Sensitive Ecosystems Inventory: Bella Vista – Goose Lake Range 2002

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

Kristi Iverson, Iverson & MacKenzie Biological Consulting Ltd.

Okanagan Indian Band

THE REAL ESTATE FOUNDATION OF BRITISH COLUMBIA

BRITISH COLUMBIA

ALLAN BROOKS NATURE CENTRE

Acknowledgements

The Steering Committee for the Bella Vista – Goose Lake Range Sensitive Ecosystems Inventory has provided project management, guidance and direction throughout the project:

Debbie Clarke	*FORECON Consulting Services*
Robert Hutton	*Okanagan Indian Band*
Keith Louis	*Okanagan Indian Band*
Susan Latimer	*Ministry of Water, Land and Air Protection*
Dale Rintoul	*City of Vernon*
Al McNiven	*Greater Vernon Services Commission*
Ken Barton	*Allan Brooks Nature Centre*
Carmen Wong	*Allan Brooks Nature Centre*
Dale Donovan	*Okanagan University College*

The project was funded by The Real Estate Foundation, the Ministry of Water, Land and Air Protection, the City of Vernon, the Ministry of Sustainable Resource Management, and the Allan Brooks Nature Centre.

Project management and extension was provided by ***Debbie Clarke***. Field work was completed by ***Kristi Iverson***[1], ***Jen Shypitka***[2], and ***Mike Sarell*** and ***Allison Haney***[3]. Bioterrain mapping was completed by ***Jen Shypitka*** and ecosystem mapping was completed by ***Kristi Iverson***. Field assistance was provided by ***Colleen Marchand*** and ***Keith Louis***[4] on Indian Reserve Lands. ***Terry McIntosh***[5] verified voucher plant and moss specimens. ***Bon Lee***[6] completed digital and cartography work.

Quality assurance was provided by ***Corey Erwin*** and ***Deepa Spaeth Filatow***[7].

This project has adapted material from the reports for the Central Okanagan Sensitive Ecosystem Inventory.

Marnie and Paul Williamson and ***Debbie and Bob Clarke*** kindly provided accommodation for field crews. ***Barend Donker***[8] provided study area maps and digital coverages for the portion of the study area within the City of Vernon.

Debbie Clarke, ***Malcolm Martin***, ***Carmen Wong***, ***Mike Sarell***, and ***Susan Latimer*** reviewed the draft version of this report.

We would like to thank Tavistock Properties Ltd., Y-K Properties Ltd., Aspen Farms Ltd., Jacana Enterprises Ltd., and especially the Okanagan Indian Band for providing access to their lands for sampling.

---

[1] Iverson & MacKenzie Biological Consulting Ltd.
[2] Private consultant
[3] Ophiuchus Consulting
[4] Okanagan Indian Band
[5] Biospherics Environmental Inc.
[6] Baseline Geomatics Inc.
[7] Ministry of Sustainable Resource Management
[8] City of Vernon

Abstract

The Okanagan Basin of British Columbia has very high biodiversity values, including many rare and endangered species and plant communities and a high diversity of ecosystems in close proximity. The region has been subject to extensive agricultural conversion, intense human settlement pressure, noxious weed invasion, uncontrolled motorized recreation, and forest ingrowth associated with fire exclusion. The Okanagan – Shuswap Local Resources Management Plan identified conservation issues on publicly owned lands and advised local governments to "encourage the adoption of wildlife habitat needs in Official Community Plans (OCP)" and to "participate in Sensitive Ecosystems Inventory".

The Bella Vista – Goose Lake Range area was identified in the Vernon Natural Features Inventory as one of the most significant relatively intact remnants of sensitive ecosystems in the North Okanagan, and, for the portion within the City of Vernon, has been designated for future urban growth in the OCP. The area supports ecosystems similar to other potential areas of urban growth around Vernon. For these reasons, the area was selected for a pilot Sensitive Ecosystem Inventory (SEI).

The Bella Vista – Goose Lake Range SEI was initiated in 2002 to provide inventory information on rare and fragile ecosystems that can be used for ecologically sustainable land use and development planning. The project area covers private land, Indian Reserve land, and a small area of crown land along the Bella Vista and Goose Lake Range west of the City of Vernon. This technical report documents inventory methods and results, and provides management recommendations.

The project followed methods used in the Central Okanagan SEI; we used Terrestrial Ecosystem Mapping (TEM) as a base to develop a Sensitive Ecosystems theme map. The inventory was compiled through aerial photograph interpretation and field survey work conducted in the summer of 2002.

Thirty-three percent of the study area is comprised of sensitive ecosystems (SE); twenty-seven percent of the area was included in the other important ecosystem (OIE) categories. The high proportion of SEs and OIEs in the study area reflects the choice of a study area known to have high ecological values. Wetlands, old forests, riparian ecosystems, and coniferous woodlands were extremely rare in the study area. Although areas of intact grasslands, broadleaf woodlands, and sparsely vegetated ecosystems remained, much of the area was covered by altered ecosystems and disturbed grasslands. Remaining grasslands are at risk to invasive plant species introduction or spread.

Many of the sensitive ecosystems are at high risk from human settlement, including loss, fragmentation, or further degradation by human use and invasion by non-native plants. These areas provide many social values including a scenic backdrop for the city and increased property values. With the study area supporting so much of remaining rare and fragile ecosystems, it is paramount that a comprehensive planning exercise be undertaken for the study area to balance the retention and ecological sustainability of sensitive ecosystems with sustainable land development.

Table of Contents

List of Figures

List of Tables

Using the Report

This report presents information on sensitive ecosystems in the Bella Vista – Goose Lake Range of the North Okanagan Valley, and provides guidance regarding their conservation and management.

> See **Volume 2** for details on the Terrestrial Ecosystem Mapping and Soil Erosion and Slope Stability.[9]
>
> See **Volume 3** for details on the Wildlife Habitat Capability and Suitability Mapping.[10]

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 and provides recommendations for Vernon's Official Community Plan. It provides management recommendations for First Nations and landowners.

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

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, updating SEI products, and extending the inventory's coverage.

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

---

[9] Iverson and Shypitka 2003
[10] Sarell and Haney 2003
[11] Iverson and Cadrin 2003. Contact Ken Arcuri at the Regional District of the Central Okanagan for more information.

Volume 2[12] provides detailed information on ***terrestrial ecosystem mapping*** (TEM) methods and gives descriptions of each of the ecosystems that occur within the sensitive ecosystems or 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*** that forms a base for the ecosystem mapping and the ***slope stability*** and ***erosion*** potential mapping. It is intended for use by professionals that require more detailed ecological and terrain information. It is recommended for use by people interested in developing other interpretive map themes from the ecosystem or terrain mapping.

Volume 3[13] contains wildlife habitat mapping themes developed from the terrestrial ecosystem mapping (TEM) for the following ten species: Great Basin Spadefoot (*Spea intermontana*), Northern Pacific Rattlesnake (*Crotalus oreganus*), Gopher Snake (*Pituophis catenifer* ssp*. deserticola*), Western Screech-owl (*Otus kennicottii* ssp*. macfarlanei*), Long-billed Curlew (*Numenius americanus*), Yellow-breasted Chat (*Icteria virens*), Brewer's Sparrow (*Spizella breweri* ssp*. breweri*), Grasshopper Sparrow (*Ammodramus savannarum*), Swainson's Hawk (*Buteo swainsonii*), and Badger (*Taxidea taxus*). All of these species are considered at risk in the province of B.C. and local populations are also a concern. These species provide a cross-section of threatened or endangered amphibians, reptiles, birds, and mammals that depend on a range of different sensitive and important ecosystems in the study area. There are many other threatened and endangered species that likely occur in the study area and are listed in each ecosystem chapter of Volume 1.

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

[12] Iverson and Shypitka 2003.
[13] Sarell and Haney 2003

1 Introduction

The Okanagan Valley is an area of tremendous biological and ecological significance, but ecosystems have been significantly modified and fragmented, and are increasingly threatened by urban and agricultural development. The valley provides a vital corridor connecting the Great Basin to the south with other dry interior landscapes of British Columbia. The Bella Vista – Goose Lake Range is a significant portion of the valley with a diverse assemblage of relatively intact ecosystems that support many endangered and other species.

The Allan Brooks Nature Centre, Okanagan Indian Band, City of Vernon, Ministry of Water, Land and Air Protection, Ministry of Sustainable Resource Management, and others, initiated this project to identify and provide a management tool for sensitive ecosystems in the Bella Vista – Goose Lake Range of the North Okanagan.

The purpose of the SEI project was to develop an inventory information base to support sound land management decisions, and promote effective stewardship of sensitive ecosystems. The goal was to provide the City of Vernon with data that could be used in revising its Official Community Plan, and providing input to Neighbourhood and Parks Plans and to provide the Okanagan Indian Band with information for land management planning. This product contributes to the tools 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 Bella Vista – Goose Lake Range, highlights their values and importance, and offers practical advice on how to best avoid or minimize damage to them. It is intended as a pilot project for the North Okanagan with the goal to inventory other significant natural areas in the future.

The Bella Vista – Goose Lake Range SEI follows from the Central Okanagan SEI and Vancouver Island SEI. Many of the materials in this report have been adapted from the reports for the Central Okanagan and Vancouver Island SEI. Other SEIs are ongoing on the Sunshine Coast and in the South Okanagan.

1.1 Study Area

The study area (Figure 1) is located on a peninsula extending into the north end of Okanagan Lake in the north Okanagan Valley of south-central British Columbia. The area covers 5,728 ha, and includes private land, Indian Reserve lands, and a small area of Crown land within the Interior Douglas-fir very dry, hot, Okanagan variant biogeoclimatic subzone[14]. The study area is located within the Southern Interior ***Ecoprovince***[15], the northern extension of the Columbia Basin that

[14] The BC Ministry of Forests ***Biogeoclimatic Ecosystem Classification*** (BEC) is a system of classifying vegetation based on climatic and topographic patterns. BEC 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.

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

extends south to Oregon and lies within the North Okanagan Basin ***Ecosection***, a wide trench formed by parallel fault lines and further carved out by multiple glaciations.

This Okanagan Valley experiences some of the warmest and driest weather conditions in the province. A rain shadow caused by the Coast and Cascade Mountains 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.

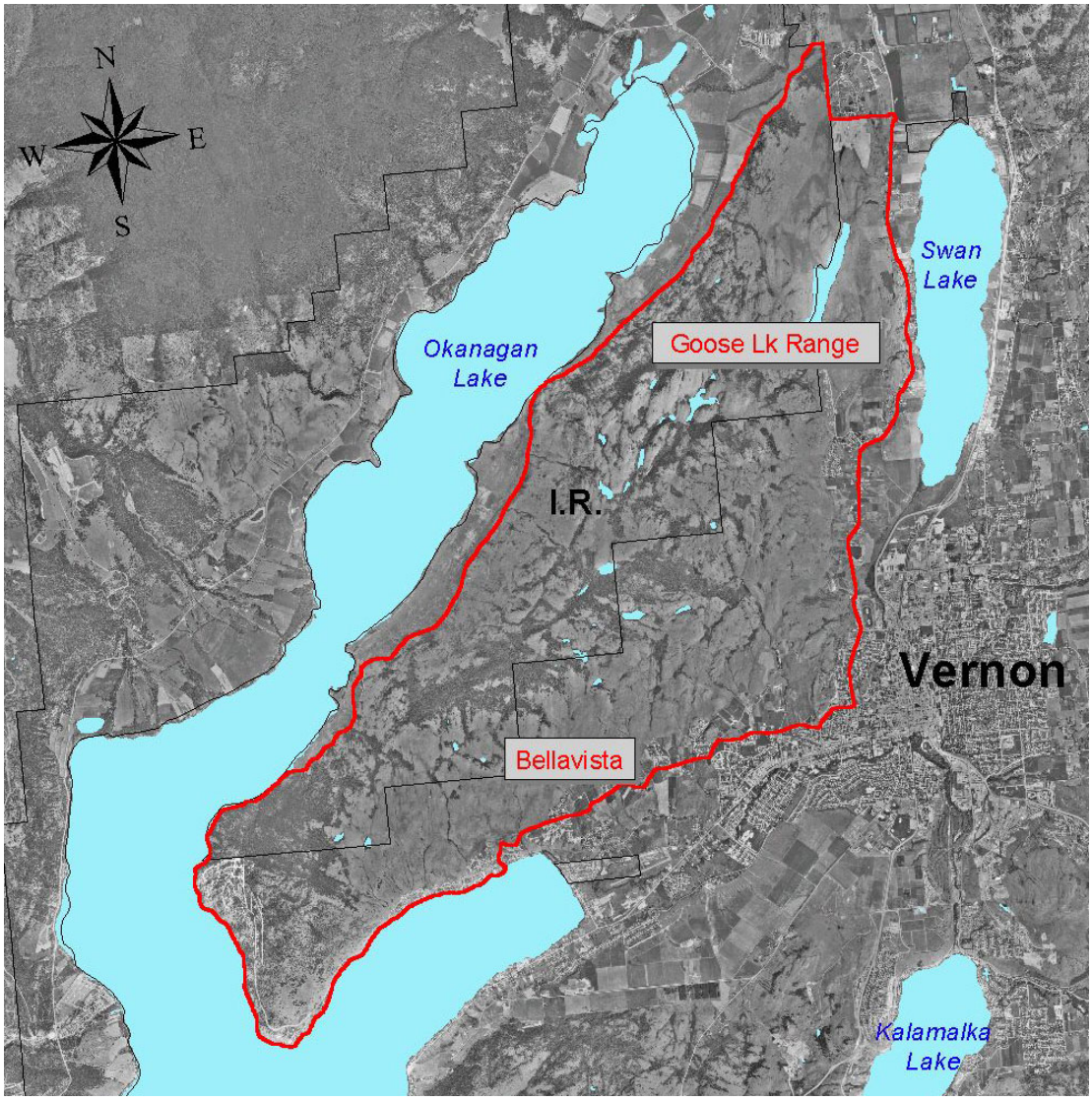


Figure 1. Bella Vista – Goose Lake Range SEI study area.

---

is a subdivision of an Ecoprovince and is an area with minor physiographic and macroclimatic or oceanographic differences.

1.2 Ecological Importance of the Study Area

The Okanagan Valley is a region of nearly unparalleled biological diversity within British Columbia and North America. The complex terrain of the area, combined with a semi-arid climate moderated by the influence of Lake Okanagan has resulted in a wide diversity of ecosystems and organisms in relatively close proximity to one another, and distinguishes the Okanagan Valley from the vast Columbia Basin to the south. Increasingly, scientists are finding that populations at the edge of their range, such as those in the Okanagan, are likely to persist longer than core populations during population declines, which also may allow them to adapt to future changes such as global warming[16].

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 southern plants and animals into B.C.'s dry interior.

The Bella Vista – Goose Lake Range was identified in the Vernon Natural Features Inventory[17] as an exceptional area with the best quality grasslands remaining in the North Okanagan Basin. The ponds, lakes, and wetlands found on the upper portions of the range also provide some of the best remaining wetland habitats. Additionally, the area is relatively large and natural, mostly unfragmented by roads and development, and has a great diversity of ecosystems, species, landforms, and bedrock geology. In the Natural Features Inventory, the area received a very high importance ranking for rarity, including at least four rare plants and 14 vertebrate species, and has potential for many other rare species. With proper planning and management, the natural features of the study area provide the potential for long-term viability of endangered species and sensitive ecosystems. Finally, the area provides a scenic and natural backdrop for the City of Vernon, and community values including aesthetics, hiking, and observing wildlife and nature.

Figure 2. Overview of study area looking south from Reed Lake.

[16] Scudder 1991
[17] Clarke et al. 1993

2 Ecosystems of Concern

2.1 What are Sensitive Ecosystems?

This sensitive ecosystems project recognises both ***sensitive ecosystems*** and ***other important ecosystems*** in the study area. *Sensitive ecosystems* refer to seven ecosystem types (Table 1) that are ecologically fragile or are rare in the provincial landscape and are relatively unmodified by human influences[18]. These sensitive ecosystems are generalised groupings of ecosystems that share many characteristics, particularly ecological sensitivities, ecological processes, rarity, and wildlife habitat values. These categories were adopted from the Central Okanagan SEI.

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

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

Table 1. Sensitive ecosystems.

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

[18] Ward et al. 1998

Table 2. Other important ecosystems.

Code	Other Important Ecosystems	Ecosystem Description
MF	Mature Forest	Forests dominated by mature trees; includes **broadleaf** (MF:bd) forests, **coniferous** (MF:co) forests, and **mixed** (MF:mx) deciduous and coniferous forests; excludes mature riparian forests and mature coniferous and broadleaf woodlands
DG	Disturbed Grasslands	Disturbed grasslands are grasslands with some noxious or invasive weeds (20 to 50% of the vegetation cover in the plant community)

2.2 Why are these ecosystems important?[19]

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 7 – 15.

Ecological Attributes

Rarity is a primary feature of sensitive ecosystems. Rarity can be due to limited natural occurrence or the result of human activities over the past 140 years. Most rare species or natural plant communities in the study area are considered to be rare both because they are restricted in distribution or abundance, and because their extent and densities have been reduced.

Rare natural plant communities and vertebrate species are listed for each sensitive ecosystem (Chapters 7 – 15).

The Okanagan Valley provides habitat for many threatened and endangered species. Nationally rare species ranked by COSEWIC[20], as of May 2002, are noted as endangered (E), threatened (T) or of special concern (C).

Red-list: The list of British Columbia's flora, fauna, and plant communities that are rare and endangered.

Some ***red-listed*** vertebrate animals in the study area include[21]:

Badger (COSEWIC-E) (*Taxidea taxus*)
Swainson's Hawk (*Buteo swainsoni*)

---

[19] Adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.
[20] **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.
[21] See Appendix D for a full list of known and potential threatened and endangered vertebrates in the study area.

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

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

Lewis's Woodpecker (COSEWIC-SC) (*Melanerpes lewis*)
Western Harvest Mouse (COSEWIC-SC) (*Reinthrodontomys megalotis*)
Townsend's Big-eared Bat (*Corynorhinus townsendii*)
Great Basin Gopher Snake (COSEWIC-T) (*Pituophis catenifer* ssp*. deserticola*)
Racer (*Coluber constrictor*)
Northern Pacific Rattlesnake (*Crotalus oreganus*)
Painted Turtle (*Chrysemis picta*)

Conservation Data Centre

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

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

COSEWIC

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

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

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

Socio-economic Values

- **Ecosystem Services** including air and water filtration and purification, nutrient cycling, and crop pollination. Clean water, water retention, and groundwater infiltration are important values provided by natural areas.

- **Green Space** networks comprised of diverse ecosystems and species of the area will provide for human enjoyment and interaction with wildlife amidst development. The area provides an attractive and aesthetic backdrop for the City.
- **High scenic values** are provided by rock outcrops, grasslands, and cliffs that provide excellent views of the landscape. These areas are often targeted for recreational and residential development. The community's natural landscape attracts visitors and new residents, and contributes towards opportunities for nature-based tourism and the unique 'sense of place', and a is source of pride and pleasure for local residents.
- **Outdoor recreation** opportunities are provided by ecosystems in public parks, and on accessible crown land where low-impact activities will not damage the habitat. Wildlife viewing is very important to Canadians[22], 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. The study area is also a source of many traditional use plants including food plants such as balsamroot and mariposa lily.
- **Research and nature education** are important at all levels of the school system from early childhood through to university, plus continuing education programs. Many schools are now working with local groups on school projects (e.g., Streamkeepers and Wetlandkeepers), and most focus on creating native plant communities and restoring wildlife habitat. Children and their families are learning directly about the need and means by which to care for the environment. The Allan Brooks Nature Centre provides opportunities for local and regional community ecosystem conservation efforts through displays, educational programs, hands-on workshops, and conservation-based volunteer activities.
- **Nature based tourism** is growing in economic importance, and can be very important in rural communities. Economic spin-offs can include benefits to local commercial services such as overnight accommodation, food concessions, and ventures such as guided nature trips and bird watching. Annual events such as the Meadowlark Festival in the South Okanagan make significant contributions to the local economy as they attract visitors from well beyond the host community.
- **Natural resource use** such as grazing and selection harvesting of forests have supported generations of Okanagan residents and continue to be important activities in the study area.
- **Increased property value** is another benefit provided by green space and wild lands. The beauty of the natural landscape is often a large part of what attracts people to the North Okanagan. Studies show that undeveloped green space measurably increases the value of nearby property[23] by 5 to 32%[24] and thus, contributes far more in property taxes than it costs in services[25].

---

[22] Environment Canada 1999
[23] Meadows 1999
[24] U.S. National Parks Service 1990
[25] Fodor 1999

3 Impacts of Concern[26]

The Bella Vista – Goose Lake Range is one of the few remaining areas in the North Okanagan with relatively intact natural ecosystems that are largely unfragmented. Human settlement pressures represent the greatest threat to sensitive ecosystems in the study area. Large-scale landscape concerns, which affect all ecosystems, include landscape fragmentation, disruption of natural disturbance regimes, edge effects, and invasive species introductions.

3.1 Landscape fragmentation

Fragmentation of the landscape often affects the functioning of ecosystems by disrupting connections between different ecosystems (e.g. between uplands and wetlands, resulting in changing water movement and water table levels). 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 distribution for wildlife species.

Although the Bella Vista – Goose Lake Range is largely unfragmented, urban and agricultural developments have affected the edges and surroundings, resulting in a somewhat isolated core natural area.

3.2 Disruption of Natural Disturbance Regime

The exclusion and suppression of natural fire has changed grassland and forest ecosystems in the study area. Ecosystems and species of the Okanagan Valley have evolved with natural fire as a major factor in ecosystem and habitat distribution. Frequent ***surface fires***[27] maintained open forests with largely grassy and shrubby understories. Fires likely limited the amount of sagebrush in grassland ecosystems. Fire exclusion has resulted in dense forests ingrown with Douglas-fir and ponderosa pine, and encroachment of these trees onto grasslands. Fire exclusion has affected both ecosystem processes and wildlife habitat values.

3.3 Invasive Species

Both the deliberate and accidental introduction of invasive non-native plant species (see below) has significantly altered the species composition of some ecosystems in the study area. The northern and lower slope portions of the study area are the areas that have been most 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 reducing vegetation diversity and soil stabilization. Invasion of non-native plants can also result in loss of forage for

---

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

[27] 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.

domestic livestock and wildlife. Recreation vehicles such as all terrain vehicles (ATVs), bicycles, domestic animals, and people can all spread weeds. Many weeds have seeds that can survive in the soil for decades; consequently, weed control must always be considered to be a long-term process.

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

Noxious weeds are aggressive invader weeds 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*), or sulphur cinquefoil (*Potentilla recta*). Disturbed grasslands are very vulnerable to takeover by invasive plant species if they are disturbed further. Riparian ecosystems and broadleaf woodlands are vulnerable to invasion by common hound's-tongue (*Cynoglossum officinale*) and common burdock (*Arctium minus*). Wetland ecosystems can be completely altered if purple loosestrife (*Lythrum salicaria*) becomes established.

Some invasive plant species:

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

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

3.4 Edge effects

Fragmentation of ecosystems combined with adjacent development contributes to the creation of 'edges' where there is an abrupt rather than natural, gradual change from one ecosystem type to

another. This edge effect can alter the habitat value of the original ecosystem by creating changes in microclimate elements such as air temperature, light level, and humidity[28]. Direct biological effects result when specific species cannot tolerate human activity nearby, or they are exposed to predation by other species. Increased non-native species invasion and competition for habitat are examples of indirect biological edge effects.

The study area is influenced by edge effects primarily along the lower slopes, especially on the eastern side of the study area in the City of Vernon. Urban growth, linear development (e.g. roads), and other land development within the study area has the potential to increase edge effects.

3.5 Direct Impacts

Direct impacts to ecosystems are those which occur on site, and which have the most immediate and visible effect. Vegetation removal or damage, and soil removal or compaction are examples of immediate and visible effects. Ditching, diking, draining and filling of wetlands and riparian areas are visible effects 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). Fragmentation associated with these lots also leaves them more vulnerable to weed invasion. All of these possible changes reduce the ecological integrity and natural values of these areas.

3.6 Indirect Impacts

Activities that occur adjacent to or at some distance from the ecosystem result in indirect impacts. Hydrological[29] changes due to roads, buildings, deforestation, removal of vegetation, invasive plant species, increased impervious road surfaces, soil compaction and agricultural practices can all result in reduced groundwater infiltration and summer soil moisture, increased annual runoff, disrupted drainage patterns, and reduced soil moisture holding capacity. These hydrological changes can change the water quality and function, structure, and wildlife habitat values of adjacent wetlands and riparian areas.

Water pollution from both point and non-point sources contributes to reduced water quality, potential outbreaks of water-borne disease, and impacts to wildlife populations through the loss of habitat and disruption of the food chain. The use of pesticides associated with agriculture and landscaping has also caused degradation of natural ecosystems and wildlife habitat[30].

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

---

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

[29] Water-related features and processes.

[30] Cannings and Durance 1998

4 Methods and Limitations[31]

This chapter describes the methods that were used to generate the sensitive ecosystems map. These methods follow those used in the Central Okanagan. The provincially recognised Terrestrial Ecosystem Mapping[32] (TEM) approach was used to create a base map. Ecosystems were evaluated for rarity and ecological sensitivity, and a sensitive ecosystems theme map was developed.

4.1 Terrestrial Ecosystem Mapping

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

Details on methods, results, limitations and management recommendations for slope stability and erosion potential mapping can be found in **Volume 2**[33].

Details on methods, results, limitations and management recommendations for wildlife capability and suitability mapping can be found in **Volume 3**[34].

4.2 Sensitive Ecosystems Mapping

For the Central Okanagan SEI, TEM units were evaluated for rarity and ecological sensitivity and were assigned to sensitive ecosystems and other important ecosystems categories accordingly. For this project, TEM units were assigned to the same sensitive ecosystems as in the Central Okanagan SEI and any new TEM units were evaluated for rarity and ecological sensitivity. The Central Okanagan criteria for ecological sensitivity included the presence of shallow soils, the susceptibility of the site to hydrological changes, erosion, and invasion by noxious weeds, and sensitivity associated with human disturbance. Rarity was based on rankings and proposed rankings by the Conservation Data Centre (CDC), provincial distribution of those ecosystems (especially in an undisturbed state) and the threats to them. If the 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.

Ecosystems were grouped into sensitive ecosystems categories using the Ecosystem-based Resource (ERM) Table Tool[35]. This tool allows ratings, or in this case, SEI categories, to be assigned to each ecosystem. Detailed conversion tables can be found in Appendix B.

---

[31] Adapted from Iverson and Cadrin 2003.
[32] Resources Inventory Committee 1998
[33] Iverson and Shypitka 2003
[34] Sarell and Haney 2003

Field Sampling and Conservation Evaluation of Sensitive Ecosystems

Prior to initiating the fieldwork for this project, landowners within the study were contacted by letter and phone to request permission to sample their lands. Four landowners and the Okanagan Indian Band agreed to have their lands sampled.

I developed a sampling plan using forest cover maps to identify areas of potentially old forest, and aerial photographs to identify accessible potentially sensitive ecosystems including grasslands, wetlands, ponds, riparian areas, rock outcrops and talus slopes. Field sampling was completed in the summer of 2002, and a total of 158 sensitive ecosystems or other important ecosystems sites were field-checked (Table 3). A team of three scientists including a plant ecologist, terrain specialist, and wildlife biologist conducted the sampling.

Three types of sample plots were used to identify and assess ecosystems: detailed ecological plots, ground inspections, and visual inspections[36] (see Appendix A in Volume 2). Sample plots were subjectively located within polygons to best represent the ecosystem(s) in that polygon. Samples sites were distributed to maximize sampling of sensitive ecosystems; other ecosystems were sampled along access routes to sensitive ecosystems. Sampling of private lands we did not have permission to access was limited to visual inspections with binoculars from accessible locations in adjacent properties. Sampling procedures for detailed ecological plots and ground inspections are outlined in *Field Manual for Describing Terrestrial Ecosystems*[37]. The *Standard for Terrestrial Ecosystem Mapping*[38] in British Columbia provides guidelines for visual inspection data collection.

Field crews used the conservation evaluation form (see Appendix A in Volume 2) to assess the conservation values of the site.

Field data provided points of calibration used to photo-interpret ecosystems that were not visited.

Table 3. Sites sampled by ecosystem type.

Sensitive Ecosystems	Full plots	Ground Inspections	Visuals	Total Plots
Broadleaf Woodland	2	5	11	18
Grasslands	3	10	10	23
Old Forest		1		1
Riparian	1	6	2	9
Sparsely Vegetated	3	9	19	31
Coniferous Woodland	1	3	2	6
Wetland	1	7	23	31
TOTAL	**11**	**41**	**67**	**119**
Other Important Ecosystems				
Disturbed Grasslands		5	27	32
Mature Forest		3	4	7
TOTAL		**8**	**31**	**39**

[35] See the following website for more information on the ERM tools and to download ERM tools: http://srmwww.gov.bc.ca/rib/wis/whr/sta.htm

[36] See Volume 2: Iverson and Shypitka 2003

[37] BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998

[38] Resources Inventory Committee 1998

4.3 Mapping Limitations

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

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

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

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

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

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

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.

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 33.2% (1901 ha) of the study area (Table 4), while modified landscapes covered the remaining 66.8%. The two other important ecosystems (OIE) mapped covered 26.8% (1536 ha) of the study area. The high proportion of SEs and OIEs in the study area reflects the choice of a study area known to have high ecological values. Figure 5 shows the distribution of sensitive 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 SEs or OIEs. Many ecosystems provide important wildlife habitat. Also, the vegetation and soils help provide the safe capture, storage, and release of water that is critical to maintaining water quality, preventing soil erosion, and maintaining the hydrological function of wetland, riparian and other ecosystems.

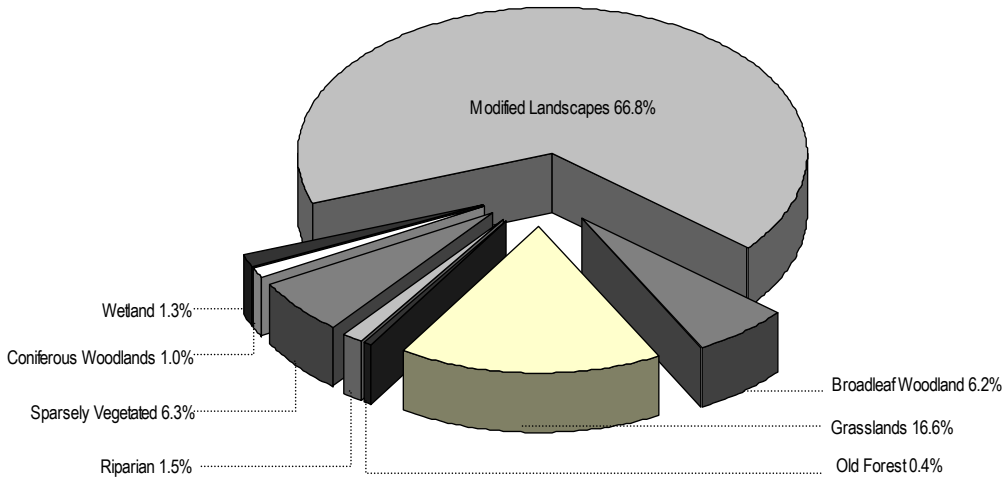


Figure 4. Relative proportion of sensitive ecosystems and modified landscapes in the study area.

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

	Area (ha)	Percent of Study Area
Sensitive Ecosystems (SE)		
Broadleaf Woodland	353	6.2
Grassland	952	16.6
Old Forest	24	0.4
Riparian	87	1.5
Sparsely Vegetated	358	6.3
Coniferous Woodland	56	1.0
Wetland	72	1.3
Total SE	**1901**	**33.2**
Other Important Ecosystems (OIE)		
Disturbed Grassland	1350	23.6
Mature Forest	187	3.3
Total OIE	**1536**	**26.8**
TOTAL SEI and OIE	**3347**	**60.0**

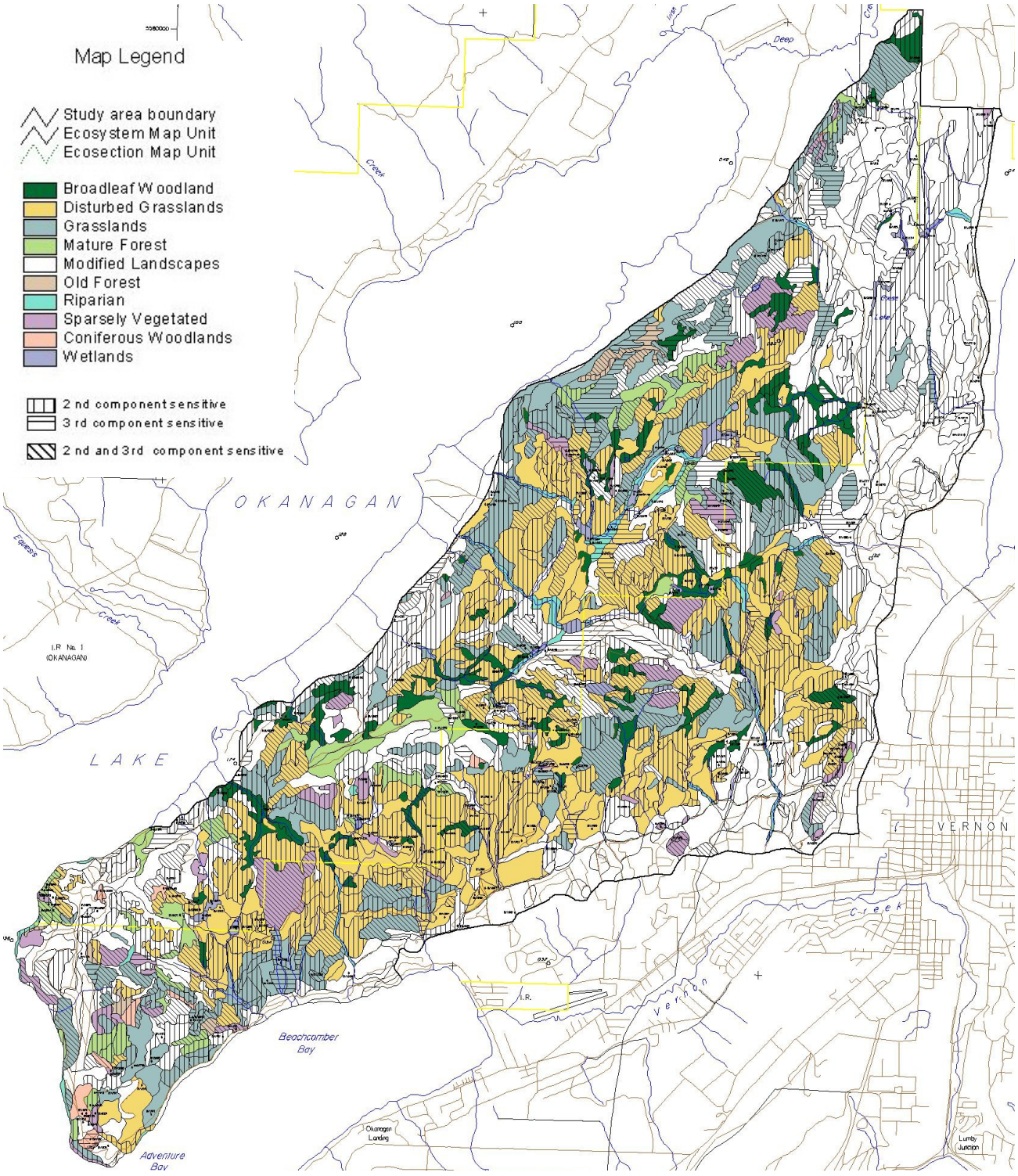


Figure 5. Sensitive Ecosystems map for the study area.

6 Planning and Management

6.1 Goals

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

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

6.2 City Planning

Develop a 'Local Ecosystems Plan'[39]

A systematic plan for prioritization and protection, and stewardship of local sensitive ecosystems should be developed. SEI mapping, terrestrial ecosystem mapping, wildlife habitat mapping, and soil erosion and slope stability terrain mapping can be used to set priorities for conservation and management. The local ecosystems plan should consider known gaps in the system of provincial and regional protected areas, and be integrated across the study area , within the City and Indian Reserve to ensure landscape level connectivity.

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

- Concentrations of high quality ecosystems and habitat for rare species should be prioritized for establishing core conservation areas.
    - Quality/condition and viability ratings of SEI units can be used to identify higher quality SEI units[40].
    - Wildlife habitat mapping can be used to determine key core areas for mapped species.
    - Core areas could be managed as natural parks, biodiversity ranches, or other forms of conservation areas.

---

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

[40] **Quality/condition** measures how well the specific site represents the biological and ecological functions of the ecosystem, degree of fragmentation, and the degree of alteration of the site by human influences and presence of introduced species. **Viability** measures the likelihood that the ecosystem will retain its biological and ecological functions based on current conditions, and surrounding land uses and management practices. There are four possible rankings for quality/condition and viability: Excellent (1), Good (2), Marginal (3), and Poor (4). Ecosystems with Excellent and Good rankings for quality/condition and viability are the highest conservation priorities.

- In consultation with a qualified professional, establish ecologically appropriate buffers to protect core conservation areas.
- Link core areas with corridors. The habitat needs of important wildlife species must be considered in this process. A professional biologist should design habitat linkages that consider the needs of a full spectrum of species.
- Design roads and utilities 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 a weed management strategy to minimize the spread and introduction of invasive plant species.

For demonstration purposes, the project team developed three preliminary modelling scenarios to illustrate the implications of three levels of ecosystem retention in the study area. These scenarios are outlined in Appendix C.

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.

Develop a Conservation Strategy[41]

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

- **Designation as Environmentally Sensitive Areas** (ESA) – The seven sensitive ecosystems should be a priority in the identification and designation of local government ESAs. In some cases, site boundaries should reflect the dynamic nature of the ecosystem (see **Retain Natural Vegetated Buffers around Sensitive Ecosystems** below). These ESAs should be identified in the Official Community Plan.
- **Acquisition of privately owned lands for conservation and protected status** – The most undisturbed of these remaining ecosystem fragments should be considered for purchase as conservation areas where only activities that do not impact the ecosystem would be permitted. Grassland, wetland, old forest, riparian and broadleaf woodland together with the highest quality coniferous woodland and sparsely vegetated sites should all be priorities for receiving protected

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

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 weeds 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.

Official Community Plan

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

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

- Designate sensitive and other important ecosystems as ***Development Permit Areas***[42] (DPAs) in the OCP. DPA boundaries may go beyond ESA boundaries.
    - Ensure that every effort shall be made to maintain or enhance the ecological integrity of these areas.
    - Ensure that the vegetation, wildlife, and ecological functions of these areas are maintained or enhanced.
    - Ensure that water balance and hydrologic functions are maintained and stormwater planning is integrated with other ecological planning.
    - Limit landscaping to restoration of removed or altered native vegetation or habitat. Use native plants adapted to on-site conditions. Control invasive plant species.
    - Adopt the recommendations for Environmental Impact Assessments in this report.
- Designate sensitive and other important ecosystem DPAs as areas for which ***Development Approval Information*** is required.
- Use the local ecosystems plan to ***determine areas for natural open space*** and develop conservation strategies for those areas. Create a natural open space designation for such areas.
- ***Ensure that only developments and other activities*** compatible with the preservation, protection, restoration, and enhancement of sensitive ecosystems occur in DPAs.
- Ensure ***neighbourhood plans are consistent with the local ecosystems plan*** and conservation strategies. At the development scale, maintain appropriate buffers, determined by

[42] 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).

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 and Corridors Between Sensitive Ecosystems page 24).
    - Do not limit the maximum density bonus to 20% in cases where density bonuses are granted in exchange for the 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. ***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.
- Policy Section G[43] – ensure that subdivision plans along Lake Okanagan have provisions for maintaining all foreshore vegetation and ecosystems and provide connectivity to upland ecosystems for wildlife.
- Policy Section K – Development Phasing. Revise this section to reflect conservation priorities and conservation plans once they are developed.
    - Avoid approval of any developments in the study area until conservation priorities have been established.
- Policy Section M – Special Areas. Re-designate O'Keefe Range Lands to be consistent with conservation priorities once they are developed.

Additional Policies for Wetland and Riparian Ecosystems

- Protect water quality from pollutants, sediments, and changed nutrient loads

[43] Refers to Policy Sections in Vernon's OCP.

- Determine and consider the overall water balance affecting wetland and riparian ecology and protect from disturbance.
    - Maintain natural surface, groundwater and nutrient regimes.

Other Local Government Policies and Plans

Use the Regional Growth Strategy and Parks and Recreation Master Plan to establish community goals and policies for ecosystem protection and to establish urban containment boundaries. Revise other policies and zoning bylaws[44] as direction is established for ecosystem protection.

6.3 Indian Reserve Planning

Develop a Local Ecosystems Plan[45]

SEI mapping, terrestrial ecosystem mapping, wildlife habitat mapping, and soil erosion and slope stability terrain mapping can be used to help set priorities for conservation and management. A local ecosystems plan should be developed cooperatively to ensure connectivity to sensitive ecosystems in the City of Vernon and elsewhere. The local ecosystems plan can provide a logical framework to determine where development could occur while conserving sensitive ecosystems and cultural use values. Ecosystem planning should include traditional ecological knowledge, and be a component of overall community planning.

- Concentrations of high quality ecosystems, habitat for rare species, and high quality sites for cultural uses should be prioritized for establishing core conservation areas.
    - Quality and viability ratings of SEI units can be used to identify higher quality SEI units[46].
    - Wildlife habitat mapping can be used to determine key core areas for mapped species.
    - Integrate local knowledge of traditional uses and values.
- Establish ecologically appropriate buffers to protect core conservation areas.
- Link core areas with corridors. The habitat needs of important wildlife species must be considered in this process.
- Design road access at a landscape scale to minimize impacts to sensitive and other important ecosystems.

---

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

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

[46] **Quality/condition** measures how well the specific site represents the biological and ecological functions of the ecosystem, degree of fragmentation, and the degree of alteration of the site by human influences and presence of introduced species. **Viability** measures the likelihood that the ecosystem will retain its biological and ecological functions based on current conditions, and surrounding land uses and management practices. There are four possible rankings for quality/condition and viability: Excellent (1), Good (2), Marginal (3), and Poor (4). Ecosystems with Excellent and Good rankings for quality/condition and viability are the highest conservation priorities.

- If needed, develop a recreation management plan that is consistent with the preservation of sensitive ecosystems.
- Develop a weed management strategy to minimize the spread and introduction of invasive plant species.
- Develop a strategy to return forests to their historically open conditions and to remove encroaching trees from grasslands. Ensure that the strategy is consistent with maintaining sensitive and important ecosystems, and species at risk.

Develop a Range Management Plan

The current primary disturbance within the Indian Reserve is domestic cattle grazing and trampling. Many riparian and grassland ecosystems have altered structure or vegetation species that has changed the value of these sites for wildlife. The shrub cover and structural diversity has been reduced in many riparian ecosystems. The foreshore of most ponds and marshes has been extensively trampled. Most level and gently sloping grasslands are dominated by grasses more tolerant of disturbance such as needlegrasses, Sandberg's bluegrass, and higher covers of big sagebrush. Without domestic livestock, these grasslands would be dominated by large clumpes of bluebunch wheatgrass, rough fescue and Idaho fescue.

Domestic livestock grazing can be compatible with conservation of sensitive ecosystems. A Range Management Plan will be of great value, and should:

- Determine the appropriate grazing levels in different ecosystems;
- Determine fencing needs, specifically pasture and riparian fencing;
- Determine needs and locations for alternate watering sites;
- Establish appropriate timing, location, and intensity of grazing, including ungrazed benchmark areas;
- Determine needs for on-site management and movement of cattle; and
- Develop a monitoring plan to ensure management objectives are met.

6.4 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[47] to provide wildlife inventory information and verify and map sensitive ecosystems at an appropriate scale for development planning. Work collaboratively with professional biologists in designing the development.

[47] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

- 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 a '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.
    - They can reduce property taxes if the market value of the land is reduced by the restrictions of the covenant.
- 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[48]

Here Today, Here Tomorrow: Legal Tools for the Voluntary Protection of Private Land in British Columbia[49]

North Okanagan Parks and Natural Areas Trust
c/o North Okanagan Regional District

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

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

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

[48] Ministry of Environment, Lands and Parks 1996

6.5 General Management Recommendations[50]

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

Retain Natural Vegetated Buffers around and Corridors Between Sensitive Ecosystems

In order to achieve adequate protection, sensitive ecosystems must be buffered from potentially adverse effects of land use practices in adjacent areas. A natural vegetated buffer zone can absorb and avoid negative edge effects that result from animal and human access and disturbance. Buffers also play a role in maintaining microclimate conditions such as temperature and humidity, particularly for wetlands and riparian areas. A vegetated buffer is established by retaining or restoring natural ecosystems that surround sensitive or other important ecosystems. The size of the buffer zone varies by ecosystem type, and by constraints of the surrounding landscape. Fencing may be necessary along some buffers where further adjacent development and activity is anticipated. In planning for protection of a particular site, assessments and recommendations should be made by a qualified professional[51] 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 narrow than buffers and must be designed to provide sufficient width and natural vegetation cover for the species that use them.

Avoid Direct and Indirect Impacts

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

- ***Discourage settlement and other development within or adjacent to sensitive ecosystems*** unless only insignificant negative impacts can be demonstrated;
- ***Manage access to land and water***: Seasonal use-restrictions (e.g. during wildlife breeding seasons), fencing, designated trails, and signage can be used to help avoid the negative effects of access to sensitive areas. Designating trails and areas for limited used (e.g. restricting motorized recreation or mountain bikes) are another access management tool;
- ***Prevent disturbance of nesting or breeding areas*:** Known and potential breeding sites, (especially for threatened or endangered species) should be protected from any activity that would disturb breeding wildlife;

---

[49] Findlay and Hillyer 1994

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

[51] See: Incorporating SEI Information into Environmental Impact Assessments, page 25, step 1 for guidelines on qualified professionals.

- ***Control invasive species*:** A broad weed management plan may be necessary to control and limit the spread of perennial weeds 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 weed invasion; and
- ***Restore natural disturbance regimes*** wherever possible. Consider some planned thinning and prescribed burning to restore open forests, and restore some encroached grassland habitat. Consult a qualified professional to develop and implement a restoration and prescribed burning plan

Plan Land Development Carefully

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

6.6 Incorporating SEI Information into Environmental Impact Assessments[52]

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

Canadian Environmental Assessment Act

BC Environment Assessment Act

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

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

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

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

1. The EIA must be prepared by a registered professional biologist together with other professionals[53] of different expertise, as the project warrants. Hydrologists and hydrogeologists should be consulted where wetlands, riparian areas, and broadleaf woodlands exist within the development area to ensure that proper hydrological function is maintained within these ecosystems. A professional geoscientist should be consulted where there are erosion potential or slope stability hazards. The consultant or team of consultants must have an understanding of wildlife biology, especially for species at risk, geomorphology, environmental assessment, and development planning in British Columbia. Specific expertise in Okanagan Valley wildlife species, wildlife habitat, and ecosystems is highly preferred.
2. Digital Sensitive Ecosystems and Wildlife Habitat mapping files should be used to generate a sensitive ecosystems map and wildlife habitat maps for the proposed development area plus a surrounding adjacent area that is at least equal in width to the development area. The soil erosion and slope stability maps should be used to determine if any risks exist in the development area.
3. A field assessment should be conducted:
    a. For those SEI polygons where field data has not been collected, ground-truthing, including an assessment of the quality and condition of the ecosystems, should be conducted. For complex polygons, sensitive ecosystems should be mapped at a larger scale than used in the SEI to show specific locations;
    b. Where potential significant wildlife habitat is indicated by wildlife habitat maps, verify the presence of wildlife or their habitats by completing detailed species inventories. The inventories should take place during the time(s) of year when wildlife species of interest are expected to be present. It will be difficult to verify the presence of some species. It may be necessary to assume the presence of these species based on habitat suitability and forgo expensive inventories efforts. Each sensitive ecosystem chapter has a list of the potential red- and blue-listed wildlife that could occur in that ecosystem in the North Okanagan. All of these species should be addressed in the assessment; and
    c. Verify any potential soil erosion (ratings of Moderate, High, or Very High) or slope stability (Class III and up) problems in the field assessment.
4. The sensitive ecosystems and wildlife habitat mapping will need to be revised to reflect the field verification work.
5. Adverse long and short-term and cumulative effects that the proposed development is likely to have on sensitive ecosystems and wildlife habitat (direct and indirect impacts) should then be identified[54].

---

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

[54] The occurrence of nationally vulnerable, threatened, or endangered species, and rare natural plant communities identified by the Conservation Data Centre should be given high priority for conservation management.

6. A site plan that incorporates the management recommendations found below for each sensitive ecosystems category and which optimizes conservation of sensitive ecosystems and wildlife habitat, maintains connectivity and buffers around them and corridors between them, and avoids erosion potential or slope stability risks should be generated. The plan should seek to maintain connectivity with sensitive ecosystems and important wildlife habitats in adjacent areas, wherever possible.
7. The construction schedule and type of equipment that will minimize or avoid adverse environmental effects should be determined.
8. Opportunities for restoration or enhancement of sensitive ecosystems and wildlife habitat should be identified and the criteria used to prioritize these opportunities should be documented.
9. The assessment should identify how the proposed development will affect sensitive ecosystems and wildlife habitat, and should provide recommendations to reduce negative impacts and mitigate unavoidable impacts (e.g. restoration or enhancement).

7 Wetland

7.1 What are wetland ecosystems?[55]

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[56]. 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 swamps, marshes, and shallow water ecosystems; they are described below.

Marsh ecosystems

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

Meadow ecosystems

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 are dominated by baltic rush, alkaligrass, foxtail barley, or saltgrass.

Shallow water ecosystems

Shallow water ecosystems were either areas of open water that were intermittently or permanently flooded up to 2 m in depth at midsummer[57], or were ponds that were greater than 2m in depth, but were less than 50 ha in area. Vegetation was limited to submerged or floating aquatic plants with less than 10% cover of vegetation that emerged above the water surface. Shallow water ecosystems often occurred in association with marshes.

[55] Adapted from Iverson and Cadrin 2003.
[56] MacKenzie and Banner 1999
[57] Voller 1998

Vegetation

	Marsh	Meadow	Shallow Water	
Grasses, Sedges & Rushes				
sedges	*			*Carex* spp.
rushes	***			*Schoenoplectus* spp.
Baltic rush		**		*Juncus balticus*
alkaligrass		**		*Puccinellia sp.*
foxtail barley		**		*Hordeum jubatum*
seashore saltgrass		**		*Distichlis spicata*
Forbs				
cattail	**			*Typhus latifolia*
duckweed	**		**	*Lemna minor*
water smartweed	*		**	*Polygonum amphibium*
pondweeds			*	*Potamogeton* spp.

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

7.2 Why are they important?[58]

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

Natural plant communities recommended for the red- or blue- list
Baltic rush (*Juncus balticus*)
Great bulrush (*Schoenoplectus acutus*)
Common spike-rush (*Eleocharis palustris*)

Rare[59] vertebrates of wetlands
Northern Leopard Frog (R, COSEWIC-E) (*Rana pipiens*)
Peregrine Falcon (R, COSEWIC-T) (*Falco peregrinus* ssp. *anatum*)
American Avocet (R) (*Recurvirostra americana*)

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

- **Rarity**: Most wetland natural plant communities have been recommended for rare status (see above).

[58] Adapted from Iverson and Cadrin 2003.
[59] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC).

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

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

7.3 Status

We found that wetland ecosystems were rare in the study area; they occupied 72 ha or 1.3% of the study area land base. However, generally steep topography naturally limits the occurrence of wetlands; but 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[60]. The study area has an unusually high proportion of wetlands remaining relative to other parts of the Okanagan Valley. Wetlands have been influenced by domestic cattle grazing in the study area, 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. However, these sites often attract off-road vehicles for 'mud-bogging'. Future housing and other developments in the study area may alter, isolate, or cause losses of wetlands.

Shallow water (42 ha) was the most common wetland type in the study area, however, all three types of wetlands were extremely uncommon (meadows 5 ha, marshes 25 ha).

[60] Voller 1998

7.4 Management Recommendations[61]

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

Retain Natural Vegetated Buffers around Wetland Ecosystems

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

Avoid Direct and Indirect Impacts

- **Prevent human settlement and other land developments within, or adjacent to, wetland areas**. It is strongly recommended that such activities in and around wetlands be avoided. Roads should not be built near wetlands as they can alter hydrology and lead to extensive mortality of wildlife species that use wetlands. Roads should never encircle wetlands and should be set back as far as possible (more than 50m; distance depends on local conditions).
- **Maintain wetland hydrology**. Draining or ditching in or around wetlands, the filling in of wetlands, and the discharge of stormwater into such sites should be avoided. Vegetation cover should not be removed as this increases surface runoff and reduces the amount of groundwater infiltration, thus reducing available summer moisture. Additionally, areas of impervious ground surfacing (i.e., pavement) should be minimized. Hydrologists familiar with wetland function should be consulted to determine how to protect wetland hydrology.
- **Maintain water quality**. Wetlands store and filter water, and maintain water quality; therefore, the addition of urban storm drainage, agricultural runoff, and sediment from road building into wetlands should be prevented. Wetlands that have artificially high nutrient levels may experience algal blooms, and vegetation in some marshes may convert from sedges or rushes to cattails.
- **Restrict recreational access**. Intensive recreational use of shoreline areas can reduce plant cover, compact soil, and disturb wildlife. Roots of trees and shrubs can be easily damaged by trampling and trail development in the moist soils of wetlands. Trails often become wide in wet, muddy areas, and sediments from trail damage may affect amphibians and insects. Motorized recreation, mountain biking, and horseback riding should be excluded 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).

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

- **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**.

8 Riparian

8.1 What are riparian ecosystems?[62]

Riparian simply refers to areas adjacent to water bodies such as lakes, rivers, streams, and ponds[63]. 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 (gully and fringe) according to their environmental and vegetation characteristics; these are described below.

[62] Adapted from Iverson and Cadrin 2003.
[63] MacKenzie and Banner 1999; Voller 1998

Gully riparian

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

Fringe riparian ecosystems

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

Vegetation

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

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

8.2 Why are they important?[64]

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

Rare[65] riparian natural plant 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 / common snowberry – birch-leaved spirea (B) (*Pseudotsuga menziesii / Symphoricarpos albus - Spiraea betulifolia*)

Douglas-fir - paper birch / Douglas maple (B) (*Pseudotsuga menziesii - Betula papyrifera / Acer glabrum*)

Rare vertebrates of riparian ecosystems

Western Screech-Owl (R, COSEWIC-E) (*Otus kennicottii* ssp. *macfarlanei*)
Yellow-breasted Chat (R, COSEWIC-E) (*Icteria virens*)
Brewer's Sparrow (R) (*Spizella breweri* ssp. *breweri*)

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

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

[64] Adapted from Iverson and Cadrin 2003.
[65] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC). See Glossary for further discussion.

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

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

8.3 Status

Riparian ecosystems are naturally rare in the study area and occupied only 1.5% (87 ha) of the study area – predominantly gully (60 ha) ecosystems with some fringe (27 ha) ecosystems. Only a small section of the Okanagan Lake foreshore was included in the study area.

Only 2% of riparian ecosystems in the study area were in the old forest structural stage. Another 17% was mature forest and 40% was young forest, indicating that many riparian ecosystems had been altered by human disturbance. Historically, riparian ecosystems would have been predominantly old and mature structural stages.

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

8.4 Management Recommendations[66,67]

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

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

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

Retain Natural Vegetated Buffers around Riparian Ecosystems

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

---

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

[67] There are no fish-bearing streams in the study area. Additional management recommendations for riparian ecosystems where fish may be present can be found in Iverson and Cadrin 2003.

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

Avoid Direct and Indirect Impacts

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

Plan Land Development Carefully

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

- **Require an environmental impact assessment conducted by a qualified professional**[68].
- **Plan, design, and implement land development activities to avoid adversely affecting or disturbing:**

[68] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

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

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

9 Old Forest

9.1 What are old forest ecosystems?[69]

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

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

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

Vegetation

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

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

[69] Adapted from Iverson and Cadrin 2003.

9.2 Why are they important?[70]

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[71] natural plant communities of old forests

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

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

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

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

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

- **Rarity**: Old forest natural plant communities are rare (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. Typically these forests are open, and, thus, provide good visibility from predators for ungulates. Large old trees provide good snow interception.
- **Specialised habitats:** Many species depend on features found only in old forests. The large, old trees in these forests provide cavities for many bird and small mammal species. Additionally, these ecosystems usually have scattered large snags and large woody debris which provide critical habitats for many species, including some species at risk.
- **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.

[70] Adapted from Iverson and Cadrin 2003.
[71] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC). See Glossary for further discussion.

9.3 Status

Historically, old forests likely dominated the majority of the forested portion of the landscape (about 20% of the study area) but now there are only small remnants. Most old forests had been lost to selection logging. The inventory showed that only 0.4% (24 ha) of the study area was old forests; these occurred in very small and fragmented patches. Thus, there is a need to conserve all remaining old forests, and retain some mature forests for recruitment to old forests.

9.4 Management Recommendations[72]

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

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

Retain Natural Vegetated Buffers around Old Forest Ecosystems

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

Avoid Direct and Indirect Impacts

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

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

- **Avoid use of insecticides in, or near, important foraging areas for wildlife**. Insecticide use near foraging habitat for animals that feed on insects (e.g., Flammulated Owl and Lewis's Woodpecker) should be avoided.
- **Recruit new old forests.** Given that old forests are extremely limited within the study area, new old forests should be encouraged by proper management of mature forests (see Management Recommendations for mature forests on page 65).

Plan Land Development Carefully

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

- **Require an environmental impact assessment conducted by a qualified professional**[73].
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimize impacts to old forest ecosystems** by addressing the following recommendations:
  - protect large, old trees and snags, and understory vegetation;
  - locate settlements and other developments away from existing large, old trees and snags;
  - design linear corridors to be as narrow as possible, and configure them to allow wildlife crossing; and
  - restore native vegetation where it has been disturbed. Seed or plant native species from nurseries, or plant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free.
- **Design trails carefully**. Ensure that trails do not affect the root systems of trees, and will not create soil erosion problems. Trails should be designed to discourage use by vehicles (e.g. ATVs), horses, and mountain bikes. Fences may be necessary in some places to prevent access. Trails should be closely monitored for noxious and invasive weeds. If weeds are present, trails should be closed until the weeds have been treated and are under control to avoid spreading them.
- **Protect endangered, threatened, or vulnerable species or plant communities** by addressing the following recommendations:
  - avoid disturbance to sites where rare plants are growing and where rare natural plant communities occur;
  - maintain habitat structures such as large old trees and snags; and
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Protect nesting and denning sites that were identified in the environmental impact assessment**. Such features include dens, cavities, and perch trees.

[73] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

10 Grasslands

10.1 What are grassland ecosystems?[74]

Grasslands in the study area were dominated by bunchgrasses with scattered forbs and a microbiotic crust. The grasslands of the North Okanagan represent a portion of the Pacific Northwest bunchgrass grasslands that are centred in south-east Washington, north-east Oregon and Idaho[75].

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

Much of the diversity within grasslands is found in the microbiotic crust that covers the soil surface between plants. The microbiotic crust is composed of lichens, mosses, algae, bacteria and cyanobacteria. Crusts slow evaporation, prevent wind and water erosion, and contribute nutrients through nitrogen fixation. The microbiotic crust is, however, sensitive to disturbance by vehicles, people, mountain bikes, and livestock.[76]

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

Bluebunch wheatgrass is a common bunchgrass in warm and dry grasslands and open forests.

[74] Adapted from Iverson and Cadrin 2003.
[75] Tisdale 1947
[76] Williston 1999

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

Grassland ecosystems

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

Shrubland ecosystems

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

Vegetation

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

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

10.2 Why are they important?[77]

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

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

Rare[78] natural plant communities of grasslands:

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

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

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

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

Great Basin Spadefoot (B, COSEWIC-T) (*Spea intermontana*)
Painted Turtle (B) (*Chrysemys picta*)
Racer (B) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp*. deserticola*)
Northern Pacific Rattlesnake (B) (*Crotalus oreganus*)
Sharp-tailed Grouse[79] (B) (*Tympanuchus phasianellus* ssp*. columbianus*)
Long-billed Curlew (B, COSEWIC-SC) (*Numenius americanus*)
Short-eared Owl (B, COSEWIC-SC) (*Asio flammeus*)
Lewis's Woodpecker (B, COSEWIC-SC) (*Melanerpes lewis*)
Fringed Myotis (B, COSEWIC-SC) (*Myotis thysanodes*)
Great Basin Pocket Mouse (B) (*Perognathus parvus*)
Western Harvest Mouse (B, COSEWIC-SC) (*Reithrodontomys megalotis*)
Nuttall's Cottontail (B, COSEWIC-SC) (*Sylvilagus nuttallii* ssp*. nuttallii*)

- **Highly threatened**: Grasslands commonly occur on sites that are very amenable to development – both for agriculture and housing – and many grasslands have already been lost to development. Overuse by domestic livestock and invasion of noxious weeds also threatens

[77] Adapted from Iverson and Cadrin 2003.
[78] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC). See Glossary for further discussion.
[79] Thought to be extirpated from the area.

remaining grasslands. Grasslands are recognised as one of British Columbia's most threatened ecosystems[80]. Only 8% of provincial grasslands are protected[81].

- **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 noxious weed invasions, which can slow or limit recovery.
- **Social values**: Grasslands provide opportunities for education, wide open spaces for walking and hiking, wildlife viewing, and aesthetic enjoyment. Grasslands are particularly attractive in spring with their vibrant display of wildflowers. The open, natural spaces that grasslands provide can add to real estate values in adjacent areas, and can draw tourists into the area.

10.3 Status

We found that grassland ecosystems covered 17% (952 hectares) of the study area. The majority of these were grasslands (72%), but a large proportion was shrublands (28%). The relatively high proportion of grasslands in the study area reflects the importance of the study area to the conservation of grasslands.

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

10.4 Management Recommendations[82]

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

Retain Natural Vegetated Buffers around Grassland Ecosystems

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

Avoid Direct and Indirect Impacts

---

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

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

Plan Land Development Carefully

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

- **Require an environmental impact assessment conducted by a qualified professional[83].**
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimize impacts to grassland ecosystems** by addressing the following recommendations:
    - protect native grasses, microbiotic crusts, and other native vegetation;

[83] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

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

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

11 Broadleaf Woodlands

11.1 What are broadleaf woodland ecosystems?[84]

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

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

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.

[84] Adapted from Iverson and Cadrin 2003.

11.2 Why are they important?[85]

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[86] natural plant communities of broadleaf woodlands

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

Rare vertebrates of broadleaf woodlands:
Ferruginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
Western Screech-Owl (R, COSEWIC-E) (*Otus kennicottii* ssp. *macfarlanei*)
Yellow-breasted Chat (R, COSEWIC-E) (*Icteria virens*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Northern Pacific Rattlesnake (B) (*Crotalus oreganus*)
Western Harvest Mouse (B, COSEWIC-SC) (*Reithrodontomys megalotis*)

- **Rarity**: Broadleaf woodland native plant communities are 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.
- **Specialised habitats**: Aspen copse ecosystems are structurally diverse, and provide cover, food, and nesting habitat for many species. Aspen trees are very important for cavity nesting birds and animals. Many species that feed in adjacent grasslands require aspen trees for nesting and denning.
- **Social values**: Broadleaf woodland ecosystems provide opportunities for education, wildlife viewing, cover from the heat and sun, walking and hiking, and aesthetic enjoyment. They provide water filtration, soil stability and can add to real estate values in adjacent areas and draw tourists into the area.
- **Fragility**: These ecosystems are sensitive to soil disturbances because of their moist soils.

11.3 Status

Broadleaf woodland ecosystems were scattered throughout the upper elevations of the study area; they covered 6% of the study area (353 ha). All broadleaf woodland ecosystems are a high priority for conservation.

---

[85] Adapted from Iverson and Cadrin 2003.

[86] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC). See Glossary for further discussion.

11.4 Management Recommendations[87]

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

Retain Natural Vegetated Buffers around Broadleaf Woodland Ecosystems

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

Avoid Direct and Indirect Impacts

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

Plan Land Development Carefully

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

- **Require an environmental impact assessment conducted by a qualified professional[88]**.

---

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

[88] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

- **Plan, design and implement land development activities** (including trails and recreation access) **to minimise impacts to broadleaf woodland ecosystems** by addressing the following recommendations:
  - protect mature and old trees and understory vegetation (especially shrubs);
  - protect live and dead trees with cavities;
  - protect standing dead and declining trees, downed trees and logs, and leaf litter;
  - protect the root systems of trees;
  - protect soil conditions and hydrologic regimes; and
  - restore native vegetation where it has been disturbed. Plant cuttings of shrubs, or plant native species from nurseries, or plant native species have been rescued from other development sites. Make sure any native plant material used is weed-free.
- **Design roads carefully**. Roads should be narrow and set back from the ecosystem to ensure that vegetation is maintained. Where roads encroach upon broadleaf woodland ecosystems, narrow the width of the road and avoid sidecasting material into the ecosystem.
- **Design trails carefully**. Ensure that trails do not affect the root systems of trees, and will not create soil erosion problems. Trails should be designed to discourage use by vehicular traffic (ATV's), horses, and mountain bikes. Fences may be necessary in some places to control access.
- **Protect endangered, threatened, or vulnerable species or plant communities, and habitat features** that were identified during the planning and inventory stages, by including the following recommendations:
  - avoid disturbance to sites where rare plants are growing and where rare natural plant communities occur;
  - maintain habitat structures such as trees with cavities, large old trees, and snags, and limbs, leaf litter and soil; and
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree. Large diameter felled trees should be left on the ground.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Protect nesting and denning sites** that were identified in the environmental impact assessment. Such features include dens, raptor nest or perch trees, owl roosts, woodpecker cavities, and bat roosts.
- **Maintain hydrologic regimes**. Changes to surface and ground water flow can negatively impact broadleaf woodland ecosystems. Trails, roads, and housing developments must be designed to maintain hydrology of these ecosystems.
- **Ensure adequate sediment and erosion control measures** are implemented.

12 Coniferous Woodlands

12.1 What are coniferous woodland ecosystems?[89]

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

Coniferous woodland ecosystems were classified into five structural stages for this SEI. Structural stages are important to identify different habitat values and the quality of the site (Table 6). Generally, older structural stages are higher conservation priority 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.

[89] Adapted from Iverson and Cadrin 2003.

12.2 Why are they important?

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

Rare[90] natural plant communities of coniferous woodlands

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

Rare vertebrates of coniferous woodlands
Swainson's Hawk (R) (*Buteo swainsoni*)
Ferriginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)

Racer (B) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Northern Pacific Rattlesnake (B) (*Crotalus oreganus*)
Western Skink (B, COSEWIC-SC) (*Eumeces skiltonianus*)
Lewis' Woodpecker (B, COSEWIC-SC) (Melanerpes lewis)
Flammulated Owl (B, COSEWIC-SC) (*Otus flammeolus*)

- **Rarity**: Coniferous woodland native plant communities have rare status (see above).
- **High biodiversity**: Coniferous woodland ecosystems are diverse and support a rich assemblage of species. Coniferous woodland ecosystems on shallow soil sites with exposed bedrock often provide habitat for snakes.
- **Specialised habitats**: Scattered large, old trees and cracks and crevices in ecosystems with exposed bedrock provide a range of habitat niches.
- **Fragility**: Coniferous woodland ecosystems commonly have shallow soils that are very sensitive to disturbance.
- **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.

12.3 Status

The types of coniferous woodland ecosystems found in the study area have a limited distribution in British Columbia. Historically, these ecosystems likely occurred as patches in areas with shallow soils in the study area. Most coniferous woodland ecosystems have been altered by disturbances such as logging, forest ingrowth, and weed invasion. Coniferous woodland ecosystems were rare in the study area (1% of study area; 56 ha).

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

[90] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC). See Glossary for further discussion.

Most coniferous woodland ecosystems were young or mature forests (93%). Mature woodlands (46%) should be a higher priority for conservation.

12.4 Management Recommendations[91]

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

Retain Natural Vegetated Buffers around Coniferous Woodland Ecosystems

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

Avoid Direct and Indirect Impacts

- **Discourage human settlement or other developments** within or adjacent to coniferous woodland ecosystems.
- **Manage access** to minimize vehicular and livestock access. Where trails can be safely established, follow the appropriate recommendations listed below under "Plan Land Development Carefully".
- **Control invasive species**. Managing human and livestock access, and treating existing invasive species will help maintain the ecological integrity of coniferous woodland sites. Retaining a healthy natural plant community and avoiding soil disturbance will help prevent weed invasions. The BC Ministry of Forests or BC Ministry of Agriculture, Fish and Food can be consulted to determine the appropriate method and timing of treatment for invasive plant species. Herbicides and biological control agents are other possible treatments.
- **Prevent soil disturbances**. Coniferous woodlands typically have shallow soils that are sensitive to disturbance. Soil disturbance can allow invasive weeds to establish and spread and can make it difficult for native plants to re-establish.
- **Reduce ingrowth.** Cut down and, if possible, remove small ingrowth trees.

Plan Land Development Carefully

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

- **Require an environmental impact assessment conducted by a qualified professional[92]**.

---

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

[92] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

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

13 Sparsely Vegetated

13.1 What are sparsely vegetated ecosystems?

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

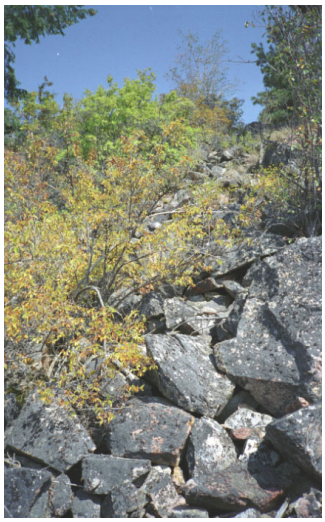
Sparsely vegetated ecosystems were subdivided into four subtypes: shrub, talus, cliff, and rock outcrop ecosystems; these are described below.

Shrub

In the study area, shrub ecosystems occurred on small rock outcrops with cracks and crevices in grassland areas. These ecosystems were steep; soils were restricted to small pockets. Scattered shrubs and cliff ferns grew in cracks and crevices.

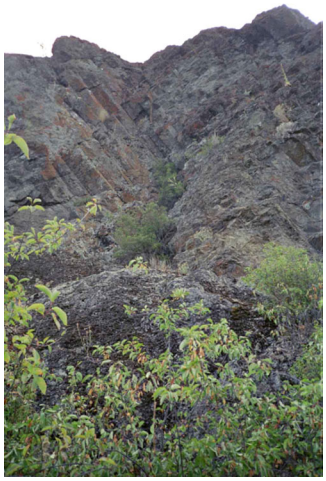
Talus

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



Cliff

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



Rock Outcrops

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

Vegetation

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

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

13.2 Why are they important?

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

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

Antelope-brush – selaginella (*Purshia tridentata*)[93]

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

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

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

[93] Although Antelope-brush does not occur in the North 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.

Rare[94] vertebrates of sparsely vegetated ecosystems
Swainson's Hawk (R) (*Buteo swainsonii*)
Ferruginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
Peregrine Falcon (R, COSEWIC-SC) (*Falco peregrinus* ssp*. anatum*)
Prairie Falcon (R) (*Falco mexicanus*)
Pallid Bat (R, COSEWIC-T) (*Antrozous pallidus*)
Racer (B) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp*. deserticola*)
Northern Pacific Rattlesnake (B) (*Crotalus oreganus*)
Western Skink (B, COSEWIC-SC) (*Eumeces skiltonianus*)
Lewis's Woodpecker (B, COSEWIC-SC) (*Melanerpes lewis*)
Fringed Myotis (B, COSEWIC-SC) (*Myotis thysanodes*)
Western Small-footed Myotis (B) (*Myotis ciliolabrum*)
Spotted Bat (B, COSEWIC-SC) (*Euderma maculatum*)
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*)

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

13.3 Status

These ecosystems covered 6% (358 ha) of the study area land base. In the study area, rock outcrops and shrub ecosystems were the most common ecosystem type (227 ha and 101 ha); cliffs and talus sites were extremely uncommon (9 ha and 21 ha).

13.4 Management Recommendations[95]

[94] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC). See Glossary for further discussion.

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

Retain Natural Vegetated Buffers around Sparsely Vegetated Ecosystems

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

Avoid Direct and Indirect Impacts

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

---

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

Plan Land Development Carefully

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

- **Require an environmental impact assessment conducted by a qualified professional**[96].
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimise impacts to sparsely vegetated ecosystems** by addressing the following recommendations:
  - protect talus that occurs at the base of rock outcroppings and protect the steep faces of rock outcrops and cliffs;
  - protect mature and old trees and all native vegetation;
  - protect large diameter (>30cm) standing dead and declining trees and downed logs;
  - protect soil conditions and hydrologic regimes; and
  - restore native vegetation where it has been disturbed. Seed or plant native species from nurseries, or plant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free.
- **Protect endangered, threatened, or vulnerable species or plant communities, and habitat features** that were identified during the planning and inventory stages by addressing the following recommendations:
  - avoid disturbance of rock debris;
  - do no permit rock climbing without determining which areas must be avoided to protect denning, nesting, and roosting habitats;
  - avoid disturbance to sites where rare plants are growing and where rare natural plant communities occur;
  - maintain habitat structures such as trees with cavities, large old trees, and snags; and,
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Avoid roads near hibernacula**. Determine locations of snake hibernacula prior to planning site layouts, including roads. Roads should not be located within 750m of a hibernaculum and barriers and underpasses or snake fences may be required to prevent snake mortality.
- **Protect nesting and denning sites that were identified in the environmental impact assessment**. Such features include dens, hibernacula, raptor nest or perch trees, woodpecker cavities, and bat roosts.
- **Ensure adequate sediment and erosion control measures** are implemented.

---

[96] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

14 Mature Forest

14.1 What are mature forest ecosystems?

Mature forest ecosystems were mapped where polygons included structural stage 6 forests[97] (mature forest), except for mature riparian, broadleaf woodland, and coniferous woodland forests, which were included in the riparian, broadleaf woodland, and coniferous woodland categories respectively.

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

The exclusion of fires has caused formerly open, park-like forests to infill with waves of smaller trees (this is referred to as forest ingrowth; historically, most of these small trees would have been killed by periodic fires). Mature forests occurred where there are mature trees and a few large old trees. These stands typically had a history of selection logging and had forest ingrowth, but the mature and old trees they contained are structurally important for wildlife. Mature forest sites provide excellent buffers for old forests and have good potential for restoration to historical stand structure.

Coniferous mature forest ecosystems

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

Mixed mature forest ecosystems

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

Broadleaf mature forest ecosystems

In the study area, broadleaf mature forest ecosystems had broadleaf tree species in the overstory including trembling aspen and paper birch. These ecosystems occurred on moister sites than coniferous mature forest ecosystems and had shrubby understories.

[97] Refer to Volume 2 (Iverson and Shypitka 2003) for details on structural stage 6.

Vegetation

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

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

14.2 Why are they important?

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

Rare[98] vertebrates of mature forests
Swainson's Hawk (R) (*Buteo swainsonii*)
Ferruginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
Badger (R, COSEWIC-E) (*Taxidea taxus*)
Racer (B) (*Coluber constrictor*)
Gopher Snake (B, COSEWIC-T) (*Pituophis catenifer* ssp. *deserticola*)
Northern Pacific Rattlesnake (B) (*Crotalus oreganus*)
Great Blue Heron (B) (*Ardea herodias*)
Flammulated Owl (B) (*Otus flammeolus*)
Lewis's Woodpecker (B) (*Melanerpes lewis*)

- **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.

[98] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC). See Glossary for further discussion.

- **Landscape connectivity:** Mature forests provide buffers, and connectivity between other ecosystems.
- **Social values**: Mature forests provide opportunities for education, recreation, wildlife viewing, and aesthetic enjoyment. The green space that mature forests provide can add to real estate values in adjacent areas. Mature forests provide opportunities for selective logging.

14.3 Status

Mature forest ecosystems covered 3.2% (186 ha) of the study area. Most mature forest ecosystems in the study area were ingrown and required thinning to restore them to high quality sites that could become old forests.

Coniferous mature forests were the most common type (160 ha); only 21 ha were mixed and a mere 5 ha were broadleaf.

14.4 Management Recommendations[99]

Avoid Direct and Indirect Impacts

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

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

  Prescribed fire may be too dangerous to conduct a prescribed burn 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 most small trees.
- **Prevent disturbance of nesting sites and breeding areas** (e.g., cavities in large trees).
- **Protect large old trees, and snags**. Old trees and snags provide critical nesting habitat for many species of birds and den sites for mammals.

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

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

Plan Land Development Carefully

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

- **Require an environmental impact assessment conducted by a qualified professional**[100].
- **Design and implement land development activities** (including trails and recreation access) **to minimise impacts to the mature forest ecosystems** by addressing the following recommendations:
  - protect large, old trees, and understory vegetation;
  - locate the development away from existing large, old trees and snags; and
  - restore native vegetation where it has been disturbed. Seed in or plant native species from nurseries or transplant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free.
- **Design trails carefully**. Ensure that trails do not affect the root systems of trees, and will not create soil erosion problems. Trails should be designed to discourage use by vehicular traffic (ATV's), horses, and mountain bikes. Fences may be necessary in some places to prevent access. Trails should be closely monitored for noxious and invasive weeds. If weeds are present, trails should be closed until the weeds have been treated and are under control to prevent spread.
- **Protect endangered, threatened, or vulnerable species and habitat features** that were identified during the planning and inventory stages by addressing the following recommendations**:**
  - avoid disturbance to sites where rare plants are growing and where rare natural plant communities occur;
  - maintain habitat structures such as large old trees and snags; and
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.

---

[100] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

- **Protect nesting and denning sites that were identified in the environmental impact assessment**. Such features include dens, raptor nest or perch trees, owl roosts, woodpecker cavities, and bat roosts.

15 Disturbed Grasslands

15.1 What are disturbed grassland ecosystems?

Disturbed grasslands, once intact grasslands, had a mixture of native bunchgrasses and forbs, and 20-50% invasive plant species including cheatgrass (*Bromus tectorum;* see photo), diffuse knapweed (*Centaurea diffusa*) and sulphur cinquefoil (*Potentilla recta*). Grasslands now dominated by big sagebrush are also included as disturbed grasslands.

In the study area, some grassland ecosystems had been invaded by noxious weeds that covered more than 50% of the plant community. These ecosystems would be extremely challenging to restore and were excluded from the disturbed grasslands category.

Vegetation

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

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

15.2 Why are they important?

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

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

Rare[101] vertebrates of disturbed grasslands
Swainson's Hawk (R) (*Buteo swainsonii*)
Ferruginous Hawk (R, COSEWIC-SC) (*Buteo regalis*)
Prairie Falcon (R) (*Falco mexicanus*)
Upland Sandpiper (R) (*Bartramia longicauda*)
Burrowing Owl (R, COSEWIC-E) (*Athene cunicularia*)
Grasshopper Sparrow (R) (*Ammodramus savannarum*)
Brewer's Sparrow (R) (*Spizella breweri* ssp. *breweri*)
Lark Sparrow (R) (*Chondestes grammacus*)
Preble's Shrew (R) (*Sorex preblei*)
Merriam's Shrew (R) (*Sorex merriami*)
Badger (R, COSEWIC-E) (*Taxidea taxus*)

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

15.3 Status

Grassland ecosystems cover only 0.8% of British Columbia's land area and many of these grasslands have been lost or disturbed[102]. The study showed that disturbed grasslands covered 24% (1350 ha) of the study area. Although these sites had up to 50% non-native plants, they could provide a source of grassland ecosystems through restoration. In particular, disturbed grassland ecosystems that occur in association with other sensitive and important ecosystems are higher priorities for preservation and restoration.

15.4 Management Recommendations[103]

Although 17% of the study area is covered by undisturbed grassland; disturbed grasslands covered a greater proportion. These disturbed grassland ecosystems need to be restored to replace invasive weeds with native vegetation. Where disturbed grasslands occur in association with other sensitive ecosystems, they have a higher preservation value and should be a higher priority for

---

[101] Provincially endangered or threatened (R-red-listed) or vulnerable (B-blue-listed) vertebrate species and natural plant communities as of August 2002 are noted. Nationally rare vertebrate species ranked by COSEWIC, as of May 2002, are noted as endangered (E), threatened (T), or of special concern (SC). See Glossary for further discussion.
[102] Grasslands Conservation Council of B.C. 2002
[103] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.

restoration. Disturbed grasslands can also form buffers, corridors, and provide wildlife habitat, but require a plan to control invasive weeds.

Avoid Direct and Indirect Impacts

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

Plan Land Development Carefully

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

- **Require an environmental impact assessment conducted by a qualified professional**[104].
- **Plan, design and implement land development activities** (including trails and recreation access) **to minimise impacts to disturbed grassland ecosystems** by addressing the following recommendations:
  - protect native grasses, microbiotic crusts, and other native vegetation,
  - protect large, old trees;
  - protect soils and other terrain features such as bedrock;
  - do not create trails unless invasive weeds have been controlled; and
  - restore native vegetation where it has been disturbed. Seed or plant native species from nurseries, or plant native species that have been rescued from other development sites. Ensure that any native plant material used is weed-free or contaminated with the same weeds present on site.
- **Protect endangered, threatened, or vulnerable species**, **and habitat features** that were identified during the planning and inventory stages by addressing the following recommendations:
  - avoid disturbance to sites where rare plants are growing and where rare natural plant communities occur;
  - maintain habitat structures such as large old trees and snags; and
  - where it is absolutely necessary to cut danger trees, cut them to a level where they are safe and retain the trunk rather than removing the whole tree.
- **Prevent disturbance of nesting and breeding areas**. Avoid development activities from May through August.
- **Protect nesting and denning sites that were identified in the environmental impact assessment**. Such features include dens, raptor nest or perch trees, owl roosts, woodpecker cavities, and bat roosts.

[104] See: Incorporating SEI Information into Environmental Impact Assessments, page 25.

Future Directions

The Bella Vista – Goose Lake Range SEI provides an essential planning tool for the study area, and an important source of information for other similar ecosystems that occur elsewhere in the North Okanagan.

For the study area, this information should be used to develop a landscape level 'local ecosystems plan' and conservation strategy, which could tie into a broader 'ecosystem plan' for the North Okanagan and the Protected Areas Strategy on crown lands.

While it may not be possible to define specific areas for conservation in the absence of other planning information, and input from the community and landowners, it should be possible to identify and assess some options. Similar to the demonstration scenarios described in Appendix 3 it should be possible to incorporate wildlife habitat information (Volume 3), and other preliminary planning information to develop scenarios for ecosystem retention. With a target established for future conservation, a property acquisition strategy can be formulated, including fundraising by conservation organizations.

As development proceeds within the study area, this inventory should be used as the basis for more detailed information gathering (at a smaller scale) for development of neighbourhood area plans and Environmental Impact Assessments. Another demonstration product could be an illustration of the use of this SEI in producing an "ecosystem-friendly" neighbourhood plan.

This SEI and the landscape level ecosystem plan for this area should be used to modify Vernon's Official Community Plan, and to provide input to a Growth Management Strategy. The 'local ecosystem plan' could be a component of the Parks and Recreation Master Plan, and this SEI can be used to provide specific input regarding the Bella Vista – Goose Lake Range, and a more general extrapolation to other important natural areas. The SEI should eventually be extended to cover other important natural areas within the North Okanagan.

This SEI also provides an important planning tool for the Okanagan Indian Band. It provides a planning base for developing a community plan , range management plan and future development proposals. It also provides a base for quantifying cultural use resources and extending traditional use and natural history information. Extending coverage of the inventory to cover the entire Indian Reserve would improve the scope of the SEI as an inventory and planning tool. Wildlife habitat mapping can be used to direct specific wildlife inventory work.

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

References

Austen, S., A. Bryan, D. Cannings, E. Durance, O. Dyer, T. Ethier, T. Gaines, M. Holm, C. Jackson, C. Johnstone, M. Ladd, T. Lea, B. Lincoln, M. Sarell, L. Scott, B. Turner and L. Warmen. 1998. *Habitat Atlas for Wildlife at Risk: South Okanagan and Lower Similkameen*. Available from Ministry of Water, Land and Air Protection 201-3547 Skaha Lake Roud, Penticton, B.C. V2A 7K2.

B.C. Ministry of Environment, Lands, and Parks and B.C. Ministry of Forests. 1998. *Field Manual for Describing Terrestrial Ecosystems*. Land Management Handbook Number 25. Province of British Columbia, Victoria, B.C.

Canadian Parks and Wilderness Society 1996. BC's grasslands facing extinction. Parks and Wilderness Quarterly 8:1-4. As quoted in Henwood 1998.

Cannings, R.J. and E. Durance. 1998. Human use of natural resources in the South Okanagan and Lower Similkameen valleys *in* Smith, I.M., and G.G.E. Scudder, eds. Assessment of species diversity in the Montane Cordillera Ecozone. Burlington: Ecological Monitoring and Assessment Network, 1998.

Chen, J., J.F. Franklin, and T.A. Spies. 1995. Growing season microclimatic gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications 5: 74-86.

Clarke, D., M. Martin, M. Sarell, and C. Siddle. 1993. Greater Vernon Natural Features Inventory. A report to Greater Vernon Parks and Recreation District.

Demarchi, D. 1996. An Introduction to the Ecoregions of British Columbia, Draft. Ministry of Environment Lands, & Parks, Victoria, B.C.

Environment Canada. 1999. *The Importance of Nature to Canadians*: Survey Highlights, see http://www.ec.gc.ca/nature/survey

Findlay, B. and A. Hillyer. 1994. *Here Today, Here Tomorrow: Legal tools for the voluntary protection of private land in British Columbia*. Vancouver: West Coast Environmental Law Research Foundation.

Fodor, E. V. 1999. *Better, not Bigger*. Gabriola Island. New Society Publishers.

Grasslands Conservation Council of B.C. 2002. BC Grasslands Mapping Project: Year 3 Midterm Statistical Report. Available at http://www.bcgrasslands.org/showpage.asp?pageid=317

Iverson, K. and C. Cadrin. 2003. Sensitive Ecosystems Inventory: Central Okanagan, 2000 – 2001. Volume 1: Methodology, Ecological Descriptions, Results and Conservation Tools. Technical Report Series No. 399, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

Iverson, K., and S. Shypitka. 2003. Sensitive Ecosystems Inventory: Bella Vista – Goose Lake Range. Volume 2: Terrestrial Ecosystem Mapping, Soil Erosion and Slope Stability, and Expanded Legends.

MacKenzie, W. and A. Banner. 1999. Classification of wetlands and related ecosystems in British Columbia. Draft report. Province of British Columbia Ministry of Forests Research Program.

Victoria, B.C.
http://www.for.gov.bc.ca/prupert/wetlands/website/html/reports.htm

McPhee, M., P. Ward, J. Kirkby, L. Wolfe, N. Page, K. Dunster, N.K. Dawe and I. Nykwist. 2000. Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands, 1993 – 1997. Volume 2: Conservation Manual. Technical Report Series No. 345, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

Meadows, D. H. Society's myths about urban growth. *In: Times Colonist*. May 27, 1999, Page A13. (based on Fodor, 1999. Better not Bigger).

Ministry of Environment Lands and Parks. 1996. *Stewardship Options For Private Landowners in British Columbia.* Victoria, B.C.

Pojar, J., K. Klinka, and D.V. Meidinger. 1987. Biogeoclimatic ecosystem classification in British Columbia. For. Ecol. and Manage. 22:119-154.

Resources Inventory Committee (RIC). 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Victoria, B.C.

Sarell, M., and A. Haney. 2003. Sensitive Ecosystems Inventory: Bella Vista – Goose Lake Range. Volume 3: Wildlife Habitat Mapping.

Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: a review. Conservation Biology 5:18-32.

Scudder, G.G.E. 1991. Biodiversity over Time. *In:* Our Living Legacy: Proceedings of a Symposium on Biological Diversity. Eds. M.A. Fenger, E.H. Miller, J.F. Johnson and E.J.R. Williams. Royal B.C. Museum, Victoria, B.C.

Tisdale, E.W. 1947. The grasslands of the southern interior of British Columbia. Ecology 28:346-382.

U.S. National Parks Service. 1990. *Economic Impacts of Protecting Rivers, Trails and Greenway Corridors: A Resource Book*. San Francisco: U.S. National Park Service.

Voller, J. 1998. Riparian areas and wetlands. In: Voller, J. and S. Harrison, eds. 1998. *Conservation biology principles for forested landscapes*. Ministry of Forests. UBC Press, Vancouver, B.C.

Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth and C. Cadrin. 1998. Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands 1993-1997. Volume 1: Methodology, Ecological Descriptions and Results. Technical Report Series No. 320, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

Williston, P. 1999. Floristics and successional patterns of microbiotic crusts in ponderosa pine forests of southern inland British Columbia. Master's Thesis. University of British Columbia, Vancouver, B.C.

Appendix A: SEI Data

Spatial and non-spatial data for the Terrestrial Ecosystem Mapping (TEM) component are available for download at the Ministry of Sustainable Resource Management's Terrestrial Ecosystem Mapping Data Warehouse at http://srmwww.gov.bc.ca/rib/wis/tem/dataware.htm under Region 3.

The following are available:

- project metadata
- Non-Spatial Polygon Attributes
- TEM Map Legend Files
- TEM report with expanded legend (Volume 2)[105]
- Wildlife Species Accounts
- Wildlife Ratings Tables
- Wildlife Report (Volume 3)[106]
- Arc/Info *.E00 Export Files includes two spatial coverages: ECI field sampling points and a ECP TEM polygon coverage

[105] Iverson and Shypitka 2003
[106] Sarell and Haney 2003

Appendix B: Sensitive Ecosystems (SEI) Units[107] and related Terrestrial Ecosystem Mapping (TEM) units.

Sensitive Ecosystems

SEI Unit	Code	TEM Unit	Code[108]	Subzone / Site Series
Wetland, marsh	WN:ms	Bulrush marsh	BM	IDFxh1 /00
		Baltic rush marsh-meadow	BR	IDFxh1 /00
		Common spikerush marsh	CS	IDFxh1 /00
		Cattail marsh	CT	IDFxh1 /00
		Sedge marsh	SM	IDFxh1 /00
Wetland, meadow	WN:md	Nuttall's alkaligrass – Foxtail barley graminoid meadow	AB	IDFxh1 /00
Wetland, shallow open water	WN:sw	Shallow open water	OW	IDFxh1 /00
		Pond	PD	IDFxh1 /00
Riparian, gully	RI:gu	Trembling aspen – Snowberry – Kentucky bluegrass	ASg, ASgk, ASgw	IDFxh1 /00
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DSg, DSgs, DSgw	IDFxh1 /07
Riparian, fringe	RI:ff	Black cottonwood – Douglas-fir – Common snowberry – Red-osier dogwood riparian	CD, CDk	IDFxh1 /00
		Hybrid white spruce – Douglas-fir – Douglas maple – Dogwood	SD	IDFxh1 /08
Old Forest, coniferous	OF:co	Douglas-fir – Ponderosa pine – Pinegrass	DP 7C	IDFxh1 /01
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DS 7C (except those with 'g' modifiers)	IDFxh1 /07
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Pinegrass	DW 7C	IDFxh1 /03
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Balsamroot	PB 7C	IDFxh1/02
		Douglas-fir – Ponderosa pine – Snowbrush – Pinegrass	SP 7C	IDFxh1 /04
Grassland, grassland	GR:gr	Idaho fescue – Bluebunch wheatgrass	FW, FW:$wf	IDFxh1 /91
		Bluebunch wheatgrass – Balsamroot	WB (no seral association)	IDFxh1 /93
Grassland, shrubland	GR:sh	Prairie Rose – Idaho fescue	RF	IDFxh1 /97
Broadleaf woodland, aspen copse	BW:ac	Trembling aspen – Snowberry – Kentucky bluegrass	AS (structural stage 2-6; except those with 'g' modifiers)	IDFxh1 /00 PPxh1 /00
Coniferous Woodland	WD	Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Pinegrass	DW (only those with 'r' or 'v' modifiers; structural stage 2-6)	IDFxh1 /03
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Balsamroot	PB (structural stage 2-6)	IDFxh1 /02
Sparsely Vegetated, rock outcrop	SV:ro	Selaginella – Bluebunch wheatgrass rocky bluff	SB (no seral association)	IDFxh1 /00
		Rock outcrop	ROr, ROw	IDFxh1 /00
Sparsely Vegetated, shrub	SV:sh	Choke cherry – Bluebunch wheatgrass rocky bluff	CW	IDFxh1 /00
		Antelope brush - Selaginella	SA	IDFxh1 /00
Sparsely Vegetated, talus	SV:ta	Saskatoon – Mock orange talus	SO	IDFxh1 /00
		Talus	TAw	IDFxh1 /00

[107] See page 4 for SEI unit descriptions.

[108] 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 Shypitka 2003) for descriptions of site modifiers, structural stages, seral associations, and TEM units.

SEI Unit	Code	TEM Unit	Code[108]	Subzone / Site Series
Sparsely Vegetated, cliff	SV:cl	Cliff	CL	IDFxh1 /00

Other Important Ecosystems

SEI Unit	Code	TEM Unit	Code[109]	Subzone / Site Series
Mature Forest, broadleaf	MF:bd	Douglas-fir – Ponderosa pine – Snowberry – Spirea	DS 6B	IDFxh1 /07
Mature Forest, coniferous	MF:co	Douglas-fir – Ponderosa pine – Pinegrass	DP 6C	IDFxh1 /01
		Douglas-fir – Ponderosa pine – Snowberry – Spirea	DS 6C (except those with 'g' modifiers)	IDFxh1 /07
		Douglas-fir – Ponderosa pine – Bluebunch wheatgrass – Pinegrass	DW 6C (except those with 'r' and 'v' modifiers)	IDFxh1 /03
		Douglas-fir – Ponderosa pine – Snowbrush – Pinegrass	SP 6C	IDFxh1 /04
Mature Forest, mixed	MF:mx	Douglas-fir – Ponderosa pine – Snowberry – Spirea	DS 6M (except those with 'g' modifiers)	IDFxh1 /07
Disturbed Grassland	DG	Idaho fescue – Bluebunch wheatgrass	FW:$sb, $sn, $sw, $wk	IDFxh1 /91
		Bluebunch wheatgrass – Balsamroot	WB:$sb, $sn, $sw, and $wk	IDFxh1 /93

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

Appendix C. Preliminary planning scenarios

Preliminary modelling used the inputs outlined below for three scenarios for setting conservation priorities. This preliminary work did not integrate wildlife habitat mapping, nor did it provide for determining core areas, buffers, and corridors. Future modelling work will integrate these additional considerations with planning and development considerations such as road placement, infrastructure, and engineering.

Scenario 1: Rudimentary environmental protection

Guidelines for 'no development' were taken from the City of Vernon's Official Community Plan (OCP) in this scenario. This scenario is not intended to identify conservation priorities. It is intended to show which parts of the landscape would not be developed under current guidelines. The lack of development on 'no-development' sites is unlikely to conserve many natural values associated with them under this scenario.

Areas for no-development:

- polygons with high slope instability ratings (V);
- TRIM[110] creeks that ran through polygons mapped with fluvial materials with a 15m buffer on either side;
- ponds, lakes, and wetlands plus a 15m buffer around them;
- polygons where riparian gullies were mapped (identified as RI:gu in the SEI mapping); this is meant to pick up areas referred to as 'vegetated ravines' in the OCP
- polygons where all slopes in the polygon are >30%

Areas for possible development with further investigation required:

- areas with slopes >30% from TRIM (this is likely a substantial overestimate of slopes >30% because contour intervals are 20m apart)

Scenario 2: Basic sensitive ecosystem retention

This scenario is intended to provide a basic level of retention for the highest priority sensitive ecosystems. Under this scenario, many natural values associated with retained ecosystems are likely to be lost in a highly fragmented landscape.

Areas for no-development:

- all polygons included in Scenario 1 as no-development
- all polygons with excellent quality sensitive ecosystems in them (qualcond=1)

---

[110] Terrain Resources Inventory Mapping provides standardized provincial mapping of waterbodies, creeks and rivers, and 20m contour interval mapping.

- all polygons with Old Forests (OF) in them
- all polygons with Riparian (RI) ecosystems as the first component
- all polygons with cliffs (SV:cl) in them

Areas for possible development in portions of them with further investigation required:

- polygons with good quality sensitive ecosystems as the dominant component (qualcond=2)
- polygons with Broadleaf Woodlands (BW) in them
- polygons with Riparian (RI) ecosystems in them as the 2nd or 3rd component
- polygons with Mature Forests (MF) in them
- polygons with moderate slope stability ratings (IV)

Scenario 3: Sensitive Ecosystem Retention

This scenario is intended to capture all ecosystems likely required to provide for retaining important values associated with sensitive ecosystems. The scenario needs to be updated to model the placement of buffers and corridors needed to achieve this objective.

Areas for no-development:

- all no-development areas from Scenario 2
- polygons with Broadleaf Woodlands (BW) in them
- polygons with Riparian (RI) ecosystems in them

Areas for possible development in portions of them with further investigation required:

- all polygons with good and marginal quality sensitive ecosystems in them (qualcond=2 or 3)
- polygons with Mature Forests (MF) in them
- polygons with moderate slope stability ratings (IV)

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

Common Name	Scientific Name	Occurrence in Study Area	Prov. Status	COSEWIC Status
Amphibians				
Great Basin Spadefoot	*Spea intermontana*	unknown but likely	Blue	Threatened
Western Toad	*Bufo boreus*	unknown but likely	-	Special Concern
Reptiles				
Painted Turtle	*Chrysemis picta*	throughout	Blue	-
Western Skink	*Eumeces skiltonianus*	unknown but likely	Blue	Special Concern
Northern Pacific Rattlesnake	*Crotalus oreganus*	southern portion	Blue	(pending)
Great Basin Gopher Snake	*Pituophis catenifer*	throughout	Blue	Threatened
Racer	*Coluber contrictor*	throughout	Blue	-
Rubber Boa	*Charina bottae*	unknown but likely	-	Special Concern
Birds				
Great Blue Heron	*Ardea herodias* ssp. *herodias*	occasional	Blue	-
California Gull	*Larus californicus*	seasonal transients	Blue	-
American Avocet	*Recurvirostre americana*	unknown but likely	Red	-
Long-billed Curlew	*Numenius americanus*	at least one breeding area	Blue	Special Concern
Upland Sandpiper	*Bartramia longicauda*	unknown but possible	Red	-
Swainson's Hawk	*Buteo swainsoni*	provincial benchmark	Red	-
Ferruginous Hawk	*Buteo regalis*	unknown but possible	Red	Special Concern
Interior Western Screech-owl	*Otus kennicotti* ssp. *macfarlanei*	unknown but likely	Red	Endangered
Flammulated Owl	*Otus flammeolus*	unknown but likely	Blue	Special Concern
Short-eared Owl	*Asio flammeus*	unknown but likely	Blue	Special Concern
Lewis' Woodpecker	*Melanerpes lewis*	known but uncommon	Blue	Special Concern
Yellow-breasted Chat	*Icteria virens*	unknown but possible	Red	Endangered
Brewer's Sparrow	*Spizella breweri breweri*	known from one location	Red	-
Grasshopper Sparrow	*Ammodramus savannarum*	at least 1 breeding colony	Red	-
Lark Sparrow	*Chondestes grammacus*	likely (OK Landing)	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*	known from one location	Blue	-
Pallid Bat	*Antrozous pallidus*	unknown but possible	Red	Threatened
Fringed Myotis	*Myotis thysanodes*	unknown (OK Landing)	Blue	Special Concern
Western Small-footed Myotis	*Myostis ciliolabrum*	unknown but likely	Blue	-
Western Harvet Mouse	*Reinthrodontomys megalotis*	known from several areas	Blue	Special Concern
Great Basin Pocket Mouse	*Perognathus parvus*	unknown but likely	Blue	-
Nuttall's Cottontail	*Sylvilagus nuttallii* ssp. *nuttallii*	not currently	Blue	Special Concern
Badger	*Taxidea taxus*	throughout	Red	Endangered