A School-Based Garry-oak Restoration and Education Project

at Royal Roads University, Colwood, B.C.

ER 390 – Selected Project

(Aerial view of Colwood Elementary School beside restoration site)

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1.0 Abstract

A severely disturbed field on the property of Royal Roads University containing a remnant Garry oak ecosystem (GOE), was chosen as the site of a restoration and education project for the students of nearby Colwood Elementary School. This restoration project was planned and carried out to address students’ perceived lack of knowledge and appreciation of Garry oak Ecosystems by educating them about GOEs, then getting them involved in the restoration work with the hope they would become stewards of the site. The restoration work would give students the opportunity to apply skills learned in the classroom in a “real life” situation.

The Project began in January 2006 with a series of introductory workshops on Garry oak ecosystems (GOEs) for students at Colwood Elementary in grades one to five. Students then went on-site to identify the species they’d learned about in class and create a vegetation map of the site. Removal of daphne (Daphne laureola) and Scotch broom (Cytisus scoparius) from the Phase One area of the site began in February, 2006. During the spring of 2006, students in grades four and five researched and wrote the text for a GOE information sign, which was erected at the southwest entrance to the site. Three other, “sensitive ecosystems”, signs were placed around the perimeter of the site. All signs were funded by the school Parent Advisory Committee. In the fall of 2006, two types of leaf mulch were spread on patches of introduced orchardgrass (Dactylis glomerata) in an attempt to smother it. One other patch was mowed and scarified to encourage re-growth of native species. A total of one hundred acorns were sown in two of the mulch patches, and twenty-four common camas (Camassia quamash) bulbs were planted. Branch fence-barriers were erected around the camas (Camassia quamash) sites to prevent grazing and trampling. Exclosures such as netting and plastic tubes were not used due to a history of vandalism on this, and neighbouring sites. Thinning and pruning of conifers was also done at this time to stop the encroachment of neighbouring forested areas onto the restoration site, and to release Garry oaks (Quercus garryana) on-site from overtopping Douglas-firs (Pseudotsuga menziesii).

By March, 2007 virtually all invasive shrubs had been removed from the Phase One site and approximately 50% of the introduced grasses had been mowed or covered with mulch. No signs of acorn sprouts were evident in the two mulch patches as of mid-March 2007, although both patches bore deer prints, suggesting browsing of acorn shoots may have occurred. Twenty of the planted common camas (Camassia quamash) bulbs had sprouted, two of which showed obvious signs of grazing – probably by deer. It is too soon to determine if the release of Garry oaks (Quercus garryana) will positively affect their growth rate.

Recommendations for future work on this site include: (1) Monitor the Phase One site for re-growth of invasive species (2) Cover remaining sections of introduced grasses on the Phase One site with mulch (3) Plant the native grasses Blue wildrye (Elymus glaucus), Alaska oniongrass (Melica subulata), and California oatgrass (Danthonia californica). (4) Explore the effectiveness of netting exclosures to prevent grazing of new plant stock. (5) Monitor growth rates of overtopped control group Garry oaks with growth rates of Garry oaks released on the Phase One site (6) Begin the removal of Scotch broom (Cytisus scoparius) from the Phase Two site in fall, 2008.
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2.0 Introduction

This report outlines restoration and preservation of a 1.1 hectare site containing a remnant Garry oak (*Quercus garryana*) ecosystem (GOE) located on the western edge of Royal Roads University (RRU) property in the City of Colwood, near Victoria, B.C. (Figure 1).

From: Ryan, Radcliffe & Buti. 1995

Figure: 1
2.1 Objectives

a) Develop a knowledge and appreciation in students and the community for Garry oak ecosystems and their component species; and in so doing, develop a deeper connection with the natural world. (See Appendix 1 for relevant B.C. Ministry of Education Prescribed Learning Outcome for science)

b) Remove all invasive plant species from the Phase One site (Figure 2) in order to preserve and restore a small example of Garry oak ecosystem, and as many of the plant and animal species associated with it as possible, for educational and aesthetic purposes. (See Appendix 2 for relevant B.C. Ministry of Education Prescribed Learning Outcome for science)

c) Give Colwood Elementary students the opportunity to learn and apply practical skills on a project which enhances their community.

Figure 2

Formal Chinese Village Site
d) Develop on-going stewardship of the RRU Garry oak site.

2.2 Project Background

When the old Colwood Elementary School building on Sooke Road was demolished in 2002 and replaced with a new school a few metres from RRU property and the remnant Garry oak site, staff began to make frequent use of the RRU property for activities such as nature walks, class picnics, fitness runs, and bird counts with their students. During some of these events, I noticed that although children often walked or biked through Royal Roads with their families, (some still live on the grounds), few were familiar with the plants and animals they pass, and even fewer were aware of Garry oaks and the ecosystems in which many of the species are found. Involving students in a restoration project on the RRU Garry oak site seemed to be an ideal way to increase students’ knowledge and appreciation of GOEs and nature in general. This restoration project also provides students opportunities to apply new knowledge and skills in a “real-life” situation and make a positive contribution to their community, things which don’t often occur at the elementary school level. Participation in this project will hopefully provide students with the necessary skills and attitudes to make lifelong positive contributions to local, national and international environmental issues. In a paper presented at the 1993 Garry oak-Meadow Colloquium in Victoria, Anne Keay summarized the value of student involvement in environmental restoration this way:

“...it is only by actively involving our youth in ‘real life’ situations that we can empower them to act convincingly in reclaiming both our external and internal landscapes. We must undertake to restore our own bioregion before we can contribute positively to the larger ecological problems which presently plague us.” (p. 79, Hebda and Aitkens, ed.)

Although the remnant GOE is small, degraded, and isolated from other GOEs, making the migration of species between them unlikely, restoration and preservation of the site is still worthwhile, not only for educational and aesthetic reasons, but also as a means of preserving species found only in these ecosystems.

In November 2005 I contacted the then, acting Environmental Services Coordinator at RRU, Brianne Czpyha inquiring into the possibility of starting a Garry oak...
restoration project on the remnant Garry oak site on Royal Roads property near our school. Brianne presented our proposal to the RRU Environmental Advisory Committee, and within a few days we had been given permission to, in Brianne's words, "do with the site what you want". Work commenced on the Project in January 2006.

2.3 Garry oak Ecosystems

Garry oaks (*Quercus garryana*) belong to the subgenus *Lepidobalanus*. It is the only oak species native to British Columbia (Erickson, 1998). In Canada, Garry oak ecosystems are found almost exclusively on the southeast coast of Vancouver Island and the southern Gulf Islands (GOERT 2000), areas which feature a near-Mediterranean climate with mild winters, and dry summers (Erickson, 1993). They represent one of the rarest and most threatened ecosystems in the country (GOERT, 2000). Over 100 species found in Garry oak ecosystems are currently considered at risk of extinction (GOERT website Mar 12, 2007),

GOEs historically covered a much greater area of the southern tip of Vancouver Island than is presently the case (Figure 3).

![Distribution of Garry oak Ecosystems, Colwood, B.C.](image)

Figure: 3 Note the proximity of restoration site to historical range of GOEs
In his historical survey of GOE distribution, Ted Lea estimates that in 1800, GOEs covered over 10,000 hectares in Greater Victoria and the Saanich Penninsula. (Lea, in Burton: 2002). Due primarily to heavy pressure from urban development, this number had shrunk to approximately 512 hectares in 2002 – only 16 of which were in Colwood (Lea, in Burton: 2002).

On the Royal Roads property, it is likely that GOEs were once more common than they are today, but fire suppression and encroachment by conifers - which shade out Garry oaks - has put these ecosystems in decline (Ryan, Radcliffe, and Butt, 2002). Our restoration site would appear to be one of these ecosystems.

2.4 Location

The restoration site is located on the western edge of RRU property on the southern tip of Vancouver Island, in the City of Colwood (Figure 1). According to the Biogeoclimatic Ecosystem Classification System, (Meidinger and Pojar, 1991), RRU lies within the Nanaimo Lowlands ecoscean and the Coastal Douglas-fir (CDF) zone. The RRU property comprises 565 acres (Royal Roads University, 2007), most of which is situated on a slope overlooking Esquimalt Lagoon and the Strait of Juan de Fuca. It has a moist marine (mm) subzone designation. RRU receives between 900mm and 1000mm of precipitation annually, approximately double the amount received annually in the city of Victoria, a few kilometres to the west (Ryan, Radcliffe, and Butt, 1995). This extra moisture, combined with the cooling effects of the ocean may account for a few Sitka spruce (Picea sitchensis) and Western hemlock (Tsuga heterophylla) trees - more typically found in the nearby Coastal Western Hemlock zone - near the shore at RRU. The RRU property is surrounded by commercial and residential development, except for the southeast side, which borders on Esquimalt Lagoon.

2.5 Soils

At the end of the last ice age most of Vancouver Island, including what is now the RRU campus, was below sea level. As the ice receded, the land beneath it rebounded, leaving fluvio-glacial outwash and well-sorted silts, sands and gravels on top of an
impervious layer of marine clay (Day et al. 1959). The 1958 soil map (Figure 4) shows the Royal Roads remnant Garry oak site lying within the area containing soils in the Esquimalt Series. These soils developed on glacial-fluvial and marine materials and are characterized by gravelly sandy loam over permeable loamy sand on top of loose gravelly sand with some cobbles. These soils generally drain rapidly, resulting in a lack of stored moisture during the summer dry period (Day et al. 1959).
2.6 Site History

The restoration site is located on the site of the former living compound for Chinese labourers (Figure 5) who worked on the Dunsmuir family estate in the early 1900s (Castle, 1995). When the buildings in the compound were demolished the resultant surface disturbance and exposed location provided an opportunity for non-native plant species to establish. There are two heritage apple trees still on the site which appear to be holdovers from the days of the Chinese residential compound.

Royal Colwood Golf Course and Northwest Corner of Royal Roads

Figure: 5  Scale: 1:12000  Chinese Workers Village circled in red
Note cleared areas around Village site
1926 B.C. Airphoto: BA 20 48
Numerous bricks are scattered throughout the Phase One areas of the site, where the residential buildings appear to have been located. Other items found on the site include chunks of concrete, rusted cooking pots, and a small glass vial of the sort perhaps used for medicine or other drugs.

2.7 Literature Review

Several schools in the Greater Victoria area have embarked on Garry oak restoration projects with their students over the past several years. Campus View Elementary, Rogers Elementary, Royal Oak Middle School, Strawberry Vale Elementary and Camosun College have all been involved in the District of Saanich's Garry oak Restoration Project (GORP, 2007). Sundance Elementary School, since 1994, has also been involved in various Garry oak restoration activities (Neame, 2005).

3.0 Methods

3.1 Determining the Study Area

In late November 2005, after our school received permission to conduct a restoration project on the Royal Roads remnant Garry oak site, I walked the site to determine reasonable boundaries for the Project. The area on the site map (Figure 2) identified as Phase One was the area which first prompted me to entertain the idea of a GOE restoration project. This area is located on a bench on the western edge of the RRU property. It contained several tree and shrub species associated with GOEs and relatively little invasive species growth compared to adjacent areas. This area, I decided, would be our main area of focus for restoration. A major consideration in this decision was how and where to start the removal of Scotch broom (Cytisus scoparius), by far the most common invasive species found in the Phase One area and the two adjacent disturbed areas. Instructions for Scotch broom management in the Decision Support Tool for Invasive Species in Garry Oak and Associated Ecosystems (Garry Oak Ecosystems Recovery Team, 2002) support the strategy of starting Scotch broom removal in the areas of lowest density, which in this case is the area identified as Phase One.
One factor limiting the spread of Scotch broom on the Phase One site was the presence of several mature deciduous trees with large canopies. Little shrub growth occurred under these trees, including Scotch broom. A large, diseased cherry (*Prunus spp.*) tree was removed from the centre of the Phase One site by Royal Roads horticultural staff in December 2005, just before our Project started, exposing an extensive carpet of moss underneath.

The areas marked as Phase Two and Phase Three on the site map, (Figure 2) are adjacent to Phase One and have far fewer native species and much greater invasive species growth. All three phases taken together form a rectangle of 1.1 hectares which very closely matches the area occupied by the village built in the early 1900s (Figure 5) for James Dunsmuir to accommodate the Chinese workers who worked in Hatley Castle and on the estate.

Phases Two and Three are included in the Project because of their proximity to Phase One and the likelihood that seed from Scotch broom and Sweet Vernalgrass (*Anthoxanthum odoratum*), especially, in those two areas, would continue to invade the Phase One area.

3.2 Methods Used to Describe the Phase One Area of Restoration

Vegetation on this site was recorded using *Plants of Coastal British Columbia* (Pojar and MacKinnon, 1994) for identification. Species which were not readily identified using this guide were collected for later study. Percent cover for each vegetation type and species were estimated in each plot using the comparison charts for visual estimation of foliage cover in the *Field Manual for Describing Terrestrial Ecosystems* (B.C. Ministry of Environment, Lands and Parks, 1998). A ground inspection form (GIF) was completed for the site.

A soil pit was dug on the site to a depth of 100 centimetres. Soil texture was determined using the Key to Soil Texture on pl 60 of the *Field Guide for Describing Terrestrial Ecosystems* (B.C. Ministry of Environment, Lands and Parks, 1998). The same field guide was also used to determine soil moisture regime (p. 10) and nutrient regime (p. 12).
The slope on the site was measured with an Invicta clinometer and the aspect was determined with a Suunto MCA-D compass.

The heights of all trees on the site were measured with an Invicta clinometer. Diameter at breast height (dbh) of all trees on the site was measured at 1.3 metres using a Lufkin dbh tape.

UTM coordinates and elevation for the site were determined using a Garmin GPS 72 GPS unit.

Ecosystem classification was done for this site using Erickson’s *Garry Oak (Quercus garryana)* Plant Communities and Ecosystems in southwestern British Columbia (1998) and the Terrestrial Ecosystem Mapping (TEM) classification system (Province of British Columbia, 1998). Ecosystem classifications for neighbouring areas were taken from Ryan, Radcliffe and Butt (1995) based on the (TEM) classification system. Airphotos and historical maps and sketches were used to learn the history of the Chinese workers village site and how it has changed over time. Discussions with Royal Roads employees also helped provide more complete knowledge of early land use on what is now the RRU campus.

3.3 Wildlife on the Restoration Site

Records were kept of all wildlife observed on or near the restoration site between January 2006 and April 2007 (Appendix 3).

3.4 Introductory Workshops on Garry oak Ecosystems

Before any restoration work on the Garry oak site could start, and to address the Project’s first goal of developing knowledge and appreciation in students and the community for Garry oak ecosystems, I organized and led a series of introductory workshops on GOEs and invasive species for all students in grades one to five at Colwood Elementary School in January 2006. The kindergarten and grade six teachers chose not to participate in these workshops due to scheduling conflicts.

For the purposes of the workshops, the Garry oak Ecosystem Resource Team (GOERT) loaned the school a large, free-standing educational display about GOEs, in addition to giving us pamphlets, posters, and other print materials to keep at the school.
Topics covered in the workshops included: background information on GOEs and their increasing rarity, how to identify Garry oaks, native plant and animal species associated with GOEs, and invasive species and their effects on native plant and animal communities. To wrap up our first sessions together, the primary children were given samples of native and non-native plants to identify and sort, most of which are found on the Royal Roads site. Students in grades four and five completed a worksheet (Appendix 4), which required them to match descriptions of native and non-native plants to their common names, and identify them as native or non-native. Students could then sketch one native and one non-native plant of their choosing at the bottom of the page using samples on display as models.

The next step was to introduce the students to the actual site we would be working on. In the last week of January 2006, I took each of the seven classes which had participated in the initial workshops out onto the remnant Garry oak site at Royal Roads. We first walked around the site and identified some of the plant species found there, several of which had been discussed and identified in our classroom sessions.

Primary students were put into pairs and given a clipboard and a sheet of paper (Appendix 5) with which to make a list of “Signs of Human Activity on the Royal Roads Garry oak Site”. Students then sorted these “signs” according to whether they had a good, bad, or neutral effect on the site (Appendix 6). The sorting exercise was not marked and none of the answers given by students were considered “right” or “wrong”. The purpose of the exercise was to generate thought and discussion about the effects of human activity on the environment, because we were about to embark on a restoration project which was going to deliberately alter the landscape of our site.

Students in grades four and five, after an introduction to the site, were given the task of performing a simple vegetation survey of the site (Appendices 7 & 8). Each class was divided into two groups; one identified the native plants on-site, and the other identified the non-natives. Students in the native plant group were each given a copy of Tree Book: learning to recognize trees of British Columbia by Parish and Thomson (1994), and two copies of Plants of Coastal British Columbia by Pojar and MacKinnon (1994) to share, for reference. Students in the non-native plant group were each given a
copy of the pamphlet, *Invader Plants of Greater Victoria* by D. Loewen. All students were asked to give both the common and latin names of the species they identified.

The purpose of this activity was to allow students to generalize and apply their learning from the classroom in the field. It was important that this group of older students be able to accurately identify and distinguish between native and non-native plants because these students would be the ones doing the bulk of the invasive species removal once active restoration began.

The grade four and five students then pooled the collected information and used it to produce vegetation maps of the site with a partner using a version of Figure 2, with only the site boundaries, service roads, scale and compass shown (Appendix 9). This activity provided students opportunity to practice map skills they may have only previously tried in a classroom, such as drawing to scale, and orienting to a map. Afterwards, as a group, we reviewed all the maps, then looked at my vegetation map of the site, Figure 2. We discussed the importance of such a document to provide a baseline before restoration work is started and to act as a decision-making tool for restoration.

### 3.5 Invasive Species Removal Training

In mid-February 2006, two Royal Roads staff conducted a short training session on invasive species removal with eleven of our grade five students during a lunch hour. Barrie Agar, the Head Gardener at Royal Roads, demonstrated how, when and why we use lopping shears or hand-pulling to remove Scotch broom and daphne (*Daphne laureola*), the two most common invasives shrubs to be removed in Phase One of the Project. Safety considerations were also addressed with regard to the proper use of lopping shears, the need for gloves and eye protection when handling daphne, and the appropriate ways to dispose of cut or pulled plant material.

### 3.6 Invasive Species Removal

Removal of Scotch broom and daphne was first performed on the Phase One site by students and adult supervisors from Colwood Elementary between February 20 and March 10, 2006 according to protocols listed in the *Decision Support Tool for Invasive Species Removal in Garry Oak Ecosystems* (GOERT, 2002) and *Invasive Species*
Management in Garry Oak Ecosystems Restoration (Polster, in Burton: 2002). Plant cuttings were stacked on the side of the service roads bordering the site for pickup and disposal by RRU gardening staff.

Older students who had participated in the invasive species removal training session were paired with younger students. Two adult helpers supervised three pairs of students each during sessions conducted at lunch breaks.

Follow-up invasive species removal was performed on the site on March 15, 2007, to eliminate any regrowth.

3.7 Information Signs

To help achieve the first objective of this project, "...develop a knowledge and appreciation in students and the community for Garry oak ecosystems ...", students in Grades four and five researched and composed the text for an information sign on GOEs. With funding from the school Parent Advisory Committee, the sign was constructed, then erected, at the southwest corner of the site (Figure 6).

![Image of students and teacher](image.png)

*Figure 6: Grade 5/6 Student Writing Team for GOE Information Sign*

- What consideration was given to the design of the sign? Looks like it is covered in text which is not considered good.
Three other signs designed by the GOERT were erected around the perimeter of the restoration site (Figure 7) reminding walkers and bikers to stay on trails to protect sensitive ecosystems.

![One of three GOERT advisory signs on site perimeter](image)

Figure 7:

3.8 Conifer Thinning and Pruning

In January 2006, the Phase One site contained a cluster of eight mature Douglas-fir (Pseudotsuga menziesii) trees and three Douglas-fir saplings ranging in height from one to three metres in the northwest corner (Figure 2). The Douglas-fir saplings were removed in February 2006 to prevent them from eventually overtopping and shading out Garry oaks on the site. One other young Douglas-fir (5 metres tall) near the centre of the site was removed at the same time.

An additional mature Douglas-fir located in the middle of the western border of the site was pruned in February 2007 using an extendable pruning saw and lopper to release two young Garry oaks it was overtopping.

3.9 Mulching and Mowing Invasive Grasses

With the Scotch broom and daphne almost completely removed from the restoration site it was time to deal with the introduced grasses on the site which had probably thrived in part, due to the nitrogen fixing abilities of the Scotch broom (Polster, in Burton: 2002). The introduced grasses, orchardgrass (Dactylis glomerata) and Alaska
bentgrass (*Agrostis aequalvis*) together covered 20% of this site. In consultation with Richard Hebda (Personal communication, Sept. 2006), and Tim Ennis (Personal communication, Oct. 2006) I decided to use locally produced, deciduous leaf mulch to smother three patches of invasive grasses (Figures 8 & 9).

Figure: 8

Spreading fresh mulch on orchard grass in southwest corner of Phase One site

Note year-old mulch in bottom left corner of photo
Patches #1 and 2 were covered 16 square metres to a depth of eight to ten centimeters with year-old mulch provided by the RRU horticultural staff. Patch #3 consisted of leaves taken from our school grounds adjacent to the RRU site in early November 2006 by School District grounds personnel and mulched on-site. This third patch was 25 square
metres in size and consisted of Garry oak, Bigleaf maple, and Willow (Salix spp.) leaves. Students created the three mulch patches in mid-November 2006.

Richard Hebda (Personal communication, Sept. 2006) and Tim Ennis (Personal communication, Oct. 2006) also suggested mowing a patch of invasive grass in the fall, both to inhibit re-growth and seed dispersal, and to allow me to check for native species which may be hidden or “choked out” by the invasive grasses. In mid-November 2006 I used a gas-powered string trimmer to “mow” a 16 square metre patch of orchardgrass (Figure #). Students then raked up the cut grass and removed it from the site in order to eliminate the seed supply. Further raking was done to scarify the soil.

3.10 Planting Native Species

On the advice of Richard Hebda (Personal communication, Sept. 2006) I sowed approximately one hundred acorns in patches 1 and 2 of mulch in mid-November 2006. The acorns were collected from two Garry oaks on the grounds of Colwood Elementary School and soaked in water for three days prior to planting to kill any insect larvae which may have been in the acorns.

In the last week of November and the first week of December 2006 students planted 24 common camas (Camassia quamash) bulbs on the Phase 1 restoration site (Figure #). The mature bulbs came from Richard Hebda’s property on the Saanich Peninsula and were planted following protocols established by the U.S. National Plant Data Center (2007). The bulbs were planted in groups of four, twenty centimeters deep.

4.0 Results and Interpretation

4.1 Site Description, Phase One Area

Area: 2351 square metres
Aspect: 999
Slope: level

UTM: N 5364813 E 464259
Elevation: 58 metres
Ecosystem Unit: DGjdf5M
This is a nearly level, mesic site, featuring deep, moderately-rich, fine-textured soils. It most closely resembles ecosystem type: c5 Oak – Broom – *Dactylis glomerata* in Erickson’s classification system for GOEs in southwestern B.C. (Erickson, 1998) (Appendix 10). It’s perhaps important to note that Ryan, Radcliffe, and Butt (1995) classified the entire Chinese Village site (Phases 1, 2, and 3) as Upland field (UF) because that area, like several others at Royal Roads, has been “… so heavily disturbed in the past that there are no species present which would identify the type of forested vegetation which likely inhabited (it)” (p. 16). We must not automatically assume that the Chinese Village site, or any part of it, once contained forest ecosystems identical to the ones which now surround it.

The site contains a small grove of mature Douglas-firs in the northwest corner. In January 2006, there were several Douglas-fir saplings at the north end of the site which had likely grown from seeds deposited by these trees and others from the forested area directly to the north (TEM classification: DGdf5Mt). This site appears to be the least disturbed of the three phases identified in Figure 2. It contains the greatest number of native plant species and, when the Project began, it had the lightest cover of invasive species (Appendix 12). In February 2006, there were 13 trees on the Phase One site, six of which measured at least 60 centimetres in diameter at breast height (Table 1).
Trees on the Phase One Site: Feb. 2006
Royal Roads Garry oak Restoration Project

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Big leaf maple</th>
<th>Garry oak</th>
<th>Douglas-fir</th>
<th>Arbutus</th>
<th>Western red cedar</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average Height</strong></td>
<td>13.6 m</td>
<td>13.2 m</td>
<td>30.5 m</td>
<td>18.5 m</td>
<td>NA</td>
<td>Average height of all trees: 19.0 m</td>
</tr>
<tr>
<td><strong>dbh</strong></td>
<td>54.1 cm</td>
<td>40.3 cm</td>
<td>78.2 cm</td>
<td>32 cm</td>
<td>NA</td>
<td>Average dbh: 51.2 cm</td>
</tr>
<tr>
<td>% of live trees</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>Total: 13</td>
</tr>
<tr>
<td>Saplings</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>Total: 11</td>
</tr>
<tr>
<td>Seedlings</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Total: 2</td>
</tr>
<tr>
<td>Snags</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Total: 1</td>
</tr>
</tbody>
</table>

Table: 1

The tallest tree on-site was a veteran Douglas-fir in the northwest corner, measuring 47.5 m, with a dbh of 167 cm. All other Douglas-firs on-site stood between 30 and 40 metres tall, with dbh measurements between 69 cm and 99 cm. An encouraging sign for the preservation and restoration of the remnant GOE was the presence of five Garry oak saplings and one arbutus sapling. These ranged in height from three metres to eight metres. Three of the Garry oak saplings, however, were overtopped by Douglas-firs. Pruning of the Douglas-firs was carried out to release the Garry oaks. All of the Douglas-fir saplings were removed from the site.

4.2 Soils

Soil Texture: Sandy Clay Loam
Soil Nutrient Regime: Medium

Soil Moisture Regime: mesic
Coarse Fragment Content: over 70%
I dug the soil pit on September 1, 2006 in the middle of the site, away from overhanging trees (Figure 2). The soil here is deep and can be characterized as Sandy Clay Loam. It is moderately well-drained. There is very little organic material on the surface. The top 30 centimetres (Ae layer) consists of very fine, light brown loam. The next 10 centimetres (Bt layer) was beige clay with loosely packed small cobbles. Below this layer was a deep layer of yellow-gold sand (C layer).

There is little evidence on this site of soil disturbance other than in three rectangular pits measuring 2 m x 1 m x 30 cm in the northwest corner. The soil horizon in the soil pit I dug appears to be unaltered and lacking obvious evidence of fill or other foreign material.

The Phase 2 site, in contrast, contains approximately 70% Scotch broom cover and features several areas of loose cobbles on the surface, with little or no topsoil.

4.3 Wildlife

Ryan, Radcliffe and Butt, in their 1995 ecological assessment of the Royal Roads property, noted that because Garry oak sites at Royal Roads are small and few in number it’s difficult to determine the value of these sites for mammals. Since January 2006, only six bird species, two mammal species, and one reptile species have been observed on or near the Phase One site (Appendix 3).

Several of the mature Douglas-firs in the northwest corner of the Phase One site display evidence of woodpeckers and use by small birds. Deer scat and evidence of grazing has also been observed in the open grassy areas of the Phase One site. Deer have been sighted on three separate occasions on or around the Phase One site. Their browsing activities will be one of the major challenges to the establishment of native species over time on this site. Deer tend to browse in Garry oak communities during the spring and summer and may have an impact on the regeneration of oaks, conifers, shrubs and herbs in these units (Ryan, Radcliffe and Butt, 1995). To add to this problem, there are no resident predators of deer on the Royal Roads property, as cougars are only occasional visitors.
Ryan, Radcliffe, and Butt (1995) also report the existence of the Eastern cottontail rabbit on the Royal Roads property, but to date, none have been observed on our restoration site.

With no coarse woody debris or snags, and few mature trees, the Phase Two and Three sites offer limited habitat for birds and mammals.

4.4 Results of Invasive Species Removal

Most of the invasive shrub growth on the Phase One site has been removed, including re-growth from last year's removals. Mulching and mowing treatments have been applied to approximately 50% of the invasive grasses on-site. As mentioned earlier, orchard grass thrives on nitrogen, and Scotch broom fixes nitrogen in the soil (Polster, in Burton: 2002). With virtually all the Scotch broom on the Phase One site now removed, nutrient regimes on the site may return to normal, which in turn will reduce the growth of remaining orchardgrass and the establishment of new orchard grass plants (Polster, in Burton: 2002).

As of March 16, 2007, there had been light growth (5%) of grass spp. on the two year-old mulch patches. The species of the grasses cannot be positively determined as yet. The larger patch of new much (#3) does not yet exhibit any new growth. Some deer grazing of new shoots has probably occurred on patches # 1 and 2, as deer tracks are clearly visible on all both.

4.5 Results of Pruning and Thinning

Garry oaks are shade intolerant (Ryan, Radcliffe, and Butt, 1995; Harrington and Kern, in Burton: 2002, Hebdia, in Hebdia and Aitkens: 2003). In their study of the effects of release on Garry oaks from overtopping conifers, Harrington and Kern (in Burton, 2002) concluded that Garry oaks would probably respond positively to release, but an increase in growing rate may not be noticeable for several years. With our baseline height and dbh measurements for all Garry oaks on the Phase One site, we can monitor annual growth rates of the trees which have been released, Garry oaks # 2,3,8, and 15 (Figure 10), and compare them with growth rates of Garry oaks on the northern perimeter of the Phase 2 site which are overtopped by mature conifers in the adjacent forest stand.
The four Douglas-fir saplings removed on the Phase One site, due to their faster growth rate, would have eventually overtopped and shaded out surrounding Garry oaks.

Garry Oak Ecosystem Site Map

- Trees on Phase One Site -

Name of Observer

General Location: ROYAL ROADS

Legend:

- FENCE
- FORMER CHINESE VILLAGE SITE
- PHASE 1
- PHASE 2
- PHASE 3

Observations:

D = Douglas Fir
A = Arbutus
G = Garry Oak
M = Bigleaf Maple

Scale = 1:780

Figure: 10

4.6 Results of Planting and Scarification

Although grazing by deer, and possibly rabbits, is likely to be a major challenge in the establishment of plant species associated with GOEs on the Phase One site,
exclusionary devices such as nets, screens, tubes, and fencing would likely not last long due to vandalism. The Phase One site, probably due to its openness and proximity to the school and residential areas, is often frequented by people, presumably youths. Evidence of such visits is often found on the site in the form of empty beer cans and cases, and condom wrappers. Additionally, two of our “Sensitive Ecosystem” signs have been tampered with. One was completely pulled out of the ground. The second sign proved to more difficult to remove, and was left standing tilted. Co1wood Elementary has also experienced vandalism, in the form of broken windows, graffiti, and broken saplings, since the school was relocated near the Garry oak site in 2003.

As of March 16, 2007 no acorn shoots had been observed in either mulch patch #1 or #2. As noted in section 4.4, deer grazing may have occurred on these sites.

Of the twenty-four common camas bulbs planted in late November/early December 2006, as of March 16, 2007, twenty had sprouted, to an average height of nine centimeters. Two of the sprouts had been grazed just above ground level.

As an alternative to mesh screens for the protection of the camas shoots - which would probably have been vandalized - I chose to encircle the planting sites with large windfall branches which form a loose barricade or fence (Figure 11).

![Planting Site Barricades](image)

Figure: 11  Planting Site Barricades

It is hoped that these barricades will encourage visitors in the restoration site to walk around, rather than through, the planted areas, while presenting less obvious targets for vandals. The branch barricades will also hopefully present obstacles to deer, which will make browsing on other, surrounding herbaceous growth more desirable.
As of March 16, 2007 no new native plant growth had been observed on the patch of orchard grass which was mowed and scarified in mid-November 2006.

5.0 Discussion and Recommendations

The most difficult aspect of this restoration project to measure, and perhaps the most important, is the degree to which students at Colwood Elementary and people in the neighbouring community have increased their knowledge and appreciation of GOEs and developed a deeper connection with the natural world. The Project has tried to facilitate this by erecting an information sign on-site and by training students and having them participate in most of the restoration work. I could have administered a short baseline survey to students at the beginning of the Project to determine the extent of their knowledge about GOEs and the species found in them, then re-administered the same survey at a selected endpoint. But how is one’s appreciation of something measured objectively? Does knowledge of something guarantee appreciation of it? I think the two can exist independently of each other.

I can only form a partial answer to the question based on my own observations of students and conversations with parents and staff. The most gratifying part of the Project has been the support and enthusiasm students - particularly younger students - have expressed for it. I often had more people volunteer for jobs on the restoration site than I could accommodate in a single session. Parents and other teachers have commented on remarks and observations students have made about the restoration site when walking through it with them. I was especially pleased to hear the mother of a child in my grade three class mention that while walking through Fort Rodd Hill Park, her son noticed that something in the wooded areas had changed since their last visit. After a moment, he realized that all the Scotch broom had been removed from the site! The broom had indeed been removed as part of a restoration project at Fort Rodd Hill.

We were successful in removing the invasive shrubs and some of the introduced grasses from the Phase One site. It will be important to remove the remaining introduced grasses as well as monitor re-growth of mowed and mulched areas. Native grasses such as Alaska oniongrass (Melica subulata) (Personal communication: Tim Ennis, February
2006), California oat-grass (*Danthonia californica*), and Blue wildrye (*Elymus glaucus*) (Personal Communication: Richard Hebda, September, 2006) should also be planted.

The introduction of plant species associated with GOEs, including native grasses, will likely prove challenging due to grazing and vandalism. In hindsight, it would have been useful to cover one of the planting areas in netting to protect it from grazing so we could assess its relative effectiveness compared to barricading.

This Project has certainly been successful in giving students opportunities to “...learn and apply practical skills on a project which enhances the community” (Objective “d”). Skills learned and applied include: mapping, measurement, plant identification, invasive plant removal, research, and non-fiction writing.

### 5.1 Future Action

**Fall 2007:** • Monitor and remove any invasive species re-growth from Phase One site; • cover remaining areas of introduced grasses on Phase One site with mulch

**Spring 2008:** • Plant native grasses on Phase One site (in exclosures?) • Compare growth rates of overtopped control group Garry oaks (#10, 11, 12, 13, and 14; Figure 11) with growth rates of Garry oaks released on the Phase One site (# 2, 3, 8, and 15; Figure 11)

**Fall 2008:** • Begin Scotch broom removal on Phase Two site

### Acknowledgements

Thanks to Barrie Agar, Head Gardener at Royal Roads University, for her support and encouragement. Thanks also to Brianne Czpyha, former Environmental Services Coordinator (Acting) at Royal Roads being our advocate at Royal Roads.

The advice of Tim Ennis and Richard Hebda on possible site treatments was greatly appreciated. Richard also contributed plant stock for the project.

Carolyn Masson from GOERT provided educational materials for use with our students and offered us the GOERT “Thanks for Staying on Track!” poster for use on the advisory signs around the perimeter of our site.
Thanks to Dan Bendall, teacher at Colwood Elementary School for his continual support and assistance; the Colwood Elementary Parent Advisory Committee for their financial support of the Project; and the students of Colwood Elementary for their hard work and enthusiasm over the past eighteen months on the Project.
6.0 References

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Neame, L. 2005. Assessment of Garry oak ecosystem characteristics and habitat connectivity in the South Jubilee neighbourhood, Victoria, British Columbia, Canada. (unpublished paper), University of Victoria, Victoria, B.C.


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Mapping in British Columbia. Prepared by the Ecosystems Working Group, Terrestrial Ecosystems Task Force, Resources Inventory Committee, Victoria, B.C.


7.0 Appendices
Grade 4 Life Science: Habitats and Communities

Prescribed Learning Outcomes

It is expected that students will:
• demonstrate awareness of the Aboriginal concept of respect for the environment

Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome. Students who have fully met the prescribed learning outcome are able to:

- describe in detail how to show respect for the environment (e.g., clean up school yard, recycle, weed garden)
- create accurate, detailed drawings to illustrate stories that demonstrate the relationship Aboriginal peoples have with the land, water, animals, plants, and sky (e.g., respect for water, earth)

Planning for Assessment

<table>
<thead>
<tr>
<th>Suggested Assessment Activities</th>
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</thead>
<tbody>
<tr>
<td>• Review skills and attitudes related to invited guests, such as SWIM:</td>
</tr>
<tr>
<td>- Sit up</td>
</tr>
<tr>
<td>- Watch the speaker</td>
</tr>
<tr>
<td>- Inquire (ask yourself what the speaker is saying)</td>
</tr>
<tr>
<td>- Make connections with what you know already.</td>
</tr>
<tr>
<td>• Observe the extent to which students use LAPS strategy while listening to the speaker:</td>
</tr>
<tr>
<td>- Listen</td>
</tr>
<tr>
<td>- Ask yourself questions</td>
</tr>
<tr>
<td>- Picture (draw) what you hear</td>
</tr>
<tr>
<td>- Summarize (retell) what you heard.</td>
</tr>
<tr>
<td>• Ask students to respond to the stories in their journals and reflect on ways they show respect for their own environment. Establish assessment criteria with students, such as students:</td>
</tr>
<tr>
<td>- select a relationship they have with any three of land, water, animal, plant, sky</td>
</tr>
<tr>
<td>- tell how they personally show respect for each of their choices</td>
</tr>
<tr>
<td>- indicate how their behaviour is similar to or different from the First Nations stories they read and wrote about.</td>
</tr>
</tbody>
</table>

Recommended Learning Resources

• Cycle of Life/Recycle Handbook for Educators
• Healthy Habitats (Pan Canadian Science Place)
• Once Upon a Seashore
• Project WET
• Salish Sea
• The Watershed Works

• Invite a local First Nations person to share an experience on how his or her culture shows respect for the environment. Students can compare this experience to their own, or suggest examples of how they are showing respect in other ways, in the community or in school. Contact the district Aboriginal Education coordinator or resource teacher for assistance in drawing on the local Aboriginal community.

• Read stories that demonstrate the relationship First Nations people have with the land, water, animals, plants, and the sky.
Grade 4 Life Science: Habitats and Communities

Prescribed Learning Outcomes

It is expected that students will:
• determine how personal choices and actions have environmental consequences.

Suggested Achievement Indicators

The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome. Students who have fully met the prescribed learning outcome are able to:

- document the steps involved in supporting actions that positively affect the school environment (such as those involved in a garbage-less lunch campaign), using detailed checklists and various group projects
- prepare and illustrate a simple, local habitat improvement plan that shows which plants and animals benefit from the plan

Planning for Assessment

• Ask students to suggest possible actions that would improve their environment. They should identify any benefits and challenges associated with each action. For example, if the proposal was to add more plants to the schoolyard, student plans could look like the following:

<table>
<thead>
<tr>
<th>Action</th>
<th>Benefits</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schoolyard garden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom composting</td>
<td>Reduce classroom waste</td>
<td>Get * composter</td>
</tr>
<tr>
<td>Recycling</td>
<td></td>
<td>* worms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* permission</td>
</tr>
</tbody>
</table>

Suggested Assessment Activities

• Look for evidence that student habitat action plans are manageable
- include the information needed to complete and sustain the project
- present solutions to challenges
- show indicators of success
- indicate how each group will work together.

Recommended Learning Resources

• Backyard Biodiversity and Beyond
• Cycle of Life/Recycle Handbook for Educators
• Hands-on Science (Habitats and Communities)
• Healthy Habitats (Pan Canadian Science Place)
• Kokanee of British Columbia
• Once Upon a Seashore
• Project WET
• Project WILD
• Salish Sea
• Science Detective™ Beginning: Higher-Order Thinking, Reading, Writing in Science
• Urban Stewards
• The Watershed Works
Appendix 3

Wildlife Sightings On or Near the Phase One Site
Royal Roads Garry oak Restoration Project
January 2006 – March 2007

Birds:
American robin (*Turdus migratorius*)
California quail (*Lophoryix californicus*)
Chestnut-backed chickadee (*Parus rufescens*)
Rufous-sided towhee (*Pipilo erythrophthalmus*)
Stellar's jay (*Cyanocitta stelleria*)
Turkey vulture (*Cathartes aura*)

Mammals:
Black-tailed deer (*Odocoileus hemionus*)
Raccoon (*Procyon lotor*)

Reptiles:
Red-sided garter snake (*T. sirtalis parietalus*)
# Garry Oak Ecosystem Scavenger Hunt

<table>
<thead>
<tr>
<th>Name of Species</th>
<th>Native or Alien?</th>
<th>Match the species number with the description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garry Oak Tree</td>
<td>✓</td>
<td>1. Dark green deciduous shrub with small leaves and yellow flowers</td>
</tr>
<tr>
<td>Scotch Broom</td>
<td></td>
<td>2. Evergreen plant/shrub with very dark green glossy leaves (do not touch)</td>
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<tr>
<td>Indian Plum</td>
<td>✓</td>
<td>4. Dark green evergreen groundcover plant that grows to a thick, climbing vine</td>
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<tr>
<td>English Ivy</td>
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<td>3. Heavy limbed deciduous tree with light grey bark and deeply round-boaked leaves</td>
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<tr>
<td>Ocean Spray</td>
<td>✓</td>
<td>5. Shrub or small deciduous tree with white flowers or clusters of small plums</td>
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<td>Daphne</td>
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<td>6. Perennial herb with milky juice and yellow, solitary flowers</td>
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<tr>
<td>Camas</td>
<td>✓</td>
<td>7. Deciduous shrub with alternate, dull green leaves and white/cream flower clusters</td>
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<tr>
<td>Dandelion</td>
<td></td>
<td>8. Perennial herb with grass-like leaves and deep blue, occasionally white flowers with long spiked petals</td>
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</tbody>
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*Adapted lesson by Mac Donald & Stieler, 2006*
Signs of Human Activity on the Royal Roads
Garry Oak Site

Name: ____________________________

1) ______________________________________

2) ______________________________________

3) ______________________________________

4) ______________________________________

5) ______________________________________

6) ______________________________________

7) ______________________________________

8) ______________________________________

9) ______________________________________

10) _____________________________________

11) _____________________________________

12) _____________________________________

13) _____________________________________

14) _____________________________________

15) _____________________________________
# Native Plants on the Garry Oak Site

**Name:**

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<tr>
<th>Common Name</th>
<th>Latin Name</th>
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</table>
# Non-Native Plants on the Garry Oak Site

<table>
<thead>
<tr>
<th>Name:</th>
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<table>
<thead>
<tr>
<th>Common Name</th>
<th>Latin Name</th>
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</tbody>
</table>
Garry Oak Ecosystem Site Map

Name of Observers

General Location: Royal Roads

Lat/Long

Driving Directions

Observations:

Scale = 1:780

FORMER CHINESE VILLAGE SITE
**c5 Oak - Broom - Dactylis glomerata**

**Ecosystem Description:**
Frequency of Occurrence: frequent, 5 plots
Distribution: From Plots: Gabriola Is.; Pender Island: Oak Bluffs; Saanich Peninsula: Thetis Lk. Pk.; western shore: Lester Pearson College From Notes: Saanich Peninsula: Summit Pk; western shore: Belmont Pk., Mary Hill.

**Plant Community Description:** *Cytisus scoparius* (introduced broom) occupies all sites as a low shrub (B2) and as a tall shrub (B1), both with an average class 3 cover. *Dactylis glomerata* (introduced orchardgrass) thrives, with high cover-class 4 to 5, on all sites.

*Galium aparine* (cleavers) and *Osmorhiza chilensis* (sweet cicely) occur on all sites and average class 2 to 3 cover. *Bromus carinatus* (California brome grass), *Poa pratensis* (introduced Kentucky bluegrass), *Vicia sativa* (introduced common vetch), and *Sanicula crassicaulis* (Pacific snakeroot) grow on all sites and average class 2 in cover.

The remaining species exist on most sites. *Vicia hirsuta* (introduced hairy vetch) averages cover class 2 to 3. *Montia perfoliata* (perfoliante-leaved miners lettuce) and *Plantago lanceolata* (introduced narrow leaved plantain) average class 1 to 2. *Nemophila parviflora* (grove lover) and *Polystichum munitum* (swordfern) average class 1.

**Tree Canopy/ Landscape Expression:** usually high cover tree canopy (A) layer

**Oak Characteristics:** Diameters: various: 18 to 82.7 cm;

**Regeneration:** is present on most sites for both saplings and seedlings. Saplings are moderately well-stocked. Seedlings are lightly-stocked.

**Physiognomic Type:** Oak - Broom - Parkland.

**Elevation:** various, 30 to 120 m **Slope:** chiefly gentle, one steep

**Aspect:** east (110 deg.) to southwest (200 deg.)

**Surface Shape:** usually straight **Moisture Regime:** mesic to submesic

**Exposure:** wind (3) **Bedrock Geology:** various, several coarse: sandstone, conglomerate (3)

**Surface Substrate Features:** few features

**Soil Classification:** usually Orthic Sombric Brunisols

**Humus Classification:** commonly Vermimulls **Depth of Ah Horizon:** usually > 25 cm(4) **Colour of Ah Horizon:** dark, 10YR 2/1, 2/1.5

**Depth to Bedrock:** typically without, two are shallow, 4 to 25 cm

**Surface Soil Texture:** tends to be coarse; all are gravelly or very gravelly

**Percent Coarse Fragments:** medium to high coarse fragments in the subsurface horizons (55 to 80 %)

**Discussion:**

Coarse-textured, deep, dark *Ah* horizons, medium to high subsurface coarse fragments, occurrence on gentle slopes and widespread geographic distribution partly distinguish this plant community.

---

*From: Erickson, 1998*
Royal Roads Garry oak Restoration and Education Project
Expenditures

February 2006

12 pairs of size small work gloves.................................................. $ 48
5 lopping shears............................................................................. $ 110

May 2006

3 advisory signs and 1 information sign........................................... $ 837

TOTAL: $ 995
# Vegetation Survey Results

## Phase One Site

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tree Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Quercus garryana</em></td>
<td>Garry oak</td>
<td>6</td>
</tr>
<tr>
<td><em>Pseudotsuga menziesii</em></td>
<td>Douglas-fir</td>
<td>25</td>
</tr>
<tr>
<td><em>Acer macrophyllum</em></td>
<td>Bigleaf maple</td>
<td>6</td>
</tr>
<tr>
<td><em>Arbutus menziesii</em></td>
<td>Arbutus</td>
<td>2</td>
</tr>
<tr>
<td><em>Prunus emarginata</em></td>
<td>Bitter cherry</td>
<td>T</td>
</tr>
<tr>
<td><strong>Shrub layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Symphoricarpos albus</em></td>
<td>Common snowberry</td>
<td>3</td>
</tr>
<tr>
<td><em>Holodiscus discolor</em></td>
<td>oceanspray</td>
<td>4</td>
</tr>
<tr>
<td><em>Mahonia aquifolium</em></td>
<td>Tall Oregon-grape</td>
<td>2</td>
</tr>
<tr>
<td><em>Mahonia nervosa</em></td>
<td>Dull Oregon-grape</td>
<td>5</td>
</tr>
<tr>
<td><em>Ilex aquifolium</em></td>
<td>English holly (introduced)</td>
<td>T</td>
</tr>
<tr>
<td><em>Daphne laureola</em></td>
<td>Spurge laurel (introduced)</td>
<td>2</td>
</tr>
<tr>
<td><em>Ulex europaeus</em></td>
<td>Gorse (introduced)</td>
<td>T</td>
</tr>
<tr>
<td><em>Cytisus scoparius</em></td>
<td>Scotch broom (introduced)</td>
<td>15</td>
</tr>
<tr>
<td><em>Gaultheria shallon</em></td>
<td>salal</td>
<td>T</td>
</tr>
<tr>
<td><em>Lonicera hispidula</em></td>
<td>Hairy honeysuckle</td>
<td>T</td>
</tr>
<tr>
<td><em>Rosa nutkana</em></td>
<td>Nootka rose</td>
<td>T</td>
</tr>
<tr>
<td><em>Rosa gymnocarpa</em></td>
<td>Baldhip rose</td>
<td>T</td>
</tr>
<tr>
<td><strong>Forb Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dactylis glomerata</em></td>
<td>orchard grass</td>
<td>14</td>
</tr>
<tr>
<td><em>Poa pratensis</em></td>
<td>Kentucky bluegrass</td>
<td>2</td>
</tr>
<tr>
<td><em>Agrostis aequivalvis</em></td>
<td>Alaska bentgrass (introduced)</td>
<td>3</td>
</tr>
<tr>
<td><em>Sanicula crassicaulis</em></td>
<td>Pacific sanicle</td>
<td>1</td>
</tr>
<tr>
<td><em>Galium aparine</em></td>
<td>cleavers</td>
<td>T</td>
</tr>
<tr>
<td><strong>Bryophyte Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhytidiodelphus triquetrus</em></td>
<td>Electrified cat’s-tail moss</td>
<td>12</td>
</tr>
<tr>
<td><em>Pleurozium schreberi</em></td>
<td>Big red stem moss</td>
<td>2</td>
</tr>
</tbody>
</table>
### Phase Two Site

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>%Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tree Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Psuedotsuga menziesii</em></td>
<td>Douglas-fir</td>
<td>45</td>
</tr>
<tr>
<td><em>Quercus garryana</em></td>
<td>Garry oak</td>
<td>T</td>
</tr>
<tr>
<td><em>Thuja plicata</em></td>
<td>Western red cedar</td>
<td>2</td>
</tr>
<tr>
<td><em>Abies grandis</em></td>
<td>Grand fir</td>
<td>1</td>
</tr>
<tr>
<td><em>Prunus emarginata</em></td>
<td>Bitter cherry</td>
<td>T</td>
</tr>
<tr>
<td><strong>Shrub Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rubus ursinus</em></td>
<td>trailing blackberry</td>
<td>T</td>
</tr>
<tr>
<td><em>Rubus discolor</em></td>
<td>Himalayan blackberry (introduced)</td>
<td>5</td>
</tr>
<tr>
<td><em>Cytisus scoparius</em></td>
<td>Scotch broom</td>
<td>10</td>
</tr>
<tr>
<td><em>Gaultheria shannon</em></td>
<td>salal</td>
<td>1</td>
</tr>
<tr>
<td><em>Salix scouleriana</em></td>
<td>Scouler’s willow</td>
<td>1</td>
</tr>
<tr>
<td><strong>Forb Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Anthoxanthum odoratum</em></td>
<td>Sweet vernalgrass (introduced)</td>
<td>7</td>
</tr>
<tr>
<td><em>Dactylis glomerata</em></td>
<td>orchard grass</td>
<td>1</td>
</tr>
<tr>
<td><em>Polystichum munitum</em></td>
<td>sword fern</td>
<td>1</td>
</tr>
<tr>
<td><strong>Bryophyte Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhytidiadelphus triquetrus</em></td>
<td>Electrified cat’s tail moss</td>
<td>3</td>
</tr>
<tr>
<td><em>Pleuroziun schreberi</em></td>
<td>Big red stem moss</td>
<td>T</td>
</tr>
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</table>

### Phase Three Site

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tree Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pinus contorta</em></td>
<td>shore pine</td>
<td>T</td>
</tr>
<tr>
<td><em>Malus spp.</em></td>
<td>Apple</td>
<td>T</td>
</tr>
<tr>
<td><em>Psuedotsuga menziesii</em></td>
<td>Douglas-fir</td>
<td>8</td>
</tr>
<tr>
<td><em>Thuja plicata</em></td>
<td>Western red cedar</td>
<td>3</td>
</tr>
<tr>
<td><em>Abies grandis</em></td>
<td>Grand fir</td>
<td>1</td>
</tr>
<tr>
<td><em>Cornus nuttallii</em></td>
<td>Pacific Dogwood</td>
<td>T</td>
</tr>
<tr>
<td><em>Quercus garryana</em></td>
<td>Garry oak</td>
<td>2</td>
</tr>
<tr>
<td><strong>Shrub Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rubus discolor</em></td>
<td>Himalayan blackberry (introduced)</td>
<td>5</td>
</tr>
<tr>
<td><em>Rubus ursinus</em></td>
<td>trailing blackberry</td>
<td>T</td>
</tr>
<tr>
<td>Species</td>
<td>Description</td>
<td>Frequency</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td><em>Cytisus scoparius</em></td>
<td>Scotch broom (introduced)</td>
<td>70</td>
</tr>
<tr>
<td><em>Holodiscus discolor</em></td>
<td>oceanspray</td>
<td>2</td>
</tr>
<tr>
<td><em>Gaultheria shallon</em></td>
<td>salal</td>
<td>1</td>
</tr>
<tr>
<td><strong>Forb Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pteridium aquilinum</em></td>
<td>bracken fern (introduced)</td>
<td>1</td>
</tr>
<tr>
<td><em>Polystichum munitum</em></td>
<td>sword fern</td>
<td>T</td>
</tr>
<tr>
<td><em>Anthoxanthum odoratum</em></td>
<td>sweet vernalgrass</td>
<td>18</td>
</tr>
<tr>
<td><em>Dactylis glomerata</em></td>
<td>orchard grass</td>
<td>7</td>
</tr>
<tr>
<td><strong>Bryophyte Layer:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhytidiadelphus triquetrus</em></td>
<td>Electrified cat’s tail moss</td>
<td>6</td>
</tr>
<tr>
<td><em>Pleurozium schreberi</em></td>
<td>Big red stem</td>
<td>2</td>
</tr>
</tbody>
</table>