ES 471/ ER 412 - Advanced Principles and Practice in Ecological Restoration

Chrystal Cove Restoration Assessment Galiano Island, BC

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Table of Contents

1 Introduction 3

2 Coastal Douglas-fir (CDF) and Restoration 3

3 Chrystal Cove Restoration Plan 5

4 Goals and Objectives for the Chrystal Cove Restoration Assessment 6

5 Methodology 6
- 5.1 Vigor 7
- 5.2 Herbivory 7
- 5.3 Height 8

6 Chrystal Cove Restoration Assessment Results 8
- 6.1 Plant Vitality Assessment 8
- 6.2 Invasive Species Assessment 11

7 Monitoring and Maintenance Program 12
- 7.1 Monitoring through Invasive Species Mapping 13
- 7.2 Monitoring through Plant Vitality Assessments 13
- 7.3 Monitoring through Photographs 14
- 7.4 Maintenance Required for Chrystal Cove Restoration 17
  - 7.4.1 Polygon 3 17
  - 7.4.2 Polygon 5 and Polygon 6 17
  - 7.4.3 Polygon 7 17
  - 7.4.4 Polygon 8 18
  - 7.4.5 Polygon 10 18
  - 7.4.6 Polygon 11 18

8 Conclusion 18

9 References 20

1 Introduction

Chrystal Cove is located on the Millard Learning Centre property on the west side of Galiano Island within one of the last remaining stands of old growth Coastal Douglas-fir forests. The Coastal Douglas-fir (CDF) biogeoclimatic zone is limited to low elevations along southeastern Vancouver Island, the Gulf Islands south of Cortes Island, and a narrow strip along the Sunshine Coast (Coastal Douglas Fir, 2013). A restoration plan for Chrystal Cove was completed by a previous University of Victoria student, Alexander Campbell in 2015 (Campbell, 2015). The restoration resulting from the plan he created was subsequently completed in the spring of 2016 and involved invasive species removal and native tree and shrub planting.

2 Coastal Douglas-fir (CDF) and Restoration

The Coastal Douglas-fir (CDF) is located within the rainshadow of Vancouver Island and Washington's Olympic Mountains. Rainstorms that approach from the west hit these mountains and release a lot of their moisture. The summers in this zone are warm and dry, and the winters are mild and wet. This climate creates a distinctive set of conditions which allow a diverse group of plants and animals to live (Coastal Douglas Fir, 2013). About 100 species of plants are found in CDF ecosystems. The species that dominate this ecosystem include trees such as Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), grand fir (*Abies grandis*), Garry oak (*Quercus garryana*), and Arbutus (*Arbutus menziesii*); shrubs include salal (*Gaultheria shallon*), dull oregon grape (*Mahonia nervosa*), and oceanspray (*Holodiscus discolor*); lastly some herbaceous plants include twinflower (*Linnaea borealis*), bracken fern (*Pteridium aquilinum*), and vanilla leaf (*Achlys triphylla*) (Holt, 2001). All of the above species are indicators of CDF environments. These are also key species for restoration initiatives in these zones. Figure 1 below indicates the biogeoclimatic zones of British Columbia, the Coastal Douglas-fir zone is indicated in yellow. As shown in the figure, the CDF makes up a very small portion of BC's ecosystems, and is therefore a critical ecosystem for protection, conservation, and restoration.

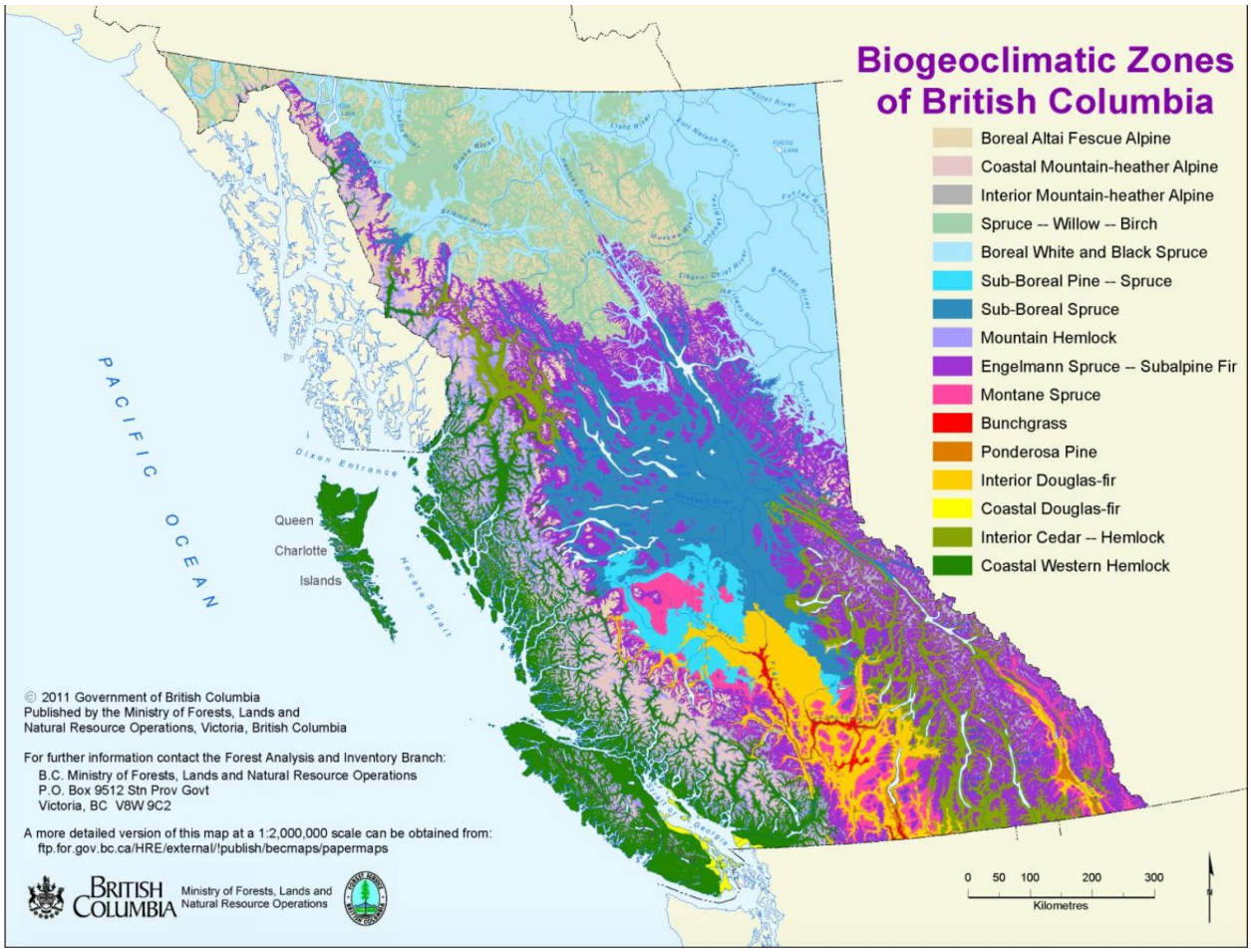

Figure 1: Biogeoclimatic zones of British Columbia (Biogeoclimatic Zones of British Columbia, 2018).

This area has been impacted by current and historical disturbances which have involved logging, agriculture, and human development. The results of these disturbances have caused almost a complete loss of old growth forest. Therefore the preservation of existing small areas of old growth forest combined with protection and enhancement from surrounding second growth stands is the highest priority for conservation and restoration of the CDF ecosystem (Holt, 2001). In order to ensure CDF ecosystems survive, corridors between isolated protected areas need to be established to allow plants and animals found in these ecosystems to move between CDF "islands" (Holt, 2001). The Chrystal Cove restoration project is an excellent opportunity to connect CDF ecosystems together.

3 Chrystal Cove Restoration Plan

Alexander Campbell created a restoration plan for Chrystal Cove, in which the initial goal for the project was to extend the health of the surrounding old growth Coastal Douglas-fir ecosystem and to assist the recovery of this CDF ecosystem back to its historical trajectory (Campbell, 2015) He identified and assessed 12 different polygons all requiring different levels of restoration or monitoring. The major restoration tasks for his project were carried out in the spring of 2016 and included invasive species removal and native tree and shrub planting in polygons identified in his restoration plan. For the restoration assessment completed by Ellie Fox and Brittany Claeys, polygons 3, 5, 6, 7, 8, 10, and 11 were the focus because they were the polygons that received native plantings and invasive species removal. Figure 2 below shows all of the polygons he identified. His report can be referenced for detailed descriptions on the polygons and restoration plan.

Figure 2: Restoration polygons identified for Chrystal Cove (Campbell, 2015).

4 Goals and Objectives for the Chrystal Cove Restoration Assessment

Goal:

To assess the success of the restoration completed at Chrystal Cove on the Millard Learning Centre property.

Objectives:

1. Locate and assess the health and condition of native species that were planted within polygons 3, 5, 6, 7, 8, 10, 11.
2. Assess the presence of invasive species within polygons 3, 5, 6, 7, 8, 10, 11 that are affecting the native tree and shrub plantings.
3. From the assessment completed, provide recommendations for maintenance and future monitoring of the restoration.

5 Methodology

The methodology used to assess the relative health of trees and shrubs planted at Chrystal Cove was taken from the same method used to determine the relative vitality of the trees and shrubs planted at the mill site. The methodology was established to determine the survival rate of the planted trees and shrubs, as well as to keep track of the success of restoration currently and into the future. The plantings were assessed on vigour, herbivory, and height.

5.1 Vigor

Vigor was assessed on a scale from 0-5. Table 1 below indicates what each rating indicates in terms of plant health and survival.

Table 1: Vigor rating scale.

Rating	Explanation
0 - Dead	No new growth, no buds alive
1 - Very Poor	Dieback on leader and branches, poor condition and color of leaves
2 - Poor	Significant dieback is observed in branching and/or leader, obvious discoloration, new growth is poor
3 - Medium	Some dieback in branches or leader is evident, discoloration is observed, but new growth is observed
4 - Healthy	Plants looks generally healthy with some new growth but not vigorous, dieback may be observed but is minimal, minor discoloration possible
5 - Very Healthy	Robust, new growth, no dieback, no discoloration in new growth

5.2 Herbivory

Herbivory was assessed on a scale of 1-3. Table 2 below outlines the explanation for each rating.

Table 2: Herbivory rating scale.

Rating	Explanation
1	No herbivory observed
2	Some herbivory observed, but minor
3	Major herbivory observed - may threaten survival

5.3 Height

Height was based on a rating of 1-5. Table 3 below outlines the rating based on a range of heights.

Table 3: Height rating scale.

Rating	Explanation
1	0 to 0.3 m
2	0.3 to 0.6 m
3	0.6 to 1.0 m
4	1 to 2 m
5	2 to 10 m

6 Chrystal Cove Restoration Assessment Results

In order to assess the Chrystal Cove restoration completed in 2016, two processes needed to be assessed. The first being the plant vitality of all of the native trees and shrubs that were planted to assist with succession within this CDF ecosystem, and the second being the assessment of invasive species present within the restoration area, specifically in areas surrounding the native plantings. The results of the plant vitality assessment and invasive species assessment are outlined below.

6.1 Plant Vitality Assessment

Native trees and shrubs that were planted during the 2016 restoration were located and assessed for relative health, browsing threat, and height. Plantings were found and assessed in polygons 3, 5, 6, 7, 8, 10, and 11. Figure 3 below indicates the percentage of plantings that were identified with each plant vigour rating from 0-5 as described in the methodology portion of this report.

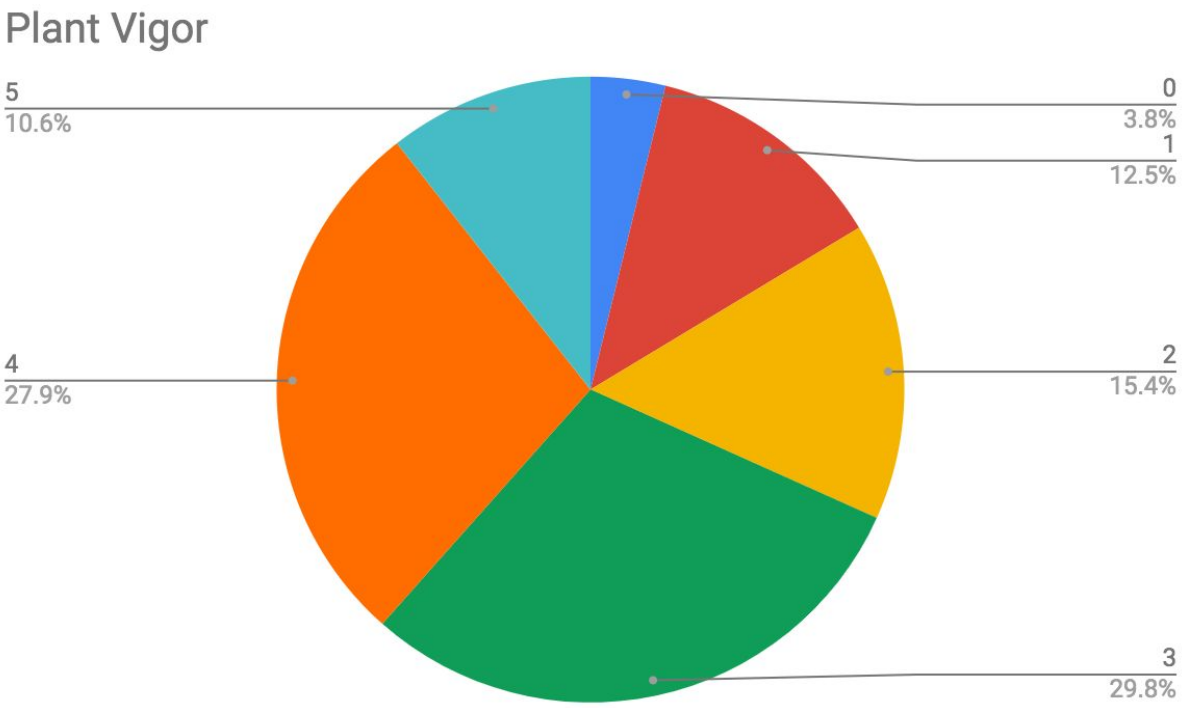

Figure 3: Percentage of plantings within each plant vigour rating (0-5).

In total the vitality of 110 plants and shrubs within polygons 3, 5, 6, 7, 8, 10, and 11 were assessed. Of those assessed, 10.6% or roughly 11 individual plants had a vigor rating of 5 (very healthy). They were robust, showed new growth, no dieback and no discolouration in new growth. 27.9% or about 30 of the plants assessed had a vigor rating of 4 (healthy). These plants looked generally healthy with some new growth, but not vigorous. Dieback may have been observed but it was minimal and some minor discolouration may have been present. 29.8% or 32 individual plants had a vigor rating of 3 (medium). On these plants some dieback in branches were evident and some discolouration was observed, but there was new growth also observed. 15.4% or 16 of the plants assessed fell into the vigor category of 2 (poor). There was significant dieback observed in the branching and/or leader, as well as obvious discolouration. 12.5% or 13 of the plants assessed had a vigor rating of 1 (very poor). These plants had significant dieback on leader and branches as well as poor condition and colour of leaves. Lastly, 3.8% or roughly 4 of the plants assessed had a vigour

rating of 0 (dead). These plantings were dead, and there was no indication that they would come back.

Just over 70% of the plants or approximately 77 individual plantings observed had a vigor rating of above 2, meaning they were in medium to very good health. Fortunately only about 4%, or 4 of the plants planted in the 2016 restoration did not survive. Approximately 30%, or about 33 plantings had a vigor rating of poor or very poor but have potential to survive with some human intervention.

The chart in Figure 4 below displays the species of trees and shrubs that were evaluated in the plant vitality assessment. Pacific ninebark made up 13.5% or roughly 14 plants of the 110 species assessed, red-flowering currant made up 12.6% or about 13 plantings and oceanspray made up about 9.9% or 10 plants, these were the most common species planted. There were 18 different species of trees and shrubs identified. 8.1% or approximately 8 plants of the species assessed were not able to be found or identified in the cages. Therefore within the chart N/A refers to those.

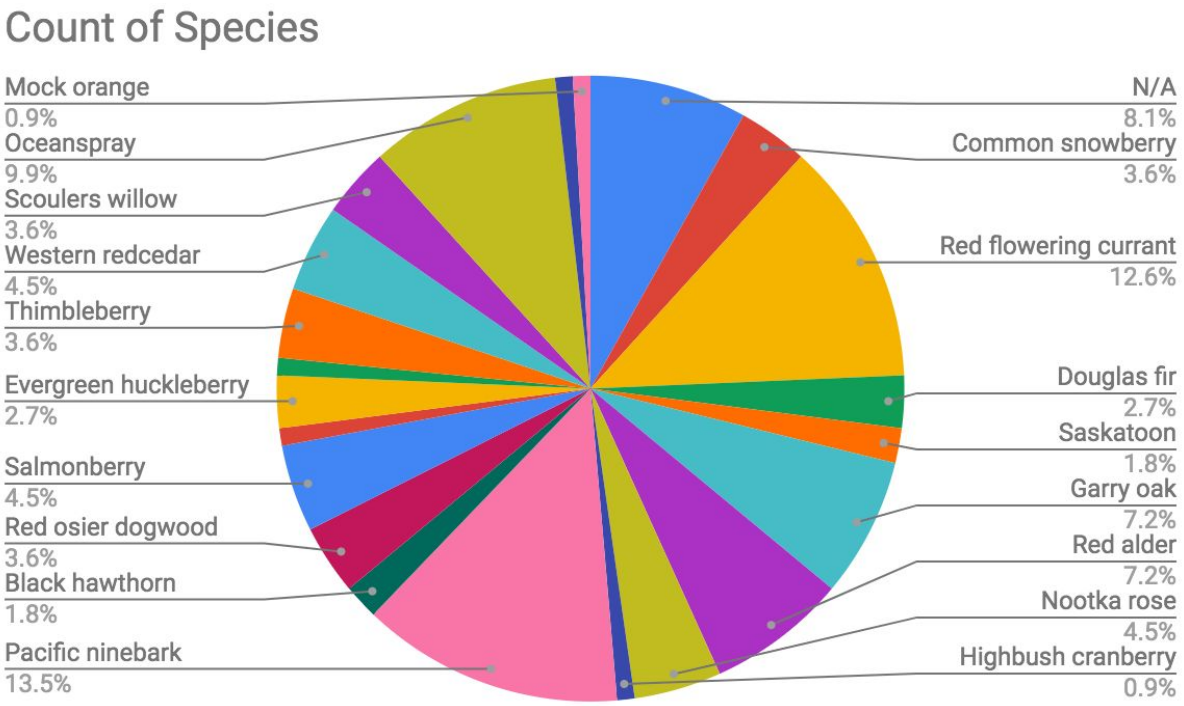

Figure 4: Percentage of tree and shrub species that were used for restoration with the polygons assessed.

6.2 Invasive Species Assessment

The invasive species assessment mainly focused on invasives that were affecting the native tree and shrub plantings in polygons 3, 5, 6, 7, 8, 10, and 11. Due to limited time to complete the invasive species assessment not all patches were mapped or recorded, we simply observed the invasive species growing within or around the cages of native tree and shrub plantings, and assessed how they may be affecting the health and growth of these native plantings. The following paragraphs describe the invasive species within each polygon that are currently affecting the growth of native plantings, or which may have negative effects on the plantings in the future.

In Polygon 3, located along the north side of the trail, the common snowberry plant was in poor health and has been overtaken by other species. The red-flowering currant plantings were generally in good health, however there is a potential that the invasive blackberry bushes will pose a threat in the future. There is also presence of foxglove and bull thistle which are currently growing inside a red-flowering currant cage and threatening its health.

In Polygon 7 there are two Douglas-fir plantings which are in good health besides the presence of periwinkle which could be a threat in the future. A Garry oak located in this polygon has been taken over by other vegetation and is in very poor health. The red-flowering currant seedlings in this polygon seem to be in good health besides some minor Scotch broom present in one cage and Himalayan blackberry growing nearby.

In Polygon 8, there are two red alders which are being threatened by heavy grazing and has resulted in one of the trees having its top half snapped off and both fences to be bent, causing tension on the trees. The Nootka rose present in this polygon has some foxglove and stinging nettle nearby, however it is not in urgent need of action as it still has a vigor rating of 4.

In Polygon 10, approximately 50% of the Pacific ninebark planted is healthy and the other 50% is in poor condition and is being heavily threatened by periwinkle. Periwinkle is also threatening the health of other plants in this polygon including the Nootka rose, Garry oak, red osier dogwood, red alder, salmonberry, and dull oregon grape. Himalayan blackberry

and evergreen blackberry patches are also posing a threat to the health of the salmonberry, Nootka rose and Pacific ninebark plantings.

In Polygon 11, the Garry oaks and evergreen huckleberry are in very poor condition. The thick patch of periwinkle is threatening the integrity of these these plants. During the restoration which took place in 2016, linoleum was laid over the periwinkle in an effort to prevent the spread of growth. Overall, this is effective in helping the health of two Garry oaks planted but should possibly be monitored more frequently to make changes to the linoleum.

Polygon 6 contains a large portion of bull thistle and Canada thistle. These invasives affected the vigor of thimbleberry, red alder, Pacific ninebark, Scouler's willow, oceanspray, red osier dogwood and salmonberry. The thistle has overgrown this polygon to the extent that we were unable to identify the plant species in two of the cages. Various species of non-native grasses were present in this polygon and are also posing a threat to the native plantings.

Bull thistle and Canada thistle continue to be a posing threat to the native plants in Polygon 5, especially threatening the common snowberry, bigleaf maple, western redcedar, salmonberry, red-flowering currant, oceanspray, and red alder. In addition, Scotch broom is also a prominent invasive in this polygon and is threatening the health of the Douglas-fir, oceanspray, and red alder. The Scotch broom has taken over some cages to the extent that we were unable to identify the native species within somes cages.

7 Monitoring and Maintenance Program

Recording the health and survival of plantings as well as the patch size and occurences of invasive species will assist with tracking the success of the Chrystal Cove restoration. Many of the natural processes occurring on the restoration site proceed slowly and may not be immediately recognizable (Quick Guide to Restoration, 2018). The data gathered will help understand what successional changes are occuring on the site and can help understand how or when to adapt the management approach so that it is effective and long-term.

7.1 Monitoring through Invasive Species Mapping

Invasive species have a huge impact on the success of restoration. They compete for light, nutrients, and space with native species. The presence of invasive species within the restoration polygons, specifically the ones that were assessed in this assessment (3, 5, 6, 7, 8, 10, 11), indicate that the invasive species are threatening the health of the native tree and shrub plantings. Although the invasive species were not mapped for this assessment, it would be good protocol to map both individual occurrences and patches of invasive species throughout the entire Chrystal Cove restoration area. It will be a large undertaking due to the extent of invasive species but will be critical for monitoring the success of this restoration project and understanding the role of invasive species within this endangered CDF and Garry oak ecosystem.

7.2 Monitoring through Plant Vitality Assessments

The Chrystal Cove restoration completed in 2016 requires ongoing monitoring to assess the health of the plants, this can be completed by performing plant vitality assessments on each individual planting. In order to remain consistent, these assessments should use the same method outlined under the methodology section of this report. This restoration undertaken at Chrystal Cove consists of straightforward objectives and established methods which makes routine evaluation an appropriate method for restoration monitoring. The plant vitality assessments consist of rapid data collection and can be completed using qualitative methods to compare one or a few response variables before and after potential treatments that are undertaken, such as invasive species removal surrounding and within the native planting cages. It may also be useful to either label or number the cages in order to ensure that all native tree and shrub plantings are located and assessed in future monitoring endeavours.

7.3 Monitoring through Photographs

Photographs have been known to be able to tell a story without using any words. When the restoration was completed in 2016, two photo point locations were taken for future monitoring. Photo Point 1 was taken along Cove Creek after restoration planting in 2016. Photo Point 2 was taken at the periwinkle treatment area where the periwinkle was treated with linoleum. The exact GPS locations of the photographs were not able to be determined for this specific assessment, but approximate photo point locations were used. Photographs are able to pick up long-term changes that monitoring through data may miss. Photos 1 and 3 were taken in 2016, and Photos 2 and 4, were taken during the assessment on August 27, 2018.

Photo 1: Photo Point 1 - Cove Creek after planting April 2016.

Photo 2: Photo Point 1 - Cove Creek during restoration assessment in August 2018.

Photo 3: Photo Point 2 - Periwinkle site after treatment - 2016.

Photo 4: Photo Point 2 - Periwinkle site during restoration assessment in August 2018.

7.4 Maintenance Required for Chrystal Cove Restoration

This restoration assessment completed has resulted in some recommendations for maintenance of the native tree and shrub plantings in order to ensure their future health and success. Approximately 70%, or 77 plantings identified during this assessment were in medium to very good health, and the other 30% or 33 plantings assessed were in relatively poor health and had more issues with competition of invasive species and browsing concerns.

7.4.1 Polygon 3

Polygon 3 requires minimal maintenance, most of cages are clear of invasive species and browsing. Some small patches and individuals of invasive species such as foxglove and bull thistle could be removed, but are not of priority at this time. Perhaps some more attentive gardening such as watering and nutrient cycling could assist with the progression of growth of these plantings in these early years of growth.

7.4.2 Polygon 5 and Polygon 6

Polygon 5 and polygon 6 are adjacent to each other. Polygon 5 has a large invasion of Canada thistle on the south side of the polygon and some native plantings and cages were difficult to even locate. This patch of thistle is a priority for maintenance. Polygon 6 also has Canada thistle issues, and the same patch of thistle from polygon 5 will likely further spread into polygon 6 in the coming years. Yellow flag-iris was also found within polygon 6 and should be removed. Scotch broom is also an issue. Specifically on the north side of polygon 5, it as found within many of the cages and needs to be removed, especially from the cages.

7.4.3 Polygon 7

Polygon 7 requires minimal maintenance at this time, although the Scotch broom located within some cages should be removed to allow the native plantings more room to grow, and reduce the competition for water and nutrients with other plants. Ongoing monitoring of the periwinkle and Himalayan blackberry should occur to assess the threat to the native

trees and shrubs. More attention should be given to the western redcedar planting to ensure its success into the future.

7.4.4 Polygon 8

There were two large red alder trees that have been heavily browsed, and their cages have been damaged. These cages should be switched and perhaps taller cages should be installed to help protect these trees until they become large enough to withstand the browsing pressures of this area.

7.4.5 Polygon 10

The periwinkle, Canada thistle, and both evergreen and Himalayan blackberry should be further assessed for their threat on the native plantings, likely some removal of these invasive species should occur.

7.4.6 Polygon 11

The presence of periwinkle within this polygon is a known ongoing issue. The periwinkle covers a large portion of this polygon, including along the steep rock faces. The linoleum used to treat the periwinkle in 2016 has been effective in a localized area , but the periwinkle continues to spread, suffocating the Garry oak trees planted within this polygon. At a minimum, the periwinkle patches should be cleared away from within and around the cages on a continuing basis, to allow the Garry oak trees a chance to grow into trees that will restore the canopy cover to this area.

8 Conclusion

This Chrystal Cove Restoration assessment provided some important information about the vitality of the native trees and shrubs planted in 2016, as well as the movement and spread of invasive species within the polygons assessed. The biggest concerns, and easiest way to maintain these plantings would be to focus maintenance in areas directly within and around the cages. If the native trees and shrubs have more room to grow, and have less pressure from browsing and competition from invasive species, they should have an easier time growing successfully and hopefully switch from a vitality rating of poor to a vitality rating of very healthy. Of the 110 plantings assessed, about 77 individuals are in relatively

good health, and 33 are in need of some immediate attention to ensure that this restoration can continue moving forward to accomplish the original restoration goal of allowing this disturbed CDF ecosystem to carry on back toward its traditional trajectory.

9 References

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