A Meadow for Moralea:

Making room for a Garry oak Meadow to flourish in Metchosin, British Columbia

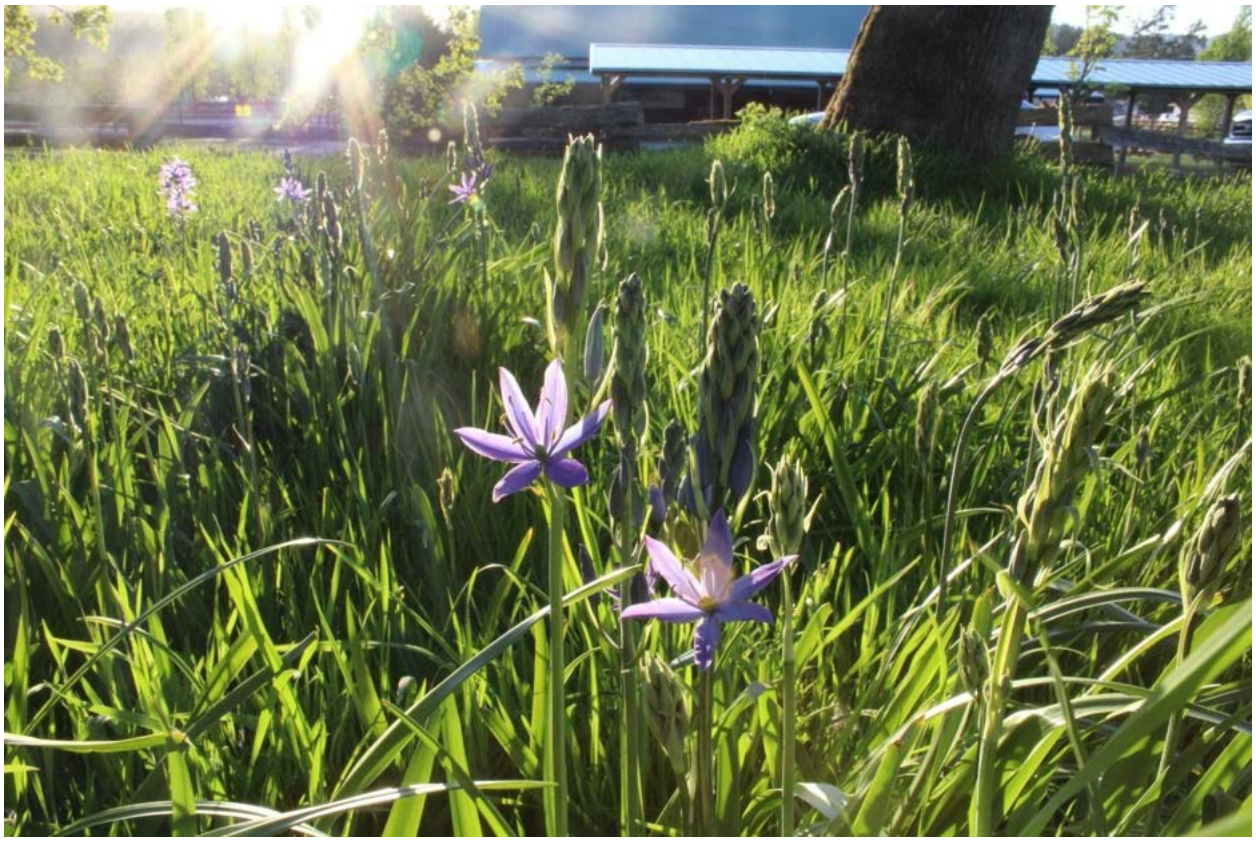

Image 1: Great camas (*Camassia leichtlinii*) on-site of Moralea's Meadow, Metchosin, British Columbia.

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ER390

Abstract

This project re-initiated the restoration of a 1360m² Garry oak meadow in Metchosin, British Columbia. The restoration is being done as a living memorial for Metchosin councillor Moralea Milne, who died unexpectedly in 2018. The meadow was experiencing woody encroachment, intense herbivory by rabbits, and competition from aggressive invasive grasses. The restoration involved 1) installation of a rabbit proof fence, 2) removal of encroaching shrubs, 3) managing invasive grasses through a series of tarping and mulching experiments, 4) planting native Garry oak associated species and 5) bench painting and path creation. Tarping trials revealed that extended tarping periods beginning in August or earlier appear to be effective at controlling some invasive grasses, including orchard grass (*Dactylis glomerata)* and Kentucky bluegrass (*Poa pratensis)* but ineffective at reducing the more aggressive rhizomatous quackgrass (*Elymus repens)*. It appears that the most effective means of reducing invasive grass cover of orchard grass and Kentucky bluegrass that was trialed during this restoration work, was through adding a layer of Garry oak leaf mulch with tarping. Monitoring will provide valuable long-term data to aid in next steps. We recommend the following: 1) removal of at least 50% of Douglas-firs; 2) continue tarping treatments beginning in August or when camas dies back (both the compression method and the mulching under tarp method) to reduce invasive grass cover; 3) long-term monitoring of tarping methods, and site more broadly, to investigate which method works best and where, and for vegetation changes over time; 4) consider use of small patches of prescribed fire to create space for native species; 5) investigate further into quackgrass management through prescribed fire and grass-specific herbicides; 6) supplementing meadow with planting native Garry Oak associated species; and 7) creating educational signage for visitors.

Acknowledgements

We are grateful for the opportunity to work on the traditional territory of the Beecher Bay Scia'new First Nation, W̱ĆIÁNE W̱, the "land of the salmon people". We extend our deepest thanks and gratitude to the many wonderful people who have supported this project. Thank you to Katy Nelson and the Moralea's Meadow Volunteers, who commissioned this work and have given their time, energy and experience so freely whenever we've asked. We want to thank the members of the Metchosin Foundation who funded this project from donations received in memory of Moralea Milne, as well at the council of the District of Metchosin who gave permission for the project and for their in-kind support. We are endlessly grateful to Kristen and James Miskelly, Andy MacKinnon, Colleen O'Brien, Val Schafer, Eric Higgs, and Nancy Shakelford, who we have consulted at various stages of the project- we are in awe of your collective knowledge, and feel so lucky to have had your guidance. Thank you to the Ecological Restoration Volunteer Network for the amazing work propagating our seedlings. Thanks to Josh Morgan, MacGregor Aubertin-Young, and Melanie Fortunato, for the extra hands and laughs. Thank you to the Metchosin community, and wider southern Vancouver Island restoration community, who supported this project through their donations.

Finally, and most importantly, we would like to acknowledge the reason we were brought to this incredibly special meadow. Moralea Milne, an environmental activist, an active restoration warrior, a dear friend to many and a positive light to all she encountered, will always be remembered for her positive footprint on the world. Moralea was a Metchosin Councillor, who held a volunteer role with the Devonian Regional Park Restoration group and graduated from the Restoration of Natural Systems program at the University of Victoria. Restoring this Garry oak meadow in Moralea's honour is a beautiful and lasting tribute to an extraordinary woman, and we are humbled to have been involved. We hope this meadow will be a place where the Metchosin community can visit, enjoy, and connect with Moralea for many years to come.

1. Introduction

The purpose of this project was to re-initiate restoration on a small Garry oak meadow in Metchosin, B.C. Garry oak meadows are rare ecosystems which support a rich mosaic of plants, animals and insects including as many as 100 which are classified as species-at-risk (GOERT et al., 2011). In the right conditions, Garry oaks will be accompanied by a well-developed herbaceous layer that is dominated by a colourful array of wildflowers such as great camas (*Camassia leichtlinii)*, common camas (*Camassia quamash*), western buttercups (*Ranunculus* spp.), and spring gold (*Lomatium utriculatum*).

These ecosystems were once widespread across southeastern Vancouver Island, when Coast Salish peoples maintained the meadows as a food source through the use of prescribed fire. Camas (*Camassia* spp.) bulbs were an essential food staple and the primary carbohydrate and starch in the diet of the Coast Salish people (Turner, 1999; Beckwith, 2004). After European colonization, fire suppression and agricultural, residential, and industrial development vastly reduced the extent of Garry oak ecosystems. Today, Garry oak ecosystems are among the rarest in Canada, and current estimates suggest that only about 1-5% of occurrences at the time of colonization remain in a productive condition (McCune, 2013; Fuchs, 2001). The Garry oak Ecosystem Recovery Team (GOERT) estimates that Garry oak ecosystems covered 1,180 hectares in Metchosin in 1800, and were reduced to 49 hectares in 1997 (GOERT, 2011). In addition to landscape modifications, many of the rare wildflowers associated with Garry oak meadows are also threatened by increasing populations of exotic and invasive grasses and shrubs (McCune, 2013). Over 173 exotic and invasive species have been recorded in Garry oak meadows (GOERT, 2002; Beckwith, 2004).

Restoring these meadows is a way to increase local biodiversity, provide learning opportunities of Indigenous land management, support the re-establishment of Indigenous food sources, and enhance the beauty of an area. Education about Garry oak ecosystems and their cultural and

ecological importance, especially in a changing climate, can lead to greater respect and stewardship over these ecosystems with future generations.

This particular meadow is being restored as a living tribute to Moralea Milne, an active restoration practitioner, who is loved and missed by her community. Moralea initiated the protection of this meadow and had the desire to restore it. Restoring this meadow will provide the Metchosin community with a peaceful space to remember their friend, and the amazing life she led.

The project has three main objectives:

Objective 1: To re-initiate the restoration of the ecological integrity of a Garry oak meadow which is capable of supporting a diverse range of associated native species.

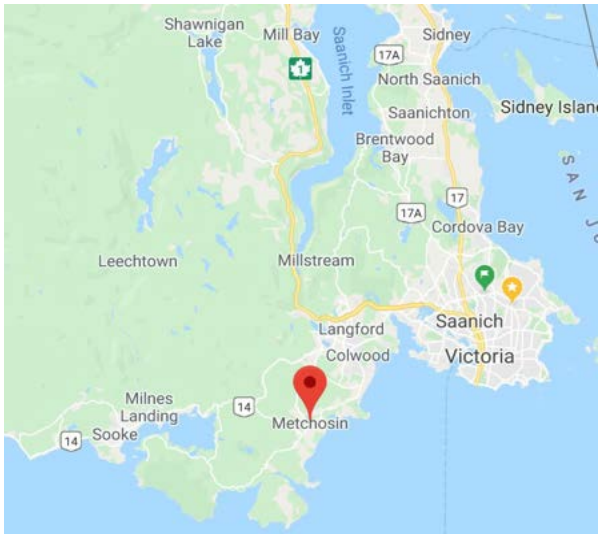
Objective 2: To provide a green space for the Metchosin community that is inviting, aesthetically pleasing, and educational.

Objective 3: To share lessons learned from trialing multiple restoration methods to better inform future restoration work in local Garry oak ecosystems.

2. Study Area

2.1. Site Description

This 0.136 ha (1360m²) site is located on the traditional territory of the Beecher Bay Scia'new First Nation, at 4401 William Head Rd, Metchosin, BC, beside the District of Metchosin Municipal Hall, and the Metchosin Volunteer Fire Department. It is in a rural area with impervious paved roads on three sides and a grass cricket pitch to the south. It is enclosed by a short (approx. 1m high at the start of the project) fence with a gate and is open to the public.



Map 1: Location of Metchosin, on Southern Vancouver Island

Map 2: Project location next to Metchosin Municipal Hall

48.379595, -123.537099

The site is part of the Coastal Douglas fir moist maritime (CDF-mm) biogeoclimatic subzone, in the Nanaimo lowlands (NAL) ecozone, and is a Fd-Bg Oregon grape site series. The south-west half of the site is dominated by a shrubby understory and a dense stand of Douglas-fir (*Pseudotsuga menziesii)* which are overcrowded, thin, and tops that have been snapped off by wind. The Northeast half of the site is an open Garry oak stand, with sparse mature Garry oak trees, and a largely herbaceous understory. On the meadow side (NE) of the site, the herbaceous layer is dominated by tall, invasive grasses. It is possible that these grasses are suppressing the less-competitive native species that are typically associated with Garry Oak ecosystems. The most dominant invasive grasses are quackgrass *(Elymus repens)* and orchard grass (*Dactylis glomerata*). At the start of our project, the site was subject to significant herbivory by rabbits. A full species list and map of the vegetation can be found in Appendix A.

Image 1: Looking North East. Taken on May 7th 2019.

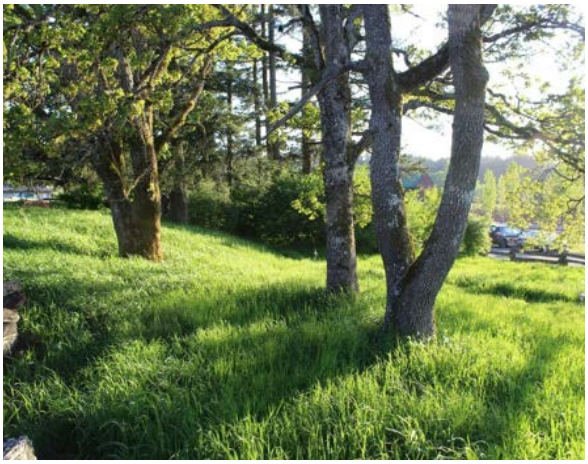


Image 2: Overlooking the site from the gate, looking South West. Taken on May 7th 2019.

2.2. Site History

This meadow is located adjacent to the Metchosin Municipal Hall, held by the District of Metchosin. The meadow is near the grounds of many community events and gatherings, where community members walk through this meadow for its beauty, especially in spring when the camas is blooming. Moralea Milne initiated the protection of this meadow. In 2010, community members gathered to build the stone wall and arc that borders part of the meadow. The site has been periodically mowed, with extra mowing and weed whacking taking place since the beginning of 2019. Some community members have maintained local memory of where native Garry oak associated plant species are present. The site receives higher than normal volumes of water from nearby land, where it has been rerouting through drainage pipes throughout the site.

3. Methods

We followed the recommendations for restoring Garry oak ecosystems outlined in the *Restoring British Columbia's Garry oak Ecosystems: Principles and Practices* manual (2011).

These recommendations were adapted to our site in consultation with local restoration experts, Colleen O'Brien (Playfair Park restoration project manager), James and Kristen Miskelly (Saanich Native Plants) and Andy MacKinnon (District of Metchosin Councillor, Forest Ecologist), and guidance from the Devonian Regional Park Restoration volunteers. A full description of the dates, attendees and details of our site visits can be found in Appendix B.

The project was planned using the *Open Standards for the Practice of Conservation* process, which helps teams be systematic about planning, implementing, and monitoring initiatives to learn what works, what doesn't, and why. Based on consultation with the Moralea's Meadow volunteers, we developed a situational model (Figure 1) which outlays the situation at the meadow, and our strategies to begin to restore it. This model identifies the targets for the site (green ovals) , the threats to those targets (red rectangles), drivers and contributing factors (orange rectangles), and potential strategies (yellow hexagon). Using a situational model ensures that there is a logical connection between management actions (strategies) and the desired end results (improved targets).

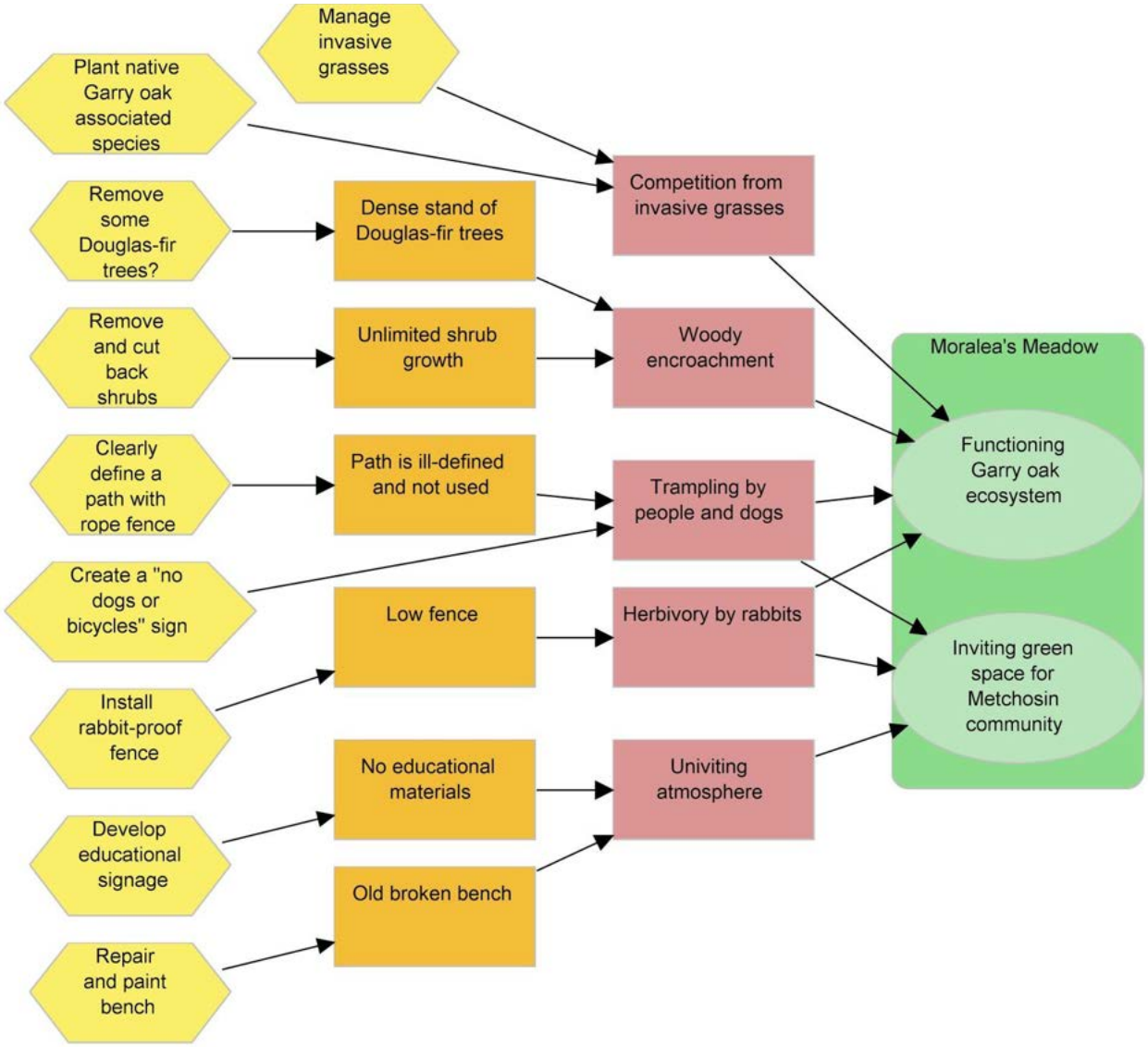


Figure 1: A situational model for Moralea's meadow. This model identifies the targets for the site (green ovals) , the threats to those targets (red rectangles), drivers and contributing factors (orange rectangles), and potential strategies (yellow hexagon).

This first stage of the restoration involved 1) installing a rabbit proof fence and gate, 2) removing and cutting back encroaching shrubs, 3) managing invasive grasses through a series of tarping treatments, 4) planting native Garry oak associated species and 5) bench painting and path creation.

3.1. Installing a rabbit proof fence and gate.

Intense rabbit herbivory was identified as a pressing problem at the site that had to be solved first if there was to be a hope for native species recovery. The Moralea's Meadow Volunteers used existing split rail fencing and wire mesh to install a rabbit-proof fence approximately 1.2m high. Two gates on either side of the meadow were repaired and self-closing springs were installed. Since the fence was raised, there have been no rabbits sighted inside the meadow to our knowledge, and herbivory has been limited to occasional deer browse.

3.2. Removing encroaching shrubs

Himalayan blackberry (*Rubus armeniacus*) on the South East side of the site had been recently removed prior to our involvement in the restoration. In May 2019, the Moralea's Meadow Volunteer Group also removed several introduced rose, and non-native thistle.

On August 17th, 2019, Sarah, Maria and Katy removed introduced rose saplings and snowberry saplings. On August 24th 2019, the Moralea's Meadow Volunteer Group dug out the three June Plums (*Oemleria cerasiformis*) that were encroaching into the camas area. This was done to allow expansion of the meadow. On October 5th 2019, a work party removed the roots of the June plum, and hand pulled as much of the invasive grasses present as possible.

3.3. Managing invasive grasses through a series of tarping treatments

We trialed a series of tarping treatments to determine what would be most effective with the conditions (i.e., tarps laid down in dry and wet seasons) and species composition on our site. A "learning while restoring" approach, also known as adaptive restoration, allows us to understand which techniques are most useful for these particular site conditions (Zedler, 2017). Tarps were placed on different sites several months apart, and then all removed in late winter, to understand which timing the invasive grasses responded to best. Two tarps (TS1 and TS2) were laid on August 17th, 2019 on one up-slope shady site, and one down-slope site with sun and shade, after a week with very little rain. Two tarps (TS3 and TS4) were laid on October 12th, 2019 after a week of approx. 25mm of rain on one upslope and one downslope site

(Precipitation data gathered from the Government of Canada Environment and Natural Resources). A final tarp (TS5) was placed on November 2nd, 2019, which was partially mulched and partially hand-pulled. See Appendix C for a list of tarping materials and costs.

Trial 1: dry conditions- August 17th, 2019

Image 3: TS1 before tarping

Image 4: TS1 after tarping

Tarp site #1: We selected a 5 metre by 5 metre area that had equal sun and shade, with camas and invasive grass, but no other visible plants. Tarp site 1 (hereafter TS1) was on the low slope side of the meadow, with relatively high moisture. It is adjacent to the NW fence (see map 2). We placed flags every couple meters to mark off the area. We weighed the tarps down with rocks, wood planks, gravel-filled buckets and large pieces of woody debris. The tarps were placed directly over the dried stems of camas. Many of the dried stems were still sticking up through the soil and were pulled up and laid flat so tarp could be laid flush to the ground.

Image 5: TS2 after tarping

Tarp site #2: the second site was selected on the up-slope, relatively dry side of the meadow. It is mostly shaded by nearby Douglas-fir trees. Tarp site 2 (TS2) was chosen because of local knowledge of white fawn lily (*Erythronium oregonum*) that was historically present on the site, but has not been seen for several years (Katy Nelson, personal communication, 2019). TS2 was 3m x 3m, and was held down by large rocks. It is adjacent to the SW fence (see map 2).

Trial 2: wet conditions- October 12th, 2019

Image 6: TS3 after tarping

Tarp site #3: TS3 is a 5m x 5m mid-slope site with a mix of great camas and invasive grasses. Location adjacent to the NE fence was selected to avoid other significant plants that were flagged earlier in the year. Large woody debris was removed from the area, so as to not puncture tarp, and the dried camas stalks were flatten down. Tarp was weighed down with scrap wood, wooden pallets and U hooks (landscape staples).

Image 7: TS4 after tarping

Tarp site #4: TS4 is a 2.5m x 3m upslope site directly adjacent to TS2. It was selected to expand coverage in the area where white fawn lily was historically sighted. It was weighed down with wooden pallets, rocks, and U-hooks.

Trial 3: mulching and hand-pulling- November 2nd, 2019

Image 8: TS5 before tarping (volunteers pictured- left: MacGregor Aubertin-Young, right: Josh Morgan)

Image 9: TS5 after tarping

Tarp site #5: TS5 was 4m x 4m, and was adjacent to Site #1, along the NW fence. The site was chosen to have a mix of great camas (*Camassia leichtlinii*) and invasive grasses, with no other native species present. This trial consisted of 4 conditions. Under the tarp included the following conditions: 1m x 1m of just tarping, 2m x 2m of a thick layer of Garry oak leaf mulch (approximately 5 large garbage bags worth from nearby the site which was laid on top of the grass), and 1m x 1m where grass was roughly hand-pulled, with an attempt to remove all rhizomes. Adjacent to the tarp was a 1m x 1m control site where nothing was done.

In addition to the tarping trials, invasive weeds have been managed mechanically on a small scale by the Moralea's Meadow Volunteers. The volunteers hand-pulled weeds from the sites where camas was planted (see section 3.4) and have been spot-removing dandelions.

3.4. Planting native Garry oak associated species

Camas bulbs were donated by Katy Nelson, from her property down the street from the project site. Approximately 40 bulbs were planted parallel to the fence on the SE side (Image 10).

Another approx. 50 bulbs were planted on the site of the June Plum (*Oemleria cerasiformis*) removal, where invasive grasses had been hand-pulled (See Section 3.2; Image 11). Approximately 10 bulbs were planted along the NE fence (Image 12).

Image 10: SE fence

Image 11: June plum removal

Image 12 NW fence

The University of Victoria's Ecological Restoration Volunteer Network (ERVN), in conjunction with the Campus Community Garden, have began propagating the following plants with seeds collected on site on July 3rd 2019: Great camas, common camas (just a few seeds from one plant on site), fawn lily (*Erythronium spp.*) all collected from the meadow, and red columbine (*Aquilegia formosa*) from the nearby Municipal Hall. Plants are reported to be germinating well (March 10th 2020).

3.5. Non-vegetative restoration: bench renewal and path planning

To support Objective 2 of this project, we improved the aesthetics of the meadow by restoring an old wood bench, and planning a road-based aggregate path with rope fence. The bench and path will not only make the space more inviting, it will also keep visitors to a restricted area to avoid trampling native plants. The rope fence was modelled after a similar path installed through the Garry oak meadow at Playfair Park (see Image 14). Details for the materials and pricing for the fence can be found in Appendix C.

Image 13: Volunteer & professional painter Josh Morgan repaired, sanded, and painted the bench, October 5th, 2019

Image 14: Rope fence path at Playfair park which was used to model the path for Moralea's Meadow, August 17, 2019

4. Results

4.1. Shrub removal results

June plum shoots have emerged in the area where they were removed on August 24th 2019. New White Fawn Lily have emerged where the introduced rose on the south west corner of the site were removed. White Fawn Lily had not previously been seen in this area according to local knowledge.

4.2. Tarping Results

All tarps were removed on January 25th, 2020, with varying results (see Table 1). All sites saw a reduction in invasive grasses. Most sites (4) saw a 70% or more reduction in living invasive grasses. Living quackgrass was present on all sites, and appeared unaffected by the tarps. The mulched portion of TS5 appeared to yield the most beneficial results, containing the least amount of invasive grasses (0.5% quackgrass, 0% any other living invasive grasses). New camas seedlings have emerged in tarped areas around the patches of mature camas (observational data from a local expert, March 23rd 2020).

Tarp Site	Months tarped	Conditions when tarped	Immediate Results January 25, 2020	Results 6 weeks after tarp removal Photos taken on March 10, 2020, unless otherwise specified
TS1 downslope	08/17/19-01/25/20	Dry, little recent rainfall (<2mm the week prior)	- 90% of invasive grasses appeared deceased -Living quackgrass cover unchanged from before tarping (~10% cover). 	50% cover of living invasive grasses Local expert noticed newly emerging camas seedlings (around the third week of March) 
TS2 upslope	08/17/19-01/25/20	Dry, no recent rainfall (<2mm the week prior)	-~80% of the invasive grasses appeared to be deceased. -quackgrass presence was limited on this site to begin with, but remained unchanged (~2% cover). 	<3% invasive grass cover 
TS3	10/12/19-	Damp,	-~70% of the orchard grass present was	-25% cover of living invasive grasses

midslope	01/25/20	~25mm of rain the week prior	deceased. -quackgrass remained alive with its extent unchanged. -Patterns were noticed where pallets directly compressed the grass (see bottom right corner of image), showing less regrowth when areas were compressed. 	-compression appeared to suppress orchard grass   Area that was partially compressed by pallet (Photo taken on March 13th 2020).
TS4 upslope	10/12/19-01/25/20	Damp, ~25mm of rain the week prior.	-~70% of the orchard grass present was deceased. -quackgrass presence was limited on this site to begin with, but remained unchanged (~2% cover). -Strong patterns of dead grass were noticed where pallets directly compressed the grass (see bottom right corner of image)	<3% cover of live invasive grasses

				
TS5 downslope	11/02/19-01/25/20	Wet, ~37.6mm of rain the week prior.	Mulched area: quackgrass was growing through the leaf mulch. After lifting a small portion of the mulch, more quackgrass was seen. 	One half of the mulch was lifted. Only quackgrass present with 0.5 % live cover. Kentucky blue grass and orchard grass did not appear to be present. Extent of quackgrass prior to tarping is unknown. Mulch was kept on site until March 10th 2020, when half was removed and added to the other adjacent 1m x 1m mulched area to monitor change/differences over time. 

				 (Photo taken March 13th, 2020)

4.3. Native Plant Results

Image 15: Camas extent (red) prior to restoration. Taken May 25, 2019. Repeat photography will continue to be conducted.

The planted camas across entire site appeared well established on March 10, 2020 (Image 16 and 17). A local expert saw newly emerging camas seedlings in the lower site that was tarped (TS1).

Image 16 and 17: Camas planted on site.

47 White Fawn lilies and 1 suspected Pink Fawn lily (Image 18) were found on site on March 10th 2020.

Image 18: One of the fawn lilies found on site.

5. Discussion

The tarping treatments revealed that tarping is effective at reducing orchard grass cover on the upslope, midslope, and downslope sites. Our timing trials suggest that the tarps were effective

at reducing orchard grass and Kentucky blue grass when placed in both dry and wet seasons. However, it appears that the quadrant of the final site (TS5) that was just tarped yielded least effective results, containing the most cover of live grasses and of several species (noticeably quackgrass and orchard grass). There are dead, dry grasses in dry season tarping trials and less in wet season, likely due to timing of mowing. Mowing just before tarping would make observations more clear in future tarping trials.

It appears that tarping has encouraged new growth of camas seedlings in areas that have mature camas present. A local expert has observed camas seedlings and suggests that may have a good growing season due to the reduced competition of invasive grasses, as a result of tarping (personal communication, March 23, 2020).

The tarping trials also revealed that tarping is an ineffective way to control quackgrass on this site, and other treatments will need to be explored if quackgrass reduction is desired (see recommendations).

Dandelion (*Taraxacum officinale*), which was only present on TS1, and Sheep sorrel (*Rumex acetosella*), which was only present on TS3, were both not reduced by tarping. It has been recommended by a community member to use landscape fabric and wood chips to reduce the dandelion where they are at high densities, such as near the stone gate.

When the tarps were first removed it appeared that areas with direct compression from the heavy wooden pallets and boards experienced higher rates of quackgrass dieback than areas with no compression. We were hopeful this meant that compression on tarping might reduce quackgrass, however site visits two weeks and six weeks after tarp removal revealed that regrowth appeared to be consistent across tarped and non-tarped areas. Compression appears to aid in grass suppression of orchard grass and kentucky bluegrass but it is unclear whether it has an effect on quackgrass and can be further tested.

It is important to consider several factors that may have influenced our results. While the tarping trials suggest that the tarps were most effective when placed in August, it is unclear whether this was due to the length of time the tarps were in place, the moisture levels when the tarps were put down, the length of grasses when the tarps were placed, or other unknown variables. However, it appears that the TS5, which was put down in the wet season and with the shortest tarping duration, was visibly the least affected by tarping, containing the greatest coverage of invasive grasses on the tarp-only quadrant.

According to local knowledge, there is a noticeable increase in white fawn lilies present on the site. It has been suggested that this increase may be a result of regular mowing being done on the site. It also appears that removal of shrub species in the South West corner may have allowed for an increase in white fawn lily presence.

6. Recommendations

We recommend the following steps for the ongoing restoration of Moralea's meadow. Although we will no longer be project leads as of the cessation of our project, we will continue to support the Moralea's Meadow Volunteers in these efforts as we are able. Generally, we recommend regular long-term maintenance of the site with continual mowing, with special attention to native plants. Long-term monitoring, with regular repeat photography and observational documentation, is recommended.

1. Thinning the Douglas-fir trees

The stand of Douglas-fir trees on the NW side of the meadow are overcrowded in a way that is not beneficial to their health, or to the species diversity in the meadow. The trees show signs of distress and all their main leaders have been snapped off in the wind. They also shade approximately 30% of the meadow, which may be limiting the growth of sun-preferring native Garry oak associated species. We recommend at least 50% of the trees be removed.

2. Invasive grass management

We recommend continued and extended tarping treatments on areas with invasive grass, or mixed invasive grass and camas. These treatments could start earlier in the summer, at the beginning of August or the end of July, after the camas has completely died back and the seeds have dropped or been collected. Tarps should be removed at the end of January. Compression, with heavy plywood, can be trialed for longer durations in areas where no camas or other native plants are present. Ensuring plywood is as flush to ground as possible is recommended. The addition of Garry oak leaf mulch under the tarps appears to speed up the process of invasive grass dieback (for orchard grass and Kentucky bluegrass) and is recommended. These processes should be completed annually until invasive grasses are reduced to a manageable level and a diverse population of native Garry oak associated species are established. Long-term monitoring of various methods should be recorded. Seeds can be planted in these areas as invasive grasses die back (see Plant List).

3. Quackgrass management

Our experience demonstrates that tarping and mulching are ineffective ways to control quackgrass. Hand-pulling appears to reduce the population slightly, but causes substantial soil disturbance. The literature and local experts indicate that the most effective way to manage quackgrass with the least harm to the meadow is through the use of grass-specific herbicides (Sevilla-Moran et al., 2016; Ringselle, 2015).

Our research and local guidance suggest using either *Poast* (active ingredient: *sethoxydim*) or *Venture* (active ingredient: *fluazifop-P-butyl*). Consultation with the municipal government, partners and stakeholders is recommended to determine whether herbicide use is appropriate for this meadow.

The literature recommends foliar application (applied directly to the plant) over soil application where possible to maximize effectiveness and efficiency (Chandrasena & Sagar, 1984). This would mean that tarping would still be required to manage the other invasive grasses in the meadow.

4. Fire management

Prior to European colonization, Garry oak meadows were managed by Coast Salish peoples using fire. Fire prevents woody encroachment from shrubs and conifer trees, accelerates recycling of mineral nutrients, encourages spring growth, promotes selection for annual or ephemeral habitat, and synchronizes fruiting (Deur & Turner, 2005).

It is possible that patch burning may be beneficial for Moralea's meadow. However some invasive grasses, including quackgrass and orchard grass have been known to respond positively to burning (CABI datasheets; Snyder, 1992). The literature regarding the use of fire to manage quackgrass is contradicting and requires further investigation with experts. Snyder (2006) suggests that a biennial schedule of burning for several years has helped manage quackgrass, and some research suggests late spring as a beneficial time to reduce biomass, cover and flowering. Other studies suggest burns in the fall may help reduce cool-season grasses, such as quackgrass (Snyder, 2006). However, the studies may not be applicable as they took place in eastern US and there is much evidence supporting the increase in quackgrass growth with fire (Snyder, 2006).

For other invasive grasses on the site, burning should be done in the late winter, in small patches, with careful recording of the response of invasive grasses. Some options to try could be to burn patches that have been tarped (where grasses have been reduced), bare patches of land, where grasses have been hand pulled, or to do multiple burns at the same site.

Any burning should be done in consultation with the Metchosin fire department, and with expert guidance.

5. Planting

As the invasive grass continues to be managed, we recommend supplementing the meadow with native Garry oak associated species until they have established populations. The areas that

have been tarped will have reduced competition from invasive grass, so these are optimal places to plant. Species may be planted as seeds, bulbs, or transplants, depending on the species preference and local availability. Local experts have helped in providing suggestions. This process also included a local expert identifying species that are common in deep soil under oak woodland in two nearby sites.

Table 2 contains a chart showing some of the species we recommend with help from local experts, suggestions for placement, and the best time of year to plant. As the meadow becomes established, divide the perennial plants every three or four years to retain their vigour (GOERT, 2011). Consult the Garry oak Gardener's Handbook (2011) for further guidance.

Plant Species	**Where to plant**	**When to plant**	**Moisture**	**Height**	**Flowering Period**
Western buttercup (*Ranunculus occidentalis*) 	Full sun to part shade TS1 and TS5 where there is deeper soil	Sow seeds or plant transplants in the fall	Dry to mesic	15-50cm	March to June
White Fawn Lily (*Erythronium oregonum*) 	Full sun to part shade Plant on southern upslope side of meadow near TS2/TS4, in shaded area, where *E. oregonum* historically spotted TS1 and TS5 where there is deeper soil	Sow seeds and bulbs in the fall	Dry to mesic	15-35cm	March - April
Great camas (*Camassia leichtlinii)*	Full sun to part shade	Plant bulbs or seeds in the fall	Dry to mesic	20-100cm	May to June

	Continue to plant bulbs and spread seeds in sunny spaces throughout the meadow				
Common camas (*Camassia quamash)* 	Full sun to part shade Continue to plant bulbs and spread seeds in sunny spaces throughout the meadow, especially where grass has been managed	Plant bulbs or seeds in the fall or early winter	Dry to mesic	30-70cm	April to June
Long stolen sedge (*Carex inops*) 	Full sun Plant transplants in the north, downslope side (the sunnier side) of the meadow. Can be planted on TS2 and TS4. TS1 and TS5 where there is deeper soil	Sow seeds in the fall	Mesic	10-50cm	Early April
California oatgrass (*Danthonia californica*) 	Full sun to part shade	Sow seeds in the fall	Dry to moist	15- 80cm	May to July
Sea blush (*Plectritis congesta*)	Full sun to part shade. Plant on TS2 and TS4.	Sow seeds in the spring or fall	Dry to moist	10-60cm	April to June

	Seeds can be collected from Municipal Hall	Late August if there has been some rain. Will provide good ground cover over winter month.			
Nodding onion (*Allium cernuum*) 	Full sun to part shade	Sow seeds or 10cm transplants in the fall	Dry to mesic	10-25cm	June to August
Broad-leaved shooting star (*Dodecatheon hendersonii*) 	Sun to part shade TS1 and TS5 where there is deeper soil	Sow seeds in the fall, or plant transplants in the spring	Mesic to dry	10 – 30 cm	April to June
Yarrow (*Achillea millefolium)* 	Full sun TS1 and TS5 where there is deeper soil	Sow or transplant in early spring or early fall	Dry to moist	30 – 100 cm	June to December
Self-heal (*Prunella vulgaris* spp. *lanceolata*)	Full sun to shade TS1 and TS5 where there is deeper soil	Sow or transplants in early spring or late fall	Mesic to wet	10-50cm	June to October

					
Yampah (*Perideridia gairdneri*) 	Part shade to full sun TS1 and TS5 where there is deeper soil	Sow seeds in the fall	Dry to moist	40-120cm	July to September
Chocolate Lily (*Fritillaria affinis)* 	Full sun to part shade TS1 and TS5 where there is deeper soil	Sow seeds in the fall	Dry to mesic	20 – 80cm	May to June
Foothill Sedge (*Carex tumulicola)*	TS1 and TS5 where there is deeper soil	Sow seeds or transplant in the fall	Dry to Moist	Up to 80cm	Spring

 Photo: P. Lawns Info: Parks Canada Agency (2012) and COSEWIC (2008)					
Prairie Woodrush (*Luzula subsessilis)* 	Full sun to part shade TS1 and TS5 where there is deeper soil	Sow seeds in the fall	Dry to mesic	10 – 30cm	April to June
Slender Toothwort (*Cardamine nuttallii)* 	Part shade to shade TS1 and TS5 where there is deeper soil	Sow seeds or transplant in winter or early spring	Moist	20 – 30cm	April to June
Wild Strawberry (*Fragaria virginiana)*	Full sun to partial shade TS1 and TS5 where there is deeper soil	Transplant in the fall	Dry to moist	Trailing	March to May

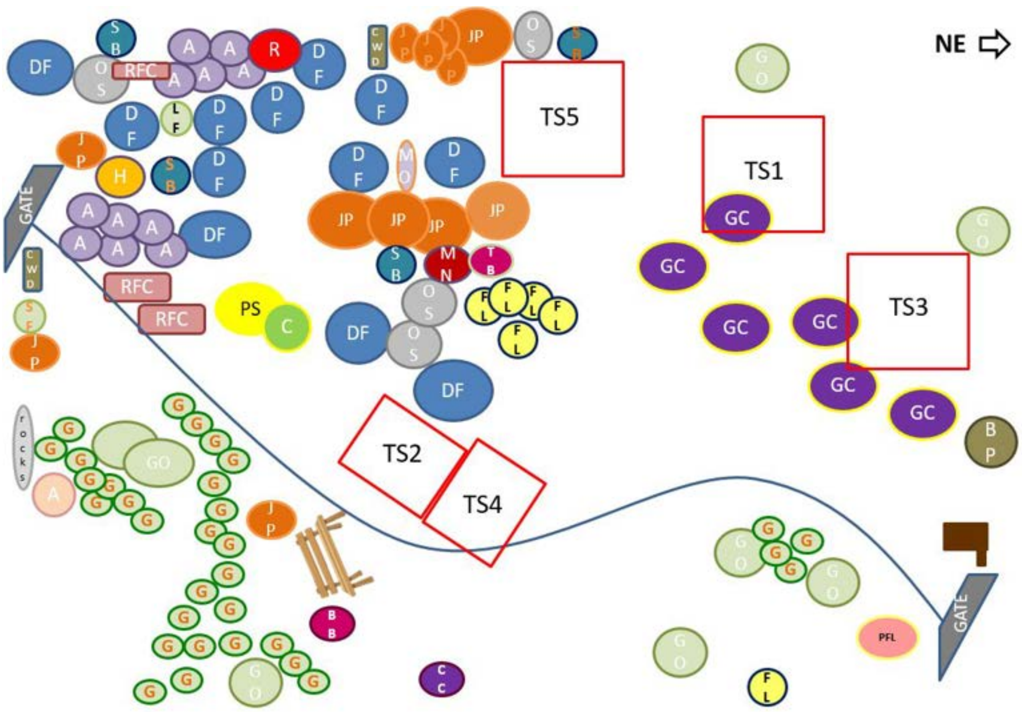
					

Majority of information gathered from Saanich Native Plants

6. Educational signage

We recommend the use of educational signage to place outside the meadow (see Appendix D for ideas). It can provide visitors information on the cultural and ecological importance of Garry oak meadow ecosystems and a species list with photographs. It could be beneficial to have students from a nearby school participate in this design. This would give students the opportunity to spend time learning about this endangered ecosystem, to become more familiar with native plants and their importance which may lead to a greater appreciation for the environment and a desire to take care of it. This space can serve as an opportunity to teach a younger generation about the unique landscape that used to be prevalent in this region, and instill in them a desire to protect it, rebuild it, and to tend to it over time with care and appreciation.

Appendix A: Site map and vegetation list



Legend

- Garry oak *Quercus garryana*
- Garry oak sapling
- Arbutus- *Arbutus menziesii*
- Douglas fir *Pseudotsuga menziesii*
- Black pine- *Pinus nigra*
- Snowberry *Symphoricarpos albus*
- June plum *Oemleria cerasiformis*
- Oceanspray *Holodiscus discolor*
- Red Flowering Currant *Ribes sanguineum*
- Sword fern *Polystichum munitum*
- Licorice fern *Polypodium glycyrrhiza*
- Great camas *Camassia leichtlinii*
- Common camas *Camassia quamash*
- Dull Oregon grape *Mahonia nervosa*
- Cleavers *Galium aparine*
- Himalayan blackberry *Rubus armeniacus*
- Trailing blackberry *Rubus ursinus*
- Mock orange *Philadelphus coronarius*
- Pink Fawn Lily *Erythronium revolutum*
- White Fawn Lily *Erythronium oregonum*
- Honey suckle Lonicera hispidula
- Pacific sannicle *Sanicula crassicaulis*
- Blackcap raspberry *R. leucodermis*
- Douglas aster- *Aster subspicatus*
- Coarse woody debris
- Entrance sign
- Planned path
- Rocks

Appendix B: Site visits

Date	Who	What
21/01/19	Maria Catanzaro, Val Schafer, Katy Nelson, Melanie Fortunato, Moralea's Meadow Volunteers	Initial site visit and walk through
21/01/19	Maria Catanzaro, Melanie Fortunato	Visit to playfair park, to learn from Colleen O'Brien
03/01/19	Moralea's Meadow Volunteers	Prepping trench for rabbit proof fencing
03/01/19	Melanie Fortunato	Data gathering
18/03/19	Moralea's Meadow Volunteers, Metchosin public works	Building rabbit fence
07/05/19	Maria Catanzaro, Sarah Cotter	Site visit, mapping out vegetation, including checking grass species
16/05/19	Moralea's Meadow Volunteers, Val Schafer	Visit to playfair park, to learn from Colleen O'Brien
16/05/19	Maria Catanzaro, Sarah Cotter, Katy Nelson, Andy MacKinnon, Kristen Miskelly, James Miskelly	Species assessment, consultation
25/05/19	Maria Catanzaro, Sarah Cotter	Mapping, measurements, drone footage, repeat photography
03/07/19	Maria Catanzaro, Sarah Cotter, Katy Nelson	Seed collection and added more to map
17/08/19	Maria Catanzaro, Sarah Cotter	Tarp work and visit to Home Depot
05/10/19	Sarah Cotter, Josh Morgan, Moralea's Meadow Volunteers	Work party

12/10/19	Maria Catanzaro	Picking up materials, driving to Metchosin to lay down new tarps and replace old ones
02/11/19	Maria Catanzaro, Sarah Cotter, Josh Morgan, MacGregor Aubertin-Young, Katy Nelson	Laying the third set of tarps
25/01/20	Maria Catanzaro, Sarah Cotter, Katy Nelson, Andy MacKinnon, Kristen Miskelly, James Miskelly, Colleen O'Brien, Nancy Shakelford	Pulling up tarps, consulting local experts on results
17/02/20	Sarah Cotter	Checking for regrowth, staking the plot corners, repeat photography
08/03/20	Moralea's Meadow Volunteers	Weeding around the perimeter of the fence where camas was planted; spot dandelion removal
10/03/20	Maria Catanzaro, Sarah Cotter	Checking for regrowth, emergence of new plants and repeat photography
13/03/20	Maria Catanzaro	Taking photos and taking closer look at tarped sites

Appendix C: Materials and Costs

Tarp Materials And Cost

Tarp - Poly material from C Y Growers Supplies Ltd., Cobble Hill, BC Cost: $311.23 (including shipping ~$80). This covered 4 sites (2 sites at ~5mx5m and 2 sites at ~2.93m x 2.36m) and there is leftover for additional experiments or more work in the coming years.
Contact: C Y Grower Supplies Ltd.
Phone: 604 856 5186
Toll Free: 1-866-856-5186
E-mail: sales@cygrowers.com
www.cygrowers.com

U hooks (landscape staples) from Castle Building Centre, 3 packs of 10, Cost: ~$13
Things to weigh down tarp, Free
Scrap wood from Castle Building Centre, Free
Scrap pallets found in Metchosin adjacent to site, Free

Path

Tools and Cost
¾”Manila Rope (330ft length), from Trotac Marine, at $0.80 /ft, Total: $295.68 (Item #: ROPE12M) 
Pencil post, 30 @ $4.09 each, Total: ~ $132. From Home Depot: 1001208119-MicroPro Sienna Pointy Post 2-3” 8’ EAN/UPC: 604603008915 
Flags (~$15 for pack from Home Depot)
Road-based aggregate (to be costed)
Excavator (in-kind)

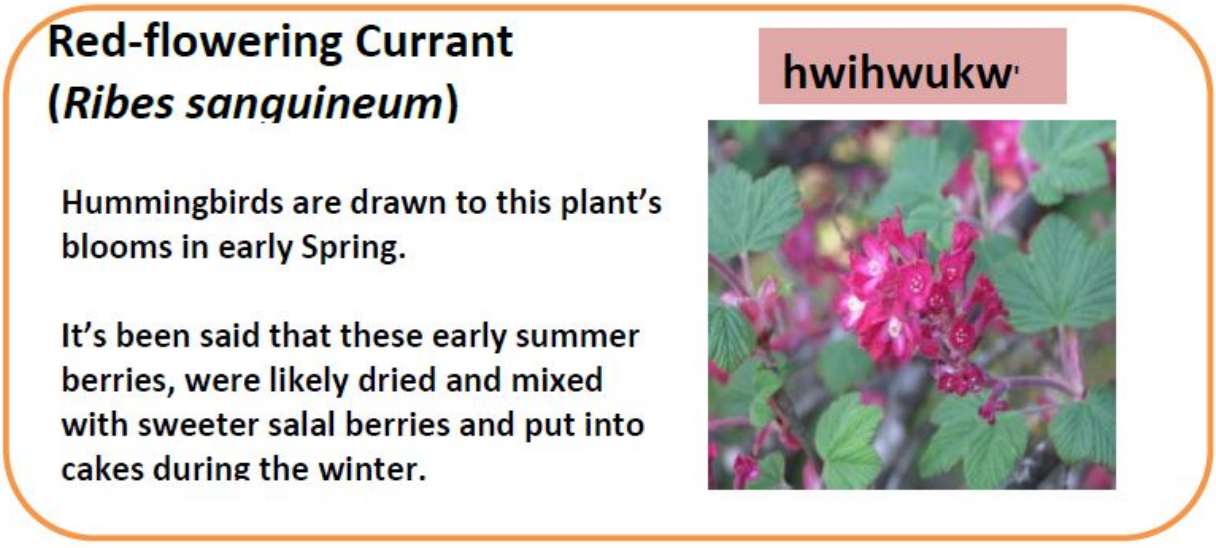
Fence

Rail fence repair	~$250
Self-closing gate latch	~$180
Rabbit proof wire fencing	~$495
Gate for stone arch with installation	~$450

Educational Signage

Message centre kit x 1, Post & plexiglass signs X 4 (includes posts, cement, plexiglass, printed material, etc) ~$1300

Appendix D: Educational Signage Idea



(Turner & Hebda 2014)

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