Sensitive Ecosystem Inventory (SEI)

For the **East Gate**, **Otter Lakes** and **Chain Lakes** areas Regional District of Okanagan South (RDOS)

For
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EXECUTIVE SUMMARY

Three areas of interest were mapped for sensitive ecosystems using standard SEI methodology (RISC 2006), East Gate, Otter Lakes and Chain Lakes. Approximately 25% of the total area mapped was classified as belonging to a sensitive ecosystem. The sensitive ecosystems mapped were Broadleaf and Coniferous Woodlands, Seasonally Flooded Fields, Grasslands, Mature Forest, Riparian, Sparsely Vegetated, and Wetlands.

A field survey of 15% of the mapped sensitive areas was completed to verify the mapping and detailed vegetation and soils data was collected using DTEIF (1998) standards.

Species at risk in the area identified by the Conservation Data Center include invertebrates, fish, reptiles, amphibians, mammals and plants. These are identified and their potential habitat related to the sensitive ecosystem classes.

Conservation measures suggested for these areas include careful planning, sensitive ecosystem buffers, avoiding direct impact by development, restoration of natural disturbance regimes, and reduction of wildfire threat.

1.0 INTRODUCTION

The Regional District Okanagan-Similkameen (RDOS) tendered a Sensitive Ecosystem Inventory (SEI) mapping project for Area H of Rural Princeton. The primary objective of the mapping is to provide baseline information to direct land use planning for parts of Electoral Area "H" by the RDOS. The products include sensitive ecosystem maps, interpretative maps (which identify some of the Federal Species at Risk that are known or presumed to use the ecosystems), a report identifying the methods, descriptions of the ecosystems, associated species at risk, results and any conservation and management recommendations, and two community presentations coordinated with the Official Community Plan (OCP) process.

According to the Ministry of Environment's Sensitive Ecosystem Inventory site (http://www.env.gov.bc.ca/sei/index.html), the SEI identifies and maps rare and fragile ecosystems in a given area. Its purpose is to identify remnants of rare and fragile terrestrial ecosystems and to encourage land-use decisions that will ensure the continued integrity of these ecosystems. SEI is a flagging tool that provides scientific information and support to local governments and others working to maintain biodiversity.

The total area of the Princeton SEI project is approximately 19,800 ha, which includes three separate areas of interest:

1. East Gate – approximately 2,455 ha
2. Chain Lakes Corridor – approximately 10,605 ha
3. Otter Lake – approximately 6,650ha

The SEI project area lies within a dry to very dry climate, as expressed by the biogeoclimatic (BGC) units mapped in each subunit are, in order of total area: IDFdk2, IDFxh1, IDFdk1, MSdm2, IDFxh1a, IDFdk2b, and MSmw1. The IDFxh1 is particularly sensitive with a combination of important SEI units like grasslands, riparian and woodland forests many of which area identified as red and blue listed ecosystems by the Conservation Data Center of British Columbia. The mapping areas also have extensive private land holdings, especially in areas adjacent to the lakes and rivers, which will be subject to development pressures.

1.1 The Project Area

Princeton is located at the confluence of the Similkameen and Tulameen Rivers. The valley floor of the Similkameen River continues toward the Okanagan Valley and the two valleys are only separated by a low elevation pass near Osoyoos. The project area represents the western extent of the Very Dry Hot BEC variant of the Interior Douglas-fir Zone in the local area, this variant extends to Osoyoos. The project area is unique in its location in the lee of the Coast Range. Figure 1 shows the location of the three areas of interest mapped by this project relative to Princeton and the Okanagan Valley and other existing SEI projects. Although continuous mapping of sensitive ecosystems would be preferable between the Okanagan and areas where development pressure is greatest along valley floors, resources predicate discontinuous mapping. The three areas of interest mapped in this project represent a prioritization of mapping areas by the Regional District of the South Okanagan within Electoral Area H.

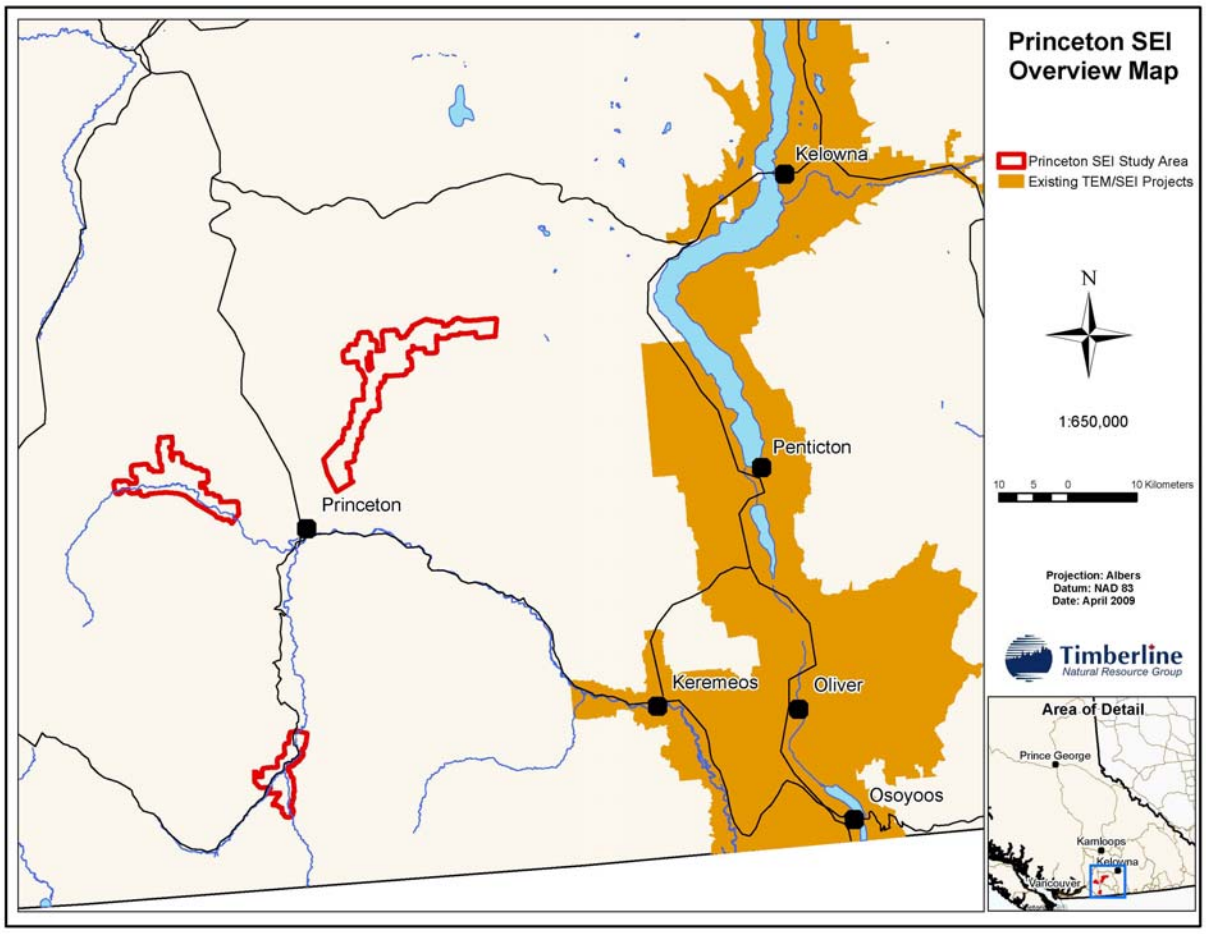


Figure 1. Location of the Princeton SEI mapping project, relative to existing SEI mapping projects in the Okanagan Valley.

The three areas of interest represent locations where recreational development pressure is increasing and development permits need to recognize ecological sensitivities through inventories of sensitive ecosystems and the habitat they represent for species at risk.

1.1.1 Biogeoclimatic Variant Distribution Within SEI Areas of Interest

Figure 2 depicts the mapping areas superimposed on the BEC subzone and variant classification (BEC7) and shows the diversity of climates, represented by the BEC variants, found in the local area. The areas of interest represent a diversity of biogeoclimatic subzones and ecosystems, many of the ecosystems that occur there are not considered sensitive or at risk, but a significant percentage are and it is critical to know where they are located. Table 1 shows the area of each BEC variant by sub-area.

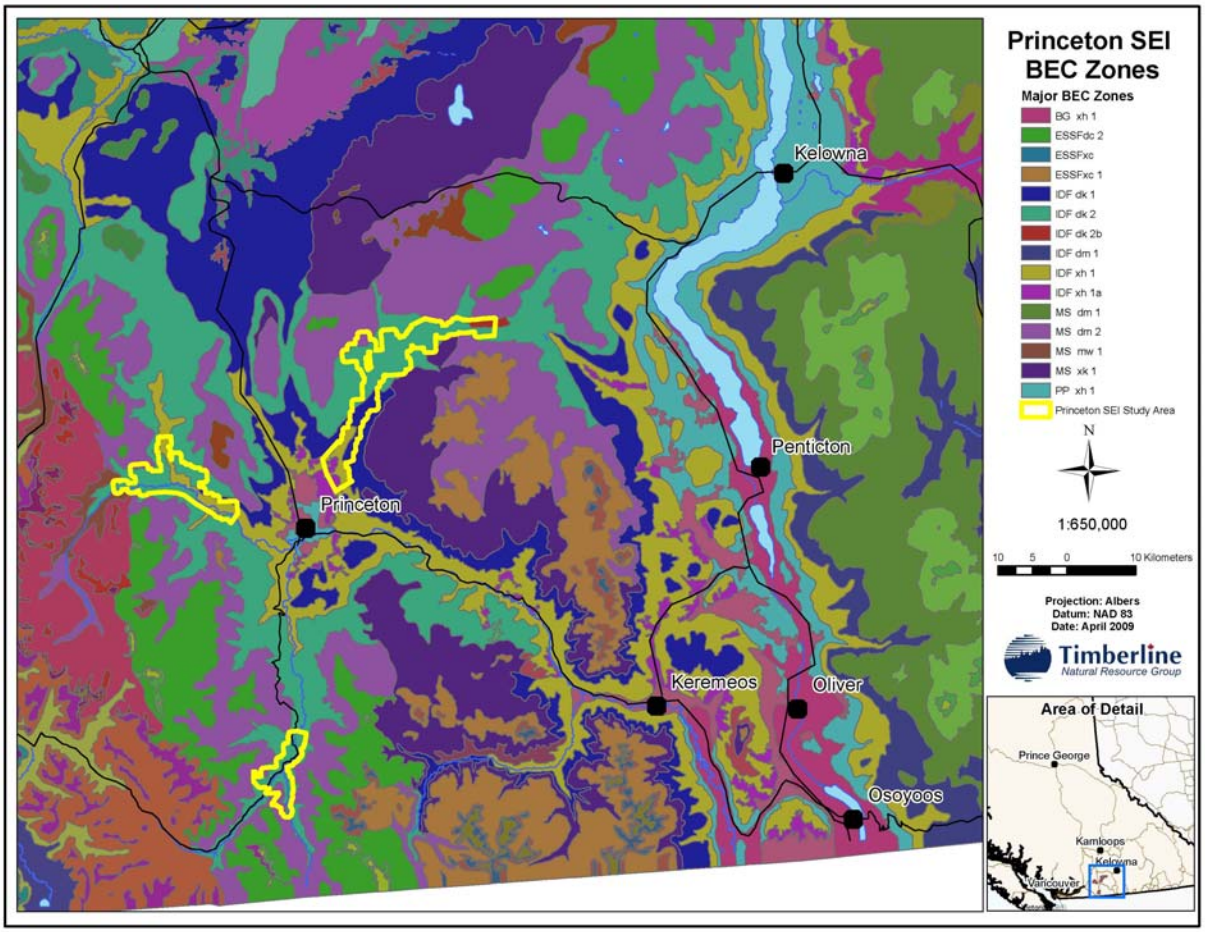
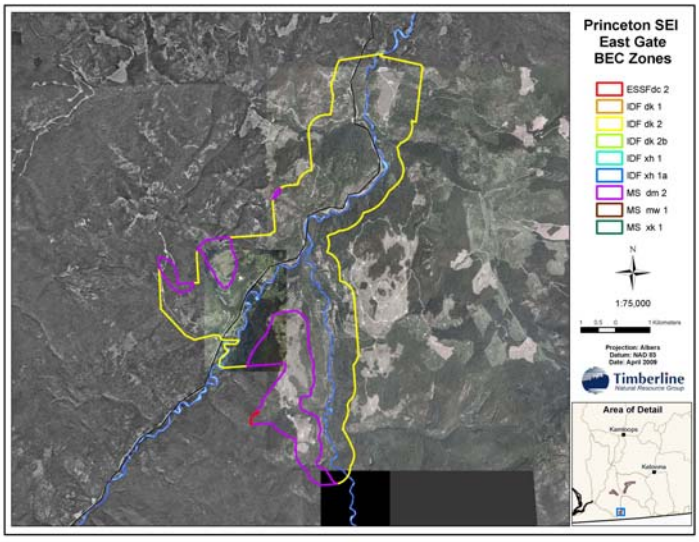


Figure 2. Princeton SEI areas of interest and BEC7 variants.

BEC variant	Mapping Area Name	Area
IDFdk2	East Gate	2466.3 ha
MSdm2	East Gate	77.8 ha
IDFdk2	Otter Lake	4016.2 ha
IDFxh1	Otter Lake	2317.8 ha
IDFdk1	Otter Lake	166.9 ha
MSdm2	Otter Lake	150.0 ha
MSmw1	Otter Lake	0.6 ha
IDFdk2	Chain Lake	8023.3 ha
IDFxh1	Chain Lakes	1473.1 ha
IDFxh1a	Chain Lakes	517.3 ha
IDFdk1	Chain Lakes	339.5 ha
IDFdk2b	Chain lakes	211.5 ha

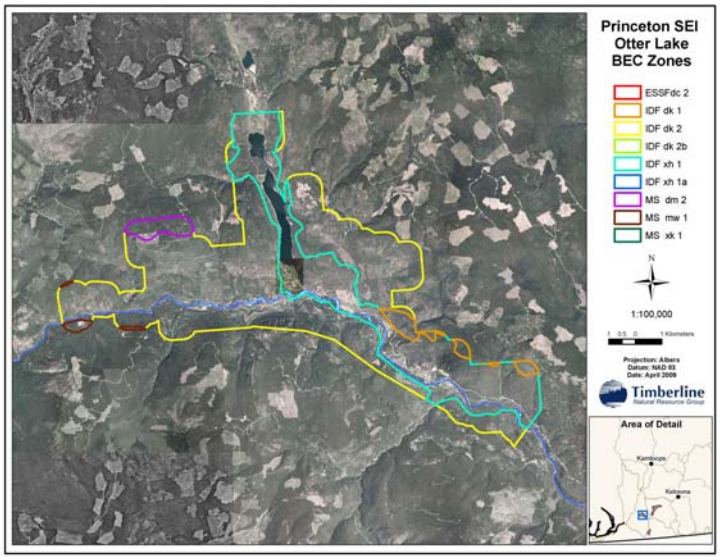
Table 1. BEC variant distribution by SEI subareas.

Figure 3 East Gate Ortho and BEC



In the East Gate area there are two BEC variants represented, the IDFdk2 and the MSdm2. The majority of the mapping area is in the IDFdk2 with the MSdk2 only occurring in a small portion (less than 100 ha).

Figure 4. Otter Lake Ortho and BEC

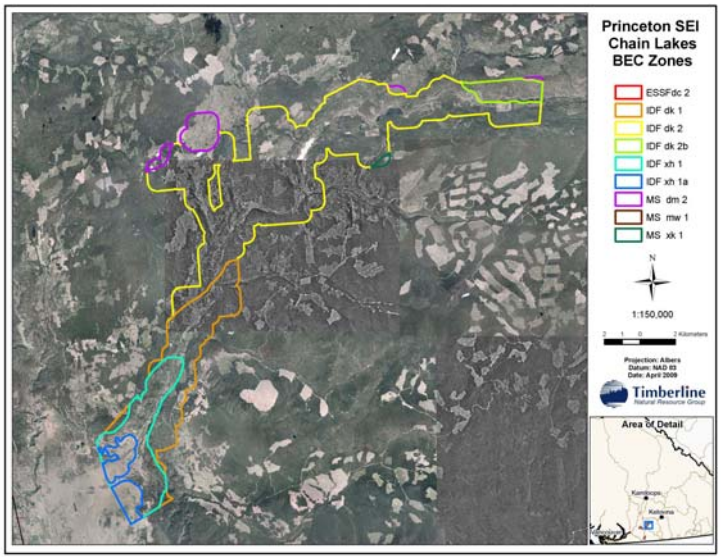


In Otter Lake there are five BEC variants represented. They are the IDFdk2, IDFdk1, IDFxh1, MSdm2 and MSmw1. The MSmw1 occupies an insignificant area of 0.6 ha. The Otter Lake area is more climatically diverse than the East Gate area. The main valley of the Tulameen River has a strong north south aspect with river channel. There is

significantly different ecology on either side of the man river channel. The Otter Lake area has the largest extent of the IDFxh1 of the three mapping areas. This is the hottest and driest BEC variant and is more widely distributed in the Okanagan Valley.

The Chain Lakes area supports six BEC variants they are the IDFdk2, IDFxh1, IDFxh1a, IDFdk1, and IDFdk2b. This area varies from extremely hot and dry at its southwestern limit to dry and cool at its eastern limit. The Chain Lakes area also supports a small area of dry cool Interior Douglas-fir variant grasslands (the IDFdk2b) which is unique to that location.

Figure 5. Chain Lake Ortho and BEC



2.0 METHODS

2.1 Sensitive Ecosystem Classification and Working Legend to BEC Site Series

Eighteen SEI classes and subclasses were mapped in the project area see Table 2. The CDC status of the Lloyd et al 1990 site series classification can be found in Table 3. Sensitive ecosystem classes were linked to the BEC classification of site series which is required within the data base for each polygon via a working legend to the site series which can be found in Appendix A. The working legend provides the detail which allocates each site series to an SEI class and notes the conservation status of the site series as being nil, blue or red. SEI mapping does not label to the level of site series and structural stage, but that data is required within the data base, enabling the client to use it at their discretion.

Note that there have been on-going revisions to the BEC site series classification within the Okanagan area by the MOF. At the request of the Conservation Data Center we used the original site series classification described by Lloyd at al (1990) but used the 2007 version of the Biogeoclimatic subzone variant mapping within which to apply that classification.

Table 2. Sensitive Ecosystem Classes and Subclasses Mapped in the Princeton Area.

SEI Code	SEI Class	Description
BW	**Broadleaved woodlands**	**Ecosystems dominated by Trembling aspen occurring in depressions and moist areas**
BW:ac		Aspen copses
FS	**Seasonally flooded fields**	**Seasonally flooded agricultural fields**
GR	**Grasslands**	
GR:gr		Grasslands
GR:st		Steep Grasslands
GR:ss		Steep, shallow soiled grasslands
MF	**Mature forests**	**A mix of seral and climax tree species generally greater than 80 years old**
MF:co		Mature Forest dominated by conifers
RI	**Riparian**	**Treed or shrubby ecosystems associated with pond and lake shorelines, swamps, floodplains or gullies with intermittent or permanent creeks**
RI:ff		Riparian Fluvial Fringe
RI:sh		Riparian Shrub
RI:fp		Riparian Floodplain
RI:ri		Riparian River
SV	**Sparsely vegetated**	**Ecosystems with little vegetation occurring on bedrock or colluvial features**
SV:ro		Sparsely Vegetated Rock Outcrops
SV:ta		Sparsely Vegetated Talus
WD	**Coniferous woodlands**	**Open stands of Douglas-fir or Ponderosa pine, often on shallow soils with grassy understories, old woodlands are part of the Old Forest category**
WD:co		Coniferous Woodlands
WN	**Wetlands**	**Ecosystems where the water table is at or near the surface.**
WN:ms		Wetland Marsh
WN:sp		Wetland Swamp
WN:sh		Wetland Shrub
WN:wm		Wetland Wet Meadow
WN:wn		Wetland unspecified

Table 3. CDC Status of Lloyd et al 1990 Site Series

BEC variant	BEC Site Series	Map Code	Status
IDFdk2	02, 03	DW, DP	blue
IDFdk2	07	RT	red
IDFxh1	03, 01, 04, 05	DW,DP, DP,PF	blue
IDFxh1	00, 06, 07,08	SD,DF,DS,SD	red
IDFxh1a	94, 98	SF,AS	red
ESSFdc2	04, 07, 03	FG,FV, LF	blue
MSdm2	06, 07	SD, SH	blue
IDFdk1, IDFdk2b, MSmw1, MSxk1,	none		

2.2 Polygon Delineation

Within each BEC variant polygons of similar terrain, soil moisture, directional exposure and structure that support sensitive ecosystems throughout the polygon, or in portions of the polygon, were delineated using the bioterrain principal from TEM methodology. An area was not delineated if it did not support sensitive ecosystems.

Sensitive ecosystem polygons were initially hand drawn on 1:14,000 colour air photos using a pen and stereoscope. Those polygons were captured digitally from the air photos using mono-restitution. The digital polygons were superimposed on ortho-photos and digital contours of the project area and the delineation re-visited using ARCMAP 9.3 to capture more detail to a minimum polygon size of one hectare.

A second objective of delineation on the screen was to broadly capture younger structural stage ecosystems supporting blue-listed site series that were not delineated on the air photos. This delineation of younger blue-listed stands is in addition to the standards for SEI mapping giving more information than required by the minimum standards. It was felt that only delineating mature blue-listed site series would handicap long-term planning for development and it was critical that RDOS know where the younger blue-listed ecosystems occurred.

These polygons may or may not also support sensitive ecosystems at this point in time (if not in a mature forest structure), but are delineated and occur in the SEI data base in the portion of the data base where the site series and structural stage data is located. They are not depicted on SEI mapping unless they are both blue-listed and meet the classification criteria for sensitive (see Table 3), however the spatial data captures these important areas and can be used for other planning purposes at a later date.

2.3 Polygon Attribution

Polygons were assigned a BEC variant using BEC7, a proportion of SEI class and subclass within the polygon (using a decile from one to ten), a site series (Lloyd 1990) and a structural stage using TEM standard nomenclature. Unlike TEM mapping, SEI polygons do not have decile proportions that necessarily add up to 10, if only a portion of the polygon support a sensitive ecosystem. Attribution of polygons was facilitated in ARCMAP 9.3 using the standard SEI data base structure for data entry.

Each polygon was visited three times, once sequentially, within each area of interest, for initial classification and a second time after all the polygons were classified. The second review was to insure that all of the polygons were attributed, that classification was consistent between each area of interest, and that early classification concepts were consistent with later classification concepts. The third review was after field data collection. Each field observation was superimposed on the pre-field polygon delineation and attribution. These observations were compared to the data base and corrections made to the field verified polygons. The entire data base was then reviewed relative to the results of the field verification and adjustments made to the mapping to reflect observations made on similar sites.

The final mapping was sent for in-house third party review by Shikun Ran of Timberline Natural Resource Group in Kelowna and final adjustments made based on his review.

2.4 Field Verification

2.4.1 Field Sampling Plan

Level four field sampling intensity (RIC 2000) was accomplished. Fifteen percent of the 1,338 total polygons were verified on the ground either through detailed plots, ground inspections or visual inspections. One hundred and ninety five field verifications were accomplished between June 12 and 21 2009 by a crew of two. The standard proportion of detailed plots to ground inspections to visual observations of 5:20:75 was achieved through 10 FS882 plots, 39 GIF plots and 146 observations. Each plot FS882 and GIF were photographed.

The sample design was subjective based on the realities of access and relative representation of the sensitive ecosystem unit on the landscape. Every effort was made to sample the full spectrum of SEI units in the three areas of interest.

Sampling was aided by field maps depicting first draft polygon delineation and attribution registered to the ortho-photos showing the BEC variant boundaries, SEI unit, site series and structural stage labels, as well as roads, water features and private land boundaries. The mapping enabled the crew to determine daily sample plans and contingency plans where access became an unanticipated issue.

2.5 Field Data Entry

Field data forms were reviewed by the senior project ecologist and corrections made where necessary. Data was entered into either VENUS 4.2 for FS 882 and GIF plots and into EXCEL spreadsheets for visual observations. Digital photography was stored on cd's as high resolution jpg's.

2.6 Map Digital Delivery Standards and Final Mapping

Spatial and data bases were finalized to meet the digital delivery standards outlined in the SEI standards. (RISC 2006). Using Iverson et al's 2008 SEI map for the Osoyoos area as a template, final maps were generated in ARCMAP 9.3. After discussion with the client about the best scale for public presentation of the SEI maps, this mapping was presented at a scale of 1:10,000 so that map labels are easily read and interpreted. This is a matter of cartographic presentation. The spatial and data based can be presented at a variety of scales showing a variety of information. The template required for delivery of this contact is the mapping in the Iverson et al 2008 format.

2.7 Species At Risk

Species at risk lists were related to the SEI classes and subclasses to determine the potential ability of that unit to provide habitat for the listed invertebrates and animals. A simple table was developed to relate each at risk invertebrate and animal to an SEI unit. This table can be found in Section 3.3 and Appendix B.

Mapping of SEI units is presented where classes are related to listed species, but mapping of the habitat value of each SEI subclass to each listed invertebrate and animal was not generated, this can easily be done using the look-up table and the spatial and data base through simple queries of the data base.

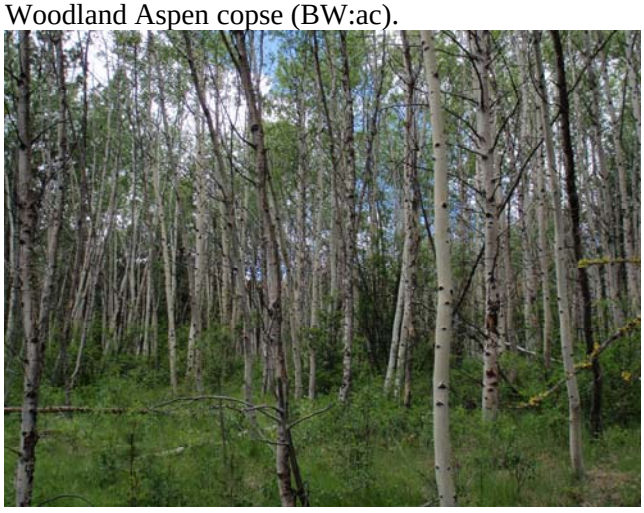
3.0 RESULTS

3.1Sensitive Ecosystem Inventory

3.1.1 SEI Unit Descriptions

Broadleaf Woodlands (BW:ac)

These are ecosystems dominated by Trembling Aspen and generally occur in depressions and moist areas associated with grasslands. They are frequently in a patchy distribution, with a shrubby understory and are often disturbed by cattle grazing. Broadleaf woodlands are important areas because they offer high biodiversity, specialized habitats, they are fragile areas and they offer social and aesthetic values when occurring in the context of populated areas. They are uncommon in the project area, occupying about 1% of the total mapped area. There is one SEI subclass mapped in the Princeton project area the Broadleaved Woodland Aspen copse (BW:ac).



Broadleaf Woodland dominated by Trembling Aspen on a level moist site. (BW:ac)

These moist areas can be excellent habitat for amphibian and reptiles, especially as they take cover in these areas from adjacent grassland. Predatory species relying on these creatures would use these areas for hunting and cover as well. Many birds utilize the Trembling Aspen for nesting either in cavities as the trees senesce or in the dense cover of branches and foliage. Adjacent grassland nesting birds will use these areas for forage. The cover offered by these areas also provides important thermal cover and forage in summer to many species of mammals. Bats use these areas for hunting and roosting. Downed logs are used by small mammals. Larger mammals will use these areas for cover and rearing areas for young. They are critical areas within a larger grassland matrix, as well as in association with open dry forests.

Broadleaf Woodland dominated by Trembling Aspen on a sloping moist site (BW:ac)

Conservation measures in Broadleaf Woodlands include, foremost, their protection from grazing by cattle or horses, removal of understory structure, and removal of diseased standing trees, dead snags or coarse woody debris.

Grasslands (GR:gr, GR:ss, GR:st)

Grasslands in the Princeton area are dominated by bunchgrasses and scattered forbs with shrubby inclusions. They can be disturbed and weedy where overgrazed in local areas. Grasslands develop on sites that are too hot and dry for forests due to factors like directional exposure, slope, shallow soils or meso-climate.

There are three grassland SEI subclasses mapped in the project area. They are general grasslands on deep soils (GR:gr), grasslands on steep shallow soils (GR:ss) and grasslands on steep deep soils (GR:st). Each have their own sensitivities to grazing and disturbance. Disturbed grassland (GR:ds) are also found in small localized areas.

Grasslands are important areas for biodiversity supporting a wide range of invertebrates, desert-adapted reptiles and amphibians including snakes and rare lizards. Rodents utilize the habitat extensively and with them their predators. Other mammals including bats, rabbits, badgers and even perhaps California Bighorn Sheet may use the grasslands in the Princeton area. Many species of birds utilize the grasslands, favoring its open nature for visual protection from prey. Because grasslands can occur on a variety of sites from deep soiled to shallow soiled they also offer a variety of habitat niches for wildlife.

Fescue dominated Grasslands found on deep soils, level sites (GR:gr)

These ecosystems support unique combinations of species that are relatively rare in the Princeton area and in British Columbia as a whole. Features not immediately obvious, like microbiotic and lichen crusts at the soil surface, ephemeral forbs and vast invertebrate fauna are often overlooked, but are critical to the functioning of grassland ecosystems.

Bluebunch Wheatgrass dominated Grasslands found on steep sites with deep soils (GR:gr)

Grasslands found on steep sites with shallow soils (GR:ss)

Disturbance in these sensitive ecosystems can be devastating for long periods of time. Poorly managed livestock, off road vehicles, mountain bikes and heavy equipment can cause damage that is long lasting in most grasslands. Weed species readily invade these areas after disturbance and can take completely replace native grassland vegetation for long periods of time. It is critical to restrict access to grasslands, conserve their extent and limit development within their area. Many grassland ecosystems are red-listed by the CDC, including those found in this project area. They are directly threatened by disturbance and development.

Weedy grasslands in overgrazed areas (GR:ds)

Grasslands cover approximately 4% of the total project area, the Chain Lakes area of interest has the most grassland sites at 6.4% of the total area of that total 3.7% are deep moderately sloping and 2.7% are steep shallow grasslands. The East Gate area has 2.7% of its area in steep sloping grasslands and the Otter Lake area has 0.7% of its area in grasslands which are roughly equally distributed between steep deep soils sites and steep shallow soiled sites.

Coniferous Woodlands (WD:co)

Coniferous woodlands are open stands of Douglas-fir or Ponderosa Pine with open grassy under stories, often on shallow soils or deep soils with warm aspects. These sites are areas where limited moisture or shallow soils limit tree growth resulting in widely spaced trees. Historically these ecosystems have been maintained by fire, but fire suppression over the past century has facilitated dense conifer in-growth which has affected the quality of these sites for habitat and biodiversity values.

Coniferous Woodlands on shallow soils with some in-growth due to long term fire suppression (WD:co)

Coniferous Woodlands have a grassy understory that shares similar flora and fauna with grassland sites and the two sensitive ecosystem types often occur in proximity to one another. Many invertebrates found in grasslands are also found in Coniferous Woodlands. The open forests, with downed logs, snags and bedrock or boulders offer a rich diverse habitat for an assortment of snakes and lizards. There are opportunities for dens, as well as foraging for prey. A combination of forest dwelling birds and grassland birds will use these ecosystems, snags and a diversity of structure are important habitat features. Mammals that use these sites may also use grassland sites and rely on the adjacent woodland areas for cover, rearing habitat, winter browse or summer forage. Predators that rely on grassland species will use these areas as cover for hunting, protection and rearing areas for young.

Northern Alligator Lizard in a Coniferous Woodland site

Many Coniferous Woodland ecosystems in the Princeton area are identified as at risk by the CDC. They are sensitive areas, usually near valley floors and subject to disturbance by grazing, forestry, recreation and development. They are important areas of biodiversity and often overlooked when development implications are considered. It is critical to maintain a balance of mature open stands, as well as grasslands in dry climatic areas in order to support the needs of both grassland and forested species. As in grasslands, disturbance to the delicate ecological balance on these sites can be devastating and long lasting. Conservation measures should include limiting timber harvest, maintenance of the mature forest structure, coarse woody debris and snags and limiting grazing and access for vehicles and mountain bikes.

In the project area approximately 6% of the total area has been mapped as Coniferous Woodlands. The East Gate area of interest has the highest proportion of this unit, with 9.6% of its total area in Coniferous Woodlands. The Otter Lake area has 7.9% of its total area in this unit and the Chain Lakes have 4.4%.

Sparsely Vegetated (SV:cl, SV:ro, SV:sh, SV:ta)

Sparsely vegetated ecosystems are areas with little vegetation on bedrock or talus slopes. They are harsh environments where site features limit the establishment of vegetation. There are four categories of this sensitive ecosystem unit. Cliffs (SV:cl), rock outcrops (SV:ro), scattered shrubs (SV:sh) and talus (SV:ta). In the Princeton mapping areas units like cliffs and scattered shrubs occur, but in areas smaller than the one hectare polygon size limit. The dominant units mapped are rock outcrops and talus. There are large scarps along the edges of fluvial or glacio-fluvial sites composed of exposed bedrock and boulders that have been included in the sparsely vegetated sensitive ecosystem category.

Sparsely Vegetated cliffs (SV:cl)

Sparsely vegetated areas are rich in niche habitats, cracks and crevices, especially on warm aspects, which provide cover, forage and rearing habitat for amphibians and reptiles. Some of these sites may even support critical snake hibernacula. Birds of prey may nest on protected rocky ledges in these areas, smaller birds may nest in cracks and crevices or small caves. Many birds forage along these areas, especially in talus. These sites are critical for bats, as many as a dozen bat species will utilize caves or crevices for roosting and rearing young, this includes most of the at-risk species. Numerous small mammals use these areas for cover and some for rearing young. Larger mammals, like California Bighorn Sheet and Mountain Goats also use these areas. Other larger mammals will hunt in these areas for prey species.

Cracks and crevices in Sparsely Vegetated areas dominated by bedrock (SV:ro) provide rich niche habitats for a wide variety of species. These sites vary greatly depending on the type of bedrock.

A Sparsely Vegetated glacio-fluvial scarp site (SV:ta) can provide important, but different, habitat and escape terrain for a variety of species

The potential for micro-site ecosystems in these areas is enormous with critical importance to biodiversity of bryophytes and lichen species, as well as many vascular plants. The type and nature of bedrock is very important to the ecology of sparsely vegetated sites. This is a sensitive ecosystem unit with an endless

variety of ecological manifestations. These sites are very sensitive to disturbance, disturbed bryophyte communities can take years to recover. Sparsely vegetated sites should be protected from access, activities like mountain biking and even hiking can result in destruction of micro-site habitats. The Princeton area has some unique bedrock types that may support some very special, poorly understood, and poorly described or catalogued species. It is important that they be protected.

Sparsely Vegetated areas mapped within the project area occupy approximately 1.5% of the total area. There are numerous sparsely vegetated sites that occur in areas of less than one hectare, so there are likely more of these sites overall than the mapping would be able to indicate at the scale of 1:10,000. East Gate has the highest percentage of these sites within its mapped boundaries at 3.7%. The sites in East Gate are predominantly bedrock outcroppings. In the Otter Lake unit 2.6% of the area is in the Sparsely Vegetated SEI class with a roughly equal split between bedrock and talus sites. Chain Lakes only has 0.3% of the area mapped as Sparsely Vegetated. The distribution of this SEI class in each area is distinct. The East Gate area should be considered as a priority area and managed to conserve these sparsely vegetated areas from disturbance that may occur as a consequence of development.

Riparian (RI:ff, RI:fp, RI:gu, RI:sh, Ri:ri)

Riparian ecosystems are associated with water bodies like creeks, rivers, ponds, lakes, marshes and swamps. They are influenced by the seasonal fluctuations of the water body and may be dominated by trees or shrubs depending on the regularity and severity of disturbances. Most riparian sites, especially those on level floodplains, are regularly disturbed by the water body depending on their distance from it and their elevation relative to the water body. These ecosystems vary in width and their nature is determined by site specific features such soil texture, surrounding vegetation, hydrology and topography. Riparian ecosystems are diverse, dynamic and important landscape features. They are difficult to map accurately as their character and structure can change from year to year depending on flooding events. Riparian ecosystems can be narrow or broad, based on site feature such as slope, terrain texture and hydrology.

A Riparian ecosystem at high water in level terrain.

There are four category of Riparian sensitive ecosystem subclasses mapped in the Princeton project area. Riparian fluvial fringes (RI:ff), floodplains (RI:fp), gullies (RI:gu), shrub dominated disturbance dis-climax sites (RI:sh) and rivers and gravel bars (RI:ri). Many fringes, gullies and gravel bars are too small to delineate at the scale of the mapping, but occur within the project area within larger mapped floodplain and upland forested ecosystems. The extent of river boundaries, including gravel bars change from day to day. For purposes of this mapping, TRIM double line water features and gravel bars have been included in the RI:ri subclass.

A cottonwood dominated Riparian ecosystem (RI:fp)

A shrub dominated riparian ecosystem (RI:sh)

Riparian ecosystems are probably the most productive and structurally diverse found in the Princeton area. They support a huge variety of insects and other invertebrates. There are strong ecological connections between the invertebrate fauna and the ecology of the water body itself, these relationships are not well documented nor completely understood. Right to the level of the role of nutrient cycling within the water body could be adversely affected by disturbance to the Riparian ecosystem.

The large deciduous trees found in these areas are critical to many species of birds and their nesting requirement, as well as for food and cover. Shore birds will nest in Riparian ecosystems. Insect eating

birds forage in Riparian areas, woodpeckers forage in snags, perching birds nest in the branches of trees and shrubs. Mammals also find critical habitat needs in Riparian ecosystems. These areas provide both food and shelter and diversity. Bats roost in the large old trees, moose frequent both the water bodies and their edges, deer find winter browse and summer forage along the water bodies, as well as cover for rearing young. The importance of healthy riparian ecosystems within the project area cannot be overstated.

Coarse woody debris in Riparian ecosystems contributes to the habitat richness of these areas

A wide variety of ecosystems that are important to invertebrates occur in Riparian ecosystems, such as Spruce-Horsetail sites, most of these ecosystems are considered at risk in the Princeton area

Rare stands dominated by Old conifers and abundant shrubs, like red-osier dogwood, in Riparian ecosystems provide important critical living requirements to a variety of birds and mammals, and are also considered as ecosystems at risk in the Princeton area.

There are a diverse variety of ecosystems found in the project area that can fall within the Riparian class, most are either red or blue-listed by the CDC mature stands are unusual, while shrubby and younger stands are more common. The dominant overstorey vegetation in mature Riparian ecosystems can vary from large cottonwoods to old spruce stands. These stands are rare and at risk. There are frequently conflicts between development and the protection of these areas as the timber has significant value, the desire for recreational development near water bodies is high, and many level riparian ecosystems develop on finer textured floodplains that are valued for agriculture and have, or will be converted to fields or pastures. The need for conservation in these areas cannot be understated. Setting buffers around Riparian ecosystems in very important when considering development.

Riparian ecosystems can also occur upland along gullies (RI:gu)

The Princeton SEI project area has a total percentage of 4.5% of its area mapped as Riparian ecosystems, not including TRIM rivers and gravel bars. Within each area of interest, East Gate has at least 8.3% of its area mapped as Riparian ecosystems, Chain Lakes has 1.9%, and Otter Lakes has 7.6%. It is very important that any further development in these areas is considered relative to disturbance within riparian areas. It is important to emphasize that many riparian ecosystems are smaller than 1 ha in area and cannot be accurately mapped at 1:10,000 scale. Education of landowners and RDOS personnel will help increase the awareness around this, and other sensitive ecosystems.

Riparian ecosystems along lakes with sloping banks can be narrow (RI:ff)

Narrow Riparian fringes are at risk in areas of development (RI:ff)

Seasonally Flooded Fields (FS)

Seasonally flooded fields are areas that have been converted to agricultural fields and usually occur on finer textured materials in low lying areas along rivers in their floodplain. These areas have standing water in them for at least some portion of the year providing habitat for amphibians, water fowl and other birds. This habitat contributes to the overall biodiversity of the Princeton area. If these areas are reclaimed into riparian habitat from agricultural fields, with time, they will contribute to restoring the natural state and diversity of the area.

Seasonally flooded fields also contribute to habitat diversity and can be restored to a riparian state. (FS)

All of the seasonally flooded fields mapped in the Princeton SEI project are in the Chain Lakes area of interest. They cover approximately 1% of the Chain Lakes area.

Wetlands (WN:wn., WN:ms, WN:sp; WN:sw, WN:wm)

Wetlands are ecosystems where the water table is at or near the surface for a long enough period to influence soil and vegetation development. These ecosystems support plants that are adapted to wet soils which have tolerance to lower dissolved oxygen in the ground water. Soils can be decomposed organic material or glysolic mineral soils. Wetlands are highly productive areas.

There are four main wetland ecosystems mapped in the project area. They are marshes (WN:ms), which occur along the margins of other water bodies such as ponds, and are dominated by cattails, sedges and some floating aquatic plants; swamps (WN:sp), which occur in similar locations but are dominated by shrubs such as willows; wet meadows (WN:wm) which are composed of grasses and herbs that are tolerant of wet conditions, may or may not be alkaline and have salt crusts, and may or may not occur in conjunction with ponds or other water bodies; and shallow open water (WN:sw). Accurate wetland classification is sometimes not possible with polygon delineation at the scale of mapping (1:10,000). When a uncertainty exists around the subclass of wetland or the wetlands are a complex of several subclasses over a small area, they are mapped as general wetlands (WN:wn).

Wetlands can exist as very small complexes of swamps, marshes and fens that are difficult to delineate at 1:10,000 (WN:wn)

Marshes, swamps, fens, wet meadows and shallow open water all have distinct ecological characteristics and their own suites of ecosystems and habitat those ecosystems offer to invertebrates, amphibian, reptiles, birds and mammals. In general wetlands are extremely productive sites offering habitat for a complexity of creatures each with an inter-related food chain, breeding requirements, and need for cover.

Many Wetland ecosystems occur in a matrix with red-listed forested Riparian ecosystems

The wetlands are critical elements in an area of dry climate like Princeton, they are relatively rare, threatened by development, and usually disturbed by grazing, timber harvest and recreational activities. Wetlands cover about 1% of the total mapping area. They are most common in the Chain Lakes area of interest with about 1.5% of the area in wetlands, Otter Lakes have about 0.5% in wetlands and East Gate about 0.3%. These are very approximate figures, as many small wetlands may occur that are smaller than one hectare in area in localized situations which cannot be mapped at 1:10,000 scale. It is very important that residents and RDOS personnel be educated to the recognition and importance of these ecosystems as many are very site specific instances of occurrence that must be recognized on an individual basis in order to make good development of conservation decisions.

Mature Forest (MF:co)

Mature Forest ecosystems are dominated by mature coniferous trees, interspersed with a few large old trees. When mature forests occur in riparian or woodlands situations they are mapped as riparian or woodland sensitive ecosystem classes. These areas typically have some kind of history of logging, have been subject to fire suppression and can have dense conifer in growth. Disturbance during early settlement days associated with the gold rush and mineral exploration has favoured the development of rather even aged stands. In a totally natural system mature forests would be part of an uneven-aged mix of stand structures. Present day mature forests provide important buffers for other sensitive ecosystems. Many ecosystems in the Princeton area are identified as blue-listed when in the mature state. These stands are included in the inventory as sensitive. These stands are dominated by Douglas-fir, ponderosa Pine and to a lesser extent lodgepole pine at higher elevations within the study area.

A blue-listed Mature Forest ecosystem (MF:co) in good condition

Some Mature Forest ecosystems (MF:co) in the Princeton area show evidence of conifer in growth and selective logging.

Some Mature Forest ecosystems (MF:co) are not blue-listed and represent a more commonly occurring combination of structure and ecology, but are still important and sensitive areas.

Mature Forests do not exhibit the biological diversity of other sensitive ecosystem classes mapped in the project area but do offer important habitat for some species of reptiles and amphibians, especially rattlesnakes, who will take cover in these ecosystems in summer. Song birds, woodpeckers and owls use the mature trees for roosting, nesting and foraging. Tree cavities and loose bark provide important habitat for bats and other small mammals. Mature forests with old snags can be very important, especially in an area where true Old Forest ecosystems are lacking or very rare.

The structure and dominant species of Mature Forest (MF:co) ecosystems differ depending upon the BEC variant within which they occur in the Princeton mapping area.

Within the Princeton study area approximately 5% of the total area is mapped as Mature Forest. Otter Lake has the greatest percentage with 6.6%, followed by the Chain Lakes at 4.3%. East Gate has only 3.2% of the area mapped as Mature Forest, but a large area of Coniferous Woodlands.

Old Forest (OF:co)

Old forest ecosystems are dominated by large aged trees typically older than 140 years of age. They are very rare in the Princeton area owing to fire history, logging and development. They exist as only very small relic areas within a matrix of mature forests, younger forests, grasslands and sparsely vegetated areas. Generally overstories are open and understories dominated by grasses and shrubs. Dead wood, snags and coarse woody debris may or may not be present depending on the fire history of the particular stand. A build up of fuels in and around relic old forest sites puts them at risk if wildfire is in the area.

Fire exclusion has affected the structure of Old Forest ecosystems previously maintained in an open state by regular low intensity burns.

Low elevation Old Forest ecosystems in the past supported a host of species, many of whom are threatened or at risk now. The diversity in the stand structure of natural old systems created habitat for salamanders, frogs and toads, lizards and snakes. Birds are offered a wider variety of nesting niches in Old Forests than in younger forests with a more even stand structure. The in-growth seen in present day Old Forests threaten the habitat needs of some very rare woodpeckers, who require an open structure. Coarse woody debris, loose bark slabs and snags offer foraging habitat for small mammals, roosting habitat for bats. Large trees provide snow interception for ungulates.

Although there are very small localized pockets of Old Forest, none were large enough to be mapped in the Princeton project area. There may be some areas mapped as Mature Forest that may meet the age criteria for Old Forest, but a more in-depth study would be required to confirm stand ages and is beyond the scope of this project.

A rare example of Old Forest dominated by Ponderosa Pine and an open grassy understory

3.1.2 SEI Distribution by Area

The results of the SEI inventory are shown in Table 4. There are 18 classes and subclasses of sensitive ecosystems mapped over the study area. The total extent of the three areas of interest, based on study area boundaries provided by RDOS is 19,802 ha. East Gate is 2,544 ha, Chain Lakes are 10,605 ha and Otter Lake is 6652 ha.

Based on a sum of the total area by SEI subclass, the three areas of interest have an average proportion of sensitive ecosystems to non sensitive ecosystems of 24.3%.

East Gate has the greatest relative proportion of sensitivity at 31.2% of the total area. This is predominantly due to the high proportion of Coniferous Woodlands, Steep Grasslands, Sparsely Vegetated Rock, Mature Forests and Riparian Fluvial Fringe ecosystems. Otter Lake has a slightly small proportion, 27.5% and it is also largely due to a high proportion of Coniferous Woodlands, Mature Forests and Riparian Fringes and Floodplains. The Chain Lakes have a total of 20.9% of their area in sensitive ecosystems, with Coniferous Woodlands, Mature Forest, Grasslands and the highest proportion of Wetlands of all three areas.

Table 4 Results of the Princeton RDOS Sensitive Ecosystem Inventory

SEI code	Description	All		East Gate		Chain Lakes		Otter Lake	
		ha	%	ha	%	ha	%	ha	%
BW:ac	Broadleaf Woodlands	208	1.1%	9.7	0.4%	99.1	0.9%	99.2	1.5%
FS	Seasonally Flooded Fields	117.4	0.6%	0	0.0%	117.4	1.1%	0	0.0%
GR:gr	Grasslands	399.9	2.0%		0.0%	397.6	3.7%	2.3	0.0%
GR:ss	Steep Grasslands	100	0.5%	65.4	2.7%	4.8	0.0%	29.8	0.4%
GR:st	Steep Shallow Grasslands	313.9	1.6%	6.3	0.3%	289	2.7%	18.6	0.3%
MF:co	Mature Forest	979	4.9%	78.4	3.2%	458.3	4.3%	442.3	6.6%
RI:ff	Riparian Fluvial Fringe	429.8	2.2%	96.3	3.9%	69.5	0.7%	264	4.0%
RI:fp	Riparian Floodplain	343.8	1.7%	64.6	2.6%	36.6	0.3%	242.6	3.6%
RI:ri	River	75.2	0.4%	74	3.0%	1.2	0.0%	0	0.0%
RI:sh	Riparian Shrub	137.3	0.7%	44.5	1.8%	92.8	0.9%	0	0.0%
SV:ta	Sparsely Vegetated Talus	135.2	0.7%	19	0.8%	13.7	0.1%	102.5	1.5%
SV:ro	Sparsely Vegetated Rock	155.1	0.8%	65.4	2.7%	17.7	0.2%	72	1.1%
WD:co	Coniferous Woodlands	1230.4	6.2%	235.1	9.6%	469	4.4%	526.3	7.9%
WN:sp	Wetland Swamp	71.8	0.4%	2.7	0.1%	44.3	0.4%	24.8	0.4%
WN:sw	Wetland Shallow Open Water	9.2	0.0%	1.5	0.1%	6.9	0.1%	0.8	0.0%
WN:wm	Wetland Wet Meadow	57.5	0.3%	3.5	0.1%	54	0.5%		0.0%
WN:wn	Wetland General	45.8	0.2%	0	0.0%	41.6	0.4%	4.2	0.1%
Total Sensitive Area		**4809.3**	**24.3%**	**766.4**	**31.2%**	**2213.5**	**20.9%**	**1829.4**	**27.5%**
Total Area of Interest		19801.8	100%	2544	100%	10605	100%	6652	100%

3.2Ecosystems at Risk in the Princeton Area

Ecosystems noted as threatened or endangered by the Conservation Data Center and have been mapped in the project area are listed in Table Z.

Table 5. Ecosystems At Risk in the Princeton Area

BEC	SEI class	Site series	Map code	Provincial status	Structural stages[1]	Ecosystem name
IDFdk2	WD,OF	02	DW	blue	6,7	Fd-Py - Bluebunch wheatgrass - Pinegrass
IDFdk2	WD, OF	03	DP	blue	6,7	Fdpy - Pinegrass
IDFdk2	RI	07	RT	red	all	CwSw Twinberry - Soft-leaved sedge
IDFxh1	WD, OF	03	DW	blue	6,7	FdPy-Bluebunch wheatgrass-pinegrass
IDFxh1	MF,OF	01	DP	blue	6,7	FdPy- Pinegrass
IDFxh1	RI,OF	00	(SD)	red	all	Black cottonwood/Fd/ red-osier/snowberry
IDFxh1	BW	00		red	all	Aspen, mock orange
IDFxh1	BW, RI	00	(SD)	red	all	Aspen/snowberry/osmorrhiza
IDFxh1	RI	00	(SD)	red	all	Cw Fd/Solomon's seal
IDFxh1	WD,OF	02	PB	red	all	Fd Py bluebunch wheatgrass
IDFxh1	WD, MF,OF	04	SP	blue	6,7	FdPy-Snowbrush-Pinegrass
IDFxh1	WD, MF,OF	05	PF	blue	6,7	FdPy-Pinegras-Idaho fescue
IDFxh1	MF,OF	06	DF	red	all	FdPy-Spirea-Feathermoss
IDFxh1	MF,OF	07	DS	red	all	FdPy-Snowberry-Spirea
IDFxh1	RI, BW	08	SD	red	all	SxwFd-Douglas maple-Dogwood
MSdm2	RI, BW	07	SH	blue	all	Sxw Horsetail Leafy moss (ws07 Sxw common horsetail-leafy moss)
MSdm2	RI, BW	06	SD	blue	all	Sxw Gooseberry Devil's club
IDFxh1a	RI, BW	94	SF	red	all	Aspen/snowberry/bluegrass
IDFxh1a	RI, BW	98	AS	red	all	Aspen/snowberry/bluegrass

[1] TEM structural stages, 6 = mature forest, 7 = old forest (>140years)

3.3 Species at Risk in the Princeton Area

Species at risk identified By the BC Species and Ecosystems Explorer (Jan 2009) are listed below and their relationship to SEI classes found in the Princeton area are noted in Tables 6 through12.

Table 6. Invertebrates At Risk in the Princeton Area

Common name	Scientific	Fed Status	Prov Status	Habitat	SEI class
Morman Metalmark	*Apodemia mormo*	Endangered	Red	Gravel banks	SV
Immaculate Green Hairstreak	*Callophrys affinis*		blue	grassland and shrub steppe	GR
Monarch	*Danaus plexippus*	Special concern	Blue	riparian	RI
Nevada Skipper	*Hersperia nevada*		Blue	confierous woodland	WD
Viceroy	*Limenitis archippus*		Red	Extirpated	
Lilac-bordered Copper	*Lyaena nivalis*		blue	mid-high ev closed forest	MF,WD,OF
Sandhill Skipper	*Hesperia nevada*		Blue	confierous woodland	WD
Sonora Skipper	*Polites sabuleti*		Red	short grass and disturbed habitat	GR:ds
Behr's Hairstreak	*Satyrium behrii*	threatened	Red	antelope brush	AS
California Hairstreak	*Satyrium californica*		blue	Grassland, shrub steppe, coniferous woodlands	GR,WD
Half-moon Hairstreak	*Satyrium semilluna*	endangered	Red	sagebrush steppe	SS
Lance-tipped Darner	*Aeshna constricta*		Red	marshes and ponds with rich aqutic veg	WN:sw
Emma's Dancer	*Argia emma*		blue	warm/cool streams and associated wetlands	WN
Vivid dancer	*Argia vivida*		Red	streams from cool springs and associated wetlands	WN
Western Pondhawk	*Erythemis collocata*		blue	warm ponds	WN:sw
Pronghorn Clubtail	*Gomphus graslinellus*		blue	Warm marshy lakeshores and ponds	WN:sw
Twelve-spotted Skimmer	*Libellula pulchella*		blue	Warm marshy lakeshores and ponds	WN:sw
Western River Cruiser	*Macromia magnifica*		blue	Warm streams and lakeshores	LAKES
Blue Dasher	*Pachydiplax longipennis*		blue	warm ponds	WN:sw
Olive Clubtail	*Stylurus olivaceus*		Red	Warm streams (large)	STREAMS
Autumn meadowhawk	*Sympetrum vicinum*		blue	Marshes and marshy lakeshores	WN:ms
California Floater	*Anodonta californiensis*		blue	Lake	LAKES
Winged Floater	*Anodonta nuttalliana*		blue	Lake	LAKES
Attenuate Fossaria	*Fossaria truncatula*		blue	Lake	LAKES
Rocky Mnt. Ridged Mussel	*Gonidea angulata*		Red	Lake	LAKES
Umbilicate Sprite	*Promenetus umbillicatellus*		blue	Lake	LAKES
Abbreviate Pondsnail	*Stagnicola apicina*		blue	Lake	LAKES
Black Gloss	*Zonitoides nitidus*		blue	Lake	LAKES

Table 7. Fish At Risk in the Princeton Area

Common	Scientific	Fed Status	Prov Status	Habitat	SEI class
Chiselmouth	*Acrocheilus alutaceus*		blue	Lakes and Rivers	LAKES, Rivers
Umatilla Dave	*Rhinichthys umatilla*	Special concern	Red	Rivers	River
Mountain Sucker	*Catostomus paltyrhynchus*		blue	Rivers	Rivers
Chinook Salmon (Okanagan)	*Oncorhynchus tshawytscha*	Threatened		Rivers	Rivers
Columbia Sculpin	*Cottus hubbsi*	special concern	RIVER	STREAM	LAKES

Table 8. Amphibians At Risk in the Princeton Area

Common	Scientific	Fed Status	Prov Status	Habitat	SEI class
Northern Leopard Frog	*Rana pipiens*	endangered	red	lakes and wetland	LAKES,WN
Western Toad	*Bufo boreas*	Special concern		lakes and wetlands	LAKES,WN
Great Basin Spadefoot	*Spea intermontana*	Threatened	B	wetlands, grasslands and shrub steppe	WN,GR
Tiger Salamander	*Ambstoma tigirnum*	endangered	red	lakes, wetlands, grasslands and shrub steppe	LAKES, WN

Table 9. Reptiles At Risk in the Princeton Area.

Common	Scientific	Fed Status	Prov Status	Habitat	SEI class
Painted Turtle	*Chrysemys picta*	special concern	blue	lakes and permanent wetlands	LAKES,WN
Pigmy Short-horned Lizard	*Phrynosoma douglasii*	extirpated	red	grasslands and shrub steppe	GR
Western Skink	*Eumeces skiltonianus*	special concern	blue	rocky areas in low to mid ev; shallow soils grassland or sagebrush	SV:ro, GR:ss
Rubber Boa	*Charina bottae*	special concern	blue	coniferous woodland, rock for denning	WD, SV:ro, OF
Racer	*Coluber constrictor*	special concern	blue	rocky habitats, grassland and shrub steppe	SV:ro, GR:ss
Night Snake	*Hypsiglena torquata*	endangered	red	rocky habitats, grassland and shrub steppe	SV:ro,GR:ss
Gopher Snake	*Pituophis catenifer deserticola*	threatened	blue	rocky habitats, grassland and shrub steppe	SV:ro GR:ss
Western Rattlesnake	*Crotalus oreganus*	threatened	blue	rocky habitats, grassland, coniferous woodlands and shrub steppe	SV:ro GR:ss, WD

Table 10. Birds At Risk in the Princeton Area.

Common	Scientific	Fed Status	Prov Status	Habitat	SEI class
Western Grebe	*Aechmophorus occidentalis*		red	wetlands	WN
Great Blue Heron	*Ardea herodias herodias*		blue	wetlands and riparian	WN,RI
American Bittern	*Botarus lentiginosus*		blue	wetlands	WN
Swainson's Hawk	*Buteo swainsoni*		red	grassland, coniferous woodland	GR,WD
Ferruginous Hawk	*Buteo regalis*	special concern		forage in grassland and shrub step nesting habitat variable	GR
Prairie Falcon	*Falco mexicanus*		red	cliffs for nesting, open areas lakes and wetlands for forage	SV:cl, WN, Lake
Peregrine Falcon	*Falco peregrinus anatum*	special concern	red	cliffs for nesting, open areas lakes and wetlands for forage	SV:cl, WN
Greater Sage Grouse	*Centrocercus urophasianus*	extirpated	red	sagebrush steppe historically	SS
Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*		blue	Short-grass grassland	GR
Sandhill Crane	*Grus canadensis*		blue	wetlands	WN
Amercian Avocet	*Recurvirostra*		red	wetlands	WN
Long-billed Curlew	*Numenius americanus*	special concern	blue	short grass grasslands	GR
California Gull	*Larus californicus*		blue	nests on islands; forages in open habitats	LAKE
Barn Owl	*Tyto alba*	special concern	blue	agricultural fields	FS
Short-eared Owl	*Asio flammeus*	special concern	blue	short grass grasslands	GR
Burrowing Owl	*Athene cunicularia*	endangered	red	grassland	GR
Western Screech-Owl	*Megascops kennicottii*	endangered	red	riparian, especially mature or old cottonwood	RI, BW
Flammulated Owl	*Otus flammeolus*	Special concern	blue	open Fd forest ;mixed age stands	WD, OF
Common Nighthawk	*Chordeiles minor*	threatened		open and semi arid areas	GR, WD
Lewis' Woodpecker	*Melanerpes lewis*	special concern	red	grasslands and shrub steppe with scattered trees and snags	GR,SS,WD
White-headed Woodpecker	*Picoides albolarvatus*	endangered	red	mature and old Py dominated coniferous woodland	WD,OF
Williamson's Sapsucker	*Sphyrapicus thyroideus thyroideus*	endangered	red	mature and old forest Lw	MF
Gray Flycatcher	*Empidonax wrightii*		blue	young PY forest	??
Barn Swallow	*Hirundo rustica*		blue	buildings insect rich areas	UR, LAKE
Canyon Wren	*Catherpes mexicanus*		blue	rocky habitats, especially talus	SV:ta, SV:cl
Sage Thrasher	*Oreoscoptes montanus*	endangered	red	sagebrush steppe	SS
Yellow-breasted Chat	*Icteria virens*	endangered	red	riparian, especially dense rose thickets	RI:sh,BW
Grasshopper Sparrow	*Spizella breweri breweri*		red	sagebrush steppe	SS
Lark Sparrow	*Chondestes grammacus*			sagebrush steppe, especially antelope brush not grassland	SS
Brewer's Sparrow	*Spizella breweri breweri*		red	sagebrush steppe	SS
Bobolink	*Dolichonyx oryzivorus*		blue	old hayfields and moist meadows or pastures not wetlands	CF

Table 11. Mammals At Risk in the Princeton Area.

Common	Scientific	Fed Status	Prov Status	Habitat	SEI class
Merriam's Shrew	*Sorex merriami*		red	sagebrush	SS
Preble's Shrew	*Sorex preblei*		red	antelope brush and grassland	GR
Pallid Bat	*Antrozous pallidus*	threatened	red	cliffs and rocks outcropping, grassland, shrub steppe	SV:cl, GR
Townsend's Big-eared Bat	*Corynorhinus townsendii*		blue	cliffs, urban and ,riparian	SV:cl, UR, RI
Spotted Bat	*Euderma maculatum*	special concern	blue	Cliffs and various foraging habitats	SV:cl
Western Ree Bat	*Lasiurus blossevillii*				RI
Western Small-footed Myotis	*Myotis ciliolabrum*		blue	rocks, wetlands, grassland, shrub steppe	SV:cl, WN
Fringed Myotis	*Myotis thysanodes*		blue	rocks, wetlands, grassland, shrub steppe	SV:cl, WN
Wolverine	*Gulo gulo luscus*	special concern	blue	variable prefers alpine	OF
Fisher	*Martes pennanti*		blue	mature and old conifer and riparian forest at mid ev	MF, RI
Badger	*Taxidea taxus*	endangered	red	grassland, shrub steppe	GR
Grizzly Bear	*Ursus arctos*	SPECIAL CONCERN	BLUE	Likely not in area at low elevations	MF, RI
California Bighorn Sheep	*Ovis canadensis*		blue	cliffs, grassland, shrub steppe, closed forest combo	SV:cl, GR
Great Basin Pocket Mouse	*Perognathus parvus*		red	grassland and shrub steppe	
Western Harvest Mouse	*Reithrodonotomys megalotus*	special concern	blue	grassland, shrub steppe, edges and agricultural areas	GR,FS
White-tailed Jackrabbit	*Lepus townsendii*		red	grassland and shrub steppe	GR
Nuttall's Cottontail	*Sylivilagus nuttallii*	special concern	blue	rocky areas in grassland and shrub steppe	SV , GR

Table 12. Plants At Risk in the Princeton Area.

Scientific Name	**Common Name**	**COSEWIC status**	**Prov Status**	**SEI class**			
Agastache urticifolia	Nettle-leaved Giant-hyssop		blue	OF	WD	MF	
Allium validum	Swamp Onion			WN			
Ammannia robusta	Scarlet Ammannia	E	Red	RI			
Apocynum x floribundum	Western Dogbane		Blue	GR			
Aster frondosus	Short-rayed Aster	E	Red	RI			
Astragalus lentigenosus	Threadstalk Milk-vetch		Blue	GR			
Astragalus sclerocarpus	The Dalles Milk-vetch		Red	GR			
Atriplex argentea spp. Argentea	Silvery Orache		Red	GR			
Azolla mexicana	Mexican Mosquito Fern		Red	WN	RI		
Bolblschoenus fluviatallis	River Bulrush		Red	WN	RI		
Botrychium ascendens	Upswept moonwort		Red	RI			
Botrychium paradoxum	Two-spiked Moonwort		Red	GR	WD	MF	
Berula erecta	Cut-leaved Water Parsnip		Red	WN			
Brickellia oblongifolia spp. oblongfolia	Narrow-leaved Brickellia		Red	GR	SV		
Bryoerythrophyllum columbianum	Columbia Carpetmoss	SC	Blue	GR			
Calochortus lyallii	Lyall's Mariposa Lily	T	Red	OF	WD	MF	
Camissonia andina	Andean Evening-primrose		Red	GR			
Camissonia breviflora	Short-flowered Evening-primrose		Red	RI			
Carex amplifolia	Bigleaf sedge		blue	RI			
Carex comosa	Bearded Sedge		Red	WN	RI		
Carex hysticina	Porqupine Sedge		Red	WN			
Carex sychnodephala	Many-headed Sedge		Blue	RI			
Carex vulpinoidea	Fox Sedge		Blue	WN	RI		
Carex xerantica	Dry-land Sedge		Red	GR			
Castilleja minor ssp. Minor	Annual Paintbrush		Red	WN	GR		
Centaurium exaltatum	Western Centaury		Red	RI			
Chamaesyce serpyllifolia ssp. serpyllifolia	Thyme-leaved Spurge		Blue	RI			
Coreopsis tinctoria var. atkinsoniana	Atkinson's Coreopsis		Red	RI			
Crepis atribarba ssp.atribarba	Slender Hawksbeard		Red	OF	GR	WD	MF
Cryptantha ambigua	Obscure Cryptantha		Blue	GR	SV		
Cryptantha celosiodes	Cockscomb Cryptantha		Red	GR	SV		
Cryptantha watsonii	Watson's Crytantha		Red	GR	SV		

Cuscuta campestris	Field Dodder		Blue	GR			
Cyperus erythrorhizos	Red-rooted Cyperus		Red	RI			
Cyperus squarrosus	Awned- Cyperus		Blue	RI			
Dryopteris cristata	Crested Wood Fern		Blue	WN			
Elatine rubella	Three-flowered Waterwort		Blue	RI			
Eleocharis atropurpurea	Purple Spike-rush		Red	RI			
Eleocharis rostellata	Beaked Spike-rush		Blue	WN	RI		
Elodea nuttallii	Nuttall's Waterweed		Blue	WN			
Entosthodon rubiginosus	Rusty Cord-moss	E	Red	WN			
Epilobium glaberrimum ssp fastigatum	Smooth Willowherb		Blue	OF	WD	MF	
Epipactis gigantea	Giant Helleborine	SC	Blue	WN	RI		
Eragrostis pectinacea	Tufted Lovegrass		Red	GR			
Erigeron leibergii	Leiberg's Fleabane		Red	OF	GR	MF	
Erigeron poliospermus var. poliosperus	Cushion Fleabane		Blue	SV			
Eriogonum strictum var. proliferum	Strict Buckwheat		Red	GR			
Floerkia proserpinacoides	False-mermaid		blue	RI			
Gaura coccinea	Scarlet Gaura		Red	SV			
Gayophytum humile	Dward Groundsmoke		Blue	RI	GR		
Gayophytum racemosum	Racemed Groundsmoke		blue	GR	WD	SV	MF
Gayophytum ramoissimum	Hairstem Groundsmoke		Red	OF	GR		
Gentiana affinis	Prairie Gentian		Blue	OF	MF		
Gilia sinuata	Shy Gilia		Red	WD			
Halimolobos whitedii	Whited's Halimolobus		Red	GR			
Herperostipa spartea	Porqupine Grass		Red	OF	WD	MF	
Heterocodon rariflorum	Heterocodon		blue	GR			
Hutchinsia procumbens	Hutchinsia		Red	WN			
Impatiens aurella	Orange Touch-me-not		Blue	RI			
Juncus confusa	Colorado Rush		Red	RI			
Lappula occidentalis var. cupulata	Western Stickseed		Red	GR	SV		
Lepidium densiflorum var. pubicarpum	Prairie Pepper-grass		Red	GR			
Linanthus septentrionalis	Northern Linanthus		Blue	GR			
Lindernia dubia var. anagallidea	False-pimpernel		Blue	WN	RI		
Lipocarpha micrantha	Small-flowered Lipocarpha	E	Red	GR			
Marsilea vestita	Hairy Water-clover		Red	WN	RI		
Melica bulbosa var bulbosa	Oniongrass		blue	RI	OF, MF	GR	WD
Microbryum vlassovii	Nugget Moss	E	Red	GR			
Mimulus breviflorus	Short-flowered Monkey-flower		Red	RI			

Mimulus breweri	Brewer's Monkey-flower		Red	RI			
Myosurus apetalus var. borealis	Bristly Mousetail		Red	GR			
Orobanche corymbosa ssp. Mutabilis	Flat-topped Broomrape		Red	GR	SV		
Orthocarpus barbatus	Grand Coulee Owl-clover	E	Red	GR			
Pectocarya penicillata	Winged Combseed		Red	GR			
Phlox speciosa ssp. Occidentalis	Showy Phlox	T	Red	OF,MF	GR	WD	SV
Physaria didymocarpa var. didymocarpa	Common Twinpod		Blue	GR			
Polemonium occidentale spp. occidentale	Western Jacob's-ladder		blue	WN			
Polygonum engelmannii	Engelmann's Knotweed		blue	WN			
Polygonum punctatum	Dotted Smartweed		blue	WN			
Polygonum polygaloides spp kelloggii	Kellog's Knotweek		Red	RI			
Polystichum lemmonii	Lemmon's Holly Fern	T	Red	SV			
Potentilla paradoxa	Bushy Cinquefoil		Red	WN	RI		
Pterygoneurum kozlovii	Alkaline Wing-nerved Moss	T	Red	RI			
Pyrrocoma carthamoides var carthamoides	Columbia Goldenweed		Red	GR			
Rotala ramosior	Toothcup Meadow-foam	E	Red	RI			
Salix amygdaloides	Peach-leaved Willow		Red	WN	RI		
Salix boothii	Booth's Willow		Blue	BW			
Salix tweedyi	Tweedy's Willow		Blue	WN			
Schoenoplectus americanus	Olney's bulrush		Red	WN	RI		
Schoenoplectus saximontanus	Rocky Mountain clubrush		Red	RI			
Sphaeralcea coccinea	Scarlet Globe-mallow		Red	GR			
Sphaeralcea munroana	Munroe's Globe-mallow		Red	GR			
Sphenopholus obtusata	Prairie Wedgegrass		Red	RI			
Sporobolus airoides	Hairgrass Dropseed		Red	RI			
Sporoboluss compositus var compositus	Rough Dropseed		Blue	RI			
Stellaria obtusa	Blunt-sepaled starwort		Blue	RI			
Talinum sediforme	Okanogan Fameflower	NAR	Blue	GR	SV		
Trifolium cyanthiferum	Cup clover		Red	RI			
Thelypodium laciniatum var. laciniatum	Thick-leaved Thelypody		Blue	SV			
Verbana hastata var. scabra	Blue Vervain		Red	RI			

4.0 DISCUSSION

Sensitive ecosystems in a developed landscape should be recognized for their values to biodiversity, wildlife and other critical ecological functions relating to hydrology, soil conservation, as well as, aesthetics and recreation. Although probably long recognized by the community in an informal way as important areas within a developed matrix, the act of inventory formalizes that recognition and enables the role and importance of conservation actions at both the individual and regulatory level.

The Sensitive Ecosystem Inventory undertaken in the Princeton area for RDOS in the East Gate, Chain Lakes and Otter Lakes indicates that approximately 25% of the total area is ecologically fragile and potentially at-risk to harm from disturbance or development. This inventory is fragmented and is out of context for the RDOS as a whole. Ideally, to put the entire Regional District into perspective, the whole RDOS should be inventoried.

This inventory can be used to help set priorities for land management and conservation in the mapped areas of interest. SEI polygons should be considered, but when specific developments occur on-site visits are necessary to assess the individual sites, the mapping is intended for broad-scale planning only.

Planning for development in sensitive ecosystems and cooperation from residents in those areas is critical.

4.1 Developing a Conservation Strategy for the Areas of Interest

Iverson et al (2008) note that *"The intent of a conservation strategy is to convey the conservation goals and actions needed to maintain and enhance sensitive ecosystems, biodiversity and ecological processes and to protect or restore ecologically significant areas."*. In order to accomplish this, the RDOS has to develop conservation goals and objectives for the areas of interest. A conservation plan needs to address the long-term viability of the sensitive ecosystems and overall biodiversity. Many sensitive ecosystems are on private property consequently education and cooperation from land owners is key to a successful conservation strategy.

Iverson et al (2008) present some conservation options for the Okanagan. They are;

1. Designation of Environmentally Sensitive Areas (ESA) based on the SEI class
2. Designation of nature or ecological reserves or similar protected status
3. Acquisition of privately owned lands containing sensitive ecosystems
4. Stewardship by private land owners with sensitive ecosystems such as registering conservation covenants on their property, conservation and protection of ecosystems, managing invasive plants or forest in-growth.
5. Other protection techniques such as cluster development, Development Permit Areas, restrictive covenants and incentives.

Iverson at al (2008) suggest some general management recommendations to support healthy ecosystems and biodiversity. They are;

1. Plan land development carefully by using SEI inventory and site visits by qualified professionals
2. Delineate buffers and corridors around sensitive ecosystems
3. Avoid direct and indirect impacts through discouraging settlement within or adjacent to sensitive ecosystems, maintaining water quality in wetlands, avoiding riparian areas, avoiding known areas of wildlife habitat, controlling invasive species, preventing soil disturbance, managing livestock access
4. Restoration of natural disturbance regimes
5. Reduction of wildfire threat across landscape

Within the political and legal framework it is possible to make the protection and conservation of sensitive ecosystems a priority, through education and stewardship at the local level it is possible to achieve this important land use goal.

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APPENDIX A WORKING LEGEND TO ECOSYSTEMS

An excel spreadsheet provided digitally

APPENDIX B SPECIES AT RISK LOOK-UP TABLES RELATING SPECIES TO SEI CLASSES

An excel spreadsheet provided digitally