# Sensitive Ecosystems Inventory: Middle Shuswap River, 2011

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

**March, 2012**

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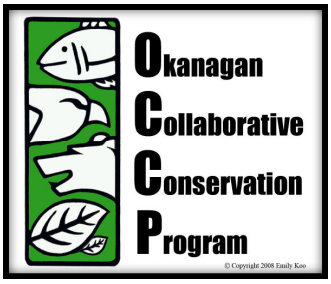


# Acknowledgements

Funding and in-kind support for field portion of the project was provided by The Okanagan Collaborative Conservation Program; BC Hydro Fish and Wildlife Compensation Program-Coastal (BCHFWCP); Regional District of the North Okanagan; Village of Lumby; Splatsin First Nation; Allan Brooks Nature Centre Society; SDL Environmental Consulting; and the Ministry of Forests, Lands and Natural Resources Operations. The White Valley Resource Centre, with funding from BCHFWCP, the Province of British Columbia and others, funded the draft mapping completed in 2006.

***Susan Latimer*** of the Okanagan Collaborative Conservation Program (OCCP) provided project management and extension. ***Kristi Iverson***[1], ***Polly Uunila***[2], ***Allison Haney***, ***Keiryn Lee***[3], ***Breanna Patterson***[4], and ***Susan Latimer*** completed the field work. ***Polly Uunila*** completed the bioterrain mapping and ***Kristi Iverson*** completed the ecosystem mapping from draft ecosystem mapping by ***John Grods***[5]. ***Bon Lee***[6] collected the draft polygon boundaries, boundary adjustments were digitized in ArcView and Google Earth on an orthophoto base. ***Allison Haney*** wrote the wildlife sections of this report.

***Helen Davis*** completed the landowner contact and ***Mark Hammerl*** ferried the field crew across to islands in the Shuswap River.

This project has adapted material from the reports for the Coldstream – Vernon Sensitive Ecosystems Inventory[7] (SEI), Central Okanagan SEI[8], and Lake Country SEI[9].

***Susan Latimer*** provided meals and accommodation for the field crew.

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

Allen Huguette and Russ Collins
Scott and Bonnie Campbell
Lee and Crystal Hesketh
Rod and Noni Hesketh
Brian and Penny Jones
Claude Labine
Hazel Matheson
Charles Meriam
Dr. Andy and Ardis Miller
Fred and Shirley Mitchell
Maurice Soltys

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[1] Iverson & MacKenzie Biological Consulting Ltd.
[2] Polar Geoscience Ltd.
[3] Splatsin First Nation Band, Enderby, B.C.
[4] B.C. Hydro
[5] Makonis Consulting Ltd.
[6] Baseline Geomatics Inc.
[7] Iverson and Shypitka 2003
[8] Iverson et al. 2004
[9] Iverson and Uunila 2006

# Executive Summary

The middle Shuswap River valley of British Columbia has high biodiversity, including many vulnerable, rare and endangered species and ecological communities. Extensive riparian ecosystems and diverse upland habitats occur in close proximity, providing habitat for many species. The region has been subject to extensive agricultural conversion, human settlement pressure, spread of invasive alien plants, widespread recreation use, logging, and forest ingrowth associated with fire exclusion.

The study area includes a swath varying from about 200 m to over two kilometres on either side of the 29 km of the middle Shuswap River between the Wilsey and Sugar Lake (Peers) dams and approximately two kilometres up Cherry, Ferry and Woodward Creeks, and some areas below Wilsey dam. The area continues to face agricultural and rural development pressures and is used extensively for recreation.

The Middle Shuswap River SEI was initiated in 2006 to provide inventory information on rare and fragile ecosystems that can be used for ecologically sustainable land use and development planning. We used Terrestrial Ecosystem Mapping (TEM) as a base to develop a Sensitive Ecosystems theme map. The inventory was compiled through aerial photograph interpretation and field sampling in the summer of 2011. Draft ecosystem mapping was completed in 2006 and was revised in the fall of 2011 following field sampling. The project area covers private land, provincial crown land (including BC Hydro lands), municipal lands, and a minor amount of federal crown land. This technical report documents inventory methods and results, the conservation analysis, and provides management recommendations.

Twenty-seven percent of the study area was comprised of sensitive ecosystems (SE); five percent of the area was included in the other important ecosystem (OIE) categories. Wetlands, sparsely vegetated ecosystems, and grasslands were extremely rare in the study area; non-riparian old forests were absent from the study area. Although greater areas of riparian and coniferous woodland ecosystems remained, much of the area was covered by altered ecosystems including extensive agricultural fields, rural human settlements, and young forests or cut blocks.

Many of the sensitive ecosystems are at high risk from human activities, including loss, fragmentation, forest harvesting, agricultural conversion, altered flood regimes, or further degradation by human use and spread of alien invasive plants. Within the drier portions of the study area, many forested areas were thick with ingrowth and are at risk of loss to catastrophic wildfires. The few grasslands within the study area often have invasive alien plants and some have trees encroaching onto them. Almost no sensitive ecosystems are protected within the study area: it is important to protect them and maintain connectivity between sensitive ecosystems.

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

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# Using the Report

This report presents information on sensitive ecosystems in the middle Shuswap River valley and provides guidance regarding their conservation and management.

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

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

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

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

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

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

***Chapter 7: Planning and management*** outlines conservation and land management planning options for the Regional District of North Okanagan and landowners.

The Okanagan Sensitive Ecosystems Inventory Conservation Manual[10] provides detailed information on conservation tools that are directly applicable to ecosystems in this study area.

***Chapters 8*** through ***14*** profile each of the five 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 15: Future directions*** presents recommendations for using the SEI, updating SEI products, and extending the inventory's coverage.

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

**Volume 2**[11] 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***. It is intended for use by professionals that require more detailed ecological and terrain information.

[10] Iverson et al. 2008

[11] Iverson and Uunila 2008, Appendix G

It is recommended for use by people interested in developing other interpretive map themes from the ecosystem or terrain mapping.

**Volume 3**[12] contains wildlife habitat mapping themes developed from the terrestrial ecosystem mapping (TEM) for the following seven species: Western Toad (*Anaxyrus boreas*), Painted Turtle (*Chrysemis picta*), Northern Rubber Boa (*Charina bottae*), Western Skink (*Plestidon skiltonianus*), Western Screech-owl (*Megascops kennicottii macfarlanei*), Flammulated Owl (*Otus flammeolus*), and American Badger (*Taxidea taxus*). All of these species are considered at risk in the province of B.C. and most are listed under the federal Species at Risk Act. These species provide a cross-section of threatened or endangered amphibians, reptiles, birds, and mammals that depend on a range of different ecosystems in the study area. There are many other threatened and endangered species that likely occur in the study area as well and are listed in Appendix C of Volume 1, and in each ecosystem chapter of Volume 1 in which they are most likely to occur.

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] Haney 2012, Appendix G

# 1 Introduction

The middle Shuswap River valley has extensive riparian ecosystems and diverse upland habitats occurring in close proximity, providing habitat for many species. The area has been subject to extensive agricultural conversion, human settlement pressure, spread of invasive alien plants, extensive recreation, logging, and forest ingrowth associated with fire exclusion; these ecosystems continue to be threatened by recreational use, rural and agricultural development.

The White Valley Resource Centre and the Ministry of Environment initiated this project in 2006 to complete an inventory information base and conservation analysis to support sound land management decisions and promote effective stewardship of sensitive ecosystems in the study area. The project provides the Regional District of North Okanagan with data that can be used in revising their Official Community Plan and provides information to input into Neighbourhood and Parks Plans. This product contributes to the tools and information required to develop and assess broad conservation and development options for the study area.

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

The Middle Shuswap SEI follows from the Coldstream - Vernon SEI[13], Vernon Commonage SEI[14], Bella Vista – Goose Lake Range SEI[15], Lake Country SEI[16], Central Okanagan SEI[17], and Vancouver Island SEI[18]. Many of the materials in this report have been adapted from the reports of those SEI projects.

## 1.1 Goals and Objectives

This goal of the project was to complete a Sensitive Ecosystems Inventory (SEI) of the area between the Wilsey and Peers Dams to Resources Information Standards Committee (RISC) standards. This Sensitive Ecosystems Inventory (SEI) systematically identified and mapped at-risk and fragile ecosystems based on Terrestrial Ecosystem Mapping (TEM). The SEI and TEMapping was also used to complete a conservation analysis for the area.

The following objectives were identified for the project:

- Flags areas of ecological importance for the **development community** that would require more detailed study through an Environmental Impact Assessment if a change in land use is propsed. Provide a baseline of information for use in interpreting best management practices provided by both federal and provincial governments and at-risk species recovery teams on the landscape.
- Provide broad scale information for **local government**, to help plan for urban growth, and to evaluate site-specific Neighborhood Plans, Environmental Impact Assessments and designation

[13] Iverson 2008
[14] Iverson 2005
[15] Iverson 2003
[16] Iverson 2006
[17] Iverson and Cadrin 2003
[18] McPhee et al. 2000

of Development Permit areas or zoning considerations. Provide information that will assist in regional planning for natural parks and for identifying Environmentally Sensitive Areas. Provide resource information for the North Okanagan Regional District (RDNO) that is currently completing Official Community Plan (OCP) reviews for electoral areas D & E and has recently completed the Regional Growth Strategy. Provide information that can be used to incorporate natural values into land use decisions associated with these planning and policy initiatives.

- Create a greater awareness of natural values for landowners (including BC hydro), and how these values contribute towards regional ecological integrity and to encourage voluntary stewardship of privately owned lands.
- Provide information for NGOs on the highest priority habitats for protection through conservation covenants, purchase or easements.
- Provide information for consultants based on provincial RISC standards that can be used in direct further research or inventory or to provide information to land managers and developers.
- Provide additional information for First Nations on the resources present within their traditional territories.

## 1.2 Study Area

The study area (Figure 1) lies within Middle Shuswap River valley of south-central British Columbia. The boundaries of the study area includes a swath varying from about 200 m to over two kilometres on either side of the 29 km of the Shuswap River between the Wilsey and Sugar Lake (Peers) dams and approximately two kilometres up Cherry, Ferry, and Woodward Creeks, and some areas below Wilsey dam. The study area covers 4863 ha and includes private land, provincial crown land (including BC Hydro lands), municipal lands, and a minor amount of federal crown land.

The study area lies within the traditional territory of the Splatsin Nation. “Splatsin is the southernmost community of the Secwepemc nation. The Secwepemc Nation consists of 17 First Nations Communities, which historically were set into geographical groupings that became divisions with caretaker responsibilities on behalf of the nation. Splatsin is a part of the Sexqeltkemc (Shuswap Arrow Lakes Division) Division of the Secwepemc Nation. Splatsin’s area of Yucwmenlucwu (stewardship) is from the Mica Creek area in the north to Kettle Falls Washington USA in the south and Monte Lake in the west.” (Stuart Lee, pers. comm. 2012)

The study area lies within the Shuswap Moist Warm Interior Douglas-fir (IDFmw1)[19] and the Shuswap Moist Warm Interior Cedar – Hemlock biogeoclimatic subzones (Figure 1 below). It includes part of the northern extension of the Columbia Basin that extends south to Oregon and portions of the highlands of the Columbia Mountains. It lies within the Northern Okanagan Highland Ecosection[20] (NOH), a cool, moist rolling upland within the Thompson Okanagan Plateau, and the Shuswap Highland Ecosection (SHH), a highland area between the plateaus to the west and the mountains to the east, within the Columbia Highlands.

The study area is located within a transition between the northern portion of a dry climatic system with warm, dry conditions and a moist climate resulting from the loss of moisture from western air masses passing over the Columbia Highlands[21]. The Coast and Cascade Mountains create a rain shadow effect in the interior of British Columbia, reducing summer and winter precipitation, but the moist Pacific air masses tend to lose their moisture as they rise over the Columbia Highlands. In summers, hot dry air from the Great Basin to the south partially penetrates the area.

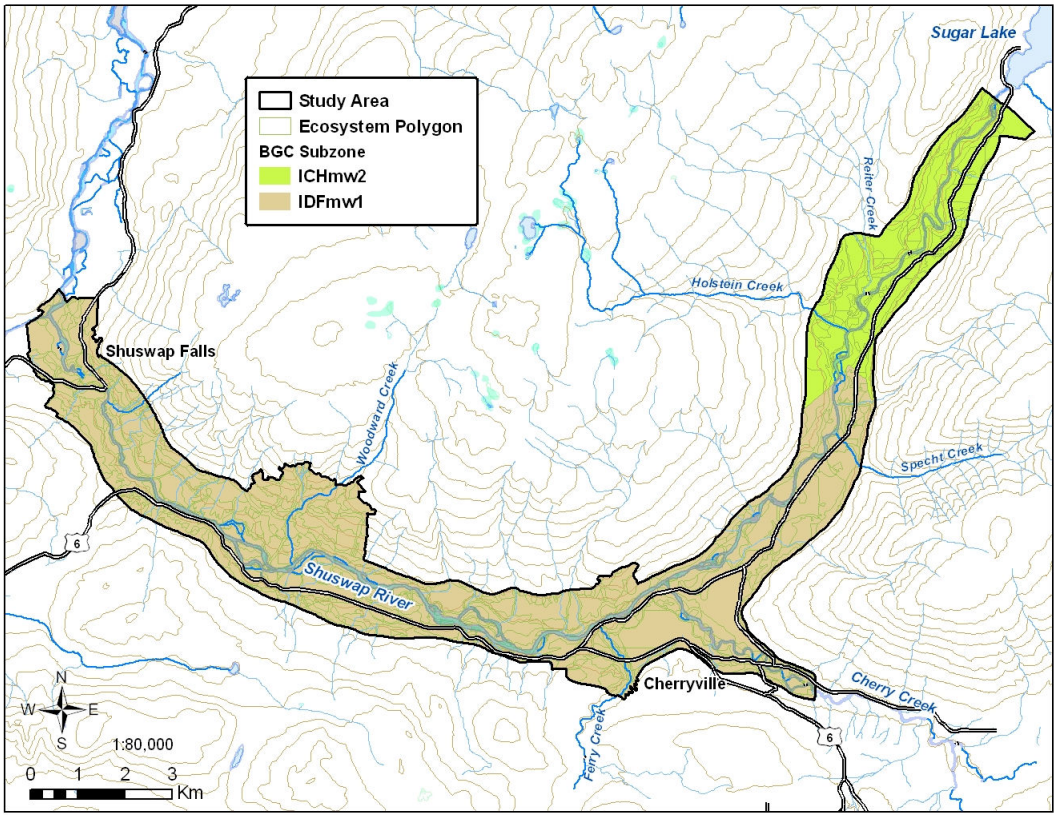


**Figure 1. Map of the Middle Shuswap SEI study area. Study area boundary is shown in black. Biogeoclimatic subzones are also shown.**

[19] The BC Ministry of Forests, Lands and Natural Resource Operations ***Biogeoclimatic Ecosystem Classification*** (BEC) is a system of classifying vegetation based on climatic and topographic patterns. The BEC system was developed to provide a basis for natural resource management, particularly forest and range management. See Pojar et al. 1987 for further information.

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

[21] Demarchi 1996

## 1.3 Ecological Importance of the Study Area

The middle Shuswap River valley is an area of great biological diversity. The extensive floodplain riparian habitats together with the complex upland ecosystems have a wide diversity of ecosystems and organisms in relatively close proximity to one another. Increasingly, scientists are finding that populations of species at the edge of their range, such as those in the study area, are likely to persist longer than core populations during population declines. This phenomenon may allow these populations to adapt to future changes such as global warming[22].

The middle Shuswap River area has many natural features that provide the potential for long-term ecological integrity (or viability) of many endangered species and sensitive ecosystems. The area also provides many community values including aesthetics, hiking, and observing wildlife and nature.

**Figure 2. Looking east across part of the study area.**

[22] Scudder 1991

**Figure 3. Some riparian habitats along the Shuswap River.**

# 2 Ecosystems of Concern

## 2.1 What are Sensitive Ecosystems?

This sensitive ecosystems project recognises both ***sensitive ecosystems*** (SE) and ***other important ecosystems*** (OIE) in the study area. *Sensitive ecosystems* refer to five ecosystem types (Table 1) that are ecologically fragile or are at-risk in the provincial landscape and are relatively unmodified by human influences[23] (Table 1). These sensitive ecosystems are generalised groupings of ecosystems that share many characteristics, particularly ecological sensitivities, ecological processes, rarity, and wildlife habitat values. These categories follow the provincial Standard for Mapping Ecosystems at Risk in British Columbia[24].

***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 essential habitats for many species. They provide ecological functions that regulate the climate, clean freshwater, regulate and clean soils, maintain genetic diversity, maintain the water cycle, recycle nutrients, and pollinate crops. They are vital in creating healthy and attractive communities for people.

[23] Ward et al. 1998. Old Forests are not included because the only remaining old forests within the study area were riparian; they are included in the Riparian category.
[24] Ministry of Environment Ecosystems Branch 2006

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

| Code | Sensitive Ecosystems | Ecosystem Description |
|---|---|---|
| **WN** | Wetlands | Non-forested ecosystems where the water table is at or near the surface; **marshes** (WN:ms), **swamps** (WN:sp), and **shallow open water** (WN:sw) ecosystems including ponds. |
| **RI** | Riparian | Ecosystems in gullies with intermittent or permanent creeks (**gully**, RI:gu); rivers and unvegetated gravel bars (**river**, RI:ri), bench riparian ecosystems along floodplains (**bench,** RI:fp), and fringe ecosystems associated with ponds and low-lying areas (**fringe**, RI:ff). |
| **GR** | Grasslands | Ecosystems dominated by bunchgrasses (**grassland**; GR:gr), invasive alien plants and bunchgrasses (**disturbed grassland**; GR:dg) and **shrubland** (GR:sh) ecosystems that occur in a grassland matrix. |
| **WD** | Coniferous Woodlands | Open stands of Douglas-fir, often on shallow soils, with typically grassy understories. |
| **SV** | Sparsely Vegetated | Grassy or unvegetated **rock outcrops** (SV:ro), and **talus** (SV:ta) slopes. |

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

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

## 2.2 Why are these ecosystems important?[25]

The ecological attributes and socio-economic values that are common to all SEI ecosystems are discussed below. Values and attributes unique to individual ecosystems are discussed in Chapters 8 – 14.

### Ecological Attributes

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

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

At-risk ecological communities and vertebrate species are listed for each sensitive ecosystem (Chapters 8 – 14).

The middle Shuswap River valley provides habitat for many species that are nationally ranked by COSEWIC[26] as endangered, threatened or of special concern, or are provincially ranked as red-listed or blue-listed[27] by the B.C. Conservation Data Centre (CDC). The Species at Risk Act[28] provides protection for species ranked as threatened or endangered that occur on Federal land. See Appendix C for a list of at-risk wildlife species with the potential to occur in the study area.

Some ***at-risk*** vertebrate animals in the study area include:

American Badger (*Taxidea taxus*) – Endangered, Red-listed
Western Screech-owl (*Megascops kennicottii macfarlanei)* – Endangered, Red-listed
Barn Swallow (*Hirundo rustica*) – Threatened, Blue-listed
Flammulated Owl (*Otus flammeolus*) – Special Concern, Blue-listed
Great Blue Heron (*Ardea herodias herodias*) – Blue-listed
Western Skink (*Plestiodon skiltonianus*) – Special Concern, Blue-listed
Northern Rubber Boa (*Charina bottae*) – Special Concern
Painted Turtle (*Chrysemis picta*) – Special Concern, Blue-listed
Western Toad (*Anaxyrus boreas*), – Special Concern, Blue-listed

**BC Species and Ecosystem Explorer**

web site: http://www.env.gov.bc.ca/atrisk/toolintro.html

Check this web site for the current national and provincial conservation status of rare plants, animals, and ecological communities, since their status can change over time.

- **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 depend on complex ecological processes that are easily disrupted, they have soils susceptible to erosion, and they are vulnerable to invasion by invasive plants.
- **High biodiversity** is a common feature of most SEI ecosystems, largely because of the close proximity of many different types of ecosystems in the landscape.

[26] **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 denotes a species facing imminent extirpation or extinction. Threatened denotes a species likely to become endangered if limiting factors are not reversed. Species of special concern are particularly sensitive to human activities or natural events.

[27] **CDC**, the BC Conservation Data Centre, determines the provincial status of BC's plants, animals, and ecological communities. Red list: BC's flora, fauna, and ecological communities that are threatened or endangered. Blue list: BC's flora, fauna and ecological communities that are of special concern, or at risk because of low or declining numbers.

[28] Government of Canada 2003.

- **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 ecological communities.

## 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.
- **Natural areas** 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 area for rural residential dwellers and recreational users.
- **High scenic values** are provided by grasslands and scattered rocky knolls; they provide excellent views of the landscape. These areas are often targeted for recreational and residential development. The community's natural landscape attracts visitors and new residents, and contributes towards opportunities for nature-based tourism and the unique 'sense of place', and is a source of pride and pleasure for local residents.
- **Outdoor recreation** opportunities are provided by ecosystems in public parks, and on accessible crown land where low-impact activities will not damage the habitat. Wildlife viewing is very important to Canadians[29], and contributes to our quality of life. Bird watching is among the fastest growing leisure pursuits. Hunting, fishing, water-based recreation (tubing, kayaking, canoeing), trapping and guide outfitting contribute to the economy and can occur where wildlife populations can sustain them.
- **Research and nature education** are important at all levels from early childhood through to university, plus continuing education programs. Many schools are now working with local groups (e.g., Streamkeepers and Wetlandkeepers); most focus on creating native plant communities and restoring wildlife habitat. 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.
- **Natural resource use** such as grazing and selection harvesting of forests have supported the local economy and continue to be important activities in the study area. The study area is also a source of many plants traditionally used by First Nations including food plants such as thimbleberry.
- **Increased property value** is provided by natural areas. The beauty of the natural landscape is often a large part of what attracts people to an area. Studies show that undeveloped natural areas measurably increase the value of nearby property[30] by 5 to 32%[31] and thus, contribute far more in property taxes than it costs in services[32].

[29] Environment Canada 1999
[30] Meadows 1999

# 3 Impacts of Concern[33]

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

## 3.2 Disruption of Natural Disturbance Regimes

The damming of the Shuswap River has modified the severity and duration of flooding. The extent of floodplain communities receiving deposits of silt and the associated nutrients has been reduced[34]. Altering natural flood events can reduce the size, diversity, site productivity, and complexity of wetland and riparian ecosystems, and alter habitat values.

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***[35] maintained open forests with largely grassy and shrubby understories. Fire exclusion has resulted in dense forests ingrown with Douglas-fir and ponderosa pine, and encroachment of these trees onto grasslands. Fire exclusion has affected both ecosystem processes and wildlife habitat values.

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[31] U.S. National Parks Service 1990

[32] Fodor 1999

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

[34] MacKenzie and Moran 2004

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

## 3.3 Invasive Species

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

The Shuswap River and its tributaries are also threatened by the invasive diatom (algae) commonly known as "Didymo" or "rock snot" (*Didymosphenia geminate*)[36]. It has been reported from the river and can easily be spreading by recreational users such as people fishing, tubing, paddling, or boating on the river. It can form mats on lakes and rivers, thereby reducing fish habitat and making recreational activities less pleasant[37].

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

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

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

Grasslands and coniferous woodlands are vulnerable to invasion by Hoary alyssum (*Berteroa incana*), cheatgrass (*Bromus tectorum*) and other alien annual bromes (*Bromus* spp.), diffuse knapweed (*Centaurea diffusa*), and sulphur cinquefoil (*Potentilla recta*). Riparian ecosystems are vulnerable to invasion by common hound's-tongue (*Cynoglossum officinale*), Hoary alyssum (*Berteroa incana*), and common burdock (*Arctium minus*).

***Some invasive plant species:***

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

## 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

[36] http://www.ec.gc.ca/envirozine/default.asp?lang=En&n=553F917C-1
[37] https://professionalbiology.com/sites/default/files/pdfs/Didymo.pdf

in microclimate elements such as air temperature, light level, and humidity[38]. Direct biological effects result when specific species cannot tolerate human activity nearby, or they are exposed to predation by other species including domestic pets. Increased invasion of alien species and competition for habitat are examples of indirect biological edge effects.

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

## 3.5 Direct Impacts

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

## 3.6 Indirect Impacts

Activities that occur adjacent to or at some distance from the ecosystem result in indirect impacts. Hydrological[39] changes due to dams, roads, buildings, irrigation[40], 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 flooding regime, 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 fertilizers and pesticides associated with agriculture and landscaping can cause degradation of natural ecosystems and wildlife habitat.

The presence of humans and their pets, even on private property can cause disturbances to wildlife. Tubers, boaters and other people and pets using the Shuswap River can spread invasive algae (Didymo), deposit silt on fish eggs, and disrupt fish and other wildlife species. Recreational activities involving all terrain vehicles (ATVs), dirt bikes, off-road vehicles, and mountain bikes create soil

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

[39] Water-related features and processes.

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

disturbances that allow rapid invasion and spread of invasive plants. They can also disturb wildlife, and cause soil erosion and damage to plants. Similarly, domestic pets such as cats and dogs may predate or harass wildlife.

# 4 Methods and Limitations

This chapter describes the methods that were used to generate the sensitive ecosystems map. These methods follow those used in the Coldstream – Vernon, Central Okanagan, Bella Vista, Vernon Commonage and Lake Country SEIs and follow the Standard for Mapping Ecosystems at Risk in British Columbia[41]. The provincially recognised Terrestrial Ecosystem Mapping[42] (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 relatively uniform vegetation, topography and terrain features. Ecosystem, terrain, and conservation attributes were recorded in a polygon database. The polygons were digitized and compiled in a geographic information system (GIS), and linked to the polygon database.

Details on methods, results, limitations and management recommendations for Terrestrial Ecosystem Mapping and terrain mapping can be found in **Volume 2**[43].

Details on methods, results, limitations and management recommendations for wildlife suitability mapping can be found in **Volume 3**[44].

## 4.2 Sensitive Ecosystems Mapping

TEM units were evaluated for rarity and ecological sensitivity and were assigned to sensitive ecosystems and other important ecosystems categories accordingly. Most TEM units were assigned to the same sensitive ecosystems as in the Coldstream - Vernon SEIs[45].

Finally, cultivated fields that occurred in areas that were formerly riparian or wetland ecosystems and likely flood in some years were mapped as “Seasonally Flooded Agricultural Fields” (FS), an ‘other important ecosystem’. Any TEM units not mapped in earlier map projects including all units within the Interior Cedar – Hemlock zone all were evaluated for rarity and ecological sensitivities and assigned to an SEI unit accordingly.

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

[41] Ministry of Environment Ecosystems Branch 2006
[42] Resources Inventory Committee 1998
[43] Iverson and Uunila 2008
[44] Haney and Sarell 2008
[45] Iverson 2008

If an ecosystem was determined to be ecologically fragile or rare, it was assigned to the applicable sensitive ecosystems category. In cases where a given ecosystem could be assigned to more than one Sensitive Ecosystems category, it was always assigned to the more sensitive category. For example, old riparian forests were assigned to the 'riparian' rather than the 'old forest' category (no other old forests remained within the study area).

Ecosystems were grouped into sensitive ecosystems categories using the Ecosystem-based Resource Mapping (ERM) Ratings Table Tool[46]. This tool allows SEI categories to be assigned to each ecosystem. Detailed conversion tables can be found in Appendix B.

Each polygon can have up to three ecosystem components mapped in it. The three components are ordered by area of occupancy from largest to smallest. The final Sensitive Ecosystems map depicts each Sensitive or Other Important Ecosystem type with a specific colour. Dot density was used to indicate where more than one ecosystem class was mapped in a polygon. The number of dots indicates the proportion of the polygon represented by the second and third components; the colour of the dots indicates their ecosystem class.

## Field Sampling and Conservation Evaluation of Sensitive Ecosystems

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

I developed a sampling plan using landowner maps and preliminary SEI maps to identify accessible areas of sensitive ecosystems including riparian areas, grasslands, wetlands, coniferous woodlands, rock outcrops, and talus slopes.

Two types of sample plots were used to identify and assess ecosystems: ground inspections and visual inspections[47]. Sample plots were subjectively located within polygons to best represent the ecosystem(s) in that polygon, or as determined by access. Samples sites were distributed to maximize sampling of sensitive and other important ecosystems; other ecosystems were sampled along access routes to sensitive ecosystems. Sampling procedures for ground inspections are outlined in *Field Manual for Describing Terrestrial Ecosystems*[48]. The *Standard for Terrestrial Ecosystem Mapping*[49] in British Columbia provides guidelines for visual inspection data collection. I also assessed the conservation values of each site (including, but not limited to, disturbance, known threats, adjacent land use, alien species, fragmentation, condition, ecological integrity, and landscape context).

Field sampling was completed in the summer of 2011, and a total of 90 sensitive ecosystems or other important ecosystems sites were field-verified (Table 3; additional plots were completed in modified landscapes). Figure 4 shows the location of all field samples, including those established in modified landscapes (a total of 134 plots). A team of three scientists including a plant ecologist, terrain specialist, and wildlife biologist conducted the sampling.

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

| *Sensitive Ecosystems* | Ground | Visuals | Total |
|---|---|---|---|

[46] See http://www.env.gov.bc.ca/wildlife/whr/erm_system_flow.html for more information on the ERM tools.
[47] See Volume 2: Iverson and Uunila 2008
[48] BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998
[49] Resources Inventory Committee 1998

| | Inspections | | Plots |
|---|---|---|---|
| Grasslands | 3 | 1 | 4 |
| Riparian | 23 | 27 | 50 |
| Sparsely Vegetated | 0 | 1 | 1 |
| Coniferous Woodland | 8 | 13 | 21 |
| Wetland | 1 | 3 | 4 |
| **TOTAL** | **35** | **45** | **80** |
| *Other Important Ecosystems* | | | |
| Seasonally Flooded Fields | 0 | 0 | 0 |
| Mature Forest | 4 | 6 | 10 |
| **TOTAL** | **4** | **6** | **10** |

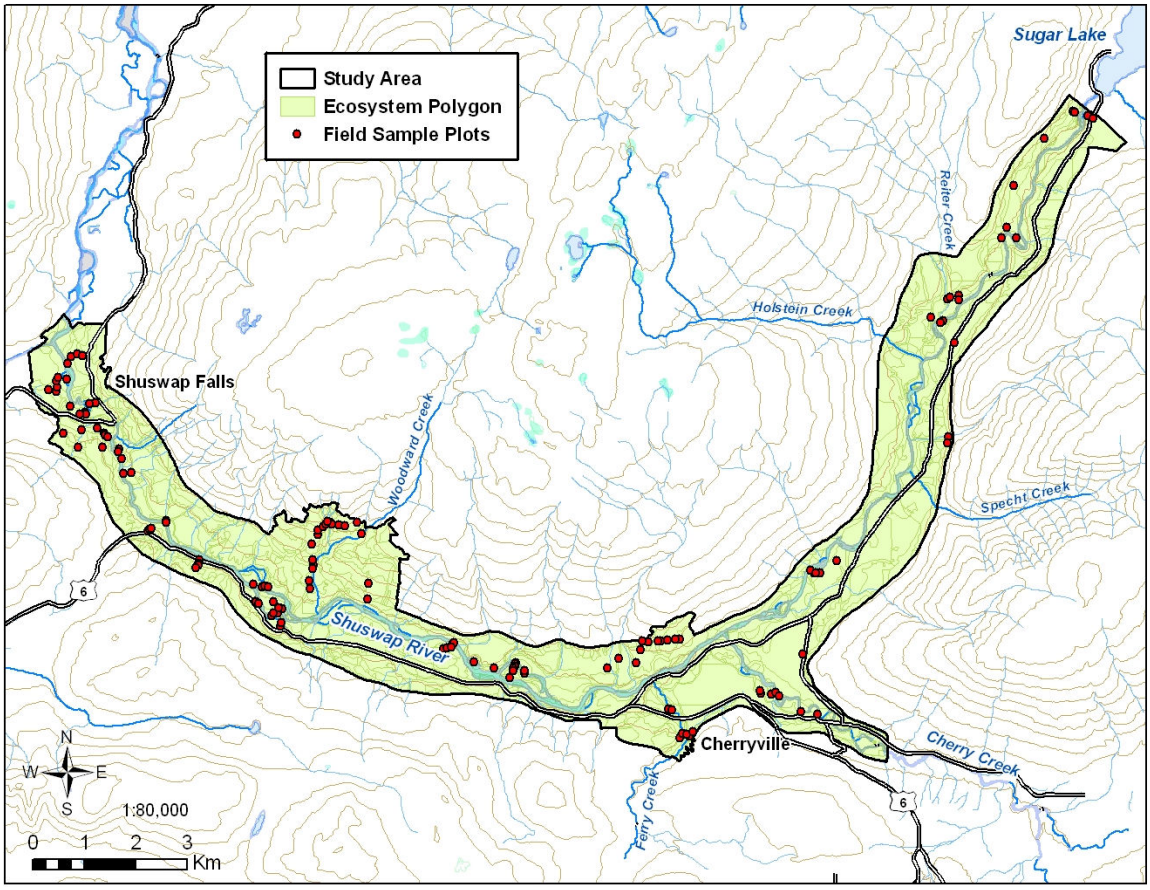


**Figure 4. Location of field plots including ground inspections and visual inspections. A total of 134 sites were sampled; 90 of these sites were located in sensitive ecosystems or other important ecosystems.**

## 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 and 2007) of the aerial photographs and orthophotos that were referenced in the final mapping.

> It is recommended that digital data not be enlarged beyond the scale of the photos (1:15,000) 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 of the aerial photographs, orthophotos or of the field sampling. Wherever possible, polygons reflect conditions that were noted during field sampling.

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

Often small sensitive ecosystems were captured as a small component of a larger polygon that was dominated by one or two other ecosystems. Many polygons contained a complex of up to three ecosystems, and sensitive ecosystems may only occupy a portion of a given polygon. While polygon delineation was detailed, the landscape is complex, resulting in many complex polygons.

# 5 Inventory Results

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

## 5.1 SEI Summary Results

Five types of sensitive ecosystems and two types of other important ecosystems were identified. Collectively the five sensitive ecosystems (SE) covered 27.3% (1327 ha) and the two other important ecosystems (OIE) mapped covered 4.8% (233 ha) of the study area (Table 4), while modified landscapes covered the remaining 67.9% (3302 ha) of the study area. Although there were no remaining old forests in the upland areas, there were some old forests within the riparian class.

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

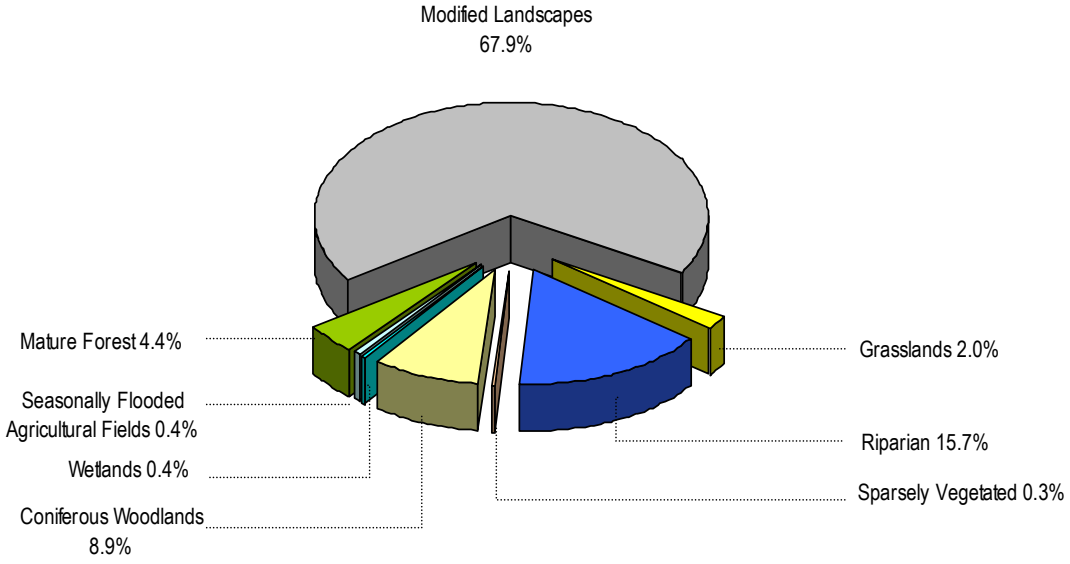


**Figure 5. Relative proportion of sensitive ecosystems, other important ecosystems, and modified landscapes in the study area.**

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

| | Area (ha) | Percent of Study Area |
|---|---|---|
| **Sensitive Ecosystems (SE)** | | |
| Grassland | 100 | 2.0 |
| Riparian | 762 | 15.7 |
| Sparsely Vegetated | 13 | 0.3 |
| Coniferous Woodland | 432 | 8.9 |
| Wetland | 20 | 0.4 |
| **Total SE** | **1327** | **27.3** |
| **Other Important Ecosystems (OIE)** | | |
| Seasonally Flooded Agricultural Fields | 18 | 0.4 |
| Mature Forest | 216 | 4.4 |
| **Total OIE** | **234** | **4.8** |
| **TOTAL SE and OIE** | **1561** | **32.1** |

# 6 Conservation Analysis

The first stage in developing a Local Ecosystems Plan (see Section 7) is the systematic prioritization of ecosystems for protection. This can provide a basis for a strategy for parks designation and acquisition, other forms of protection, and sensitive development. This can be accomplished using the base mapping used to develop the Sensitive Ecosystems Inventory. This conservation analysis is intended to provide the prioritization of ecosystems. It follows methods developed for the conservation analysis in 'Balanced Growth for the Bella Vista – Goose Lake Range'[50].

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

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

To achieve these objectives, we used a broad scale planning approach based on GIS data from the Sensitive Ecosystems Inventory, Terrestrial Ecosystem Mapping[51], and wildlife habitat mapping[52].

## 6.1 Conservation analysis methods[53]

Three stages were used to identify priority areas for conservation.

**Stage 1: Cumulate Conservation Values**

1. A rating scheme based on at-risk status and ecological sensitivity, condition, and wildlife habitat values of ecosystems, was developed to prioritize sensitive ecosystems mapped in the study area.

    a. **SEI Value**
    The relative value of sensitive and other important ecosystems in the study area was ranked in order of importance from 0 (minimal importance) to 10 (highest importance), and the results shown below (Table 5).[54] We assigned a value for each component, or decile of a polygon (SEIval_1, SEIval_2, SEIval_3), based on Table 5.

[50] Clarke et al. 2004
[51] Iverson and Uunila 2012
[52] Haney 2012
[53] This section and these methods are adapted from Clarke et al. 2004
[54] Values are not intended to be absolute, instead only the relative ranking of ecosystems is important.

**Table 5. Relative ecosystem values for sensitive and other important ecosystems.**

| SEI category | SEI sub-category | Relative SEI Value | Rationale (% of study area) |
|---|---|---|---|
| Grassland | Grassland | 9 | Very Sensitive & provincially rare; very rare in the study area (1.4%) |
| | Shrubland | 9 | Very Sensitive & provincially rare; very rare in the study area (0.1%) |
| | Disturbed Grassland | 7 | Disturbed but provide values for many grassland species including many rare and endangered species, very rare (0.5%) |
| Mature Forest | Coniferous | 3 | Moderately distributed, less sensitive, but no old forest (2.9%) |
| | Mixed | 3 | Very rare, but less sensitive, but no old forest (0.3%) |
| Not a Sensitive or Other Important Ecosystem | | 0 | Not sensitive (61.4%) |
| Old Forest | Coniferous | 10 | Very sensitive, very important wildlife habitat, rare (1.9%) |
| | Mixed | 10 | Sensitive, important wildlife habitat, very rare (0.1%) |
| Riparian | Fluvial Fringe | 10 | Very sensitive, very important wildlife habitat, extremely rare (0.1%) |
| | Floodplain | 10 | Very sensitive, very important wildlife habitat, common (10.4%) |
| | Gully | 10 | Very sensitive, very important wildlife habitat, very rare (0.6%) |
| | River | 9 | Very sensitive, important wildlife habitat, uncommon (4.6%) |
| Seasonally Flooded Agricultural Fields | | 4 | Rare, less sensitive, potential for restored riparian habitat (0.4%) |
| Sparsely Vegetated | Rock | 8 | Sensitive, important wildlife habitat, very rare (0.2%) |
| | Talus | 8 | Sensitive, important wildlife habitat, very rare (0.1%) |
| Woodland | Coniferous | 6 | Sensitive, very important wildlife habitat, common (8.9%) |
| Wetland | Marsh | 10 | Very sensitive, very important wildlife habitat, very rare (0.7%) |
| | Shallow Water | 10 | Very sensitive, very important wildlife habitat, very rare (1.3%) |

b. **Condition Value**

The ecological condition[55] of each sensitive or other important ecosystem was rated for each decile of each polygon (database fields CondVal_1, CondVal_2, CondVal_3). The SEI values were adjusted downwards based on the proportion in Table 6 below.

**Table 6. Values assigned to each condition rating.**

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

2. **Wildlife Value**

Wildlife habitat values were examined for the most important life requisites of the seven selected species whose habitats were mapped (Table 7). All ecosystems, including sensitive and non-sensitive ecosystems were rated for current habitat suitability for various life requisites for each of these species. We converted wildlife suitability ratings to values

[55] Formerly referred to as Quality – Condition in previous SEI projects; use of the term and definition of "Condition" follows the Standard for Mapping Ecosystems at Risk in British Columbia (Ministry of Environment Ecosystems Branch 2006).

(High=10, Moderate=5, Low=1, Nil=0) for each declie of a polygon (WLhv_1, WLhv _2, WLhv _3). We assigned the highest value of the 10 values for each component of each polygon.

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

| Species | Species Code | Life Requisite | Rating Code |
|---|---|---|---|
| Western Toad | A-ANBO | Breeding | RE |
| Painted Turtle | R-CHPI | General Living (foraging, wintering) | LIA |
| Western Skink | R-PLSK | General Living (foraging, egg-laying, denning) | LIA |
| Northern Rubber Boa | R-CHBO | General Living (foraging, birthing, denning) | LIA |
| Western Screech-owl | B-WSOW | Nesting | RE |
| Flammulated Owl | B-FLOW | Nesting | RE |
| American Badger | M-TATA | General Living (denning and foraging) | LIA |

3. For each polygon component, sensitive ecosystem and wildlife habitat values were combined into a single value giving a two to one weighting of ecosystems over wildlife (2 x ecosystem value + wildlife value). Wildlife ratings may raise conservation values (e.g. little or no ecosystem value due to condition, but may be important for at least one rare species), or lower them (e.g. due to slope, aspect or soil depth). Ecosystems were weighted more heavily as they also represent values for a much broader range of species whose habitat was not mapped[56]. The final value used for the polygon was the component (decile) with the highest value.
    a. multiply SEI value by Condition value for each decile
    b. add SEI/Condition value and wildlife value, with a weighting of two to one for SEI/Condition, for each decile and divide by three (Cons_1 = 2 [SEIval_1 * CondVal_1] + WLhv_1 / 3)
    c. assign conservation rating value to polygon based on highest value of all components (Cons_val = [Max of Cons_1, Cons_2 and Cons_3])

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

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

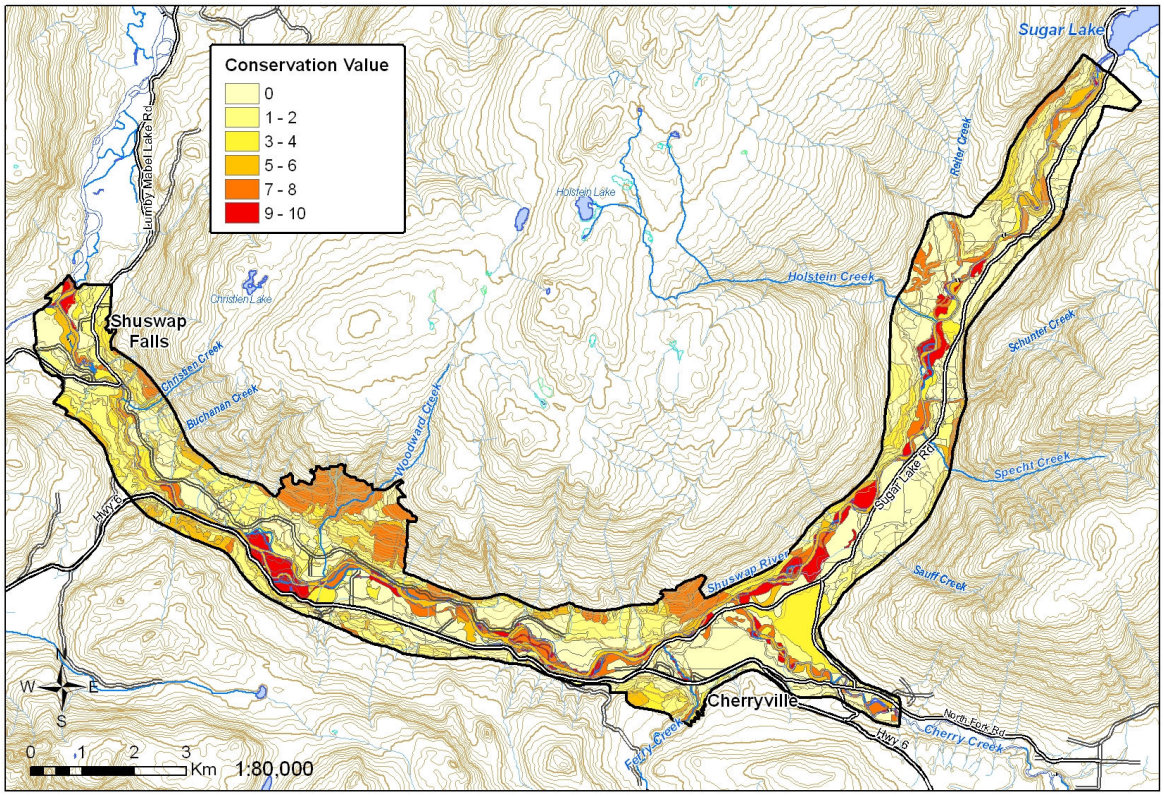


**Figure 6. Conservation values map. Higher conservation values are shown in darker colours.**

Our methods emphasize the highest conservation values within each polygon. Although the resulting map is biased towards higher conservation values (e.g. they appear to occupy a larger area than they actually do), we feel ***this method is important to avoid masking important conservation values*** that would result if the values within a polygon were averaged. The scale of the aerial photographs used in the project has inherent limitations in the size of polygons that can be delineated. Larger scale photographs would result in additional smaller polygons that would enable more small important conservation sites to be represented as individual polygons rather than as a component of a larger polygon. Where changes in land use are proposed, we recommend mapping ecosystems, wildlife habitat, and wildlife features at a larger scale (1:5000). The mapping should be refined, field-verified, and revised as necessary with clear documentation of the rationale for changes.

## Stage 2: Identify Priority Conservation Areas

Using the conservation values map, conservation areas including core areas, buffers, wildlife corridors, and other important conservation areas were identified based on size, concentration and connectivity of high value areas (see Figure 7). The figure illustrates priorities for conservation, and could be used to develop a vision for a system of protected areas and resource lands connected across the landscape.

### 1. Core Conservation Areas

Areas with a large concentration of high and some moderate conservation values were identified as core conservation areas. These would be the areas of highest priority for conservation. Ideally,

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

### 2. Core Conservation Area Buffers

Core conservation areas need to be buffered from potential adverse effects of adjacent land uses. One hundred meter buffers around core areas were identified to conserve values in core conservation zones, and need to be managed for that purpose. The width and design of buffers also needs to be refined at larger scales to reflect the size of patches, ecosystem types, local landscape features and wildlife habitat values. Wetland and riparian buffers will likely need to be wider[57], but it is possible that buffers around some upland ecosystems may be narrower.

### 3. Wildlife Corridors

Wildlife corridors provide animals with an opportunity to move freely between two or more habitat patches or habitat types in an otherwise fragmented landscape. This movement is essential to provide genetic links between populations and prevent inbreeding, and to compensate for temporary population declines in one of the habitat patches. The habitat needs of all priority species should be incorporated into the design of the corridor. Corridors must be suitably wide, with appropriate habitat features to provide security cover during movement. Corridors usually consist of linear habitats such as gully or streamside riparian areas; they are often composed of two or more ecosystem types to provide complexity to the corridor. Development and roads should avoid these zones, and mitigation will be required where roads and other developments transect the corridor. Wildlife corridors were identified to connect core areas to each other and to outside the study area.

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

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

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

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

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

### 4. Other Important Conservation Areas

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

## Stage 3: Refine Conservation Priorities

The conservation area design identified in Stage 2 was compared to the SEI map and each wildlife habitat map to ensure all high priority values were included in the appropriate zone. This ensured that core areas included old forests and wetlands, and that there was diversity within each core area. The resulting Conservation Zones map is shown below in Figure 7.

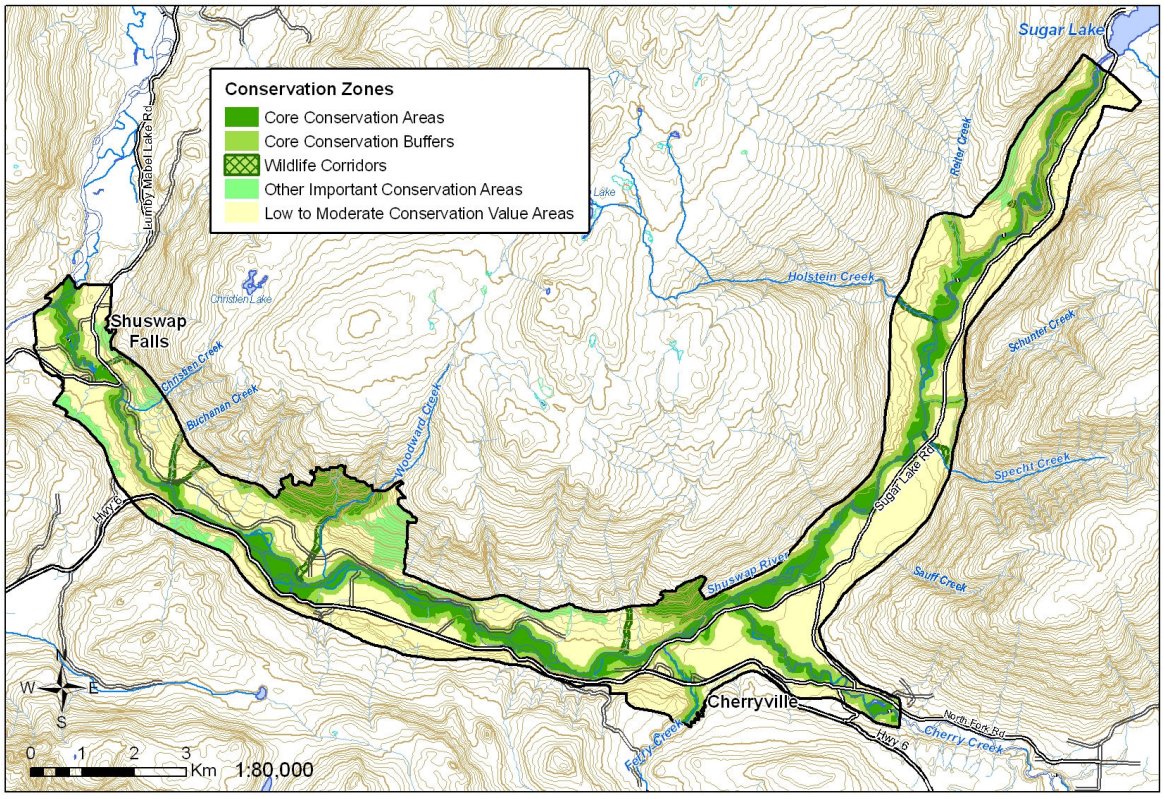


**Figure 7. Conservation zones for the Middle Shuswap SEI study area. The conservation zones include core conservation areas, core conservation area buffers, wildlife corridors, other important conservation areas and low to moderate conservation values areas.**

## 6.2 Management of Conservation Zones

### Management of Core Conservation Areas (CCA)

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

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

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

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

### Management of Buffers

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

### Management of Corridors

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

### Management of Other Important Conservation Areas (OICA)

Some managed resource uses (e.g., grazing and selection harvesting of ingrown coniferous forests) are likely compatible with conservation values in OICA. Grazing of domestic livestock should be managed to prevent changes in vegetation cover and composition. Forest harvesting should be limited to thinning of smaller diameter trees and leaving larger, older trees in reserve. Forest densities should be similar to historical densities as evidenced by stumps and coarse woody debris. OICAs that are situated on properties subject to urban or other development should be a priority for protection.

# 7 Planning and Management Recommendations

## 7.1 Goals

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

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

## 7.2 North Okanagan Regional District Planning

### Develop a 'Local Ecosystems Plan'[58]

A systematic plan for prioritization and protection, and stewardship of local sensitive and other important ecosystems should be developed. The conservation analysis provides priorities for conservation. The local ecosystems plan should consider known gaps in the system of provincial and regional protected areas, and be integrated across the study area, and with adjacent areas to ensure landscape level connectivity. This mapping data should be used in the ***Shuswap River Watershed Sustainability Plan*** and any other regional or landscape plans that cover all or part of the study area.

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

- Design initial road and utility layouts at a landscape scale to minimize impacts to sensitive and other important ecosystems.
- Integrate ecosystem retention and conservation with other land use planning considerations (such as parks and recreation) that are consistent with the conservation of sensitive ecosystems.
- Develop and implement an invasive alien plant management strategy to minimize the spread and introduction of invasive plant species.

[58] Refer to the Conservation Tools Section of Iverson et al. 2008 for more detailed information.

- Develop and implement a fire management plan that identifies forests that are a fire hazard and provides a strategy to reduce this hazard and return forests to historical stand densities.
- Develop a recreation use plan to avoid recreation in critical areas and designate appropriate types of recreation for other areas.

Aside from the ecosystems prioritized for protection in the ecosystem plan, other sensitive and other important ecosystems, and natural areas should be considered in all levels of planning and protection, and mitigation strategies should be developed in areas where development will occur. SEI maps are intended 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[59]

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

- **Designation as Environmentally Sensitive Areas** (ESA) – The five 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 core conservation areas, particularly the best condition ecosystems should be considered for purchase as conservation areas where only activities that do not impact the ecosystem would be permitted. Grasslands, wetland, and sparsely vegetated ecosystems together with the best condition riparian and coniferous woodland sites should all be priorities for receiving protected status. ***Sites where different sensitive ecosystems occur adjacent or in close proximity to one another should also be given priority with regards to protection***.
- **Stewardship** – Private landowners with sensitive ecosystems who wish to retain ownership could become involved in voluntary stewardship initiatives such as registering conservation covenants on their property to protect ecosystem values. Protection of grasslands and managing invasive plants should all be priorities for stewardship programs.
- **Use other protection techniques** such as cluster development, Development Permit Areas, restrictive covenants, purchase of development rights, and incentives to leave sensitive sites intact.

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

## Official Community Plan

The Official Community Plan (OCP) provides overall policy direction for the local government and establishes the basis for its regulations and development approvals. The Green Bylaws Toolkit (www.greenbylaws.ca) has additional information and practical tools for protecting green infrastructure (see textbox below for additional information). Below are specific recommendations for integrating this SEI into the Regional District of North Okanagan's OCP.

- Designate sensitive and other important ecosystems as ***Development Permit Areas***[60] (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.
- Designate sensitive and other important ecosystem DPAs as areas for which ***Development Approval Information*** is required.
- Use the local ecosystems plan to ***determine natural areas*** and develop conservation strategies for those areas. Create a natural areas designation for such areas.
- Ensure that only ***developments and other activities*** compatible with the preservation, protection, restoration, and enhancement of sensitive ecosystems occur in DPAs.
- Ensure ***sector/neighbourhood plans are consistent with the local ecosystems plan*** and conservation strategies. At the development scale, maintain appropriate buffers, determined by qualified professionals, around sensitive ecosystem areas and provide connectivity between sensitive and other important ecosystems.
- Provide for ***greater incentives for density bonuses*** in developments in exchange for the retention of sensitive ecosystems:
    - Ecosystems identified for conservation in the local ecosystems plan should be the highest priority for retention.
    - Ecosystems must be retained in such a way that natural values are maintained or enhanced.
    - Provide buffers and connectivity to other natural ecosystems within and beyond the development (See Retain Natural Vegetated Buffers around Sensitive Ecosystems and Corridors between Sensitive Ecosystems page 31).

[60] 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).

- Do not limit the maximum density bonus to 20% in cases where density bonuses are granted in exchange for the secured conservation of sensitive ecosystems.
- Retained natural ecosystems should be covenanted to ensure that future uses are compatible with the protection, restoration, and enhancement of sensitive ecosystems.

- ***Eliminate large lot zoning designations*** in favour of cluster development zones where the net number of housing units remains the same. ***Reduce minimum lot size to permit cluster development*** if more than 20% natural area is retained and is not disturbed. ***Consider the development of cluster housing as a zoning designation***.
- ***Plan and manage recreational access*** to minimize impacts to sensitive ecosystems, especially during wildlife breeding and nesting seasons. Both uncontrolled motorized and water recreations are of particular concern.
- Add a goal into OCPs to ***acquire high priority sensitive ecosystems*** to add to protected natural areas.
- Add a goal into OCPs to ensure that ***trail and other recreation development*** is consistent with broader level conservation priorities and ecological integrity of sensitive ecosystems.

**Green Bylaws Toolkit for Conserving Sensitive Ecosystems and Green Infrastructure**
www.greenbylaws.ca
This comprehensive document is designed to provide municipal and regional governments with practical tools for protecting the green infrastructure within their jurisdictions.

The Toolkit contains practical examples of bylaw provisions currently in use in B.C., including model provisions for Regional Growth Strategies, Official Community Plans, Development Permit Areas, Zoning, Tax Exemptions, Environmental Assessment, Stormwater Management and other regulatory tools. It includes several examples and case studies of successful green infrastructure projects and bylaws.

## Additional Policies for Wetland and Riparian Ecosystems

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

## Other Local Government Policies and Plans

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

## 7.3 Landowners

### Plan Land Development Carefully

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

### Tools for the Protection of Sensitive Ecosystems

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

**Further Information:**

*Stewardship Options for Private Landowners in British Columbia*[61]

*Here Today, Here Tomorrow: Legal Tools for the Voluntary Protection of Private Land in British Columbia*[62]

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

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

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

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

## 7.4 General Management Recommendations[63]

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

### Retain Natural Vegetated Buffers around Sensitive Ecosystems and Corridors between Sensitive Ecosystems

In order to achieve adequate protection, sensitive ecosystems must be buffered from potentially adverse effects of land use practices in adjacent areas. A natural vegetated buffer zone can absorb and avoid negative edge effects that result from animal and human access and disturbance. Buffers also play a role in maintaining microclimate conditions such as temperature and humidity, particularly for wetlands and riparian areas. Retaining or restoring natural ecosystems that surround sensitive or other important ecosystems provide a vegetated buffer for them. The size of the buffer zone varies by ecosystem type, and by constraints of the surrounding landscape. Fencing compatible with safe wildlife movement[64] may be necessary along some buffers to delineate and protect the buffer from encroaching land uses and inappropriate activities. In planning for protection of a particular site, assessments and recommendations should be made by a qualified professional to ensure that conservation options are effective.

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

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

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

## Avoid Direct and Indirect Impacts

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

- ***Discourage settlement and other development within or adjacent to sensitive ecosystems*** unless only insignificant negative impacts can be demonstrated;
- ***Manage access to land and water***: Seasonal use-restrictions (e.g., during wildlife breeding seasons), fencing, designated trails, and signage can be used to help avoid the negative effects of access to sensitive areas. Designating trails and areas for limited used (e.g., restricting motorized recreation or mountain bikes) are another access management tool;
- ***Protect large old trees and snags***. Old trees and snags provide critical nesting habitat for many species of birds, bats, and other wildlife.
- ***Avoid use of insecticides in, or near, important foraging areas for wildlife***. Insecticide use near foraging habitat for animals that feed on insects (e.g., bats, Flammulated Owls and Lewis' Woodpeckers) should be avoided.
- ***Prevent disturbance of nesting or breeding areas*****:** Known and potential breeding sites, (especially for threatened or endangered species) should be protected from any activity that would disturb breeding wildlife;
- ***Control invasive species*****:** A broad invasive alien plant management plan may be necessary to control and limit the spread of plants such as diffuse knapweed (*Centaurea diffusa*), sulphur cinquefoil (*Potentilla recta*), hoary alyssum (*Berteroa incana*) and invasive annual grasses such as cheatgrass (*Bromus tectorum*). Reclaim disturbed sites using native vegetation species adapted to the site to reduce the potential for the introduction and spread of invasive plants. Managing human and livestock access, and treating existing invasive plant species will help maintain the ecological integrity of sensitive ecosystems. Invasive plant control can include hand-pulling (for species that are not spread by this activity), and native species can be planted to help prevent the establishment of more invasive plants. Herbicides and biological control agents are other possible treatments, especially where manual control or other control options are not likely to be effective. The BC Ministry of Forests, Lands and Natural Resource Operations or BC Ministry of Agriculture can be consulted to determine the appropriate method and timing of treatment for invasive plant species; and
- ***Restore natural disturbance regimes*** wherever possible. Consider some planned thinning and prescribed burning to restore open forests, restore some encroached grassland habitat, and reduce wildfire hazard in interface areas. Consult a qualified professional to develop and implement a restoration and prescribed burning plan. Consider restoring natural flooding regimes on creeks where possible.

## Plan Land Development Carefully

Where it is not possible to limit settlement or other developments within or immediately adjacent to a sensitive ecosystem, activities should be carefully planned to minimize adverse effects to the ecosystem. An environmental impact assessment should be completed (see below) and inventories

of wildlife, vegetation, including wildlife trees and the extent of tree root systems, terrain features such as cliffs and talus, adjacent water bodies, and other important microhabitats are necessary to determine and minimize the full impact of development on biodiversity at the site.

- **Require an environmental impact assessment conducted by a qualified professional**.
- **Plan, design, and implement land development activities to avoid adversely affecting or disturbing:**
  - native vegetation;
  - large old trees;
  - threatened or endangered species or ecological communities;
  - soils, and other terrain features such as bedrock;
  - wildlife nesting or denning sites;
  - standing dead trees (snags), and downed trees and logs; and
- **Restore native vegetation where it has been disturbed.** Seed or plant native species from nurseries, or plant native species that have been salvaged from other development sites. Ensure that any native plant material and erosion control seed mixes used are free of alien plant seeds.
- **Ensure adequate sediment and erosion control measures** are implemented.

# 8 Wetland

## What are wetland ecosystems?[65]

Wetlands occur on sites where the water table is at, near, or above the soil surface for a sufficient period of time to influence soil and vegetation development[66]. Wetland ecosystems have plants that are adapted to growing on saturated soils with low oxygen levels.

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

***Marsh ecosystems***

Marsh wetland ecosystems occur at the edge of shallow open water and in depressions in old back-water channels along the Shuswap River where the water table is above or near the soil surface. Rushes, cattails, or sedges usually dominate marshes, and some floating aquatics such as duckweed are often present.

***Shallow water ecosystems***

Shallow water ecosystems are either areas of open water that are intermittently or permanently flooded up to 2 m in depth at midsummer[67]. Vegetation is limited to submerged or floating aquatic plants with less than 10% cover of vegetation emerging above the water surface. Shallow water ecosystems often occur in association with marshes; they typically occurred in backwater channels along the Shuswap River.

[65] Adapted from Iverson and Cadrin 2003.
[66] MacKenzie and Moran 2004
[67] Voller 1998

### *Vegetation*

| | Marsh | Shallow Water | |
|---|---|---|---|
| **Shrubs** | | | |
| mountain alder | ** | | *Alnus incana* |
| willows | * | | *Salix* spp. |
| **Grasses, Sedges & Rushes** | | | |
| small-flowered bulrush | *** | | *Scirpus microcarpus* |
| beaked sedge | ** | | *Carex utriculata* |
| reed canarygrass | ** | | *Phalaris arundinacea* |
| sedges | ** | | *Carex* spp. |
| **Forbs** | | | |
| cattail | ** | | *Typhus latifolia* |
| duckweed | ** | * | *Lemna minor* |

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

## Why are they important?

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

***At-risk ecological communities of wetland ecosystems***

The mapped units have not been evaluated by the conservation data centre, but are likely at-risk.

***At-risk[68] vertebrates of wetlands***

Barn Swallow (*Hirundo rustica*): Threatened, Blue-listed
Bobolink (*Dolichonyx oryzivorus)*: Threatened, Blue-listed
Great Basin Spadefoot (*Spea intermontana*): Threatened, Blue-listed
Western Toad (*Anaxyrus boreus*): Special Concern, Blue-listed
Painted Turtle (*Chrysemys picta*): Special Concern, Blue-listed
Great Blue Heron (*Ardea herodias herodias*): Blue-listed
Little Brown Myotis (Myotis lucifugus): Emergency Endangered
Townsend's Big-eared Bat (*Corynorhinus townsendii*): Blue-listed

- **At-risk status**: Most wetland ecological communities are likely at-risk (see above).
- **High biodiversity**: Ponds and marshes are focal points for wildlife because of their infrequent occurrence in this landscape. Wetlands provide wildlife and biodiversity values that are disproportionate to the area they occupy on the land base. Wetland vegetation provides food, shelter, breeding habitat, and cover for many species of amphibians, mammals, birds, and insects. The abundance of insects provides food to different species of birds and bats. Wetlands in the study area, including slow-moving back channels of the river, provide Painted Turtle and Western Toad habitat.

[68] Vertebrate species that are nationally ranked as endangered, threatened, or of special concern, and those that are provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.

- **Fragility**: Wetlands are vulnerable to a range of human disturbances such as vegetation removal, dredging, diking, filling, and trampling by livestock. Small changes in hydrology such as reduced flows or lowered water tables, irrigation run-off, and urban run-off (including stormwater drainage) and other sources of nutrients including fertilizers and livestock manure can change and reduce the diversity of wetland communities. Such changes may occur away from the wetland, but can still influence it. Intensive recreational activities in and near wetlands can reduce plant cover, compact soil, and disturb nesting birds. Wetlands are vulnerable to overuse by livestock, but can still be extremely valuable and may recover quickly with improved livestock management.

- **Maintenance of water quality**: Properly functioning wetlands store and filter water, and maintain water quality. They reduce the levels of sediment, nutrients, and toxic chemicals in outflow water.

- **Social values**: Wetlands provide water storage and filtration and opportunities for wildlife viewing, education, and aesthetic enjoyment. They are focal points in the arid landscape of the Okanagan. They can add to real estate values in adjacent areas and can provide a tourist attraction.

## Status

Wetland ecosystems were very rare in the study area; they occupied 20 ha or 0.4% of the study area land base. Within the study area, wetlands were associated with old back channels of the Shuswap River. The hydrology of many wetlands has been altered through changes in land use in the surrounding area (primarily agriculture) and by altered flooding regimes caused by the damming of the Shuswap River. Wetlands have likely been influenced by effluent irrigation run-off resulting in unnaturally high nutrient loads and different hydrology, and by some domestic cattle grazing in the study area, together reducing plant cover and changing species on some sites. Such sites are still extremely valuable for wildlife and can recover quickly with effective range management. Future housing and other developments in the study area may alter, isolate, or cause losses of wetlands.

Marshes (7 ha) and shallow water (13 ha) were the only wetland types in the study area.

## Management Recommendations[69]

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

General management recommendations for all sensitive ecosystems are found in Section 7.4 (page 31). Below are additional management recommendations specific to wetlands.

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

## Avoid Direct and Indirect Impacts

- **Roads** should not be built near wetlands as they can alter hydrology and lead to extensive mortality of wildlife species that use wetlands. Roads should never encircle wetlands and should be set back as far as possible, preferably more than 50m. Depending on local conditions, special fencing to prevent road mortality of amphibians and turtles may be necessary.
- **Maintain wetland hydrology**. Draining or ditching in or around wetlands, the filling in of wetlands, irrigation run-off, and the discharge of stormwater into such sites should be avoided. Vegetation cover in adjacent areas should not be removed as this increases surface runoff and reduces the amount of groundwater infiltration, thus reducing available summer moisture. Additionally, areas of impervious ground surfacing (i.e., pavement) should be minimized. Hydrologists familiar with wetland function should be consulted to determine how to protect wetland hydrology.
- **Maintain water quality**. Wetlands store and filter water, and maintain water quality; therefore, the addition of agricultural runoff, urban storm drainage, and sediment from road building into wetlands should be prevented. Wetlands that have artificially high nutrient levels may experience algal blooms, and changes in vegetation composition (e.g. some marshes may convert from sedges or rushes to cattails).
- **Restrict recreational access**. Intensive recreational use of shoreline areas can reduce plant cover, compact soil, and disturb wildlife. Roots of trees and shrubs can be easily damaged by trampling and trail development in the moist soils of wetlands. Trails often become wide in wet, muddy areas, and sediments from trail damage may affect amphibians and insects. Motorized recreation, mountain biking, and horseback riding should be excluded from wetlands. In areas where trails to viewpoints in wetlands are desired, raised boardwalks should be used (avoid using rock or bark mulch on trails).
- **Manage livestock access**. Livestock use of wetlands and ponds for water has altered some 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 and livestock grazing in and near wetlands can impact amphibians, nesting waterfowl, and other birds, and should be avoided during the breeding season (May through August). Avoid disturbance of soils around wetlands, especially sandy soils that might be used by Painted Turtles for egg-laying or Western Toads for burrowing.
- **Restrain pets near wetlands during spring and summer**. Pets should be controlled to avoid disturbances to turtles, amphibians, waterfowl, and other birds during the breeding season (May through August).
- **Allow natural wetland processes to maintain wetland functions and values**. Beaver activity, flooding, seasonal drawdown, and groundwater recharge and discharge should be maintained. Inflow or outflow streams should not be diked or channelized.

- **Avoid use of pesticides and fertilizers in or near wetlands**. Follow the restrictions for each pesticide and ensure that winds do not cause sprays to drift and contaminate the water body. Roundup (glyphosate) is particularly toxic to amphibians[70].

[70] Relvea 2005

# 9 Riparian

## What are riparian ecosystems?

Riparian simply refers to areas adjacent to water bodies such as lakes, rivers, streams, and ponds[71]. In this study, riparian ecosystems were defined as ecosystems that are adjacent to, and significantly influenced by a water body or subsurface seepage. That is, these sites are moister than and have a plant community that is distinct from the surrounding upland. Riparian ecosystems are typically linear in nature. Wetlands are riparian in nature but were described separately because of their distinct ecological nature.

Riparian ecosystem
vs.
Riparian zone

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

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

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

**Table 8. Structural stages of riparian ecosystems**

| Code | Name | Definition |
|---|---|---|
| RI:1 | Unvegetated or sparsely vegetated | Less than 10% cover of vegetation, generally gravel bars or rivers |
| 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 (bench, fringe, gully and river) according to their environmental and vegetation characteristics; these are described below.

[71] MacKenzie and Moran 2004; Voller 1998

### *Bench riparian ecosystems*

Bench riparian ecosystems are flood or fluvial ecosystems that are associated with moving water such as the Shuswap river and its major tributaries. They are influenced by flooding and subsurface irrigation. They usually occurred as plains or terraces with sandy, gravely soils adjacent to flowing water. The forest overstories were broadleaf, coniferous or mixed; understories were typically shrubby.

### *Gully riparian*

Gully riparian ecosystems occurred at the base and lower slopes of 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. They were rich and productive sites, providing habitat that was distinctly different from the surrounding landscape. These ecosystems usually had a mixed coniferous and deciduous overstory with shrubby understories.

### *Fringe riparian ecosystems*

Fringe riparian ecosystems were associated with significant seepage sites that are sensitive to soil and hydrological disturbances. These ecosystems usually had mixed coniferous and broadleaf overstories with shrubby understories.

### *River riparian*

In the study area, river riparian ecosystems occurred on along the Shuswap River and its major tributaries. They have little vegetation and occur where there is moving water including riverbeds and gravel bars.

## *Vegetation*

| | Bench | Gully | Fringe | |
|---|---|---|---|---|
| **Trees** | | | | |
| black cottonwood | *** | * | * | *Populus balsamifera* ssp. *trichocarpa* |
| paper birch | ** | ** | ** | *Betula papyrifera* |
| Douglas-fir | ** | ** | *** | *Pseudotsuga menziesii* |
| western redcedar | ** | ** | ** | *Thuja plicata* |
| hybrid white spruce | ** | ** | * | *Picea engelmanii x glauca* |
| **Shrubs** | | | | |
| beaked hazelnut | *** | ** | ** | *Corylus cornuta* |
| common snowberry | *** | *** | *** | *Symphoricarpos albus* |
| mountain alder | *** | * | * | *Alnus incana ssp. tenuifolia* |
| red-osier dogwood | ** | ** | ** | *Cornus stolonifera* |
| thimbleberry | ** | ** | ** | *Rubus parviflorus* |
| **Forbs** | | | | |
| wild sarsaparilla | ** | ** | ** | *Aralia nudicaulis* |
| Star-flowered false Solomon's seal | ** | ** | ** | *Maianthemum stellatum* |
| mountain sweet-cicely | ** | ** | ** | *Osmorhiza berteroi* |
| horsetail | ** | * | * | *Equisetum* spp. |
| lady fern | ** | | | *Athyrium filix-femina* |
| **Mosses** | | | | |
| leafy mosses | ** | * | * | *Mnium* or *Plagiomnium* spp. |

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

## Why are they important?[72]

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

***At-risk[73] ecological communities of riparian ecosystems***

Black cottonwood – Douglas-fir – common snowberry – red-osier dogwood: Red-listed
Douglas-fir – western larch / pinegrass: Red-listed
Trembling aspen / common snowberry / Kentucky bluegrass: Red-listed
Douglas-fir / common snowberry – birch-leaved spirea: Blue-listed
Douglas-fir / Douglas maple – red-osier dogwood: Blue-listed
Hybrid white spruce / black gooseberry: Blue-listed
Western redcedar – Douglas-fir / red-osier dogwood: Blue-listed

***At-risk[74] vertebrates of riparian ecosystems***

Western Screech-Owl (*Megascops kennicottii macfarlanei*): Endangered, Red-listed
Lewis's Woodpecker (*Melanerpes lewis*): Threatened, Red-listed
Western Toad (*Anaxyrus boreas*): Special Concern, Blue-listed
Great Blue Heron (*Ardea herodias herodias*): Blue-listed
Little Brown Myotis (Myotis lucifugus): Emergency Endangered
Townsend's Big-eared Bat (*Corynorhinus townsendii*): Blue-listed
Grizzly Bear (*Ursus arctos*): Special Concern, Blue-listed

- **At-risk status**: Most riparian ecological communities are listed as at-risk (see above).
- **High biodiversity**: Riparian ecosystems support disproportionately high numbers of species relative to the area they occupy on the land base. They provide wildlife with water, cover, breeding habitat, and food. The wide diversity of plants, invertebrate organisms, and structural complexity of these ecosystems provide many habitat niches. Riparian vegetation provides food for many aquatic organisms. Gullies generally lack surface water flow but often have lush, productive vegetation that provides significant cover and food for wildlife and may be natural travel corridors.
- **Fragility**: Riparian ecosystems are strongly influenced by adjacent water bodies and, thus, they are sensitive to disturbance and changes in hydrology.
- **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

[72] Adapted from Iverson and Cadrin 2003.
[73] Ecological communities that are provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.
[74] Vertebrate species that are nationally ranked as endangered, threatened, or of special concern, and those provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.

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

- **Wildlife corridors**: The riparian areas associated with the Shuswap River and its major tributaries are all wildlife corridors. Linear riparian areas form natural wildlife corridors, including gullies that connect lower and upper slopes of the study area. Riparian ecosystems adjacent to or connecting different types of ecosystems provide valuable links for wildlife with various habitat needs.
- **Social values**: Riparian areas provide water retention and filtration, prevent erosion, and provide natural areas, and opportunities for education, bird watching, wildlife viewing, and walking and hiking. They are cooler places to enjoy nature on hot summer days. Retention of riparian corridors can enhance and maintain property values and attract tourists by retaining the natural beauty that many people seek out.

## Status

Riparian ecosystems are naturally common in the study area and occupied 15.7% (762 ha) of the study area – predominantly bench (506 ha) with some river (29), gully (28 ha) and very little fringe (4 ha) (Figure 8).

Only 4% of riparian ecosystems in the study area were in the old forest structural stage. Another 26% was mature forest and 31% was young forest, indicating that many riparian ecosystems had been altered by human disturbance. Historically, riparian ecosystems would have been had a higher proportion of old and mature structural stages (Figure 9), with some younger areas on more recent floodplain deposits.

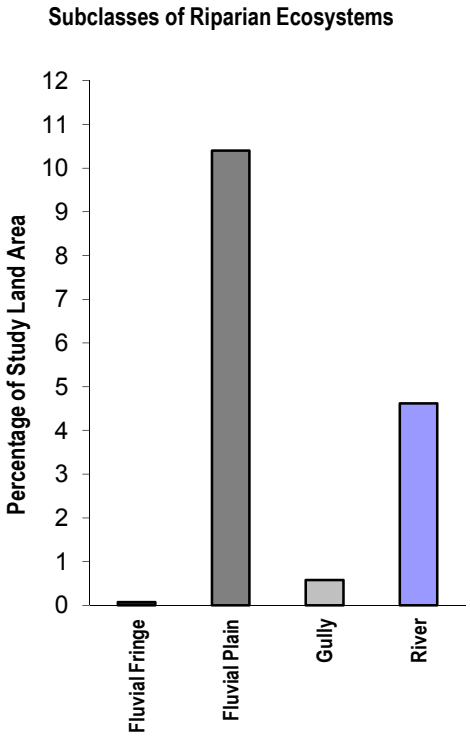


**Figure 8. Percentage of study land area for riparian ecosystem subclasses.**

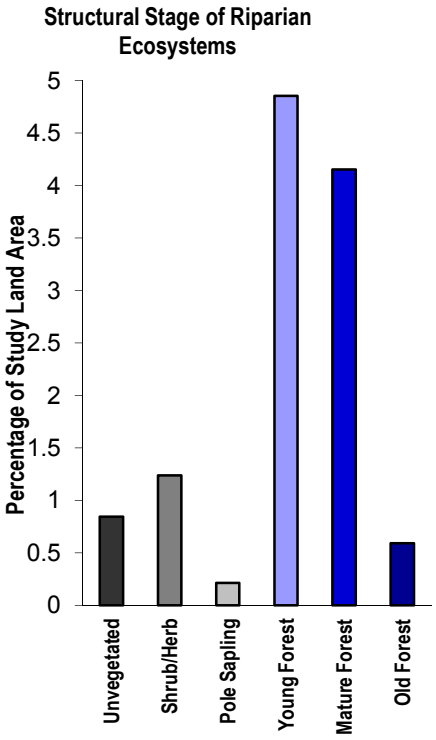


**Figure 9. Percentage of study land area for riparian ecosystem structural stages.**

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

## Management Recommendations[75]

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

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

General management recommendations for all sensitive ecosystems are found in Section 7.4 (page 31). Below are additional management recommendations specific to riparian ecosystems.

The **Middle Shuswap Sensitive Ecosystem Inventory and Sensitive Habitat Inventory Mapping Project:06.SHU.03**[76] summarizes the fish present in the study area: "Fish species identified in earlier studies in this section of the river are: bull trout (*Salvelinus confluentus*), rainbow

[75] Management recommendations have been adapted from McPhee et al. 2000 and Iverson and Cadrin 2003.
[76] Minor 2007

trout (*Oncorhynchus mykiss*), mountain whitefish (*Prosopium williamsonii*), longnose dace (*Rhinichthys cataractae*), redside shiner (*Rhichardsonius balteatus*), prickly sculpin (*Cottus asper*), slimy sculpin *(Cottus cognatus)*, *longnose* sucker (*Catostomus catostomus*) and northern pikeminnow *(Ptycheilus oregonensis)* (Triton 1995). Whitefish are the most abundant species in the Shuswap River between the dams (Griffith 1979; Fee and Jong 1984). Rainbow trout are the dominant species in the tributary streams. Standing stock assessments carried out in 1979, 1984 and 1995 indicate that the river system was performing below theoretical capacity (Arc 2001). Adult Chinook salmon were transplanted above Wilsey dam in 1993 and 1995. Chinook fry were transplanted above Wilsey Dam in 2007."

Additional management recommendations for riparian ecosystems where fish may be present can be found in Iverson et al. 2008.

## Avoid Direct and Indirect Impacts

- **Riparian vegetation should be maintained where it is present, and restored where it has been lost**. Vegetation maintains the cohesive nature of banks and provides inputs of organic matter into soils, which increases their capacity to adsorb and store water. Additionally, riparian vegetation moderates water temperatures, provides an important source of food for many aquatic organisms, and provides important wildlife cover for nesting and feeding.
- Where practical or necessary, **restrict livestock access** by using fencing, alternative water sources or other range management techniques. To allow safe wildlife access, fences should be top-railed, and bottom wires should be 45cm (18") above ground level (this height is for cattle, lower bottom wires are needed for sheep and other livestock).
- **Control pets**. Pets should be restrained and hunting dogs should be trained away from riparian areas during the spring and summer. Other disturbances to waterfowl during the nesting season should also be avoided.
- **Protect structural features***:* Maintain structures such as rocks and logs within streams as they provide important habitat and prevent erosion.
- **Avoid use of insecticides in or near water and important foraging areas for wildlife**. Insecticide use near foraging habitat for animals that feed on insects (e.g., Western Screech-Owl, bats 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:

- **Design roads carefully**. Roads should be narrow and set back from the riparian ecosystem to ensure that both the riparian vegetation and bank stability are maintained. If roads must cross riparian ecosystems, bridges are recommended to minimize disturbance of soil and vegetation and to provide a wildlife corridor below. Where roads encroach upon riparian

ecosystems, narrow the width of the road and avoid side-casting material into the riparian area.

- **Design trails carefully**. Trails should provide a direct route to a viewing area or crossing, and should avoid sensitive vegetation, seepage areas and wetlands, and stream banks or gully sidewalls with easily eroded soils.

# 10 Grasslands

## What are grassland ecosystems?

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

Areas where grasslands occurred are generally too hot and dry for forests to establish. Often, grasslands occurred on steep warm aspects within the drier climate (Interior Douglas-fir) of the study area. Moisture is effectively funnelled by the conical shape of bunchgrasses and captured by extensive grass roots in the upper portions of the soil (generally the top 30cm), leaving little moisture available for tree seedlings. Grasslands are also favoured in areas where frequent, low-severity fires historically occurred and most young trees were killed by fire.

In the study area, grasslands occurred in pockets along the south-facing aspects above the north side of the Shuswap River. Other areas adjacent to the study area have grasslands on warm slopes; this section would apply to these grasslands as well.

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

***Grassland ecosystems***

Bunchgrasses, most commonly bluebunch wheatgrass, junegrass, and Idaho fescue dominated healthy grassland ecosystems in the study area. Bunchgrasses are designed to funnel moisture to the center of the plant, and have extensive fine roots to capture moisture in the upper horizons of the soil. Grassland soils are topped by a thick, dark-coloured horizon enriched by organic matter from the decomposition of grass roots. Grasslands may have a component of invasive alien plants, but are dominated by native plants.

[77] Tisdale 1947

### *Disturbed grassland ecosystems*[78]

Disturbed grasslands, once intact grasslands, have a mixture of native bunchgrasses and forbs and invasive alien plants. More than about 50% of the total plant cover was comprised of invasive plant species including cheatgrass (*Bromus tectorum*), diffuse knapweed (*Centaurea diffusa*), sulphur cinquefoil (*Potentilla recta*), and other alien species.

### *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.

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

### *Vegetation*

| | Grassland | Disturbed Grasslands | Shrubland | |
|---|---|---|---|---|
| **Shrubs** | | | | |
| common snowberry | | | *** | *Symphoricarpos albus* |
| roses | | | *** | *Rosa* spp. |
| **Grasses** | | | | |
| bluebunch wheatgrass | ** | ** | | *Pseudoroegneria spicata* |
| Idaho fescue | ** | | | *Festuca idahoensis* |
| junegrass | * | ** | | *Koeleria macrantha* |
| Columbian needlegrass | | ** | | *Achnatherum nelsonii* |
| **Forbs** | | | | |
| pasture sage | ** | ** | | *Artemisia frigida* |
| parsnip-flowered buckwheat | ** | ** | | *Eriogonum heracleoides* |
| yarrow | ** | ** | * | *Achillea millefolia* |
| lemonweed | ** | ** | * | *Lithospermum ruderale* |
| **Mosses and Lichens** | | | | |
| sidewalk moss | ** | * | | *Tortula ruralis* |
| clad lichens | ** | * | | *Cladonia* spp. |
| **Invasive Alien Plants** | | | | |
| cheatgrass or Japanese brome | * | ** | | *Bromus tectorum* or *B. japonicus* |
| diffuse knapweed | | ** | | *Centaurea diffusa* |
| sulphur cinquefoil | * | ** | * | *Potentilla recta* |

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

## Why are they important?

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

***At-risk[79] ecological communities of grasslands***:

Bluebunch wheatgrass – balsamroot: Red-listed

Idaho fescue – bluebunch wheatgrass: Red-listed

Prairie rose – Idaho fescue: Red-listed

***At-risk[80] vertebrates of grasslands***

American Badger (*Taxidea taxus*): Endangered, Red-listed

Lewis's Woodpecker (*Melanerpes lewis*): Threatened, Red-listed

Common Nighthawk (*Chordeiles minor*): Threatened

Great Basin Spadefoot (*Spea intermontana*): Threatened, Blue-listed

Northern Rubber Boa (*Charina bottae*): Blue-listed

Western Skink (*Eumeces skiltonianus*): Special Concern, Blue-listed

[79] Ecological communities that are provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.

[80] Vertebrate species that are nationally ranked as endangered, threatened, or of special concern, and those provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.

- **Highly threatened**: Human developments, forest encroachment, overuse by domestic livestock and invasive plants threaten grasslands. Grasslands are recognised as one of British Columbia's most threatened ecosystems[81]. Only 8% of the grasslands in the province are protected[82].
- **Rarity**: All grassland native plant communities are listed by the B.C. Conservation Data Centre (see above).
- **High biodiversity**: Grasslands and shrublands support a unique assemblage of species that includes a high proportion of at-risk species. Grasslands ecosystems are used by many species that are restricted to the limited distribution of grasslands in BC.
- **Sensitivity to disturbance**: Grasslands are very sensitive to disturbances including off-road vehicle use and mountain biking, and intensive livestock grazing, and recovery can take many decades. Disturbance to grassland soils can damage the fragile microbiotic crust, and can allow the introduction and spread of invasive alien plants, which can slow or limit recovery.
- **Social values**: Grasslands provide opportunities for education, wide open spaces for walking and hiking, wildlife viewing, and aesthetic enjoyment. Grasslands are particularly attractive in spring with their vibrant display of wildflowers. The open, natural spaces that grasslands provide can add to real estate values in adjacent areas, and can draw tourists into the area. Grasslands have many important traditional-use plants for First Nation peoples.

[81] Canadian Parks and Wilderness Society 1996
[82] Grasslands Conservation Council of B.C. 2002

## Status

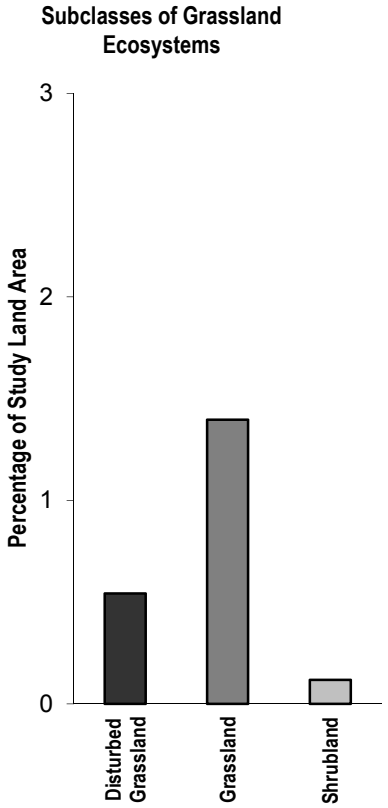


**Figure 10. Percentage of study land area in different subclasses of grassland ecosystems.**

Grassland ecosystems covered 2% (100 hectares) of the study area. The majority of these were grasslands (68 ha), with some disturbed grasslands (26 ha) and a very small area of shrublands (6 ha) (see Figure 10).

All grassland ecosystems are a high priority for conservation considering their rarity and ecological importance.

## Management Recommendations[83]

General management recommendations for all sensitive ecosystems are found in Section 7.4 (page 31). Below are additional management recommendations specific to grassland ecosystems.

### Avoid Direct and Indirect Impacts

- **Manage access**. All motorized vehicles should be restricted to existing roads. Mountain bikes should be restricted to existing or carefully planned trails that are free of invasive plants, and not subject to erosion; otherwise, these trails should be closed until invasive plant problems have been controlled. Trails can create erosion problems, disturb fragile vegetation, and spread or introduce invasive alien species. Existing trails with erosion problems need to be rehabilitated and restored.
- **Protect large old trees and snags.** Scattered trees or snags are extremely important for wildlife in grassland areas. These trees can be isolated structures in grassland areas.
- **Manage livestock use**. Livestock grazing needs to be carefully managed to ensure that ecological values associated with grassland ecosystems are maintained. Season-long grazing damages bunchgrasses. Excessive grazing that increases the cover of bare soil can also promote the spread of invasive plants. Careful monitoring should be implemented to ensure that grazing levels and timing meet management objectives for the site.
- **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.

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

## Plan Land Development Carefully

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

- **Maintain native grassland ecosystems and their wildflowers** by encouraging landowners and developers to maintain natural sites, and landscape with native species adapted to local conditions. Native plant gardening can help create wildlife habitat, and minimize the need to water or irrigate.

# 11 Coniferous Woodlands

## What are coniferous woodland ecosystems?

Coniferous woodland ecosystems in the study area had open coniferous tree canopies. They occurred on steep warm aspects, rocky knolls and shallow soils where limited moisture or shallow soil limited tree establishment. These ecosystems had scattered Douglas-fir trees, some ponderosa pine and scattered shrubs and patches of grasses and forbs.

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

**Table 9. Structural stages of coniferous woodland ecosystems.**

| Code | Name | Definition |
|---|---|---|
| WD:3 | Shrub/herb | Shrub cover 20% or greater, tree cover less than 10% |
| WD:4 | Pole sapling | Trees are >10m tall & 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 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* |
| birch-leaved spirea | ** | *Spirea betulifolia* |
| common snowberry | ** | *Symphoricarpos albus* |
| **Grasses** | | |
| pinegrass | ** | *Calamagrostis rubescens* |
| bluebunch wheatgrass | ** | *Pseudoroegneria spicata* |
| **Forbs** | | |
| silky lupine | ** | *Lupinus sericeus* |
| **Lichens** | | |
| 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.

## 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.

***At-risk[84] ecological communities of coniferous woodlands***

Douglas-fir / shrubby penstemon – pinegrass: Blue-listed

***At-risk[85] vertebrates of coniferous woodlands***

American Badger (*Taxidea taxus*): Endangered, Red-listed
Lewis's Woodpecker (*Melanerpes lewis*): Threatened, Red-listed
Common Nighthawk (*Chordeiles minor*): Threatened
Great Basin Spadefoot (*Spea intermontana*): Threatened, Blue-listed
Northern Rubber Boa (*Charina bottae*): Blue-listed
Western Skink (*Eumeces skiltonianus*): Special Concern, Blue-listed
Flammulated Owl (*Otus flammeolus*): Special Concern, Blue-listed
Townsend's Big-eared Bat (*Corynorhinus townsendii*): Blue-listed

- **At-risk status**: Some coniferous woodland ecological communities have at-risk status (see above).
- **High biodiversity**: Coniferous woodland ecosystems are diverse and support a rich assemblage of species. The open nature of these forests provides deer with good visibility from predators and provides habitat for many grassland species that do not tolerate closed forests. Coniferous woodland ecosystems on shallow soil sites with exposed bedrock often provide denning habitat for snakes and lizards.
- **Specialised habitats**: Scattered large, old trees and snags, and cracks and crevices in 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.

[84] Ecological communities that are provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.
[85] Vertebrate species that are nationally ranked as endangered, threatened, or of special concern, and those provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.

## Status

The types of coniferous woodland ecosystems found in the study area have a limited distribution in the dry interior valleys of southern British Columbia. Historically, these ecosystems likely occurred on steep warm aspects and in areas with shallow soils in the study area. Most coniferous woodland ecosystems have been altered by disturbances such as logging, forest ingrowth, and invasive alien plants. Coniferous woodland ecosystems were relatively common in the study area (9% of study area; 432 ha).

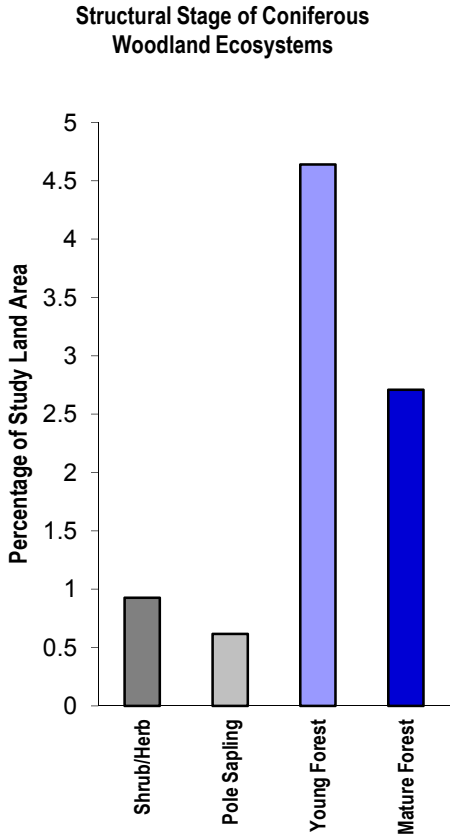


**Figure 11. Percentage of study land area in different coniferous woodland structural stages.**

Most coniferous woodland ecosystems were young forests (52%). Mature coniferous woodlands (30%) should have the highest priority for conservation.

## Management Recommendations

General management recommendations for all sensitive ecosystems are found in Section 7.4 (page 31). Below are additional management recommendations specific to coniferous woodland ecosystems.

### Avoid Direct and Indirect Impacts

- **Prevent soil disturbances**. Coniferous woodlands often have shallow soils that are sensitive to disturbance. Soil disturbance can allow invasive plants to establish and spread and can make it difficult for native plants to re-establish.

- **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 smaller trees to restore forest densities to the low tree densities of the late 1800's. Following thinning, initial prescribed burns should be conducted to consume unnaturally heavy fuels. Prescribed burning should be planned and conducted by qualified professionals.

  Prescribed fire may be too dangerous to conduct on small, private lots. Landowners can reduce the risk of wildfire and maintain some of the ecological functioning of coniferous woodland ecosystems on their land by raking and removing fuels from beneath trees, and by cutting and removing small trees.

# 12 Sparsely Vegetated

## What are sparsely vegetated ecosystems?

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

Sparsely vegetated ecosystems were subdivided into two subtypes: rock and talus ecosystems; these are described below.

***Rock (SV:ro)***

Rock outcrop ecosystems occurred on areas of exposed rock that had very little soil development and sparse vegetation cover. (Photo from near Vernon, probably less grass cover in this study area)

***Talus (SV:ta)***

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

### *Vegetation*

| | Rock | Talus | |
|---|---|---|---|
| **Shrubs** | | | |
| saskatoon | * | * | *Amelanchier alnifolia* |
| oceanspray | * | ** | *Holodiscus discolor* |
| mock orange | | ** | *Philadelphus lewisii* |
| **Forbs** | | | |
| selaginella | ** | | *Selaginella* spp. |
| cliff fern | | * | *Woodsia* spp. |
| shrubby penstemon | | * | *Penstemon fruticosus* |

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

## Why are they important?

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

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

Saskatoon – mock orange talus

***At-risk[86] vertebrates of sparsely vegetated ecosystems***

Northern Rubber Boa (*Charina bottae*): Blue-listed
Western Skink (*Eumeces skiltonianus*): Special Concern, Blue-listed
Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*): Blue-listed

- **Rarity**: one sparsely vegetated ecological community has been recommended for rare status (see above).
- **Specialised habitats**: A variety of specialised habitats are found in sparsely vegetated ecosystems. A number of species, including many at-risk species are dependant on these habitats. Rock ecosystems with deep crevices, and some talus slopes provide roosting or hibernacula sites for a variety of snake, lizard and bat species. Isolated trees provide important roosting or nesting sites for Lewis' woodpeckers and raptors.
- **Fragility**: Sparsely vegetated sites are sensitive to disturbance. They can take very long periods of time to recover, or never if soil or rock is removed or eroded.
- **Social values**: Sparsely vegetated ecosystems often provide focal points in the landscape for scenic viewpoints, wildlife viewing, and aesthetic enjoyment. They can add to real estate values in adjacent areas, and can draw tourists into the area.

## Status

Sparsely vegetated ecosystems were very rare and covered only 0.3% (13 ha) of the study area land base. In the study area, rock ecosystems covered 8 ha; and talus sites covered 5 ha.

## Management Recommendations

General management recommendations for all sensitive ecosystems are found in Section 7.4 (page 31). Below are additional management recommendations specific to sparsely vegetated ecosystems.

### Avoid Direct and Indirect Impacts

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

[86] Vertebrate species that are Nationally ranked as endangered, threatened, or of special concern, and those Provincially Red-listed (endangered or threatened) or Blue-listed (special concern), as of December 2011, are noted.

causes mortality to wildlife species that rely on these ecosystems. Road access should be avoided and rock climbing should be carefully managed on cliffs. ***Do not develop trails*** on sparsely vegetated ecosystems. Trails can create erosion problems, disturb fragile vegetation, and spread or introduce invasive alien species.

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

### Plan Land Development Carefully

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

- **Protect endangered, threatened, or vulnerable species or ecological communities, and habitat features** that were identified during the planning and inventory stages by addressing the following recommendation:
  - avoid disturbance of rock debris.

# 13 Mature Forest

## What are mature forest ecosystems?

Mature forest ecosystems were mapped where polygons included structural stage 6 forests[87] (mature forest), except for mature riparian and coniferous woodland forests, which were included in the riparian and coniferous woodland categories respectively.

Historically, most forests in the upland areas of the drier part of the study area (Interior Douglas-fir) had open overstories. These open forests were maintained by frequent surface fires that killed most small trees and allowed few trees into the overstory. Overstories were generally open, multi-aged, and had a largely single-layered canopy of mostly large, old trees. The understory of mature forests was open and dominated by grasses and shrubs. Frequent fire also limited the occurrence of dead wood; only scattered large snags and large, downed wood occurred.

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

Within the wetter portion of the study area (Interior Cedar – Hemlock), fire was less frequent and likely had more crown fires and fewer surface fires. This allowed older forests to become multi-layered and more closed.

[87] Refer to Volume 2 (Iverson and Uunila 2012) for details on structural stage 6.

Mature forest ecosystems were divided into two subclasses based on the composition of the trees in the forest: coniferous, and mixed mature forest ecosystems.

### *Coniferous mature forest ecosystems*

Coniferous mature forests in the study area were dominated by Douglas-fir, western larch, with western redcedar and western hemlock in the wetter parts of the study area. These forests occurred on sites with a wide range of ecological conditions. Most sites had a scattered grasses, forbs, and shrubs in the understory.

### *Mixed mature forest ecosystems*

In the study area, mixed mature forests had both coniferous and broadleaf tree species, primarily paper birch. These ecosystems occurred on slightly moister sites than coniferous mature forest ecosystems and had shrubby understories with scattered grasses and forbs. They differ from riparian ecosystems in that they do not occur in a gully or adjacent to a creek, wetland, pond, or lake.

## *Vegetation*

| | | Coniferous | Mixed | |
|---|---|---|---|---|
| **Trees** | | | | |
| | Douglas-fir | ** | ** | *Pseudotsuga menziesii* |
| | western redcedar | ** | ** | *Thuja plicata* |
| | western hemlock | ** | ** | *Tsuga heterophylla* |
| | paper birch | * | ** | *Betula papyrifera* |
| **Shrubs** | | | | |
| | common snowberry | ** | *** | *Symphoricarpos albus* |
| | tall Oregon-grape | ** | ** | *Mahonia aquifolium* |
| | thimbleberry | * | ** | *Rubus parviflorus* |
| | black huckleberry | * | ** | *Vaccinium membranaceum* |
| **Grasses** | | | | |
| | blue wildrye | | * | *Elymus glaucus* |
| **Forbs** | | | | |
| | sarsaparilla | ** | ** | *Aralia nudicaulis* |
| | queen's cup | ** | ** | *Clintonia uniflora* |
| **Mosses** | | | | |
| | red-stemmed feathermoss | ** | ** | *Pleurozium schreberi* |
| | step moss | ** | ** | *Hylocomnium splendens* |

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

## Why are they important?

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

***At-risk[88] vertebrates of mature forests***

Olive-sided Flycatcher (*Contopus cooperi*): Threatened, Blue-listed

Flammulated Owl (*Otus flammeolus*): Special Concern, Blue-listed

Little Brown Myotis (Myotis lucifugus): Emergency Endangered

Townsend's Big-eared Bat (B) (*Corynorhinus townsendii*): Blue-listed

- **Future old forest ecosystems**: With the exception of some riparian forests, old forest ecosystems have been eliminated from the study area. With proper restoration, mature forests can, over time, become old forest ecosystems. However, removal of forest ingrowth in drier areas is required to develop old forest ecosystems.
- **Biodiversity**: Mature forest ecosystems have many important structural attributes, including some remaining large, old trees and snags, which provide habitat for many species. Broadleaf trees in mixed mature forest provide additional cavity-nesting opportunities for many species.
- **Landscape connectivity:** Mature forests provide buffers, and connectivity between other ecosystems.
- **Social values**: Mature forests provide opportunities for education, recreation, wildlife viewing, and aesthetic enjoyment. The natural areas that mature forests provide can add to real estate values in adjacent areas. Mature forests provide opportunities for selective logging.

## Status

Mature forest ecosystems covered 4.4% (216 ha) of the study area. Most mature forest ecosystems in the drier part of 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 (205 ha); only 11 ha were mixed.

## Management Recommendations[89]

### Avoid Direct and Indirect Impacts

- **Restore and maintain ecological structures and functions**. Restoration requires understanding of historical disturbance regimes (particularly fire), and of the structure of these forests prior to fire exclusion and logging. A qualified professional should develop a detailed restoration plan.

[88] Vertebrate species that are nationally ranked as endangered, threatened, or of special concern, and those provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.

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

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

Prescribed fire may be too dangerous to conduct on small, private lots. Landowners can reduce the risk of wildfire and maintain some of the ecological functioning of mature forest ecosystems on their land by raking and removing fuels from beneath trees, and by cutting and removing small trees.

# 14 Seasonally Flooded Agricultural Fields

## What are seasonally flooded agricultural field ecosystems?

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

## Why are they important?

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

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

***At-risk vertebrates[90] of Seasonally Flooded Agricultural Fields***

American Badger (*Taxidea taxus*): Endangered, Red-listed
Common Nighthawk (*Chordeiles minor*): Threatened
Barn Swallow (*Hirundo rustica*): Threatened, Blue-listed
Bobolink (*Dolichonyx oryzivorus*): Threatened, Blue-listed
Great Basin Spadefoot (*Spea intermontana*): Threatened, Blue-listed
Western Toad (*Anaxyrus boreus*): Special Concern, Blue-listed
Northern Rubber Boa (*Charina bottae*): Blue-listed
Great Blue Heron (*Ardea herodias herodias*): Blue-listed
Little Brown Myotis (Myotis lucifugus): Emergency Endangered
Townsend's Big-eared Bat (*Corynorhinus townsendii*): Blue-listed

## Status

Seasonally flooded agricultural fields occupied 18 ha or 0.4% of the land base in the study area.

## Management Recommendations

[90] Vertebrate species that are nationally ranked as endangered, threatened, or of special concern, and those provincially red-listed (endangered or threatened) or blue-listed (special concern) as of December 2011 are noted.

## Avoid Direct and Indirect Impacts

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

# 15 Future Directions

The Middle Shuswap River SEI provides an essential planning tool for the study area, and an important source of information for similar ecosystems that occur elsewhere in the region.

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 including the protected areas on crown lands. The *Shuswap River Watershed Sustainability Plan*[91] could fulfill part of this strategy, which could be nested within the *Okanagan Biodiversity Conservation Strategy*[92] for the Okanagan Valley (including all lands within the North Okanagan Regional District). Conservation priorities identified in this conservation analysis and *Biodiversity Conservation Strategy* can together provide the basis of a property acquisition, covenant and stewardship strategy.

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

This SEI and the landscape level ecosystem plan for this area should be used to modify the Regional District of North Okanagan's Official Community Plans. Sensitive and Other Important Ecosystems should be designated as Development Permit Areas within the Official Community Plans. The SEI map and conservation analysis can be used to guide zoning designations within the study area.

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

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[91] http://www.rdno.ca/index.php/services/planning-building/planning-projects/shuswap-river-watershed-sustainability-plan

[92] "The OCCP [Okanagan Collaborative Conservation Program] aims to build on the work done by the South Okanagan Similkameen Conservation Strategy (SOSCP) to complete a biodiversity conservation strategy for the north and central Okanagan, with a goal of having a complete strategy for the Okanagan Basin. This is an environmental policy framework that sets priorities for identifying, preserving and restoring important natural areas. It promotes a landscape view of the region and provides a framework for considering conservation options for entire ecosystems and watersheds that go beyond municipal or rural boundaries and includes all land-tenures."
http://okcp.ca/index.php?option=com_mtree&task=viewlink&link_id=136&Itemid=513

# References


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.

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., K. Knuever, K. Iverson, M. Sarell, and A. Haney. 2004. Balanced growth for the Bella Vista – Goose Lake Range: a demonstration of landscape planning and urban growth in the North Okanagan. Report prepared for the Allan Brooks Nature Centre.

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.

Government of Canada. 2003. *Species at Risk Act*, an Act respecting the protection of wildlife species at risk in Canada. Assented 12 December 2002. Came into force 5 June 2003.

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

Haney, A. 2012. Sensitive Ecosystems Inventory: Middle Shuswap River, 2011. Volume 3: Wildlife Habitat Mapping. Unpub. report prepared for the Fish and Wildlife Conservation Program.

Iverson, K. 2008. Sensitive Ecosystems Inventory: Coldstream – Vernon, 2007. Volume 1: Methods, Ecological Descriptions, Results and Management Recommendations. Unpub. report prepared for the Allan Brooks Nature Centre.

Iverson, K. 2006. Sensitive Ecosystems Inventory: District of Lake Country, 2005. Volume 1: Methods, Ecological Descriptions, Results and Management Recommendations. Unpub. report prepared for the District of Lake Country and the BC Ministry of Environment.

Iverson, K. 2005. Sensitive Ecosystems Inventory: Vernon Commonage, 2005. Volume 1: Methods, Ecological Descriptions, Results and Management Recommendations. Unpub. report prepared for the Ministry of Environment and the Allan Brooks Nature Centre.

Iverson, K. 2003. Sensitive Ecosystems Inventory: Bella Vista – Goose Lake Range, 2002. Volume 1: Methods, Ecological Descriptions, Results and Management Recommendations. Unpub. report prepared for the Okanagan Indian Band and Allan Brooks Nature Centre.

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., D. Curran, T. Fleming, and A. Haney. 2008. Sensitive Ecosystems Inventory – Okanagan Valley: Vernon to Osoyoos, 2000 – 2007. Volume 1: Methods, Ecological Descriptions, Results and Conservation Tools. Technical Report Series No. 495, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

Iverson, K., and P. Uunila. 2012. Sensitive Ecosystems Inventory: Middle Shuswap River, 2011. Volume 2: Terrestrial Ecosystem Mapping, Terrain Mapping, and Expanded Legend. Unpub. report prepared for the Fish and Wildlife Conservation Program.

Iverson, K., and P. Uunila. 2008. Sensitive Ecosystems Inventory: Coldstream – Vernon, 2007. Volume 2: Terrestrial Ecosystem Mapping, Terrain Mapping, and Expanded Legend. Unpub. report prepared for the Allan Brooks Nature Centre.

MacKenzie, W. H. and J. R. Moran. 2004. Wetlands of British Columbia: a guide to identification. Land management handbook no. 52. B.C Ministry of Forests. Victoria, B.C.

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.

Ministry of Environment Ecosystems Branch. 2006. Standard for Mapping Ecosystems at Risk: An Approach to Mapping Ecosystems at Risk and Other Sensitive Ecosystems. Version 1.0. Victoria, B.C.

Minor, T. 2007. Middle Shuswap Sensitive Ecosystem Inventory and Sensitive Habitat Inventory Mapping Project: 06.SHU.03. Unpub. report prepared for the Whitevalley Community Resource Centre Society. Available at: www.bchydro.com/bcrp/projects/docs/06SHU03.pdf

Pojar, J., K. Klinka, and D.V. Meidinger. 1987. Biogeoclimatic ecosystem classification in British Columbia. Forest Ecology and Management 22:119-154.

Relyea, R.A. 2005. The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. Ecological Applications 15(2): 618–627.

Resources Inventory Committee (RIC). 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Victoria, B.C. http://ilmbwww.gov.bc.ca/risc/pubs/teecolo/index.htm

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.

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

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.

# Appendix A: SEI Data

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

The following are available:

- project metadata
- non-spatial polygon attributes
- TEM report with expanded legend (Volume 2)[93]
- TEM and SEI map legends
- wildlife species accounts
- wildlife ratings tables
- wildlife report (Volume 3)[94]
- Arc/Info *.e00 Export Files includes two spatial coverages: ECI field sampling points and a ECP TEM polygon coverage

[93] Iverson and Uunila 2008
[94] Haney and Sarell 2008

# Appendix B: Sensitive Ecosystems (SEI) Units[95] and related Terrestrial Ecosystem Mapping (TEM) units.

## Sensitive Ecosystems

| SEI Unit (Class, subclass) | SEI Code | TEM Unit Name | Map Code[96] | Subzone / Site Series |
|---|---|---|---|---|
| **Grasslands, disturbed** | GR:dg | Bluebunch wheatgrass – Balsamroot | WB:$cg | IDFmw1 /00 |
| **Grassland, grassland** | GR:gr | Idaho fescue – Bluebunch wheatgrass | FW | IDFmw1 /00 |
| | | Bluebunch wheatgrass – Balsamroot | WB | IDFmw1 /00 |
| **Grassland, shrubland** | GR:sh | Prairie Rose – Idaho fescue | RF | IDFmw1 /00 |
| **Riparian, fringe** | RI:ff | Western redcedar / Douglas-fir - Dogwood | RR, RRc, RRn | IDFmw1 /05 |
| **Riparian, fluvial plain** | RI:fp | Mountain alder – common horsetail low bench | FI01 | ICHmw2 /FI01<br>IDFmw1 /FI01 |
| | | Cottonwood – spruce – red-osier dogwood middle bench | Fm02 | ICHmw2 /FI01<br>IDFmw1 /FI01 |
| | | Western hemlock/western redcedar – falsebox – feathermoss | HF$ft | ICHmw2 /01 |
| | | Western redcedar/western hemlock – devil's club – sarsaparilla | RDa, RDt | ICHmw2 /05 |
| | | Douglas-fir / western redcedar – falsebox – prince's pine | DF$ft | IDFmw1 /01 |
| | | Western redcedar / Douglas-fir - Dogwood | RRa, RRt | IDFmw1 /05 |
| **Riparian, gully** | RI:gu | Western redcedar / Douglas-fir - Dogwood | RRg | IDFmw1 /05 |
| | | Western redcedar/western hemlock – oak fern - foamflower | HOg | ICHmw2 /04 |
| **Riparian, river** | RI:ri | Gravel bar | GB | IDFmw1 /00<br>ICHmw2 /00 |
| | | River | RI | IDFmw1 /00<br>ICHmw2 /00 |
| **Sparsely Vegetated, rock outcrop** | SV:ro | Rock outcrop | RO | ICHmw2 /00<br>IDFmw1 /00 |
| **Sparsely Vegetated, talus** | SV:ta | Saskatoon – Mock orange talus | SO | IDFmw1 /00 |
| | | Talus | TA | ICHmw2 /00 |
| **Coniferous Woodland** | WD:co | Douglas-fir/western redcedar – falsebox – prince's pine | DF | ICHmw2 /02 |
| | | Douglas-fir / Ponderosa – Snowberry – Bluebunch wheatgrass | DS | IDFmw1 /02 |
| | | Douglas-fir – Penstemon - Pinegrass | PP | IDFmw1 /03 |
| **Wetland, marsh** | WN:ms | Bluejoint – glowmoss | BJ | ICHmw2 /08 |
| | | Sedge marsh | SE | IDFmw1 /00 |
| **Wetland, shallow open water** | WN:sw | Shallow open water | OW | ICHmw2 /00<br>IDFmw1 /00 |

[95] See page 5 for SEI unit descriptions.

[96] All site modifiers, structural stages and stand composition modifiers are included unless otherwise noted. Structural stages are indicated by a number (e.g. '6'). Structural stage stand composition modifiers are indicated by a capital letter after the number (e.g., 'C' in '6C'). See Volume 2 (Iverson and Uunila 2012) for descriptions of site modifiers, structural stages, seral associations, and map units.

## Other Important Ecosystems

| SEI Unit | Code | TEM Unit | Map Code[97] | Subzone / Site Series |
|---|---|---|---|---|
| **Seasonally Flooded Fields** | FS | Cultivated Field | CFa | IDFmw1 /00 |
| **Mature Forest, coniferous** | MF:co | Western hemlock/western redcedar – falsebox – feathermoss | HF 6C | ICHmw2 /01 |
| | | Western redcedar/Douglas-fir – falsebox | RF 6C | ICHmw2 /03 |
| | | Douglas-fir / western redcedar – falsebox – prince's pine | DF 6C | IDFmw1 /01 |
| | | Douglas-fir – Pinegrass – Feathermoss | DP 6C | IDFmw1 /04 |
| **Mature Forest, mixed** | MF:mx | Western redcedar/western hemlock – oak fern - foamflower | HO 6M | ICHmw2 /04 |
| | | Douglas-fir / Western redcedar – Falsebox – Prince's pine | DF 6M | IDFmw1 /01 |

[97] All site modifiers are included unless otherwise noted.

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

| Common Name | Scientific Name | Occurrence in Study Area | Prov. Status | Federal Status |
|---|---|---|---|---|
| **Amphibians** | | | | |
| Great Basin Spadefoot | *Spea intermontana* | unknown but possible (know from Lumby) | Blue | Threatened |
| Western Toad | *Anaxyrus boreas* | one location, and several others near study area | Blue | Special Concern |
| **Reptiles** | | | | |
| Painted Turtle | *Chrysemis picta* | one location, likely elsewhere | Blue | Special Concern |
| Western Skink | *Eumeces skiltonianus* | three locations in one area | Blue | Special Concern |
| Rubber Boa | *Charina bottae* | two locations in one area | - | Special Concern |
| **Birds** | | | | |
| Great Blue Heron | *Ardea herodias herodias* | unknown but likely | Blue | - |
| Western Screech-owl | *Megascops kennicotti macfarlanei* | numerous locations | Red | Endangered |
| Flammulated Owl | *Otus flammeolus* | unknown but likely | Blue | Special Concern |
| Common Nighthawk | *Chordeiles minor* | likely throughout in open areas | - | Threatened |
| Lewis' Woodpecker | *Melanerpes lewis* | unknown but possible | Red | Threatened |
| Olive-sided Flycatcher | *Contopus cooperi* | unknown but likely | Blue | Threatened |
| Barn Swallow | *Hirundo rustica* | likely throughout, in open and rural areas | Blue | Threatened |
| Bobolink | *Dolichonyx oryzivorus* | one location, likely elsewhere | Blue | Threatened |
| **Mammals** | | | | |
| Little Brown Myotis | *Myotis lucifugus* | likely throughout | - | Emergency Endangered |
| Townsend's Big-eared Bat | *Corynorhinus townsendii* | one location | Blue | - |
| American Badger | *Taxidea taxus* | scattered records throughout | Red | Endangered |
| Grizzly Bear | *Ursus arctos* | likely throughout, in very low numbers | Blue | Special Concern |