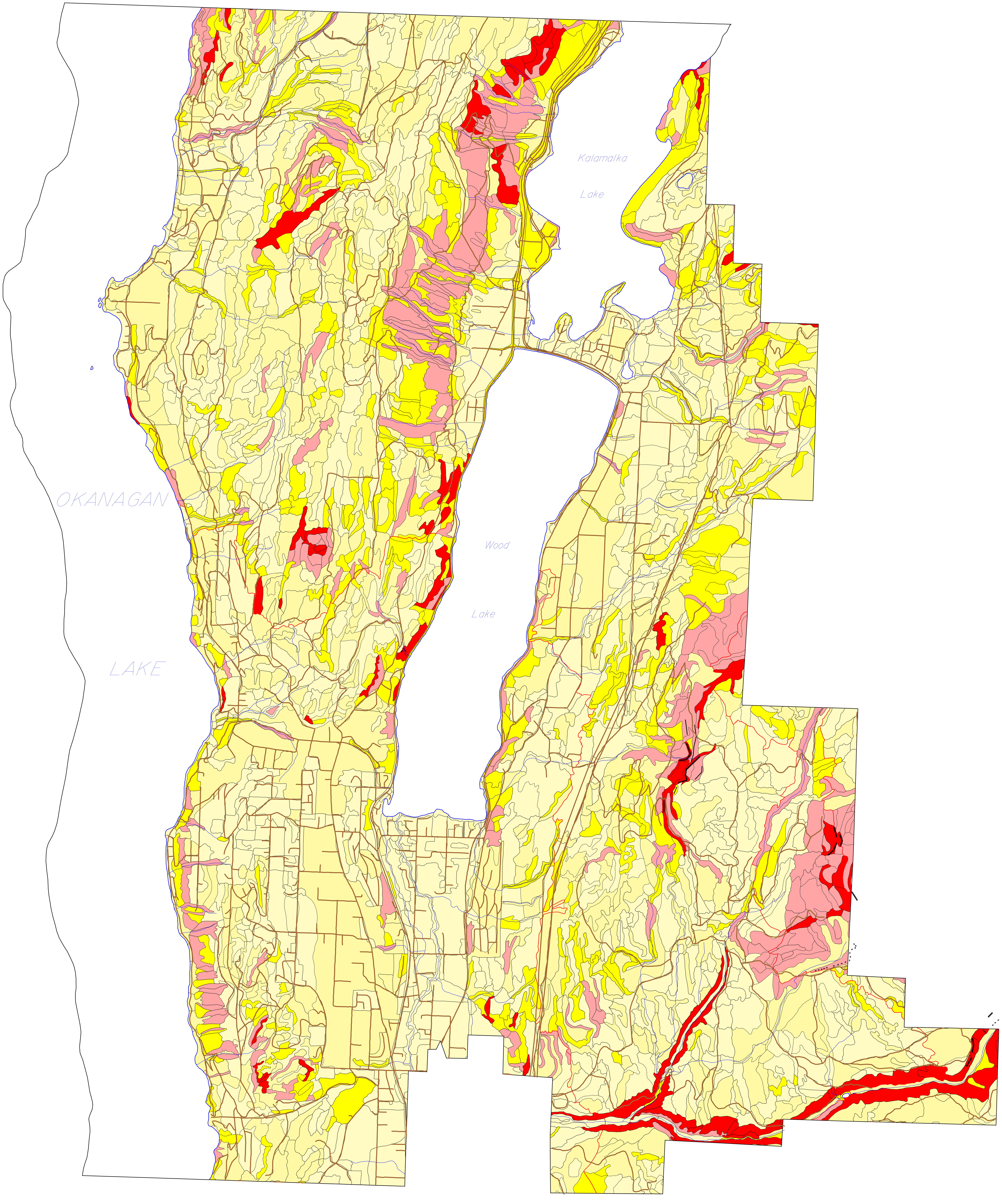
Digitizing and Cartography: Bon Lee (Baseline Geomatics Inc., Victoria, B.C.).

Funding: The District of Lake Country, The Real Estate Foundation of BC, and the BC Ministry of Environment.

Citation

Iverson, K. 2005. Ecosystem Mapping of the IDFmw1, IDFxh1, MSdm1, and PPxh1 in the District of Lake Country. Prepared for the District of Lake Country and the BC Ministry of Environment.





TERRAIN STABILITY MAPPING OF THE DISTRICT OF LAKE COUNTRY

For portions of map sheets **082L.003, 082L.004, 082L.013,** and **082L.014**

Scale 1:20,000

2005

DISTRICT of LAKE COUNTRY

Data Sources

This mapping project is based on 1:15,000 colour stereo aerial photography from Geographic Data BC taken in 1994 and updated based on field work in 2005. Base map is from Terrain Resource Inventory Mapping (TRIM) from Geographic Data BC. A total of 11% polygon inspection was achieved (Terrain Survey Intensity Level D).

Terrain Stability Classes

Class	Interpretation
I	• No significant stability problems exist.
II	• There is a low likelihood of landslides following disturbance or development. • Minor slumping is expected along road cuts and excavations.
III	• Stability problems can develop. • Follow Best Management Practices to reduce the likelihood of causing slope failure. • Minor slumping is expected along road cuts and excavations. There is a low likelihood of landslide initiation following road construction. • On-site inspection required by geotechnical staff.
IV	• Expected to contain areas with a moderate likelihood of landslide initiation following development, disturbance or road construction. • These areas should be avoided. Use caution when planning intensive land use above or below these areas. • On-site inspection required by geotechnical staff.
V	• Expected to contain areas with a high likelihood of landslide initiation. Signs of existing instability present. • Avoid these areas. Do not plan intensive land use above or below these areas. • On-site inspection required by geotechnical staff.

Credits

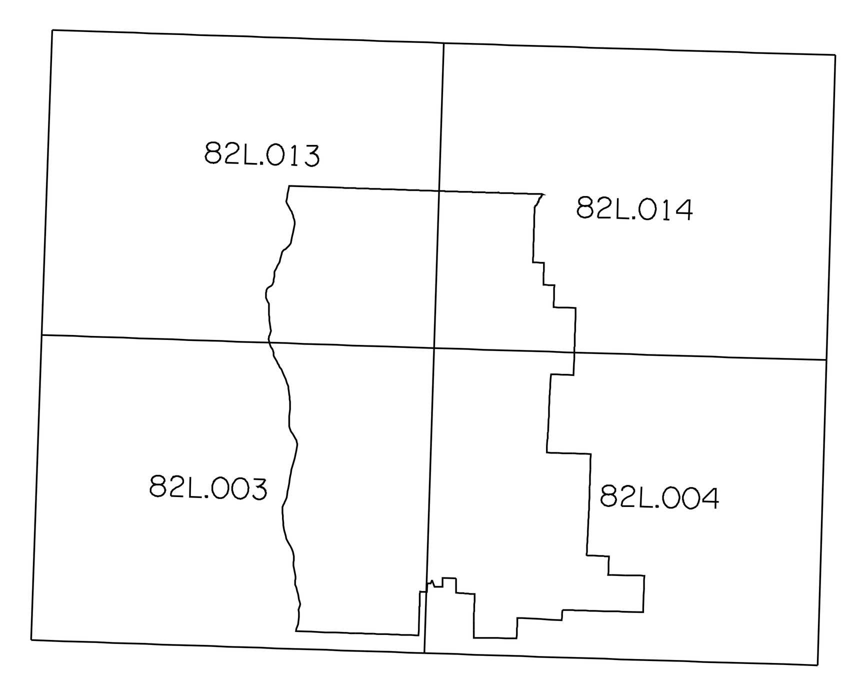
Terrain stability mapping: Polly Uunila, P. Geo. (Polar Geoscience, Coldstream, B.C.)
Digitizing and Cartography: Bon Lee (Baseline Geomatics Inc., Victoria, B.C.)
Funding: The District of Lake Country

Accompanying Report

Iverson, K. and P. Uunila 2005. Sensitive Ecosystems Inventory: District of Lake Country, 2005. Volume 2: Terrestrial Ecosystem Mapping, Terrain, Terrain Stability, and Erosion Potential Mapping, and Expanded Legend.

Terrain Stability Classes

I
II
III
IV
V



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