Planting and exclosure plan for the west branch of the Chrystal Creek Watershed

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Abstract

In this report, we make recommendations for a planting plan and exclosure plots for the west branch of the Chrystal Creek Watershed located on the Galiano Conservancy Association's (GCA) Millard Learning Centre on Galiano Island, BC. These recommendations align with the goals of the overarching project, Cedars for Next Century, which is a restoration plan for the Chrystal Creek Watershed over the next five years (EcoAction 2020-2022 Proposal). We worked within budget constraints, recommendations, site dynamics, and history to determine appropriate species for planting. Additionally, we took climate change into account by suggesting a variety of plant species. To ensure a higher success rate and to be efficient in our use of resources, we recommended creating exclosure plots to protect a diversity of species on the site and to allow experimental and control plots for comparing the impacts of deer herbivory.

1.0 Introduction

1.1 Land acknowledgement

We would like to acknowledge that this project and this plan are taking place on the unceded traditional territories of the Penelakut First Nation and Hul'qumi'num speaking peoples whose connection to these lands are deep-rooted and continue to this day. We would like to express our deep gratitude for the opportunity to learn, grow, and experience the beauty of Galiano Island for the duration of this course. As we are visitors to this space, we want to be respectful in our interactions with this place and be mindful of our presence. We are students from the University of Victoria on the unceded traditional territories of the lək̓ʷəŋən, Songhees, Esquimalt, and W̱SÁNEĆ peoples. We recognize that decision making should be done in consultation and partnership with local decision makers and indigenous knowledge holders and hope that these recommendations support local interest and plans such as the Cedars for the Next Century project.

1.2 Geographical location

The restoration site for this project is the Chrystal Creek Watershed. It is entirely situated within the Millard Learning Centre, a 76 hectare property on Galiano Island, B.C (Duncan, J. and Warren, M. 2020). The entire Chrystal Creek Watershed lies within the GCA property. This poses a unique and rare opportunity for the restoration of an entire watershed. The Chrystal Creek Watershed restoration site boundaries are defined in Figure 1.

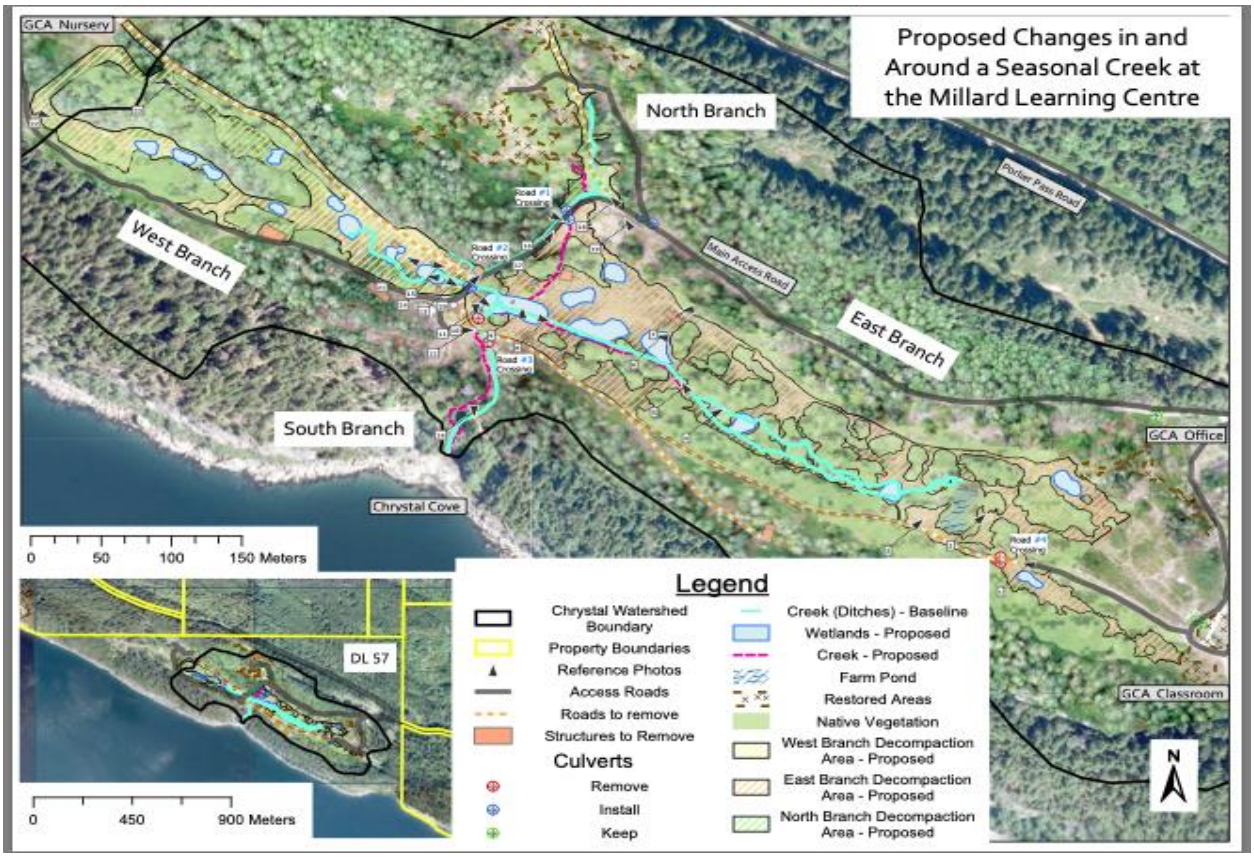

Figure 1. The proposed changes in and around the seasonal Chrystal Creek at the Millard Learning Centre on Galiano Island, BC. We use this map to illustrate the orientation of the site, to show the scope of our project, and to give context for potential changes to the site.

1.3 Site characteristics

Preliminary soil test pits were dug on the restoration site. The soil composition of these test pits was compared with the Terrestrial Ecosystem Mapping (TEM), which mapped the terrestrial ecosystems across B.C. (Figure 2). There are four different TEM categories found in the west branch of the watershed, which are part of the Coastal Douglas-fir moist maritime (CDFmm) biogeoclimatic subzone (Green, R. and Kinka, K. 1994). The CDFmm zone has

warm, dry summers and mild, wet winters, which leads to longer growing seasons and pronounced water deficits (Green, R. and Kinka, K. 1994). These zones are CDFmm-01, CDFmm-06, CDFmm-12, CDFmm-14.

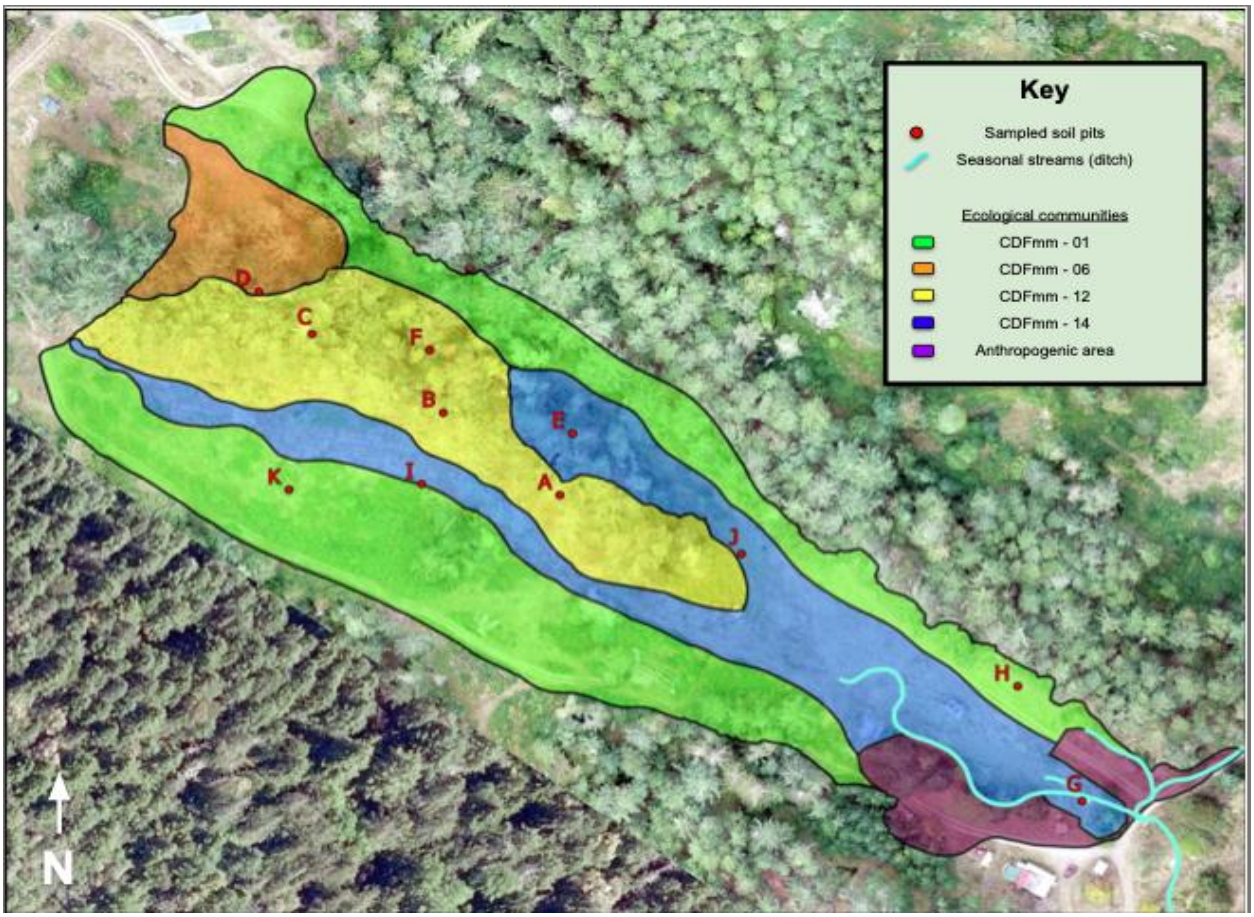

Figure 2. The terrestrial ecosystem map for the west branch of the Chrystal Creek Watershed. Using the key from Green, R.N. and Klinka, K. 1994 - A Field Guide for Site Identification and Interpretation for the Vancouver Forest Region, we can infer which species will do well in these areas and thus make informed recommendations for plantings on the site.

1.4 Site background

There were several previous owners of this property. The first purchase of the land parcel was in 1896 by John W. Walker for agriculture. The subsequent owner was John Shaw. There were several other owners over the next 30 years. In 1932, it was purchased by the Scholefield family who used the site as a residence. The site was then owned and managed as agricultural land by The Olympia Cooperation from the 1940s until 1958. (Duncan, J. and Warren, M. 2020). This site has high degrees of compaction due to the overuse of heavy machinery and logging activity, which was carried out by the most recent previous landowner, Bill Campbell. Campbell owned the property from 1958 until 2012 when the property was acquired by the GCA for conservation and restoration. (Huggins, A. 2017).

Natural aspects of the Chrystal Creek Watershed have been lost due to the disturbance and historical use of the site. The historic soil, hydrology, plant community composition, and forest structure are examples of how this site has changed significantly. (EcoAction 2020-2022 Proposal). The ditches along the roads that line either side of the site and the structures on the site, such as the field house near the base of the Chrystal Creek Watershed, are evidence of past use.

The deer population on Galiano Island has seen exponential growth in recent years. Over-browsing by Colombian black-tailed deer (*Odocoileus hemionus columbianus*) is a threat to young plants and a recovering ecosystem because they negatively impact plant growth, recruitment, and diversity. Species that are tolerant or resistant to browsing often begin to

dominate and can create an understory that prevents the recovery of some species. (Pendergast, 2016).

To mitigate the impact of deer on the new plants in the watershed, a combination of plant cages and exclosure plots will be used. Exclosure plots have been used elsewhere on the Millard Learning Centre property and are used for several reasons: they provide data on deer herbivory levels, they act as educational tools, and they protect plants from deer herbivory, allowing young plants to establish and grow beyond the reach of deer. Exclosures are informative and useful in preventing browsing when replanting an area, especially when increasing plant diversity is one of our goals. The size of a standard exclosure plot at the MLC is 10 by 10 meters (Huggins, A. 2021. personal communication).

1.5 The plan

Our project focuses on the west branch of the watershed, which is the first component of a multi-year restoration initiative, Cedars for the Next Century. Our project aims to establish a native planting list that will help to regain ecosystem functions and services and support native fauna. We are providing recommendations for exclosure plots and caging of plantings within the restoration site.

Our project supports the Cedars for the Next Century plan by providing a planting plan and exclosure plot. In Fall 2021, restoration of the west branch of the Chrystal Creek Watershed will begin. This phase includes pulling down Douglas fir trees *(Pseudotsuga menziesii)* to open up the canopy, simulating windfall, which creates microtopography within the site. The next step centers around decompacting the soil with the rough and loose technique. Digging of shallow wetlands will occur in September and October 2021, which will need to occur before wetland

restoration plantings occur. Planting and early caging of plants will take place in October and November 2021 with monitoring and continued planting and caging continuing into April 2022.

The entire restoration site is 4.5 hectares. (EcoAction 2020-2022 Proposal). The west branch is approximately 1.3 ha, or 28 percent of the total area. (Chrystal Creek Watershed Restoration Work Plan. n.d.). A conservative estimate for how many native plants, trees, and shrubs should be planted across the whole watershed is 1000 plants. (EcoAction 2020-2022 Proposal). To estimate how many plants should be selected for planting in the west branch, we considered the total number, as well as the limitations of our budget. If the west branch is 28 percent of the total restoration area, then we could estimate allocating around 28 percent of the total number to be planted there, or 280 plants (28% of 1000). Our plant budget for this project is $2500, which can afford us 250 1 gallon plants (Table1). We suggest planting 250 plants, which is a conservative estimate. If there is more room in the budget, more plants could be planted later on.

We estimate that the 3 10x10m exclosures that will be planted will hold around 20 plants each, or 60 total, leaving 190 plants to be individually caged. The planting density estimates for a 10x10m exclosure were based on Sound Native Plants' "Calculating Plant Quantities" (Sound Native Plants. n.d.) and King County's "Plant Spacing Preferences" (King County n.d.).

Table 1. Plant, caging, and fencing budget for the west branch of the Chrystal Creek Watershed.

	Cost (CAD)
Budget	
Plant Budget	2500
Fencing Budget	4500
Total Budget	7000
Pricing	
Plant Cage	8.5
1m of fencing	7.5
4" plant	5
1 gal plant	10
2 gal plant	20
Expenses	
190 Plant Cages	1615
280m of fencing (7 10x10 exclosures)	2100
250 1 gal Plant	2500
Total Expenses	6215

2.0 Goals and Objectives

2.1 Goal 1

Design a native species planting plan for the west branch of the Chrystal Creek Watershed project.

2.1.1Objective 1A

Plant approximately 250 plants (as consistent with budget limitations and overall Chrystal Creek planting estimates), consisting of shrubs, coniferous trees, and deciduous trees across the site in October-November 2021 that will resemble an early seral stage western redcedar *(Thuja plicata)* habitat.

2.1.2 Objective 1B

Plant the seasonal wetlands with native to support native species such as the Northern red-legged frog (*Rana aurora*) and the North American beaver *(Castor canadensis).*

2.2 Goal 2

Design a caging and exclosure plan for the west branch of the Chrystal Creek Watershed project.

2.2.1 Objective 2A

Individually cage all new plants outside proposed exclosure plots to reduce herbivory by Columbian Black-tailed deer.

2.2.2 Objective 2B

Establish standard size (10 m by 10 m) exclosure plots that are consistent with practices conducted by the MLC and control plots in each of the four ecological communities in the west branch of the Chrystal Creek watershed. There is one planted exclosure plot in the west branch already. We propose three more planted exclosures and four additional control exclosures to monitor species succession. Monitor species success as well as deer herbivory with a timeline of November 2021 - April 2022.

3.0 Approach

3.1 Ecological communities

We used TEM to determine the types of pre-disturbance ecological communities that could be found on the site based on the map in Figure 2. Test pits were dug to determine moisture and soil composition across the site to determine what plants would grow best in the varying conditions found across the site. There are four different TEM categories found in the est branch of the watershed. There are four CDFmm zones found on the site, which are described below.

CDFmm-01 is dominated by Douglas-fir trees and the shrub layer is mainly dull Oregon-grape (*Mahonia nervosa*), salal (*Gaultheria shallon*), trailing blackberry (*Rubus ursinus*), and oceanspray (*Holodiscus discolor*) (Wartig, W. and Inselberg, A. 2010). Western redcedar is also found in this plant community. This is one of the drier areas in the site and has poor nutrient concentration in the soil (Wartig, W. and Inselberg, A. 2010).

CDFmm-06 is dominated by western redcedar and grand fir (*Abies grandis*) (Wartig, W. and Inselberg, A. 2010). This community has a sparse shrub layer, which includes dull Oregon-

grape and a ground cover of sword fern (*Polystichum munitum*), three-leaved foamflower (*Tiarella trifoliata*), and vanilla leaf (*Achlys triphylla*) (Wartig, W. and Inselberg, A. 2010). The soil is very rich and moist (Green, R. and Kinka, K. 1994; Wartig, W. and Inselberg, A. 2010).

CDFmm-12 consists of a tree layer of red alder (*Alnus rubra*), grand fir, douglas-fir, and bigleaf maple (*Acer macrophyllum*) (Green, R. and Klinka, K. 1994). There are few shrubs, but sword ferns dominate the understory (Green, R. and Klinka, K. 1994). This community is characterized by rich soils and a fluctuating water table (Green, R. and Klinka, K. 1994).

CDFmm-14 is seasonally flooded and has a canopy of red alder and black cottonwood (*Populus trichocarpa*) (Wartig, W. and Inselberg, A. 2010). The shrub layer consists of common snowberry (*Symphoricarpos albus*) and red-osier dogwood (*Cornus sericea*) (Wartig, W. and Inselberg, A. 2010). The herb layer is mainly slough sedge (*Carex obnupta*) (Wartig, W. and Inselberg, A. 2010). The site is low-lying with very rich soil and there is a strongly fluctuating water table with flooding during the winter (Wartig, W. and Inselberg, A. 2010).

We used the TEM as a guide for what plants to incorporate into our planting plan for the west branch of the Chrystal Creek Watershed. Because there is a high level of diversity in soil nutrient and moisture levels across the site, there will be distinct differences between the four plant communities outlined above. CDFmm-01 and CDFmm-06 will be more forested and have the potential of becoming western redcedar habitat in the future. CDFmm-12 and CDFmm-14 are very wet seasonally and will be the sites of seasonal and potentially year-round wetlands. These wetlands will provide a habitat for red-legged frogs and beavers.

3.2 Seral stage western redcedar habitat

One of the long-term goals of the overarching Chrystal Creek Watershed restoration project is to create suitable habitat for western redcedars, which are on the decline due to climate change (Hamann, A. & Wang, T. 2006). Western redcedars are shade tolerant and can grow in the early successional stages following disturbance (Antos, J. *et al*. 2016). Western redcedars also tend to grow slower than other tree species because of their tolerance to stress (Antos, J. *et al*. 2016). Due to their ability to handle stress, they grow slower because they invest more resources into dealing with the stress (Antos, J. *et al*. 2016). Because western redcedars are shade tolerant, we recommend planting them initially along with other coniferous and deciduous trees as well as shrubs. Peter Stickney observed the succession of a western redcedar forest following a wildfire (1986). He observed shrubs coming back first followed by deciduous and coniferous trees like willow and douglas-fir (Stickney, P. 1986). He found that after 25-30 years, the other trees that had sprung up initially started to thin out, leaving space for the western redcedars to fill their spaces (Stickney, P. 1986). The forest in the Chrystal Creek Watershed will likely follow a similar path over the next 25-30 years. If we plant a variety of coniferous trees, deciduous trees, and shrubs along with the western redcedars, there is a chance that over time we will see the forest going through successional stages, eventually leading to a mature western redcedar forest.

We are using the TEM for the site to determine the types of plants that will thrive in this environment. Since large trees like western redcedars are slow-growing, we are shifting some of the focus on planting other plants that are a good fit for this site. We are doing this to help speed up the recovery of the degraded site, so it can become a functional ecosystem faster. By planting fast-growing trees and shrubs in addition to western redcedars, we can help to jumpstart

succession and create habitat for animals while the cedars grow and eventually become a key species in the ecosystem.

3.3 Climate considerations

This project aims to establish a western redcedar forest, which is particularly important because of the impact climate change has had on western redcedars (Hamann, A. & Wang, T. 2006). Western redcedars in this area are limited by precipitation, so if an area does not get enough rain, the cedars will not be able to grow there (Seebacher, T. 2007). This is concerning for Galiano Island and the entire region because with climate change, we are seeing hotter, drier summers (Hamann, A. & Wang, T. 2006). According to the Climate Atlas of Canada projections, the temperature in this region will increase by 1.4°C from 2021-2050 under a low emissions scenario and 1.7°C from 2021-2050, with worsening increases from 2051-2080, under a high emissions scenario (2021). With increased temperatures, drought is more likely to occur in the region (Climate Atlas of Canada 2021). There were major shifts in the range of western redcedars long ago, and it is believed that this is due to climate change (Seebacher, T. 2007). Although western redcedars prefer a moist environment, we have suggested a variety of plants that can tolerate drier conditions as well as the current moist site conditions. If there is a drastic change in moisture and precipitation at the site, it may no longer support western redcedars, but there will be other species present that can tolerate less moisture, so there will still be a functional ecosystem. Since western redcedars are quite tolerant to stress, they will likely tolerate small changes to the amount of moisture (Antos, J. *et al*. 2016). Ideally, we hope to see the western redcedars thrive, but if climate change causes unfavorable conditions for the cedars, there will be other species on the site to take their place in the ecosystem.

3.4 Wetland flora and fauna

Another overarching goal of the project is to provide habitat for native species with the creation of more wetland habitat (EcoAction 2020-2022 Proposal). We aim to plant species that will attract beavers and Northern red-legged frogs. Both of these species play important roles in the ecosystem and have been designated as important components of the ecosystem in the Cedars for the Next Century restoration project.

Northern red-legged frogs require standing water to breed and prefer sites that have complexity in their microhabitat (Maxcy, K. 2004). They also spend a lot of time in forests, so having the forest close to the wetland is very important. The frogs depend on both aquatic and forested habitats to support their different life stages (Duncan, J. *et al*. 2018). Northern red-legged frogs spend a lot of time in wetland areas that are made up of sedges, grasses, rushes, and shrubs (Duncan, J. *et al*. 2018). They need this vegetation for their egg masses, as well as providing shade and shelter for their tadpoles (Duncan, J. *et al*. 2018). Although northern red-legged frogs will use permanent bodies of water, they prefer temporary seasonal wetlands, which we will have on this site (Duncan, J. *et al*. 2018). Seasonal wetlands offer protection from fish and offer warmer temperatures for the eggs (Duncan, J. *et al*. 2018). We want to create habitat for red-legged frogs because they are Blue Listed in British Columbia and designated as a species of *Special Concern* in Canada (Maxcy, K. 2004). Red-legged frogs are also an indicator species, so if they are found in the wetlands in the watershed, we know that the ecosystem is healthy and functioning.

We also want to create a habitat that will encourage beavers to inhabit the site and build dams there. Beavers are important to an ecosystem like this because they are ecosystem engineers and can help to create microtopography and small-scale disturbance on the site

(Boonstra, R. 2013). They create habitat for a variety of other animals and plants by opening up dense forests when they build their dams (Boonstra, R. 2013). Red alder, vine maple, and black cottonwood attract beavers, so we want to focus on planting those near the wetland sites to encourage beavers to use the area. Beavers can cause some destruction in an ecosystem, but overall, they tend to increase species richness (Law, A. *et al*. 2017). In a study that used beavers on land degraded by agriculture, they found that after 12 years, the presence of beavers led to a 46% increase in plant species richness and an increase of 148% in the cumulative number of species compared to the plots without beavers (Law, A. *et al*. 2017). Heterogeneity also increased by 71% (Law, A. *et al*. 2017). To combat the potential indiscriminate browsing by beavers, as well as deer browsing, we will be caging the young plants that will be planted across the site. By preventing herbivory on the younger plants, they will be able to grow and be uncaged when they are more mature, and the ecosystem can handle some browsing pressure.

3.5 Designing a caging and exclosure plan

The west branch of the Chrystal Creek Watershed contains four separate ecological communities under the CDFmm designation (Green, R. and Kinka, K. 1994 1994). Only two of those ecological communities, CDFmm-01 and CDFmm-14, will be decompacted (Huggins, A. 2021B). Because of this, all four ecological communities will experience different changes to their hydrology and species composition and are all good candidates for exclosure plots, observation, and monitoring. By installing planted and unplanted exclosure plots, as well as similarly sized, unexclosed plots, we can compare the impact of planting and how deer herbivory affects regeneration.

4.0 Recommendations

4.1 Planting plan

We suggest planting approximately 250 plants, as determined by the overall planting estimate of the Cedars for the Next Century project and our budget, consisting of shrubs and trees across the west branch of the Chrystal Creek Watershed. The planting should be focused on the areas that will be decompacted, as well as the lower sites of the watershed where the wetlands will occur. Table 2 outlines our suggestions for plants for each of the ecological communities. We used TEM as a guideline to select plants that should be found in the conditions present on the restoration site. We also selected plants that would prevent erosion, fix nitrogen, and provide habitat for native species. To be included as a planting suggestion, the species would ideally have one or more qualities that would assist in the restoration of the wetland.

We hope that new plants will establish on their own from seeds of the plants that are already on the site. Some areas of the site already have a well-established shrub and herb layer of native species, which should be left on the restoration site. In areas that already have a lot of native shrubs and groundcover growing, it is not necessary to plant other native plants in that area.

Table 2. Plant recommendations for the west branch of the Chrystal Creek Watershed.

Latin Name	Erosion control	Shade	Fast Growing	Drought tolerar	Beaver attractant	Biodiversity Value	Cultural Value
Thuja Plicata						Yes	Yes
Alnus Arbra	Yes	Yes	Yes		Yes		
Acer circinteum				Yes	Yes	Yes	
Populus balsamifera			Yes	Moderate	Yes	Yes	
Malus fusca	Yes					Yes	Yes
Cornus nuttallii	Yes			Yes		Yes	
Rubes spectablis	Yes	Yes	Yes	Yes		Yes	Yes
Sambucus racemosa	Yes					Yes	Yes
Oemleria cerasiformis			Yes	Yes		Yes	Yes
Rosa nutkana	Yes	Yes	Yes	Yes			
Rosa gymnocarpa	Yes					Yes	
Cornus stolonifera	Yes	Yes	Yes	Yes		Yes	
Carex obnupta	Yes		Yes				
Lysichiton americanum						Yes	
Physocarpus capitatus	Yes	Yes				Yes	
Symphoricarpos Albus	Yes			Moderate		Yes	
Mahonia nerbosa						Yes	

4.2 Exclosure plan and deer herbivory

One of the overarching goals of this project was to establish a caging and exclosure plot plan for the west branch of Chrystal Creek. To think of the long-term trends for the site, we need to ask questions like what will this site look like years from now? Plant cages can be removed once they reach a certain height (typically >2m) or are deemed low risk for deer browsing pressure. These cages can then be reallocated to different restoration projects within the site. Our specific exclosure recommendations for each community are as follows:

CDFmm -01: add 2 10 by 10 exclosure plots, one planted, one unplanted, where natural regeneration will occur (control plot). Mark another 10 by 10 control plot that will not be enclosed or be planted.

CDFmm-06: add 2 10 by 10 exclosure plots, one planted, one unplanted, where natural regeneration will occur (control plot). Mark another 10 by 10 control plot that will not be enclosed or be planted.

CDFmm-12: already one exclosure plot present. Add a second exclosure plot and a 10 by 10 control plot that will not be enclosed or be planted.

CDFmm-14: add 2 10 by 10 exclosure plots, one planted, one unplanted, where natural regeneration will occur (control plot). Mark another 10 by 10 control plot that will not be enclosed or be planted.

In total, 7 new 10 by 10 exclosure plots will be added to the west branch of the Chrystal Creek Watershed. 280 meters of fencing will be needed to create the exclosure plots (10x10 exclosure = 40m, 40x7=280m), with a cost of $2100 (see budget table).

If there is not enough time or labor available to erect all 7 exclosures, we suggest focusing on placing exclosures in CDFmm-01 and CDFmm-14, as they are the areas that will be subject to decompaction and subsequent planting in Fall 2021, and will most likely see the most change in plant growth and diversity over the next few years.

We estimate that each planted exclosure (3 total) can be planted with around 20 plants, meaning that 60 total plants will be protected by the exclosures. The other 190 plants will need to be protected with plant cages.

4.3 Management and monitoring

Management and monitoring of site restoration activities will be conducted by staff from the GCA, which is outlined in the project description of Proposed Changes in and Around a Seasonal Creek at the Millard Learning Centre. (Huggins, A. 2021B).

5.0 Conclusion

The goal of our project is to design a plant list and suggestions for caging and exclosure plots for the restoration that will occur in the west branch of the Chrystal Creek watershed. We selected plants that are a good fit for the site as well as plants that are usually associated with western redcedars. We hope that in the future, the site will become primarily cedar forest and seasonal wetland habitat, but with climate change, it is possible that the site conditions and outcomes could change. If this is the case, the variety of plants we suggested will ensure there is still a functioning ecosystem. The restoration of the west branch of the Chrystal Creek watershed is the first step in the overarching Cedars for the Next Century restoration project that will restore the entire Chrystal Creek Watershed over the next several years.

6.0 Acknowledgements

During the field school on Galiano Island, we learned on the unceded territories of the Penelakut First Nation and Hul'qumi'num speaking peoples (GCA, n.d.). We want to acknowledge the privilege we have to be able to learn on these lands. We want to acknowledge how thankful we were to take part in this experience and to share knowledge from many wonderful members of the community and the insights from our guest lecturers, especially Dr. Jeanine Rhemtulla. We would like to thank the Teel sisters for providing the fuel we needed to

continue our fieldwork but also want to thank them for the kindness and hospitality they showed us throughout our stay on Galiano Island. Restoration Coordinator Adam Huggins and the staff at the GCA were very helpful in providing support with resources for our project and site tours. This provided a critically important learned experience that helped us complete this project. We would like to thank our professor Dr. Eric Higgs and our teaching assistant Alina Fisher for their incredible support before, during, and after this field course. We would like to thank them for making this course happen, especially during a period of uncertainty given the Covid-19 pandemic. The course was a unique learning experience that we couldn't have done without them. Thank you to everyone!

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