Fort Rodd Hill National Historic Site's (FRHNHS) GO LEARN Restoration Project: Defining a Reference Ecosystem and Long-Term Propagation Planning Tool

Prepared for the Parks Canada Agency
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By Helena Mahoney
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Executive Summary

The Garry Oak Learning Meadow (GO LEARN) was approved in 2009 as part of FRHNHS's efforts to increase and enhance Garry oak habitat on site. The goal is to restore .5 Ha of disturbed lawn to a mesic deep-soil Garry oak woodland, meadow, and rock outcrop complex: supporting habitat enhancement for native species (including wildlife) and fostering public engagement through ecological restoration activities and interpretive tours.

The project received initial funding of $170,000 to be allocated over four fiscal years from 2010-2014 (Tanner, 2011). A Camas Meadow Planning and Development Committee comprising representatives from both the SAR team and FRHNHS, was formed in June 2010. This was to facilitate site selection, development, and planning for the restoration site. Initial baseline plant surveys were completed in the spring of 2010, indicating almost 100% invasive species cover of the site. Restoration activities began in September 2010 with the construction of a native plant nursery on site, as well as the establishment of a native plant propagation program (Tanner, 2011). Restoration research, project planning, environmental assessments, archaeological assessments, material sourcing (ongoing), and site preparation (using leaf litter mulch) took place in 2011. During the spring of 2012, research on propagation techniques was undertaken, along with the construction of a deer exclusion fence around the site and research trials conducted by UVic undergraduate students- to determine the effectiveness of mulch treatments.

Figure 1Volunteers helping to re-pot 1-year old camas bulbs at FRHNHS in September 2011.

As a UVic co-op student, my direct involvement in the project spanned 16 months, from May 2011 to August 2012. During this time, I participated in a variety of different active resource management and public outreach activities, including: invasive species removals across FRHNHS's 54 Ha, native seed and cuttings collection, native plant propagation, native species out-plantings, maintenance and erection of deer exclosure fences, vegetative surveys, monitoring of SAR and SAR translocations, invasive species removal trials, restoration site preparation, and volunteer events. More specifically, I took the lead on photo-monitoring of restoration sites, as well as GIS mapping of invasive species removals, seed collection sites, and SAR, in the summer of 2011; of SAR critical habitat mapping for Recovery Strategies throughout the fall, winter, and spring of 2011-2012; and of managing and expanding the native plant nursery, as well as leading a team of 3 other co-op students, during the summer of 2012.

Figure 2 Nursery expansion construction at FRHNHS in August 2012.

In my final co-op term at FRHNHS, I identified the need for a defined reference ecosystem to guide restoration and monitoring targets, specifically for the GO LEARN project. This became the basis for my ER390 restoration project that I undertook in the capacity as a student from September 2012 to April 2013.

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Acknowledgements

I would like to thank Parks Canada's Garry Oak Learning Meadow (GO LEARN) project manager, Aimee Pelletier, for her countless hours of support and collaboration in the definition of restoration targets, and the development of the site landscape design and propagation planning tool. Her commitment to incorporating a learning laboratory into this project has allowed me, and countless other students, the opportunity to be involved in a long-term, large-scale restoration project providing an applied and rich learning experience. I would also like to thank Camosun College co-op student, Nathan Fisk, for providing ample feedback and collaboration in the development of the propagation-planning tool. As a co-op student with Parks Canada, Nathan invested many hours into the programming of the propagation-planning tool along with preparation and presentation of the expert review workshop.

A big thank you also goes to Tim Ennis and Irvin Banman from the Nature Conservancy of Canada (NCC) for sharing their experience and research in the development of a restoration tool for the Cowichan Garry Oak Preserve (CGOP). Their contribution to this work served as a catalyst for the propagation planning tool and definition of restoration targets in the GO LEARN project. Also, I would like to thank Ian Giesbrecht who was contracted by NCC to develop the restoration tool for taking the time to discuss the details of this restoration framework.

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Finally, I would like to acknowledge Parks Canada and their Species At Risk Team who have invested both time and money into this project since 2009. The program has been a huge success with all the hard working help from co-op students and volunteers who have spread mulch, pulled weeds, collected seed, monitored rare plants, managed the native plant nursery, and much, much more!

1 Introduction

Restoration of degraded habitats is critical to support ecological resilience in the face of changing climatic conditions. Garry oak ecosystems (GOE), occurring from Northern California to Southern British Columbia, are of particular concern as they have become fragmented with remnants covering less than 5% of their former range (Lea, 2006). These remnant habitats host the highest density of associated Species at Risk in Canada.

A combined total of 11 Ha of critical GOE habitat is found at Fort Rodd Hill National Historic Site (FRHNHS) located on southern Vancouver Island, BC. Since 2001, Parks Canada's Coastal BC Field Unit Species at Risk (SAR) program has implemented restoration and outreach activities at FRHNHS, in accordance with obligations outlined in the federal Species at Risk Act. Activities to date include monitoring listed vascular plants, and managing the recovery of endangered, threatened, or extirpated species by removing invasive species, propagating native plants, collecting native seed, research trials, public outreach, and habitat enhancement. The Garry Oak Learning Meadow (GO LEARN) restoration project was undertaken in 2009 to enhance and diversify critical Garry oak habitat for Species At Risk found at FRHNHS.

Site preparation for the GO LEARN project began in the fall of 2011, with the spreading of leaf litter mulch across the entire .5 Ha restoration site. Seed/live-stake collection and propagation occurred simultaneously; although, the native plant nursery quickly filled to capacity by the spring of 2012, stalked with previously seeded one-year old camas (90, 000 bulbs) and a selection of shrub cuttings. During the summer of 2012, the need for a propagation management plan, along with a defined reference ecosystem for the site was identified. This was to support future seed collection efforts based on individual species' propagation requirements and timelines, while providing accurate estimates of propagule requirements necessary to re-vegetate the GO LEARN restoration site within the project's timeline and budget.

An ecosystem approach, using standardized plant community[1] types to provide a basis for restoration targets, inventory, and monitoring, was chosen to meet the following project goals:

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[1] As defined by Erickson and Meidinger (2007).

(1) restoring the ecological processes of a mesic, deep soil GOE woodland and meadow complex, (2) monitoring the successional pathways of its restoration, (3) creating a learning laboratory on site, and (4) showcasing species richness and abundance for interpretive purposes.

Until this point, the native plant propagation program had been guided by a target species list informed by several Parks Canada Garry Oak Ecosystem Restoration Technicians using: The Garry Oak Gardener's Handbook (Goert, 2009), the Vegetation of Fort Rodd Hill/Fisgard Lighthouse National Historic Sites Technical Report (Fairbarns, 2002), and suggestions from local professionals in the field of conservation and restoration, including Rob Hagel, Fred Hook, Louise Goulet, and Pat Johnston. The next step was to determine species richness and abundance within plant community associations, to inform planting densities and establish the appropriate successional pathways leading to desired reference ecosystems.

In addition, the need to organize this information and make it easily accessible, specifically for large-scale projects taking an ecosystem-based approach, led to the development of a propagation planning database tool, to support on-the-ground decision-making in GOE restoration projects. For example, this tool could be used to inform planting prescriptions for the variety of restoration sites currently being managed at FRHNHS, or be used regionally by restoration practitioners to determine species richness and abundance of reference plant community associations, in an easily accessible information database. Too often, restoration projects do not have the timeline or budget to complete this phase of research in the planning process.

For these reasons, the tool was further developed to support the planning, design, and implementation of a restoration project by addressing questions such as how many plants are required to fill an entire restoration site, which species are found in any particular plant community association, what species are best propagated or procured from a commercial nursery, and what are realistic restoration targets given particular funding or time parameters? Such information is also useful for planning for seed collection requirements, nursery propagation schedules, and project timelines.

2 Objectives

The goals of this project were to determine a reference ecosystem for the GO LEARN restoration project, to produce a landscape design for the project, and to develop a decision-support framework to inform restoration targets, planting densities, seed/propagule requirements, and to establish long-term monitoring criteria. Subsequently, the development of the propagation planning tool could be used to support the same planning process for the variety of FRHNHS's other restoration sites, and possibly GOE restoration projects found region-wide.

3 Site Description

The total GO LEARN restoration site covers one half a hectare (Ha) and is situated near the public exit of FRHNHS (Figure 3). The project area slopes gently towards the ocean, with an east-southeast aspect. Approximately half of the project area has an existing canopy of mature Garry oak, Douglas-fir and big leaf maple, suggesting the presence of a historically deep soil woodland and meadow GOE plant association. This site was chosen as it adds habitat complexity to the already existing mosaic of 11 ha of rare GOE found at FRHNHS. These patches are characterized by remnant patches of shallow soil, rocky outcrop, vernal pool, and transitional forest plant community associations (Figure 4).

Figure 3 Aerial photo of FRHNHS, circa. 1942 (FRHNHS archives).

Over the past century, frequent mowing of the GO LEARN site maintained an open turf field of invasive grasses. Initial mulch treatment application to the site in the fall of 2011 caused the cessation of mowing and removed invasive grass competition. Along with the subsequent exclusion of deer from the site, persisting native species had the opportunity to reveal themselves the following spring and summer. A variety of mature native forbs were observed in and around the rocky outcrop complex, as well as around the base of mature Garry oaks near the entrance of the restoration site. Species observed included: white fawn lily (*Erythronium oregonum*), white brodaeia (*Triteleia hyacinthina*), harvest brodaeia (*Brodiaea coronaria*), hairy honeysuckle (*Lonicera hispidula*), tall Oregon grape (*Mahonia aquifolium*), and snowberry (*Symphoricarpos albus*).

3.1 Biophysical Environment

In Canada, GOE plant communities are found within the southern Vancouver Island region of moist maritime Coastal Douglas-fir subzone (CDFmm)[2] ranging from sea level to 150m in elevation (Fairbarns, 2002). FRHNHS is located within this CDFmm zone, characterized by a warm, moderate sub-Mediterranean climate in the lee of the rain shadow cast by the Olympic Mountains, Vancouver Island Mountains and nearby Sooke Hills (GOERT, 2011). The mild, wet winters and warm, dry summers are further influenced by warm air originating in the mid-latitude Pacific Ocean and moderated by the surrounding ocean straits.

3.1 Human Environment

The presence of large shell middens coupled with deep soil Garry oak habitat reflects a long history of aboriginal use at this site known to be the traditional lands of the Lekwungen family groups, including Songhees and Esquimalt First Nations (Fairbarns, 2002; MacIsaac, 2012). In 1895, Fort Rodd Hill was established as a coastal artillery post, later abandoned in the late 1950s. The turf field was kept mowed for use in military training purposes. Parks Canada assumed management and administration of the Historic Site and surrounding lands in the 1960s. The restoration site continued to be mowed as part of the larger turf field maintenance.

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[2] BEC classification system.

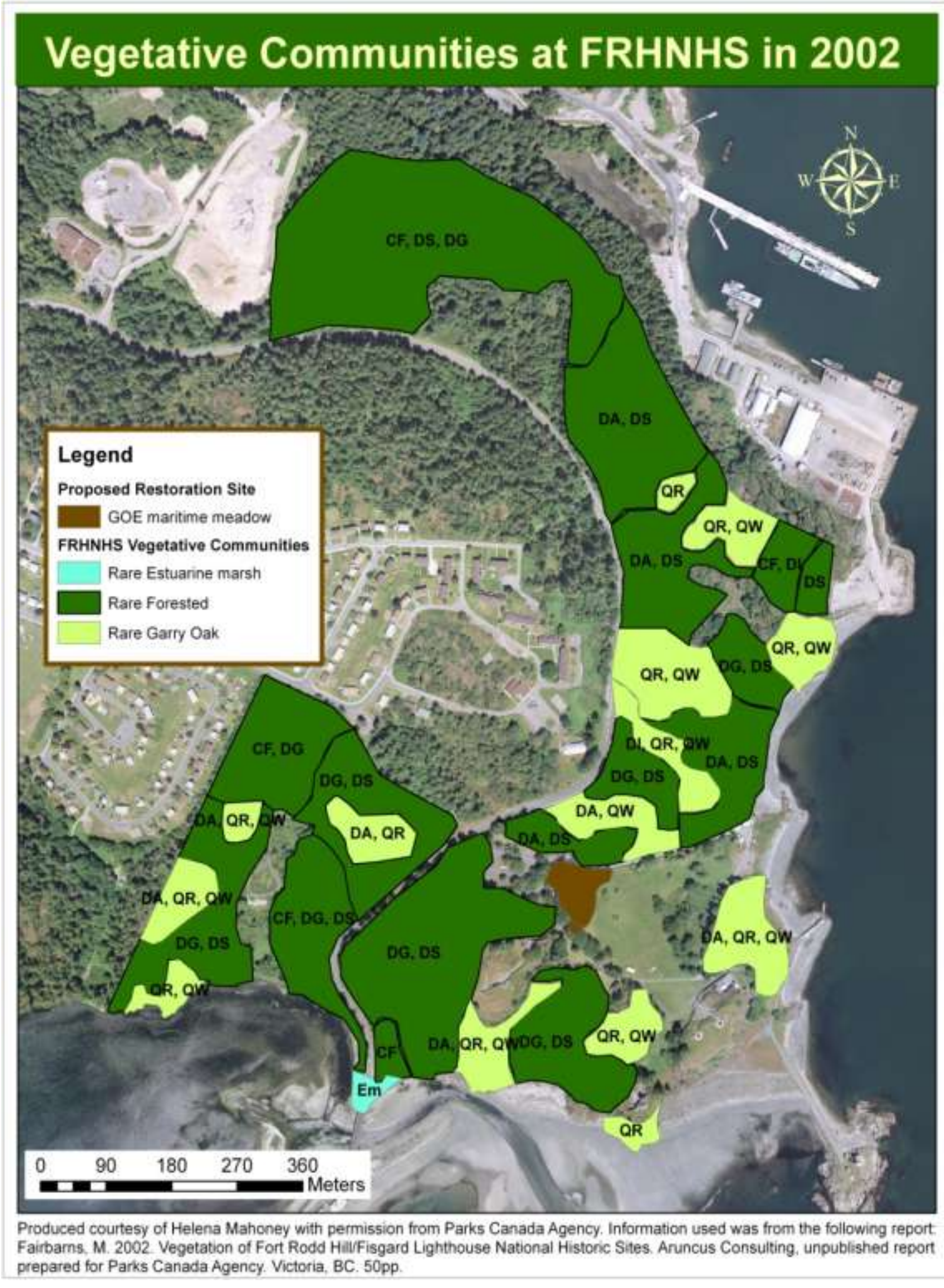

Figure 4 FRHNHS vegetative communities (Fairbarns, 2002).

4 Methods

4.1 Reference Ecosystem

Literature Review. Synthesis of background information included a review of scientific reports and papers, technical reports, restoration manuals, and correspondence with restoration practitioners and research academics. Primary resources of standardized reference plant community associations included:

- Erickson, W., & D. Meidinger. 2007. Garry Oak (Quercus garryana) Plant Communities in British Columbia: A Guide to Identification.
- GOERT. 2011. Restoring British Columbia's Garry Oak Ecosystems: Principles and Practices.
- Giesbrecht, I. 2012. Summary Report of Expert Restoration Workshop for the Cowichan Garry Oak Preserve: Development of a Restoration Tool.

Supplementary restoration and reference GOE resources included:

- GOERT. 2009. The Garry Oak Gardener's Handbook.
- MacDougall, A., Beckwith, B., & C. Maslovat. 2003. Defining Conservation Strategies with Historical Perspectives: A Case Study from a Degraded Oak Grassland Ecosystem.
- HAT. 2009. Gardening with Native Plants.
- Personal communications with Tim Ennis, Brenda Beckwith, Peter Dunwiddie, Carolina Maslovat, Matt Fairbarns, Louise Goulet, Irv Banman, Andrew MacDougal, Cascadia Prairie Oak Partnership, and FRHNHS Restoration Staff .

Standardized plant community types were reviewed and evaluated to determine an appropriate reference ecosystem for the GO LEARN site, based on existing species, soil depth, slope, aspect, and geological landform criteria. Species richness was increased within individual plant community types, based on a collection of personal and professional knowledge of plant ecology and biology. This was done to supplement for the invasive species recorded in these plant community associations and to account for speculated losses in native plant biodiversity found in remnant patches of GOE. For the purposes of the GO LEARN project, target species lists defined within each plant community association type were further revised to exclude all invasive species, species with safety concerns (I.e. death camas- *Zigadenus venenosus*), any federally listed and provincially red and blue listed species, and most tree species (as they already existed on site, and are late successional).

Species' relative abundances defined as percent cover within plant community associations, were sourced individually from Erickson and Medinger (2007) plot data. Plant community guilds developed by Giesbrecht (2012) for several GOE plant community types, were used to guide overall relative abundances of forbs, grasses, and annuals within each community type. Diploma.

Site Evaluation. The GO LEARN restoration site was assessed using a variety of methods. Prior to this ER390 project, a vegetative survey and archeological assessment were completed on site. This information was reviewed and compiled to determine existing species composition and the history of disturbance for the site. Information for existing historic site infrastructure was sought from FRHNHS site managers. Throughout 2011 and 2012, visual surveys were completed to evaluate the following criteria: aspect, slope, canopy cover, sun exposure, moisture retention, seepages, and geological landforms. Soil depth was observed in a variety of locations, based on out-plantings, digging, and the archeological assessment. Finally, site visits to the Nature Conservancy of Canada's Cowichan Garry Oak Preserve and the City of Victoria's Beacon Hill Park were undertaken to observe specie composition and site characteristics of remnant patches of mesic deep soil Garry oak ecosystem plant communities.

Site Mapping. GPS mapping of GO LEARN site features occurred simultaneously with the visual surveys. Features mapped include: site periphery, deer exclosure fences, site entrances/gates, nursery infrastructure, utility area, tree locations (DBH also measured), rocky outcrop, full/partial sun exposure, and seepage areas. Parks Canada soil surveys and shapefiles, along with the most recent Soil Survey of Southeastern Vancouver Island (1959) were consulted. All of these shapefiles were managed using ArcGIS. Expected plant community associations based on site characteristics were then delineated overtop these layers.

4.2 Propagation Planning Tool

The propagation planning tool and information database was developed using Microsoft Excel. Synthesized background information from Section 4.1 was used to populate the various columns in this database. These include: a species list, initial target species, life forms, NCC guilds, relative abundance, species density calculations, ideal species targets per community type, inventory, purchasing, propagation details and planning, and nursery timeline. Methods within particular columns are described below. It should be noted that target plant community associations need to be identified for a site and mapped based on site characteristics and existing vegetative communities, prior to using this tool.

Species List. Both common and latin names were listed. Special considerations for species were listed in individual cell comment boxes in this column. Orange highlight was used to flag species yet to be confirmed/vetted as Garry oak species. Erickson and Meidinger (2007) was our main reference, from which we listed all the species in B, C, and D layers that had greater than or equal to 50% presence. We also included native species listed under "additional species" with less than 50% presence, but did not use the percent covers for this data.

Initial Target Species. To distinguish between priority species ideal for establishing initial dominant cover and species intended to augment biodiversity in later stages of the project, a binary yes or no list was created. Species that were considered challenging to procure or propagate were also delegated to the latter group.

Life Forms- To provide a useful way to sort species for propagation and landscaping purposes, this column was created, based off a revised version of Louise Goulet's (2012) life form designations (Table 1).

Table 1 Life Forms Key (Goulet, 2012)

Life forms: (revised from Louise Goulet, 2012)
A = annual
Fe = fern
G = Grasses or sedges
GcS = Ground Cover Shrub
GcH = Ground cover herb or vine
M = moss
O= orchid
pF = perennial Forb (herb)
pV = perennial vine
S = shrub
Se= sedum
T = tree

NCC Guilds- This column serves as a more general differentiation of life forms based on NCC's percent cover class guilds. The purpose of this filter is to ensure that relative abundances of each species fit into their designated percent cover class guild as outlined by NCC's restoration tool.

Relative Abundance. The relative abundance of perennial graminoids, perennial forbs, and annuals within each plant community association was guided by NCC's percent cover class guilds, as defined in Giesbrecht's (2012) restoration tool under attribute ratings of "very good". The DAFOR (dominant, abundant, frequent, occasional, and rare) scale was used to categorize individual species' abundance within these plant community associations (Table 2). In this case,

Table 2 DAFOR cover classes defining individual species' relative abundance within plant community associations.

Class Guilds by Abundance	Upper Limit of Guild Class	Percentage Values	Midpoint of Guild Class	Percentage Values	All species have been linked to this mid-point guild value for the density calculations. This has been done with the intent of being realistic in our inital planting estimates and with consideration towards seed bank establishment.
D = Dominant = 51-70% cover	70	0.7	60.5	0.605	
A = Abundant = 31-50% cover	50	0.5	40.5	0.405	
F = Frequent = 11-30% cover	30	0.3	20.5	0.205	
O = Occasional = 2-10%	10	0.1	6	0.06	
R = Rare = > or = 1%	1	0.01	1	0.01	

each DAFOR rating was given a percent cover class based on percent cover categories outlined in the Field Manual for Describing Terrestrial Ecosystems (BCMFR, 2010). The cover classes are weighted towards species with more presence to reflect naturally occurring rare and occasional species abundances.

In propagation planning tool, red lettering in the abundance columns refers to Erickson and Medinger (2007) data, whereas black lettered abundance ratings were inferred from other sources (Section 4.1) and Table 2.

Species Density Calculations. Density calculations are based on the mature plant size for each species and are expressed using m^2 units of measurement. These were decided upon collaboratively within the Parks Canada Species At Risk Team based at FRHNHS. In most cases, a circle form is used to denote the area covered by a mature plant, with the exception of some vines in which a rectangle was more appropriate. Once the number of plants per m^2 at 100%

coverage is calculated for a species, the mature plant density for each DAFOR percent cover class is calculated by multiplying the number of plants per m^2 at 100% coverage by the median percentile of each DAFOR percent cover class.

Note: seedlings will cover a smaller area compared to the mature plant area. The area covered by a mature plant was chosen for several reasons: it produces realistic propagation and procurement targets, limits the variation in plant size depending on its age when planted, and allows for natural recruitment. The limitations of a mature plant area compared with the seedling area of an individual plant are: it does not account for mortality and it leaves room for invasive species colonization emphasizing the need for a long-term invasive species management regime at the site.

Ideal Species Targets per Community Type. To determine target numbers of propagules or plants for the restoration project, the total area for each plant community or shrub thicket is added at the top of the plant community association column under this heading. This total area of a particular plant community association polygon can be calculated using geoprocessing tools in ArcMAP or other mapping software. The total polygon area of a plant community association is then multiplied by the mature plant density within its abundance rating for a particular plant community association. A logical test equation has been programmed into the excel sheet, linking the abundance rating in each plant community association to its appropriate density column. Therefore, the "Ideal Species Targets" will change automatically if a species' abundance rating is changed in a particular plant community association.

Purchasing, Propagation Details and Planning, and Nursery Timeline. These columns were added to support project planning and management of the native plant propagation program. The intent was to fill them in, as new information became available, in the development of a propagation information warehouse.

4.3 Expert Panel Review

An expert panel review workshop was organized and coordinated by myself, Aimee Pelletier, and Nathan Fisk, with the intent to present and receive professional feedback on the defined reference ecosystem, propagation planning tool, and site landscape plan. A total of twenty professionals and restoration practitioners from local municipal government, NGO land conservancies, and regional environmental consultant businesses were invited by email to attend a full day workshop hosted by Parks Canada at FRHNHS (Appendix A).

The workshop consisted of a powerpoint presentation, to introduce and provide background information on the GO LEARN project, including a summary of project activities to date. The rationale for the defined reference ecosystem for the GO LEARN site was also reviewed, along with a site landscape plan with associated species lists and species abundances for each plant community association. Handouts were provided, detailing this information, to be reviewed and edited by individuals during the site tour that followed (Appendix B). In the afternoon, participants were introduced to the propagation planning tool. A projector was used to display the excel sheet database and to demonstrate examples of how the tool could be used. Following this, participants were given a feedback form to evaluate criteria such as user friendliness and applicability of the tool, along with presentation of workshop materials. This feedback form was developed for this workshop using feedback form templates found online and revising questions to account for peer review of this project. The feedback questionnaire is found in Appendix C.

5 Results

5.1 Reference Ecosystem

Literature review. Erickson and Medinger (2007) standardized plant community association units were used as a reference ecosystem, whereas species listed within these plant community associations were added to based of off additional resources (see Section 4.1). A total of six different plant community association units were identified at the GO LEARN site, including:

- C13- Garry oak- Alaska Onion grass (*Quercus garryana – Melica subulata*);
- C35a- Garry oak – common camas- white fawn lily (*Quercus garryana – Camassia quamash – Erythronium oregonum*);
- C35b- Garry oak- common camas- broad-leaved shooting star (*Quercus garryana – Camassia quamash – Dodecatheon hendersonii*);
- C36- Garry oak- great camas (*Quercus garryana – Camassia leichtlinii*);
- C37b- Garry oak- common camas- western buttercup (*Quercus garryana – Camassia quamash – Ranunculus Occidentalis*); and

- C51- Garry oak- broom moss- seablush (*Quercus garryana – Dicranum scoparium – Plectritis congesta*).

All of these except C13 are early season communities as opposed to late season communities. Species listed in each community, with relative abundance class guild codes, can be found in AppendixB.

Site evaluation. The total GO LEARN restoration site covers one half a hectare. The project area slopes gently towards the ocean, with an east-southeast aspect. Approximately half of the project area has an existing canopy of mature Garry oak, Douglas-fir and big leaf maple, suggesting the presence of a historically deep soil woodland and meadow GOE plant association. Open meadow plant communities comprise a total of 2083 m^2 of the project area, whereas woodland plant communities comprise a total of 1163 m^2, rocky outcrop plant communities comprise a total of 509 m^2, and shrub thickets combine a total of 574 m^2. The utility area, labeled unit "x" in Figure 7, contains Parks Canada water infrastructure and is characterized by shallow, gravelly soils. This area comprises a total of 189 m^2 of the project area.

Figure 5 Location and features found during the archeological assessment undertaken in 2011.

Baseline vegetative surveys completed in 2010 confirmed almost 100 percent cover of invasive species in the herbaceous layer of the GO LEARN site. The archaeological assessment undertaken in 2011, revealed the presence of numerous known public works trenches, depicted in Figure 5 by the straight lines in the red box. The curved feature also present in the red box is a shallow roadbed, unreferenced in archival maps or photos. This feature is of interest to the restoration project as it suggests an area of heavier soil compaction, gravel introductions, and disturbed soil profile. Several physical soil pits were also dug in accompaniment of the archaeological assessment. These revealed the presence of old terracotta drainage pipes in the soil profile of the

GO LEARN site, inserted by Parks Canada in the 1960s (Pelletier, 2012). The extent of the terracotta drainage pipe network is currently unknown; although its presence suggests the restoration site historically held more water and that the natural hydrology of the site has been altered.

Using the soil pits dug as part of the archaeological assessment, GO LEARN project manager, Aimee Pelletier, made anecdotal observations of the soil profile in a few select spots. Here, she elaborates on her findings:

> *"There was approximately six inches of dark soil on top. Underneath is approximately 40" of sandy soil combined with mixed sizes of rocks; these rocks had slightly rounded edges and varied from 1"- 6" in diameter. The sandy silt mixed in with rock is of possible fluvial origin and suggests the restoration site is fairly well drained."*

Generally, soils in and around the rocky outcrop feature were shallow and sometimes rocky, whereas the woodland and open meadow areas were characterized by deep soils.

Networks of utility lines are also found below ground at the GO LEARN site. These lines are depicted in Figure 1 and include power, telephone, sanitary, storm, and water main lines, all running approximately one meter below the surface of the ground (Pelletier, 2012). Surface access points for storm drain cleanout, water sprinklers and water valves exist within the restoration site.

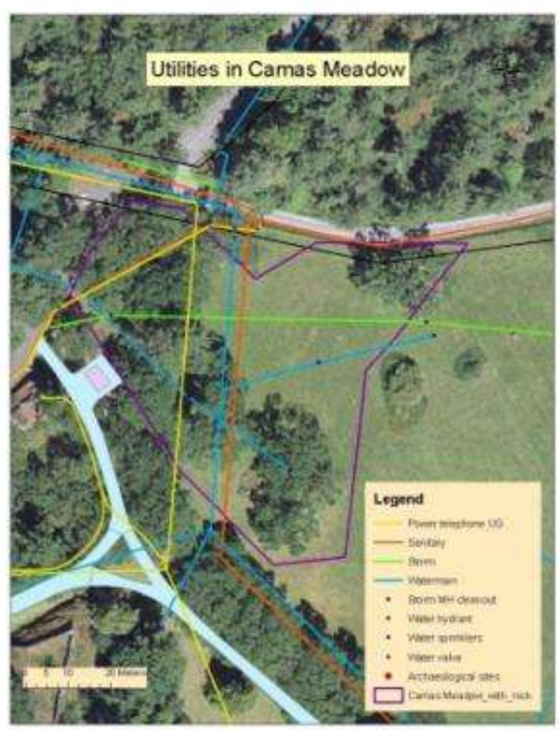

Figure 6 Utility lines found underground at the GO LEARN Site.

Site mapping. The site landscape plan is depicted in Figure 7. The restoration area is ecologically a small-scale site, however, the total of six plant community association units are mapped from a propagation planning and planting perspective to highlight species richness. Shrubs communities are modeled after open mosaic habitat structure, and include species found in the six plant community association units identified on the restoration site. Proposed interpretive pathways, onsite nursery infrastructure, and water access are also highlighted in Figure 7.

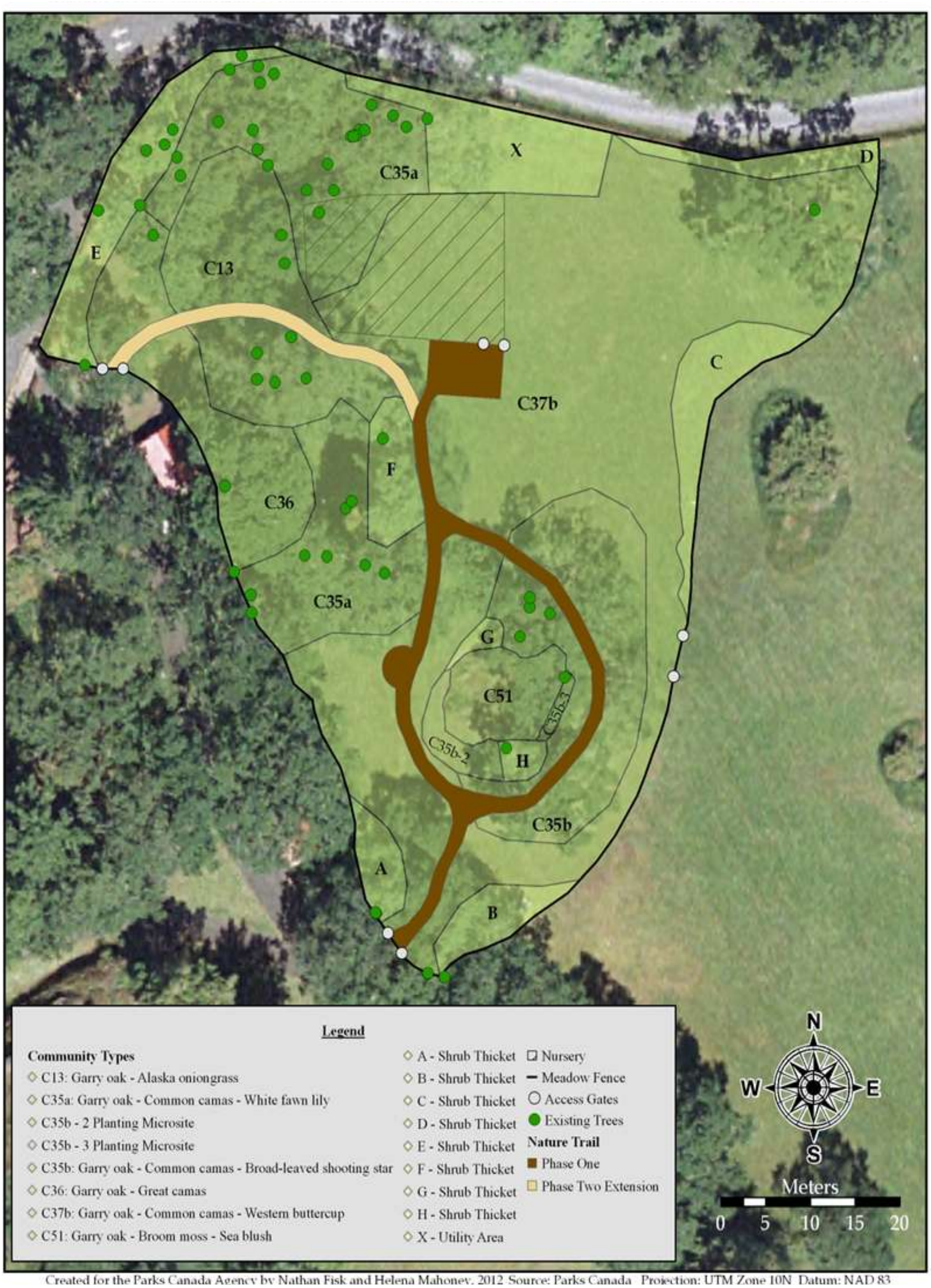

Figure 7 Proposed landscape design and plant community associations, based on site characteristics, for the GO LEARN restoration site at FRHNHS.

5.1 Propagation Planning

The propagation planning tool was developed in 2012 and applied to planning for the GO LEARN project in early 2013. Since then, the tool has continued to be used, however, in a modified and revised. Feedback from Parks Canada regarding the usefulness, effectiveness and applicability of the tool during the period from January 2013 to January 2014 is found in Appendix D.

At present, a total of 119 GOE species and their relative abundances have been defined within plant community associations C13, C35a, C35b, C36, C37b, and C51. These do not include all GOE plant community associations defined in Erickson and Meidinger (2007). Mature plant size per m^2 has been defined for the majority of the species listed in this tool, with some exceptions. Planting densities can be calculated for these species, based on planting community association type, resulting in an estimate of propagule requirements by species by project phase (I.e. 2013 or 2014 field season) for the GO LEARN project.

Please see the propagation planning tool in full, attached as the *Propagation Planning Tool 2012* excel document, under the “Master List V.3.0” tab.

5.2 Expert Panel Review Feedback.

The Expert Panel Review workshop resulted in greater public and professional understanding and involvement in Parks Canada’s GO LEARN restoration project. It also provided a platform for knowledge sharing and collaboration amongst professionals in the field or GOE restoration. Participants were keen to see Parks Canada taking such a role in GOE restoration research, offering advice and brainstorming ideas for the GO LEARN project.

Out of the 20 participants, 4 of them filled out and returned the feedback forms. These included: Tim Ennis from the Nature Conservancy of Canada (NCC), Thomas Munson from the City of Victoria, James Miskelly as an independent contractor, and Todd Kohler with the Garry Oak Ecosystems Restoration Team (GOERT). Their responses to the questionnaire are listed in

Appendix D. Unfortunately the questionnaire from Tim Ennis was misplaced and has not been included in Table 3 of Appendix D.

Generally, participants found the defined reference ecosystem to be appropriate for the GO LEARN site. Gradients of species richness and abundance within the plant community C37b, versus all of the plant community associations listed for this project, was discussed. Some participants felt that the GO LEARN site was ecologically a small enough scale to be identified as one plant community, although, the site specific variation was captured for planning purposes by defining individual plant community associations as in Figure 7. The species lists for each of these communities were noted to be overly extensive for initial planning and implementation of the project, but useful in long-term restoration of ecological diversity and integrity.

The propagation planning tool framework was well-received by the group. It was agreed that it was most applicable to large-scale disturbed sites where restoration involved starting from scratch. Participants did find the complexity of the tool as a barrier to its use, and mentioned that mature plant size and relative abundances should be further researched through scientific study seeking to ground-truth known representations of these plant communities. Site-to-site variability and within site heterogeneity are two other considerations affecting the applicability of this tool, whereas these components could be addressed by site-specific evaluations and analysis in the field. A few commented on the difficulty of attempting to capture natural variability within such a framework.

6 <u>Discussion</u>

6.1 Reference Ecosystem

Literature Review. Ideally, the definition of a reference ecosystem for these purposes would involve referencing existing and intact examples of mesic, deep soil GOE; although, few of these exist, as they have been drastically modified by European colonization and subjected to agricultural development, urbanization, cessation of fire regime, plant invasion, and/or habitat loss (MacDougall, Beckwith, and Maslovat, 2003; Goert, 2011). An in-depth, comprehensive species list and reference ecosystem was pursued for this project in effort to supplement for the limited biodiversity found in plant community associations of remnant patches of GOEs.

Giesbrecht (2012) outlines a few important ways in which Erickson and Meidinger (2007) data differ from a (theoretical) natural reference condition. These include:

- Modifications resulting from European settlement. Because the plots were sampled many decades after European settlement, the dataset likely reflects a number of the ecological changes known to have occurred in BC following settlement:
  - Cessation of burning and other land management practices such as bulb digging;
  - Invasion of exotic plant species. This can be readily seen the in the Qgcc-c37b case study presented above; a number of the most common species are exotic; and
  - Altered herbivore populations and the influence of herbivores on Garry oak plant communities.
- Small sample sizes. Particularly for some communities, the dataset includes only a few plots and thus likely does not adequately characterize the statistical distributions of species frequencies and cover values.
- A snapshot in time from a naturally variable system. Garry oak ecosystems are naturally dynamic in space and time, including ‘random’ year to year variation as well as predictable trajectories over time associated with climate, disturbance, and post-settlement modifications.

Despite these limitations, Erickson and Meidinger (2007) offered the most comprehensive inventory to date of species richness and abundance, along with their associated site characteristics. Furthermore, using Erickson and Meidinger (2007) standardized plant community association units, as opposed to Goert’s (2011) Restoration Ecosystem Units (REU), allowed us to integrate our work with the development of the Nature Conservancy of Canada’s Restoration Tool (Giebrecht, 2012). However, REUs do build off of Erickson and Meidinger (2007) data, making it easily accessible to non-scientific restoration practitioners by providing simplified plant community types specifically for restoration purposes. Goert’s (2011) restoration compendium was a valuable resource in this project, although information on species abundance and planting densities was limited.

Finally, throughout the years of military and Parks Canada use, the GO LEARN site was heavily disturbed resulting in a varied and altered soil profile across the site, along with areas of gravel introductions and heavy soil compaction. Natural soil amendments, such as leaf litter and thatch mulch were removed from the site for over a century. The state of the current soil profile is far removed from its naturally occurring processes. Amount of top soil, soil depth, drainage, and compaction will influence restoration success, and also have the potential to veer the desired restoration efforts away from achieving the goal of a reference ecosystem, towards a novel plant community association.

Site Evaluation. It should be noted that an existing GIS soil shapefile was located on the common drive, however did not prove to be useful as the entire GO LEARN restoration site fell within the "disturbed" soil classification. Furthermore, the most recent soil survey of Southeastern Vancouver Island (1959) offered little insight into historic conditions as it was not mapped at a fine enough scale, classifying all of FRHNHS as Rough Mountainous Land (Rm)-bed rock with thin soil or soil material, much bare rock. The GO LEARN site evaluation could have benefitted from a more comprehensive attempt to determine soil depth throughout the restoration site. One way to accomplish this could be to establish a grid of 5x5 sampling cells across the site, and then randomly sample soil depth using a re-bar or similar type of tool to measure soil depth. Extrapolation using ArcGIS could then be performed to predict soil depth across the site.

6.2 Propagation Planning Tool

The propagation planning tool was developed in an attempt to provide an informative framework and decision-support tool to guide GOE restoration activities for larger-scale restoration projects. Through this process, we took the opportunity to see whether or not this tool could be used as a regional tool by the ecological restoration community on Southern Vancouver Island. Based on feedback from the expert panel review, this tool would need to be further revised to include corrections in methodology pertaining to abundance and mature plant size calculations to account for site-to-site variation and within site heterogeneity; and to be made more accessible through a user-friendly platform (I.e. using Microsoft Access), to achieve these goals. Translating percent covers into planting densities is another challenge faced by this approach.

7 Summary

The GO LEARN restoration project nearing its 5^{th} year of action on the ground and has served as a learning laboratory for the region when it comes to GOE restoration, particularly in mesic, deep-soiled meadows and woodlands. The defined reference ecosystem, landscape design, and restoration tool developed through this research project continue to help guide restoration activities at FRHNHS using an adaptive management approach. To date, Phase 1 of the planting focused on and around the rocky outcrop feature has been completed and Uvic students have been involved in planting density trials to examine propagule survival in relation to inter- and intra-competition of both native and invasive species. Future learning and research opportunities may also exist in the revision and further development of the propagation planning tool as a decision-support tool.

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Appendix A: Expert Panel Review Workshop Invitation

parkscanada.gc.ca parcscanada.gc.ca

Garry Oak Habitat Enhancement and Learning Project (GO LEARN) Expert Workshop

Parks Canada is seeking expert input into our Garry Oak Learning Meadow (GO LEARN). The goal of this workshop is to introduce Parks Canada's restoration planning framework and newly developed decision-support tool for propagation planning to a community of restoration experts for feedback. We are hoping to make this tool accessible and useful to restoration practitioners in the region. The workshop will include a presentation of our restoration framework, a field session to look at the restoration site, and time for discussion.

Date: Tuesday, February 19 from 9:00 am to 2 pm PST.

Location: Administration Building, Fort Rodd Hill and Fisgard Lighthouse National Historic Sites of Canada, 603 Fort Rodd Hill Road, Victoria, BC. *Please park in the gravel parking lot.*

Weather: Please bring outdoor clothing/rain gear for the outdoor field session.

Lunch: Please bring a bag lunch. Coffee/tea/juice and snacks will be provided.

Call-in information for those unable to attend in person: 1.877.413.4785, press 1 when prompted for English, then conference ID#2419846.

Please RSVP by February 12th to Aimee Pelletier at aimee.pelletier@pc.gc.ca if you are planning to attend.

Aimee Pelletier
Garry Oak Ecosystems Restoration Technician
Coastal BC Field Unit | Unité de gestion de la côte de la C.-B.
Parks Canada Agency | L'Agence Parcs Canada
603 Fort Rodd Hill Rd., Victoria, BC, V9C 2W8 | 603 chemin Fort Rodd Hill, Victoria, C.B. V9C 2W8
Telephone | Téléphone: 250-478-5140
Facsimile | Télécopieur: 250-478-8415
Government of Canada | Gouvernment du Canada aimee.pelletier@pc.gc.ca

Project Background

In 2010, a Garry Oak Learning Meadow (GO LEARN) was initiated to restore one acre area of lawn near the entrance to the historic site, to a mesic deep-soil Garry oak woodland, meadow and rock outcrop complex. The project at Fort Rodd Hill endeavours to both enhance habitat for native species while fostering public engagement in the process of restoration.

Approximately half of the project area has an existing canopy of mature Garry oak, Douglas-fir and big leaf maple. The restoration area was heavily compacted from years of military and Parks Canada use. Baseline plant surveys indicated almost 100% invasive species cover.

Site preparation for the project involved mulching with approximately eight inches of shredded oak leaf mulch acquired from curb side collection programs in Saanich and Victoria. The mulch treatment has been very effective in eradicating invasive species and alleviating soil compaction.

A seven foot deer fence was erected around the perimeter of the project area in 2011 to protect transplants from herbivory. Two access gates currently provide pedestrian access to the site, and a chip trail will be installed in early 2013 to allow visitors to explore the site. Interpretive signage and rest areas will be added in the near future.

“Understanding how ecosystems are put together allows us to fashion strategies for restoring damaged ecosystems. Reference ecosystems provide a roadmap that shows how a historically intact ecosystem is put together. Unfortunately, there are few Garry Oak ecosystems that have not suffered some form of degradation; from fire management to invasive species establishment. The reference ecosystems for Garry oak restoration therefore must be composed of a composite description (SERI, 2004) derived from a wide variety of sources” (GOERT, 2011).

In particular, few integral examples of mesic, deep soil Garry oak meadow and woodland sites exist today. The Cowichan Garry Oak Preserve (NCC), Somenos Garry Oak Protected Area (BC Parks), and Beacon Hill Park (City of Victoria), are the closest approximation of remnant Garry oak plant communities on southern Vancouver Island that offer guidance in defining a reference site and subsequent restoration goals for this project.

Restoration research and planning conducted by the Nature Conservancy of Canada (NCC) provided helpful guidance into the interpretation and application of Erickson and Meidinger’s (2007) Garry oak plant community classification system. Erickson and Meidinger’s plant community descriptions and accompanying site characteristics were used to identify restoration targets for the GO LEARN site. Restoration targets for this project were further guided by NCC’s restoration tool and prescriptive framework (Giesbrecht, 2012 [in progress]) that identifies ecological indicators and percent cover class guilds for several plant community associations as defined by Erickson and Meidinger (2007).

At this point, the need for a decision-support tool in planning propagation targets became apparent. A detailed species list and propagation planning tool were developed for this project using Excel, to determine approximate number of individuals and planting densities required for each plant community mapped in the project area. The site has been divided into four planting phases, with a target of completing re-vegetation within five years. Planting in Phase 1 began in fall 2012 with the establishment of native shrub thickets and a few native trees. Approximately three hundred mature camas (Camassia quamash and C. leichtlinii) bulbs were also planted in the immediate vicinity of the small rock outcrop feature, along with a variety of forbs (perennials and annuals) in soil pockets nestled into the rock outcrop feature.

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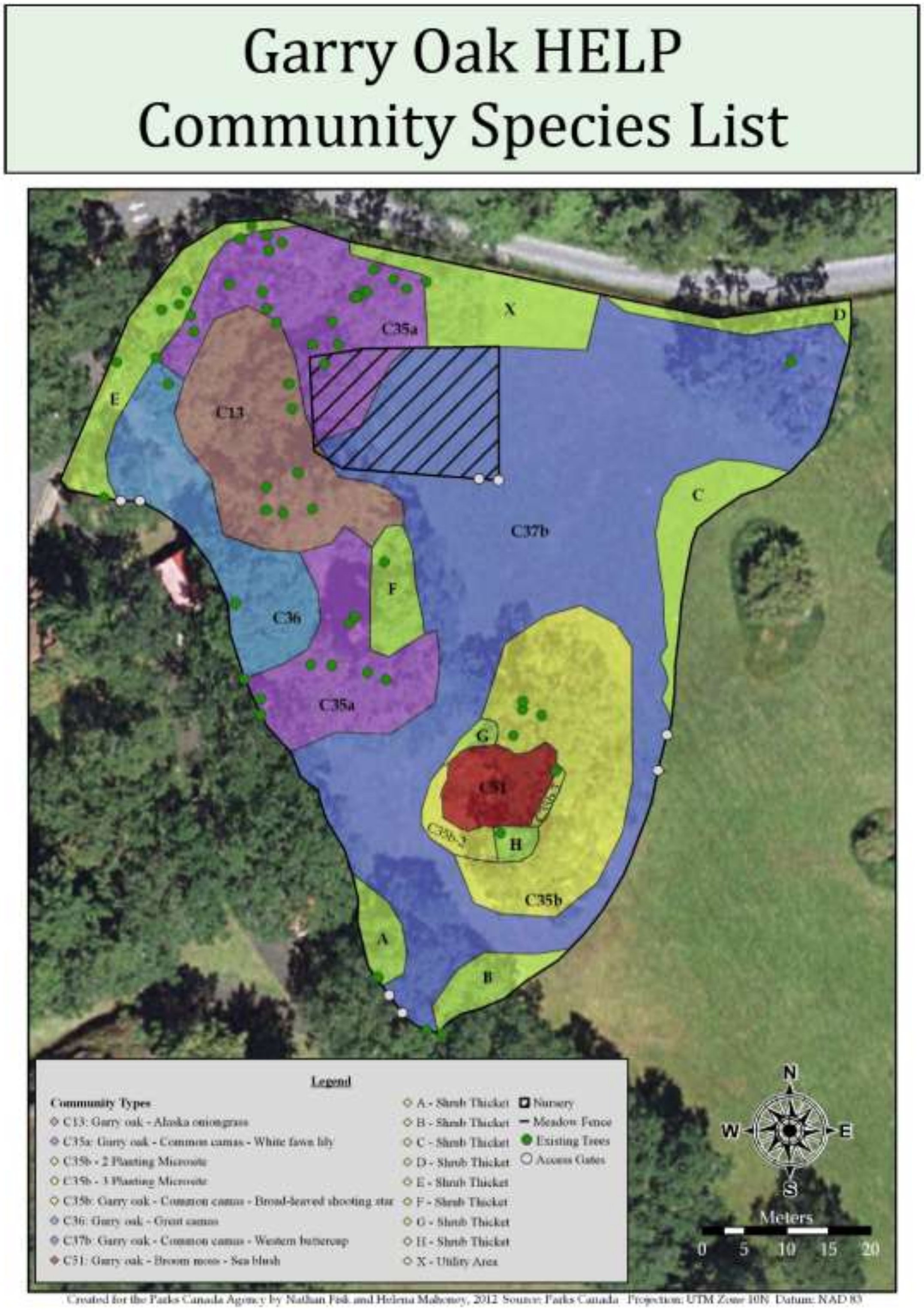
Appendix B:Expert Panel Field Handouts (6pp)



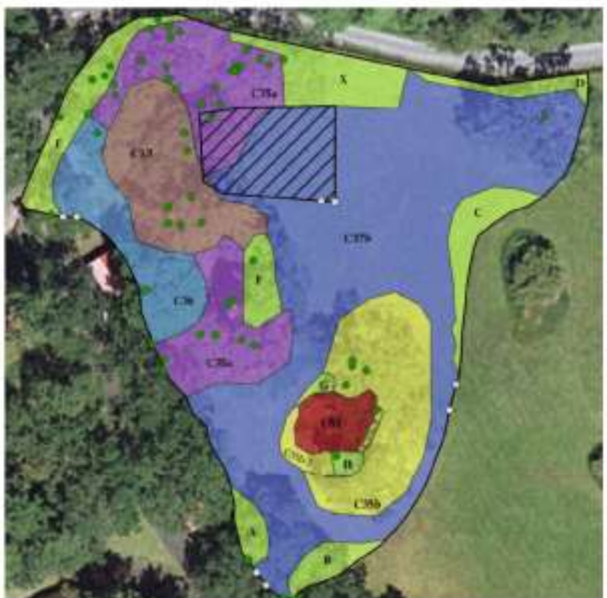
Common Name	Latin Name	Community C35b	
Blue-eyed mary	*Collinsia grandiflora var. pusilla*	R	912
Sea Blush	*Plectritis congesta*	R	1191
Chickweed monkeyflower	*Mimulus alsinoides*	R	1191
Small-flowered bird's-foot trefo	*Lotus micranthus*	R	#DIV/0!
Yellow Rattle	*Rhinanthus minor*	O	4580
California Brome	*Bromus carinatus*	R	259
Blue wildrye	*Elymus glaucus*	O	875
Long-stoloned sedge	*Carex inops ssp. Inops*	O	875
Many flowered wood-rush	*Luzula multiflora*	R	146
Pacific woodrush	*Luzula comosa*	R	#DIV/0!
Roemer's fescue	*Festuca roemeri*	F	1329
Cleavers	*Galium aparine*	R	912
Woodland strawberry	*Fragaria vesca*	R	36
Hairy manzanita	*Arctostaphylos columbiana*	R	9
Kinnikinnick	*Arctostaphylos uva-ursi*	R	16
Yerba Buena	*Clinopodium douglasii*	R	36
Elegant rein orchid	*Piperia elegans*	R	1621
Broad-leaved shootingstar	*Dodecatheon hendersonii*	O	3501
Chocolate Lily	*Fritillaria affinis*	R	259
Common Camas	*Camassia quamash*	F	11961
Field Chickweed	*Cerastium arvense*	O	875
Harvest Brodiaea	*Brodiaea coronaria*	R	1191
Menzies' Larkspur	*Delphinium menziesii*	R	405
Pacific Sanicle	*Sanicula crassicaulis*	R	228
Red Columbine	*Aquilegia formosa subsp. Form*	R	259
Sooke Shooting-star	*Dodecatheon pulchellum Sook*	R	912
Spring Gold	*Lomatium utriculatum*	R	259
Tiger Lily	*Lilium columbianum*	R	482
White brodiaea	*Triteleia hyacinthina*	O	3501
White fawn lily	*Erythronium oreganum*	O	1556
Woolly eriophyllum	*Eriophyllum lanatum*	R	36
Yarrow	*Achillea millefolium*	R	146
Early Blue Violet	*Viola adunca*	R	583
Hairy honeysuckle	*Lonicera hispidula*	O	24
Tall Oregon-grape	*Mahonia aquifolium*	R	2

Common Name	Latin Name	Community C35b - 2	
Blue-eyed mary	*Collinsia grandiflora var. pusilla*	R	82
Sea Blush	*Plectritis congesta*	O	640
Chickweed monkeyflower	*Mimulus alsinoides*	R	107
Small-flowered bird's-foot tr	*Lotus micranthus*	R	#DIV/0!
California Brome	*Bromus carinatus*	R	23
Blue wildrye	*Elymus glaucus*	O	78
Long-stoloned sedge	*Carex inops ssp. Inops*	O	78
Many flowered wood-rush	*Luzula multiflora*	R	13
Pacific woodrush	*Luzula comosa*	R	#DIV/0!
Roemer's fescue	*Festuca roemeri*	F	119
Cleavers	*Galium aparine*	R	82
Yerba Buena	*Clinopodium douglasii*	R	3
Elegant rein orchid	*Piperia elegans*	R	145
Broad-leaved shootingstar	*Dodecatheon hendersonii*	O	313
Chocolate Lily	*Fritillaria affinis*	R	23
Common Camas	*Camassia quamash*	O	313
Common Harebell	*Campanula rotundifolia*	O	122
Field Chickweed	*Cerastium arvense*	O	78
Harvest Brodiaea	*Brodiaea coronaria*	R	107
Hooker's Onion	*Allium acuminatum*	R	82
Menzies' Larkspur	*Delphinium menziesii*	R	36
Miner's lettuce	*Claytonia perfoliata*	R	52
Spring Gold	*Lomatium utriculatum*	R	23
Western buttercup	*Ranunculus occidentalis*	O	139
White brodiaea	*Triteleia hyacinthina*	O	313
Woolly eriophyllum	*Eriophyllum lanatum*	R	3

Common Name	Latin Name	Community C35b - 3	
Blue-eyed mary	*Collinsia grandiflora var. pusilla*	R	20
Sea Blush	*Plectritis congesta*	R	26
California Brome	*Bromus carinatus*	R	6
Blue wildrye	*Elymus glaucus*	O	19
Long-stoloned sedge	*Carex inops ssp. Inops*	O	19
Many flowered wood-rush	*Luzula multiflora*	R	3
Roemer's fescue	*Festuca roemeri*	F	29
Cleavers	*Galium aparine*	R	20
Trailing Blackberry	*Rubus ursinus*	R	13
Broad-leaved shootingstar	*Dodecatheon hendersonii*	O	76
Chocolate Lily	*Fritillaria affinis*	R	6
Common Camas	*Camassia quamash*	O	76
Field Chickweed	*Cerastium arvense*	O	19
Pacific Sanicle	*Sanicula crassicaulis*	R	5
Red Columbine	*Aquilegia formosa subsp. Form*	O	34
Spring Gold	*Lomatium utriculatum*	R	6
White brodiaea	*Triteleia hyacinthina*	O	76
Woolly eriophyllum	*Eriophyllum lanatum*	F	16
Western trumpet honeysuckl	*Lonicera ciliosa*	R	1

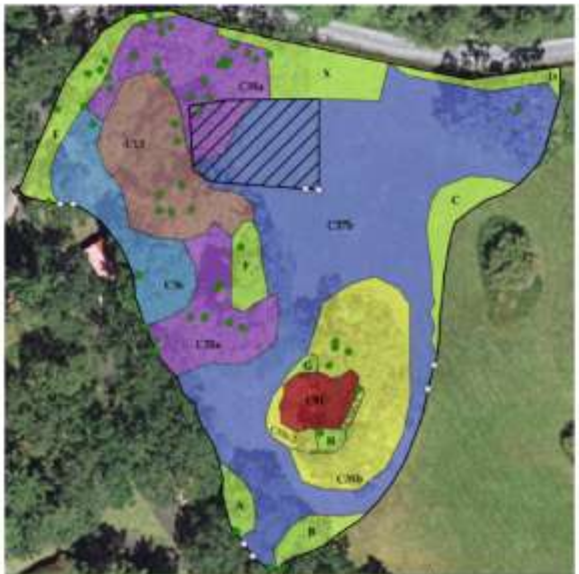
Common Name	Latin Name	Community C13	
Licorice Fern	*Polypodium glycyrrhiza*	F	4
Sword Fern	*Polystichum munitum*	R	4
California Brome	*Bromus carinatus*	O	1427
Alaska oniongrass	*Melica subulata*	A	3631
Blue wildrye	*Elymus glaucus*	O	803
Columbia Brome	*Bromus vulgaris*	O	1427
Roemer's fescue	*Festuca roemeri*	R	59
False Lily of the Valley	*Maianthemum dilatum*	R	#DIV/0!
Oregon wood sorrel	*Oxalis oregana*	R	#DIV/0!
Pathfinder	*Adenocaulon bicolor*	O	803
Twinflower	*Linnaea borealis*	O	8917
Vanilla leaf	*Achlys triphylla*	O	357
Woodland strawberry	*Fragaria vesca*	O	201
Dull Oregon-grape	*Mahonia nervosa*	R	33
Evergreen huckleberry	*Vaccinium ovatum*	O	13
Yerba Buena	*Clinopodium douglasii*	O	201
Field Chickweed	*Cerastium arvense*	O	803
Great Camas	*Camassia leichtlinii*	O	2229
Miner's lettuce	*Claytonia perfoliata*	O	3210
Mountain sweet-cicely	*Osmorhiza berteroi*	O	557
Pacific Sanicle	*Sanicula crassicaulis*	O	1254
White fawn lily	*Erythronium oreganum*	O	1427
Toothwort	*Cardamine nuttallii*	O	3210
Baldhip rose	*Rosa gymnocarpa*	O	89
Common Snowberry	*Symphoricarpos albus*	O	32
Pacific rhododendron	*Rhododendron macrophyllum*	O	13
Tall Oregon-grape	*Mahonia aquifolium*	O	13

Common Name	Latin Name	Community X	
California Brome	*Bromus carinatus*	A	4334
Blue wildrye	*Elymus glaucus*	D	3642
Trailing Blackberry	*Rubus ursinus*	R	241
Barestem desert-parsley	*Lomatium nudicaule*	O	361
Coast Penstemon	*Penstemon serrulatus*	F	2194
Douglas' Aster	*Symphyotrichum subspicatum*	O	58
Entire-leaved Gumweed	*Grindelia integrifolia*	O	361
Graceful Cinquefoil	*Potentilla gracilis*	O	361
Pearly Everlasting	*Anaphalis margaritacea*	O	564
Woolly eriophyllum	*Eriophyllum lanatum*	O	90
Yarrow	*Achillea millefolium*	O	361



Class Guilds by Abundance	Midpoint of Guild Class	Percentage Values
D = Dominant = 51-70% cover	60.5	0.61
A = Abundant = 31-50% cover	40.5	0.41
F = Frequent = 11-30% cover	20.5	0.21
O = Occasional = 2-10%	6	0.06
R = Rare = > or = 1%	1	0.01

Common Name	Latin Name	Community C35a	
Sea Blush	*Plectritis congesta*	R	1048
California Brome	*Bromus carinatus*	R	228
Alaska oniongrass	*Melica subulata*	R	228
Blue wildrye	*Elymus glaucus*	R	128
California Oatgrass	*Danthonia californica*	R	32
Long-stoloned sedge	*Carex inops ssp. inops*	O	770
Many flowered wood-rush	*Luzula multiflora*	O	770
Pacific woodrush	*Luzula comosa*	R	#DIV/0!
Roemer's fescue	*Festuca roemeri*	R	57
Woodland strawberry	*Fragaria vesca*	R	32
Trailing Blackberry	*Rubus ursinus*	R	513
Yerba Buena	*Clinopodium douglasii*	R	32
American vetch	*Vicia americana*	O	770
Broad-leaved shootingstar	*Dodecatheon hendersonii*	R	513
Chocolate Lily	*Fritillaria affinis*	O	1369
Common Camas	*Camassia quamash*	F	10524
Field Chickweed	*Cerastium arvense*	O	770
Great Camas	*Camassia leichtlinii*	O	2139
Harvest Brodiaea	*Brodiaea coronaria*	O	6286
Pacific Sanicle	*Sanicula crassicaulis*	R	201
Red Columbine	*Aquilegia formosa subsp. Form*	R	228
Spring Gold	*Lomatium utriculatum*	R	228
Tiger Lily	*Lilium columbianum*	R	424
Western buttercup	*Ranunculus occidentalis*	R	228
White brodiaea	*Triteleia hyacinthina*	O	3080
White fawn lily	*Erythronium oreganum*	F	4677
Woolly eriophyllum	*Eriophyllum lanatum*	R	32
Early Blue Violet	*Viola adunca*	R	513
Toothwort	*Cardamine nuttallii*	O	3080
Beaked Hazelnut	*Corylus cornuta var. Californic*	R	4
Common Snowberry	*Symphoricarpos albus*	F	105
Tall Oregon-grape	*Mahonia aquifolium*	O	12
Pacific Crab Apple	*Malus fusca*	R	2



Class Guilds by Abundance	Midpoint of Guild Class	Percentage Values
D = Dominant = 51-70% cover	60.5	0.61
A = Abundant = 31-50% cover	40.5	0.41
F = Frequent = 11-30% cover	20.5	0.21
O = Occasional = 2-10%	6	0.06
R = Rare = > or = 1%	1	0.01

Common Name	Latin Name	Community C51	
Farewell-to-spring	*Clarkia amoena*	R	141
Blue-eyed mary	*Collinsia grandiflora var. pusilla*	R	55
Sea Blush	*Plectritis congesta*	F	1479
Chickweed monkeyflower	*Mimulus alsinoides*	O	433
Goldenback fern	*Pentagramma triangularis*	R	35
Sword Fern	*Polystichum munitum*	R	0.3
California Brome	*Bromus carinatus*	O	94
Blue wildrye	*Elymus glaucus*	O	53
California Oatgrass	*Danthonia californica*	O	13
Roemer's fescue	*Festuca roemeri*	O	24
Small-flowered woodland star	*Lithophragma parviflorum*	R	35
Wallace's selaginella	*Selaginella wallacei*	R	98
Common Camas	*Camassia quamash*	O	212
Harvest Brodiaea	*Brodiaea coronaria*	R	72
Hooker's Onion	*Allium acuminatum*	R	55
Menzies' Larkspur	*Delphinium menziesii*	O	147
Miner's lettuce	*Claytonia perfoliata*	F	725
Naked Broomrape	*Orobanche uniflora*	R	#DIV/0!
Nodding Onion	*Allium cernuum*	R	98
Pacific Sanicle	*Sanicula crassicaulis*	R	14
Satinflower	*Olsynium douglasii var. Douglasi*	R	55
Small-flowered alumroot	*Heuchera micrantha*	O	83
Small-leaved montia	*Montia parviflora*	O	13
Spring Gold	*Lomatium utriculatum*	O	94
White brodiaea	*Triteleia hyacinthina*	O	212
White fawn lily	*Erythronium oreganum*	R	16
Hairy honeysuckle	*Lonicera hispidula*	O	15
Broad-leaved Stonecrop	*Sedum spathulifolium*	O	212
Lance-leaved sedum (stone crc	*Sedum lanceolatum*	O	212
Oregon stonecrop	*Sedum oreganum*	O	212

Common Name	Latin Name	Community C36	
Sword Fern	*Polystichum munitum*	R	3
California Brome	*Bromus carinatus*	O	1060
Alaska oniongrass	*Melica subulata*	O	1060
Blue wildrye	*Elymus glaucus*	F	2037
Long-stoloned sedge	*Carex inops ssp. inops*	R	99
Roemer's fescue	*Festuca roemeri*	R	44
Pathfinder	*Adenocaulon bicolor*	R	99
Starflower	*Trientalis borealis*	O	#DIV/0!
False box	*Paxistima myrsinites*	O	95
American vetch	*Vicia americana*	O	596
Field Chickweed	*Cerastium arvense*	O	596
Great Camas	*Camassia leichtlinii*	F	5658
Miner's lettuce	*Claytonia perfoliata*	O	2385
Mountain sweet-cicely	*Osmorhiza berteroi*	R	69
Nodding Onion	*Allium cernuum*	R	1104
Pacific Sanicle	*Sanicula crassicaulis*	O	932
Red Columbine	*Aquilegia formosa subsp. Formosa*	O	1060
Tiger Lily	*Lilium columbianum*	R	328
Western buttercup	*Ranunculus occidentalis*	O	1060
White fawn lily	*Erythronium oreganum*	O	1060
Woolly eriophyllum	*Eriophyllum lanatum*	R	25
Tall Oregon-grape	*Mahonia aquifolium*	O	9

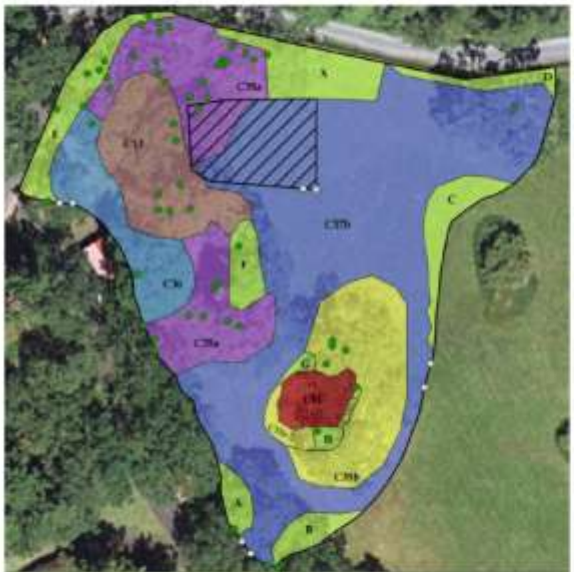
Common Name	Latin Name	Community C37b	
Bicoloured lupin	*Lupinus bicolor*	R	2654
Blue-eyed mary	*Collinsia grandiflora var. pusilla*	R	4146
Sea Blush	*Plectritis congesta*	R	5415
Yellow Rattle	*Rhinanthus minor*	O	20830
California Brome	*Bromus carinatus*	O	7076
Alaska oniongrass	*Melica subulata*	R	1179
Blue wildrye	*Elymus glaucus*	R	663
California Oatgrass	*Danthonia californica*	O	995
Long-stoloned sedge	*Carex inops ssp. inops*	O	3980
Many flowered wood-rush	*Luzula multiflora*	R	663
Pacific woodrush	*Luzula comosa*	R	#DIV/0!
Roemer's fescue	*Festuca roemeri*	R	295
Slender hairgrass	*Deschampsia elongata*	O	1769
Cleavers	*Galium aparine*	R	4146
Small-flowered woodland star	*Lithophragma parviflorum*	O	15921
Black raspberry	*Rubus leucodermis*	R	10
Kinnikinnick	*Arctostaphylos uva-ursi*	R	74
Barestem desert-parsley	*Lomatium nudicaule*	O	3980
Broad-leaved shootingstar	*Dodecatheon hendersonii*	R	2654
Chocolate Lily	*Fritillaria affinis*	R	1179
Common Camas	*Camassia quamash*	F	54397
Douglas' Aster	*Symphyotrichum subspicatum*	R	106
Field Chickweed	*Cerastium arvense*	O	3980
Graceful Cinquefoil	*Potentilla gracilis*	O	1769
Great Camas	*Camassia leichtlinii*	R	1843
Harvest Brodiaea	*Brodiaea coronaria*	R	5415
Pacific Sanicle	*Sanicula crassicaulis*	O	6219
Spring Gold	*Lomatium utriculatum*	O	7076
Western buttercup	*Ranunculus occidentalis*	F	24176
White brodiaea	*Triteleia hyacinthina*	O	15921
White fawn lily	*Erythronium oreganum*	O	7076
Woolly eriophyllum	*Eriophyllum lanatum*	R	166
Yampah	*Perideridia gairdneri*	R	1179
Yarrow	*Achillea millefolium*	R	663
Grassland saxifrage	*Saxifraga integrifolia*	O	15921
Tall Oregon-grape	*Mahonia aquifolium*	R	10

Common Name	*Latin Name*	Community A	
Red Columbine	*Aquilegia formosa subsp.*	O	166
White fawn lily	*Erythronium oreganum*	O	166
Western trumpet honeysuckle	*Lonicera ciliosa*	R	7
Baldhip rose	*Rosa gymnocarpa*	O	10
Indian plum	*Oemleria cerasiformis*	F	5
Mock Orange	*Philadelphus lewisii*	F	13
Red-flowering currant	*Ribes sanguineum*	O	4
Saskatoon	*Amelanchier alnifolia*	F	3
Twinberry	*Lonicera involucrata*	O	4

Common Name	*Latin Name*	Community B	
Red Columbine	*Aquilegia formosa subsp.*	O	228
White fawn lily	*Erythronium oreganum*	O	228
Western trumpet honeysuckle	*Lonicera ciliosa*	R	9
Baldhip rose	*Rosa gymnocarpa*	R	2
Indian plum	*Oemleria cerasiformis*	F	7
Mock Orange	*Philadelphus lewisii*	F	17
Oceanspray	*Holodiscus discolor*	F	17
Red-flowering currant	*Ribes sanguineum*	O	5
Saskatoon	*Amelanchier alnifolia*	F	4
Twinberry	*Lonicera involucrata*	O	5

Common Name	*Latin Name*	Community C	
Douglas' Aster	*Symphyotrichum subspicatum*	F	125
Western buttercup	*Ranunculus occidentalis*	O	408
Indian plum	*Oemleria cerasiformis*	R	1
Mock Orange	*Philadelphus lewisii*	O	9
Nootka rose	*Rosa nutkana*	O	6
Oceanspray	*Holodiscus discolor*	F	31
Pacific Ninebark	*Physocarpus capitatus*	O	5
Red Elderberry	*Sambucus racemosa*	R	2
Red-flowering currant	*Ribes sanguineum*	O	9
Salmonberry	*Rubus spectabilis*	O	14
Saskatoon	*Amelanchier alnifolia*	O	2
Scouler's willow	*Salix scouleriana*	O	8

Common Name	*Latin Name*	Community D	
Douglas' Aster	*Symphyotrichum subspicatum*	F	63
Pearly Everlasting	*Anaphalis margaritacea*	O	179
Yarrow	*Achillea millefolium*	O	115
Western trumpet honeysuckle	*Lonicera ciliosa*	R	8
Common Snowberry	*Symphoricarpos albus*	D	46
Indian plum	*Oemleria cerasiformis*	F	6
Nootka rose	*Rosa nutkana*	F	11
Red-osier dogwood	*Cornus stolonifera*	F	11
Saskatoon	*Amelanchier alnifolia*	O	1
Tall Oregon-grape	*Mahonia aquifolium*	R	0



Class Guilds by Abundance	Midpoint of Guild Class	Percentage Values
D = Dominant = 51-70% cover	60.5	0.61
A = Abundant = 31-50% cover	40.5	0.41
F = Frequent = 11-30% cover	20.5	0.21
O = Occasional = 2-10%	6	0.06
R = Rare = > or = 1%	1	0.01

Common Name	*Latin Name*	Community G	
Yellow Rattle	*Rhinanthus minor*	O	140
California Brome	*Bromus carinatus*	O	48
Blue wildrye	*Elymus glaucus*	F	91
Kinnikinnick	*Arctostaphylos uva-ursi*	O	3
Yerba Buena	*Clinopodium douglasii*	F	25
Pacific Sanicle	*Sanicula crassicaulis*	R	7
Woolly eriophyllium	*Eriophyllum lanatum*	F	23
Hairy honeysuckle	*Lonicera hispidula*	F	3
Common Snowberry	*Symphoricarpos albus*	O	1
Oceanspray	*Holodiscus discolor*	F	4
Tall Oregon-grape	*Mahonia aquifolium*	O	0

Common Name	*Latin Name*	Community H	
Yellow Rattle	*Rhinanthus minor*	O	200
California Brome	*Bromus carinatus*	O	68
Blue wildrye	*Elymus glaucus*	F	131
Kinnikinnick	*Arctostaphylos uva-ursi*	O	4
Yerba Buena	*Clinopodium douglasii*	F	33
Common Camas	*Camassia quamash*	R	25
Pacific Sanicle	*Sanicula crassicaulis*	R	10
Western buttercup	*Ranunculus occidentalis*	R	11
Woolly eriophyllium	*Eriophyllum lanatum*	F	33
Hairy honeysuckle	*Lonicera hispidula*	O	1
Western trumpet honeysuckl	*Lonicera ciliosa*	R	3
Red-flowering currant	*Ribes sanguineum*	F	5
Saskatoon	*Amelanchier alnifolia*	O	0
Tall Oregon-grape	*Mahonia aquifolium*	O	1

Common Name	*Latin Name*	Community E	
Sword Fern	*Polystichum munitum*	O	10
False Lily of the Valley	*Maianthemum dilatum*	O	#DIV/0!
Oregon wood sorrel	*Oxalis oregana*	O	#DIV/0!
Dull Oregon-grape	*Mahonia nervosa*	O	80
Evergreen huckleberry	*Vaccinium ovatum*	O	5
False box	*Paxistima myrsinites*	O	51
Salal	*Gaultheria shallon*	O	16
Yerba Buena	*Clinopodium douglasii*	O	80
White fawn lily	*Erythronium oreganum*	O	567
Common Snowberry	*Symphoricarpos albus*	F	44
Indian plum	*Oemleria cerasiformis*	F	17
Nootka rose	*Rosa nutkana*	F	30
Pacific rhododendron	*Rhodendron macrophyllum*	O	5
Red-osier dogwood	*Cornus stolonifera*	O	9
Tall Oregon-grape	*Mahonia aquifolium*	R	1
Thimbleberry	*Rubus parviflorus var. Parviflor*	O	20
Twinberry	*Lonicera involucrata*	O	13

Common Name	*Latin Name*	Community F	
Alaska oniongrass	*Melica subulata*	O	262
Columbia Brome	*Bromus vulgaris*	O	262
False Lily of the Valley	*Maianthemum dilatum*	R	#DIV/0!
Pathfinder	*Adenocaulon bicolor*	O	147
Twinflower	*Linnaea borealis*	R	272
Woodland strawberry	*Fragaria vesca*	O	37
Evergreen huckleberry	*Vaccinium ovatum*	O	2
Yerba Buena	*Clinopodium douglasii*	O	37
Blue-eyed grass	*Sisyrinchium idahoense var. Ma*	F	503
Graceful Cinquefoil	*Potentilla gracilis*	O	65
Mountain sweet-cicely	*Osmorhiza berteroi*	O	102
Red Columbine	*Aquilegia formosa subsp. Form*	O	262
Hairy honeysuckle	*Lonicera hispidula*	R	1
Western trumpet honeysuckl	*Lonicera ciliosa*	R	11
Indian plum	*Oemleria cerasiformis*	O	2
Mock Orange	*Philadelphus lewisii*	O	6
Oceanspray	*Holodiscus discolor*	O	8
Pacific Ninebark	*Physocarpus capitatus*	F	10
Red Elderberry	*Sambucus racemosa*	R	1
Red-flowering currant	*Ribes sanguineum*	R	1
Salmonberry	*Rubus spectabilis*	F	31
Saskatoon	*Amelanchier alnifolia*	O	1
Twinberry	*Lonicera involucrata*	O	6

Comments:

Name: ________________

Appendix C: Feedback Form - Propagation Planning Tool

Field Session:

1. Have we correctly matched target plant community associations (sensu Erickson and Meidinger 2007) to site conditions? Given your impression of site conditions, are there any plant community associations that should be added or omitted from the site?

2. Are there species that should be added to or omitted from the target species list? If yes, please list them below with respect to the plant community association in question.

3. Is our strategy for site preparation reasonable? Would you recommend any different strategies?

4. What approaches or techniques would you recommend for re-vegetating the area?

5. What methods would you recommend for minimizing invasion of the site while natives establish?

6. How best could we capitalize on this project as a learning opportunity to add to our understanding of restoring degraded sites?

Restoration Planning Framework:

7. Does our restoration planning framework (aka propagation planning tool) provide adequate support to restoration planning, design and implementation? Please explain.

8. Evaluate the methodology used in developing this tool by circling one of the following: poor, adequate, sound. Please explain your rating.

9. Is our formula for translating target percent covers for each species into planting densities reasonable?

10. Can you see this tool being applicable to other projects with which you are involved? Please explain and/or list examples.

11. In your opinion, how do you think this tool could be improved?

12. What recommendations would you make in the future development of this tool?

Workshop:

13. On a scale of 1-10, how would you rate the success of this workshop (1 being poor, 10 being great)?

14. Did you learn anything new at this workshop?

15. Do you have any general comments regarding this workshop?

Appendix D: Expert Panel Review Feedback

Table 3 Feedback received from 3 of the 20 Expert Panel Review participants.

Question	Feedback
1. Have we correctly matched target plant community associations (Erickson and Meidinger 2007) to site conditions? Given your impression of site conditions, are there any plant community associations that should be added or omitted from the site?	Kohler: Although I'd be tempted to reduce the plant community associations (one each for Woodlands, Meadows, and Rocky outcrop) it looks like the proposed associations are reasonable. According to Erickson (2007) the Qgcc and Qggc are seral plant communities and you may want to do some research on how they start out and what they may turn into. Miskelly: Target plant associations generally seem appropriate to the site. Additional plant community associations could be added if the fence were moved to include wet pocket by shrub thicket C. Shrub thickets in general may become too dominant as shrubs grow. In particular, placement of shrub thicket C may reduce potential diversity at the site by preempting wettest part of site. Munson: My impression is that the plant community associations are very detailed for such a small site, and that the planting plan is very ambitious given the small dimensions of the project area. It is likely that normal site series mapping would have concluded that there are fewer plant community associations than the ones that you have described for a 1 ha. Plot, and likely far fewer native plant species would 'normally' be present on 1 ha. Of Garry Oak meadow.
2. Are there species that should be added to or omitted from the target species list? If yes, please list them below with respect to the plant community association in question.	Kohler: -Remove Rhododendron macrophyllum. -Remove Potentilla gracilis (blue listed), FRH has Potentilla egedii, but the habitat is not right for the project area. Oxalis oregana is also blue listed. -Could add Madia madioides to C13. -Remove Rhinanthus minor (can get weedy). -Achlys triphylla, Maianthemum dilatatum and Vaccinium ovatum are more appropriate for Douglas-fir forest than a GO Woodland. Suggest removing. Miskelly: Addressed in previous correspondence.

3. Is our strategy for site preparation reasonable? Would you recommend any different strategies?	Kohler: The mulching is reasonable. Miskelly: Depth of organic mulch may create germination problems for some meadow species, particularly annuals. However, given difficult initial site conditions no perfect solution was available and strategy seems reasonable. Munson: It will be difficult to achieve any bare ground plant establishment with such a heavy mulch cover; you may want to remove mulch from some areas to favour plants that do not need mulch for propagation.
4. What approaches or techniques would you recommend for re-vegetating the area?	Kohler: Target small manageable areas and expand out from there. Also see # 5. Miskelly: Take full advantage of this relatively weed-free period and plant as fast as possible. Munson: Allow for natural revegetation from surrounding ecosystem; If some introduced seeds or seedlings do NOT establish, don't be discouraged, as the planting plan is very ambitious for such a small area, and conditions may simply not be correct for some of the rarer species. Some species may never grow there, or may grow years from now after other species have established.
5. What methods would you recommend for minimizing invasion of the site while natives establish?	Kohler: There will be a lot of weeding to be done in the future. Perhaps planting with native species that do well, such as Sanicula crassicaulis in the beginning will help prevent some of this. The concept of the sterile grass to create initial cover is interesting one that should be explored. Miskelly: Use volunteer workparties or staff to stay on top of weeds now while they are sparse. Do not wait for problems to appear. Prepare for possibility that in future years additional treatments including mulching and/or sheet-mulching may be necessary in areas that have been left unplanted. Munson: Keep up the deer fencing; Use volunteers to weed on a regular basis.

6. How best could we capitalize on this project as a learning opportunity to add to our understanding of restoring degraded sites?	Kohler: Create a long term monitoring program. Perhaps several 5x5m grids where you record which and how many native species planted and percent cover of all species annually. Apply different planting approaches to different areas that can be compared. Miskelly: Ensure proper documentation of all activities. Involve volunteers, students, and restoration colleagues as much as possible. Present findings/progress at GOERT colloquium, VNHS, NPSG, or other appropriate venues. Munson: Interpretive signage and tours (without damaging the planted area) for scientific community and public; Publish your project startup and results in local, regional scientific journals, ie, Ecological Restoration Journal, etc. and seek feedback from other experts.
7. Does our restoration planning framework (aka propagation planning tool) provide adequate support to restoration planning, design and implementation? Please explain.	Kohler: It's a good starting point, but to mimic natural systems and processes is difficult, if not impossible. I think that it's a good framework to start with and that it will be adjusted as you move forward with the project. Miskelly: The framework provides adequate initial support for one aspect of restoration planning and design (i.e. desired density/abundance). Adaptive management will allow for site-specific refinement of numbers produced by the framework. Munson: Quite adequate support for restoration planning, more detailed than anything that I have used.
8. Evaluate the methodology used in developing this tool by circling one of the following: poor, adequate, sound. Please explain your rating.	Kohler: (adequate). Did not fully understand the methodology, but overall seemed adequate. Miskelly: Erickson and Meidinger (2007) fail to capture site to site variability and within site heterogeneity. An alternate approach could have been more site-specific field research to define community targets. Munson: Adequate, given the complexities of statistical analysis.

9. Is our formula for translating target percent covers for each species into planting densities reasonable?	Kohler: I would ground truth your model by applying to an appropriate area and estimating density, then counting the plants and comparing. Then adjust your model accordingly. Also, mortality needs to be considered more carefully. Miskelly: The formula translates target percent cover into final density of plants, not planting density. A conversion factor is needed to convert desired future density into planting density. This conversion factor will vary between species and must also be related to time.
10. Can you see this tool being applicable to other projects with which you are involved? Please explain and/or list examples.	Kohler: I can see this tool being most useful to highly degraded sites, where you're pretty much starting from scratch. Miskelly: Other projects for which we are involved have somewhat different objectives and have taken different approaches. Haliburton: at this site we have exaggerated the cover of graminoids in order to provide dense cover to exclude invasives Rocky Point: at this site natives are planted below optimum density in order to improve diversity and composition in invasive-dominated meadows Munson: The propagation tool could have been used on the restoration project on the Garry oak meadow along Circle Drive in Beacon Hill Park. I used a presence/absence approach for adding (and re-adding) native forb seed from the adjacent Garry oak meadow to the restoration site.
11. In your opinion, how do you think this tool could be improved?	Kohler: Consider mortality and ground truth your model. Miskelly: The tool needs to take into account how each species is likely to increase/decrease over time. Munson: The propagation tool could have been used on the restoration project on the Garry oak meadow along Circle Drive in Beacon Hill Park. I used a presence/absence approach for adding (and re-adding) native forb seed from the adjacent Garry oak meadow to the restoration site.

12. What recommendations would you make in the future development of this tool?	Kohler: As above. Miskelly: A series of trials could be conducted to determine minimum planting rates that will ultimately lead to desired future density. Ground truthing desired density will also help to improve the tool. Munson: As noted in the discussion, a site artificially planted and watered may produce different plant cover densities than a 'natural' meadow, which could affect your calculations of plant cover; In terms of planting it may be worthwhile to simulate primary succession and plant early pioneer native species first, and secondary native species (likely rarer ones) later, to mimic a natural site successional process; Make a more user-friendly interface for the propagation tool to be useful for field practitioners.
13. On a scale of 1-10, how would you rate the success of this workshop (1 being poor, 10 being great)?	Kohler: 7. Miskelly: 9. Munson: 8 out of 10; I need more time to study the propagation tool and determine its applicability to my work.
14. Did you learn anything new at this workshop?	Kohler: The great progress made on the GO HELP project. Miskelly: Yes. Any exposure to unfamiliar restoration projects is valued. We particularly appreciated the discussion regarding cover crops and the use of aggressive native species. Munson: Yes, I am amazed at the depth of knowledge of all the people involved.

15. Do you have any general comments regarding this workshop?	Kohler: The propagation planning tool methodology could have been explained better or simplified to get better feedback on what you need. Otherwise, it was great. Miskelly:It was very gratifying to see Parks Canada engaged in this valuable work. We very much appreciated seeing the site and the progress that has been made. The field session could have benefited from some more specific focus to discussions as well as more unstructured exploration of the project. We appreciate being able to take part in the workshop and look forward to seeing how the project develops. Munson: Repeat a field tour of the site during flowering season in the next two years, to assess the success of propagation.

***Participants were as follows: Todd Kohler with GOERT, James Miskelly as an independent consultant, and Thomas Munson with City of Victoria.**

Appendix E: Feedback From Parks Canada

Propagation planning tool feedback received via email from Parks Canada staff Nathan Fisk and Aimee Pelletier on 21/01/2014 following a full year of using the tool:

- We have continued to use the PPT regularly over the past year. Its utility is mainly in giving us ballpoint propagation targets for each species in each community type as well as suggested outplanting density per m2. We have found that we often need to "vet" these numbers with other restoration professionals more familiar with the species.

- Graminoid densities have been particularly difficult to predict accurately with the tool. Using the Erickson data really underestimates the density of native graminoids needed because it most systems he looked at the graminoid niche was filled with naturalized non-native graminoids. Especially for c37b, we have had to greatly increase the density of native bunchgrasses (California oatgrass, Roemer's fescue) over what is reported in the Erickson data. The approach we have taken for graminoids has been to decide on an overall target graminoid density per m2 (based on recommendations from experts) and then tweak either the mature size or abundance categories in the PPT to meet those targets.

- The two subjective elements (or decision points) of the PPT that most influence number predictions are the predicted size of the mature plant, and the abundance category. Ideally the mature size for each plant would be vetted with field data for expert input. We have done this for few species, but not for the majority. With respect to the abundance category, our decision to choose the upper limit of the percent cover class also appears to have a major influence on predicted propagation targets. In many cases, I think it results in overestimation of the number of plants we require, and potential overstocking of the communities. This decision point is something else that should have been vetted with experts.

- We have refined the species list over the past year, taking out many species that don't seem to fit well for the site, despite being in Erickson. The ones that are highlighted in orange are ones that we are still not sure about including.

- The automation of the formulas that Nathan worked on has made the tool much less cumbersome to work with. Changing one field automatically changes all of the other fields.

- We have not used the extra columns on propagation details and nursery timelines as a planning tool. Instead Nathan created some columns labelled "Stock Estimates" where we are keeping track of numbers planted thus far, and what numbers remain to be planted. I think it would actually be very useful to also fill in those other sections, but we have not had the time to work on it.

- We think that the approach and general template of the tool is one that could be broadly shared for us in other restoration projects. However, for each project, the user would still need to do the leg-work of determine which communities fit their site etc.

- I have often felt that the tool is quite a complex approach and that we might have been able to get away with doing much simpler calculations. For example, for each community type we could have decided on a general ratio of graminoids:forbs per m2 (e.g., the Miskelly's have recommended for meadows, a ratio of 16 graminoids:16 forbs). We could then have looked at Erickson to determine the relative abundance of each species within that m2, and then scaled up to the whole site.