Restoring British Columbia's Garry Oak Ecosystems

PRINCIPLES AND PRACTICES

Chapter 4
Species and Ecosystems at Risk

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Chapter 4

Species and Ecosystems at Risk

by Kersti Vaino, in collaboration with Brenda Costanzo, Shyanne Smith, and Ted Lea

Garry Oak and associated ecosystems are highly biodiverse and have a disproportionately high number of species at risk. At least three species at risk are known and managed for at the Cowichan Garry Oak Preserve, one of the few remaining deep soil Garry Oak woodlands. Photo: Chris Junck

4.1 Introduction

Garry Oak and associated ecosystems have very high biodiversity and a disproportionately high number of species at risk compared to other ecosystems in British Columbia and Canada. Approximately 10% of the SARA-listed species at risk in Canada occur in Garry Oak ecosystems, and these ecosystems cover less than 2000 hectares (S. Smith, pers. comm. 2011). Garry Oak and associated ecosystems make up one of the most endangered ecosystems in Canada (T. Lea, pers. comm. 2009). It is important to conserve species and ecosystems at risk as they provide

biodiversity, and many of these species occur nowhere else in Canada. Restoration practitioners need to be aware of all species and ecosystems at risk occurring on their site and carefully look for these prior to beginning any work. The purpose of this chapter is to provide guidance and direction on how to deal with these sensitive species and ecosystems during restoration.

The introductory section of this chapter defines species and ecosystems at risk. Section 4.2 lays out how these are protected under provincial and federal legislation, and discusses requirements for permits for restoration work, if necessary. Resources are provided in Section 4.3 regarding whom to contact for identifying and working with species at risk, as well as potential funding programs for the restoration of their habitats. The importance of identifying threats and defining recovery goals is also discussed. Section 4.4 discusses some common complications when it comes to restoring the habitats of species at risk, which should be taken into consideration. These include alien invasive species, hydrologic regimes, the timing of restoration, and translocations. Finally, monitoring requirements for the restoration of species and ecosystems at risk are discussed in Section 4.5.

4.1.1 Ranking Species and Ecosystems at Risk

Simply speaking, a species or ecosystem at risk is at risk of dying out or disappearing, either from a specific area (e.g., province or country) or from the world. In order to prioritize recovery actions, the level of risk needs to be determined for each species or ecosystem. In Canada, this ranking is done by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, www.cosewic.gc.ca) and provincially in British Columbia by the BC Conservation Data Centre (CDC, www.env.gov.bc.ca/cdc).

In Canada, risk status for species at risk is established by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an independent panel of experts. Provincially in B.C., the BC Conservation Data Centre ranks species at risk.

Species at risk are assessed and ranked by provincial, federal, and global authorities. Geyer's Onion (*Allium geyeri*) is a globally (G4G5) ranked and provincially Blue-listed species at risk that has not yet been assessed by COSEWIC. Photo: Chris Junck

COSEWIC is an independent panel of experts that advises the federal government on the status of species at risk (COSEWIC 2009a). The designations extinct, extirpated, endangered, threatened, special concern, not at risk, and data deficient (COSEWIC 2009b) are used to list species under the *Species at Risk Act* (SARA 2003). SARA establishes Schedule 1 as the official list of wildlife species at risk for those species designated extirpated, endangered, threatened, or special concern.

SARA does not include reference to ecosystems at risk but does permit a multi-species or ecosystem-wide approach to the recovery of listed species (GOERT 2007). As of 2010, there have been three multi-species recovery strategies prepared by GOERT, under SARA, for: Garry Oak woodlands (www.sararegistry.gc.ca/document/default_e.cfm?documentID=874); maritime meadows associated with Garry Oak ecosystems (www.sararegistry.gc.ca/document/default_e.cfm?documentID=873); and vernal pools and other ephemeral wet areas associated with Garry Oak ecosystems (www.sararegistry.gc.ca/document/dspDocument_e.cfm?documentID=875).

Taylor's Checkerpot (*Euphydryas editha taylori*) is an Endangered species (SARA Schedule 1) for which recovery planning is included in the multi-species recovery strategy for species at risk in maritime meadows associated with Garry Oak ecosystems. Photo: Andrew Fyson

SARA STATUS DEFINITIONS FOR SPECIES AT RISK IN CANADA

Extinct – a species that no longer exists anywhere in the world

Extirpated – a species that no longer occurs in the wild in Canada, but does occur elsewhere in the wild

Endangered – a species facing imminent extirpation or extinction

Threatened – likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction

Special concern – a species that may become threatened or endangered because of a combination of biological characteristics and identified threats

Not at risk – a species that has been assessed and found to be secure

Data deficient – not enough is known about the species to assess its status

The CDC assesses, ranks, and provides information on the status of species and ecological communities within the province of British Columbia. The CDC uses the NatureServe conservation status methodology to rank species and ecological communities (MOE 2007). Each entity is ranked both globally (G) and sub-nationally (S) on a scale of 1 (critically imperiled) to 5 (secure) (NatureServe 2009, www.natureserve.org). Based on these rankings, each entity is then assigned to either a *Red*, *Blue*, or *Yellow* List; the Red List is for those species at greatest risk, the Blue List for those at intermediate risk, and the Yellow List for those least at risk (MOE 2007).

As of 2011, there are 104 provincially-listed species at risk in Garry Oak and associated ecosystems and, of these, 55 are also listed federally (see Table 4.1) (GOERT 2011). The number of species listed federally will likely grow, as many species have not yet been assessed for listing under SARA. A current list (as of 2011) of all listed species at risk in Garry Oak and associated ecosystems is provided in Appendix 4.1 along with the Restoration Ecosystem Units (REUs) (see Chapter 2: Distribution and Description) for each species to assist restoration practitioners in knowing which species might occur on their site. Appendix 4.2 lists the species at risk potentially found in each REU.

There are currently 10 plant communities associated with Garry Oak ecosystems that are included on British Columbia's Red List; six more will likely be added to the Red List after assessment (C. Cadrin, pers. comm. 2009) (see Appendix 4.3). The CDC's ability to rank ecological communities is limited by the lack of available data (Fuchs 2001).

4.1.2 Why are These Species and Ecosystems at Risk?

Garry Oak and associated ecosystems are vanishing rapidly in British Columbia. Historically, their range in the province was limited within the already relatively small extent of the Coastal

THE BC CONSERVATION DATA CENTRE (CDC) PROVIDES AN IN-DEPTH DESCRIPTION OF BOTH THE RED AND BLUE LISTS.

The Red List "includes any ecological community, and indigenous species and subspecies that is extirpated, endangered, or threatened in British Columbia. Extirpated elements no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered elements are facing imminent extirpation or extinction. Threatened elements are likely to become endangered if limiting factors are not reversed. Red-listed species and sub-species may be legally designated as, or may be considered candidates for legal designation as Extirpated, Endangered or Threatened under the *Wildlife Act* (see www.env.gov.bc.ca/wld/faq.htm#2). Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation (MOE 2010)."

The Blue List "Includes any ecological community, and indigenous species and subspecies considered to be of special concern (formerly vulnerable) in British Columbia. Elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at risk, but are not Extirpated, Endangered or Threatened (MOE, 2010)."

Table 4.1 Numbers of B.C.-listed and COSEWIC[a]-listed Species at Risk per taxonomic category within Garry Oak and associated ecosystems in 2011

	B.C. Listings		COSEWIC Listings			
Taxonomic Category	**Red**	**Blue**	**Extirpated**	**Endangered**	**Threatened**	**Special Concern**
Plants	51	19	1	30	4	4
Mammals		3				
Reptiles & Amphibians	2		1	1		
Birds	7	7		2	2	5
Invertebrates	7	8	1	3	1	
Totals	67	37	3	36	7	9
	104		**55**			

a- Committee on the Status of Endangered Wildlife in Canada

Douglas-fir biogeoclimatic zone (Chapter 2: Distribution and Description). It is estimated that less than 5% of the area covered by these ecosystems prior to European contact remains in a near-natural state today (Lea 2006). Habitat loss due to land conversion for agriculture and urban development is the primary cause of this alarming decline (GOERT 2002). Remaining Garry Oak and associated ecosystems are further threatened by habitat degradation and fragmentation, invasion by exotic species, and suppression of fire disturbance. Alien invasive species compete with native species and change the species composition of the ecosystem (Chapter 9: Alien Invasive Species), while suppression of fire alters ecosystem function (Chapter 3: Natural Processes and Disturbance). Climate change also impacts these ecosystems as changing weather patterns affect seasonal soil moisture patterns, the growth of alien species, and susceptibility to burning (GOERT 2002).

Land conversion is the primary threat to Garry Oak and associated ecosystems in B.C.; invasion by exotic species, habitat degradation and fragmentation, and fire suppression also play a role in their decline.

Many of the rare plant species and ecological communities occurring in Garry Oak and associated ecosystems are naturally rare (Fuchs 2001). The majority of them are endemic, meaning that they are found only in these ecosystems. These species are highly adapted to the unique conditions of these habitats, especially those found in such specialized habitats as seepages and vernal pools. It is this natural rarity combined with specialized habitat needs that makes many of these species particularly vulnerable to extinction. Political boundaries further add to the rarity of many of these entities in Canada, with their Canadian occurrences being at the very northern periphery of their ranges. Although they are uncommon south of the American border as well, many of these species are even less common in B.C. (Fuchs 2001).

Plants

In addition to these reasons for their natural rarity, many rare plant species are greatly threatened by habitat loss and fragmentation resulting from land conversion and management, including herbicide use (GOERT 2003a). Remaining populations are often damaged due to trampling and/or soil erosion. Many endemic species have adapted to the presence of soil moisture at key times in

Habitat loss is the primary threat to Bog Bird's-foot Trefoil (*Lotus pinnatus*), a Red-listed, Endangered species (SARA Schedule 1) that grows in seasonally wet meadows. The known occurrences of Bog Bird's-foot Trefoil in British Columbia are at the northernmost extent of the species' global range. Globally, this species is considered secure (G4G5). Photo: Chris Junck

their lifecycles; activities and invasive species that affect hydrological cycles can be devastating to these species. As the climate and resulting weather patterns change, further changes to hydrologic cycle become a key factor contributing to decline for some populations. Furthermore, many rare plants are grazed or browsed by both native and introduced fauna (GOERT 2003a).

Vertebrates

A number of vertebrates that were reliant on Garry Oak and associated ecosystems have become extirpated or endangered (Fuchs 2001). These include the Horned Lark *strigata* subspecies (*Eremophila alpestris strigata*), Vesper Sparrow *affinis* subspecies (*Pooecetes gramineus affinis*), Western Meadowlark (Georgia Depression population, *Sturnella neglecta*), Lewis's Woodpecker (Georgia Depression population, *Melanerpes lewisii*), and Western Bluebird (Georgia Depression population, *Sialia mexicana*) (Fuchs 2001). These species have been affected by rapid habitat loss, fragmentation, and degradation due to invasive plant and animal species, as well as insufficient food sources and loss of habitat elements such as tree cover, including large live trees and standing or downed dead wood (GOERT 2003a).

Invertebrates

Very little is known about most invertebrate species at risk associated with Garry Oak ecosystems, with the exception of several butterfly species (Fuchs 2001). Most of the invertebrate species at risk in these ecosystems are at risk due to loss of food sources and suitable habitat (GOERT 2003a). Moist meadow areas preferred by butterflies are being destroyed by urban development and heavy grazing or are being overgrown by invasive shrubs and grasses. Leaf litter, often providing shelter for overwintering pupae, is frequently cleared from the bases of oaks in residential areas. Butterfly populations are also affected by pesticide use, predation by pets, and the introduction of parasites from other introduced species such as the Cabbage White Butterfly (*Pieris rapae*) (GOERT 2003a).

4.2 Legislation

4.2.1 Legislated Protection of Species and Ecosystems at Risk

This section describes only federal and provincial legislation for the protection of species at risk. There are additional potential methods of legal protection for species at risk at the municipal level through the *BC Community Charter*, the *Local Government Act,* and the *Land Title Act*

(GOERT 2007). Under this legislation, local governments can create bylaws, manage land use zoning, designate environmentally sensitive areas, and manage development permits. In addition, restrictive covenants can be placed on a property's land title, which restrict the activities of both present and future holders of the title (GOERT 2007). Local regulations vary from region to region so are not discussed here in detail, but should be investigated by restoration practitioners. U.S. legislation, which falls under the federal *Endangered Species Act,* is also not discussed; more information can be found on the Endangered Species Program website of the U.S. Fish and Wildlife Service (www.fws.gov/endangered).

Federal

In Canada, federal protection for rare species falls under the *Species at Risk Act* (SARA 2003, www.sararegistry.gc.ca/approach/act/default_e.cfm). There is no legislative protection for ecosystems at risk; however, SARA does allow for an ecosystem-based approach to species at risk recovery. COSEWIC follows a multi-step process for assessing and ranking a species' level of risk (see the COSEWIC website, www.cosewic.gc.ca/eng/scto/assessment_process_e.cfm, for more details on this process) and provides a recommendation to the federal Minister of Environment. It is the Minister, in consultation with COSEWIC, who then determines the final ranking of the species. A species must be added to Schedule 1 to receive protection under SARA (Environment Canada 2009).

Species listed as Endangered or Threatened must have a recovery strategy and an action plan written, and a management plan must be developed for species of Special Concern.

Once listed on Schedule 1, an endangered or threatened species is automatically protected on federal lands; no person shall kill, harm, harass or possess an individual or cause damage to the residence of one or more individuals. The habitats of species at risk are also recognized as *critical habitat* under the SARA once species have been designated. Critical habitat is defined as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

SARA requires the development of planning documents to guide recovery for species at risk. For endangered and threatened species a recovery strategy and an action plan must be written, and for species of Special Concern a management plan must be developed. Once completed, these documents can be found on the SARA public registry (www.sararegistry.gc.ca/default_e.cfm). These documents guide species recovery and outline threats, limiting factors, knowledge gaps, targets, and actions for each species. Critical habitat is currently being identified and included in several recovery strategies and action plans for species in Garry Oak and associated ecosystems, as of April 2011. Signing up for the registry e-news is an easy way to keep up on newly posted recovery planning documents (www.sararegistry.gc.ca/involved/newsletter/default_e.cfm).

These recovery planning documents are often produced by a group of experts brought together as a recovery team. For the many species associated with Garry Oak ecosystems, the Garry Oak Ecosystems Recovery Team (GOERT) was formed to lead in recovery planning and to coordinate recovery activities (see www.goert.ca). In addition to the ecosystems-wide recovery strategy, three approved multi-species recovery strategies covering 20 species, two proposed single-species strategies, and three proposed single-species management plans are currently posted on the SARA registry (as of June 2011): Garry Oak woodlands; maritime meadows associated with Garry Oak

ecosystems; vernal pools and other ephemeral wet areas associated with Garry oak ecosystems (www.goert.ca/publications); Rigid Apple Moss (www.sararegistry.gc.ca/virtual_sara/files/plans/rs_rigid_apple_moss_0411_e.pdf); Dense-flowered Lupine (www.sararegistry.gc.ca/virtual_sara/files/plans/rs_Dense_flowered_Lupine_0311_e.pdf); Coastal Wood Fern (www.sararegistry.gc.ca/virtual_sara/files/plans/mp_coastal_wood_fern_0411_e.pdf); Banded Cord-moss (www.sararegistry.gc.ca/virtual_sara/files/plans/mp_banded_cord_moss_0411_e.pdf); and Twisted Oak Moss (www.sararegistry.gc.ca/virtual_sara/files/plans/mp_twisted_oak_moss_0411_e.pdf).

Provincial

Protection of species at risk on non-federal land is under provincial jurisdiction and is subject to the legislation in each province. In British Columbia, there is currently no stand-alone legislation to protect species at risk or their habitats (i.e., protection for species at risk falls under several different Acts).

The *Wildlife Act* (1996, www.bclaws.ca/Recon/document/freeside/--%20W%20--/Wildlife%20Act%20%20RSBC%201996%20%20c.%20488/00_96488_01.xml) provides protection to all vertebrate species by prohibiting the possession, harassment, or injury of wildlife, or damage to designated wildlife habitat, other than as allowed by issued permits or licenses (e.g., for hunting) (MOE 1996). It also contains provisions to allow listing of vertebrate species as endangered or threatened. Only four species are currently listed under this act, none of which are associated with Garry Oak ecosystems (MOE 1996).

The *Wildlife Amendment Act 2004* (www.leg.bc.ca/37th5th/3rd_read/gov51-3.htm), which has not yet been brought into force by regulation as of 2010, enhances the protection of species at risk. It allows invertebrate and plant species (in addition to vertebrate species) to be listed, prohibits the

The Great Blue Heron *fannini* subspecies (*Ardea herodias fannini*) is a provincially Blue-listed species and a species of Special Concern nationally (SARA Schedule 1). On federal lands, it is fully protected under SARA and its nests and eggs are protected provincially under B.C.'s *Wildlife Act*. Additionally, the Great Blue Heron, its nests, and eggs are protected from harm under the Migratory Birds Convention of 1994 and from harm by forest and range practices by the *Forest and Range Practices Act*. Photo: Todd Carnahan

damage or destruction of a listed species' residence, and increases the penalties if these species or their residences are harmed (including killed, taken, etc.) (MOE 2004b). A residence is defined as an area or natural feature of the habitat of a species at risk that is habitually occupied or used as a dwelling place by one or more individuals of the species at risk (e.g., nest or den) (MOE 2004b).

The *Forest and Range Practices Act* (2004, FRPA, www.for.gov.bc.ca/code) governs the activities of forest and range licensees on provincial Crown land (MOFR 2008). FRPA enables the designation of areas of special management for species listed in the Category of Species at Risk or the Category of Regionally Significant Wildlife (MOE 2006). Within these areas, called Wildlife Habitat Areas, listed species are protected from damage due to forest and range practices. As of 2010, the Short-eared Owl (*Asio flammeus*), Great Blue Heron *fannini* subspecies (*Ardea herodias fannini*), and Lewis's Woodpecker (*Melanerpes lewisii*) are the only species associated with Garry Oak ecosystems listed under the Category of Species at Risk under the FRPA (MOE 2006).

Federal-Provincial

The federal, provincial, and territorial governments have jointly signed the *Accord for the Protection of Species at Risk* (www.sararegistry.gc.ca/approach/strategy/default_e.cfm), in which the importance of intergovernmental cooperation for the protection of species at risk is acknowledged (Environment Canada 2009). The Canadian Endangered Species Conservation Council (CESCC), composed of ministers from each level of government, was established to oversee the activities of COSEWIC and the various levels of government. The British Columbian and federal ministries responsible for the management of species at risk have also signed the *Canada-British Columbia Agreement on Species at Risk* (www.llbc.leg.bc.ca/public/PubDocs/bcdocs/419585/aa_Canada-British_Columbia_agreement_on_species_at_risk_0805_e.pdf). This agreement provides a framework for a coordinated approach to species at risk conservation and protection in the province (Environment Canada 2009).

4.2.2 Permits

Federal

Where a species is protected under SARA, a permit or agreement is required for any "activity affecting a listed wildlife species, any part of its critical habitat or the residences of its individuals" (Environment Canada 2009). For restoration activities in which "the activity benefits the species or is required to enhance its chance of survival in the wild," permits or agreements may be issued (Environment Canada 2009). This also includes the introduction or re-introduction of species listed on Schedule 1.

The following conditions must also apply:

- All reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;
- All feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and
- The activity will not jeopardize the survival or recovery of the species (Environment Canada 2009).

See the SARA public registry for further details on permits and agreements (www.sararegistry.gc.ca/sar/permit/permits_e.cfm, Environment Canada 2009).

Provincial

Under the *Wildlife Act*, the capture, possession, shipping, and import of a vertebrate species is forbidden without a permit (MOE 1996). Permits are therefore required for the translocation of any vertebrate wildlife species in British Columbia (see Section 4.4.5: Translocations).

Under the *Ecological Reserve Act* (1996) or the *Protected Areas of British Columbia Act* (2000), permits are required to conduct research activities in provincial parks and protected areas. Permitted activities relevant to restoration include "collection; monitoring; survey and inventory; and other research" (BC Parks 2007). See the BC Parks website for more information on permits (www.env.gov.bc.ca/bcparks/info/permit_overview.html) in provincial parks and protected areas.

Local

Permits are often required to work on municipal or regional district lands. This varies from one municipality or regional district to the next. Practitioners having restoration sites on such public lands should consult their local government regulations.

4.3 Planning for Restoration

Before beginning planning for ecological restoration involving species or ecosystems at risk, the practitioner must be able to guarantee a multi-year commitment to the restoration project. Most projects require on-going maintenance and monitoring (Chapter 7: Inventory and Monitoring); if this maintenance is not possible then restoration work should not begin. If restoration activities

Permits are needed for any activity that has the potential to affect a species at risk or its critical habitat on federal lands. A permit was required to conduct this survey of the Endangered (SARA Schedule 1) Yellow Montane Violet *(Viola praemorsa* spp. *praemorsa)* on Navigation Canada land at Mt. Tuam on Salt Spring Island. Photo: Carolyn Masson

are abandoned, previous efforts are rendered futile and can result in harming the species or ecosystems. Chapter 5: Restoration Planning goes through the process of planning a restoration project in detail; the information in this section will help you to flesh out the steps identified there.

4.3.1 Who to Contact

Species or Ecosystems at Risk Identification

Early in the planning phase of any restoration project in a sensitive Garry Oak or associated ecosystem, restoration planners should determine whether there are any species or plant communities at risk at the site.

- A detailed species inventory should be completed by a qualified biologist as there are a number of factors to consider in examining rare species. Among other considerations, these include familiarity with the species, time of year, and annual population fluctuations. The Garry Oak Ecosystems Recovery Team can provide referrals to qualified professionals (phone: 250-383-3427; email: info@goert.ca).
- Consult the B.C. Ministry of Environment's Conservation Data Centre to find out if they have any such records at the restoration site. This can be done by using their online mapping tool (http://webmaps.gov.bc.ca/imfx/imf.jsp?site=imapbc) or by contacting the CDC staff directly (phone: 250-356-0928; email: cdcdata@gov.bc.ca).
- Consult the B.C. Species and Ecosystems Explorer (www.env.gov.bc.ca/atrisk/toolintro.html) to see if any of the species found on the site are provincially listed as at risk.
- Check the SARA public registry (www.sararegistry.gc.ca/species/default_e.cfm) to see if any of the species found on the site are also federally listed.

Before beginning planning for ecological restoration involving species or ecosystems at risk, the practitioner must be able to guarantee a multi-year commitment to the restoration project.

Expert Advice

Obtain expert advice from a qualified specialist when planning any restoration project. Such a specialist can include university researchers, specialized consultants, local stewardship groups, or government biologists (GOERT 2003a). Again, GOERT can be contacted for referrals to such specialists.

In addition, for many SARA-listed species, recovery teams consisting of government and conservation experts have been formed. When working with any species for which such a recovery team exists, the team must be involved in the entire planning and restoration process. A list of the recovery team chairs and their contact information can be found on the SARA website (www.sararegistry.gc.ca). For species occurring in Garry Oak or associated ecosystems, contact GOERT.

Landowner Contact

Permission should be obtained from all relevant landowners to conduct restoration work on their land. If landowners are municipalities or other government agencies, this might require additional permits (see Section 4.2.2).

Conducting detailed inventories of a site is an important first step in the planning of any restoration project. Photo: Kersti Vaino

4.3.2 Identifying Threats

All threats to rare species or ecosystems, both imminent and long-term, should be identified. This will need to be done by a qualified professional or in consultation with a recovery team, if applicable, who will likely already have produced a list of threats. For those species having a recovery strategy (see Section 4.2.1), the strategy will include a section on identified threats, as will any COSEWIC status reports (www.sararegistry.gc.ca/search/advSearchResults_e.cfm?stype=doc&docID=18). Potential threats that might occur as a result of restoration activities (e.g., trampling and soil compaction or disturbance) should also be identified so that these can be minimized.

4.3.3 Identifying Habitat

Very little is known about many species at risk and their habitat requirements. It is therefore important that the restoration practitioner learn as much as they can about the species' biology in order to understand its habitat requirements to the fullest extent possible. The habitat important to the species' survival at the site should then be identified. GOERT maps and monitors habitat for many of the species at risk in Garry Oak and associated ecosystems and can provide this information on request to assist with restoration efforts. Habitat elements that are important to consider include seepages, plant associations, and shade that provide essential ecosystem functions (see Section 3.4.2) for the species. Suitable habitat (i.e., additional habitat that meets the species' requirements but does not contain the species) should also be identified. Restoration activities should maintain these habitat elements and ecosystem functions to ensure the survival of the species at this site. More information on a number of species at risk, including their habitat requirements, is available in the field manual, *Species at Risk in Garry Oak and Associated Ecosystems in British Columbia* (www.goert.ca/pubs_at_risk.php).

CASE STUDY

Case Study 1. Golden Paintbrush and Parasitic Associations

by Matt Fairbarns

Golden Paintbrush (*Castilleja levisecta*) is a perennial herbaceous plant that occurs in a small proportion of native grassland areas on islands near Victoria, B.C., and similar habitats in Puget Sound. It is globally rare and listed as Endangered in Canada, where only two populations remain (Ryan and Douglas 1995). The Garry Oak Ecosystems Recovery Team has supported recovery actions for Golden Paintbrush, including the removal of invasive species from its habitat, studies into its seasonal development and population processes, and experiments on propagation techniques. A key requirement for successful propagation involves the establishment of an essential parasitic relationship with a suitable host plant.

Parasitism is often viewed in a negative light but this view is incompatible with a mature appreciation of biodiversity, considering the rich assemblage of native plants and animals which are parasitic on others. Upon reflection, parasitism is evidently similar to predation in many respects (although many hosts may cope with parasitism, while predation tends to have more fatal consequences).

Golden Paintbrush (*Castilleja levisecta*) blooming among the Common Camas (*Camassia quamash*) of Trial Island. Photo: Chris Junck

Some parasitic plants extract both basic nutrients and complex energy sources from their hosts. They typically lack chlorophyll, since they rely upon the photosynthesis of their host plants. Lacking chlorophyll, their stems and leaves are often white rather than green. Such species are referred to as holoparasites. Golden Paintbrush, in contrast, is a hemiparasite. It invests little effort in building an extensive root system; instead it simply latches on to the roots of other plants using special suction-cup structures called haustoria. The haustoria extract water and mineral nutrients from the host plant and for this reason hemiparasites are also called root parasites. Unlike holoparasites, however, they do produce green leaves containing chlorophyll, which harvest energy from the sun to build carbon-based structures.

It is likely that Golden Paintbrush, like many of its close relatives, is capable of growing even in the absence of a host. Nevertheless, by latching on to the roots of a suitable host it can reduce the amount of energy expended in creating an extensive root system and use the "savings" to build larger shoots and more seeds.

The association between hemiparasite and host is a relatively random process and a broad range of species may be parasitized. A single Golden Paintbrush plant may form haustorial connections with more than one host and populations may collectively form a complex network of interconnected root systems with many host plants across a wide range of species. Different host plants may have different effects on their hemiparasite's growth and reproduction, and some hosts may actually reduce the parasite's success.

Golden Paintbrush is not easily re-introduced to areas where it formerly occurred, nor is it easy to add plants to existing populations to increase their population size. Attempts to do so by adding

CASE STUDY

seed tend to meet with little success, even when large numbers of seed are used and a favourable seedbed is created at the translocation site. For example, Fairbarns (2009) sowed 9,000 seeds of Golden Paintbrush into a maritime meadow site on Trial Island, site of Canada's largest population of Golden Paintbrush. The experimental site lay within 20 metres of an existing subpopulation of Golden Paintbrush and shared the same habitat conditions. Despite the large number of seeds, no Golden Paintbrush plants were observed in the experimental area over the following four growing seasons. While some germination may have occurred (the seedlings are extremely small and very difficult to observe), the experiment was unsuccessful in augmenting the existing population. Similar results have been obtained in Washington State: Pearson and Dunwiddie (2006) found that even with large numbers of seed sown over a number of years, these efforts alone were insufficient to establish a new population. They had much greater success planting out Golden Paintbrush plants which had been raised in a greenhouse environment together with a suitable host plant.

Future trials to establish Golden Paintbrush plants would benefit by using greenhouse-reared plants growing with a host such as Woolly Sunflower (*Eriophyllum lanatum*), a host plant which occurs naturally in the maritime meadow environments favoured by Golden Paintbrush.[1]

Golden Paintbrush is not the only hemiparasitic species at risk in Garry Oak ecosystems. Victoria's Owl-clover (*Castilleja victoriae*), a globally endangered species entirely restricted to vernal seeps associated with Garry Oak ecosystems, is a closely related species. Rosy Owl-clover (*Orthocarpus bracteosus*) and Bearded Owl-clover (*Triphysaria versicolor*) are also hemiparasitic species at risk found in vernal seeps and pools associated with Garry Oak ecosystems. Attempts to restore the three owl-clover species are complicated by the fact that they are delicate, short-lived annuals which may be difficult to propagate and are likely to die when transplanted. These difficulties, along with their hemiparasitic life strategy, complicate translocation efforts.

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1 In 2009, Parks Canada translocated 250 greenhouse-reared Golden Paintbrush plants to a small islet in Gulf Islands National Park Reserve. The experimental translocation is designed to address key biological and ecological knowledge gaps and to test translocation methodologies. If successful, the experimental population will be augmented to establish a viable self-sustaining population. (N. Kroeker, pers. comm. 2011).

4.3.4 Defining Goals

A critical step for any successful restoration project is to set target restoration goals. For species at risk, it is further necessary to ensure that these fit into the long-term recovery goals for the species, which are determined in consultation with the recovery team and recovery strategy, when these exist, and/or a qualified expert. Recovery goals should be applied to the individual project, resulting in restoration goals and objectives that address the site-specific threats to the species.

Typical recovery goals for a species at risk are:

- To maintain the current population
- To expand the current population
- To re-introduce or introduce a new population or sub-population

To maintain the current population, restoration objectives should mitigate identified threats and maintain identified important habitat. In addition to this, objectives for expansions of current populations should maintain or create suitable habitat adjacent to the existing population. Objectives for the introduction or re-introduction of a species at risk (via translocation; see Section 4.4.4 for more information on translocations) should maintain existing, or create new, suitable habitat at the recipient site.

When a site has species at risk, target restoration goals must fit into the long-term recovery goals for the species.

The provincially recognized recovery goals for Endangered Sharp-tailed Snakes *(Contia tenuis)* are to ensure the species persistence across its native range in Canada over the long-term, and to maintain known occurrences of Sharp-tailed Snakes in the short-term. Creating artificial cover objects, like the ones pictured above, is one way to counteract the degradation of Sharp-tailed Snake habitat. Photo: Carolyn Masson

4.3.5 Funding Programs

There are several government sources of funding available for work on the protection and recovery of species at risk. Target groups involved in restoration projects can apply for funding from these sources.

Table 4.2 Government funding sources available for the restoration of species at risk

Name	Description	Target Groups	Agency
Habitat Stewardship Program (HSP) www.ec.gc.ca/hsp-pih/default.asp?lang=En&n=59BF488F-1	"The overall goal of the HSP is to "contribute to the recovery of endangered, threatened, and other species at risk, and to prevent other species from becoming a conservation concern, by engaging Canadians from all walks of life in conservation actions to benefit wildlife.""	Any group conducting activities on private lands, provincial Crown lands, Aboriginal lands, or in aquatic and marine areas	Environment Canada with Parks Canada and the Department of Fisheries and Oceans
Inderdepartmental Recovery Fund (IRF) www.fir-irf.gc.ca/dspConfirmation_E.cfm?action=not_logged_in	"The IRF provides access to funding for federal departments and departmental corporations for implementing recovery activities for and conducting surveys on species at risk that occur on federal lands or waters, or for species under federal jurisdiction."	Federal departments and departmental corporations	Environment Canada
Endangered Species Recovery Fund (ESRF)[a] wwf.panda.org/who_we_are/wwf_offices/canada/projects/index.cfm?uProjectID=CA0063	"The ESRF sponsors high-priority research and education projects to assist in the recovery of extirpated, endangered and threatened Canadian species, and to prevent other species from becoming so classified."	University researchers and conservation organizations	Environment Canada and World Wildlife Fund–Canada
Ecological Gifts Program www.cws-scf.ec.gc.ca/egp-pde	"In order to help Canada's landowners and conservation groups preserve Canada's natural heritage, the Government of Canada has eliminated the tax on capital gains for all certified ecological gift donations made on or after May 2, 2006 by reducing the inclusion rate to zero."	Private landowners and corporations	Environment Canada
EcoAction www.ec.gc.ca/ecoaction	"EcoAction encourages project submissions that will protect, rehabilitate or enhance the natural environment, and build the capacity of communities to sustain these activities into the future."	Non-profit groups	Environment Canada

a This funding source is under review as of 2010

4.4 Special Considerations for Restoration Methods

Restoration methods should be tailored for every site and species. Best management practices are not known for many species and are changing as new and more effective methods are discovered. Methods should therefore be determined in consultation with an expert and using an adaptive management approach, which may require some experimentation. Adaptive management allows restoration practitioners to learn about the species throughout the restoration project and to adapt their methods and objectives based on the responses of the target species.

These considerations for restoration methods are meant to complement Chapter 8: Restoration Strategies with specific reference to species at risk. Other sources and experts should be consulted. GOERT's *Species at Risk in Garry Oak and Associated Ecosystems in British Columbia* (www.goert.ca/pubs_at_risk.php) manual has some management information for a growing number of species at risk, and GOERT is producing an increasing number of documents to guide activities in Garry Oak and associated ecosystems. Restoration practitioners should regularly check GOERT's webpage (www.goert.ca/publications) for new materials.

General management recommendations that apply for all species and ecosystems at risk occurrences include the following (GOERT 2003):

- Access to the site as well as land use should be limited, particularly at times of the year when the occurrence is most sensitive
- Pesticides and herbicides should be used with extreme caution in the immediate and surrounding areas
- All affected landowners should be notified of the occurrence of an at-risk species or ecosystem and appropriate management practices encouraged

CASE STUDY

Case Study 2. Habitat Restoration for an Endangered Bird Species, the Coastal Vesper Sparrow, at the Nanaimo Airport: a Study in Adaptive Management

by Trudy Chatwin

The Coastal Vesper Sparrow, listed federally under the name Vesper Sparrow, *affinis* subspecies, (*Pooecetes gramineus affinis*) is a small bird that occupies sparsely vegetated grasslands with scattered shrubs or trees, and occurs west of the Cascade Mountains (COSEWIC 2006). It is rare in Canada and is federally listed as Endangered and is also on the provincial Red List. The Garry Oak Ecosystems Recovery Team's Vertebrates at Risk Recovery Implementation Group (Verts RIG) has been working over the past 7 years (2003–2010) to recover the remaining population of around 6 pairs of the sparrow. An inventory of Vancouver Island in 2002 revealed that the only remaining site occupied by Coastal Vesper Sparrows in Canada is at the Nanaimo Airport. Funding from the Habitat Stewardship Program, the GOERT Society, and Canadian Wildlife Service has supported inventory, stewardship, and restoration work at the Nanaimo Airport since that time.

The federally Endangered, provincially Red-listed Vesper Sparrow *affinis* subspecies (*Pooecetes gramineus affinis*) nests on the ground. Extreme caution must be taken when surveying the habitat of this species and when coordinating restoration efforts. Photo: Shyanne Smith

Issues and Considerations

The Coastal Vesper Sparrow utilizes habitat at the south end of the airport that is comprised of grasses, forbs, shrubs, and the occasional cottonwood tree. In some areas, vegetative cover is minimal due to the gravelly nature of the substrate and the majority of the cover is comprised of introduced species of grasses and forbs and Scotch Broom (*Cytisus scoparius*). The sparrows nest on the ground under partial cover of mown broom, Himalayan Blackberry (*Rubus armeniacus*), and other forbs. Males use the broom, as well as fences, for singing perches, while both sexes also use the broom as escape cover. Although the sparrows use the broom patches and sparsely vegetated grassland in between, the Verts RIG is concerned about allowing the aggressive invasion of broom to continue. It is thought that ultimately this invasion will result in filling in the open areas and also result in excessive nitrogen in the soil, thus promoting lush grass growth and reducing habitat quality. The Nanaimo Airport Commission is also concerned that the broom harbours introduced European Rabbits (*Oryctolagus cuniculus*) that cause significant safety concerns at the airport.

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Restoration History

In 2002, the Verts RIG began discussions with the Nanaimo Airport Commission on how to maintain the habitat of the endangered bird and meet the commission's safety interests. A Stewardship Agreement was signed which recommended that no more than 20% of broom be removed in the area occupied by the sparrow and that any mowing and broom removal not be done during the breeding period. From 2003 to 2005, some areas were hand-thinned using loppers and weed trimmers and a larger adjacent area was cleared using a mechanical mower in 2003. In 2005, native shrubs (Common Snowberry (*Symphoricarpos albus*), Saskatoon (*Amelanchier alnifolia*), and Nootka Rose (*Rosa nutkana*)) were planted to replace the broom but within months these had been chewed by the introduced rabbits. The sparrows used all the areas following clearing; however, the mowed areas were quickly re-populated by broom growing to 90 cm high! In 2006 and 2007, hedgerows of the burgeoning broom were cleared. In March 2007, excavators were used to scarify the habitat in the south-east corner of the airport, leaving only about 5% herbaceous cover. Large piles of cut broom were left on site. Despite this major habitat alteration, the sparrows used the hedgerows and the broom piles as singing perches. However, during the nesting seasons, the majority of the population shifted further to the south end of the airport. The habitat that had been excavated filled in with sparse grasses and herbs by 2008 and looked as though it would serve as nesting habitat in the 2009 breeding season. However, the Coastal Vesper Sparrows shifted their nesting south again. Only one bird held a territory at the south end of the excavated area and no nests were found in the hand-cleared areas.

Adapting Restoration to Changing Habits of the Coastal Vesper Sparrow

Given the changing nesting pattern, it was uncertain what direction to take for restoration. In the fall of 2008, members of the Verts RIG did a joint field inspection with airport staff to discuss this. It was decided that a hydro-mower would be hired to cut all non-native vegetation in an area north[1] of the birds' territories. Prior to the hydro-mowing, all native Nootka Rose, Cottonwood (*Populus* sp.), and Trailing Blackberry (*Rubus ursinus*) were flagged and broom was hand cleared around them. In this way, the hydro-mower could clearly avoid the native shrubs. After mowing, the vegetative debris was raked from gravelly areas in order to avoid undesirable mulching of the potentially suitable habitat. Native shrubs were again planted with protective barriers in April just before the sparrows returned to nest. In the 2009 breeding season, the sparrows continued their southward movement and did not use the restored areas. It is believed that this movement was due mostly to bird site fidelity and conspecific attraction[2], rather than habitat preference.

Due to the ever-burgeoning broom problem, restoration activities in fall 2009 and 2010 involved hand-cutting broom in patches adjacent to the habitat used by the sparrows in those years. The patches were based on a 5 m radius around patches of likely habitat on gravelly substrate. The cleared patches have been mapped to better judge the effectiveness of the program.

Conclusion

While there were limitations to the effectiveness of the restoration program, each year joint field

1 There was concern that cutting broom in the existing territory of the sparrows might alter the habitat too much.

2 Conspecific attraction is the attraction of being near others of the same species.

meetings were held to determine the plan of action based on the response of the sparrows, the vegetation, and the interests of the Nanaimo Airport Commission. A variety of techniques were used, ranging from hand-cutting to excavating, to restore the degraded ecosystem. The most effective method for maintaining Coastal Vesper Sparrow habitat at the Nanaimo Airport appears to be a combination of mowing and hand-clearing.

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4.4.1 Alien Invasive Species

Second only to habitat loss, the presence of alien invasive species is the greatest threat to Garry Oak and associated ecosystems and their species at risk. However, there are instances when alien invasive species can serve a critical ecosystem function for a species at risk and might need to be preserved. For example, some rare plants may rely on protection from herbivory provided by invasive shrubs, and some rare butterflies feed extensively on invasive plant species. See Chapter 9 for more information on alien invasive species and control methods.

Before any alien invasive species are removed, the impact of their removal should be evaluated and a strategy developed to minimize potential negative impacts. The removal of invasive plants by pulling up the roots can disturb the soil, which further encourages the germination of alien plant seeds (e.g., see Ussery and Krannitz 1998). Plants should therefore be removed in a manner that minimizes soil disturbance. This can be achieved by cutting instead of hand pulling or, if pulling is required, by doing so in the wetter winter months when the soil is softer. The presence of some invasive species also affects the chemistry of the site. For example, Scotch Broom (*Cytisus scoparius*) fixes nitrogen from the air and increases soil nutrient levels (GOERT 2003b). Once cut, broom can leave behind nitrogen-rich soils favourable to invasive species, and cut broom plants should be removed from sensitive areas to reduce the effects of the phytotoxin they produce which inhibits growth of other plants.

Before any alien invasive species are removed, the impact of their removal should be evaluated and a strategy developed to minimize potential negative impacts.

The impacts of invasive and/or alien species should be evaluated prior to their removal. Many Garry Oak ecosystems have been used for sheep grazing, beginning in the mid- to late-1800s, and sheep remain feral on Salt Spring Island today. Exclosure experiments can be used to assess the potential positive and negative effects that this alien species has on Garry Oak and associated ecosystems. The exclosure fencing is protecting a population of Endangered, Red-listed Yellow Montane Violet (*Viola praemorsa* spp. *praemorsa*) from sheep grazing. Photo: Carolyn Masson

4.4.2 Hydrologic Regimes

Hydrologic regimes can be important to plant and animal species alike. Many rare plants in these ecosystems, particularly those adapted to seasonally flooded areas or seeps, rely on the presence of soil moisture at critical times of the year for survival. For some animals, the dependence on soil moisture is indirect, such as the Common Ringlet butterfly (*Coenonympha california insulana*) relying on green grasses throughout the dry summer months to provide habitat for larvae, and the Sharp-tailed Snake (*Contia tenuis*) relying on the presence of slugs for food, which require moist soils (GOERT 2003). It is important that restoration practices do not disrupt the hydrology of the site, or if it has already been disrupted, that the hydrology be restored. Soil compaction due to trampling or the use of heavy machinery should be avoided around sensitive areas; also, if hydrology-altering species are present e.g., Orchard-grass (*Dactylis glomerata*) or Sweet Vernalgrass (*Anthoxanthum odoratum*), restoration for the site should include removing and controlling them.

4.4.3 Timing of Restoration

Appropriate timing is critical to the effectiveness of restoration efforts and must be incorporated into the work plan. Restoration work conducted in the vicinity of a species at risk occurrence could be more damaging than beneficial if carried out at the wrong time of year. Areas in the vicinity of a species at risk should be avoided during the most sensitive times in the species' lifecycle, e.g., when plants are developing, flowering, and setting seed; when insect larvae are developing; and when birds are nesting. It is important instead to undertake restoration activities when they will have the least negative effect on the target species and its critical habitat. For plants this will usually be after they have set seed or when they are dormant, and for animals this time is typically after the young have matured. If restoration work must be conducted during the sensitive period, extreme care must be taken not to damage the target species.

Restoration work conducted in the vicinity of a species at risk occurrence could be more damaging than beneficial if carried out at the wrong time of year.

Restoration work, including planting native grass plugs (as shown here), is conducted each fall at Somenos Garry Oak Protected Area in Duncan, B.C. By mid-fall all the native forbs, including at least three species at risk, are dormant at the site and restoration work can be conducted with minimal damage to the native species. Photo: Dave Polster

Due to the seasonality of Garry Oak and associated ecosystems (i.e., extreme wetness in winter and spring followed by summer drought), the sensitive time of year for most species falls between early spring and early summer. However, this is not the case for all species, such as the White-top Aster (*Sericocarpus rigidus*) which flowers in late summer, and the Common Ringlet butterfly, which produces a second brood during the summer. It is therefore important that enough is known about the biology and lifecycle of a species to be able to avoid its sensitive times (see Section 4.3.3 Identifying Habitat). More information on a number of species at risk, including their life histories, is available in the *Species at Risk in Garry Oak and Associated Ecosystems in British Columbia* (www.goert.ca/pubs_at_risk.php) manual.

4.4.4 Translocations

By translocation, a species can be either re-introduced to where it was once known to occur or introduced to a new site where it has not historically occurred. Translocations are only to be used when the long-term survival of existing populations cannot be ensured and other management options have failed. It is important that translocations never come before the protection and management of plants *in situ* and are not viewed as a solution to their destruction at a site.

Translocations are the deliberate movement of individuals or propagules from one location to another. They can be used to re-establish the historical distribution of a species (see Case Study 3), to maintain or restore biodiversity, to promote conservation awareness, and to increase our understanding of the biology, ecology, and genetic adaptation of a species at risk (Austin 2004; Vallee et al. 2004; McKay et al. 2005). Translocation may include adding new individuals to an existing population (augmentation), establishing a new population within the historical range (introduction), or establishing a population in a location which had previously supported the species (re-introduction). Translocation beyond the historical range of the species should only be done in well-thought-out circumstances, for example, when no other sites that seem appropriate are available within the range, or in anticipation of long-term climate change.

Translocations must be planned very carefully, as poorly conducted ones may cause damage to both donor and recipient sites. Insufficient knowledge of the biology, ecology and genetic adaptation of the species at risk can lead to failures (see Fiedler 1991; Falk et al. 1996) through the introduction of pathogens, alteration of ecological processes, and/or displacement of other species (see Fahselt 1988; Vallee et al. 2004). Many translocation projects are expensive and have low success rates due to the fact that they need long-term maintenance and necessary goals and targets are not established. Few monitoring data are available to prove the long-term viability of translocated populations.

CASE STUDY

Case Study 3. The San Juan Islands Western Bluebird Re-introduction Project

by Lisa Dumoulin

A bright spring sky falls
Speck by speck into the valley
Bluebirds returning

–ELIZA HABEGGER

Background

After an absence of almost 50 years, Western Bluebirds (*Sialia mexicana*) are once again migrating to breed in the San Juan Islands, a small archipelago north of Puget Sound, Washington. The spring and summer of 2010 saw the return of 24 Western Bluebirds, the most to return to the islands since their extirpation in the 1960s (K. Foley, pers. comm. 2010). The birds' return is a mark of success for the San Juan Islands Western Bluebird Re-introduction Project: a five-year project (2007–2011) to re-establish a breeding population of the birds on the San Juan Islands.

A male and female Western Bluebird perch on the feeding station near their nestbox on San Juan Island. Their nesting is one of the many incremental successes that the San Juan Islands Western Bluebird Re-introduction Project has had since its initiation in 2007. Photo: Elyse Portal

The natural range of Western Bluebirds is from Mexico to Canada, west of the Rocky Mountains (Peterson 1990). Western Bluebirds began to decline in abundance in the northern extent of their range during the 1930s due to the loss of suitable habitat (e.g., Garry Oak woodlands and meadows). The extirpation of the Georgia Depression population of Western Bluebirds from the San Juan Islands was driven primarily by the declining availability of a specific habitat element—nest cavities—through the conversion of oak woodlands to agricultural lands and through management practices that removed large dead trees. Prior to their decline, Western Bluebirds were a significant part of the landscape (www.sjpt.org). The San Juan Islands Western Bluebird Re-introduction Project (a partnership of the San Juan Preservation Trust [SJPT], the American Bird Conservancy, the San Juan Islands Audubon Society, and the Ecostudies Institute) has embraced the bluebird as a "flagship species" for their ongoing efforts to restore and preserve the integrity of the San Juan Islands' Garry Oak ecosystems (Slater 2009).

Justification

Ecologically, the Western Bluebird is an ideal candidate species for a re-introduction program. Bluebirds breed in a wide variety of open habitats, as long as nest cavities, low perches and an open understorey are present (Guinan et al. 2008). Moreover, individuals often show site fidelity, returning to the same nesting territory year after year. Juveniles, too, have been observed to return to their site of fledging (Scriven 1999). Being cavity nesters, they also respond well to nestbox programs (Slater 2009). Western Bluebirds have re-colonized areas of their former range in Oregon and Washington where nestbox programs have been managed effectively. Furthermore, the recent successful re-establishment of Eastern Bluebirds (*Sialia sialis*) in South Florida through translocation offers transferable methodologies suitable for a re-introduction of Western Bluebirds (Slater 2001, Lloyd et al. 2009).

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Equally, the San Juan Islands are well-suited for supporting bluebirds. The San Juan Islands and the Canadian southern Gulf Islands were among the last strongholds for the Georgia Depression population of Western Bluebirds in the northern extent of their range. Although much of the land on the San Juan Islands has been transformed for agricultural purposes, a pre-project assessment indicated that suitable habitat was sufficient (with nestbox management) in north Puget Sound, centred on San Juan Island, to support a population (G. Slater, pers. comm. 2010). By providing bluebird-specific nestboxes, a key component of their habitat needs—cavities for nesting—is restored.

Translocation

For the San Juan re-introduction, bluebirds are translocated as pairs from the source population at Fort Lewis, WA by road and ferry. The birds are then placed into large outdoor aviaries located in suitable habitat at sites on San Juan Island. Pairs are held until there is evidence of nest-building or other breeding behaviour. Pairs are released after three weeks if no breeding or nest building activity is observed during the holding period. Later in the breeding season, some pairs are translocated with nestlings. During transport, nestlings are separated from their parents so that they can be fed and to reduce stress to the adults. Juveniles and their parents are reunited in the aviary upon arrival to San Juan Island (K. Foley, pers. comm. 2010a). These family groups are released once the young have fledged and are capable of sustained flight (G. Slater, pers. comm. 2010). Single females are also translocated to balance the increasing male-bias of the re-establishing population.

Results

To date (fall 2010), 79 adults have been translocated, and in 2010, after the fourth year of the project, the established bluebird population size on San Juan Island has reached 33 adults (San Juan Islands Bluebird Project, unpublished data). The program has met preliminary criteria of success: individuals have been safely translocated to the release site and released individuals have established breeding territories; both translocated individuals and their offspring have reproduced successfully; and the re-introduced population has grown in size each year (G. Slater, pers. comm. 2010). In 2007, the first year of the project, only one pair was observed to have bred and only three young are known to have fledged. In 2010, 84 juveniles fledged. Program managers are optimistic that the population will continue to increase in 2011, the last year of re-introductions. However, as with any re-introduction or translocation project, the re-colonization process is slow, and the establishing San Juan Islands bluebird population is vulnerable, making long-term monitoring an important component of a re-introduction project.

The San Juan Islands Western Bluebird Re-introduction Project has followed IUCN's Guidelines for Re-introductions (International Union for Conservation of Nature, IUCN 1998). Results from the project will contribute to the growing documentation of re-introduction projects, particularly for land birds. Therefore, the results should help improve the success rate of species re-introductions, a primary goal in the field of re-introduction biology (Sutherland et al. 2010; Ewen and Armstrong 2007; Seddon et al. 2007).

Challenges and Successes

Among the most challenging aspects of the project were developing and implementing translocation protocols, adapting aviary logistics, and finding and monitoring released birds. Much of this project's success can be attributed to the Bluebird Project's adaptive management practices. Several aspects of the project have been refined as the project has progressed. For example, the project switched

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to using larger aviaries and longer holding times after territory establishment was relatively low with small aviaries and a short holding period (K. Foley, pers. comm. 2010b). Project managers also responded to the increasingly male-biased sex-ratio of the establishing population by developing translocation and release protocols for single females. The project has increased juvenile survival and adult reproductive success by increasing the amount of supplemental food (mealworms) provided to nesting pairs during periods of cold weather and periods when young are feeding in the nest, and the first several weeks following fledging. Predator and competitor deterrents have also been erected where necessary (K. Foley, pers. comm. 2010a).

Access to greater funds has also allowed the Bluebird Project to realize increased successes. In the first year of re-introductions there were no available funds to support a full-time technician, despite the need for consistent monitoring of the released birds' health and whereabouts. Since 2008, however, the Bluebird Project has been able to fund a full-time summer technician. The technician plays an essential role, monitoring the birds post-release and surveying for returning birds, monitoring nestboxes in established breeding territories, providing supplemental food, and identifying and mediating threats in each nesting territory.

Community involvement in the Bluebird Project has also contributed to its successes. The SJPT, who has responsibility for the majority of the local education and outreach efforts, initially approached the San Juan Island community through educational seminars prior to commencing the re-introduction. Interested nestbox hosts and monitors were sought and community concerns were addressed. Nestbox hosts often play an important role in the project (the nest that produced three clutches in 2010 is provided supplemental mealworms by its nestbox host twice a day), acting in addition to the summer technician. Being able to play a significant role in supporting a family of bluebirds encourages a sense of ownership of the project for nestbox hosts. The SJPT hopes that this involvement in turn may encourage greater community support for prairie oak ecosystem preservation (www.sjpt.org). The SJPT has also engaged its community creatively, providing nestbox kits for purchase, holding nestbox building workshops, staffing outreach booths at local farmers' markets, conducting educational programs for schoolchildren, conducting media releases, writing a website blog, distributing an e-newsletter, and even holding a bluebird haiku contest (K. Foley, pers. comm. 2010b)! Generating and sustaining sufficient community support for the re-introduction project has been crucial to its success thus far.

Next Steps

For the re-introduced San Juan Island Western Bluebird population to persist, additional populations or sub-populations will need to be established within the northern extent of the species' range (Slater 2009). New populations may emerge through dispersal, as the San Juan Island population grows, but additional translocations may be necessary. A re-introduction project is currently being planned by the Garry Oak Ecosystems Recovery Team (GOERT) for 2012–2016 in the Canadian southern Gulf Islands, part of the same archipelago as the San Juan Islands. The GOERT project will face additional challenges, including permitting for the international transport of living species. The project will benefit, however, by the lessons learned and experience gained through the San Juan project.

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Surveys to monitor the results of restoration should be conducted annually by a qualified biologist and at the appropriate time(s) of year.

4.4.5 Monitoring

Prior to commencing restoration work on any site, it is strongly recommended that a baseline survey be conducted. A baseline survey provides a starting point for all future surveys to be compared against. The focus of the baseline survey for species at risk will be to gather data on the size (distribution and number of individuals) and condition (population health and reproductive success) of species at risk on the site.

All known populations of species at risk, whether the target of restoration efforts or not, should be monitored on a long-term basis for population trends (GOERT 2003a). As relatively little is known about many rare species, monitoring helps us to learn more about their biology, evaluate their viability, and detect developing threats. Surveys to monitor the results of restoration should be conducted annually by a qualified biologist (see Section 4.3.1 Who to Contact) and at the appropriate time(s) of year. Any new data on a species at risk occurrence should be reported to the Conservation Data Centre (GOERT 2003a). See Chapter 7: Inventory and Monitoring for more information on monitoring.

Experimental plots, like the exclosure and control pictured here, help to refine local knowledge and restoration practices but require a multi-year commitment to maintenance and monitoring. The restoration taking place at the site above has been on-going for three years. Experimental plots are being maintained to assess whether the restoration is benefiting the species of Special Concern at the site. Photo: GOERT

All known populations of species at risk, whether the target of restoration efforts or not, should be monitored on a long-term basis for population trends. Deltoid Balsamroot (*Balsamorhiza deltoidea*) is a Red-listed, Endangered (SARA Schedule 1) species at risk in Garry Oak woodlands. Photo: Carolyn Masson

4.5 Conclusions

It is important to consider species and ecosystems at risk during any restoration project and the effects that the project might have on them. This chapter provides resources to help restoration practitioners determine whether there are species or ecosystems at risk on their site. If present, then restoration practitioners should work with the appropriate experts to learn all that they can about the occurrence and how to manage for its survival. It is important that restoration activities not be detrimental to these sensitive species and that every effort be made to preserve them. The restoration project should be planned with care, utilizing the principles and guidelines discussed in this chapter.

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Appendix 4.1

Listed Species at Risk in Garry Oak and Associated Ecosystems[a]

A. ALPHABETICALLY BY ENGLISH NAME

English Name	Scientific Name	Global Rank	Provincial Rank	COSEWIC Status[b]	BC Status	REUs[c]
VASCULAR PLANTS						
Bear's-foot Sanicle	*Sanicula arctopoides*	G5	S1	E	Red	1; 3
Bearded Owl-clover	*Triphysaria versicolor* ssp. *versicolor*	G5T5	S1	E	Red	5; 6
Bog Bird's-foot Trefoil	*Lotus pinnatus*	G4G5	S1	E	Red	6
Brook Spike-Primrose	*Epilobium torreyi*	G5	SX	E	Red	5; 6
California Buttercup	*Ranunculus californicus*	G5	S1	E	Red	5
California Hedge-parsley	*Yabea microcarpa*	G5?	S1S2		Red	3; 4
California-tea	*Rupertia physodes*	G4	S3		Blue	3
Carolina Meadow-foxtail	*Alopecurus carolinianus*	G5	S2		Red	5
Coast Microseris	*Microseris bigelovii*	G4	S1	E	Red	6; 7
Coastal Scouler's Catchfly	*Silene scouleri ssp. grandis*	G5TNR	S1	E	Red	5
Coastal Wood Fern	*Dryopteris arguta*	G5	S2S3	SC	Blue	7;8
Common Bluecup	*Githopsis specularioides*	G5	S2S3		Blue	4
Cup Clover	*Trifolium cyathiferum*	G4	S1		Red	6
Deltoid Balsamroot	*Balsamorhiza deltoidea*	G5	S1	E	Red	1; 3;5
Dense Spike-primrose	*Epilobium densiflorum*	G5	S1	E	Red	2;5;6
Dense-flowered Lupine	*Lupinus densiflorus* var. *densiflorus*	G5T4	S1	E	Red	5
Densetuft Hairsedge	*Bulbostylis capillaris*	G5	S1		Red	4
Dune Bentgrass	*Agrostis pallens*	G4G5	S3S4		Yellow	5

Dwarf Sandwort	*Minuartia pusilla*	G5	S1	E	Red	6
Elegant Rein Orchid	*Piperia elegans*	G4	S3S4		Yellow	5
Erect Pygmyweed	*Crassula connata* var. *connata*	G5TNR	S2		Red	5
Farewell-to-spring	*Clarkia amoena* var. *caurina*	G5T5?	S3		Blue	5
Farewell-to-spring	*Clarkia amoena* var. *lindleyi*	G5T5	S3		Blue	5
Fern-leaved Desert-parsley	*Lomatium dissectum* var. *dissectum*	G4T4	S1		Red	3; 5
Foothill Sedge	*Carex tumulicola*	G4	S2	E	Red	5
Fragrant Popcorn-flower	*Plagiobothrys figuratus*	G4T4	S1	E	Red	5; 6; 7
Geyer's Onion	*Allium geyeri* var. *tenerum*	G4G5T3T5	S2S3		Blue	5
Golden Paintbrush	*Castilleja levisecta*	G1	S1	E	Red	5
Gray's Desert-parsley	*Lomatium grayi*	G5	S1	T	Red	3
Green-sheathed Sedge	*Carex feta*	G5	S2		Red	5; 6
Heterocodon	*Heterocodon rariflorum*	G5	S3		Blue	4; 5
Howell's Triteleia	*Triteleia howellii*	G3G4	S1	E	Red	5
Howell's Violet	*Viola howellii*	G4	S2S3		Blue	5
Kellogg's Rush	*Juncus kelloggii*	G3?	S1	E	Red	5; 6
Lindley's False Silverpuffs	*Uropappus lindleyi*	G5	S1	E	Red	3; 5; 7
Lobb's Water-buttercup	*Ranunculus lobbii*	G4	SH		Red	6
Macoun's Meadow-foam	*Limnanthes macounii*	G2	S2	T	Red	6
Macrae's Clover	*Trifolium dichotomum*	G4?	S2S3		Blue	7
Manroot	*Marah oreganus*	G5	S1	E	Red	7; 8
Muhlenberg's Centaury	*Centaurium muehlenbergii*	G5?	S1	E	Red	5; 6

Needle-leaved Navarretia	*Navarretia intertexta*	GNR	S2		Red	5 & 6
Nuttall's Quillwort	*Isoetes nuttallii*	G4?	S3		Blue	6
Oregon Lupine	*Lupinus oreganus* var. *kincaidii*	G5T2	SX	XT	Red	5
Poison Oak	*Toxicodendron diversilobum*	G5	S2S3		Blue	3
Poverty Clover	*Trifolium depauperatum* var. *depauperatum*	G5T5?	S3		Blue	5
Prairie Lupine	*Lupinus lepidus*	G5	S1	E	Red	3
Purple Sanicle	*Sanicula bipinnatifida*	G5	S2	T	Red	5
Pygmyweed	*Crassula aquatica*	G5	S4		Yellow	6
Rosy Owl-clover	*Orthocarpus bracteosus*	G3?	S1	E	Red	6
Scalepod	*Idahoa scapigera*	G5	S2		Red	5
Seaside Bird's Foot Lotus	*Lotus formosissimus*	G4	S1	E	Red	5
Sharp-pod Peppergrass	*Lepidium oxycarpum*	G4	SX		Red	2(?); 5 (?); 6
Slender Popcorn-flower	*Plagiobothrys tenellus*	G4G5	S1	T	Red	5
Slender Woolly-heads	*Psilocarphus tenellus* var. *tenellus*	G4	S3	NAR	Blue	6
Slimleaf Onion	*Allium amplectens*	G4	S3		Blue	5
Small-flowered Godetia	*Clarkia purpurea* ssp. *quadrivulnera*	G5T5	S1		Red	5
Small-flowered Tonella	*Tonella tenella*	G5	S1	E	Red	3
Small-headed Tarweed	*Hemizonella minima* (*Media minima*)	G4	S1		Red	3
Smooth Goldfields	*Lasthenia glaberrima*	G5	S1	E	Red	6
Spanish-clover	*Lotus unifoliolatus* var. *unifoliolatus*	G5T5	S3		Blue	5
Tall Woolly-heads	*Psilocarphus elatior*	G4Q	S1	E	Red	3; 6
Texas Toadflax	*Nutallanthus texanus*	G4G5	S3		Blue	3; 5

Victoria's Owl-clover	*Castilleja victoriae*	G1	S1	E	Red	6
Water-plantain Buttercup	*Ranunculus alismifolius* var. *alismifolius*	G5T5	S1	E	Red	6
Western rush	*Juncus occidentalis*	G5	S3S4		Blue	5;6
White Meconella	*Meconella oregana*	G2G3	S1	E	Red	5
White-lip Rein Orchid	*Piperia candida*	G3	S2		Red	1;8
White-top Aster	*Sericocarpus rigidus*	G3	S2	SC	Red	2; 3
Winged water-Starwort	*Callitriche marginata*	G4	S1		Red	5; 6
Yellow Montane Violet	*Viola praemorsa* ssp. *praemorsa*	G5T3T5	S2	E	Red	5
REPTILES						
Gopher Snake, *catenifer* subspecies	*Pituophis catenifer catenifer*	G5T5	SX	XT	Red	Extir-pated
Sharp-tailed Snake	*Contia tenuis*	G5	S1	E	Red	1,2,3,5, 7,8
MOSSES						
Banded Cord-moss	*Entosthodon fascicularis*	G4G5	S2S3	SC	Blue	3
Rigid Apple Moss	*Bartramia stricta*	GU	S2	E	Red	3
Twisted Oak Moss	*Syntrichia laevipila*	GNR	S2S3	SC	Blue	1; 2
MAMMALS						
Ermine, *anguinae* subspecies	*Mustela erminea anguinae*	G5T3	S3		Blue	8?
Roosevelt Elk	*Cervus elaphus roosevelti*	G5T4	S3S4		Blue	1, 2, 8?
Townsend's Big-eared Bat	*Corynorhinus townsendii*	G4	S3		Blue	1, 3
INVERTEBRATES (excluding butterflies)						
Blue Dasher	*Pachydiplax longipennis*	G5	S3S4		Blue	Un-known
Blue-grey Taildropper	*Prophysaon coeruleum*	G3G4	S1	E	Red	3

Western Pondhawk	*Erythemis collocata*	G5	S3		Blue	Un-known
Autumn Meadowhawk	*Sympetrum vicinum*	G5	S3S4		Blue	Un-known
BUTTERFLIES						
Boisduval's Blue, *blackmorei* subspecies	*Plebejus icariodes blackmorei*	G5T3	S3		Blue	4?
Common Ringlet, *insulana* subspecies	*Coenonympha california insulana*	G5T3T4	S1		Red	5; 7
Common Wood-nymph, *incana* subspecies	*Cercyonis pegala incana*	G5T4T5	S2		Red	5; 7
Dun Skipper	*Euphyes vestris*	G5	S3	T	Blue	4?; 6?
Great Arctic	*Oeneis nevadensis*	G5	S4		Yellow	3
Island Blue	*Plebejus saepiolus insulanus*	G5TH	SH	E	Red	4?;6?
Island Marble, *insulanus* subspecies	*Euchloe ausonides insulanus*	G5T1	SX	XT	Red	1;2
Moss' Elfin, *mossii* subspecies	*Incisalia mossii mossii*	G4T4	S2S3		Blue	3
Propertius Dusky-wing	*Erynnis propertius*	G5	S2S3		Blue	1;2;3;5; 7
Taylor's Checker-spot	*Euphydryas editha taylori*	G5T1	S1	E	Red	5
Western Branded Skipper, *oregonia* subspecies	*Hesperia colorado oregonia*	G5T3T4	S2S3		Blue	5; 7
Western Sulphur	*Colias occidentalis*	G4	S4		Yellow	3
Zerene Fritillary, *bremnerii* subspecies	*Speyeria zerene bremnerii*	G5T3T4	S2		Red	3
BIRDS						
Band-tailed Pigeon	*Patagioenas fasciata*	G4	S3S4B	SC	Blue	8
Barn Owl	*Tyto alba*	G5	S3	T	Blue	1,2
Horned Lark, *strigata* subspecies	*Eremophila alpestris strigata*	G5T2	SXB	E	Red	5

Lewis's Woodpecker (Georgia Depression population)	*Melanerpes lewis* pop. 1	G5TXQ	SXB, SNA	T	Red	1,2,3,5, 7,8
Northern Pygmy-owl, *swarthi* subspecies	*Glaucidium gnoma swarthi*	G4G5T3Q	S3		Blue	1,2,3,5, 7,8
Great Blue Heron, *fannini* subspecies	*Ardea herodias fannini*	G5T4	S2S3B,S4N	SC	Blue	1, 5
Peregrine Falcon, *anatum* subspecies	*Falco peregrinus anatum*	G4T4	S2?B	SC	Red	7
Purple Martin	*Progne subis*	G5	S2S3B		Blue	Ukn.
Short-eared Owl	*Asio flammeus*	G5	S3B,S2N	SC	Blue	1
Vesper Sparrow, *affinis* subspecies	*Pooecetes gramineus affinis*	G5T3	S1B	E	Red	3
Western Bluebird, Georgia Depression population	*Sialia mexicana* pop. 1	G5TNRQ	SHB, SNA		Red	1, 2, 3, 5, 7
Western Meadowlark, Georgia Depression population	*Sturnella neglecta* pop. 1	G5TNRQ	SXB		Red	1
Western Screech Owl, *kennicottii* subspecies	*Megascops kennicottii kennicottii*	G5T4	S3	SC	Blue	8
Yellow-billed Cuckoo	*Coccyzus americanus*	G5	SXB		Red	Extirpated

a Source: Garry Oak Ecosystems Recovery Team (GOERT). 2011. Species at Risk. GOERT. Victoria, B.C. www.goert.ca/pubs_at_risk.php (Accessed June 19, 2011).
b SC = Special Concern, T = Threatened, E = Endangered, XT = Extirpated.
c REU: Restoration Ecosystem Units as defined in Chapter 2: Distribution and Description

B. ALPHABETICALLY BY SCIENTIFIC NAME

Scientific Name	English Name	Global Rank	Provincial Rank	COSEWIC Status[b]	BC Status	REUs[c]
VASCULAR PLANTS						
Agrostis pallens	Dune Bentgrass	G4G5	S3S4		Yellow	5
Allium amplectens	Slimleaf Onion	G4	S3		Blue	5
Allium geyeri var. *tenerum*	Geyer's Onion	G4G5T3T5	S2S3		Blue	5
Alopecurus carolinianus	Carolina Meadow-foxtail	G5	S2		Red	5
Balsamorhiza deltoidea	Deltoid Balsamroot	G5	S1	E	Red	1; 3;5
Bulbostylis capillaris	Densetuft Hairsedge	G5	S1		Red	4
Callitriche marginata	Winged water-Starwort	G4	S1		Red	5; 6
Carex feta	Green-sheathed Sedge	G5	S2		Red	5; 6
Carex tumulicola	Foothill Sedge	G4	S2	E	Red	5
Castilleja levisecta	Golden Paintbrush	G1	S1	E	Red	5
Castilleja victoriae	Victoria's Owl-clover	G1	S1	E	Red	6
Centaurium muehlenbergii	Muhlenberg's Centaury	G5?	S1	E	Red	5; 6
Clarkia amoena var. *caurina*	Farewell-to-spring	G5T5?	S3		Blue	5
Clarkia amoena var. *lindleyi*	Farewell-to-spring	G5T5	S3		Blue	5
Clarkia purpurea ssp. *quadrivulnera*	Small-flowered Godetia	G5T5	S1		Red	5
Crassula aquatica	Pygmyweed	G5	S4		Yellow	6
Crassula connata var. *connata*	Erect Pygmyweed	G5TNR	S2		Red	5
Dryopteris arguta	Coastal Wood Fern	G5	S2S3	SC	Blue	7;8
Epilobium densiflorum	Dense Spike-primrose	G5	S1	E	Red	2;5;6
Epilobium torreyi	Brook Spike-Primrose	G5	SX	E	Red	5; 6

Githopsis specularioides	Common Bluecup	G5	S2S3		Blue	4
Hemizonella minima (Media minima)	Small-headed Tarweed	G4	S1		Red	3
Heterocodon rariflorum	Heterocodon	G5	S3		Blue	4; 5
Idahoa scapigera	Scalepod	G5	S2		Red	5
Isoetes nuttallii	Nuttall's Quillwort	G4?	S3		Blue	6
Juncus kelloggii	Kellogg's Rush	G3?	S1	E	Red	5; 6
Juncus occidentalis	Western rush	G5	S3S4		Blue	5; 6
Lasthenia glaberrima	Smooth Goldfields	G5	S1	E	Red	6
Lepidium oxycarpum	Sharp-pod Pepper-grass	G4	SX		Red	2(?); 5 (?); 6
Limnanthes macounii	Macoun's Meadow-foam	G2	S2	T	Red	6
Lomatium dissectum var. *dissectum*	Fern-leaved Desert-parsley	G4T4	S1		Red	3; 5
Lomatium grayi	Gray's Desert-parsley	G5	S1	T	Red	3
Lotus formosissimus	Seaside Bird's Foot Lotus	G4	S1	E	Red	5
Lotus pinnatus	Bog Bird's-foot Trefoil	G4G5	S1	E	Red	6
Lotus unifoliolatus var. *unifoliolatus*	Spanish-clover	G5T5	S3		Blue	5
Lupinus densiflorus var. *densiflorus*	Dense-flowered Lupine	G5T4	S1	E	Red	5
Lupinus lepidus	Prairie Lupine	G5	S1	E	Red	3
Lupinus oreganus var. *kincaidii*	Oregon Lupine	G5T2	SX	XT	Red	5
Marah oreganus	Manroot	G5	S1	E	Red	7; 8
Meconella oregana	White Meconella	G2G3	S1	E	Red	5
Microseris bigelovii	Coast Microseris	G4	S1	E	Red	6; 7
Minuartia pusilla	Dwarf Sandwort	G5	S1	E	Red	6

Navarretia intertexta	Needle-leaved Navarretia	GNR	S2		Red	5 & 6
Nutallanthus texanus	Texas Toadflax	G4G5	S3		Blue	3; 5
Orthocarpus bracteosus	Rosy Owl-clover	G3?	S1	E	Red	6
Piperia candida	White-lip Rein Orchid	G3	S2		Red	1;8
Piperia elegans	Elegant Rein Orchid	G4	S3S4		Yellow	5
Plagiobothrys figuratus	Fragrant Popcorn-flower	G4T4	S1	E	Red	5; 6; 7
Plagiobothrys tenellus	Slender Popcorn-flower	G4G5	S1	T	Red	5
Psilocarphus elatior	Tall Woolly-heads	G4Q	S1	E	Red	3; 6
Psilocarphus tenellus var. *tenellus*	Slender Woolly-heads	G4	S3	NAR	Blue	6
Ranunculus alismifolius var. *alismifolius*	Water-plantain Buttercup	G5T5	S1	E	Red	6
Ranunculus californicus	California Buttercup	G5	S1	E	Red	5
Ranunculus lobbii	Lobb's Water-buttercup	G4	SH		Red	6
Rupertia physodes	California-tea	G4	S3		Blue	3
Sanicula arctopoides	Bear's-foot Sanicle	G5	S1	E	Red	1; 3
Sanicula bipinnatifida	Purple Sanicle	G5	S2	T	Red	5
Sericocarpus rigidus	White-top Aster	G3	S2	SC	Red	2; 3
Silene scouleri ssp. *grandis*	Coastal Scouler's Catchfly	G5TNR	S1	E	Red	5
Tonella tenella	Small-flowered Tonella	G5	S1	E	Red	3
Toxicodendron diversilobum	Poison Oak	G5	S2S3		Blue	3
Trifolium cyathiferum	Cup Clover	G4	S1		Red	6
Trifolium depauperatum var. *depauperatum*	Poverty Clover	G5T5?	S3		Blue	5

Trifolium dichotomum	Macrae's Clover	G4?	S2S3		Blue	7
Triphysaria versicolor ssp. *versicolor*	Bearded Owl-clover	G5T5	S1	E	Red	5; 6
Triteleia howellii	Howell's Triteleia	G3G4	S1	E	Red	5
Uropappus lindleyi	Lindley's False Silverpuffs	G5	S1	E	Red	3; 5; 7
Viola howellii	Howell's Violet	G4	S2S3		Blue	5
Viola praemorsa ssp. *praemorsa*	Yellow Montane Violet	G5T3T5	S2	E	Red	5
Yabea microcarpa	California Hedge-parsley	G5?	S1S2		Red	3; 4
REPTILES						
Contia tenuis	Sharp-tailed Snake	G5	S1	E	Red	1,2,3,5,7,8
Pituophis catenifer catenifer	Gopher Snake, *catenifer* subspecies	G5T5	SX	XT	Red	Extir-pated
MOSSES						
Bartramia stricta	Rigid Apple Moss	GU	S2	E	Red	3
Entosthodon fascicularis	Banded Cord-moss	G4G5	S2S3	SC	Blue	3
Syntrichia laevipila	Twisted Oak Moss	GNR	S2S3	SC	Blue	1; 2
MAMMALS						
Cervus elaphus roosevelti	Roosevelt Elk	G5T4	S3S4		Blue	1, 2, 8?
Corynorhinus townsendii	Townsend's Big-eared Bat	G4	S3		Blue	1, 3
Mustela erminea anguinae	Ermine, *anguinae* subspecies	G5T3	S3		Blue	8?
INVERTEBRATES (excluding butterflies)						
Erythemis collocata	Western Pondhawk	G5	S3		Blue	Unkn.
Pachydiplax longipennis	Blue Dasher	G5	S3S4		Blue	Unkn.
Prophysaon coeruleum	Blue-grey Taildropper	G3G4	S1	E	Red	3

Prophysaon coeruleum	Blue-grey Taildropper	G3G4	S1	E	Red	3
Sympetrum vicinum	Autumn Meadowhawk	G5	S3S4		Blue	Unkn.
BUTTERFLIES						
Cercyonis pegala incana	Common Wood-nymph, *incana* subspecies	G5T4T5	S2		Red	5; 7
Coenonympha california insulana	Common Ringlet, *insulana* subspecies	G5T3T4	S1		Red	5; 7
Colias occidentalis	Western Sulphur	G4	S4		Yellow	3
Erynnis propertius	Propertius Duskywing	G5	S2S3		Blue	1;2;3;5;7
Euchloe ausonides insulanus	Island Marble, *insulanus* subspecies	G5T1	SX	XT	Red	1;2
Euphydryas editha taylori	Taylor's Checkerspot	G5T1	S1	E	Red	5
Euphyes vestris	Dun Skipper	G5	S3	T	Blue	4?; 6?
Hesperia colorado oregonia	Western Branded Skipper, *oregonia* subspecies	G5T3T4	S2S3		Blue	5; 7
Incisalia mossii mossii	Moss' Elfin, *mossii* subspecies	G4T4	S2S3		Blue	3
Oeneis nevadensis	Great Arctic	G5	S4		Yellow	3
Plebejus icariodes blackmorei	Boisduval's Blue, *blackmorei* subspecies	G5T3	S3		Blue	4?
Plebejus saepiolus insulanus	Island Blue	G5TH	SH	E	Red	4?;6?
Speyeria zerene bremnerii	Zerene Fritillary, *bremnerii* subspecies	G5T3T4	S2		Red	3
BIRDS						
Ardea herodias fannini	Great Blue Heron, *fannini* subspecies	G5T4	S2S3B,S4N	SC	Blue	1, 5
Asio flammeus	Short-eared Owl	G5	S3B,S2N	SC	Blue	1
Coccyzus americanus	Yellow-billed Cuckoo	G5	SXB		Red	Extirp.
Eremophila alpestris strigata	Horned Lark, *strigata* subspecies	G5T2	SXB	E	Red	5

Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	G4T4	S2?B	SC	Red	7
Glaucidium gnoma swarthi	Northern Pygmy-owl, *swarthi* subspecies	G4G5T3Q	S3		Blue	1,2,3,5,7, 8
Megascops kennicottii kennicottii	Western Screech Owl, *kennicottii* subspecies	G5T4	S3	SC	Blue	8
Melanerpes lewis pop. 1	Lewis's Woodpecker (Georgia Depression population)	G5TXQ	SXB, SNA	T	Red	1,2,3,5,7, 8
Patagioenas fasciata	Band-tailed Pigeon	G4	S3S4B	SC	Blue	8
Pooecetes gramineus affinis	Vesper Sparrow, *affinis* subspecies	G5T3	S1B	E	Red	3
Progne subis	Purple Martin	G5	S2S3B		Blue	Unkn.
Sialia mexicana pop. 1	Western Bluebird, Georgia Depression population	G5TNRQ	SHB, SNA		Red	1, 2, 3, 5, 7
Sturnella neglecta pop. 1	Western Meadowlark, Georgia Depression population	G5TNRQ	SXB		Red	1
Tyto alba	Barn Owl	G5	S3	T	Blue	1,2

Appendix 4.2

Listed Species at Risk in Garry Oak and Associated Ecosystems[a], per Restoration Ecosystem Unit (REU)[c]

REU	English Name	Scientific Name	Global Rank	Provincial Rank	COSEWIC Status[b]	BC Status
1	Bear's-foot Sanicle	*Sanicula arctopoides*	G5	S1	E	Red
	Deltoid Balsamroot	*Balsamorhiza deltoidea*	G5	S1	E	Red
	Twisted Oak Moss	*Syntrichia laevipila*	GNR	S2S3	SC	Blue
	White-lip Rein Orchid	*Piperia candida*	G3	S2		Red
	Roosevelt Elk	*Cervus elaphus roosevelti*	G5T4	S3S4		Blue
	Townsend's Big-eared Bat	*Corynorhinus townsendii*	G4	S3		Blue
	Sharp-tailed Snake	*Contia tenuis*	G5	S1	E	Red
	Island Marble, *insulanus* subspecies	*Euchloe ausonides insulanus*	G5T1	SX	XT	Red
	Propertius Duskywing	*Erynnis propertius*	G5	S2S3		Blue
	Barn Owl	*Tyto alba*	G5	S3	T	Blue
	Great Blue Heron, *fannini* subspecies	*Ardea herodias fannini*	G5T4	S2S3B,S4N	SC	Blue
	Lewis's Woodpecker (Georgia Depression population)	*Melanerpes lewis* pop. 1	G5TXQ	SXB, SNA	T	Red
	Northern Pygmy-owl, *swarthi* subspecies	*Glaucidium gnoma swarthi*	G4G5T3Q	S3		Blue
	Short-eared Owl	*Asio flammeus*	G5	S3B,S2N	SC	Blue
	Western Bluebird, Georgia Depression population	*Sialia mexicana* pop. 1	G5TNRQ	SHB, SNA		Red
	Western Meadowlark, Georgia Depression population	*Sturnella neglecta* pop. 1	G5TNRQ	SXB		Red
2	Dense Spike-primrose	*Epilobium densiflorum*	G5	S1	E	Red
	Twisted Oak Moss	*Syntrichia laevipila*	GNR	S2S3	SC	Blue
	White-top Aster	*Sericocarpus rigidus*	G3	S2	SC	Red

	Roosevelt Elk	*Cervus elaphus roosevelti*	G5T4	S3S4		Blue
	Sharp-tailed Snake	*Contia tenuis*	G5	S1	E	Red
	Island Marble, *insulanus* subspecies	*Euchloe ausonides insulanus*	G5T1	SX	XT	Red
	Propertius Duskywing	*Erynnis propertius*	G5	S2S3		Blue
	Barn Owl	*Tyto alba*	G5	S3	T	Blue
	Lewis's Woodpecker (Georgia Depression population)	*Melanerpes lewis* pop. 1	G5TXQ	SXB, SNA	T	Red
	Northern Pygmy-owl, *swarthi* subspecies	*Glaucidium gnoma swarthi*	G4G5T3Q	S3		Blue
	Western Bluebird, Georgia Depression population	*Sialia mexicana* pop. 1	G5TNRQ	SHB, SNA		Red
2(?)	Sharp-pod Peppergrass	*Lepidium oxycarpum*	G4	SX		Red
3	Bear's-foot Sanicle	*Sanicula arctopoides*	G5	S1	E	Red
	California Hedge-parsley	*Yabea microcarpa*	G5?	S1S2		Red
	California-tea	*Rupertia physodes*	G4	S3		Blue
	Deltoid Balsamroot	*Balsamorhiza deltoidea*	G5	S1	E	Red
	Fern-leaved Desert-parsley	*Lomatium dissectum* var. *dissectum*	G4T4	S1		Red
	Gray's Desert-parsley	*Lomatium grayi*	G5	S1	T	Red
	Lindley's False Silverpuffs	*Uropappus lindleyi*	G5	S1	E	Red
	Poison Oak	*Toxicodendron diversilobum*	G5	S2S3		Blue
	Prairie Lupine	*Lupinus lepidus*	G5	S1	E	Red
	Small-flowered Tonella	*Tonella tenella*	G5	S1	E	Red
	Small-headed Tarweed	*Hemizonella minima (Media minima)*	G4	S1		Red
	Tall Woolly-heads	*Psilocarphus elatior*	G4Q	S1	E	Red
	Texas Toadflax	*Nutallanthus texanus*	G4G5	S3		Blue
	White-top Aster	*Sericocarpus rigidus*	G3	S2	SC	Red

	Banded Cord-moss	*Entosthodon fascicularis*	G4G5	S2S3	SC	Blue
	Rigid Apple Moss	*Bartramia stricta*	GU	S2	E	Red
	Ermine, *anguinae* subspecies	*Mustela erminea anguinae*	G5T3	S3		Blue
	Sharp-tailed Snake	*Contia tenuis*	G5	S1	E	Red
	Blue-grey Taildropper	*Prophysaon coeruleum*	G3G4	S1	E	Red
	Great Arctic	*Oeneis nevadensis*	G5	S4		Yellow
	Moss' Elfin, *mossii* subspecies	*Incisalia mossii mossii*	G4T4	S2S3		Blue
	Propertius Duskywing	*Erynnis propertius*	G5	S2S3		Blue
	Western Sulphur	*Colias occidentalis*	G4	S4		Yellow
	Zerene Fritillary, *bremnerii* subspecies	*Speyeria zerene bremnerii*	G5T3T4	S2		Red
	Lewis's Woodpecker (Georgia Depression population)	*Melanerpes lewis* pop. 1	G5TXQ	SXB, SNA	T	Red
	Northern Pygmy-owl, *swarthi* subspecies	*Glaucidium gnoma swarthi*	G4G5T3Q	S3		Blue
	Vesper Sparrow, *affinis* subspecies	*Pooecetes gramineus affinis*	G5T3	S1B	E	Red
	Western Bluebird, Georgia Depression population	*Sialia mexicana* pop. 1	G5TNRQ	SHB, SNA		Red
4	California Hedge-parsley	*Yabea microcarpa*	G5?	S1S2		Red
	Common Bluecup	*Githopsis specularioides*	G5	S2S3		Blue
	Densetuft Hairsedge	*Bulbostylis capillaris*	G5	S1		Red
	Heterocodon	*Heterocodon rariflorum*	G5	S3		Blue
4?	Boisduval's Blue, *blackmorei* subspecies	*Plebejus icariodes blackmorei*	G5T3	S3		Blue
	Dun Skipper	*Euphyes vestris*	G5	S3	T	Blue
	Island Blue	*Plebejus saepiolus insulanus*	G5TH	SH	E	Red
5	Bearded Owl-clover	*Triphysaria versicolor* ssp. *versicolor*	G5T5	S1	E	Red

Brook Spike-Primrose	*Epilobium torreyi*	G5	SX	E	Red
California Buttercup	*Ranunculus californicus*	G5	S1	E	Red
Carolina Meadow-foxtail	*Alopecurus carolinianus*	G5	S2		Red
Coastal Scouler's Catchfly	*Silene scouleri* ssp. *grandis*	G5TNR	S1	E	Red
Deltoid Balsamroot	*Balsamorhiza deltoidea*	G5	S1	E	Red
Dense Spike-primrose	*Epilobium densiflorum*	G5	S1	E	Red
Dense-flowered Lupine	*Lupinus densiflorus* var. *densiflorus*	G5T4	S1	E	Red
Dune Bentgrass	*Agrostis pallens*	G4G5	S3S4		Yellow
Elegant Rein Orchid	*Piperia elegans*	G4	S3S4		Yellow
Erect Pygmyweed	*Crassula connata* var. *connata*	G5TNR	S2		Red
Farewell-to-spring	*Clarkia amoena* var. *caurina*	G5T5?	S3		Blue
Farewell-to-spring	*Clarkia amoena* var. *lindleyi*	G5T5	S3		Blue
Fern-leaved Desert-parsley	*Lomatium dissectum* var. *dissectum*	G4T4	S1		Red
Foothill Sedge	*Carex tumulicola*	G4	S2	E	Red
Fragrant Popcornflower	*Plagiobothrys figuratus*	G4T4	S1	E	Red
Geyer's Onion	*Allium geyeri* var. *tenerum*	G4G5T3T5	S2S3		Blue
Golden Paintbrush	*Castilleja levisecta*	G1	S1	E	Red
Green-sheathed Sedge	*Carex feta*	G5	S2		Red
Heterocodon	*Heterocodon rariflorum*	G5	S3		Blue
Howell's Triteleia	*Triteleia howellii*	G3G4	S1	E	Red
Howell's Violet	*Viola howellii*	G4	S2S3		Blue
Kellogg's Rush	*Juncus kelloggii*	G3?	S1	E	Red
Lindley's False Silverpuffs	*Uropappus lindleyi*	G5	S1	E	Red
Muhlenberg's Centaury	*Centaurium muehlenbergii*	G5?	S1	E	Red

Needle-leaved Navarretia	*Navarretia intertexta*	GNR	S2		Red
Oregon Lupine	*Lupinus oreganus* var. *kincaidii*	G5T2	SX	XT	Red
Poverty Clover	*Trifolium depauperatum* var. *depauperatum*	G5T5?	S3		Blue
Purple Sanicle	*Sanicula bipinnatifida*	G5	S2	T	Red
Scalepod	*Idahoa scapigera*	G5	S2		Red
Seaside Bird's Foot Lotus	*Lotus formosissimus*	G4	S1	E	Red
Slender Popcornflower	*Plagiobothrys tenellus*	G4G5	S1	T	Red
Slimleaf Onion	*Allium amplectens*	G4	S3		Blue
Small-flowered Godetia	*Clarkia purpurea* ssp. *quadrivulnera*	G5T5	S1		Red
Spanish-clover	*Lotus unifoliolatus* var. *unifoliolatus*	G5T5	S3		Blue
Texas Toadflax	*Nutallanthus texanus*	G4G5	S3		Blue
Western rush	*Juncus occidentalis*	G5	S3S4		Blue
White Meconella	*Meconella oregana*	G2G3	S1	E	Red
Winged water-Starwort	*Callitriche marginata*	G4	S1		Red
Yellow Montane Violet	*Viola praemorsa* ssp. *praemorsa*	G5T3T5	S2	E	Red
Sharp-tailed Snake	*Contia tenuis*	G5	S1		Red
Common Ringlet, *insulana* subspecies	*Coenonympha california insulana*	G5T3T4	S1		Red
Common Wood-nymph, *incana* subspecies	*Cercyonis pegala incana*	G5T4T5	S2		Red
Propertius Duskywing	*Erynnis propertius*	G5	S2S3		Blue
Taylor's Checkerspot	*Euphydryas editha taylori*	G5T1	S1	E	Red
Western Branded Skipper, *oregonia* subspecies	*Hesperia colorado oregonia*	G5T3T4	S2S3		Blue
Great Blue Heron, *fannini* subspecies	*Ardea herodias fannini*	G5T4	S2S3B,S4N	SC	Blue

	Horned Lark, *strigata* subspecies	*Eremophila alpestris strigata*	G5T2	SXB	E	Red
	Lewis's Woodpecker (Georgia Depression population)	*Melanerpes lewis* pop. 1	G5TXQ	SXB, SNA	T	Red
	Northern Pygmy-owl, *swarthi* subspecies	*Glaucidium gnoma swarthi*	G4G5T3Q	S3		Blue
	Western Bluebird, Georgia Depression population	*Sialia mexicana* pop. 1	G5TNRQ	SHB, SNA		Red
5 (?)	Sharp-pod Peppergrass	*Lepidium oxycarpum*	G4	SX		Red
6	Bearded Owl-clover	*Triphysaria versicolor* ssp. *versicolor*	G5T5	S1	E	Red
	Bog Bird's-foot Trefoil	*Lotus pinnatus*	G4G5	S1	E	Red
	Brook Spike-Primrose	*Epilobium torreyi*	G5	SX	E	Red
	Coast Microseris	*Microseris bigelovii*	G4	S1	E	Red
	Cup Clover	*Trifolium cyathiferum*	G4	S1		Red
	Dense Spike-primrose	*Epilobium densiflorum*	G5	S1	E	Red
	Dwarf Sandwort	*Minuartia pusilla*	G5	S1	E	Red
	Fragrant Popcornflower	*Plagiobothrys figuratus*	G4T4	S1	E	Red
	Green-sheathed Sedge	*Carex feta*	G5	S2		Red
	Kellogg's Rush	*Juncus kelloggii*	G3?	S1	E	Red
	Lobb's Water-buttercup	*Ranunculus lobbii*	G4	SH		Red
	Macoun's Meadow-foam	*Limnanthes macounii*	G2	S2	T	Red
	Muhlenberg's Centaury	*Centaurium muehlenbergii*	G5?	S1	E	Red
	Needle-leaved Navarretia	*Navarretia intertexta*	GNR	S2		Red
	Nuttall's Quillwort	*Isoetes nuttallii*	G4?	S3		Blue
	Pygmyweed	*Crassula aquatica*	G5	S4		Yellow
	Rosy Owl-clover	*Orthocarpus bracteosus*	G3?	S1	E	Red
	Sharp-pod Peppergrass	*Lepidium oxycarpum*	G4	SX		Red

	Slender Woolly-heads	*Psilocarphus tenellus* var. *tenellus*	G4	S3	NAR	Blue
	Smooth Goldfields	*Lasthenia glaberrima*	G5	S1	E	Red
	Tall Woolly-heads	*Psilocarphus elatior*	G4Q	S1	E	Red
	Victoria's Owl-clover	*Castilleja victoriae*	G1	S1	E	Red
	Water-plantain Buttercup	*Ranunculus alismifolius* var. *alismifolius*	G5T5	S1	E	Red
	Western rush	*Juncus occidentalis*	G5	S3S4		Blue
	Winged water-Starwort	*Callitriche marginata*	G4	S1		Red
6?	Dun Skipper	*Euphyes vestris*	G5	S3	T	Blue
	Island Blue	*Plebejus saepiolus insulanus*	G5TH	SH	E	Red
7	Coast Microseris	*Microseris bigelovii*	G4	S1	E	Red
	Coastal Wood Fern	*Dryopteris arguta*	G5	S2S3	SC	Blue
	Fragrant Popcornflower	*Plagiobothrys figuratus*	G4T4	S1	E	Red
	Lindley's False Silverpuffs	*Uropappus lindleyi*	G5	S1	E	Red
	Macrae's Clover	*Trifolium dichotomum*	G4?	S2S3		Blue
	Manroot	*Marah oreganus*	G5	S1	E	Red
	Sharp-tailed Snake	*Contia tenuis*	G5	S1	E	Red
	Common Ringlet, *insulana* subspecies	*Coenonympha california insulana*	G5T3T4	S1		Red
	Common Wood-nymph, *incana* subspecies	*Cercyonis pegala incana*	G5T4T5	S2		Red
	Propertius Duskywing	*Erynnis propertius*	G5	S2S3		Blue
	Western Branded Skipper, *oregonia* subspecies	*Hesperia colorado oregonia*	G5T3T4	S2S3		Blue
	Lewis's Woodpecker (Georgia Depression population)	*Melanerpes lewis* pop. 1	G5TXQ	SXB, SNA	T	Red
	Northern Pygmy-owl, *swarthi* subspecies	*Glaucidium gnoma swarthi*	G4G5T3Q	S3		Blue
	Peregrine Falcon, *anatum* subspecies	*Falco peregrinus anatum*	G4T4	S2?B	SC	Red

	Western Bluebird, Georgia Depression population	*Sialia mexicana* pop. 1	G5TNRQ	SHB, SNA		Red
8	Coastal Wood Fern	*Dryopteris arguta*	G5	S2S3	SC	Blue
	Manroot	*Marah oreganus*	G5	S1	E	Red
	White-lip Rein Orchid	*Piperia candida*	G3	S2		Red
	Sharp-tailed Snake	*Contia tenuis*	G5	S1	E	Red
	Band-tailed Pigeon	*Patagioenas fasciata*	G4	S3S4B	SC	Blue
	Lewis's Woodpecker (Georgia Depression population)	*Melanerpes lewis* pop. 1	G5TXQ	SXB, SNA		Red
	Northern Pygmy-owl, *swarthi* subspecies	*Glaucidium gnoma swarthi*	G4G5T3Q	S3	T	Blue
	Western Screech Owl, *kennicottii* subspecies	*Megascops kennicottii kennicottii*	G5T4	S3	SC	Blue
8?	Ermine, *anguinae* subspecies	*Mustela erminea anguinae*	G5T3	S3		Blue
	Roosevelt Elk	*Cervus elaphus roosevelti*	G5T4	S3S4		Blue

a Source: Garry Oak Ecosystems Recovery Team (GOERT). 2011. Species at Risk. GOERT. Victoria, B.C. www.goert.ca/pubs_at_risk.php (Accessed June 19, 2011).
b SC = Special Concern, T = Threatened, E = Endangered, XT = Extirpated.
c REU: Restoration Ecosystem Units as defined in Chapter 2: Distribution and Description
"?" = uncertainty whether the species occurs in this REU

Appendix 4.3

Ecological Communities at Risk in Garry Oak and Associated Ecosystems[a]

Restoration Ecosystems Unit (REU) Number and Name	Scientific Name	English Name	G rank	CDC list	Biogeo-climatic Unit	Reference
Restoration Ecosystem Unit #1: Deep Soil, Average Moisture Garry Oak Communities	*Quercus garryana – Festuca roemeri*	Garry Oak – Roemer's Fescue		Red[b]		Erickson and Meidinger (07)
	Quercus garryana – Bromus carinatus	Garry Oak – California Brome	G1	Red	CDFmm/00	Conservation Data Centre
	Quercus garryana – Camassia quamash – Elymus glaucus	Garry Oak – Common Camas – Blue Wildrye plant association		Red[b]		Erickson and Meidinger (2007)
	Quercus garryana – Camassia leichtlinii – Elymus glaucus	Garry Oak – Great Camas – Blue Wildrye plant association		Red[b]		Erickson and Meidinger (2007)
Restoration Ecosystem Unit #2: Deep Soil, Wetter Garry Oak Communities	*Quercus garryana – Holodiscus discolor*	Garry Oak – Oceanspray	G1	Red	CDFmm/00	Conservation Data Centre
	Quercus garryana – Symphoricarpos albus – Holodiscus discolor	Garry Oak – Oceanspray – Common Snow-berry plant association		Red[b]		Erickson and Meidinger (2007)
Restoration Ecosystem Unit #3: Shallow Soil Garry Oak Communities	*Festuca roemeri – Koeleria macrantha*	Roemer's Fescue – Junegrass	G1	Red	CDFmm/00; CWHxm1/00	Conservation Data Centre
	Quercus garryana – Racomitrium elongatum – Selaginella wallacei	Garry Oak – Grey Rock-moss – Wallace's Selaginella plant association		Red[b]		Erickson and Meidinger (2007)

Restoration Ecosystem Unit #3 (cont.): Shallow Soil Garry Oak Communities	*Quercus garryana – Dicranum scoparium*	Garry Oak – Broom-moss plant association		Red[b]		Erickson and Meidinger (2007)
	Quercus garryana – Arbutus menziesii	Garry Oak – Arbutus	G1	Red	CDFmm/00	Conservation Data Centre
	Quercus garryana – Acer macrophyllum – Prunus spp.	Garry Oak – Bigleaf Maple – cherries	G1	Red	CWHds1/00	Conservation Data Centre
	Arbutus menziesii – Arctostaphylos columbiana	Arbutus – Hairy Manzanita	G2	Red	CDFmm/00; CWHxm1/00	Conservation Data Centre
Restoration Ecosystem Unit #4: Shallow Soil Seepage Communities	*No communities defined*					
Restoration Ecosystem Unit #5: Maritime Meadow Communities	*No communities defined*					
Restoration Ecosystem Unit #6: Vernal Pool Communities	*Myosurus minimus – Montia* spp. *–Limnanthes macounii*	Tiny Mousetail – Montia –Macoun's Meadow-foam	G2	Red	CDFmm/00	Conservation Data Centre
Restoration Ecosystem Unit # 7: Coastal Bluff Communities	*No communities defined*					

Restoration Ecosystem Unit #8: Douglas-fir Communities	*Pseudotsuga menziesii – Mahonia nervosa*	Douglas-fir–Dull Oregon-grape	G2	Red	CDFmm/01	Green and Klinka (1994); Conservation Data Centre
	Pseudotsuga menziesii – Arbutus menziesii	Douglas-fir–Arbutus	GNR	Red	CDFmm/02	Green and Klinka (1994); Conservation Data Centre
	Pseudotsuga menziesii –Melica subulata	Douglas-fir –Alaska Oniongrass	G1	Red	CDFmm/03	Green and Klinka (1994); Conservation Data Centre

a Source: T. Lea, pers. comm. 2009

b Indicates that these would be red-listed plant communities if assessed by the BC Conservation Data Centre (C. Cadrin, pers. comm. 2009)

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