# Ecological Novelty on a Hot and Dry Slope at the Millard Learning Centre, Galiano Island


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ES 471 / ER412: Galiano Field Course

A01

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July 2026

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## 1.0 Summary:

In this report we explore the role of ecological novelty at a dry southern exposed slope at the Millard Learning Centre, which is owned and operated by the Galiano Conservancy Association. We describe ecological novelty, a relatively new conceptual framework that address rapid ecological changes and then describe our site in terms of novelty. Our focus is to explore why ecological novelty may be manifesting in the context of the site and explore the viability of proposed restoration efforts.

After identifying our "zones" of focus (Figures 4 and 5), we explore our methods which include a literature review, vegetation analysis, field observations and assessment, and a climatic projection future suitability assessment. Data is a major aspect of our report and details of survival rates and future viability are extensively explored in our findings, specifically we focus on the health outcomes for western red cedar and its associated species assemblage, as this is a main focus in the development in the *Cedars for the Next Century* project as a leading restoration effort which led to the development of our report. Finally, we will discuss potential trajectories of the site in consideration of novel conditions.

## 2.0 Territorial Acknowledgement:

We acknowledge with respect the Lekwungen peoples on whose traditional territory the University of Victoria stands, and the Songhees and Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day. (University of Victoria) As well as being the traditional unceded territories we live, work and reside.

We acknowledge with respect the Hul'qumi'num-speaking peoples, SENĆOTEN speaking peoples, Coast Salish Nations, Penelukut First Nation and Straits Salish Nations whose relationships to these lands and waterways have been maintained and unceded since time immemorial. Galiano Island and Sqthaqa'lh (Active Pass) played a role in many nations' safe passage throughout time in the Salish Sea, and this continues.

We acknowledge with respect the sanctity of this connection between the land and the sea, the role it plays on Galiano Island where we pursued our work on the field for this project and its role in connecting the Galiano Conservancy Association and The School of Environmental Studies.

## 3.0 Introduction:

Traditionally, ecological restoration aims to recover historical "reference" ecosystems, but climate change, altered hydrology, invasive species, and historical land use are producing conditions that no longer resemble historic conditions (Higgs 2017). Ecological novelty describes the process of an ecosystem being fundamentally changed from its historic conditions in an assemblage that is unlike anything we have seen before: ecosystems that have no analogue. Therefore, the state of novelty invites us to make choices on which future trajectories we should support. Novel ecosystems are those where the ecological conditions— processes and composition-- are so fundamentally changed that there is no practical possibility of recovery to an historic reference condition. Hybrid ecosystems are those where restoration to something resembling a historical condition is still possible although novel elements have significantly altered composition and/or processes (Hobbs et al. 2013). Many ecosystems around the globe are now experiencing some degree of ecological novelty— not necessarily becoming a novel ecosystem but accumulating novel environmental conditions (Kerr et al. 2025). Along with ecological novelty, an increased prevalence in climate extremes also causes several nuanced issues that can create ecologically novel conditions. Extreme climate events such as atmospheric rivers, drought, and novel heat conditions can all contribute to a "step change" in an ecosystem, where novel conditions are suddenly present where they weren't previously. Climate change is a big perpetrator in the continuation of increasing ecologically novel conditions, more uncertainty will create more novel conditions. Restoration becomes less about recreating the past and more about deciding which ecological trajectories should be supported, especially in a world of increasing climate instability.

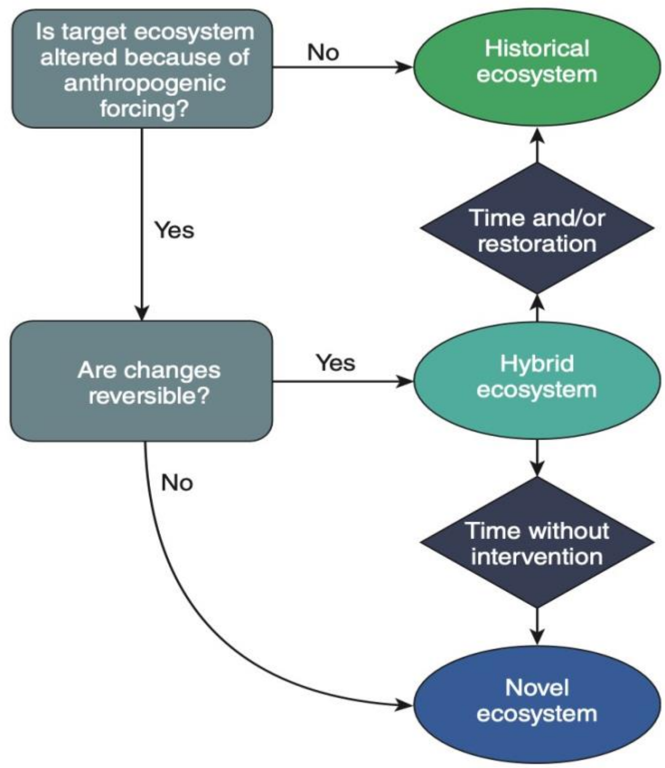



Figure 1: (Hobbs et al. 2013., This flow chart describes the difference between a historical and a novel ecosystem, and the relationships between the states and how it can change over time.)

## 4.0 Goals and Objectives

Our goal in this report is to discuss ecological novelty in the context of the south-western facing slope within the east branch of the Chrystal Creek watershed at the Millard Learning Centre. We will be looking over data provided and gathered by the Galiano Conservancy Association regarding the distribution of species planted in our dedicated “zones” (Figures 4 and 5) to assess the probability of success within the changed landscape in the aftermath of the ambitious project of the *Cedars for the next Century* restoration project (Galiano Conservancy, Wong 2023).

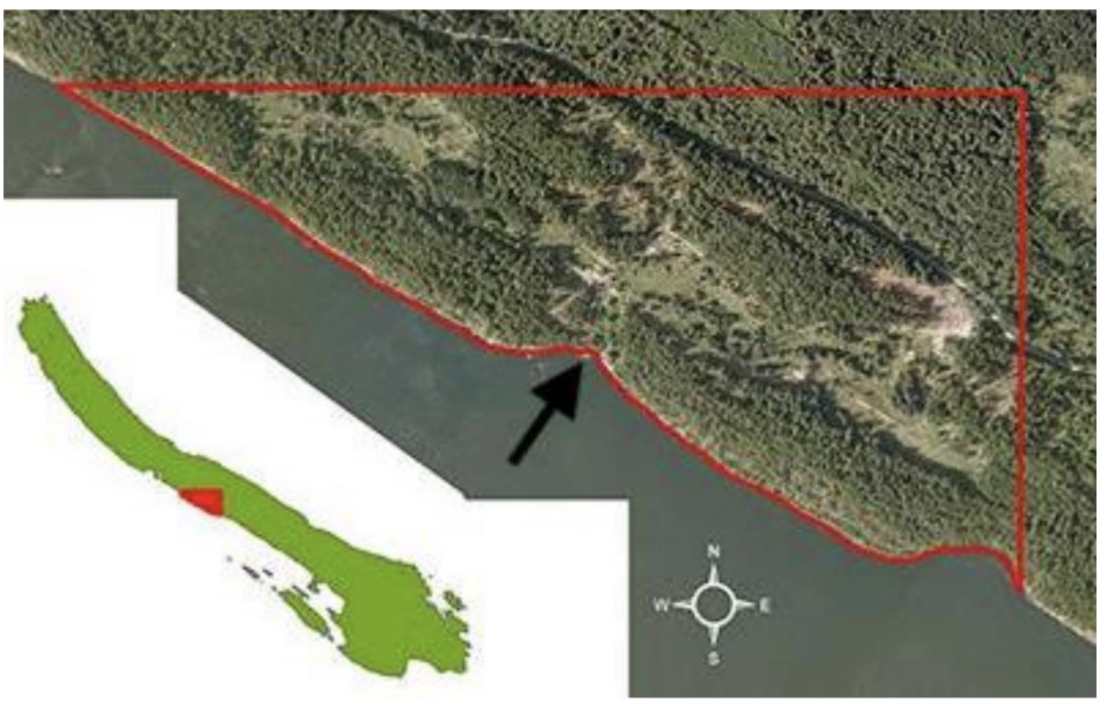
Our objective is to provide the conservancy with helpful and relevant data analysis informed by our understanding of ecological novelty, historical reference ecosystems and our fieldwork assessments gathered within our time at the conservancy (Figure 2). Since we arrived on the site after the completion of the *Cedars for the Next Century* project, we hope to help inform future directions on the site. By utilizing the site as an example of trajectories towards either ecological novelty, a historic baseline, or a hybrid ecosystem, we will attempt to provide the conservancy with both ‘future focused’ direction and historicity informed context to help inform future decisions on the site location and maybe inform some next steps in a rapidly changing climate with consideration of extreme climate events.

In our data assessment we will involve localized climate predictive modelling and have this inform both the potential directions of restoration efforts, and have this inform the likelihood of success, and viability in the ultimate goal of the *Cedars for the Next Century* towards the planned trajectory of a historical baseline, cedar wetland ecosystem.

## 5.0 Site Description

### *5.1 Location: The Galiano Conservancy Association*

Founded in 1989 by Ken Millard and others, The Galiano Conservancy Association was created as a land trust by those concerned about clearcut logging on the island (Galiano, 2026). Today, the conservancy holds over 500 hectares across Galiano Island in the trust (Galiano, 2024). Projects like this one are part of a bigger motion towards the goals and objectives of both conservation and restoration in the GCA on the properties they hold. Our site is located on the GCA's main property (Figure 2), located beside the Millard Learning Centre, a "dry, sunny south-west slope within the East Branch of the Chrystal Creek Watershed" (Appendix A). This project is in alignment with the ambitious project, *Cedars for the next Century* (Figure 3) as an effort to reshape the physical landscape using "rough and loose" landscaping methods, primarily redirecting the flow of water,  in attempt to reconstruct a historical baseline in the area. The objective was to see if restoring to a cedar wetland reference ecosystem is possible in the Chrystal Creek Watershed (Galiano, n.d, Wong 2023).




(**Figure 2:** Location of The Galiano Conservancy Association, site of the Millard Learning Centre, and The Chrystal
Creek Watershed. *District lot 57* (Emma Borg and Emily Wharin (2022))

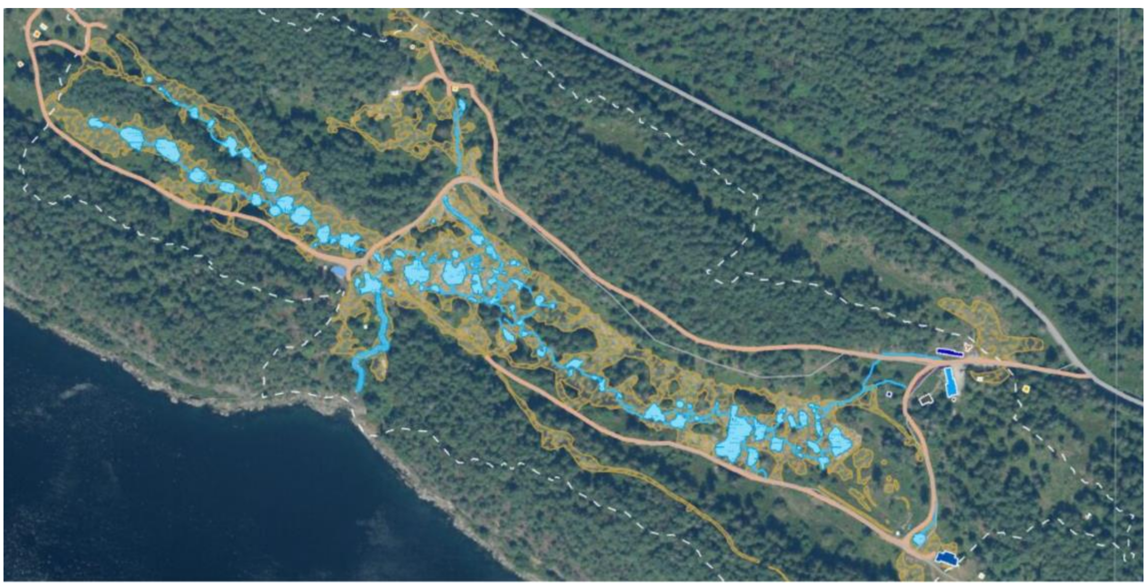
### *5.3 Site History/Historical Context:*

Before the purchase of the Conservancies land, the area was logged extensively, leaving most of the current status of forests within the area as a third growth forest where trees still stand.

Grazing and livestock soil compaction impacted the species assemblage and hydrology, as well as the creation and dependence of logging roads and site drainage. There were also about 100 years of agricultural practices on the property, predominantly where the wetland restoration project, *Cedars for the next Century* took place (Galiano Conservancy, Wong 2023).

This area within the watershed (Figure 3) went through an extensive restoration project broken into three stages over three years, reshaping the landscape using rough and loose techniques in the old agricultural area and the removal of an old ditch, of which there does not seem to be a clear record of how when or why it was created, but dramatically altered the hydrology of the site. Pre-restoration there was significant flooding and water runoff with little to no plant species retention or diversity throughout the year (Wong, 2023). It is suspected that an old wetland was drained for livestock which is why the wetland restoration project was put in place (*Personal Correspondence, 2026*). The final stage of this project finished recently, and we are covering what looks like the beginning of the next stage in restoration development.

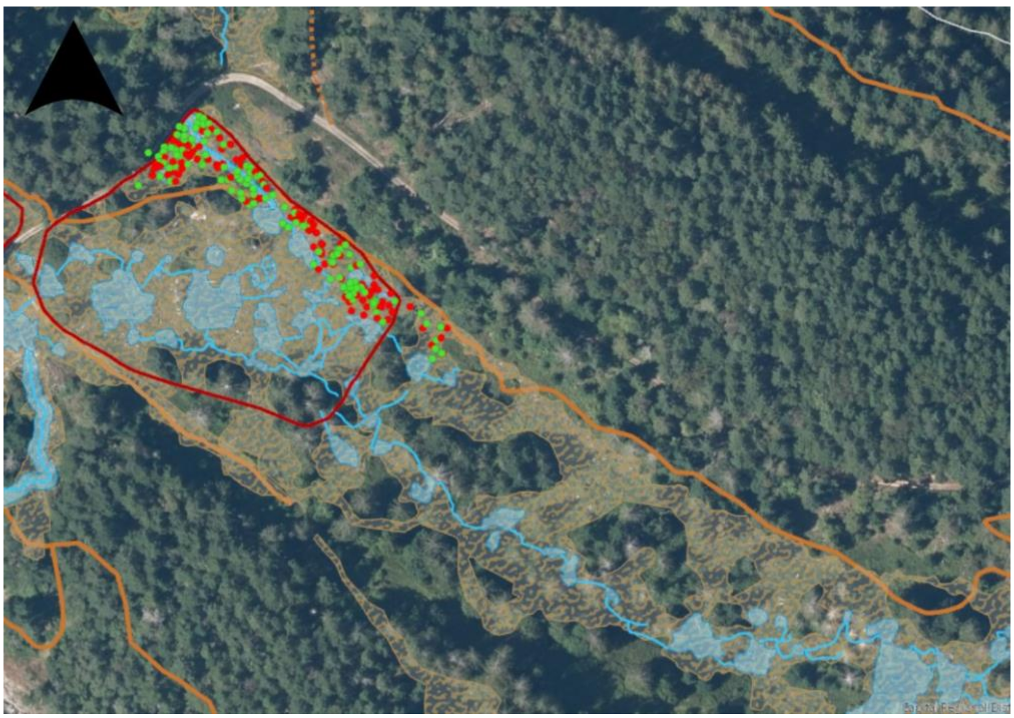
## *Galiano Conservancy, Millard Learning Centre*:



**(Figure 3:** "Brown is restored area, Blue is wetlands and streams, White dotted line is the watersheds boundary" Galiano Conservancy, (2026). (*Cedars for the Next Century, (Wong, 2023)*))

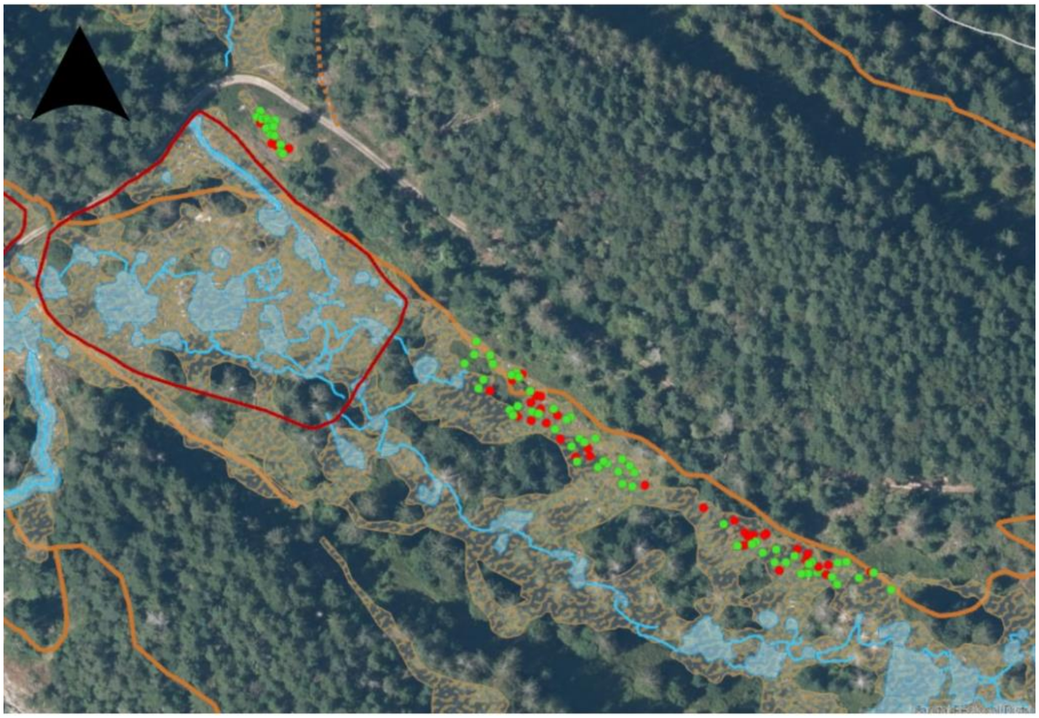
Last year (2025) there was another significant development in the site as a new trail was developed in the area (Shown within Figure 3), giving us a new way to look at the area. This trail is the predominant focal point of our site and the trail runs along the open hot and dry slope area. Figures 4 (*Zone A*) and 5 (*Zone B*) are data points overlaid on the Conservancy's personal watershed and restoration map data as presented previously in Figure 3 (Galiano, 2026). We separated the site into two zones because we observed that there is a distinct gradient separating the two sections in both temperature and species assemblage. *Zone B* (Figure 5) is significantly more dry as it is not as close to the available water, and is therefore experiencing more adverse heat effects and die off with more heat exposure (*Personal Correspondence, 2026*). All the data points in Figures 4 and 5 are planted species, with the specific intent to help grow early succession plants found in a Cedar wetland reference ecosystem. The areas not “rough and loosed” (indicated by a lack of yellow filled in space) in this section (Figures 3, 4 and 5) were to avoid bigger trees, predominantly larger cedars. The Red Line within Figures 4 (*Zone A*) and 5 (*Zone B*), indicates the fence surrounding the main wetland area where most of our species in *Zone A* (Figure 4) are found. In *Zone B* (Figure 5) the species are individually caged. Site B also includes a dry area on a hill above the wetland. We included this in the data as the conditions matched more closely with site B than A.

## ***Zone A*: Wetland Toe Slope**



(Figure 4: Green dots are alive or thriving plants. Red dots are dead or dying plants. The majority of our documented plants here are within the fenced wetland restoration area which is indicated by the red line, on the toe of the slope. Credit to Abby Matheson at the Galiano Conservancy Association for creating plot maps with our data on July 9, 2026)

## *Zone B*: Exposed Toe Slope



(Figure 5: Green dots are alive or thriving plants. Red dots are dead or dying plants. We put the boundaries along the slope from end to end getting close enough to the water to account for a gradient in moisture levels. Credit to Abby Matheson at the Galiano Conservancy Association for creating plot maps with our data on July 9, 2026)

## 6.0 Methods:

### *6.1 Literature Review:*

To provide a conceptual framework for interpreting restoration outcomes, literature on ecological novelty, novel ecosystems, and climate-adapted ecological restoration was reviewed. Emphasis was placed on research examining how interacting drivers, including climate change, altered disturbance regimes, invasive species, and land-use history, can modify ecosystem structure, function, and trajectories relative to historical reference conditions (Heger et al., 2019; Hobbs et al., 2013, 2014; Higgs, 2017). Current principles and standards for ecological restoration were also reviewed to situate the project within contemporary restoration practice (Gann et al., 2026). Previous research and restoration planning within the Chrystal Creek watershed were reviewed to establish the site's restoration history and provide context for the current vegetation analysis. This included Galiano Conservancy Association documentation of the *Cedars for the Next Century* initiative and previous studies examining terrestrial ecosystem conditions, wetland design and construction, revegetation, planting and browse protection, and watershed-scale ecological processes (Borg & Wharin, 2022; Cameron, 2021; Dewar, 2021; Galiano Conservancy Association, n.d.; Hawkins et al., 2022; Wong, 2023). Together, these sources were used to reconstruct the ecological and restoration context of the site and identify the objectives and interventions that preceded the current vegetation monitoring.

### *6.2 Vegetation Monitoring Data Analysis*

Vegetation monitoring data were obtained from the Crystal Creek East Branch Dry Slope ArcGIS Field Maps database maintained by the Galiano Conservancy Association. The database contains monitoring records for every planted individual within the restoration area and includes species identity, planting date, plant functional group, inspection date, and a standardized health status score assigned during monitoring.

Plant health was recorded using a six-point ordinal scale:

| Status | Description |
|---|---|
| 0 | Dead |
| 1 | Barely alive |
| 2 | Poor |
| 3 | Average |
| 4 | Vigorous |
| 5 | Vigorous and mature |

For the purposes of this analysis, individuals with a health status of 3, 4 or 5 were classified as surviving, and labelled as Green (Figures 4 and 5). While those with a status of 0, 1 or 2 were considered unsuccessful, and labelled as Red (Figures 4 and 5).

The complete dataset was exported to Microsoft Excel, where records were organized by species and summarized to quantify the total number of individuals planted, mean health status, distribution of health scores, and overall survival (*see Appendix A*). These summaries were used to compare species performance across the restoration site and identify patterns in survival and establishment. To examine how local environmental conditions may influence restoration outcomes, the monitoring data were further divided into two spatial zones (Zone A and Zone B) corresponding to the existing restoration design.

### *6.3 Field Assessment*

To complement the quantitative vegetation monitoring data, a qualitative field assessment was conducted throughout the Crystal Creek East Branch dry slope restoration site. Field observations were recorded as written notes and subsequently synthesized with the vegetation monitoring data to provide ecological context for interpreting restoration outcomes and identifying potential drivers of ecosystem change. Site visits focused on documenting ecological conditions that could influence restoration success but were not captured within the monitoring dataset. Observations included canopy condition, natural regeneration, understory composition, evidence of historical disturbance, topographic variation, and changes in moisture across the site. Attention was given to the condition of mature western red cedar, patterns of tree recruitment, and the occurrence of potential indicator species that may provide insight into ongoing ecological change.

### *6.4 Future Climate Suitability Assessment*

To evaluate whether observed restoration outcomes align with projected future climatic conditions, a climate suitability assessment was conducted using the Climate Change Informed Species Selection (CCISS) tool developed by the British Columbia Ministry of Forests (British Columbia Ministry of Forests, n.d.). The analysis was completed for the mapped site series CDFmm/101 – Douglas-fir–Salal–Dull Oregon-grape, which represents the current Biogeoclimatic Ecosystem Classification (BEC) for the study area. The CCISS viewer integrates projected climate scenarios with Biogeoclimatic Ecosystem Classification (BEC) modelling to estimate future climatic suitability for both ecosystems and individual tree species.

For each species, projected suitability was evaluated across three stages of development: environmental suitability, representing the ability of the future climate to support the species; establishment suitability, reflecting the likelihood of successful seedling establishment; and maturity suitability, indicating the capacity for mature individuals to persist under projected climatic conditions. These suitability ratings (E1–E3, Trial, and X) were compared with vegetation monitoring data and field observations to assess whether current restoration trajectories are consistent with projected climate change and to explore the potential implications of ecological novelty for future restoration planning.

## 7.0 Results:

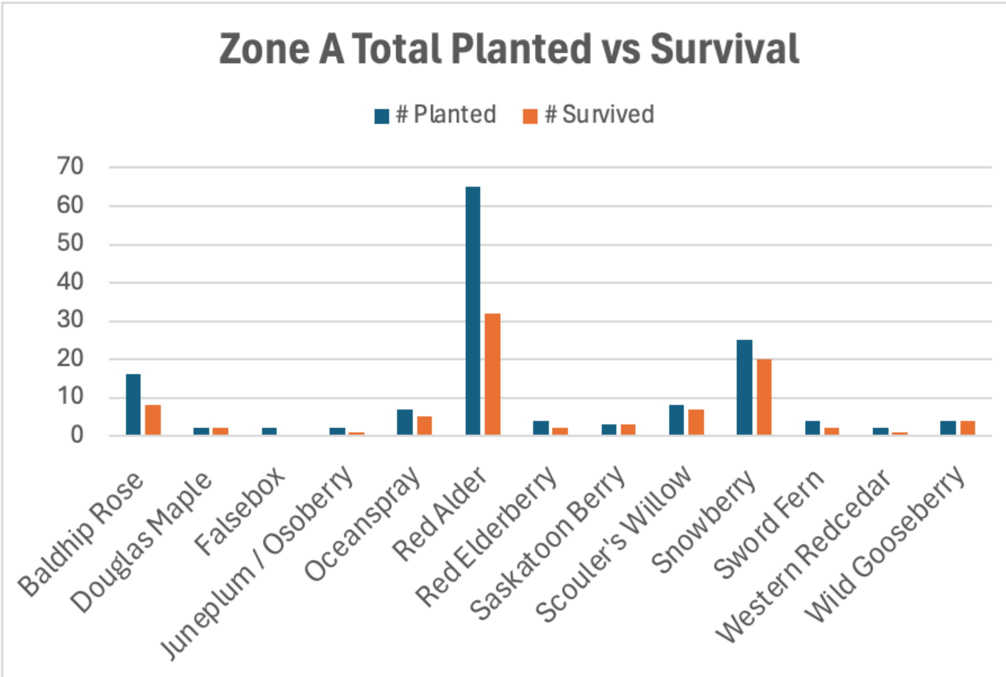
### 7.1 *Vegetation Monitoring Results*

Vegetation monitoring records from the Crystal Creek East Branch dry slope restoration project were compiled and summarized to evaluate planting effort and species performance across the restoration site (Appendix B). The dataset contained all recorded plantings completed between 2022 and 2026 and included species identity, planting date, functional group, and subsequent health assessments.

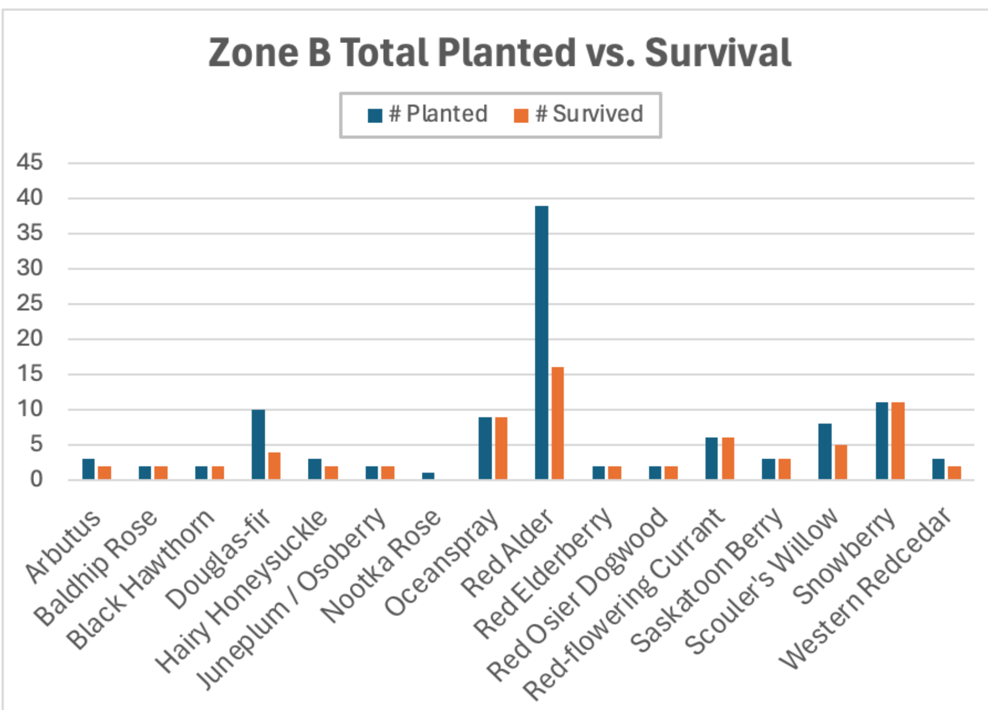
Across both Zone A and Zone B, shrubs comprised the majority of species planted, although broadleaf pioneer trees represented the greatest proportion of individual plants due largely to the extensive use of red alder (*Alnus rubra*). Red alder was by far the dominant restoration species, accounting for 65 planted individuals in Zone A and 39 individuals in Zone B (Figures 1 and 2). Other frequently planted species included snowberry (*Symphoricarpos albus*), baldhip rose (*Rosa gymnocarpa*), Douglas-fir (*Pseudotsuga menziesii*), Scouler's willow (*Salix scouleriana*), oceanspray (*Holodiscus discolor*), and western redcedar (*Thuja plicata*), although planting densities varied considerably between the two restoration zones (Appendix B).

Despite the large planting effort, survival differed markedly among species. In Zone A, fewer than half of planted red alder individuals remained in good condition at the time of assessment, resulting in the lowest mean health score (1.85) among the dominant restoration species and a recorded mortality of 46.2%. Western redcedar also performed poorly, exhibiting the lowest mean health score (1.50) among conifer species despite only two individuals being planted. Pacific ninebark (*Physocarpus capitatus*) experienced complete mortality (100% dead), while red elderberry (*Sambucus racemosa*) exhibited relatively poor survival, with 25% mortality and a mean health score of 2.0. Conversely, several shrub species demonstrated consistently stronger performance. Saskatoon berry (*Amelanchier alnifolia*) exhibited a mean health score of 3.33 with no recorded mortality, while Scouler's willow maintained a mean health score of 3.12 despite a relatively large planting effort of eight individuals.

Douglas maple (*Acer glabrum*), Juneplum/Osoberry (*Oemleria cerasiformis*), baldhip rose, snowberry, and wild gooseberry (*Ribes divaricatum*) also maintained relatively high average health scores with little or no mortality. Although snowberry exhibited only a moderate mean health score (2.72), mortality remained low (8%) owing to the large number of surviving individuals (Appendix B).




**(Figure 6:** Number of individuals planted and surviving for each monitored species within Zone A of the Crystal Creek East Branch dry slope restoration site)




**(Figure 7:** Number of individuals planted and surviving for each monitored species within Zone B of the Crystal Creek East Branch dry slope restoration site)

Patterns observed within Zone B differed slightly from those in Zone A but showed several consistent trends. Red alder again represented the dominant planting species but experienced relatively poor performance, with a mean health score of 2.0 and 42% mortality.

Douglas-fir, which was planted more extensively within Zone B than Zone A, exhibited moderate performance (mean status = 2.2; 22% mortality), while western red cedar similarly demonstrated relatively poor health (mean status = 2.3; 33% mortality).

Several shrub species consistently exhibited higher health ratings within Zone B. Baldhip rose, juneplum/osoberry, red-flowering currant (*Ribes sanguineum*), black hawthorn (*Crataegus douglasii*), and red osier dogwood (*Cornus sericea*) all maintained mean health scores between 3.5 and 4.0 with no recorded mortality. Snowberry, which was planted extensively throughout both restoration zones, maintained a mean health score of 3.3 with no recorded mortality. Oceanspray also demonstrated strong performance, with nine individuals planted and no recorded mortality.

Although both restoration zones contained species exhibiting both high and low survival, Zone B generally contained a greater proportion of species with mean health scores above 3.0. Complete species-level summaries, including planting effort, mean status, median status, mortality, planting year, and assessment year, are presented in Appendix B.

### *7.2 Field Observation Results*

Field observations complemented the vegetation monitoring data by documenting vegetation composition, canopy condition, microsite variability, and evidence of historical disturbance throughout the restoration site. Although the restoration area occupies a relatively small portion of the Chrystal Creek East Branch watershed, substantial environmental heterogeneity was observed over short distances. The restoration site occupies a southwestfacing slope receiving prolonged solar exposure throughout the growing season. Numerous large stumps distributed across the site indicate a history of intensive logging, while historical agricultural use has altered the site's surface topography and hydrology.

Mature western red cedar occurred throughout both restoration zones; however, many individuals exhibited varying degrees of crown dieback, ranging from isolated branch mortality to extensive canopy decline. In contrast, larger, well-established cedar generally appeared healthier than younger planted individuals. Topographic variability was pronounced throughout the site. Numerous small depressions, berms, and irregular surface features created an array of microsites with noticeably different moisture conditions over short distances.

Wetter depressions and areas adjacent to the constructed wetland supported more mesic vegetation, while elevated berms and exposed slopes were considerably drier. Distinct moisture gradients were evident across the site, with conditions generally becoming drier moving upslope away from the wetland. Natural regeneration also varied across the site. Young Douglas-fir

(*Pseudotsuga menziesii*) were abundant and vigorous throughout the drier portions of the slope, while naturally established bigleaf maple (*Acer macrophyllum*) and occasional grand fir (*Abies grandis*) were also present.

Mature and regenerating arbutus (*Arbutus menziesii*) occurred primarily on the drier slopes, indicating successful recruitment in these areas. The understory was similarly heterogeneous. Salal (*Gaultheria shallon*) and bracken fern (*Pteridium aquilinum*) dominated much of the shrub layer, with patches of Oregon grape (*Mahonia nervosa*), trailing blackberry (*Rubus ursinus*), and snowberry (*Symphoricarpos albus*) distributed throughout the site. Notably, stinging nettle (*Urtica dioica*) occurred in bands across both restoration zones, particularly along berms and localized moisture-retaining features. These observations highlight considerable finescale variability in vegetation composition and site conditions across the restoration area.

### *7.3 Future Climate Suitability Assessment Results*

Future climatic projections generated using the Climate & Ecosystem Futures Viewer indicate substantial changes in the climatic conditions projected for the Crystal Creek East Branch dry slope over the twenty-first century (*Table 1*) (British Columbia Ministry of Forests, n.d.). The site is currently classified within the Coastal Douglas-fir Moist Maritime (CDFmm) biogeoclimatic sub-zone. However, the CCISS analysis compares future climatic conditions at the site with the climates currently experienced by British Columbia's BEC zones to determine their closest climatic analogue. The complete CCISS ecosystem projection output is provided in Appendix B. Under the historical and observed climate (2001–2020), the site's climate closely matches the Coastal Western Hemlock very dry maritime (CWHxm) and Coastal Douglas-fir ecosystems.

Beginning in the 2021–2040 projection period, however, the majority of projected climatic conditions no longer resemble any existing BEC climate. According to the Climate Change Informed Species Selection (CCISS) Climate Viewer, approximately 74% of the site's projected climate is classified as Novel Climate, while only 26% remains climatically analogous to current BEC conditions. The proportion classified as Novel Climate continues to increase throughout the century, reaching approximately 87% by 2081–2100, with only 13% of projected conditions remaining comparable to existing BEC climates (British Columbia Ministry of Forests, n.d.; Table 1).

***Table 1.*** Projected climatic similarity of the Crystal Creek East Branch dry slope restoration site to the current Coastal Douglas-fir Moist Maritime (CDFmm) ecosystem under future climate scenarios generated using the Climate & Ecosystem Futures Viewer (CCISS)

| Projected Climatic Analogue for the Crystal Creek East Branch Dry Slope | |
|---|---|
| **Time Period** | **Predicted Climate** |
| Historic | 100% CDFmm |
| 2001–2020 | 100% CWHxm/CDF equivalent |
| 2021–2040 | ~26% resembles current BEC, ~74% Novel Climate |
| 2041–2060 | ~30% resembles current BEC, ~70% Novel Climate |
| 2061–2080 | ~18% resembles current BEC, ~82% Novel Climate |
| 2081–2100 | ~13% resembles current BEC, ~87% Novel Climate |

Species-specific suitability projections also varied considerably among the dominant native tree species currently present or planted within the restoration site (Table 2). Douglas-fir retained the highest projected suitability, receiving high suitability (E1) ratings for environmental conditions, establishment, and long-term persistence. Bigleaf maple maintained moderate suitability (E2) across all three categories. Western redcedar exhibited low environmental suitability (E3) but moderate suitability (E2) for both establishment and long-term persistence. Similarly, red alder received low environmental suitability but moderate establishment and maturity ratings. Grand fir received moderate environmental suitability (E2) but low suitability (E3) for establishment and maturity. Arbutus (*Arbutus menziesii*) received low suitability (E3) across all three categories. Western hemlock (*Tsuga heterophylla*) and western white pine (*Pinus monticola*) were not recommended under projected environmental conditions, although both were identified as potential trial species for establishment.

**Table 2.** Projected future climatic suitability of selected tree species for the Crystal Creek East Branch dry slope (CDFmm/101: Douglas-fir–Salal–Dull Oregon-grape site series) based on the Climate & Ecosystem Futures Viewer developed by the Climate Change and Integrated Sciences Section (CCISS), British Columbia Ministry of Forests. Suitability ratings are provided for three components of species performance: Environmental (ability of the future climate to support the species), Establishment (likelihood of successful seedling establishment), and Maturity (ability of mature individuals to persist under projected future climatic conditions). Ratings range from E1 (high suitability), E2 (moderate suitability), and E3 (low suitability), with Trial indicating uncertain suitability warranting experimental planting and X indicating species that are not recommended under projected future climates.)

| Projected Future Suitability of Tree Species for the Crystal Creek East Branch Dry Slope | | | | |
|---|---|---|---|---|
| **Species** | **Environmental Suitability** | **Establishment** | **Maturity** | **Interpretation** |
| Douglas-fir | E1 | E1 | E1 | Remains highly suited under future climate |
| Western redcedar | E3 | E2 | E2 | Existing trees may persist, but new establishment becomes more difficult |
| Grand fir | E2 | E3 | E3 | Marginal under future conditions |
| Red alder | E3 | E2 | E2 | Early establishment possible but declines over time |
| Arbutus | E3 | E3 | E3 | Marginal according to CCISS, although already present on site |
| Bigleaf maple | E2 | E2 | E2 | Moderate future suitability |
| Western hemlock | X | Trial | E2 | Poor candidate; only experimental establishment recommended |
| Western white pine | X | Trial | E3 | Experimental only |

## 8.0 Discussion:

### *8.1 Drivers of Ecological Novelty*

Ecological novelty does not describe a single disturbance or the sudden emergence of a novel ecosystem. Rather, it reflects the accumulation of interacting environmental changes that increasingly alter ecological processes, species assemblages, and ecosystem trajectories (Heger et al., 2019). Virtually all terrestrial ecosystems are now experiencing some degree of ecological novelty as climate change interacts with historical land use, altered disturbance regimes, hydrological change, and species turnover (Kerr et al., 2025).

The Crystal Creek East Branch dry slope contains several of these interacting drivers. Historical logging and agricultural use altered the site's vegetation and soils, while roads, drainage infrastructure, and subsequent wetland restoration have further modified hydrological and topographic conditions. These legacies now occur within a changing climate characterized not only by gradual shifts in temperature and moisture regimes, but also by increasingly consequential extreme events. These extremes include periods of drought, heat, and intense precipitation. Such events are relevant because they may produce abrupt changes in vegetation condition and hydrological processes, superimposed on longer-term environmental change. The ecological responses observed at Crystal Creek are therefore unlikely to result from any single driver. Differences in planted-species performance, natural regeneration, cedar condition, and vegetation composition occur across a site already characterized by substantial environmental variability. Climate change adds another influence on these existing conditions, interacting with historical land-use legacies, altered hydrology, and contemporary site conditions (Heger et al., 2019). This interaction is central to ecological novelty: environmental change can modify the processes governing establishment and succession without necessarily causing an ecosystem to cross a threshold into a fully novel state (Hobbs et al., 2014).

### *8.2 Vegetation as an Indicator of Ecological Trajectories*

The vegetation monitoring data provide insight into the ecological trajectory of the restoration site by showing which planted species are successfully establishing under current conditions and which are experiencing comparatively poor survival or health. As species differ in their environmental tolerances and establishment requirements, contrasting patterns of performance provide an indication of how current site conditions are influencing establishment and potential successional pathways.

One of the clearest patterns was the contrasting performance among native species. Red alder, planted extensively as a fast-growing pioneer species to facilitate canopy development and the subsequent establishment of western red cedar, exhibited the lowest mean health scores among the dominant restoration species in both monitoring zones. Western red cedar a focal species of the *Cedars for the Next Century* initiative (Galiano Conservancy Association, n.d., Wong, 2023), also demonstrated relatively poor establishment, despite the continued presence of mature cedar throughout the site. In contrast, several native shrubs, including snowberry

(*Symphoricarpos albus*), baldhip rose (*Rosa gymnocarpa*), saskatoon (*Amelanchier alnifolia*), wild gooseberry (*Ribes divaricatum*), and oceanspray (*Holodiscus discolor*), maintained comparatively high health scores and low mortality. These differences indicate that establishment constraints are not affecting all native vegetation equally and that current conditions may favour a different combination of species than originally anticipated.

The monitoring results also indicate that increasing drought alone is insufficient to explain species responses. Scouler's willow (*Salix scouleriana*), a species typically associated with moist habitats, exhibited relatively high survival despite occurring within the same broader restoration area as more drought-tolerant species such as snowberry. This suggests that moisture availability varies considerably across the site, instead of following a dry-to-wet gradient. Field observations support this interpretation. Localized depressions, berms, and drainage pathways created differing moisture conditions over short distances, while bands of stinging nettle (*Urtica dioica*) corresponded with areas of greater apparent moisture and nutrient availability. Water movement toward the constructed wetland further contributed to a mosaic of microsites across the slope. Consequently, broad characterization of the site as a "dry slope" may obscure the finescale environmental variability relevant to plant establishment**.**

Natural regeneration provides an additional line of evidence because it reflects establishment without direct species selection or placement by restoration practitioners. Douglasfir appeared vigorous in several drier areas, while bigleaf maple and occasional grand fir (*Abies* were also regenerating. Mature arbutus occurred on exposed slopes alongside numerous young recruits. Western redcedar, in comparison, was represented principally by established trees, many showing some degree of crown dieback, with limited evidence of successful recruitment. These observations make natural recruitment particularly informative for assessing trajectory: the species establishing independently provide an indication of which components of the native tree community are currently able to pass through the establishment stage under existing site conditions.

The relationship between arbutus and cedar should not be interpreted as evidence that one species is replacing the other; they illustrate different temporal dimensions of vegetation response. Mature cedar reflects conditions that have permitted its persistence overtime, whereas arbutus recruitment demonstrates successful establishment under contemporary conditions in at least some micro-sites. Established cedar may therefore continue to provide important structural and ecological functions even where recruitment becomes less reliable, while continued arbutus and Douglas-fir establishment could gradually influence future canopy composition. This distinction between persistence and recruitment is important because the species that currently dominate a site may not necessarily be those most capable of establishing under emerging novel conditions. The understory further demonstrates that poor performance among some planted trees does not indicate a general limitation on vegetation productivity. Salal, dull Oregon grape, trailing blackberry bracken fern, nettle, and multiple native shrubs occupied substantial portions of the site, while agronomic grasses remained localized rather than dominant. That said, the central ecological pattern is one of selective establishment within a heterogeneous environment.

Heger et al. (2019) describe ecological novelty as an umbrella concept for examining interconnected responses to global environmental change at the levels of organisms, communities, and ecosystems. This framing is useful at Crystal Creek because no single observation—cedar crown dieback, alder mortality, arbutus recruitment, wet micro-sites, or shrub survival—adequately represents the site. The significance lies in their interaction. Historical land use, hydrological modification, topographic variation, restoration activity, herbivory, and climatic stress can influence different species and life stages in different ways. Ecological novelty provides a framework for examining why community development may depart from expectations without requiring the conclusion that the site has already become a novel ecosystem.

### *8.3 Future Climate and Restoration Trajectories*

The CCISS climate suitability analysis provides an additional line of evidence that the environmental conditions supporting restoration are likely to continue changing over the coming century. While the site is currently classified within the Coastal Douglas-fir Moist Maritime (CDFmm) biogeoclimatic zone, projections indicate that its future climate increasingly diverges from this present-day classification. By 2021–2040, approximately 74% of projected climatic conditions are classified as novel relative to the current ecosystem, increasing to 87% by 2081–2100. These projections suggest that restoration will occur under climatic conditions that increasingly differ from those experienced today.

Projected species responses show that climate change is unlikely to affect all components of the ecosystem equally. Although climate suitability models cannot predict future species composition, they provide valuable context for interpreting these field observations. Together, the monitoring data and CCISS projections suggest that climate change may be altering the relative competitiveness of native species, influencing patterns of regeneration and the direction of future succession. The species projections reinforce the importance of distinguishing among environmental suitability, seedling establishment, and mature-tree persistence. Douglas-fir received high suitability ratings across all three categories, while bigleaf maple retained moderate suitability. Western redcedar received low environmental suitability but moderate establishment and maturity ratings. Grand fir, red alder, and arbutus had different combinations of low or moderate suitability. These ratings identify climatic constraints and opportunities, while actual outcomes will also depend on microsite conditions, soil properties, competition, browsing, disturbance, and management.

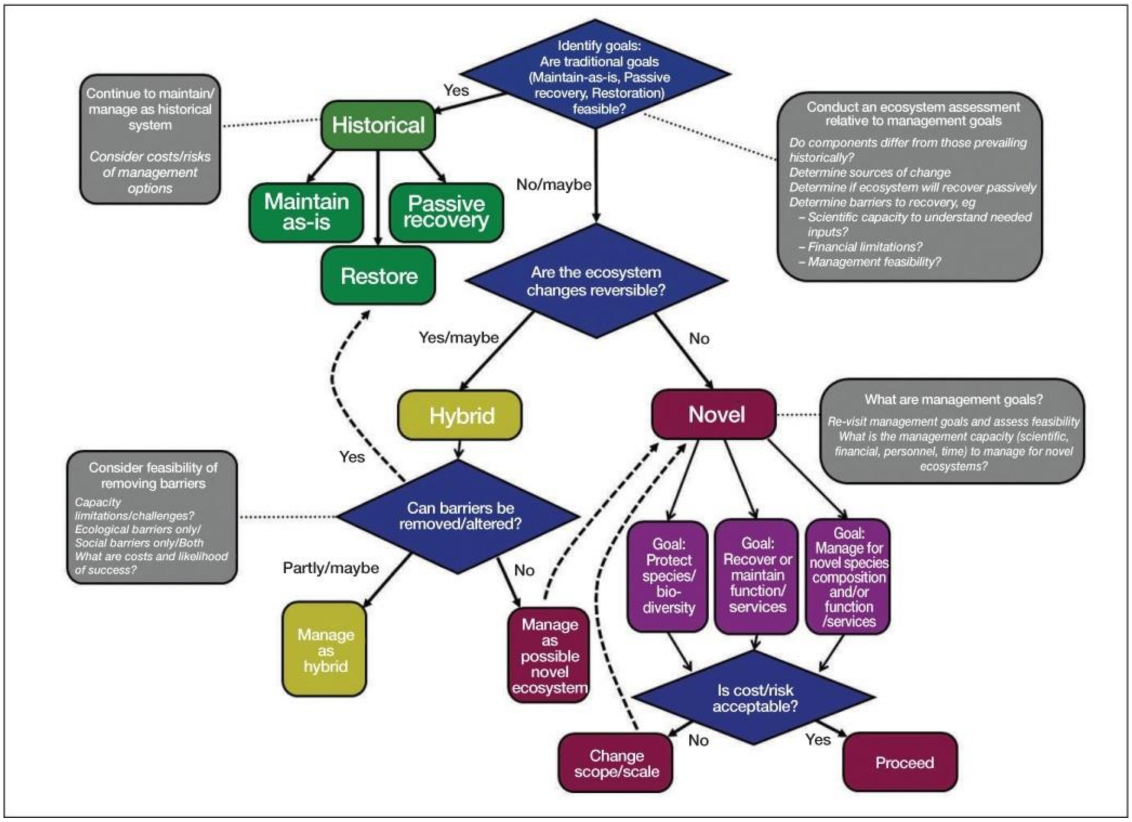
The agreement between some modelled and observed patterns is nevertheless informative. Natural recruitment of Douglas-fir and bigleaf maple is broadly consistent with their projected climatic suitability, while the more limited establishment of western redcedar corresponds with its lower projected environmental suitability. This partial correspondence suggests that present recruitment patterns may provide an early indication of how vegetation responds as climatic conditions continue to change. Arbutus, however, highlights the limits of interpreting regional projections without local evidence. Although CCISS assigned it low suitability across the assessed categories, mature trees and young recruits were observed on the drier slopes. CCISS describes climatic suitability at the selected BEC and site-series scale, whereas field observations capture localized establishment within micro-sites. This discrepancy emphasizes why neither projected climate nor short-term monitoring should be used alone to define the future ecosystem.

Kerr et al. (2025) mapped climate change together with defaunation and floristic disruption to demonstrate that ecological novelty is widespread across the terrestrial biosphere. Their analysis treats novel climate as one dimension of broader novelty, not as proof that every exposed ecosystem has crossed into a novel state. At Crystal Creek, the CCISS results similarly identify increasing exposure to climatic conditions without close present-day analogues. The ecological outcome will depend on how those conditions interact with the site's altered hydrology, land-use legacies, species pool, regeneration, and ongoing management.

### *8.4 Reference Conditions and Hybrid Trajectories Future*

The combined evidence is most consistent with a site whose future remains open, rather than one that has already crossed an irreversible threshold. Higgs (2017) reserves the term novel ecosystem for systems transformed beyond the practical reach of conventional restoration and capable of sustaining their novel characteristics without regular intervention. Crystal Creek remains actively managed, retains substantial native vegetation and mature cedar structure, and contains micro-sites where species associated with both moist and dry conditions persist. The available evidence therefore does not support classifying it as a novel ecosystem.

The Crystal Creek restoration site is most appropriately considered through the historical–hybrid–novel continuum described by Hobbs et al. (2014). Moving beyond a binary distinction between historical restoration and ecological change, this framework recognizes that ecosystems can occupy intermediate states where historical characteristics persist alongside emerging environmental conditions (Figure 10).




***(Figure 10:*** Decision-making framework for selecting management approaches across historical, hybrid, and novel ecosystem states. The framework evaluates whether traditional restoration goals remain feasible, whether ecosystem changes are reversible, and whether barriers to recovery can be removed or altered. Depending on these assessments, management may focus on maintaining or restoring historical conditions, managing the system as a hybrid ecosystem, or establishing goals appropriate to a novel ecosystem. Adapted from Hobbs et al. (2014).)

This framework provides a useful lens through which to interpret the Chrystal Creek restoration site, rather than serving as a definitive classification. Mature western red cedar, native understory communities, and wetland-associated micro-sites remain important components of the ecosystem. At the same time, altered hydrology, legacy effects of historical land use, variable planting outcomes, and projected climatic change indicate that ecological processes are responding to conditions that differ from those under which the original restoration objectives were established. As Hobbs et al. (2014) argue, ecosystems occupying this intermediate position require a broader range of management options than a simple choice between restoring historical conditions and accepting ecological novelty.

Historical references remain essential, but their role may need to evolve. They provide evidence of native biodiversity, ecosystem structure, ecological relationships, and processes that restoration can seek to recover. However, treating a historical reference as a fixed compositional endpoint becomes increasingly challenging where climate, hydrology, and regeneration dynamics no longer reflect the conditions under which those ecosystems developed. Historical knowledge can instead provide a foundation for understanding ecological legacies, interpreting contemporary change, and evaluating potential restoration trajectories under changing environmental conditions (Higgs et al., 2014). Higgs (2017) similarly argues that ecological novelty should not be viewed as a rationale for abandoning historical reference conditions. Instead, it encourages a more adaptive approach in which restoration objectives are informed by both historical ecosystem characteristics and the environmental conditions likely to shape future ecosystem development.

For the Chrystal Creek restoration site, the question is not whether western red cedar or arbutus represents the "correct" future ecosystem. Instead, the evidence suggests that multiple native assemblages are developing simultaneously in response to fine-scale environmental variability. This combination of species assemblages supports neither a uniform return to a cedar dominated ecosystem nor a simple transition toward a more drought-tolerant forest. Viewed through the framework of ecological novelty, these findings suggest that restoration planning should be informed by both historical reference conditions and the environmental conditions that are likely to shape future ecosystem development. Restoration practitioners may be better served by identifying native species assemblages capable of maintaining ecological function, biodiversity, and resilience under continued environmental change (Higgs, 2017). The value of the ecological novelty framework at Chrystal Creek provides a structured approach for recognizing emerging ecological trajectories and supporting adaptive restoration before environmental change progresses beyond the range where historical restoration objectives remain achievable.

### *8.5 Uncertainty and Future Work*

Although the vegetation monitoring, field observations, and climate suitability analysis provide valuable insight into potential restoration futures, several uncertainties remain. First, the vegetation monitoring dataset is observational in nature and does not allow individual environmental drivers to be isolated. Species performance likely reflects the combined influence of soil moisture, competition, microsite conditions, planting methods, browsing pressure, and climate, yet the relative importance of these factors cannot be determined from the available data.

One of the clearest observations was the pronounced environmental heterogeneity across the restoration site. Numerous localized depressions, drainage pathways, berms, and moisture gradients were identified during field assessments, suggesting that microsite variability may play a substantial role in determining restoration success. However, these environmental characteristics were not quantified within the monitoring program. Future work incorporating measurements of soil moisture, groundwater depth, soil texture, organic matter, topography, and solar exposure would allow vegetation responses to be linked more directly to site conditions. Pairing these measurements with a functional or trait-based approach could further identify the characteristics that enable particular species to establish and persist under different microsite conditions, providing a stronger mechanistic understanding of the observed differences in species performance.

Similarly, the CCISS climate suitability analysis provides projections at the scale of the biogeoclimatic site series and cannot capture the fine-scale variability observed across the restoration area. While regional climate projections provide valuable context for long-term planning, individual micro-sites may continue to provide localized refuge that allow moisturedependent species to persist despite broader climatic trends. Understanding how these local environmental conditions buffer or amplify the effects of climate change represents an important area for future research.

The monitoring dataset also raises several ecological questions that extend beyond species survival alone. Determining whether this reflects changing hydrological conditions, reduced seedling establishment, increased drought stress, or interactions among multiple stressors would improve understanding of future forest development. Additionally, long-term monitoring of species regeneration is necessary to determine whether these patterns represent short-term responses to restoration or the beginning of sustained changes in community composition.

Finally, our data represents a relatively short period within what is inherently a long-term restoration process. Ecological trajectories often emerge over decades rather than years, particularly in forested ecosystems. Continued monitoring of vegetation performance, natural regeneration, canopy condition, and hydrological change will be essential for determining whether the patterns identified here persist through time or reflect transitional responses following restoration activities. Long-term monitoring will also provide an opportunity to evaluate whether adaptive management approaches can respond effectively as environmental conditions continue to change.

## 9.0 Conclusion

Our findings in the Chrystal Creek Watershed have led us to conclude that achieving a true historic baseline ecosystem would be both costly and hard to achieve. With such extensive historical change to both the land and species assemblage, approaching future restoration trajectories will likely be more successful with the prioritization of species with higher success rates. In the longer term of the project area, western red cedar viability will more likely improve in the future as a understory species. For now, prioritizing the preservation of larger trees and high success species should be considered. In terms of progression following the Cedars for the Next Century project, it may still be possible to move towards the historic baseline aim of a cedar wetland ecosystem. However, the succession of the ecosystem may not behave as expected, and future planting may need to prioritize high survivability in order to create an overstay that cedar can grow under. As conditions changed so rapidly with the wetland restoration, any additional climactic stresses will likely increase novel conditions. Ultimately, with frequent assessment of species success and assemblage of the ecosystem, novelty can be worked with as long as its considered.

## 10.0 Acknowledgements

We would like to thank the following people for your contributions:

Eric Higgs, in your guidance and expertise in ecological novelty and aspirational work introducing more people into the growing field of restoration in the context of ecological novelty.

Meghan Hamp, for your help in our fieldwork and sharing your expertise with ecological novelty as you study novelty in the Arctic.

Jeanine Rhemtulla, for your help in developing a starting point for our data.

Adam Huggins, for your years of expertise in the conservancy.

Abby Matheson, for creating our map data on ArcGIS. (Figures 4 and 5)

Millie Kuyer, for your help in coming into the field and sharing your knowledge.

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## 12.0 Appendices

**Appendix A.** Initial Project Description on Incipient Ecological Novelty

There is growing evidence and theory that ecological novelty is rising in ecosystems globally (e.g., Kerr et al. 2025), which would necessarily include those stewarded by the GCA. Novel elements include altered soil regimes, persistent introduced species (especially those that tend to be exclusionary), thermal stress, changing precipitation patterns. Separately these make restoration challenging by shifting goals away from the Society for Ecological

Restoration aim of recovering “native reference ecosystems.” In combination they can make classical restoration very difficult, and eventually can leave to novel ecosystems, which are historically unprecedented and practically unrestorable. As a case study, students can explore the dry, sunny south-west slope within the East Branch of the Crystal Creek watershed. Vegetation monitoring suggests lower revegetation success rates in this area and the GCA is looking for some answers on what site factors are most limiting and potentially affecting native vegetation establishment and whether there are creative solutions (i.e., novel ecosystem approach) to consider in the face of a changing climate

**Appendix B.** Species summary table of the vegetation monitoring data collected from the two restoration zones. Each table represents the number of individuals planted, the species functional group, the year of planting and assessment, and indicators of restoration performance, including mean and median health status and the percentage of individuals that were dead at the time of assessment. These summaries provide the basis for comparing species performance between the two zones and support the discussion of how environmental conditions and ecosystem novelty may be influencing restoration outcomes.

**Zone A Species Summary**

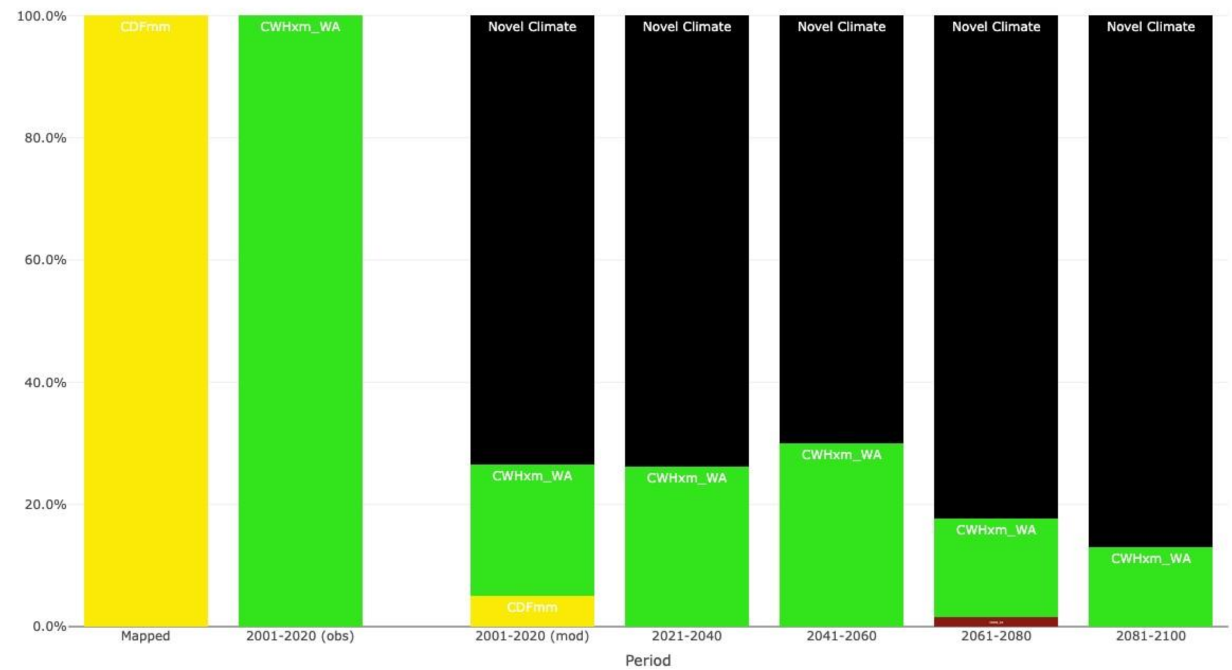
| Species | Functional Group | # Planted | Mean Status | Median Status | Percent Dead (%) | Year Planted | Year Assessed |
|---|---|---|---|---|---|---|---|
| Baldhip Rose (*Rosa gymnocarpa*) | Shrub | 16 | 2.69 | 3 | 0 | 2022 | 2025 |
| Bigleaf Maple (*Acer macrophyllum*) | Broadleaf | 3 | 1.67 | 2 | 33.3 | 2022 | 2025 |
| Douglas Maple (*Acer glabrum*) | Broadleaf | 2 | 3 | 3 | 0 | 2022 | 2026 |
| Hairy Honeysuckle (*Lonicera hispidula*) | Shrub | 4 | 2.5 | 3 | 25 | 2022 | 2024 |
| Juneplum / Osoberry (*Oemleria cerasiformis*) | Shrub | 2 | 2.5 | 2.5 | 0 | 2022 | 2024 |
| Mock Orange (*Philadelphus lewisii*) | Shrub | 1 | 2 | 2 | 0 | 2022 | 2024 |
| Nootka Rose (*Rosa nutkana*) | Shrub | 2 | 3.5 | 3.5 | 0 | 2022 | 2024 |
| Orange Honeysuckle (*Lonicera ciliosa*) | Shrub | 2 | 3 | 3 | 0 | 2022 | 2024 |
| Red Alder (*Alnus rubra*) | Broadleaf | 65 | 1.85 | 3 | 46.2 | 2022 | 2026 |
| Red Osier Dogwood (*Cornus sericea*) | Shrub | 2 | 3.5 | 3.5 | 0 | 2022 | 2024 |
| Red-flowering Currant (*Ribes sanguineum*) | Shrub | 2 | 3.5 | 3.5 | 0 | 2022 | 2025 |
| Salal (*Gaultheria shallon*) | Shrub | 1 | 3 | 3 | 0 | 2022 | 2024 |
| Salmonberry (*Rubus spectabilis*) | Shrub | 1 | 4 | 4 | 0 | 2022 | 2025 |
| Saskatoon Berry (*Amelanchier alnifolia*) | Shrub | 3 | 3.33 | 3 | 0 | 2022 | 2025 |
| Scouler's Willow (*Salix scouleriana*) | Broadleaf | 8 | 3.12 | 3.5 | 12.5 | 2022 | 2025 |
| Sword Fern (*Polystichum munitum*) | Fern | 4 | 2.5 | 2.5 | 0 | 2022 | 2024 |
| Thimbleberry (*Rubus parviflorus*) | Shrub | 4 | 3 | 3 | 0 | 2022 | 2024 |
| Western Redcedar (*Thuja plicata*) | Conifer | 2 | 1.5 | 1.5 | 50 | 2022 | 2026 |
| Wild Gooseberry (*Ribes divaricatum*) | Shrub | 4 | 2.75 | 3 | 0 | 2022 | 2024 |
| Beaked Hazelnut (*Corylus cornuta*) | Broadleaf | 2 | 2.5 | 2.5 | 0 | 2026 | 2026 |
| Black Hawthorn (*Crataegus douglasii*) | Broadleaf | 1 | 3 | 3 | 0 | 2026 | 2026 |
| Falsebox (*Paxistima myrsinites*) | Shrub | 2 | 2 | 2 | 0 | 2026 | 2026 |
| Hooker's Willow (*Salix hookeriana*) | Broadleaf | 1 | 4 | 4 | 0 | 2026 | 2026 |
| Oceanspray (*Holodiscus discolor*) | Shrub | 7 | 2.86 | 3 | 0 | 2026 | 2026 |
| Pacific Ninebark (*Physocarpus capitatus*) | Shrub | 1 | 0 | 0 | 100 | 2026 | 2026 |
| Red Elderberry (*Sambucus racemosa*) | Shrub | 4 | 2 | 2.5 | 25 | 2026 | 2026 |
| Snowberry (*Symphoricarpos albus*) | Shrub | 25 | 2.72 | 3 | 8 | 2026 | 2026 |

**Zone B Species Summary**

| Species | Functional Group | # Planted | Mean Status | Median Status | % Dead | Year Planted | Year Assessed |
|---|---|---|---|---|---|---|---|
| Hairy Honeysuckle (*Lonicera hispidula*) | Shrub | 3 | 2 | 3 | 33% | 2022 | 2024 |
| Nootka Rose (*Rosa nutkana*) | Shrub | 1 | 2 | 2 | 0% | 2022 | 2026 |
| Red Alder (*Alnus rubra*) | Broadleaf | 48 | 2 | 3 | 42% | 2022 | 2024–2026 |
| Douglas-fir (*Pseudotsuga menziesii*) | Conifer | 9 | 2.2 | 2 | 22% | 2022–2025 | 2024–2026 |
| Western Redcedar (*Thuja plicata*) | Conifer | 3 | 2.3 | 3 | 33% | 2022 | 2025 |
| Arbutus (*Arbutus menziesii*) | Broadleaf | 3 | 2.7 | 3 | 0% | 2022 | 2024 |
| Scouler's Willow (*Salix scouleriana*) | Broadleaf | 8 | 2.9 | 3 | 13% | 2022 | 2024–2026 |
| Bigleaf Maple (*Acer macrophyllum*) | Broadleaf | 1 | 3 | 3 | 0% | 2022 | 2026 |
| Falsebox (*Paxistima myrsinites*) | Shrub | 1 | 3 | 3 | 0% | 2022 | 2025 |
| Oceanspray (*Holodiscus discolor*) | Shrub | 7 | 3 | 3 | 0% | 2026 | 2026 |
| Red Elderberry (*Sambucus racemosa*) | Shrub | 2 | 3 | 3 | 0% | 2026 | 2026 |
| Thimbleberry (*Rubus parviflorus*) | Shrub | 1 | 3 | 3 | 0% | 2022 | 2025 |
| Saskatoon Berry (*Amelanchier alnifolia*) | Shrub | 3 | 3.3 | 3 | 0% | 2022 | 2024 |
| Snowberry (*Symphoricarpos albus*) | Shrub | 10 | 3.3 | 3 | 0% | 2026 | 2026 |
| Baldhip Rose (*Rosa gymnocarpa*) | Shrub | 2 | 3.5 | 3.5 | 0% | 2022 | 2024 |
| Juneplum / Osoberry (*Oemleria cerasiformis*) | Shrub | 2 | 3.5 | 3.5 | 0% | 2022 | 2025–2026 |
| Red-flowering Currant (*Ribes sanguineum*) | Shrub | 6 | 3.5 | 3.5 | 0% | 2022 | 2024–2025 |
| Black Hawthorn (*Crataegus douglasii*) | Broadleaf | 2 | 4 | 4 | 0% | 2022–2025 | 2025 |
| Red Osier Dogwood (*Cornus sericea*) | Shrub | 2 | 4 | 4 | 0% | 2022 | 2025 |

**Appendix C.** Climate analogue projection generated using the Climate Change Informed Species Selection (CCISS) Climate & Ecosystem Futures Viewer (British Columbia Ministry of Forests, n.d.). The figure illustrates the projected similarity between future climatic conditions at the Crystal Creek East Branch dry slope and the current climates associated with British Columbia's Biogeoclimatic Ecosystem Classification (BEC) zones. As projected climatic conditions diverge from the current Coastal Douglas-fir Moist Maritime (CDFmm) climate envelope, an increasing proportion of the site's future climate is classified as Novel Climate, indicating conditions without a close present-day analogue among existing BEC zones.

**Complete CCISS Climate Analogue Projection for the Crystal Creek East Branch Dry Slope**



## 13.0 Author Contributions

**Camille Lauridsen-Hoegh:** Led the data analysis and synthesis underlying the report. This included organizing and analyzing the Galiano Conservancy Association vegetation monitoring dataset and independently conducting the CCISS climate analogue and species suitability analyses. Camille developed the analyses used to produce Figures 6 and 7, Tables 1 and 2, and both vegetation summary tables presented in Appendix B, including data organization, calculation, interpretation, and visualization. She also prepared the cartographic elements (i.e. north arrow) for Figures 4 and 5.

Camille authored the Methods and Results sections, integrating the vegetation monitoring analysis, field observations, supplementary literature review, and CCISS climate projections. She also authored the Discussion, including *Drivers of Ecological Novelty*, *Vegetation as an Indicator of Ecological Trajectories*, *Future Climate and Restoration Trajectories*, *Reference Conditions and Hybrid Trajectories*, and *Uncertainty and Future Work*. This involved synthesizing the project findings with the broader literature on ecological novelty, reference conditions, climate change, and restoration trajectories. Camille additionally compiled and formatted the reference list and assembled the report appendices.

**Emma-Jeanne Voyer:**
Revising and editing, summary, introduction, land acknowledgement, title page, contributed in background research, conducted data collection, formulated goals and objectives, site description and history, compiled reference list.