ER 390

Wetland Revegetation in an Agriculturally Degraded Western Red Cedar *(Thuja plicata)* Forest on Galiano Island, B.C.

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ABSTRACT

Cedars for the Next Century is a three-year, three-phase wetland restoration project led by the Galiano Conservancy Association (GCA). The project goal is to restore the hydrological regime and native species composition of the historical Western red cedar *(Thuja plicata)* swamp ecosystem in the East Branch of the Chrystal Creek watershed, located at the Millard Learning Centre on Galiano Island. Prior to restoration, the site contained ditches, an agricultural field, and a secondary growth Western red cedar forest. Due to long-term land use, the East Branch severely lacked productive soils, hydrophilic vegetation, and surface water sequestration. As part of Phase 2 of *Cedars for the Next Century,* GCA planned a full hydrological restoration for the East Branch, including culvert installation, stream and wetland creation, and native species planting. To achieve biodiversity objectives, GCA required a revegetation strategy targeting riparian species typical to cedar-swamp ecosystems. This strategy was co-developed with GCA and included an inventory of existing plants, a Terrestrial Ecosystem Map (TEM), and Indicator Species Group (ISG) analysis. The TEM identified three site series in the East Branch, 05 Cw-Bg, 06 Cw-Fd and 11 Cw-Skunk Cabbage, and the ISG analysis informed the selection of moisture-tolerant native species for planting. To prepare the East Branch for revegetation, the GCA team applied “rough and loose” mechanical decompaction to restore topographical complexity and create new wetlands, around which 33 species (1298 total plants) were planted in November 2022. Fencing, cages, and burlap were used to mitigate invasive species encroachment and hyper-abundant black tail deer *(Odocoileus hemionus)* browsing. Recommendations include monitoring for plant success and Western red cedar regeneration to inform plant selection for the Phase 3 site in 2023.

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ACKNOWLEDGEMENTS

This project takes place on the historically occupied and unceded and unsurrendered traditional territory of the Hul'qumi'num Treaty Group (Cowichan Tribes, Halalt, Ts'uubaa-asatx, Lyackson, and Penelakut), Stz'uminus First Nation, Hwlitsum First Nation, and Tsawwassen First Nation. This work is land-based and is done in recognition that restoration and stewardship occurs within ecosystems that continue to be places of traditional use and cultural value, and represent the knowledge and land management systems of Indigenous peoples since time immemorial.

I would like to thank my colleagues at the Vancouver Island Decade on Ecological Restoration (VIDER) and UVic Ecological Restoration Club (ERC) volunteers for participating in restoration activities, and Adam Huggins, GCA's Restoration Coordinator, for his guidance and support in developing my portion of this project.

1.0 INTRODUCTION

Wetlands ecosystems are distinct from terrestrial and aquatic systems, representing the medium through which complex and dynamic hydrologies interact (Mackenzie and Banner, 2001). Through this confluence, wetlands support flood mitigation, pollution cycling, waste treatment services, and provide immense biodiversity value disproportionate to their limited extent (Mackenzie and Banner, 2001). At present, wetland ecosystems host up to 40% of global biodiversity, including waterbirds, amphibians, reptiles, fish, and vegetation (ICUN, 2020). Due to their gentle topography and high soil organic matter, these ecosystems are targeted for development (Cox and Barnett, 2009). In British Columbia (B.C.), urban expansion and agricultural land conversion have contributed to an 80% reduction of wetland cover over the last century, and currently, wetlands comprise only 5.6% of B.C.'s land mass (Cox and Barnett, 2009).

These impacts are well represented at the Millard Learning Centre (MLC), a 76-hectare property situated within the Chrystal Creek watershed on the eastern coast of Galiano Island, B.C. Currently, wetlands make up 1.3% of the Galiano Island landscape, and while these ecosystems are naturally limited due to the island's small watersheds, this is only a fraction of pre-settlement cover (Emmings and Erickson, 2004). Historically, the Chrystal Creek watershed captured healthy surface water flows in ephemeral and perennial wetlands across the central valley of the property, called the East Branch, which once sustained a swamp ecosystem dominated by Western red cedar trees *(Thuja plicata),* or *X'PEY* in Hul'qumi'num (First Voices, 2022). Through decades of forestry and agriculture, the ecosystem was fragmented into a dry agricultural field and a secondary growth forest (GCA, 2020a). Without wetlands, this landscape lacks the natural hydrology needed to support the cedar-swamp ecosystem endemic to the MLC.

Over the last 30 years, an environmental society known as the Galiano Conservancy Association (GCA) has targeted the loss of wetlands on Galiano Island (Huggins, 2021a). Following the receipt of three EcoAction research grants, GCA developed a three-year, three-phase restoration project called *Cedars for the Next Century,* which aims to restore the Chrystal Creek watershed and the cedar-swamp ecosystem at the MLC. Phase 2 of the project took place in the East Branch, and developing a revegetation strategy was a key part of this work. This report describes the ecological context and species composition of the East Branch pre-restoration, and the technical methods used to select native species for planting post-wetland creation. The goal of the revegetation strategy was to increase Western red cedar cover, riparian shrub diversity, and wetland habitat for existing wildlife at the MLC.

2.0 PROJECT OBJECTIVES

The Galiano Conservancy Association (GCA) was established on Galiano Island in 1989 as one of the first community-based land trusts in B.C. (GCA, 2020b). After purchasing District Lot 57 in 2012, the property was renamed the Millard Learning Centre (MLC) and became GCA's centre for environmental education and ecological restoration. In the past decade, GCA has implemented several projects at the MLC, including a food forest, the Nuts'a'maat Forage Forest, and a liner wetland (GCA, 2021). Through community-based restoration projects, GCA is driven by a purpose to preserve and enhance the quality of human-environment relationships (GCA, n.d.).

Cedars for the Next Century is the second wetland restoration project at the MLC. Due to its large scale, the project site was divided into four zones reflecting three years of project work: the West Branch and the North Branch (Phase 1, 2021), the East Branch (Phase 2, 2022), and the South Branch (Phase 3, 2023). Following the completion of Phase 1, Phase 2 occurred between January and November 2022.

The current threats to the East Branch of the watershed, which point to the necessity for an informed revegetation strategy, include:

- Drought and low annual precipitation influenced by climate change;
- Compacted soils and a levelled topography;
- Ditches and an altered hydrology;
- Black-tail deer *(Odocoileus hemionus)* browsing; and
- Invasive species, including agronomic grasses.

In light of these threats, GCA proposed six project objectives for Phase 2 of *Cedars for the Next Century* in the 2021 EcoAction grant proposal, combining wetland design, revegetation, and community involvement:

1. Restore the natural hydrology of the Chrystal Creek watershed through soil decompaction;
2. Reconstruct water flows through culvert installations and stream creation;
3. Create perennial and ephemeral freshwater wetlands;
4. Revegetate the restored areas with Western red cedars and native species;
5. Remove roads, garbage, and structures on site, and;
6. Conduct outreach to community volunteers to participate in learning, site preparation and invasive species removal events (GCA, 2020b).

Objective 4 required the selection of native species for planting upon completion of Objectives 1 - 3 and 5. This led to the co-development of a revegetation strategy capable of identifying pre-disturbance conditions, with the goal of allowing the natural progression of a structurally mature cedar-swamp ecosystem into the future. As a climax Western red cedar ecosystem would take decades to establish, the priority was to plant pioneer riparian shrubs and trees, along with Western red cedar saplings, to enhance interim site biodiversity. The vulnerability of Western red cedars under climate change highlights the need to restore the East Branch through both hydrological connectivity and informed revegetation (Seebacher, 2007; Keane et al., 2017).

The approach to achieve Objective 4 is provided in Table 1. To adhere to GCA's socioecological mandate, this approach also incorporated social elements outlined in Objective 6.

Table 1. Revegetation Strategy Objectives and Planned Activities

EcoAction Objective	Category	Description of Planned Restoration Activity
Objective 4: **"**Revegetate the restored wetland area with a variety of native species, with a focus on restoring the Western red cedar ecosystems that previously dominated the project area in a climate-resilient fashion" (GCA, 2020a).	**Ecological**	1. Conduct site visits and a plant inventory.
		2. Complete a Terrestrial Ecosystem Map (TEM) to identify the site series.
		3. Complete Indicator Species Group (ISG) analysis to identify which existing species in the East Branch to increase in cover based on suitability to the post-restoration landscape.
		4. Use the site series and ISG results to inform species selected for planting, prioritizing early successional riparian shrubs and Western red cedar saplings, primarily sourced by local nurseries.
		5. Source burlap, fencing, and cages to mitigate black-tail deer browsing and invasive grasses.
		6. Following mechanical soil decompaction, site preparation, and fencing (Objectives 1-3, 5), plant selected species across the East Branch according to individual ecologies, site series, and micro-topographical conditions identified during early field surveys.
	Social	1. Determine a portion of the East Branch to fence to ensure deer populations are maintained to support GCA's *Feed the People* traditional hunting initiative with Penelakut Tribe. Source cages for the remaining areas.
		2. Use volunteer networks, such as UVic's Ecological Restoration Club, the Vancouver Island Decade on Ecological Restoration, and the Galiano Island community, to help site preparation, planting, and learn about the project.

3.0 SITE DESCRIPTION

The East Branch is a 5.5 hectare site located in the lower Chrystal Creek watershed at the MLC, accessed through an entry road used regularly by GCA staff. The site lies within a valley surrounded by sandstone ridges containing old growth and secondary growth forests with a mixed canopy of Western red cedar *(Thuja plicata)* and Douglas fir *(Pseudotsuga menzeisii)*. To the west, the site is adjacent to the Phase 1 and Phase 3 sites, and to the east, sits below the Nuts'a'maat Forage Forest and the GCA classroom (Figure 1). The site also contains an agricultural field and a pond from past land use and has undergone significant disturbance from human activities, which remain evident in the form of old structures, garbage, and logging slash piles (GCA, 2020).

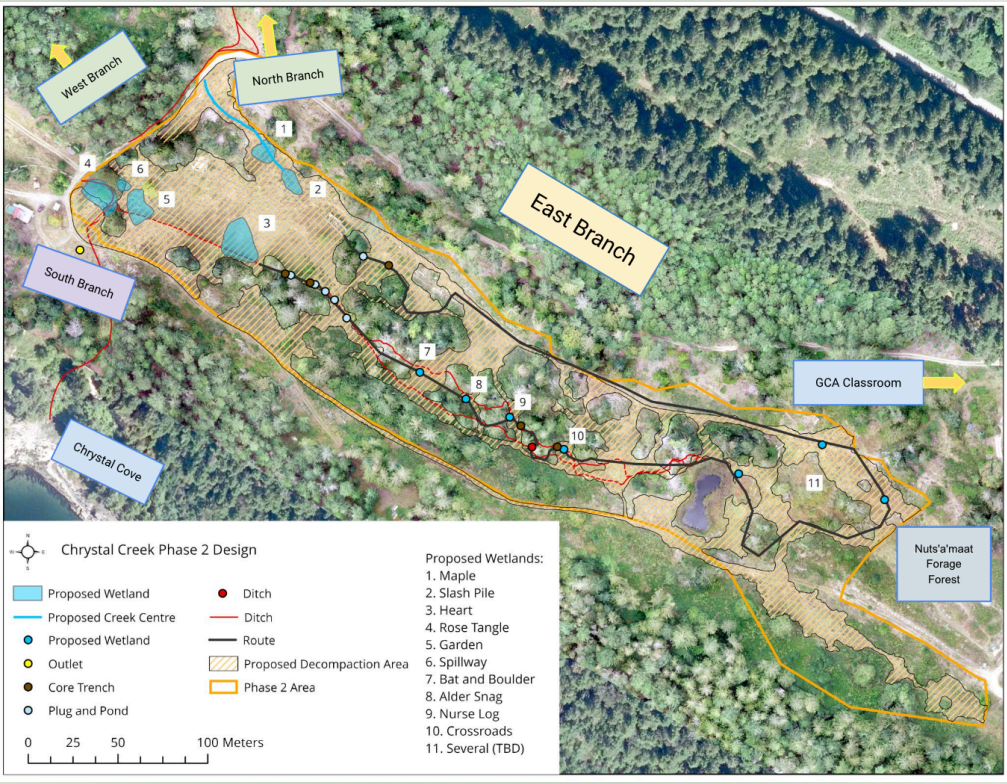


Figure 1. Map of proposed changes to the Phase 2 Site (2020). Developed by GCA, the map displays proposed changes in the East Branch. Of particular note are the current ditch paths and proposed wetland locations. The ditch pathways are currently draining all water that flows in the Chrystal Creek watershed.

3.1 Climate

The East Branch is located in the Coastal Douglas fir lowland moist maritime biogeoclimatic subzone (CDFmm1) and experiences a mesothermal climate of warm, dry summers and cool, wet winters (BC Gov, 2010). Precipitation is primarily influenced by the rain-shadow of the Olympic Mountains to the south (ClimateData, n.d.). Historically, the 28-hectare Chrystal Creek watershed was a catchment area for all precipitation in the East Branch, yet due to climate change, the site has experienced reduced annual rainfall and many winters and summers have been comparatively dry (Meteoblue, 2023; GCA, 2019). Today, approximately 80% of precipitation is drained through ditches into the Trincomali Channel, and without wetlands to capture surface water, mesic ecologies have shifted to drier conditions (GCA, 2020a). Along with human activities, climatic effects have increased the site's susceptibility to drought, which GCA has observed over the past few years (GCA, 2020a).

3.2 Soils

Galiano Island is underlain by glaciomarine bedrock that formed from high sea levels at the end of the Fraser Glaciation (Valentine et al., 1978). In the East Branch, geochemical weathering formed rich loam soils with variable sub-soil drainage regimes dependent on site topography and surrounding vegetation (BC Gov, 2015). The site's highly fertile clay soils act as a natural wetland liner, storing water and allowing aquatic processes to persist throughout dry seasons (Easton and Bock, 2016). However, long-term land use led to a compacted and degraded soil structure with poor nutrient cycling and minimal aeration, and an increasing trend of warmer temperatures has restrained the capacity of these soils to store water (Alberta Gov, 2010).

3.3 Land Use History

After millennia of sustainable living by Hul'qumi'num-speaking Indigenous peoples, the colonization of Galiano Island in the 1800's led to a multitude of land use changes. In particular, the MLC experienced ten successive land transfers since early settlement (GCA 2012; GCA, 2020b). Aerial photography reveals the East Branch was used for small-scale agriculture between 1932 and 1962, where at least a hectare was cleared and converted to a sedge and rush-dominated field (Huggins 2023, pers comms). Previous landowners drained the site's natural wetlands by digging ditches that continue to maintain an unnaturally lowered water table. Soil productivity was also severely altered by the replacement of native vegetation with agronomic grasses, and tilling compacted topographic depressions that captured surface water runoff (Parikh & James, 2012). Along with the loss of Indigenous land management systems, these activities effectively erased naturally occurring perennial and ephemeral wetlands, reducing the site's aquatic and riparian diversity.

Selective logging of high-value stands likely occurred prior agriculture (Huggins, 2023 pers comms). Between 1962 and 1996, industrial forestry contributed to habitat fragmentation, erosion, and water loss, and Western red cedar cover declined (ICT, 2012; Klinka and Brisco, 2009; Huggins, 2023, pers comms). The site continued to experience logging until GCA purchased the property in 2012. Although some regeneration has occurred since the cessation of forestry, mature cedar slash piles are scattered throughout the East Branch, indicating the size and age of trees the site once sustained. Of particular note is skyscraper-high "Grandmother Cedar" at the centre of the Nuts'a'maat Forage Forest. These Western red cedar trees require a healthy supply of water and year-round mesic soils, and the alteration of hydrological and topographical conditions have collectively constrained their regeneration today (Klinka and Brisco, 2009).

3.4 Ecological Context

The East Branch is located within a Coastal Forest Region (RCO). The lower valley is covered by a secondary growth Western red cedar and red alder *(Alnus rubra)* forest that developed along the site's historical wetlands, experiencing seasonal floods where water levels were low enough to allow woody species to flourish. The remainder areas were heavily logged and now contain open fields. Generally, Western red cedars are a common feature in coastal old growth forests and thrive in well-drained soils along the riparian zones of rivers and streams (Swayze and Simpson, 2008). These trees play an important role in forest ecology, as cedar foliage can increase forest floor decomposition and enhance soil acidity (Government of British Columbia, n.d.; Klinka and Brisco, 2009). Risks to cedar re-establishment, such as deer browsing and an altered hydrology, limit the ability for these trees to replace the stands that existed prior to logging (Klinka and Brisco, 2009). Overall, vegetation in the East Branch varies due to gradients in moisture, topography, and the intensity of past land use. Figure 2 divides the site into three zones based on this observed variation.

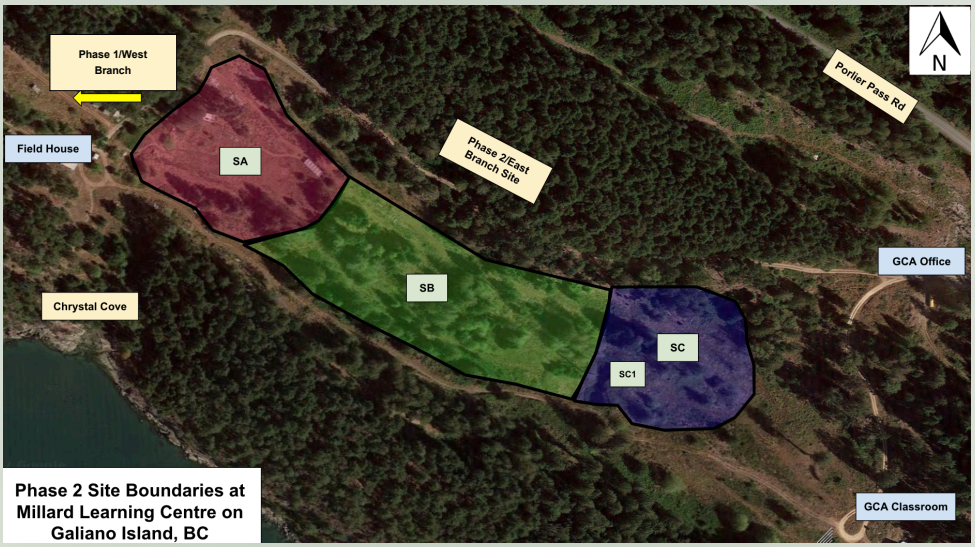


Figure 2. Division of the East Branch into three zones. Table 2 provides a breakdown of geographical information for each zone. The zones are divided based on observed boundaries; SA from SB through a linear border of Western red cedar trees; and SB from SC through the beginning of a heavily logged area.

Table 2. Division of Zones in the East Branch

	Old Field (SA)	Forested Zone (SB)	Flooded Fields (SC) / Pond (SC1)
Median Coordinates	48° 55’ 50” N, 123° 28’ 27” W	48° 55’ 47” N, 123° 28’ 20” W	48° 55’ 45” N, 123° 23’ 18” W
Size (ha)	1.72 ha	2.37 ha	1.06 ha

3.4.1 SA: Old Field

The Old Field (SA) was the centre of agriculture in the East Branch (Figure 3). The site is grass and forb-dominated, consisting primarily of common rush *(Juncus effuses)* and invasive bull thistle *(Cirsium vulgare)*. Remaining agricultural structures include old fences, bird boxes, and orchard trees, such as plum *(Prunus domestica)* and apple *(Malus domestica).* With poorly functioning and compacted soils, agronomic species like common velvet-grass *(Holcus lanatus)* have decreased landscape connectivity in being the only plants suitable for such conditions (Godfree et al., 2017). As such, this zone is comparatively low in species diversity to other areas of the East Branch.

3.4.2 SB: Forested Zone

The Forested Zone (SB) is the most biodiverse area in the East Branch (Figure 4). The upper slopes contain salal *(Gaultheria shallon),* big leaf maple *(Acer macrophyllum),* stinging nettle *(Urtica dioica)* and bracken fern *(Pteridium aquilinum)* alongside young stands of Douglas fir *(Pseudotsuga menzeisii)* and Grand fir *(Abies grandis).* Agronomic species, such as common vetch *(Vicia sativa),* proliferate in the valley flats. In this area, Western red cedars persist alongside riparian species such as sword fern *(Polystichum munitunum),* wild strawberry *(Fragaria vesca),* and coastal hedge nettle *(Stachys chamissonis).* Overall, the understory is a simplified composition of moisture-preferring facultative[1] plants typical of CDFmm1 rather than a strong association of species expected of a swamp. For example, small patches of obligate[2] species, such as skunk cabbage *(Lysichiton*

[1] Facultative (FAC) is a classification for vegetation existing both in wetland and non-wetlands (Mackenzie and Banner, 2004).

[2] Obligate (OBL) is a classification assigned to vegetation that exists only in wetlands (Mackenzie and Banner, 2004).

americanus), common bulrush *(Scirpus microcarpus),* and Pacific water parsley *(Oenanthe sarmentosa)*, persist along ditches, clinging to remnant water flows. Water is essential to this ecosystem's health, and the impacts of past land use have constrained the soil moisture regime and limited the cover of hydrophilic vegetation. Given the natural fluctuating water table, it is clear the East Branch once supported species adapted to periodic flooding of freshwater. Invasive species such as Himalayan blackberry *(Rubus americanus)*, scotch broom *(Cystisus scoparius)*, and holly *(Ilex aquifolium)* also established post-disturbance, and GCA regularly manages these invasive species today (GCA, 2021).

3.4.3 SC: Flooded Fields

The Flooded Fields are almost completely cleared save for a few yellowing cedars, a sign of soil nutrient deficiency and poor moisture (BC Gov, 2015). This zone primarily contains bulrush, slough sedge (*Carex obnupta)*, and horsetail *(Equisetum telmateia),* and a few patches of Oregon grape *(Mahonia aquifolium)* sit under a mature Western red cedar at the border of the Forested Zone. The site experiences seasonal flooding by a pond (SC1) used for irrigation during early agriculture (Figure 5). A key indicator of perennial moisture is a large patch of reed canary grass *(Phalaris arundinacea)* and an unidentified species of cattail *(Typha spp.)* surrounding a 10 metre buffer around the pond (Figure 6). Today, this pond provides northern red legged frog *(Rana aurora)* and Pacific chorus frog *(Pseudacris regilla)* habitat, with some evidence of North American beaver *(Castor canadensis)* (Figure 7) (Huggins, 2021b). Historic pipes connected to the pond have continuously drained water into the Old Field, highlighting how agricultural land use has caused long-term changes to the site's natural water flow.

Figures 3-7. From top left clockwise: SA, the Old Field; SB, the Forested Zone; SC, the Flooded Fields; signs of beaver activity near SC; SC1, the agricultural pond.

4.0 METHODOLOGY

The revegetation methodology selected for Phase 2 was specific to the geographic area and standard methods in B.C. for characterizing ecosystems and identifying pre-disturbance reference conditions. In selecting species to revegetate the East Branch, the GCA team also elected to replace plants in the West and North Branches that were unsuccessful the previous year to maintain density. A summary of the methodology is in Table 3.

Table 3. Methodological Timeline of Project Activities (Phase 2) January - November 2022

Stage	Activity	J	F	M	A	M	J	J	A	S	O	N
Data Collection	Plant Inventory											
	TEM survey and ISG analysis											
	Plant Selection											
Site Preparation	Wetland Design											
	Structure and Invasive Removal											
	Decompaction (Wetland Creation)											
Planting	Caged Replacement (North Branch)											
	Caged Replacement (West Branch)											
	Fenced/Caged Planting (East Branch)											

4.1 Plant Inventory

Data collection in January, February, and March 2022 provided a baseline of ecological conditions in the East Branch. Fieldwork included a plant inventory and documentation of potential influences on plant distribution and priority areas for revegetation.

4.1.1 Tools

The plant inventory took place on January 7 and February 26, 2022, focusing on species ID and cover (%). iNaturalist was used for interim identification and the *Plants of Coastal British Columbia* guide later confirmed ID (Pojar & Mackinnon, 2004). The inventory was completed in 12 sample plots measuring approximately 20m x 20m, selected based on observed changes in topography and vegetation, with a bias towards south-facing slopes due to the easily navigable terrain (Figure 14, see page 14).

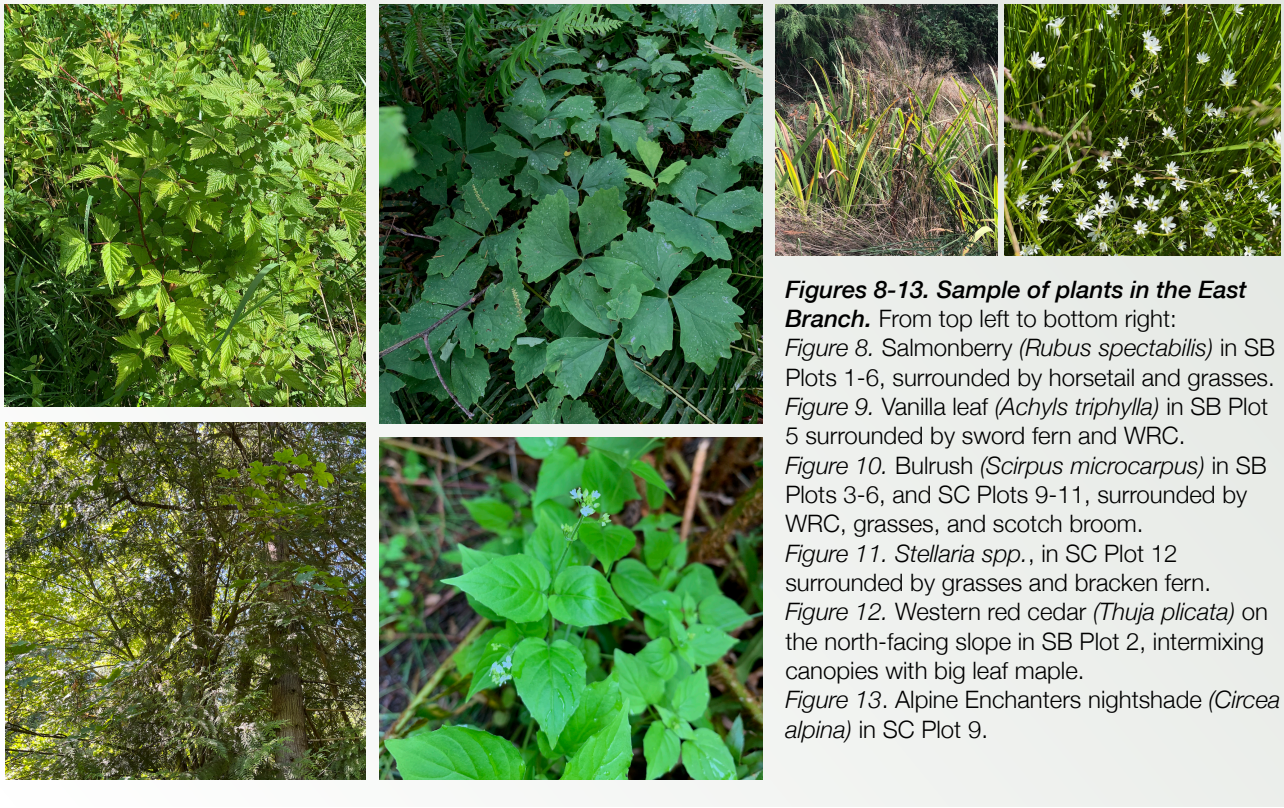
4.1.2 Results

82 species were identified in the East Branch, with some insight from GCA's team (sample listed in Figures 8-13, full list in Appendix A). The Old Field was chosen as the priority for revegetation due to the intensity of past land use and low plant diversity compared to the Forested Zone and the Flooded Fields. Plants with the highest distribution, summarized in Table 4, were determined by calculating the proportion of total species identified to relative cover in all sample plots. The results were expected, with Western red cedar and sword fern the most commonly occurring species in their classes. Overstory cover appears low (14.3%) as the Flooded Fields and Old Field are almost completely cleared. Although common vetch had the highest cover in the herbaceous layer, this

species is introduced and not a useful representation of reference conditions. The low cover of obligate species confirms that past land use, introduced species, and an altered hydrology have reduced wetland-specific species on-site.

Table 4. Summary of Cover Classes in the East Branch

Code	Class	Total Class Cover Across all Plots (n=12)	Species with Highest Distribution	Total Species Cover Across all Plots (n=12)
A	Overstory	14.3%	Western red cedar *(Thuja plicata)*	28%
B	Shrubs	51.4%	Sword fern (*Polystichum munitum)*	17%
C	Herbaceous	34.3%	Common vetch *(Vicia sativa)*	21%



Figures 8-13. Sample of plants in the East Branch. From top left to bottom right:
Figure 8. Salmonberry *(Rubus spectabilis)* in SB Plots 1-6, surrounded by horsetail and grasses.
Figure 9. Vanilla leaf *(Achyls triphylla)* in SB Plot 5 surrounded by sword fern and WRC.
Figure 10. Bulrush *(Scirpus microcarpus)* in SB Plots 3-6, and SC Plots 9-11, surrounded by WRC, grasses, and scotch broom.
Figure 11. Stellaria spp., in SC Plot 12 surrounded by grasses and bracken fern.
Figure 12. Western red cedar *(Thuja plicata)* on the north-facing slope in SB Plot 2, intermixing canopies with big leaf maple.
Figure 13. Alpine Enchanters nightshade *(Circea alpina)* in SC Plot 9.

4.2 Terrestrial Ecosystem Map

The purpose of a Terrestrial Ecosystem Map (TEM) is to identify the site series, or the vegetation that would be present at maturity pre-disturbance (Ministry of Forests, 2010a). This method was the primary tool for strategizing revegetation and would also support plant placement based on site series locales. The TEM was guided by the *Field Manual for Describing Terrestrial Ecosystems*, 2nd Ed. (2010a) and was informed by early data collection, including observed site anomalies and existing species cover recorded during the plant inventory.

4.2.1 Tools

The TEM occurred on June 11 and June 26, 2022 in the Forested Zone and the Flooded Fields, as another student completed a TEM in the Old Field. Tools included a remote GPS, shovels, and a

Trimble GNSS receiver system. The Trimble mapped polygons and sample plot points on-site which were later corrected in ArcDesktop (8.1). Twelve soil pits measuring 30cm x 60cm were dug in the same sample plots as the plant inventory (Figure 14-15). The survey used a Ground Inspection Form[3] and analyzed soil texture, drainage and nutrient regimes, as well as site modifiers[4] (see Appendix B). Site series were determined using vegetation summary tables in the *Field Manual* (2010a).

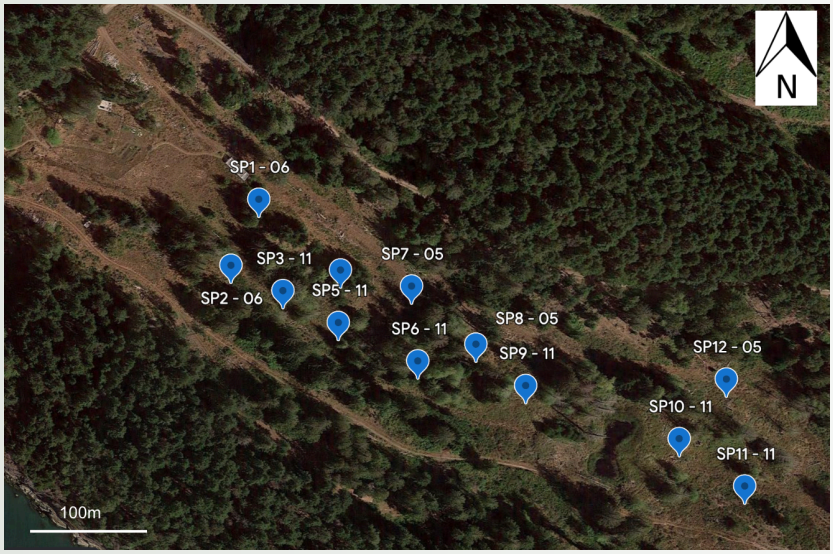


Figure 14. Sample plots in the East Branch.

Figure 15. Soil pit in the Flooded Fields (2022)

4.2.2 Results

Site series in the East Branch include 05, 06, and 11 (Table 5, Figure 16). The nutrient regime is *Rich/ Very Rich* and the drainage regime varies from *Poor* in the the valley flats to *Moderate* in the upper slopes. Surficial soil type also varies from sandy loam (SL) to clay loam (CL) based on topographical position.

Table 5. Site Series in the East Branch

Plot	Site Series	Zone	Position	Aspect	Texture	Humus	Drainage	Stage	Stand	SMR	SNR	Code
1	06 Cw - Fd / Foamflower	SB	Low Slope	South	SCL	Moder	Poor	5 (Young Forest)	Mixed	6	R/VR	RF5Cjfwv
2	06 Cw - Fd / Foamflower	SB	Low Slope	South	SCL	Moder	Poor	5 (Young Forest)	Conifer	6	R/VR	RF5Mfwv
3	11 Cw - Skunk Cabbage	SB	Flats	South	CL	Moder	Poor	5 (Young Forest)	Mixed	7	R/VR	RC5Mdfywv
4	06 Cw - Fd / Foamflower	SB	Low-Mid Slope	South	SiL	Moder	Poor	5 (Young Forest)	Conifer	6	R	RF5Cjfwv

[3] Ground Inspection Forms are available in the *Field Guide:* https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/ecosystems/bec/codes-standards/gif_frm98.pdf

[4] Site modifiers are included in a TEM based on atypical features in a landscape, such as disturbances from last use history, invasive species, and herbivore browsing.

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Plot	Site Series	Zone	Position	Aspect	Texture	Humus	Drainage	Stage	Stand	SMR	SNR	Code
5	11 Cw - Skunk Cabbage	SB	Flats	South	CL	Moder	Poor	5 (Young Forest)	Mixed	7	R/VR	RC5Mdfywv
6	11 Cw - Skunk Cabbage	SB	Flats	South	CL	Moder	Poor	5 (Young Forest)	Mixed	7	R/VR	RC5Mdfwv
7	05 Cw - Bg / Kindbergia	SB	Mid-Slope	East	SL	Moder	Moderate	5 (Young Forest)	Conifer	6	M	RK5Cjgwv
8	05 Cw - Bg / Kindbergia	SB	Mid-Slope	North	SiL	Moder	Moderate	5 (Young Forest)	Conifer	5	M	RK5Cjfwv
9	11 Cw - Skunk Cabbage	SC	Flats	East	CL	Moder	Poor	3 (Shrub)	N/A	7	R/VR	RC3dabfw
10	11 Cw - Skunk Cabbage	SC	Flats	North	CL	Moder	Poor	3 (Shrub)	N/A	7	R/VR	RC3dafw
11	11 Cw - Skunk Cabbage	SC	Flats	South	SC	Moder	Imperfect	3 (Shrub)	N/A	7	R/VR	RC3hjfwv
12	05 Cw - Bg / Kindbergia	SC	Low-Mid Slope	South	SC	Moder	Moderate - Poor	3 (Shrub)	N/A	5	R/VR	RK3jxfwv

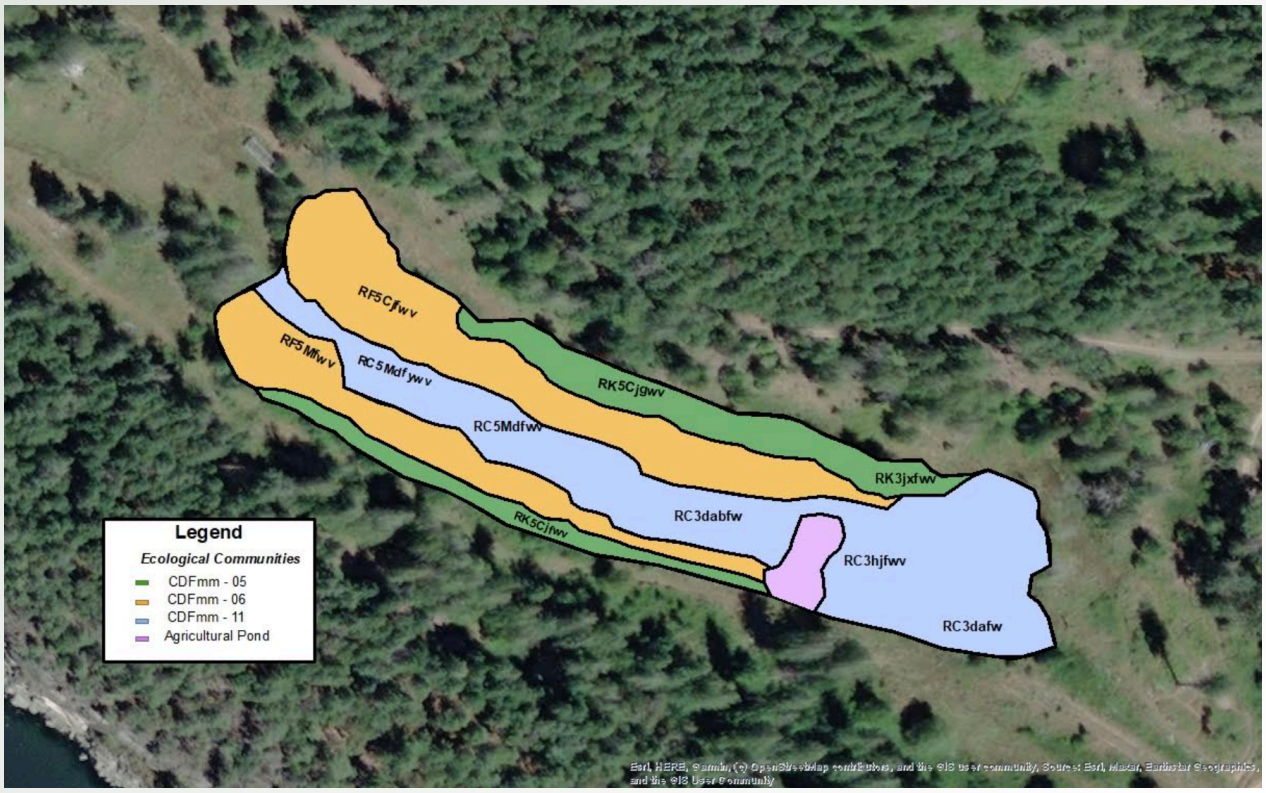

Figure 16. Completed TEM for the East Branch. Note that 06 series RF5Cjfwv is represented by 3 soil pits sharing the same TEM code. RV5Mdfwv comprises 2 soil pits.

05 Cw-Bg

The 05 zone contains light and red sandy loam soils (SL). Decomposing cedar bark indicates a lower pH typical of Western red cedar forests. There was no seepage, and streaks of oxidation and sharper pebbles suggest moderate drainage in the free movement of air and water. The sites contained some mesic species with patches of open canopy supporting subxeric species in SP12, such as *Stellaria* spp. (potentially *S. pallida* or *S. graminea*). This moisture change reflects a fluctuating water table in the transition between 05 and 06 site series.

06 Cw-Fd

The 06 zone dominates the low slopes of the East Branch. The Ah horizon contains silty loam (SiL) and silty clay loam (SCL) soils. Mottling and seepage were present in each sample plot by 30 cm, with SP1 containing charcoal at 25 cm that may be the result of past fire and/or occupation. The south-facing slopes experience more sun and were comparatively drier to the north-facing slopes, supporting submesic soils suitable for species such as bracken fern and Douglas fir. Vanilla leaf *(Achlys triphylla)* on the north-facing slopes point to a mesic moisture regime, likely due to shade from Western red cedars and big leaf maples. Rounded pebbles indicate a fluctuating water table.

11 Cw- Skunk Cabbage

The 11 zone is dominated by Western red cedar and red alder trees with an understory of bulrush, hedge nettles, horsetail, and a large patch of slough sedge in SP9, which also contained evidence of beaver cutting. These species indicate the site supports a hygric-subhydric moisture regime and experiences year-round wet conditions. Seepage was immediate at the 15 cm mark and soils contain both gleying and mottling, indicating poor drainage and anaerobic conditions (Ministry of Forests, 2010b). SP11 unknowingly took place on an old soil pile leftover from digging the pond, reflecting the *Imperfect* drainage regime. High seepage made analysis challenging, although it was evident the soil texture was sandy clay (SC) at SP11, an 05 transition point, and clay loam (CL) in the valley flats as strong casts were easily formed.

The TEM revealed the valley edges are “mirrors” as the upper slopes transition from 05 to 06 in the low slopes, and 06 transitions to 11 in the valley. The 11 diagnostic contrasts the current low cover of subhydric species in this zone, suggesting the influence of ditches on the natural water table. The pre-disturbance moisture regime is therefore one series wetter than it appears, and Western red cedars should have highest cover in the 06 zones under a natural hydrological regime. Overall, Vegetation Summary Tables in the *Field Manual* (2010a) provided a list of species that occur in 05, 06, and 11 series, which informed plant selection as not every species was present (Table 6).

Table 6. Vegetation Summary Tables for each site series (Ministry of Forests, 2010a).

Latin name	Occurring Species	Site Series
Pseudotsuga menzeisii	Douglas fir	05
Thuja plicata	Western red cedar	05, 06, 11
Cornus nuttallii	Pacific dogwood	06
Acer macrophyllum	Bigleaf maple	06, 11
Gaultheria shallon	Salal	05, 06, 11
Rosa gymnocarpa	Baldhip rose	05
Holodiscus discolor	Oceanspray	05

Latin name	Occurring Species	Site Series
Polystichum munitum	Sword Fern	05, 06, 11
Achlys triphylla	Vanilla Leaf	05, 06
Pteridium aquilinum	Bracken Fern	05
Oemleria cerasiformis	Osoberry	11
Rubus spectabilis	Salmonberry	11
Sambucus racemosa	Red elderberry	11
Tiarella trifoliata	Three-leaved foamflower	06, 11
Lysichitum americanum	Skunk cabbage	11

4.2 Indicator Species Group Analysis

Indicator Species Group (ISG) analysis (from Klinka et al., 1989) evaluates the suitability of a species to its relative environment (Ministry of Forests, 2010a). This analysis was informed by the *Field Guide* (2010a) and was chosen to identify which on-site species to plant more of, based on suitable ecological profiles for expected conditions in the new wetland landscape. ISG analysis is fine-scale and applies to a wide range of successional stages, especially in disturbed sites, whereas vegetation summary tables (used in the TEM) are more reliable on a coarse scale for mature forests and well-developed understories (Ministry of Forests, 2010a). Given the East Branch consists of mixed stands and has undergone continued disturbance, combining methods increases accuracy of the site series.

4.2.1 Tools

The ISG analysis was guided by the *Field Manual* (2010a) and the the *Plants of Coastal British Columbia* (Pojar & Mackinnon, 2004). Combining the results of the TEM and the plant inventory, species found in the East Branch were grouped together based on moisture and nutrient preferences. The objective was to to identify the Indicator Value (IV), or the highest distribution of species sharing a similar ecology, based on cover class:

$$\mathrm{IV} = 100\ (\mathit{Cover} \times \mathit{Frequency})$$

The resulting ISG profiles created a “plant database”, revealing which existing species to increase in cover in the new wetland landscape.

4.2.2 Results

Final ISG categories (Table 6) confirm that IV scores in each sample plot adhere to the site series identified in the TEM: the majority of plants in the East Branch prefer a mesic moisture regime (SMR 4) and a rich to very rich nutrient regime (SNR 3), characteristic of 05 and 06. SMR 5 and SNR 2 IVs accurately reflect the 11 series, which experience more water and poorer nutrient cycling. Given the high IVs of SMR 4 and SNR 3 across the site, species in this profile were chosen for planting. This included sword fern, salmonberry, and red alder. Obligate wetland species (SMR 5), including skunk cabbage, bulrush, and slough sedge, were debated for plant selection but were ultimately excluded considering the threat of climate change; facultative plants would enhance adaptability in periods of drought.

Table 6. ISG Analysis Results

Plot	Representative Moisture Class (SMR)	Representative Nutrient Class (SNR)
1	4 (Fresh-Very Moist) / IV: 32.76	3 (Rich-Very Rich) / IV: 86.86
2	4 (Fresh-Very Moist) / IV: 82.28	3 (Rich-Very Rich) / IV: 101.08
3	4 (Fresh-Very Moist) / IV: 101.40	3 (Rich-Very Rich) / IV: 28.38
4	4 (Fresh-Very Moist) / IV: 67.08	3 (Rich-Very Rich) / IV: 64.77
5	4 (Fresh-Very Moist) / IV: 77.28	3 (Rich-Very Rich) / IV: 104.00
6	4 (Fresh-Very Moist) / IV: 83.93	3 (Rich-Very Rich) / IV: 136.22
7	3 (Moderately Dry-Fresh) / IV: 52.00	3 (Rich-Very Rich) / IV: 113.19
8	4 (Fresh-Very Moist) / IV: 76.16	3 (Rich-Very Rich) / IV: 96.48
9	5 (Very Moist-Wet) / IV: 88.20	2 (Medium) / IV: 46.41
10	5 (Very Moist-Wet) / IV: 34.96	3 (Rich-Very Rich) / IV: 48.06
11	4 (Fresh-Very Moist) / IV: 91.76	3 (Rich-Very Rich) / IV: 88.33
12	4 (Fresh-Very Moist) / IV: 28.38	2 (Moderate) - 3 (Rich-Very Rich) / IV: 24.00

4.3 Plant Selection

The EcoAction research grant provided a $10,000.00 budget for plants. A total of 697 native B.C. plants, sized 4 inches, 1 gallon, and 2 gallon, were sourced from GCA's nursery. 585 red alder *(Alnus rubra)* plugs were purchased from the NATS nursery and a community member donated 16 black hawthorn (*Crataegus douglasii)*. Early successional riparian trees, such as red osier dogwood *(Cornus stolonifera sericea)* and black cottonwood *(Populus balsamifera trichocarpa),* were chosen to eventually be replaced by Western red cedars in late succession. Obligate wetland species and high-demand species, such as Pacific dogwood *(Cornus nuttallii),* were challenging to find. "Showy" shrubs like currant *(Ribes spp.)* and mock orange *(Philadelphus lewisii)* were selected for the Old Field to encourage visitors. All species were chosen using the *Plants of Coastal British Columbia* (2014) guide and through consultation with GCA, basing selections on geographic distribution and wetland suitability.

The full list of purchased plants is in Table 4, which are categorized according to size and moisture preferences as the nutrient regime in the East Branch is relatively ubiquitous. Occurrence data is based a species' natural presence in the East Branch prior to restoration treatment.

Table 7. Species Selected for Revegetation in the East Branch and Zones Planted

Latin name	Western Name	Occurrence	4"	1g	2g	Xeric - 05	Mesic - 06	Hygric - 11
Acer glabrum	Douglas maple	New	0	10	0	I	I	
Acer macrophyllum	bigleaf maple	Existing	0	7	0	I	I	
Alnus rubra	red alder	Existing	585	0	0		I	I
Amelanchier alnifolia	Saskatoon berry	Existing	0	5	0	I		

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Latin name	Western Name	Occurrence	4”	1g	2g	Xeric - 05	Mesic - 06	Hygric - 11
Cornus stolonifera sericea	red osier dogwood	New	0	68	0			I
Crataegus douglasii	black hawthorn	New	16	28	0			I
Lonicera ciliosa	orange honeysuckle	New	0	4	0		I	
Lonicera hispidula	hairy honeysuckle	Existing	0	5	0	I		
Malus fusca	Pacific crab apple	Existing	0	8	0		I	I
Oemleria cerasiformis	osoberry	Existing	0	17	0		I	
Oenanthe sarmentosa	Pacific water parsley	Existing	0	15	0			I
Populus balsamifera trichocarpa	black cottonwood	New	0	27	0			I
Polystichum munitum	sword fern	Existing	0	40	0		I	
Rhamnus purshiana	cascara	New	0	10	1	I	I	
Ribes bracteosum	perfume currant	New	0	7	0		I	I
Philadelphus lewisii	mock orange	New	0	5	0		I	
Physocarpus capitatus	Pacific ninebark	New	0	20	0		I	I
Ribes divaricatum	wild gooseberry	New	0	10	0		I	
Ribes lobbii	gummy gooseberry	New	0	5	0	I		
Ribes sanguineum	red flowering currant	Existing	0	6	0	I	I	
Rosa gymnocarpa	baldhip rose	Existing	0	19	0	I		
Rosa nutkana	Nootka rose	Existing	0	13	0		I	
Rubus parviflorus	thimbleberry	Existing	0	17	0		I	
Rubus spectabilis	salmonberry	Existing	0	19	0		I	I
Salix lucida	Pacific willow	New	0	53	0			I
Salix scouleriana	Scouler's willow	Existing	0	26	0			I
Sambucus racemosa	red elderberry	Existing	0	9	0		I	I
Spirea douglasii	hardhack	New	0	12	0		I	I
Thuja plicata	Western red cedar	Existing	0	20	0		I	
Tiarella trifoliata	foamflower	Existing	0	10	0		I	
Vaccinium ovatum	evergreen huckleberry	Existing	0	3	0		I	
Viburnum edule	highbush cranberry	New	0	8	0	I		

5.0 REVEGETATING THE EAST BRANCH

Planting took place between November 26-28, 2022. Volunteers from the Galiano Island community and the UVic Ecological Restoration Club (ERC) helped to plant the Old Field, while the GCA team planted in the Forested Zone and Flooded Fields due to the more difficult terrain.

5.1 Lessons Learned from Phase 1

Revegetation for Phase 2 was informed by the limitations and successes of Phase 1. In the North and West Branches, GCA distributed 8 plants in twenty-three 5 x 5 metre plots using plant plugs, seed mixes, and live-stakes. Seeding had limited success and densification may have yielded better results as agronomic grasses quickly returned by spring 2022. GCA also determined red alders would fare better if planted in the spring than in the fall. For Phase 2, planting container nursery stock around priority areas was a better adaptive management practice and a more strategic use of the available budget. To manage invasive species, more pioneer trees were sourced in Phase 2 to increase the rate at which herbaceous invasives would be shaded out over time. Black-tail deer browsing is also a current management problem at the MLC, and in Phase 1, the entire site was fenced. To ensure a stable deer population for GCA's *Feed the People* initiative, it was decided to fence the Old Field and use cages in the Forested Zone and Flooded Fields. This would preserve budget, allow deer to remain in relative abundance around the caged areas, and protect the Old Field, which would receive the most intensive treatment. Therefore, in contrast to Phase 1's standardized and experimental approach, the revegetation strategy for Phase 2 was adaptive and prescriptive.

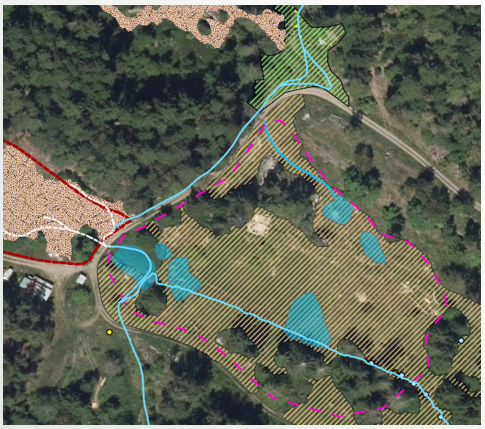

Figure 17. Map of the fenced area in pink dashed lines around the Old Field.

5.2 Site Prepration

Old structures were disassembled in the summer of 2022. In June, volunteers from the Vancouver Island Decade on Ecological Restoration (VIDER) removed invasive yellow flag iris *(Iris pseudacorus)* from a pond at the corner of the Old Field, as well as holly, scotch broom, and blackberry using pull-bearers (Figure 18). Decompaction work occurred in mid-November 2022 after a period of rainfall. The Old Field was transformed into a heterogeneous landscape with the help of an expert excavator, who constructed a stream, wetlands, and spillways to channel water from the North and West Branches into the new wetlands in the East Branch (Figure 19-20). The team applied fine-scale decompaction in the Forested Zone and Flooded Fields to avoid disturbing existing tree stands and native vegetation, and core-trenched ditches to restore the water table. The agricultural pond (SC1) was retained, expanded, and enhanced to improve its existing habitat value.

5.3 Planting

Immediately following excavation, the GCA team collected and seeded slough sedge *(Carex obnupta)* and bulrush *(Scirpus microcarpus)* in the Old Field and live-staked black cottonwood in the new wetland spillways. 494 plants were planted by hand in the fenced Old Field, and 203 were planted across the Forested Zone and Flooded Fields in cages. During the November planting event, volunteers cut 1-foot holes in burlap for placement around plants and staked bamboo branches to

easily indicate plant location. Species were planted according to a standardized method, with trees placed 2m apart and shrubs placed between 1m to 1.5m apart to densify open spaces. Based on the TEM and ISG results, placement was primarily dependent on site series, species ecology, and topographical conditions. For example:

- Western red cedars prefer mounded soils, and saplings were placed upon higher peaks around the wetlands.
- The border between Old Field and the Forested Zone contained young Western red cedars surrounding a few salmonberry shrubs. More salmonberry was planted here to increase cover, alongside thimbleberry due to the similar ecology.
- The decompacted area had large quantities of clay and only clay-preferring plants, such as hairy honeysuckle *(Lonicera hispidula),* were planted there.
- Pacific water parsley was the only emergent species purchased and roots were tossed into the wetland pits for eventual regrowth.

The approach for the remainder of the site was to place species based on moisture regime, increasing mesic and dry-adapted species along the upper slopes near the road and early-successional riparian trees such as cascara, red osier dogwood, and Pacific willow near the wetland edges. Planting was completed by November 28, 2022, and GCA began monitoring shortly after. The red alders were set aside for planting in March 2023, and an additional 16 black hawthorns were planted in April 2023.

Figures 18-22. *Clockwise from top left.*
Figure 18. VIDER volunteers at the invasive removal event.
Figure 19. Excavator activity in the East Branch (Huggins, 2022).
Figure 20. Decompaction in the Old Field.
Figure 21. Image of the Old Field on November 26. Red osier dogwood plugs wait to be planted.
Figure 22. Image of approximately 300 pots from Day 1, surrounded by burlap.

6.0 MONITORING

By January 2023, water was actively flowing in the East Branch and the new wetlands readily captured winter precipitation. The new hydrological infrastructure connected surface water flows from the North Branch and West Branch to the East Branch, bringing *Cedars for the Next Century* a step closer in the goal to restore the Chrystal Creek watershed. A 2019 test pit in the Old Field held water year-round, and considering the 11 site series in the low valley, it is likely that the wetlands in the East Branch will be perennial and smaller pools may experience ephemerality in the summer.

Figures 23-24. Restored wetland landscape in the Old Field (February 2023, Huggins). Active spillways channeled through a new culvert; west-facing view.

Vegetation success will not be visible for several months after planting. Monitoring strategies for the East Branch were replicated from Phase 1, with one new suggestion to adhere to the overarching goal of C*edars for the Next Century* (Table 8). The ideal scenario would be to monitor plant success over a five-year period and supplement cover after one year, and inform the final Phase 3 plant selection based Phase 2 success. Future direction includes habitat mapping to monitor how the wetlands influence wildlife populations, and continued invasive species management.

Table 8. Recommended Monitoring for the East Branch

Monitoring Strategy	Description
Repeat Photography	Setting up permanent photo plots in the East Branch in each zone to capture vegetation growth over time. This method also monitors water levels.
Spillway armoring	GCA is working with BCIT students in spring 2023 to armour spillways with livestakes, logs, and rocks to prevent erosion.
Hydrophone monitoring	GCA is using hydrophones to monitor abundance/presence of Northern red legged frogs, Pacific chorus frogs, and other amphibians habituating in the wetlands.
Survival monitoring	GCA is monitoring vegetation survival for each plot according to species type (trees, shrubs, forbs, graminoids) based on percent (%) cover.
Western Red Cedar mapping (New)	Recommendation to develop a GIS mapping strategy for Western red cedar regeneration over time, based on current distribution and changes over five years to identify the influence of hydrological restoration on cover.

With the ecological aspects of Objective 4 complete, the social aspects of *Cedars for the Next Century* continue into the future. In April 2023, GCA held a Supporter Appreciation Event with 54 Galiano Island community members that included a presentation of the new wetland landscape in the East Branch. While the East Branch will experience minimal human intervention to enhance its biodiversity value, GCA will continue to engage with the Galiano Island community on environmental education and collaborate with Indigenous peoples to create multi-purpose human-environment management systems within the restored wetland landscapes at the MLC.

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Appendix A. List of Existing Species in the East Branch - Prior to Restoration Treatment

Latin Name	Western Name	Zone	Slope Position	Moisture
Abies grandis	Grand fir	SB	Mid-Slope	Mesic
Acer macrophyllum	Big leaf maple	SB	Upper Slope	Mesic
Achlys triphylla	Vanilla leaf	SB	Flats	Wet
Aesculus hippocastanum	Horse chestnut	SB, SC	Flats	Dry
Agrostis capillaris	Colonial bentgrass	SA, SB, SC	Entire Site	Mesic
Agrostis stolonifera	Creeping bentgrass	SA, SB, SC	Entire Site	Mesic
Alnus ruba	Red alder	SB	Flats	Wet
Anaphalis margaritacea	Pearly everlasting	SA, SB, SC	Mid-Slope, Upper Slope	Dry
Anthoxanthum odoratum	Sweet vernal grass	SA, SB, SC	Flats	Mesic
Arctium	Burdock	SA, SB	Flats	Dry
Athyrium filix-femina	Lady fern	SB, SC	Flats	Wet
Carex obnupta	Slough sedge	SB, SC	Flats	Wet
Carex pallescens	Pale sedge	SA, SB, SC	Flats, Mid-Slope	Mesic
Centaurium erythraea	Common centuary	SA, SB, SC	Entire Site	Dry
Circaea alpina	Alpine enchanter's nightshade	SA, SB, SC	Flats	Wet
Cirsium arvense	Canada thistle	SA, SB, SC	Mid-Slope, Upper Slope	Dry
Cirsium vulgare	Bull thistle	SA, SB, SC	Mid-Slope, Upper Slope	Dry
Cladonia asahinae	Western pixie cup	SB	Flats	Mesic
Cladonia macilenta	Lipstick powderhorn	SA, SB, SC	Flats	Mesic
Dactylis glomerata	Orchard grass	SA, SB, SC	Entire site	Dry
Dicranum scoparium	Broom moss	SC	Mid-Slope	Mesic
Digitalis purpurea	Foxglove	SB, SC	Mid-Slope	Dry
Equisetum telmateia	Horsetail	SB	Flats	Wet
Fragaria vesca	Wild strawberry	SB	Flats	Mesic
Galium aparine	Cleavers	SB	Mid-Slope	Mesic
Gaultheria shallon	Salal	SB, SC	Mid-Slope, Upper Slope	Mesic

Gamochaeta ustulata	featherweed	SA, SB, SC	Mid-Slope, Upper Slope	Dry
Holcus lanatus	Velvet grass	SA, SB, SC	Entire Site	Mesic
Holodiscus discolor	Oceanspray	SB	Mid-Slope	Mesic
Hordeum murinum	Wall barley	SB, SC	Flats	Dry
Hypochaeris radicata	Hairy cat's ear	SB, SC	Mid-Slope	Dry
Juncus articulatus	Articulated rush	SA, SB, SC	Flats	Mesic
Juncus bolanderi	Bolander's rush	SA, SB, SC	Flats	Mesic
Leucanthemum vulgare	Oxeye daisy	SA, SB, SC	Flats	Dry
Linnaea borealis	twinflower	SA, SB, SC	Flats	Mesic
Lotus corniculatus	Bird's-foot trevoil	SA, SB, SC	Flats	Dry
Juncus effusus	Soft rush	SA, SB, SC	Flats, Mid-Slope	Mesic
Lysimachia latifolia	Western starflower	SA, SB, SC	Mid-Slope, Upper Slope	Dry
Lysichiton americanus	Skunk cabbage	SB, SC	Flats	Mesic
Mahonia aquifolium	Oregon grape	SB	Mid-Slope	Mesic
Malus domestica	Apple	SA	Mid-Slope	Mesic
Mentha arvensis	American cornmint	SA, SB, SC	Entire Site	Mesic
Mimulus moschatus	Musk monkeyflower	SA, SB, SC	Flats	Mesic
Mycelis muralis	Wall lettuce	SA, SB, SC	Flats	Wet
Myosotis laxa	Bay forget-me-not	SA, SB, SC	Flats	Wet
Oenanthe sarmentosa	Pacific water parsley	SA, SB, SC	Flats	Wet
Oregon eurhynchium	Oregon beaked moss	SB	Mid-Slope	Mesic
Phalaris arundinacea	Reed canary grass	SA, SC	Flats	Wet
Poa pratensis	Kentucky bluegrass	SA, SB, SC	Entire Site	Mesic
Polystichum munitunum	Sword fern	SA, SB, SC	Entire Site	Mesic
Prunus domestica	Common plum	SA	Flats	Mesic
Pseudotsuga menzeisii	Douglas fir	SA, SB, SC	Mid-Slope, Upper Slope	Mesic
Pteridium aquilinum	Bracken fern	SA, SB, SC	Flats	Dry
Ranunculus repens	Creeping buttercup	SA, SB, SC	Entire Site	Dry

Rhytidiadelphus triquetrus	Big shaggy moss	SB	Mid-Slope	Mesic
Rumex spp.	dock	SA, SB, SC	Entire Site	Dry
Rosa gymnocarpa	Baldhip rose	SA, SB	Upper Slope	Mesic
Rosa nutkana	Nootka rose	SA, SB	Mid-Slope	Mesic
Rosa rubiginosa	sweet-briar	SA, SB, SC	Entire Site	Mesic
Rubus armeniacus	Himalayan blackberry	SA, SB, SC	Mid-Slope	Dry
Rubus laciniatus	Cut leaf blackberry	SA, SB, SC	Mid-Slope	Dry
Rubus parviflorus	Thimbleberry	SB	Mid-Slope	Mesic
Rubus spectabilius	Salmonberry	SB	Mid-Slope, Flats	Wet
Rubus ursinus	Trailing blackberry	SB	Flats	Mesic
Sanicula crassicaulis	Pacific sanicle	SA, SB, SC	Entire Site	Dry
Schedonorus arundinaceus	Meadow fescue	SA, SB, SC	Entire Site	Dry
Scirpus microcarpus	Small-headed Bulrush	SB, SC	Flats	Wet
Silene coronaria	Rose campion	SA, SB, SC	Mid-Slope, Upper Slope	Dry
Spiranthes romanzoffiana	Hooded ladies' tresses	SA, SB, SC	Flats	Mesic
Stachys chamissonis	Coastal hedge nettle	SB, SC	Flats	Wet
Stellaria graminea	Lesser stitchwort	SA, SB, SC	Mid-Slope, Upper Slope	Dry
Struthiopteris spicant	Deer fern	SA, SB, SC	Flats, Mid-Slope	Mesic
Taxus brevifolia	Western yew	SA, SB, SC	Flats	Mesic
Thuja plicata	Western red cedar	SA, SB, SC	Entire Site	Mesic
Typha spp.	cattail	SA, SB, SC	Flats	Wet
Urtica diotica	Stinging nettle	SB	Upper slope	Mesic
Usnea spp.	Beard lichen	SB	Mid-Slope	Mesic
Vaccinium parvifolium	Red huckleberry	SB	Mid-Slope	Mesic
Veronica americana	American speedwell	SB, SC	Flats	Wet
Veronica scutellata	Marsh speedwell	SA, SB, SC	Flats	Wet
Vicia cracca	Tufted vetch	SA, SB, SC	Flats	Wet
Vicia sativa	Common Vetch	SA, SB, SC	Flats	Mesic

Appendix B. Ground Inspection Form for Sample Plot 1

Category	Result	Notes
Soil Pit Coordinates	48° 55’ 49” N, 123° 28’ 23” W	N/A
Aspect	South	South-facing slope with minimal tree cover; experiences sun through the day.
Meso Slope Position	Low-Mid Slope	
Soil Drainage	Poor	Ah horizon contained well-decomposed organic matter (WRC) bark. Earthworms present. Orange mottling evident at 20 cm with clay at 30 cm. Seepage at 60 cm. Charcoal also present.
Mineral Soil Texture	Sandy Loam	Drainage appears efficient until clay layer. Seepage further indicates poor drainage.
Humus Form	Moder	Not a mor considering limited fungal evidence. Earthworms present, showing decomposition by fauna is active, a moder indicator.
Moisture	Mesic	Soil was relatively dry considering recent rainfall and gentle slope, but still damp to the touch and formed a cast easily. Suggests presence of clay and poor drainage.
Coarse Fragment Content	20%	Coarse fragments (pebbles) were present but composed less than 20% of total sample. Pebbles were rounded, indicating presence of a fluctuating water table.
Soil SMR:	6	Indicator: Water seepage at 60 cm deep
Soil SNR:	R/VR	Indicator: Wet, dark soil with thin Ah horizon

Code	Modifier	Description
5	Structural Stage: Young Forest	Overstory constitutes maturing WRC and Grand Fir. Recent disturbance (40-80 years), presence of WRC saplings and mixed understory indicates composition and structure expected at fully climax forest has not yet developed.
C	Stand composition: Conifer	> 75% of total tree cover is coniferous
j	Topography: Gentle Slope	The site series occurs on gently sloping topography
f	Soil texture: fine textured soils	Fine-textured soils
w	Wildlife grazing/browsing	Deer browsing is a known disturbance on Galiano. Preventative plant regrowth.
v	Aggressive Vegetation	Agronomic grasses crowd out native shrubs.