Sensitive Ecosystems Inventory: Kelowna, 2007

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

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This project has adapted material from the reports for the Bella Vista – Goose Lake Range Sensitive Ecosystems Inventory[8] (SEI), Commonage SEI[9], Lake Country SEI[10] and Central Okanagan SEI[11].

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

Todd Cashin reviewed the draft version of this report.

[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] City of Kelowna
[3] Iverson & MacKenzie Biological Consulting Ltd.
[4] Polar Geoscience Ltd.
[5] Makonis Consulting Ltd.
[6] Working on behalf of Timberline Forest Inventory Consultants Ltd. at that time
[7] Baseline Geomatics Inc.
[8] Iverson 2003
[9] Iverson 2005
[10] Iverson 2006
[11] Iverson and Cadrin 2003

Abstract

The Okanagan Basin of British Columbia is an area of very high biodiversity, including many vulnerable, rare and endangered species and plant communities. A high diversity of ecosystems occurs in close proximity, providing habitat for many species. The region has been subject to widespread agricultural conversion, intense human settlement pressure, extensive spread of invasive alien plants, uncontrolled motorized recreation, and selective logging of old trees. Additionally, changes in natural fire regimes have resulted in forests dense with ingrowth and vulnerable to catastrophic wildfire and loss of grasslands due to encroaching trees. Although a large portion of the area has been converted to agriculture and urban, rural, and commercial developments, significant natural areas and values remain.

Kelowna's strategic plan indicates that "the climate and natural beauty of the area are major attractions to residents, visitors and businesses" but that "housing needs have placed development pressures on agricultural and environmentally sensitive lands." This Sensitive Ecosystems Inventory (SEI) of the City of Kelowna was initiated in 2007 to provide inventory information on remaining rare and fragile ecosystems that can be used for ecologically sustainable land use and development planning. These natural areas are a vital portion of the north – south corridor in the Okanagan Valley and are facing further rural and urban development pressures.

This project includes new ecosystem mapping for the majority of the City of Kelowna and updated mapping for the South Slopes area along the southern edge of the city and including adjacent lands in the Regional District of the Central Okanagan. Terrestrial Ecosystem Mapping (TEM) was used as a base to develop a Sensitive Ecosystems theme map. The inventory was compiled through digital aerial photograph interpretation on a DiAP viewer and field sampling in the fall of 2007. This technical report documents inventory methods and results and provides management recommendations.

Twenty-eight percent of the City of Kelowna was comprised of sensitive ecosystems (SE); less than one percent of the area was included in the other important ecosystem (OIE) categories. Wetlands, old forests, sparsely vegetated ecosystems and broadleaf woodlands were extremely rare in the study area; riparian and grassland ecosystems were uncommon. Although greater areas of intact coniferous woodlands remained, much of the area was covered by altered ecosystems including extensive urban and rural human settlements, agricultural fields, and burned forests.

Many of the sensitive ecosystems are at high risk of loss and additional fragmentation by human settlement. Most remaining coniferous woodlands have been selectively logged historically and have become ingrown and are at continued risk of loss of understory vegetation and loss to catastrophic wildfire. Some remnant grasslands have tree encroachment and invasive plants associated with them. Many wetland and riparian ecosystems have become isolated and fragmented. Sensitive and other important ecosystems provide many social values including scenic backdrops, recreational opportunities and increased property values. With few remaining intact sensitive ecosystems in the study area, 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 City of Kelowna and provides guidance regarding their conservation and management.

Chapter 1: Introduction sets the context of the SEI project by describing the importance of both biodiversity and the study area.

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: Planning and management outlines conservation and land management planning options for the City of Kelowna and landowners.

The Okanagan Sensitive Ecosystems Inventory Conservation Manual[12] provides detailed information on conservation tools that are directly applicable to ecosystems in the City of Kelowna.

Chapters 7 through *15* 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 16: Future directions presents recommendations for using the SEI and updating SEI products.

Volume 2[13] 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. 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 mapping,*** including 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.

[12] Iverson et al. 2008
[13] Iverson and Uunila 2008

1 Introduction

The Okanagan Valley is an area of tremendous biological, ecological and geological diversity. Most of the ecosystems that occur here have a limited distribution within British Columbia, Canada, and North America. However, many of these 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 City of Kelowna includes natural areas that are important for maintaining connectivity in the valley and have a diverse assemblage of ecosystems that support many species at risk and other important species.

The City of Kelowna's strategic plan[14] indicates that "the climate and natural beauty of the area are major attractions to residents, visitors and businesses" but that "housing needs have placed development pressures on agricultural and environmentally sensitive lands."

The City of Kelowna initiated this project to complete an inventory information base to support sound land management decisions and promote effective stewardship of sensitive ecosystems. The project provides the City with data that can be used in revising their Official Community Plan 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 City of Kelowna, highlights their values and importance, and offers practical advice on how to best avoid or minimize damage to them.

The Kelowna SEI follows from the Vernon Commonage SEI[15], Bella Vista – Goose Lake Range SEI[16], Lake Country SEI[17], Central Okanagan SEI[18], and Vancouver Island SEI[19]. Many of the materials in this report have been adapted from the reports of those SEI projects.

Study Area

The study area (Figure 1Error! Reference source not found.) lies within the central Okanagan Valley of south-central British Columbia and includes two components: the South Slopes area and the Kelowna area. For the purposes of generating results, the study area was bounded by the extent of the City of Kelowna. Excluding Okanagan Lake, the city covers 21 628 ha and includes private land, regional parks, provincial parks, and small areas of provincial crown land and city and regional district lands.

The South Slopes area was originally mapped in 2001 as part of the Central Okanagan SEI[20] and was updated as part of this project, particularly the portions that burned in the 2003 Okanagan

[14] City of Kelowna 2004
[15] Iverson 2005
[16] Iverson 2003
[17] Iverson 2006
[18] Iverson and Cadrin 2003
[19] McPhee et al. 2000
[20] Iverson and Cadrin 2003

Mountain Park Fire. The South Slopes area includes part of the southern edge of the City of Kelowna and adjacent lands within the Regional District of the Central Okanagan. The Kelowna area covers the remainder of the City of Kelowna and was newly mapped in 2007-2008.

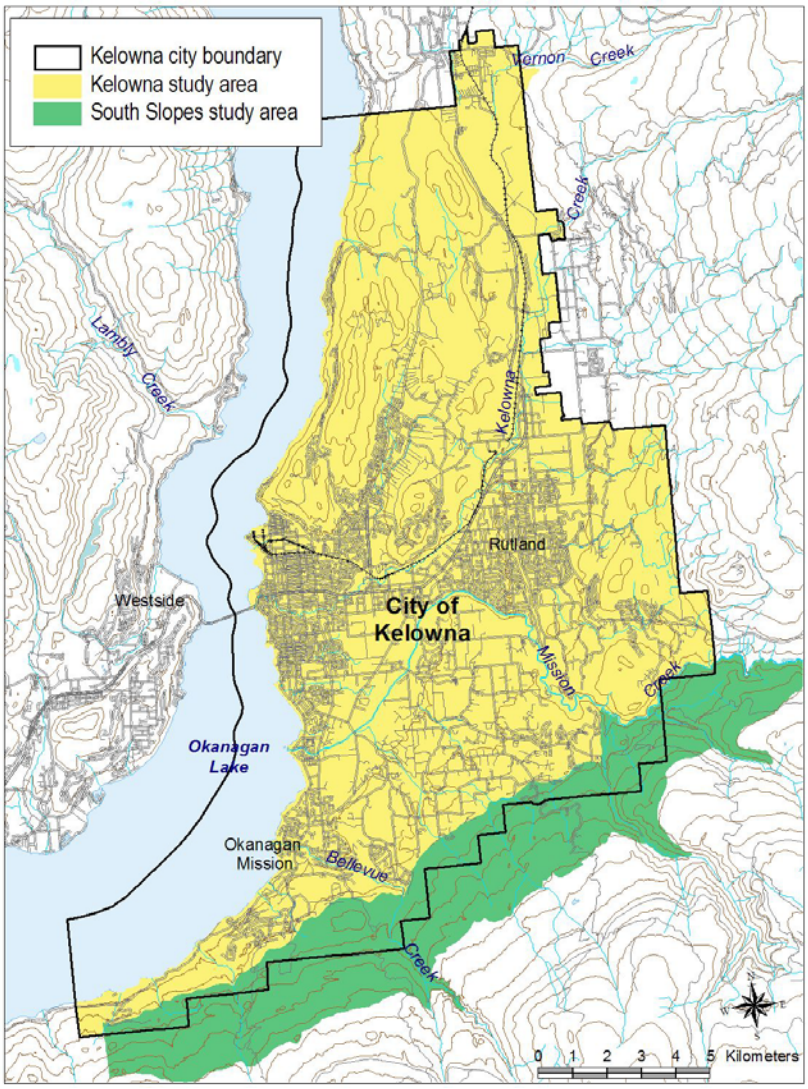

Figure 1. Map of the Kelowna SEI study area. The extent of the City of Kelowna, used to generate results, is shown in black. The "Kelowna" portion of the study area is shown in yellow and the South Slopes portion of the study area is shown in green.

The study area lies within the Okanagan Very Dry Hot Ponderosa Pine (PPxh1) and the Okanagan Very Dry Hot Interior Douglas-fir (IDFxh1) biogeoclimatic variants[21] (Figure 2 below). It is part of the northern extension of the Columbia Basin that extends south to Oregon and lies within the

[21] 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.

North Okanagan Basin ***Ecosection***[22], a wide trench formed by parallel fault lines and further carved out by multiple glaciations.

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 Lake (a large, glacial-relic lake), moderates these temperatures somewhat by cooling the air in summer and warming it in winter.

[22] An ***Ecosection*** is a subdivision of an Ecoprovince and is an area with minor physiographic and macroclimatic or oceanographic differences.

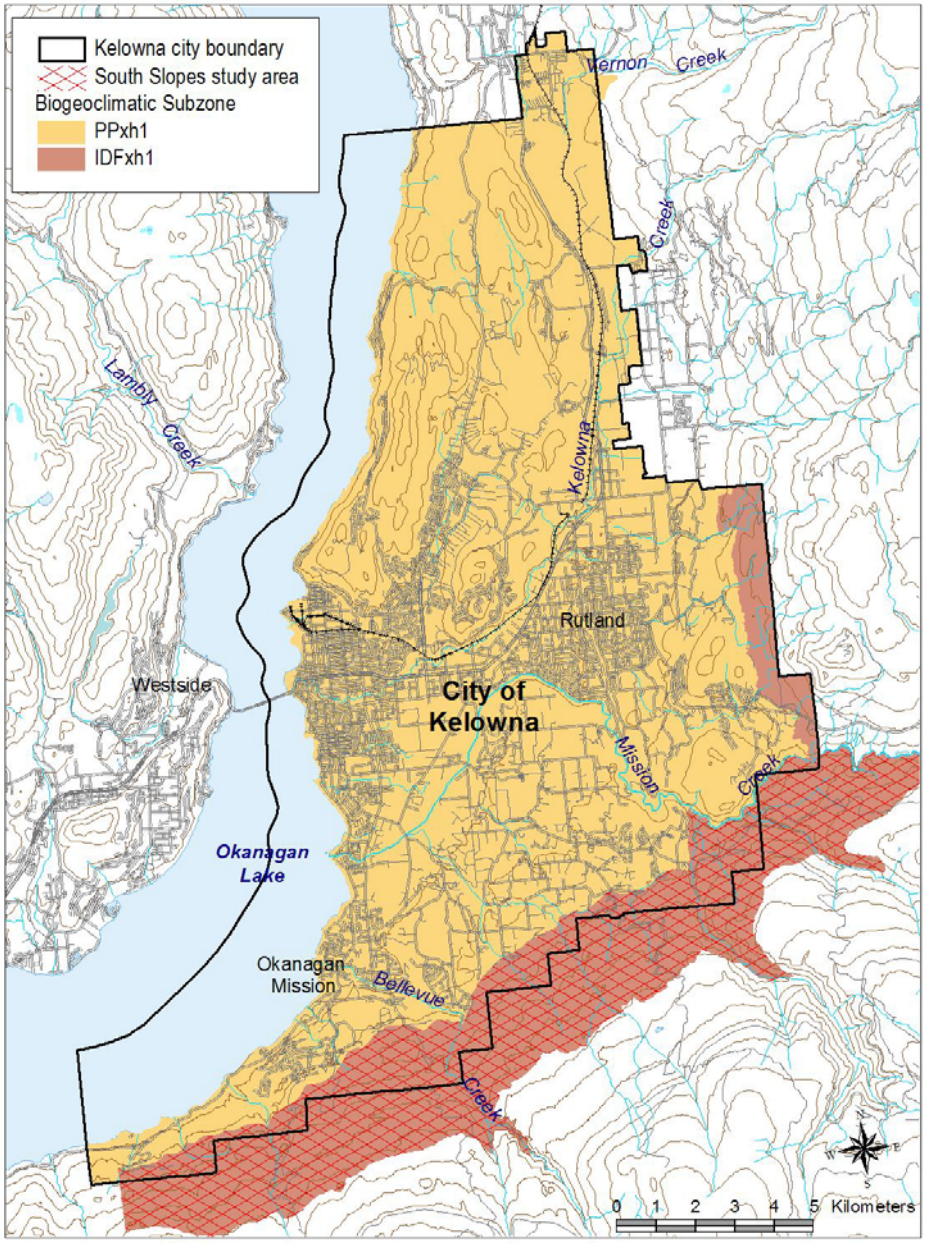

Figure 2. Biogeoclimatic subzones in the study area.

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 Okanagan Lake 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 in the United States of America. Increasingly, scientists are finding that populations of species 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[23].

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 City of Kelowna has many remaining natural areas that include sensitive ecosystems and that provide habitat for many rare and endangered species. Many of these areas form part of the north – south corridor of the Okanagan valley. These natural areas also provide many community values including aesthetics, hiking, and observing wildlife and nature.

[23] Scudder 1991

Figure 3. Overview of part of the City of Kelowna from Knox Mountain (above) and Glenmore Highlands (below).

2 Ecosystems of Concern

What are Sensitive and Other Important 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 that are ecologically fragile or are rare in the provincial landscape and are relatively unmodified by human influences[24] (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 follow the provincial Standard for Mapping Ecosystems at Risk in British Columbia[25].

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), **swamps** (WN:sp), and **shallow open water** (WN:sw) ecosystems including ponds.
RI	Riparian	Ecosystems in gullies (**gully**, RI:gu); beaches (**beach**, RI:be), bench riparian ecosystems along floodplains (**bench**, RI:fp), fringe ecosystems associated with the edges of wetlands, ponds and lakes (**fringe**, RI:ff), and **river** ecosystems (RI:ri).
OF	Old Forest	Forest ecosystems dominated by large, old coniferous trees (OF:co); excludes old riparian forests; includes old Coniferous Woodlands and old Broadleaf Woodlands.
GR	Grasslands	Ecosystems dominated by bunchgrasses (**grassland**; GR:gr), invasive alien plants and bunchgrasses (**disturbed grassland**; GR:dg) and **shrubland** (GR:sh) ecosystems that occur in a grassland matrix
BW	Broadleaf Woodlands	Aspen copse 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)

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

[24] originally defined by Ward et al. 1998
[25] Ministry of Environment Ecosystems Branch 2006

the water cycle, recycle nutrients, and pollinate crops. They are vital in creating healthy and attractive communities for people.

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

Code	Other Important Ecosystems	Ecosystem Description
FS	Seasonally Flooded Agricultural Fields	Cultivated fields that usually flood annually, providing important migrating habitat for birds and habitat for other wildlife. These sites were formerly riparian or wetland ecosystems and may have some potential for restoration of these ecosystems.
MF	Mature Forest	Forests dominated by coniferous mature trees (MF:co); excludes mature riparian forests and mature coniferous and broadleaf woodlands

Why are these ecosystems important?[26]

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. 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 has 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 (see below) as endangered (E), threatened (T) or of special concern (C), or are provincially ranked as red-listed or blue-listed (see below). The Species at Risk Act[27] provides protection for species ranked as threatened or endangered that occur on Federal land. See Appendix C for a list of at-risk wildlife species with the potential to occur in the study area.

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.

Web site: http://www.sararegistry.gc.ca/

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

[26] Adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.
[27] Government of Canada 2003.

Red-list: The list of British Columbia's flora, fauna, and plant communities that are rare and endangered. Blue-list: The list of British Columbia's flora, fauna and plant communities that are at risk because of low or declining numbers.

Conservation Data Centre

web site: http://www.env.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.

Some ***red-listed*** vertebrate animals in the study area include[28]:

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

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

Gopher Snake (COSEWIC-T) (*Pituophis catenifer* ssp*. deserticola*)
Racer (COSEWIC-SC) (*Coluber constrictor*)
Western Rattlesnake (COSEWIC-T) (*Crotalus oreganus*)
Painted Turtle (COSEWIC-SC) (*Chrysemis picta*)
Great Basin Spadefoot (COSEWIC-T) (*Spea intermontana*)
Great Blue Heron (*Ardea herodias*)
Long-billed Curlew (COSEWIC-SC) (*Numenius americanus*)

- 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 and spread of invasive species, and fragmentation. Many of the SEI ecosystem types are fragile because they are vulnerable to the establishment and spread of invasive plants, they have soils vulnerable to erosion, and they depend on complex ecological processes such as flooding and low-severity fire regimes that are easily disrupted.
- High biodiversity is a common feature of most SEI ecosystems, both 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 or North America.
- Specialized habitats occur throughout the SEI ecosystems. They support many species of plants and animals. Typically, these ecosystems are critical habitats for many rare, threatened or endangered 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.

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

Socio-economic Values

In consultation for the development of a strategic plan for the city, ***Kelowna residents identified the preservation and maintenance of the natural environment as a high priority***. Residents identified the four most appealing things about Kelowna as the climate, the natural setting, the outdoor recreation opportunities, and Okanagan Lake.[29]

- 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.
- Natural areas networks comprised of diverse ecosystems and species of the area will provide for human enjoyment and interaction with wildlife amidst development. Natural areas provide an attractive and aesthetic backdrop for the City and attract people to live here.
- 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. Kelowna's strategic plan describes Kelowna's most defining characteristics as "its natural and agricultural setting. These attributes contribute to the stability and strength of the local economy and to the quality of life of local residents."[30]
- 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[31], 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.
- 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 natural areas. The beauty of the natural landscape is often a large part of what attracts people to the Okanagan. Studies show that undeveloped natural areas measurably increase the value of nearby property[32] by 5 to 32%[33] and thus, contribute far more in property taxes than they cost in services[34].

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[29] City of Kelowna 2004
[30] City of Kelowna 2004
[31] Environment Canada 1999
[32] Meadows 1999
[33] U.S. National Parks Service 1990
[34] Fodor 1999

3 Impacts of Concern[35]

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 the introduction and spread of invasive species.

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 and pets. 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.

Disruption of Natural Disturbance Regimes

The exclusion and suppression of natural fire has changed grassland and forest ecosystems in the study area. Historically, frequent surface fires[36] maintained open forests with grassy understories (see Figure 4 and Figure 5 below). Generally grasses, forbs, shrubs and mature trees survived most historical fires, but small trees likely often died[37].

Fire exclusion has resulted in dense forests ingrown with Douglas-fir and ponderosa pine (see Figure 6 below). Fire exclusion has also resulted in the encroachment of trees onto grasslands, gradually converting grasslands to forests. The dense forests resulting from fire exclusion

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

[36] 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. Most of the understory vegetation would survive and re-sprout. In the Okanagan Mountain Park fire of 2003, the fire burned through the forest canopy because forests are now more closed than they were historically (Filmon 2004).

[37] Agee 1993

contributed to the intensity of the Okanagan Mountain Park fire in 2003[38] (see

Figure 7 below); under historical conditions, fires would likely have primarily burned through the understory of the forest, leaving most large trees alive but killing small regenerating trees and top-killing shrubs, bunchgrasses and forbs, which would then re-grow. Fire exclusion and the Okanagan Mountain Park fire have affected both ecosystem processes and wildlife habitat values.

[38] Filmon 2004

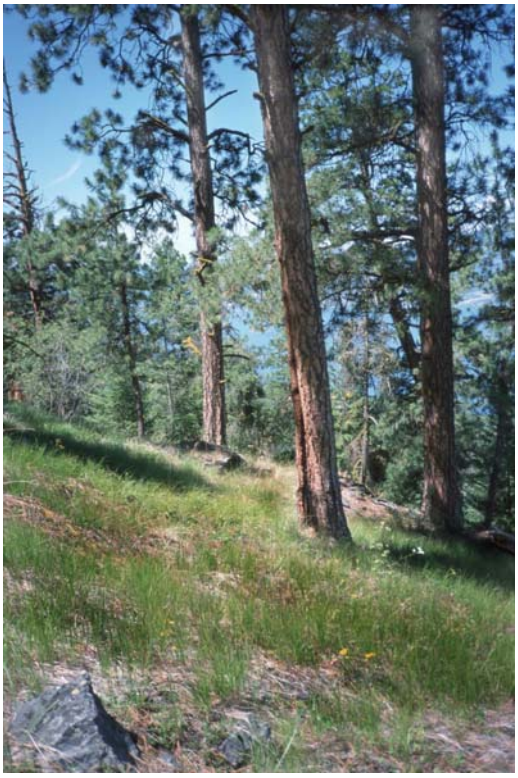

Figure 4. Open forest showing the wide spacing of trees and grassy understory that most forests had historically.

Figure 5. Prescribed understory fire similar to how most historical fires burned. Photo by R. Gray.

Figure 6. Ingrown forest resulting from fire exclusion. The site was also selectively harvested and none of the large veteran trees that dominated historical forests are present. Note the sparse understory.

Figure 7. An area of the Okanagan Mountain Park fire where all overstory trees were killed. In this area, fire severity was not so high that the understory was also killed; most bunchgrasses survived. In many areas, the understory bunchgrasses were also killed.

Many streams have been partly or fully channelized and no longer have natural flooding regimes. Preventing natural flood events can reduce the size, diversity, site productivity, and complexity of wetland and riparian ecosystems, alter habitat values, and can intensify flood events downstream.

Invasive Species

Both the deliberate and accidental introduction of invasive alien 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 alien 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*), sulphur cinquefoil (*Potentilla recta*) and many other invasive alien plants. 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.

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*)

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[39] (particularly in moist

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

forests and riparian areas). 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 invasion of alien species and competition for habitat are examples of indirect biological edge effects.

The study area is influenced by edge effects adjacent to rural developments and the urban areas of the city. 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.

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 which 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 the introduction and spread of invasive alien plants. All of these possible changes reduce the ecological integrity and natural values of these areas.

Indirect Impacts

Activities that occur adjacent to or at some distance from the ecosystem result in indirect impacts. Hydrological[40] changes due to roads, buildings, irrigation[41], 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, riparian areas, and broadleaf woodlands.

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 fertilizers and pesticides associated with agriculture and landscaping has also caused degradation of natural ecosystems and wildlife habitat[42].

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

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[40] Water-related features and processes.

[41] The effluent spray irrigation program is the most extensive disruptive hydrological influence in the study area. In addition to the affects noted above, it also likely increases nutrient levels in water bodies, changes plant composition, promotes algal growth, and reduces oxygen levels.

[42] Cannings and Durance 1998

mountain bikes create soil disturbances that allow rapid invasion and spread of invasive plants. 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.

4 Methods and Limitations

This chapter describes the methods that were used to generate the sensitive ecosystems map. These methods largely follow those used in the Central Okanagan, Bella Vista, Vernon Commonage, and Lake Country SEIs but have been altered slightly to meet the Standard for Mapping Ecosystems at Risk in British Columbia[43]. The provincially recognised Terrestrial Ecosystem Mapping[44] (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.

Terrestrial Ecosystem Mapping

Terrestrial Ecosystem Mapping (TEM) formed the foundation of the thematic sensitive ecosystems map that was created for this project. Polygons were digitally delineated using a DiAP viewer with digital 1:10,000 aerial photographs taken in 2006 around areas of relatively uniform vegetation, topography and terrain features. Ecosystem, terrain, and conservation attributes were recorded in a polygon database. The polygon delineations were digitally cleaned 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[45].

Sensitive Ecosystems Mapping

TEM units were evaluated for rarity and ecological sensitivity and were assigned to sensitive ecosystems and other important ecosystems categories accordingly. Most TEM units were assigned to the same sensitive ecosystems as in other Okanagan SEIs (Central Okanagan[46], Bella Vista[47], Vernon Commonage[48], and Lake Country[49]). The exception includes the treatment of grasslands: units formerly assigned to disturbed grasslands (DG), an other important ecosystem in previous projects, were assigned to the disturbed grasslands subclass of grasslands (GR:dg) and are now considered a sensitive ecosystem in the provincial Standard for Mapping Ecosystems at Risk in British Columbia[50]. Furthermore, disturbed grasslands were formerly restricted to

[43] Ministry of Environment Ecosystems Branch 2006
[44] Resources Inventory Committee 1998
[45] Iverson and Uunila 2008
[46] Iverson and Cadrin 2003
[47] Iverson 2003
[48] Iverson 2005
[49] Iverson 2006
[50] Ministry of Environment Ecosystems Branch 2006

grasslands with 20-50% non-native plants and have now been defined as grasslands with approximately greater than 50% non-native plants.

Finally, cultivated fields that occurred in areas that were formerly riparian or wetland ecosystems and likely flood in most years were mapped as "Seasonally Flooded Agricultural Fields" (FS), an other important ecosystem. Any TEM units not mapped in earlier map projects were evaluated for rarity and ecological sensitivity and assigned to an SEI unit accordingly.

The criteria used in the Central Okanagan, Bella Vista, Lake Country, 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 alien plants, and sensitivity associated with human disturbance. Rarity was based on rankings and proposed rankings by the Conservation Data Centre (CDC), the 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. 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[51]. 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. 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.

For the South Slopes portion of the study area, part of the Central Okanagan SEI, attributes in the original TEM were updated using 2006 digital aerial photographs, particularly where the Okanagan Mountain Park fire had burned forests. TEM units were re-assigned to sensitive ecosystems as above and a new SEI ratings table was created for the South Slopes area. Polygon boundaries were largely unchanged except to update areas with new rural or urban developments.

Field Sampling and Conservation Evaluation of Sensitive Ecosystems

Prior to fieldwork, landowners within the study were contacted to request permission to sample their lands. Numerous landowners agreed to have their lands sampled, although other landowners did not grant access.

I developed a sampling plan using 1:10,000 hard copies of 2006 orthophotos to identify accessible sensitive ecosystems including grasslands, wetlands, ponds, aspen copses, riparian areas, rock outcrops, and talus slopes.

[51] See http://www.env.gov.bc.ca/wildlife/whr/erm_system_flow.html for more information on the ERM tools.

Two types of sample plots were used to identify and assess ecosystems: ground inspections and visual inspections[52]. 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 and other important ecosystems; other ecosystems were sampled along access routes to sensitive ecosystems. Sampling procedures for detailed ecological plots and ground inspections are outlined in *Field Manual for Describing Terrestrial Ecosystems*[53]. The *Standard for Terrestrial Ecosystem Mapping*[54] in British Columbia provides guidelines for visual inspection data collection. We also assessed the conservation values of each site (including, but not limited to, disturbance, known threats, adjacent land use, alien species, fragmentation, condition, ecological integrity, and landscape context). Additional plot data from the original field sampling for the South Slopes in 2001, including one detailed ecological plot, was also used for the mapping in that area (ecological and terrain data were collected by K. Iverson and D. Spaeth Filatow, P.Geo.).

Field sampling was completed in the summer and fall of 2007, and a total of 238 sensitive ecosystems or other important ecosystems sites were field-verified (Table 3; additional plots were completed in modified landscapes for a total of 249 plots with ecological data). Figure 8 shows the location of all field samples, including those established in modified landscapes and those established to verify terrain stability and erosion potential mapping (a total of 403 plots). A team of two scientists including a plant ecologist and terrain specialist conducted the sampling.

Table 3. Number of sites field sampled by ecosystem type. Field sampling statistics are presented for the area of the City of Kelowna; data includes 11 plots from the City of Kelowna portion of the South Slopes field sampling in 2001.

Sensitive Ecosystems	Detailed Ecological plots	Ground Inspections	Visuals	Total Plots
Broadleaf Woodland	0	0	6	6
Grasslands	0	6	23	29
Old Forest	0	0	0	0
Riparian	1	3	19	23
Sparsely Vegetated	0	7	15	22
Coniferous Woodland	0	14	91	105
Wetland	0	6	47	53
TOTAL	1	36	201	238
Other Important Ecosystems				
Seasonally Flooded Fields	0	0	0	0
Mature Forest	0	0	0	0
TOTAL	0	0	0	0

[52] See Volume 2: Iverson and Uunila 2008
[53] BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998
[54] Resources Inventory Committee 1998

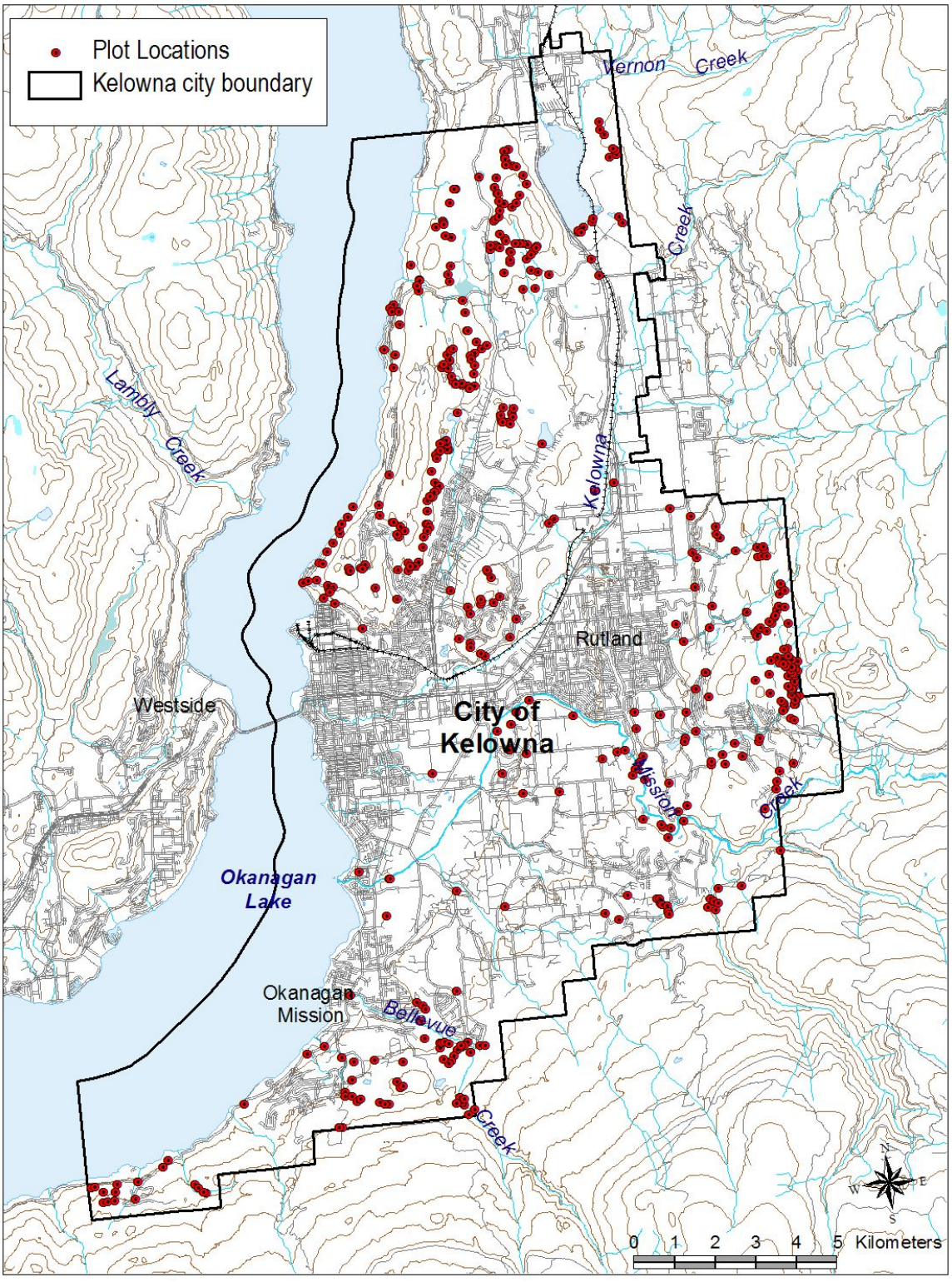

Figure 8. Location of field plots including detailed ecological plots, ground inspections and visual inspections. A total of 403 sites were sampled within the City of Kelowna; 238 of these sites were located in sensitive ecosystems or other important ecosystems.

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 (1:10,000) and date (2006) 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 (1:10,000) as this may result in unacceptable distortion and faulty registration with other data sets.

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 ecosystem mapping projects, the landscape is complex, resulting in many complex polygons. Some small sensitive ecosystems such as wetlands or rock outcrops were too small to capture even as a component of a larger polygon.

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 28.1% (6041 ha) and the two other important ecosystems (OIE) mapped covered 0.5% (102 ha) of the study area (Table 4), while modified landscapes covered the remaining 71.4% (15,322 ha) of the study area. Figure 9 below shows the distribution of sensitive and other important ecosystems in the study area.

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 mature forests, old forests, and coniferous woodlands. Many non-sensitive ecosystems provide important wildlife habitat. Also, the vegetation and soils of these non-sensitive ecosystems 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.

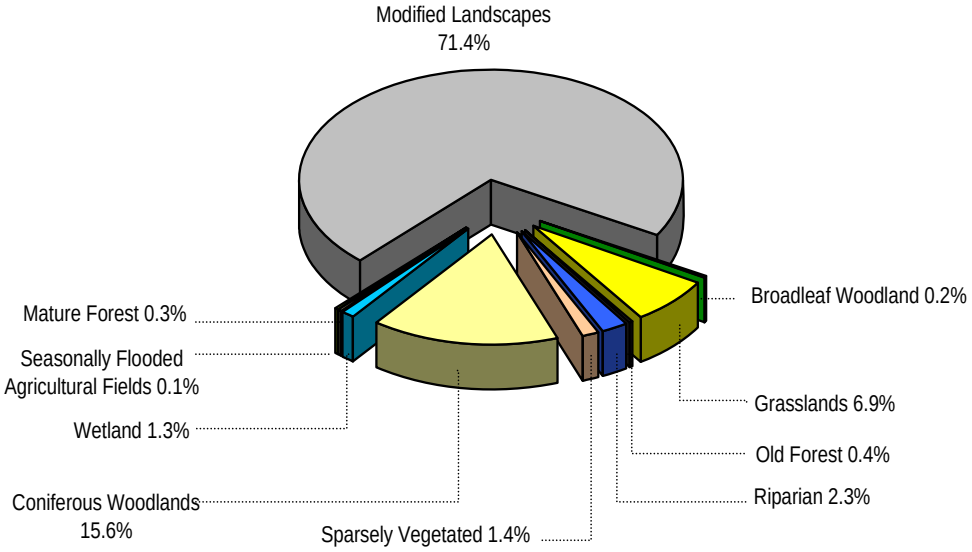

Figure 9. Relative proportion of sensitive ecosystems, other important ecosystems, and modified landscapes in the study area.

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

	Area (ha)	Percent of Study Area[55]
Sensitive Ecosystems (SE)		
Broadleaf Woodland	47.2	0.2
Grassland[56]	1489.7	6.9
Old Forest	86.2	0.4
Riparian	486.6	2.3
Sparsely Vegetated	291.4	1.4
Coniferous Woodland	3354.5	15.6
Wetland	285.0	1.3
Total SE	6040.6	28.1
Other Important Ecosystems (OIE)		
Seasonally Flooded Agricultural Fields	31.3	0.1
Mature Forest	71.2	0.3
Total OIE	102.5	0.5
TOTAL SE and OIE	6143.1	28.6

[55] This is a percentage of the study area excluding lakes. Lakes are now considered an aquatic sensitive ecosystem, but results are presented as per the Okanagan Conservation Manual (Iverson et al. 2008) for consistency. The total study area including Ellison Lake is 21,628 ha, without Ellison Lake, the area is 21,365 ha.

[56] Other SEI projects in the North and Central Okanagan mapped Disturbed Grasslands as a separate Other Important Ecosystem. Here they are mapped as part of the Grasslands category as per the recently published Standard for Mapping Ecosystems at Risk in British Columbia (Ministry of Environment Ecosystems Branch 2006).

6 Planning and Management

City of Kelowna

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 minimize the loss of ecosystem functions.

Develop a 'Local Ecosystems Plan'[57]

The City of Kelowna should develop a systematic plan for prioritization and protection, and stewardship of local sensitive and other important ecosystems. A conservation evaluation similar to those done for SEI mapping in for the District of Lake Country[58] and in the North Okanagan can help establish conservation priorities. Recognizing and protecting environmentally sensitive areas early in the community planning process provides the best chance of protecting environmental values.

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.

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

- 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 an invasive alien plant management strategy to minimize the spread and introduction of invasive plant species.
    - Review current noxious weed bylaw:
        1. Ensure compatibility with provincial noxious weed act;

[57] Refer to the Conservation Tools Section of Iverson et al. 2008 for more detailed information.
[58] see Lake Country SEI (Iverson 2006)

2. Review cutting policy – some species will still flower and produce seed close to the ground after cutting;
3. Develop a noxious weed policy for areas of native vegetation to promote control and minimize their spread;
4. Develop policies for specific species; and
5. Consult with local weed management committee(s) to co-ordinate efforts and seek weed management recommendations.

- Develop and implement a wildfire 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.
    - Review policies for Wildland Fire Development Permit Areas. These are the primary areas where a reduced tree density is desirable. Beyond the immediate vicinity of buildings, coniferous forests should be sensitively harvested to minimize soil disturbance and return stands to historical densities. This can improve ecosystem functions and composition, improve wildlife habitat and reduce wildfire hazard. The largest trees should be retained. The guideline to "remove and dispose of all dead trees" should be modified to protect significant wildlife trees that can be safely retained.
    - Tree Protection Bylaw: needs to be modified for Wildland Fire Development Permit Areas as a reduction of coniferous tree densities is desirable to reduce wildfire hazard and improve ecosystem conditions. It is, however, desirable to retain and promote the density of broadleaf trees where they naturally occur.
- Develop a recreation use plan to avoid recreation in critical areas and designate appropriate types of recreation for other areas. Given the population of Kelowna relative to public recreation areas in natural spaces, carefully managing access and recreational use of any new parks will be necessary to retain values of sensitive and other important ecosystems.

Develop a Conservation Strategy[59]

Aside from some small regional and provincial parks in the study area, most sensitive ecosystems in Kelowna 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

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

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.

Conduct a Review of Environmental Bylaws

The strategic plan, Official Community Plan and other environmental bylaws should be reviewed by a lawyer specializing in local government laws and conservation to ensure consistency and the ability to withstand court scrutiny. The Hillside Development Audit[60] identified inconsistencies between the strategic plan, Official Community Plan, Zoning Bylaw No. 8000, and difficulty achieving implementation of goals such as cluster development that should be addressed in this review.

Planning

- Designate sensitive and other important ecosystems as *Development Permit Areas*[61] (DPAs) in the OCP. DPA boundaries may go beyond ESA boundaries.
    - Include any additional wetland and riparian ecosystems identified in the City's wetland inventory and Sensitive Habitat Inventory Mapping (SHIM) as DPAs.
    - 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.
- Designate sensitive and other important ecosystem DPAs as areas for which *Development Approval Information* is required.

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[60] UMA Engineering Ltd. 2006

[61] 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).

- Use the local ecosystems plan to ***determine natural areas*** and develop conservation strategies for those areas. Create a natural areas 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.
    - Provide buffers and connectivity to other natural ecosystems within and beyond the development (See Retain Natural Vegetated Buffers around Sensitive Ecosystems and Corridors between Sensitive Ecosystems page 28).
    - 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 area 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.

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.

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 to provide wildlife inventory information and verify and map sensitive ecosystems at an appropriate scale for development planning (generally 1:5,000). 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.

Further Information:

Stewardship Options for Private Landowners in British Columbia[62]

Here Today, Here Tomorrow: Legal Tools for the Voluntary Protection of Private Land in British Columbia[63]

North Okanagan Parks and Natural Areas Trust (president: Jamie Kidston (250) 542-1582)

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

General Management Recommendations[64]

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 (mature forests and seasonally flooded agricultural fields), broader conservation-oriented management practices are discussed.

Retain Natural Vegetated Buffers around Sensitive Ecosystems 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 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

[62] Ministry of Environment, Lands and Parks 1996
[63] Findlay and Hillyer 1994
[64] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

narrower 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;
- *Protect large old trees and snags.* Old trees and snags provide critical nesting habitat for many species of birds, bats, and other wildlife.
- *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., bats, Flammulated Owls and Lewis' Woodpeckers) should be avoided.
- *Prevent disturbance of nesting or breeding areas*: Known and potential breeding sites, (especially for threatened or endangered species) should be protected from any activity that would disturb breeding wildlife;
- *Control invasive species*: A broad invasive alien plant management plan may be necessary to control and limit the spread of plants such as diffuse knapweed (*Centaurea diffusa*), sulphur cinquefoil (*Potentilla recta*) and invasive annual grasses such as cheatgrass (*Bromus tectorum*). Reclaim disturbed sites using native vegetation species adapted to the site to reduce the potential for the introduction and spread of invasive plants. Managing human and livestock access, and treating existing invasive plant species will help maintain the ecological integrity of sensitive ecosystems. 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 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; 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. Consider restoring natural flooding regimes on creeks where possible.

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.

- Require an environmental impact assessment conducted by a qualified professional.
- Plan, design, and implement land development activities to avoid adversely affecting or disturbing:
  - native vegetation;
  - large old trees;
  - threatened or endangered species or ecological communities;
  - soils, and other terrain features such as bedrock;
  - wildlife nesting or denning sites;
  - standing dead trees (snags), and downed trees and logs; 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 free of alien plant seeds
- Ensure adequate sediment and erosion control measures are implemented.

7 Wetland

What are wetland ecosystems?[65]

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[66]. 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, wet meadows, swamps and shallow water ecosystems; they are described below.

Marsh ecosystems (WN:ms)

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, reed canarygrass (shown here) or occasionally sedges usually dominate marshes, and some floating aquatics such as water smartweed are sometimes present.

Meadow ecosystems (WN:md)

Meadow wetland ecosystems occurred as a fringe at the edges of ponds and marshes, especially alkaline sites indicated by a white soil crust. Meadows occur where the water table is at or above the soil surface for only a short portion of the growing season. Meadows were dominated by saltgrass or foxtail barley.

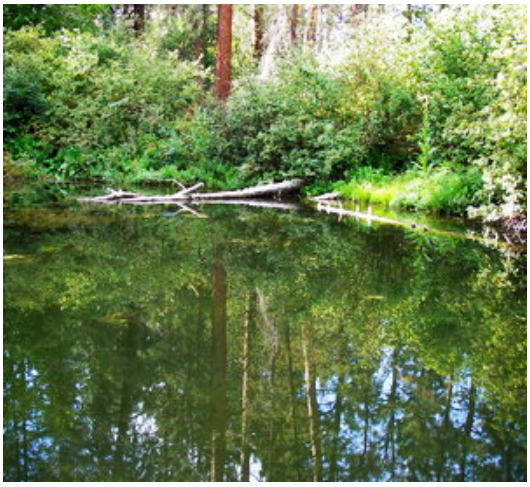
[65] Adapted from Iverson and Cadrin 2003.
[66] MacKenzie and Moran 2004

Swamp ecosystems (WN:sp)

Swamp wetland ecosystems occurred in forested areas with extensive subsurface irrigation (water flow). These swamps were dominated by mountain alder and skunk cabbage. Some swamps also occurred at the edges of ponds and wetlands, forming a shrubby willow-dominated fringe around them.

Shallow water ecosystems (WN:sw)

Shallow water ecosystems are either areas of open water that are intermittently or permanently flooded up to 2 m in depth at midsummer[67], 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. Shallow water ecosystems often have a marsh fringe at the edge.



Vegetation

	Marsh	Wet Meadow	Swamp	Shallow Water	
Trees					
Western redcedar			**		*Thuja plicata*
Shrubs					
mountain alder			***		*Alnus incana*
willows			***		*Salix* spp.
Grasses, Sedges & Rushes					
large rushes	***				*Schoenoplectus* spp.
baltic rush	**				*Juncus balticus*
sedges	*		**		*Carex* spp.
seadshore saltgrass		***			*Distichlis spicata*
foxtail barley		**			*Hordeum jubatum*
Forbs					
skunk cabbage			***		*Lysichiton americana*
cattail	**				*Typhus latifolia*
common silverweed		**			*Potentilla anserina*
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.

[67] Voller 1998

Why are they important?

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

Rare[68] *ecological communities of wetland ecosystems*
Alkali saltgrass - Nuttall's alkaligrass (R) (*Distichlis spicata* var. *stricta - Puccinellia nuttalliana*)
Giant wildrye (R) (*Leymus cinereus*)
Baltic rush – field sedge (B) (*Juncus balticus – Carex praegracilis*)
Common cattail marsh (B) (*Typha latifolia*)
Hard-stemmed bulrush deep marsh (B) (*Schoenoplectus acutus*)

Rare vertebrates of wetlands
Peregrine Falcon (R, COSEWIC-SC) (*Falco peregrinus* ssp. *anatum*)
Western Grebe (R) (*Aechmophorus occidentalis*)
American Avocet (R) (*Recurvirostra americana*)
Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Western Toad (COSEWIC-SC) (*Bufo boreus*)
Painted Turtle (B, COSEWIC-SC) (*Chrysemys picta*)
American Bittern (B) (*Botaurus lentiginosus*)
Great Blue Heron (B) (*Ardea herodias*)
Sandhill Crane (B) (*Grus canadensis*)
California Gull (B) (*Larus californicus*)
Western Small-footed Myotis (B) (*Myotis ciliolabrum*)
Fringed Myotis (B, COSEWIC-SC) (*Myotis thysanodes*)
Townsend's Big-eared Bat (B)(*Corynorhinus townsendii*)

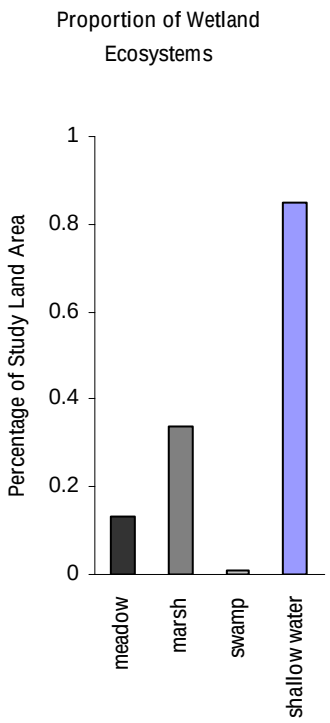
- Rarity: Most wetland ecological communities have rare status (see above).
- High biodiversity: Ponds and marshes are focal points for wildlife because of their infrequent occurrence in this landscape. Wetlands provide wildlife and biodiversity values that are disproportionate to the area they occupy 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.

[68] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, are noted as endangered (E), threatened (T), or of special concern (SC).

- 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.

Status



Wetland ecosystems were rare in the study area; they occupied 285 ha or 1.3% 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[69]. Wetlands have been influenced by effluent 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.

Marshes (72 ha) and shallow water (183 ha) were the most common wetland types in the study area; wet meadows (28 ha) and swamps were uncommon (2 ha).

Management Recommendations[70]

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 by re-creating 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.

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[69] Voller 1998

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

General management recommendations for all sensitive ecosystems are found starting on page 28. Below are additional management recommendations specific to wetlands.

Avoid Direct and Indirect Impacts

- 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; could 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 in adjacent areas 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 changes in vegetation composition (e.g. some marshes may convert from sedges or rushes to cattails or reed canarygrass).
- 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 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[71].

[71] Relvea 2005

8 Riparian

What are riparian ecosystems?

Riparian simply refers to areas adjacent to water bodies such as lakes, rivers, streams, and ponds[72]. 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 5) in order to identify different habitat values.

Table 5. 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 (beach, fringe, bench, gully, and river) according to their environmental and vegetation characteristics; these are described below.

[72] MacKenzie and Moran 2004; Voller 1998

Beach riparian (RI:be)

In the study area, beach riparian ecosystems occurred primarily on the shoreline of Okanagan Lake. They have little vegetation and are the area of sediments reworked recently by wave action.

Gully riparian (RI:gu)

Gully riparian ecosystems occur at the base and lower slopes of small valleys or ravines with significant moisture. These ecosystems have either permanent or intermittent surface water flow, or significant subsurface flow, but are usually not subject to flooding. They are rich and productive sites, providing habitat that is distinctly different from the surrounding landscape. They occurred in both grassland and forested landscapes. These ecosystems usually had a mixed coniferous and deciduous overstory with shrubby understories.

Fringe riparian ecosystems (RI:ff)

Ponds, marshes, Ellison Lake, 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.

Bench riparian ecosystems (RI:fp)

Bench riparian ecosystems are flood or fluvial ecosystems that are associated with moving water such as creeks and rivers. They are influenced by flooding and subsurface irrigation. They usually occur as linear ecosystems on plains or terraces with sandy, gravely soils adjacent to creeks and rivers. The forest overstories were broadleaf, coniferous or mixed; understories were typically shrubby.

River riparian ecosystems (RI:ri)

These are river ecosystems that include the flowing water and unvegetated sandbars, gravel bars and banks of the river.

Vegetation

	Fringe	Gully	Bench	
Trees				
black cottonwood	*	*	***	*Populus balsamifera* ssp. *trichocarpa*
Douglas-fir	*	**	*	*Pseudotsuga menziesii*
western redcedar		**	*	*Thuja plicata*
trembling aspen	***	***	*	*Populus tremuloides*
paper birch	*	*		*Betula papyrifera*
Shrubs				
common snowberry	***	***	**	*Symphoricarpos albus*
red-osier dogwood	**	**	**	*Cornus stolonifera*
Douglas maple	**	**	**	*Acer glabrum*
Nootka rose	**	**	*	*Rosa nutkana*
Forbs				
Star-flowered false Solomon's seal	**	**	**	*Maianthemum stellatum*
mountain sweet-cicely	**	**	**	*Osmorhiza berteroi*
horsetail		*	*	*Equisetum* spp.
Mosses				
leafy mosses		*	**	*Mnium* or *Plagiomnium* spp.

This table broadly shows what vegetation occurred in these ecosystems. Abundance of different species is indicated by: * uncommon species, ** common species, *** abundant species. Beach and river ecosystems have little or no vegetation.

Why are they important?[73]

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

Rare[74] *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 - water birch / Douglas maple (R) (*Pseudotsuga menziesii - Betula occidentalis / Acer glabrum*)

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

Western redcedar - Douglas-fir / false Solomon's seal (R) (*Thuja plicata - Pseudotsuga menziesii / Maianthemum racemosum*)

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

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

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

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Great Blue Heron (B) (*Ardea herodias*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- Rarity: The B.C. Conservation Data Centre lists all riparian ecological communities in the study area as at-risk (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 and may be natural travel corridors.
- Fragility: Riparian ecosystems are strongly influenced by adjacent water bodies and, thus, they are sensitive to disturbance and changes in hydrology.

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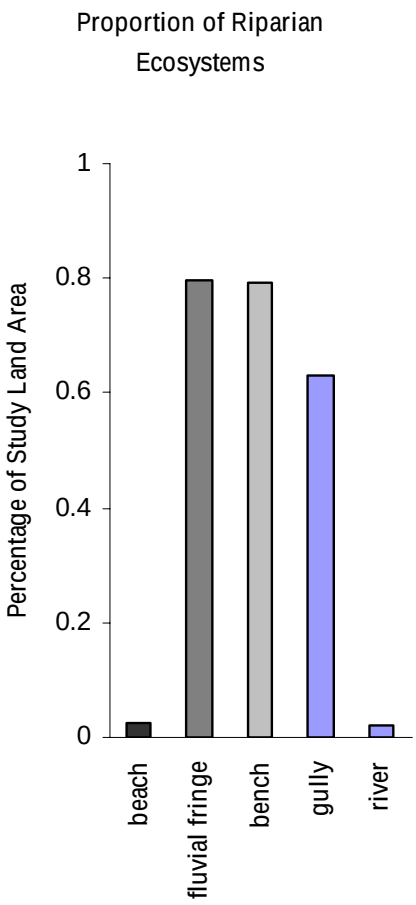
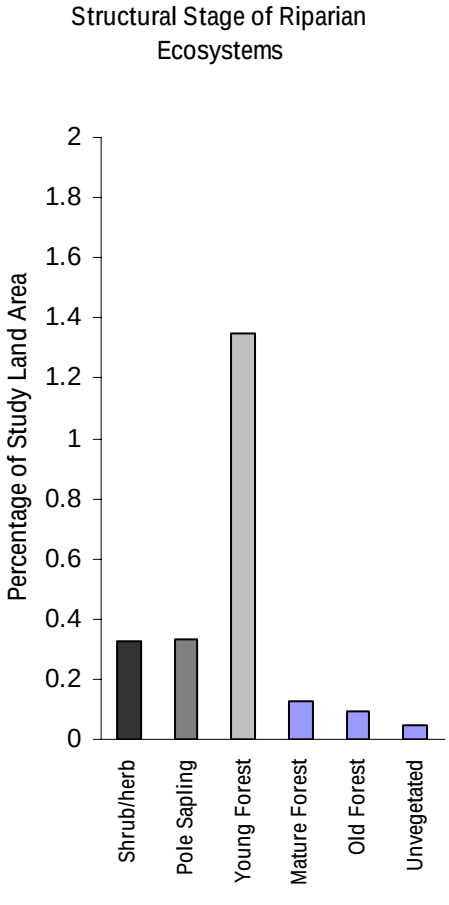
[73] Adapted from Iverson and Cadrin 2003.
[74] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, are noted as endangered (E), threatened (T), or of special concern (SC).

- 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 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 connecting different types of ecosystems.
- Social values: Riparian areas provide water retention and filtration, prevent erosion, and provide natural areas, 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.

Status





Riparian ecosystems are naturally uncommon in the study area and occupied only 2.3% (487 ha)

of the study area – predominantly fringe (171 ha), bench (170), and gully (136 ha) and with minor beach (6 ha) and river (4 ha) ecosystems.

Only 4% of riparian ecosystems in the study area were in the old forest structural stage. Another 6% were mature forests and 59% were young forests, 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.

Management Recommendations[75]

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.

General management recommendations for all sensitive ecosystems are found starting on page 28. Below are additional management recommendations specific to riparian ecosystems.

Avoid Direct and Indirect Impacts

- 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.
- 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: Maintain structures such as rocks and logs within streams, as 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, Townsend's Big-eared Bat and amphibians) should be avoided.

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

- 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 and restore these functions wherever possible.

Plan Land Development Carefully

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

- 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.

9 Old Forest

What are old forest ecosystems?

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 category.

Historically, most forests had frequent surface fires that killed most regenerating trees. Overstories were generally very open, multi-aged and understories were dominated by bunchgrasses 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). Old forests still occur where large, old trees have not been selectively harvested. In most cases these stands have 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.

All old forests within the study area fell within the "coniferous" subcategory (OF:co).

Vegetation

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

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

Why are they important?

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[76] *ecological communities of old forests*

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

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

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

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

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

Rare vertebrates of old forests
Swainson's Hawk (R) (*Buteo swainsonii*)
Lewis's Woodpecker (R, COSEWIC-SC) (*Melanerpes lewis*)
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 (COSEWIC-SC) (*Buteo regalis*)
Great Blue Heron (B) (*Ardea herodias*)
Flammulated Owl (B, COSEWIC-SC) (*Otus flammeolus*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- Rarity: Most old forest ecological communities have rare status (see above).
- 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, many of them associated with old trees. Typically old forests have open understories, and provide good visibility and ease of travel for ungulates, while the complex structure provides ample foraging, nesting and roosting opportunities for numerous wildlife species. Large old trees provide good snow interception, enabling animals such as mule deer to move easily through old forests in the winter.
- Specialized 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.

[76] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, 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.

Status

Historically, old forests likely dominated the majority of the forested portion of the landscape (about 19% of the study area; not including riparian forests) but now there are only small remnants. Most old forests had been lost to selection logging and some were lost to the Okanagan Mountain Park fire. The inventory showed that only 0.4% (86 ha) of the study area was old forests; these occurred primarily in rocky inaccessible portions of the Glenmore Highlands and scattered in very small and fragmented patches. There is a need to conserve all remaining old forests, and retain and restore stand structure in some mature forests and coniferous woodlands for recruitment to old forests.

Management Recommendations

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

General management recommendations for all sensitive ecosystems are found starting on page 28. Below are additional management recommendations specific to old forest ecosystems.

Avoid Direct and Indirect Impacts

- 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 old 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., large trees with cavities).

- 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 Recommendations89F for mature forests on page 66).

10 Grasslands

What are grassland ecosystems?

Grasslands are ecosystems dominated by bunchgrasses with scattered forbs and a microbiotic crust. The grasslands of the Central Okanagan represent a portion of the Pacific Northwest bunchgrass grasslands that are centred in south-east Washington, north-east Oregon and Idaho[77]. In British Columbia, grasslands cover less than 1% of the provincial land base but provide habitat for about 1/3 of the province's threatened and endangered species.

Areas where grasslands occurred are generally too hot and dry for forests to establish. Often, grasslands occur 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. Grasslands are also favoured in areas where frequent, low-severity fires historically occurred and most young trees were killed by fire.

In the study area, grasslands were concentrated along the eastern edge of the study area, and scattered as small pockets in amongst other ecosystems.

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

Grassland ecosystems (GR:gr)

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 topped by a thick, dark-coloured horizon enriched by organic matter from the decomposition of grass roots. Grasslands may have a component of invasive alien plants, but are dominated by native plants.

[77] Tisdale 1947

Disturbed grassland ecosystems[78](GR:dg)

Disturbed grasslands, once intact grasslands, have a mixture of native bunchgrasses and forbs and invasive alien plants. Approximately more than 60% of the total plant cover is comprised of invasive plant species including cheatgrass (*Bromus tectorum*), diffuse knapweed (*Centaurea diffusa*), sulphur cinquefoil (*Potentilla recta*), and other alien species. A grassland dominated by diffuse knapweed is shown in the picture to the right.

Shrubland ecosystems (GR:sh)

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.

[78] In earlier projects (Bella Vista SEI, Central Okanagan SEI, Commonage SEI, and Lake Country SEI), disturbed grasslands were a separate category under "other important ecosystems". They were defined as having 20-50% invasive alien plants. Grasslands with >50% invasive alien plants were categorized as modified landscapes. Recognizing the provincial rarity of grasslands and the many values that grasslands with alien plants retain, particularly wildlife habitat values, the provincial Rare Ecosystem Mapping standards have provided this new definition of disturbed grasslands as a subcategory of grasslands and include grasslands with >50% invasive alien plants.

Vegetation

	Grassland	Disturbed Grasslands	Shrubland	
Shrubs				
common snowberry			***	*Symphoricarpos albus*
roses			***	*Rosa* spp.
Grasses				
bluebunch wheatgrass	**	**		*Pseudoroegneria spicata*
rough fescue	**			*Festuca campestris*
Idaho fescue	**			*Festuca idahoensis*
junegrass	*	**		*Koeleria macrantha*
Columbian needlegrass		**		*Achnatherum nelsonii*
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.
Invasive Alien 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.

Why are they important?

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

Rare[79] *ecological communities of grasslands*:

Big sagebrush / bluebunch wheatgrass - arrowleaf balsamroot (R) (*Artemisia tridentata / Pseudoroegneria spicata - Balsamorhiza sagittata*)

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*)
Prairie Falcon (R) (*Falco mexicanus*)
Burrowing Owl (R, COSEWIC-E) (*Athene cunicularia*)
Grasshopper Sparrow (R) (*Ammodramus savannarum*)
Lark Sparrow (R) (*Chondestes grammacus*)
Preble's Shrew (R) (*Sorex preblei*)
Merriam's Shrew (R) (*Sorex merriami*)

[79] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and ecological communities as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, are noted as endangered (E), threatened (T), or of special concern (SC).

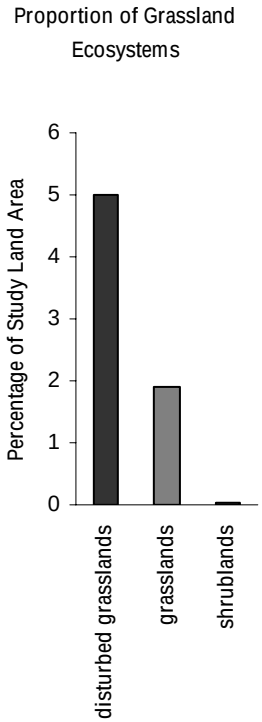
Badger (R, COSEWIC-E) (*Taxidea taxus*)

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
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[80] (B) (*Tympanuchus phasianellus* ssp*. columbianus*)
Long-billed Curlew (B, COSEWIC-SC) (*Numenius americanus*)
Short-eared Owl (B, COSEWIC-SC) (*Asio flammeus*)
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 threaten remaining grasslands. Grasslands are recognised as one of British Columbia's most threatened ecosystems[81]. Only 8% of the grasslands in the province are protected[82].
- Rarity: All grassland native plant 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 the introduction and spread of invasive alien plants, 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. Grasslands have many important traditional-use plants for First Nation peoples.

[80] Thought to be extirpated from the area.
[81] Canadian Parks and Wilderness Society 1996
[82] Grasslands Conservation Council of B.C. 2002

Status



Grassland ecosystems covered 7% (1490 ha) of the study area. The majority of these were disturbed grasslands (1074 ha), with some grasslands (405 ha) and very little shrublands (10 ha).

All grassland ecosystems are a high priority for conservation considering that many have been lost to agricultural and urban settlement.

Management Recommendations[83]

General management recommendations for all sensitive ecosystems are found starting on page 28. Below are additional management recommendations specific to grassland ecosystems.

Avoid Direct and Indirect Impacts

- Manage access. All motorized vehicles should be restricted to existing roads. Mountain bikes should be restricted to existing or carefully planned trails that are free of invasive plants, and not subject to erosion; otherwise, these trails should be closed until invasive plant problems have been controlled. Trails can create erosion problems, disturb fragile vegetation, and spread or introduce invasive alien species. Existing trails with erosion problems need to be rehabilitated and restored.
- 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.

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

- 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.

Plan Land Development Carefully

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

- 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.

11 Broadleaf Woodlands

What are broadleaf woodland ecosystems?

Broadleaf woodland ecosystems occurred on sites where conditions result 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 and draws in grassland areas. They were typically small ecosystems with trembling aspen overstories and shrubby understories dominated by common snowberry and roses.

Vegetation

Trees			
	trembling aspen	***	*Populus tremuloides*
Shrubs			
	common snowberry	***	*Symphoricarpos albus*
	Nootka rose	**	*Rosa nutkana*
	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.

Why are they important?

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[84] *ecological communities of broadleaf woodlands*

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

Rare vertebrates of broadleaf woodlands:
Western Screech-Owl (R, COSEWIC-E) (*Megascops kennicottii* ssp. *macfarlanei*)
Lewis's Woodpecker (R, COSEWIC-SC) (*Melanerpes lewis*)
Yellow-breasted Chat (R, COSEWIC-E) (*Icteria virens*)

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- Rarity: the only broadleaf woodland ecological community mapped in the study area is listed as rare by the B.C. Conservation Data Centre (see above).
- High biodiversity: Broadleaf woodland ecosystems have diverse plant communities that support a rich assemblage of species. Deciduous litter fall results in an organically enriched upper layer of soil.
- Specialized 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.

Status

Broadleaf woodland ecosystems were rare in the study area; they covered 0.2% of the study area (47 ha) and occurred scattered in grassland dominated areas. All broadleaf woodland ecosystems are a high priority for conservation.

Management Recommendations

General management recommendations for all sensitive ecosystems are found starting on page 28.

[84] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, are noted as endangered (E), threatened (T), or of special concern (SC).

12 Coniferous Woodlands

What are coniferous woodland ecosystems?

Coniferous woodland ecosystems in the study area had open coniferous tree canopies. They occurred on most treed sites in the Ponderosa Pine zone and on rocky knolls and shallow soils where limited moisture or shallow soil limited tree establishment in the Interior Douglas-fir zone. These ecosystems had scattered ponderosa pine and Douglas-fir trees, bunchgrasses and scattered shrubs in the understory.

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 6). 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 6. 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.

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[85] *ecological communities of coniferous woodlands*

Douglas-fir – ponderosa pine / bluebunch wheatgrass (R) (*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 - Idaho fescue (B) (*Pinus ponderosa / Pseudoroegneria spicata - Festuca idahoensis*)

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

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

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

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
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*)
Flammulated Owl (B, COSEWIC-SC) (*Otus flammeolus*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

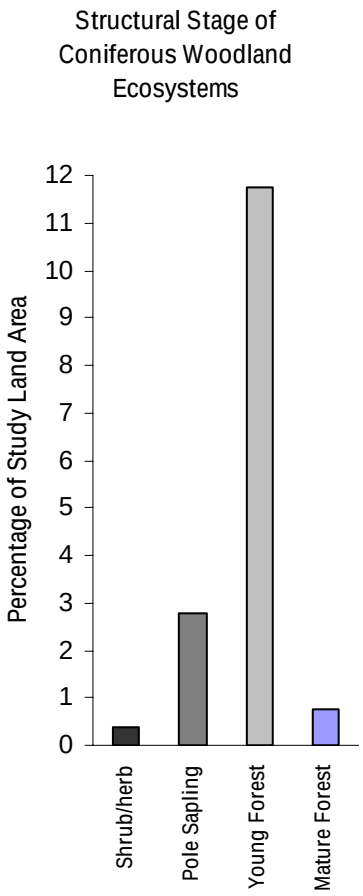
Rubber Boa (COSEWIC-SC) (*Charina bottae*)
Ferruginous Hawk (COSEWIC-SC) (*Buteo regalis*)

- Rarity: Most 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, 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 denning habitat for snakes.
- Specialized 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.

[85] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, 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.

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 treed portions of the Ponderosa Pine zone (most of the City) and on steep warm aspects and in areas with shallow soils in the Interior Douglas-fir zone (South Slopes and south-eastern edge of the City). However, historically most of these sites would have been dominated by old trees and would have belonged to the 'Old Forest' ecosystem unit. Most coniferous woodland ecosystems have been altered by disturbances such as logging, forest ingrowth, and invasive alien plants. Coniferous woodland ecosystems were relatively common in the study area (15.6% of study area; 3354 ha).

Most coniferous woodland ecosystems were young forests (75%) because of selection logging and ingrowth. Mature coniferous woodlands (5%) should have the highest priority for conservation. Old coniferous woodlands were placed in the Old Forest unit.

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

Management Recommendations

General management recommendations for all sensitive ecosystems are found starting on page 28. Below are additional management recommendations specific to coniferous woodland ecosystems.

Avoid Direct and Indirect Impacts

- Prevent soil disturbances. Coniferous woodlands often have sandy or 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.

- 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 coniferous woodland ecosystems on their land by raking and removing fuels from beneath trees, and by cutting and removing small trees.

13 Sparsely Vegetated

What are sparsely vegetated ecosystems?

Sparsely vegetated ecosystems in the study area occurred on sites where bedrock 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: cliff, rock, shrub, and talus ecosystems; these are described below.

Cliff (SV:cl)

Sparsely vegetated cliff ecosystems are steep, vertical bedrock. Cliffs have minimal vegetation restricted to cracks and crevices, narrow ledges and small soils pockets

Rock (SV:ro)

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

Shrub (SV:sh)

Shrub ecosystems occur on small rock outcrops with cracks and crevices. Soils are restricted to small pockets. Scattered shrubs and grasses grow in cracks and small soil pockets.

Talus (SV:ta)

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

Vegetation

	Cliff	Rock	Shrub	Talus	
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.

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.

Natural sparsely vegetated ecological communities recommended for the red- or blue- list

Antelope-brush – selaginella (*Purshia tridentata*)[86]

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

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

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

Rare[87] *vertebrates of sparsely vegetated ecosystems*

Peregrine Falcon (R, COSEWIC-SC) (*Falco peregrinus* ssp*. anatum*)
Prairie Falcon (R) (*Falco mexicanus*)

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) (*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).
- Specialized habitats: A variety of specialized habitats are found in sparsely vegetated ecosystems. A number of species, including many at-risk species are dependant on these habitats. Shrub, rock and cliff ecosystems with deep crevices, and some talus slopes, provide roosting or hibernacula sites for a variety of snake and 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 or rock is removed or eroded.
- 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.

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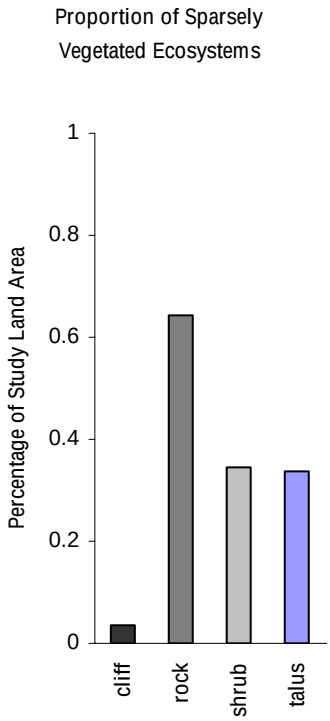
[86] Although antelope-brush only rarely occurs in the Central Okanagan, this plant community is still considered to occur here. Some plant communities have a broad range of vegetation species and plant community names do not always reflect the dominant species at a particular site.

[87] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, are noted as endangered (E), threatened (T), or of special concern (SC).

Status



Sparsely vegetated ecosystems covered 1.4% (291 ha) of the study area land base. In the study area, rock ecosystems were the most common ecosystem type (137 ha); shrub and talus ecosystems were uncommon (74 and 73 ha respectively), and cliffs were rare (7 ha).

Management Recommendations

General management recommendations for all sensitive ecosystems are found in starting on page 28. Below are additional management recommendations specific to sparsely vegetated ecosystems.

Avoid Direct and Indirect Impacts

- Manage access to minimise vehicular, mountain bike, and livestock access on and near sparsely vegetated ecosystems. Vehicle traffic, including bicycles, erodes thin soils and 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 alien 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.
- 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:

- Protect endangered, threatened, or vulnerable 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 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.

14 Mature Forest

What are mature forest ecosystems?

Mature forest ecosystems were mapped where polygons included structural stage 6 forests[88] (mature forest). Mature riparian, broadleaf woodland, and coniferous woodland forests 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 maintained open forests with widely spaced trees. The understory of mature forests was open and dominated by bunchgrasses 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 now occur where there are mature trees and a few large old trees. These stands typically have a history of selection logging and have 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.

Only coniferous mature forest ecosystems (MF:co) occurred in the study area.

Vegetation

Trees			
	ponderosa pine	**	*Pinus ponderosa*
	Douglas-fir	**	*Pseudotsuga menziesii*
Shrubs			
	common snowberry	**	*Symphoricarpos albus*
	tall oregon-grape	**	*Mahonia aquifolium*
Grasses			
	bluebunch wheatgrass	**	*Pseudoroegneria spicata*
	rough fescue	**	*Festuca campestris*
	pinegrass	**	*Calamagrostis rubescens*
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.

[88] Refer to Volume 2 (Iverson and Uunila 2008) for details on structural stage 6.

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[89] *ecological communities of mature forests*

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

Douglas-fir / common snowberry / pinegrass (R) (*Pseudotsuga menziesii / Symphoricarpos albus / Calamagrostis rubescens*)

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

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

Rare vertebrates of mature forests
Swainson's Hawk (R) (*Buteo swainsonii*)

Racer (B, COSEWIC-SC) (*Coluber constrictor*)
Western Rattlesnake (B, COSEWIC-T) (*Crotalus oreganus*)
Great Blue Heron (B) (*Ardea herodias*)
Flammulated Owl (B, COSEWIC-SC) (*Otus flammeolus*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

- Rarity: All mature forest ecological communities in the study area have rare status (see above).
- 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.
- 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 natural areas that mature forests provide can add to real estate values in adjacent areas. Mature forests provide opportunities for selective logging.

[89] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species and ecological communities as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, are noted as endangered (E), threatened (T), or of special concern (SC).

Status

Mature forest ecosystems covered 0.3% (71 ha) of the study area. Mature forest ecosystems in the study area were ingrown and required thinning to restore them to high quality sites that could become old forests.

Management Recommendations[90]

Avoid Direct and Indirect Impacts

- 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.

[90] Management recommendations have been adapted from Iverson and Cadrin 2003.

15 Seasonally Flooded Agricultural Fields

What are seasonally flooded agricultural field ecosystems?

Seasonally flooded agricultural fields are lands that have been converted to agricultural use but have seasonally important wildlife habitat values. They are primarily located along low lying areas in the floodplain adjacent to large creeks. These sites may flood some springs or have patches of water, providing habitat for insects, amphibians, waterfowl and other birds. Vegetation is dominated by agronomic grass species.

Why are they important?

Ecological attributes and socio-economic values of seasonally flooded agricultural ecosystems are listed below.

- Agricultural benefits: Provide areas for growing crops.
- Biodiversity: Seasonally flooded agricultural fields provide important habitat for waterfowl, other bird species and other wildlife.
- Linkages and travel corridors: These sites provide opportunities for wildlife to travel between riparian and upland habitats.
- Future riparian habitat: These sites have the potential to recover riparian vegetation if agricultural use is discontinued.

Rare vertebrates[91] of Seasonally Flooded Agricultural Fields
Swainson's Hawk (R) *Buteo swainsonii*
Badger (R, COSEWIC-E) *Taxidea taxus*

Great Basin Spadefoot (B, COSEWIC-T) Spea intermontana
Gopher Snake, deserticola subspecies (B, COSEWIC-T) *Pituophis catenifer* ssp. *deserticola*
Racer (B, COSEWIC-SC) *Coluber constrictor*
Western Rattlesnake (B, COSEWIC-T) *Crotalus oreganus*
Western Skink (B, COSEWIC-SC) *Eumeces skiltonianus*
Bobolink (B) *Dolichonyx oryzivorus*
Great Blue Heron, herodia subspecies (B) *Ardea herodias* ssp. *herodias*
Long-billed curlew (B, COSEWIC-SC) *Numenius americanus*
Short-eared Owl (B, COSEWIC-SC) *Asio flammeus*
Fringed Myotis (B) *Myotis thysanodes*
Townsend's Big-eared Bat (B) *Corynorhinus townsendii*
Western Harvest Mouse (B, COSEWIC-SC) *Reithrodontomys megalotis*
Western Small-footed Myotis (B) *Myotis ciliolabrum*

Western Toad (COSEWIC-SC) *Bufo boreas*
Rubber Boa (COSEWIC-SC) *Charina bottae*

[91] Provincially endangered or threatened (R-red-listed) or special concern (B-blue-listed) vertebrate species as of May 2008 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of April 2008, are noted as endangered (E), threatened (T), or of special concern (SC).

Status

Seasonally flooded agricultural fields occupied 31 ha or 0.1% of the land base in the study area.

Management Recommendations

Avoid Direct and Indirect Impacts

- Maintain or restore hydrological regime: allow natural flooding to occur to improve wildlife habitat and to ensure continued health of adjacent riparian ecosystems. Where practical, plant native riparian shrubs and trees to restore riparian ecosystems.
- Control invasive plant species: Canada thistle and other unwanted introduced species can threaten both the wildlife and agronomic and native plant species.
- Discourage human settlement or other land developments adjacent to seasonally flooded agricultural field ecosystems. These sites are not suitable for development because they are prone to flooding; adjacent developments can disrupt connections to other ecosystems.
- Prevent disturbance of nesting sites and breeding areas. Many waterfowl are ground-nesters. Avoid haying during the nesting season if rare species are present.

16 Future Directions

The Kelowna SEI provides an essential planning tool for the study area.

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 Central Okanagan including the protected areas on crown lands. A conservation analysis can identify conservation priorities to 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 larger scale) for development of neighbourhood area plans and Environmental Impact Assessments.

This SEI and the landscape level ecosystem plan for this area should be used to modify the City of Kelowna'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 Plan. The SEI map and 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 five to ten years to reflect and measure such changes.

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Appendix A: SEI Data

Spatial, non-spatial data and reports for the Terrestrial Ecosystem Mapping (TEM) component will be available for download at Ecocat http://www.env.gov.bc.ca/ecocat/ and can be found by searching by the project name "Kelowna".

The following are available:

- project metadata
- non-spatial polygon attributes
- TEM report with expanded legend (Volume 2)[92]
- Arc/Info *.E00 Export Files includes two spatial coverages: ECI field sampling points and a ECP TEM polygon coverage

[92] Iverson and Uunila 2008

Appendix B: Sensitive Ecosystems (SEI) Units[93] and related Terrestrial Ecosystem Mapping (TEM) units.

Sensitive Ecosystems

SEI Class, subclass	Code	TEM Unit	Code[94]	Subzone / Site Series
Broadleaf woodland, aspen copse	BW:ac	Trembling aspen – Snowberry – Kentucky bluegrass	AS (no "g" modifier)	IDFxh1 /98 PPxh1 /00
Grasslands, disturbed	GR:dg	Kentucky bluegrass – Stiff needlegrass	BN	IDFxh1 /96
		Rough fescue – Bluebunch wheatgrass	FB:$kc FB:$wk	PPxh1 /00
		Idaho fescue – Bluebunch wheatgrass	FW:$kc, FW:$nc FW:$wk	IDFxh1 /91
		Prairie Rose – Idaho fescue	RF 2	IDFxh1 /97
		Snowberry – Rose – Kentucky bluegrass	SR 2	PPxh1 /00
		Bluebunch wheatgrass – Balsamroot	WB:kc, WBwk	IDFxh1 /93 PPxh1 /00
Grassland, grassland	GR:gr	Rough fescue – Bluebunch wheatgrass	FB (no seral association)	PPxh1 /00
		Idaho fescue – Bluebunch wheatgrass	FW (no seral association)	IDFxh1 /91
		Rough fescue - Cladina	FC	IDFxh1 /00 PPxh1 /00
		Big sagebrush – Bluebunch wheatgrass - Balsamroot	WA	IDFxh1 /92
		Bluebunch wheatgrass – Balsamroot	WB (no seral association)	IDFxh1 /93 PPxh1 /00
Grassland, shrubland	GR:sh	Prairie Rose – Idaho fescue	RF 3	IDFxh1 /97
		Snowberry – Rose – Kentucky bluegrass	SR 3	PPxh1 /00
Old Forest, coniferous	OF:co	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
		Douglas-fir – Ponderosa pine – Saskatoon – Mock orange	FO 7C	PPxh1 /00
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Balsamroot	PB 7C	IDFxh1/02
		Ponderosa pine – Red three-awn	PT 7C	PPxh1 /02
		Antelope brush - Selaginella	SA 7C	IDFxh1 /00
		Saskatoon – Mock orange talus	SO 7C	PPxh1 /00
Riparian, beach	RI:be	Beach	BE	PPxh1 /00
Riparian, fringe	RI:ff	Black cottonwood – Douglas-fir – Common snowberry – Red-osier dogwood riparian	CD, CDc	IDFxh1 /00 PPxh1 /00
		Douglas-fir – Water birch – Douglas maple	DM, DMn, DMw	PPxh1 /08
		Western red cedar – Douglas-fir – False Solomon's Seal	RS (no modifiers)	IDFxh1 /00 PPxh1 /00
		Hybrid white spruce – Douglas-fir – Douglas maple – Dogwood	SD, SDc	IDFxh1 /08

[93] See page 7 for SEI unit descriptions.

[94] 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 2008) for descriptions of site modifiers, structural stages, seral associations, and TEM units.

SEI Class, subclass	Code	TEM Unit	Code	Subzone / Site Series
Riparian, bench	RI:fp	Black cottonwood – Douglas-fir – Common snowberry – Red-osier dogwood riparian	CDct, CDt	IDFxh1 /00 PPxh1 /00
		Douglas-fir – Water birch – Douglas maple	DMt	PPxh1 /08
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DSct, DSt	IDFxh1 /07 PPxh1 /07
		Western red cedar – Douglas-fir – False Solomon's Seal	RSa, RSac	IDFxh1 /00
Riparian, gully	RI:gu	Trembling aspen – Snowberry – Kentucky bluegrass	ASg	IDFxh1 /98 PPxh1 /00
		Black cottonwood – Douglas-fir – Common snowberry – Red-osier dogwood riparian	CDg	IDFxh1 /00 PPxh1 /00
		Douglas-fir – Water birch – Douglas maple	DMg, DMgk	PPxh1 /08
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DSg, DSgk, DSgw,	IDFxh1 /07 PPxh1 /07
		Western red cedar – Douglas-fir – False Solomon's Seal	RSg	IDFxh1 /00 PPxh1 /00
		Hybrid white spruce – Douglas-fir – Douglas maple – Dogwood	SDcg, SDg	IDFxh1 /08
Riparian, river	RI:ri	River	RI	IDFxh1 /00 PPxh1 /00
Sparsely Vegetated, cliff	SV:cl	Cliff	CL	IDFxh1 /00 PPxh1 /00
Sparsely Vegetated, rock outcrop	SV:ro	Rock outcrop	RO	IDFxh1 /00 PPxh1 /00
		Selaginella – Bluebunch wheatgrass rocky bluff	SB	IDFxh1 /00 PPxh1 /00
Sparsely Vegetated, shrub	SV:sh	Choke cherry – Bluebunch wheatgrass rocky bluff	CW	PPxh1 /00
		Antelope brush - Selaginella	SA	IDFxh1 /00 PPxh1 /00
Sparsely Vegetated, talus	SV:ta	Saskatoon – Mock orange talus	SO	IDFxh1 /00 PPxh1 /00
		Talus	TA	IDFxh1 /00 PPxh1 /00
Coniferous Woodland	WD	Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Pinegrass	DW (structural stage 4-6)	IDFxh1 /03
		Douglas-fir – Ponderosa pine – Saskatoon – Mock orange	FO (structural stage 3-6)	IDFxh1 /00 PPxh1 /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
		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
Wetland, meadow	WN:md	Alkali saltgrass	Gs01	PPxh1/Gs01
		Nuttall's alkaligrass – Foxtail barley	Gs02	PPxh1/Gs02
		Field sedge	Gs03	PPxh1/Gs03
		Giant wildrye	GW	PPxh1 /00

SEI Class, subclass	Code	TEM Unit	Code	Subzone / Site Series
Wetland, marsh	WN:ms	Bulrush marsh	BM	IDFxh1 /00 PPxh1 /00
		Baltic rush marsh-meadow	BR	IDFxh1 /00 PPxh1 /00
		Reed canarygrass	CG	IDFxh1 /00 PPxh1 /00
		Common spikerush marsh	CS	IDFxh1 /00
		Cattail marsh	CT	IDFxh1/00 PPxh1 /00
Wetland, swamp	WN:sp	Willow – Sedge wetland	WS	PPxh1 /00
		Mountain alder – Skunk cabbage – Lady fern	Ws01	IDFxh1/00 PPxh1 /00
Wetland, shallow open water	WN:sw	Alkaline pond	AK, AKx	PPxh1 /00
		Shallow open water	OW, OWx	IDFxh1 /00 PPxh1 /00
		Pond	PD	IDFxh1 /00 PPxh1 /00

Other Important Ecosystems

SEI Class, subclass	Code	TEM Unit	Code[95]	Subzone / Site Series
Seasonally Flooded Fields	FS	Cultivated Field	CFy	PPxh1 /00
Mature Forest, coniferous	MF:co	Douglas-fir – Ponderosa pine – Pinegrass	DP 6C	IDFxh1 /01
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DS 6C	IDFxh1 /07
		Douglas-fir – Ponderosa pine – Snowbrush – Pinegrass	SP 6C	IDFxh1 /04

[95] All site modifiers 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	Federal Status
Amphibians				
Great Basin Spadefoot	*Spea intermontana*	numerous locations, likely throughout	Blue	Threatened
Western Toad	*Bufo boreus*	unknown but likely	-	Special Concern
Reptiles				
Painted Turtle	*Chrysemis picta*	likely throughout	Blue	Special Concern
Western Skink	*Eumeces skiltonianus*	unknown but possible	Blue	Special Concern
Western Rattlesnake	*Crotalus oreganus*	likely throughout	Blue	Threatened
Gopher Snake	*Pituophis catenifer*	adjacent records, likely throughout	Blue	Threatened
Racer	*Coluber contrictor*	unknown, likely throughout	Blue	Special Concern
Rubber Boa	*Charina bottae*	likely throughout	-	Special Concern
Birds				
Western Grebe	*Aechmophorus occidentalis*		Red	-
American White Pelican	*Pelecanus erythrorhynchos*	Okanagan Lake	Red	-
Great Blue Heron	*Ardea herodias herodias*	likely single nests throughout	Blue	-
American Bittern	*Botaurus lentiginosus*	unknown but possible	Blue	-
Swainson's Hawk	*Buteo swainsoni*	likely throughout	Red	-
Ferruginous Hawk	*Buteo regalis*	unknown but possible	-	Special Concern
Prairie Falcon	*Falco mexicanus*	unknown but likely	Red	-
Peregrine Falcon	*Falco peregrinus anatum*	unknown but likely	Red	Special Concern
Long-billed Curlew	*Numenius americanus*		Blue	Special Concern
California Gull	*Larus californicus*	unknown but possible	Blue	-
Short-eared Owl	*Asio flammeus*	unknown but possible	Blue	Special Concern
Western Screech-owl	*Megascops kennicotti macfarlanei*		Red	Endangered
Flammulated Owl	*Otus flammeolus*	unknown but likely	Blue	Special Concern
Common Nighthawk	*Chordeiles minor*	likely throughout	-	Threatened
Lewis' Woodpecker	*Melanerpes lewis*	unknown but likely throughout	Red	Special Concern
Williamson's Sapsucker	*Sphyrapicus thyroideus thyroideus*	unknown, possible at higher elevations	Red	Endangered
Canyon Wren	*Catherpes mexicanus*		Blue	-
Yellow-breasted Chat	*Icteria virens*	unknown but possible	Red	Endangered
Grasshopper Sparrow	*Ammodramus savannarum*		Red	-
Lark Sparrow	*Chondestes grammacus*		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
Fringed Myotis	*Myotis thysanodes*	unknown but likely	Blue	-

Common Name	Scientific Name	Occurrence in Study Area	Prov. Status	Federal Status
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	-
Badger	*Taxidea taxus*	scattered records, likely rare throughout	Red	Endangered