Restoration and Learning Gardens in Georgia Park

Prepared by Rhia J. Ironside (rhia@ironside.ca)

For the project component of the Restoration of Natural Systems Diploma

University of Victoria

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Executive Summary

Georgia Park is a 2 hectare parcel of land in the southern end of Campbell River, BC. Impacted by construction during the 1990's, the land is disturbed by soil compaction, altered hydrology and invasive plant species. Inspired by Lisa Walls, a teacher at Georgia Park Elementary, Greenways Trust got engaged to fund restoration work on the site in the spring of 2018. This project offers a vegetation survey of the site and plans for creating two native plant learning gardens for students and teachers to use as an educational resource as well as recommendations for blackberry removal and native species planting. The project was implemented in the fall of 2018 with mechanical removal of the blackberries followed by planting of conifers and shrubs. The learning gardens are implemented with planting of native shrubs and herbs to enhance biodiversity and enhance the use of the site as an outdoor classroom.

1.0 Introduction

Urban forests are islands of biodiversity and green space in the urban matrix, but are facing increased pressure from human use and invasive species. Invasive plant species occupy niche space and reduce the abundance of native species and overall biodiversity (Vitousek, D'Antonio, Loope, Rejmanek & Westbrooks 1997). Ecological restoration can assist in increasing bio- and structural diversity in urban settings (Bullock, Aronson, Newton, Pywell & Rey-Benayas, 2011). On global and local scales, climate change is rendering historical ecosystems less appropriate as restoration goals, but looking forward, restoration can help ecosystems adapt to new climatic conditions in terms of species composition and ecological functions. The effects of climate change are difficult to predict on the local scale, so having maximum biodiversity gives the land options to respond to changing conditions better than a monoculture.

Even in a disturbed state, urban green spaces serve important functions. They filter air and water, improve rainwater infiltration and reduce flooding, provide shade, beauty and habitat for urban dwellers both human and otherwise. Urban forests are

a site of connection to nature for local residents, who often form personal connections to a particular place and grow to care about it.

A movement is afoot to get children outside, learning directly from the land in nature preschools and outdoor classrooms. Early childhood education around the human impact on nature leads to a greater sense of environmental ethics later in life (Eick, 2011).

This project aims to restore biodiversity, reduce invasive species, and create accessible outdoor classroom space for ecological education and play while maintaining and enhancing public use of a small suburban green space in Campbell River, BC.

1.1 Literature Review

"Restoration" is defined by the Society for Ecological Restoration (SER) as 'assisting the recovery of a degraded, damaged, or destroyed ecosystem' (SER, 2004). The ideal approach would focus on both structures and processes. This can include restoring the physical environment, landscape topography and drainage patterns, vegetation communities (either specific species complexes or functional groups) and even disturbance regimes such as fire or flooding.(Palmer, Zedler & Falk, 2016). Active restoration involves specific work such as the aforementioned activities, whereas passive restoration lets the land restore itself over time by simply removing the sources of disturbance (Morrison & Lindell, 2010). Although the passive restoration approach can be effective and inexpensive, it does require time and patience and may not be effective in completely achieving site goals. That said, restoration treatments have been shown to be effective in achieving the goals of increasing biodiversity and accelerating the successional process (Johnson and Handel, 2016; Palmer et al., 2016).

Traditionally, restoration uses historical reference ecosystems that serve as the goal state for a project, but with climate change these historical systems may make less and less sense (Harris, Hobbs, Higgs & Aronson, 2006). It is hard to predict how climate change will affect ecological communities on the local scale, and for this reason a new way of looking at restoration is to focus more on ecosystem services

than specific species, to focus more on processes than structures (Harris et al., 2006).

Two strategies in adapting restoration to non-historical reference ecosystems are responsive and proactive. The responsive approach tries to conserve habitats and species in new areas that may be made suitable for them by climate change; in other words assisted range shifting (Richardson & Chaney, 2018). The other approach is proactive, which tries to mitigate climate change through carbon sequestration and influencing local climate.

Georgia Park is an example of secondary succession from a non-stand-replacing disturbance. Secondary succession in terms of species diversity and change through time can be thought of as a function of distance to potential source populations (Cook, Yao, Foster, Holt & Patrick, 2005). The park is about 600m from other, larger second growth forest patches, including a smaller patch to the south and more extensive forest on the edge of Campbell River to the west. This is close enough for bird-dispersed plants to reach Georgia Park, but less likely for wind and water dispersed seeds and much too far for vegetative spread (Clark, Silman, Kern, Macklin, & HilleRisLambers, 1999).

Himalayan Blackberry, is a robust, perennial plant that grows biennial stems from a thick root stock (Soll and Lepinski, 2003). It forms dense, impenetrable thickets that can offer habitat to nesting songbirds, prevent soil erosion and provide an abundance of delicious fruits. However, it also prevents any other plants from growing underneath it and can spread by rhizome, seed and stem fragments, allowing it to quickly become a monoculture over large areas of land, reducing overall biodiversity and slowing succession (Bennett, 2007; Murphy, 2006).

To manage blackberry, the approach is threefold: removal of the roots and stems (Soll and Lepinski, 2003), replanting with native species and using blackberries' shade intolerance against it by establishing conifers with dense canopies to shade them out (Bennett, 2007).

Prioritization schemes for blackberry removal have been proposed (eg.Fuller and Barbe, 1985; GOERT, 2002) that suggest working on the least invaded areas first and progressively moving towards the densest patches. This is the principle of prevention of further spread (GOERT, 2002). Hand pulling and cutting is effective for

young plants and low-density areas. For large patches with no native species, a backhoe is recommended to remove blackberries down to the roots (GOERT, 2002). It is best to do machine work when nesting birds are not present.

Hand pulling can be an effective means of controlling the spread of Himalayan blackberry, but is labour-intensive and time-consuming. Cutting only the above ground stems can just stimulate growth. To effectively reduce blackberry, the root crowns and roots must be dug out (Murphy, 2006). For larger areas, a backhoe can remove above ground parts and scrape the soil down to get to the root layer. This technique is not appropriate on riparian slopes due to the possibility of soil erosion. There is also the possibility that disturbing the soil just creates more disturbed habitat for blackberry and other invasive (pioneer) plant species.

That is why removal of invasive species is just one part of the restoration process - planting the newly cleared space with native plant species fills the empty niche left by the blackberry removal. This gives the natives a head start and hopefully helps suppress the growth of invasives. Blackberry is not shade-tolerant, so getting fast-growing native species on the site helps build an overstory that can shade out blackberries. Replanting also addresses the risk of soil erosion by establishing root mass to hold soil in place. Planting in clusters as opposed to evenly spread over the whole site can be an effective and efficient way to restore forest biodiversity (Corbin & Holl, 2012; Corbin, Robinson, Hafkemeyer & Handel, 2016).

Removal of invasive plant species followed by replanting with native species is a common practice of restoration.

1.2 Campbell River

Campbell River is a city of ~35000 on the Northeastern coast of Vancouver Island where the Strait of Georgia narrows into the northern islands. The area lies within the Georgia Depression ecoprovince and the Coastal Western Hemlock biogeoclimatic zone. The city extends along the east side of the island for 20 km. To the west is Elk Falls Provincial Park and Campbell Lake in the mostly uninhabited second growth forest and timber cuts. Logging has been the main industry in the area historically and its legacy is written on the landscape in patches of different aged plantation forestry and clearcuts.

1.3 Greenways Land Trust

Founded in 1996, Greenways Land Trust is a charity and conservation organization. Their mission: to restore, sustain and protect natural areas and critical habitats in the Campbell River area for the benefit of the community. In 2018 the organization received funding as part of the EcoAction Project "Engaging Community in Urban Foreshore and Riparian Habitat Restoration". EcoAction Community Funding is a program run by Environment and Climate Change Canada to support fresh water. Several sites were selected by Greenways for projects based on EcoAction funding criteria.Georgia Park, located adjacent to Georgia Park Elementary School was identified as a good candidate for its potential to meet several EcoAction goals that also align with Greenways' mandate: to engage community in urban riparian restoration, increase species diversity, enhance urban forest and engage students.

1.4 Geological and Ecological context

The Coastal Western hemlock (CWH) biogeoclimatic zone very dry (xm2) variant zone occurs at low to mid-elevations along most of BC's coast. It is characterized by coniferous forest of western hemlock (*Tsuga heterophylla*), red cedar (*Thuja plicata*), Douglas fir (*Pseudotsuga menziesii*) and bigleaf maple (*Acer macrophyllum*). In a young to mature seral stage such as this site, salmonberry (*Rubus spectabilis*), elder (*Sambucus racemosa*), swordfern (*Polystichum munitum*), Oregon grape (*Berberis nervosa*), salal (*Gaultheria shallon*) and red huckleberry (*Vaccinium parvifolium*) are common in the shrub layer. The climate is moderate, with cool summers and mild winters.

Campbell River is at the northern tip of the Nanaimo Group, a group of sediments laid down 90-65 million years ago combined with layers of upthrust continental bedrock from a large piece of crust called Wrangellia which collided with the North American continent about 100 million years ago. The overlying parent material is fluvial and glaciofluvial sediments including gravel, sand, and clay.

Soils in this zone are mostly podzols. Podzols are often very sandy with little clay or silt and thus have lower water and nutrient holding capacity (www.soilsofcanada.ca).There are also marine and glaciomarine deposits of clayey

silt and intertidal deposits of sand and gravel. Coniferous forests grow on the podzols and add organic matter to form a humo ferric layer. Fungi are the primary decomposers of organic matter.

1.5 Georgia Park

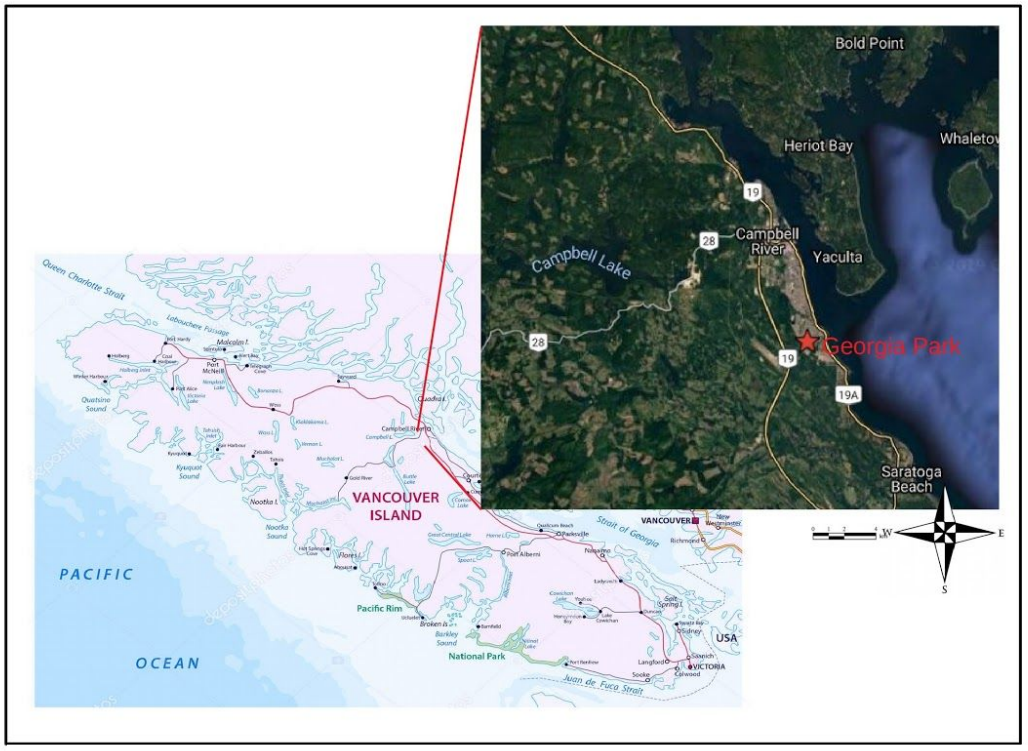


Figure 1: Project location in Georgia Park, Campbell River, BC

Site Description

The project site is a mostly treed 2 ha parcel of land owned by the City of Campbell River located at 49°57'46.5"N, 125°13'40.8"W at the Southern end of Campbell River (see Figure 1, above). Georgia Park is nestled in a suburban context, surrounded by single family homes and paved roads in a neighbourhood built in the 1990's. The site is adjacent to Georgia Park Elementary School to the Northwest. It is most likely in the Willow Creek watershed. The site slopes slightly from the high point on the West end at 30m elevation down to 24m at the East end. A small unnamed stream emerges from a culvert in the Northwest corner and flows through a constructed ditch before being allowed to find its own course about halfway through the park. The water flows into a drain in the Southeast corner of Georgia Park and continues underground into a small retaining pond across Denman St. The stream is

ephemeral, but the water is enough to support a moist forest and small wetland in the lowest points in Georgia Park.Most of the site is treed with early successional species such as red alder (*Alnus rubra*), cottonwood (*Populus balsamifera ssp. trichocarpa*) and cascara (*Rhamnus purshiana*).

Figure 2: Filberts (*Corylus avellana*) make a nice trail snack.

The Northwest section of the park is the highest point and there the soils are dry and compacted with almost no organic matter. On the northside is a fence line separating the park from the elementary school field. This fenceline is mowed and to maintain visibility and prevent blackberry from encroaching onto the field. The lowest point on the site is in the southeast where moisture accumulates and the streamlet drains through a culvert. Here the forest is lush with understory plants beneath western hemlock, Sitka spruce and willows. The south side of the park is an open meadow of grasses and sedges. The boundary between the trees and the field is edged with thimbleberry, Pacific ninebark and occasional Himalayan blackberry (*Rubus armeniacus*) stems. Along the stream through the park red alder is abundant, with salmonberry, ferns, and other shrubs and herbs. See Figure 3, below, for an approximation of major vegetation areas in Georgia Park.

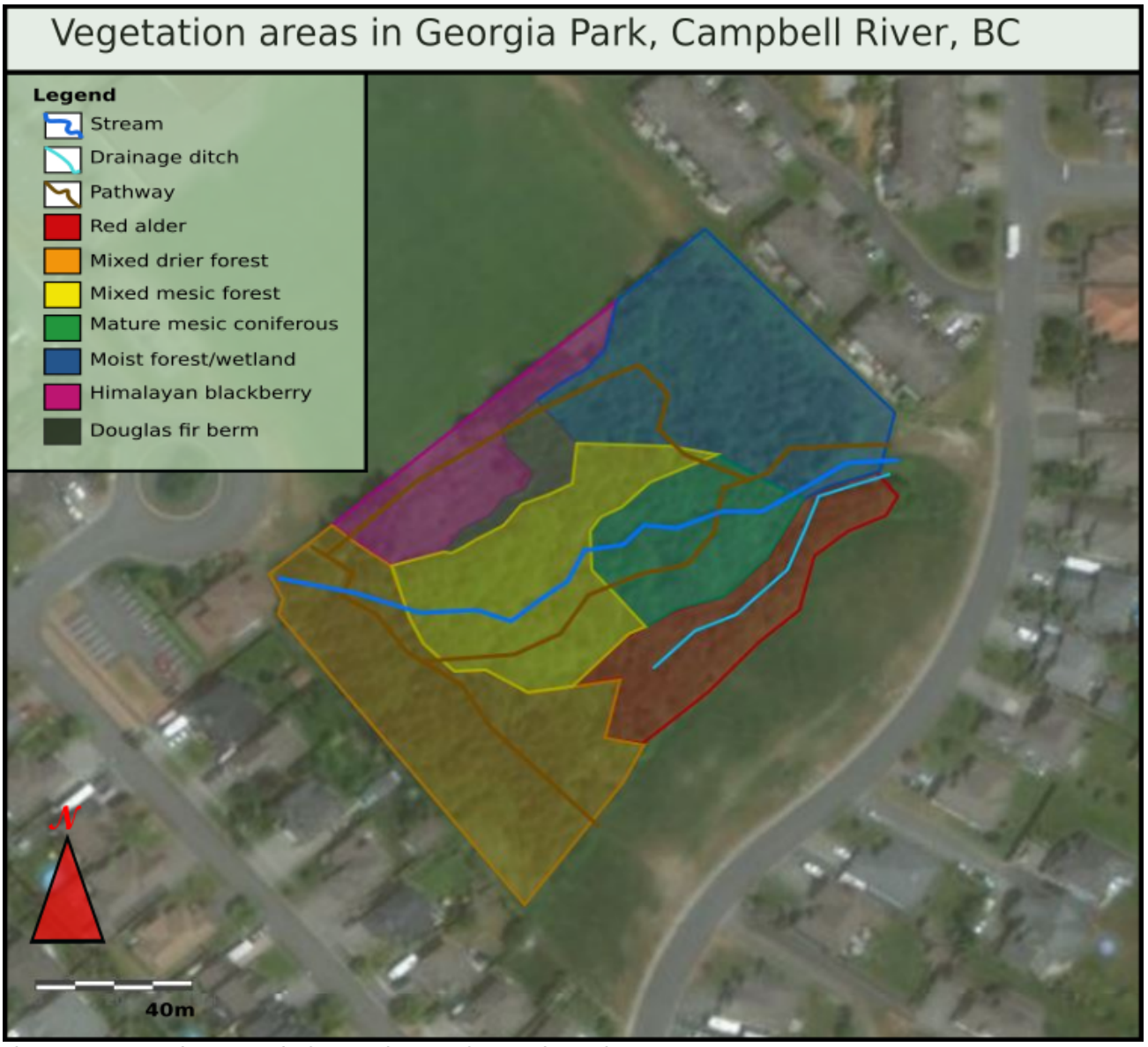


Figure 3: Vegetation types in forested area of Georgia Park.

Recent history

The surrounding neighbourhood was constructed during the 1990's. During that time the site of Georgia Park was disturbed.

Sources of disturbance

- dumping construction fill
- soil compaction
- invasive species.
- Stream drainage altered by culvert
- Constructed drainage ditch

Current use

The park is used for recreation and dog walking by the general public on informal walking trails. Children play there, constructing tree forts and bike jumps. Deer, birds and other wildlife find food and refuge in the trees. The site is used by students and teachers from Georgia Park Elementary as a site of nature connection and outdoor education. Sources of disturbance were either observed onsite by me or related by Greenways director Chuck DeSorcy.

Sources of disturbance

- possible upstream pollution runoff
- Dumping of garden waste
- Invasive plants
- children play on the site reducing the understory and possibly causing bank erosion along the streamlet
- Urban deer browse evident on shrubs and small trees

A note about small streams: the importance of headwaters

The stream in Georgia Park is small, ephemeral and unnamed. This is an example of a headwater stream, which are often ephemeral, unmapped, and can be underappreciated and subject to passive neglect (Richardson & Danehy, 2006). However, small headwater streams are where all rivers begin, and create unique habitats of more stable temperature and humidity perfect for mosses, fungi, and other hydrophilic organisms. The stream in Georgia Park is not fish habitat and probably has limited invertebrates, but complete canopy cover helps maintain water temperature and low flow rates help the filtration of water through the wetland as sediment has time to settle out.

Maybe it’s time this stream had a name on a map?

2.0 Goals and Objectives

Goal	Objective
Enhance biodiversity	Remove invasive species
	Plant native species
Engage community	Work with student groups
	Create outdoor classroom ‘learning gardens’

3.0 Site Assessment

3.1 Data collection methods

Data was collected by direct observation on site, with context and additional information added by conversation with Greenways staff and Georgia Park School staff. The vegetation data was gathered according to the standard for terrestrial ecosystem mapping in British Columbia (BC Ministry of Forests and Range, 2010). Three sample plots were chosen non-randomly based on earlier conversations about site goals with Greenways Trust and Georgia Park school representatives. One of the goals is to define and develop teaching gardens to engage the students and teachers in ecological learning. Site one, the ‘Upper Learning Garden’ represents the highly disturbed, young forest on the uphill side of the small creek which is drier with less understory. Site two, the ‘Lower Learning Garden’, represents a less impacted, young moist habitat forest adjacent to the wetland. Site three includes the transition from open field to riparian forest on the south side of the land parcel.

20x20m plots were laid out and trees greater than 10cm in diameter at breast height (DBH) were measured and species recorded. Shrub and herb species were identified and visually estimated for percent cover. A soil test pit was dug in the centre of each plot, except for plot 3 where two were dug, one in the field and one inside the treed riparian zone. Soil was analyzed using hand methods outlined in the BC Ministry of Forests field guide to site identification and interpretation for the Vancouver Forest Region (Green and Klinka, 1994) to determine the soil nutrient and moisture regimes and site series.

High levels of accuracy for cover were not necessary for this project. Greenways staff indicated that this sort of information would not be useful to them or necessary to achieve the goals of the project. The purpose of collecting this information was to get an idea of species diversity and the stand age and composition as indicators of time since disturbance, extent of disturbance and soil conditions.
Data was analysed to find an estimate of basal area per hectare (BA/ha) and percent basal area for each tree species. For data analysis, dead trees were not included.

3.2 Adaptive management/ planning process

For the restoration planning, a best case scenario plan was created which was then scaled and altered to fit with reasonable expectations of volunteers and uncertainty about the level of support from the city as well and time and funding constraints. Ongoing dialogue between stakeholders and planners kept the planning direction in line with Greenways's goals and within the budget and scope of the project while coordinating with the City of Campbell River to ensure compliance with bylaws and maintain updated communication.
As much as possible, the plan tried to stack functions with Greenways' mandates by involving school groups when possible to help with invasive species removal.

3.3 Results

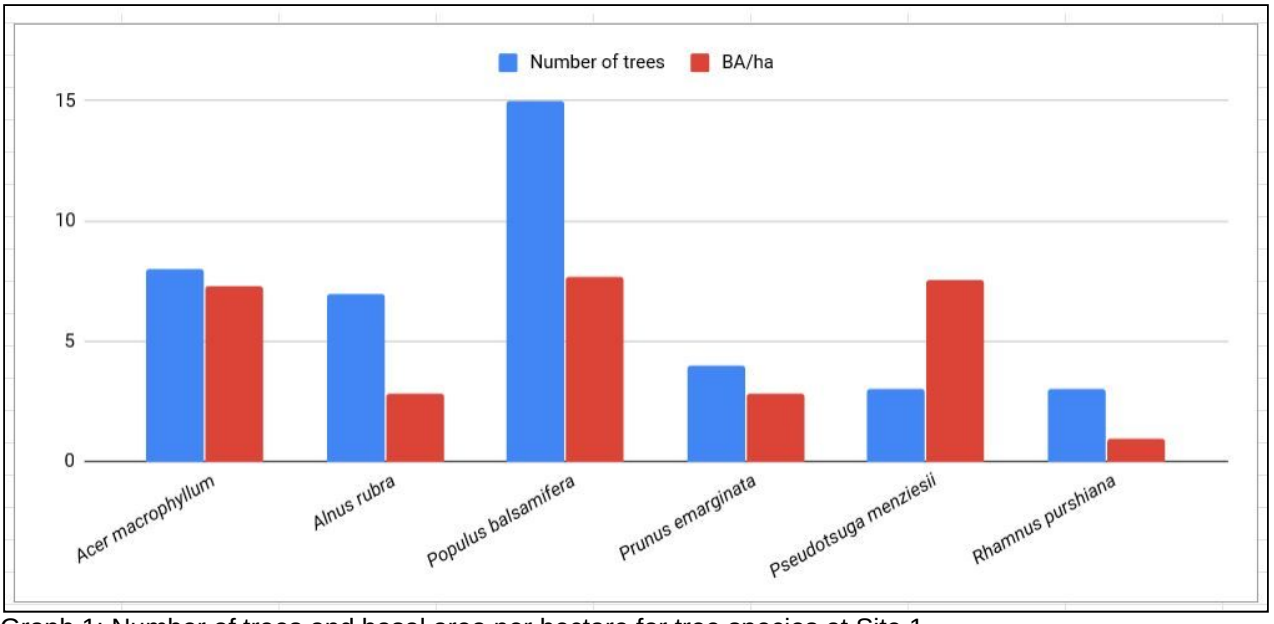
Site 1: Upper learning Garden

The upland site could be site series CWHxm 03(FdHw-Salal) or 01(HwFd-Kindbergia). It is hard to say due to the disturbance at this site altering the substrate by compaction, dumping of fill, and alterations to hydrology. The soil is dry and almost completely inorganic. Some drainage ditches have been constructed that cross the plot, which increase runoff and decrease infiltration of rainfall. This area of Georgia Park is bordered to the west by the backyards of homes and dumping of garden waste is evident. Patches of understory plants cluster around an old stump and at the base of some trees but there is a lot of bare ground at this site (see Figure 4, below). The successional status is young-maturing seral stage, with mostly early-successional tree species of more or less even age and little structural complexity. Other than a few large remnant stumps, there is no coarse woody debris.

Figure 4: Sampling site 1, future Upper Learning Garden, looking east.

Trees

Cottonwood make up the majority of individual trees as well as a quarter of basal area per hectare (see Graph 1, below). Bigleaf maple and Douglas fir each made up another quarter of the total basal area. Although there were only 3 Douglas fir compared to 15 cottonwood and 8 bigleaf maple, their larger diameter made them disproportionately represented in the basal area. They are likely remnants of the forest present before the neighbourhood was built. Other species present were red alder, bitter cherry (*Prunus emarginata*), and cascara. All these species (except bigleaf maple) need light and exposed mineral soil to regenerate which indicates recent site clearing and soil disturbances (Klinka, Worral, Skoda, Varga &



Graph 1: Number of trees and basal area per hectare for tree species at Site 1.

Chourmouzis, 1999). Many of these trees (cascara, alder, cherry) are relatively short-lived species which will create soil through addition of leafy detritus throughout their lives and coarse woody debris when they senesce.

Shrubs

The shrub layer contains many of the characteristic species for drier mixed forests in the CWH zone. Swordfern, Oceanspray (*Holodiscus discolor*) and Pacific ninebark (*Physocarpus capitatus*) cover the most area in the sample plot, followed by red huckleberry, trailing blackberry (*Rubus ursinus*), Salmonberry and thimbleberry (*Rubus parviflorus*). There was Himalayan blackberry present, but under the shade of the overstory it is minimal.

Herbs

Swordfern dominated the herb layer in this area of Georgia Park. Other herb species present in small populations are Dandelion (*Taraxacum spp.*), wall lettuce (*Lactuca muralis*), Starflower (*Trientalis latifolia*) and Foamflower (*Tiarella trifoliata*). Wall lettuce is a European herb naturalized in our region that is common on disturbed sites and early seral communities (Klinka et al., 1989). There was very little moss present in the herb layer. The low coverage and low species diversity could be due in part to the soil compaction and low nutrient availability coupled with the younger seral stage and perhaps an absence of seed bank, propagules or dispersal from neighbouring more intact forest. As well, the bare ground and compaction is being maintained by human use of the site for recreation/play.

Site 2: Lower Learning Garden

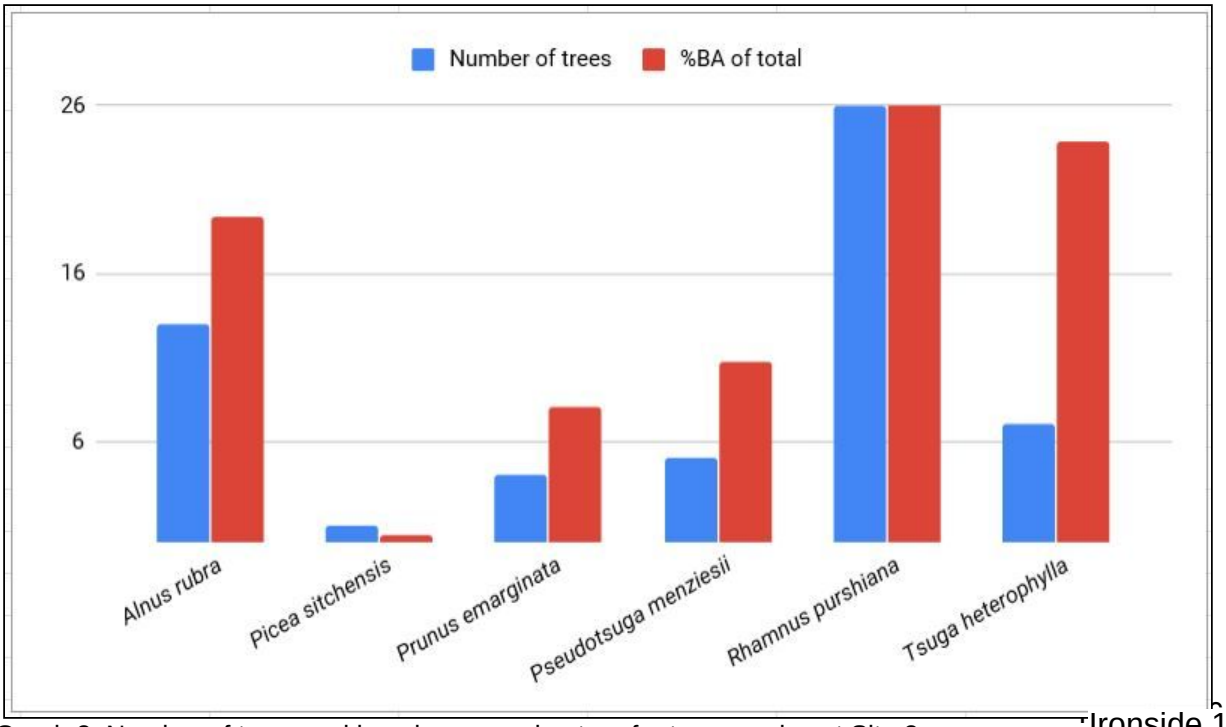
The second site sampled in the lower, eastern part of the park (see figure #) was selected to represent the moist forest bordering on a skunk cabbage/cedar swamp. The site series is CWHxm 07:Cw-foamflower. This site had a different species mixture, soil type and moisture regime than the upper site. At first glance, this site is much greener with no bare ground (see Figure 5, below). Looking deeper, this part of Georgia Park was not as disturbed as the northwest area. The surrounding area has many older trees, a layer of organic duff and fungi. Soil here was rich, dark, and wet with a 15-25cm deep organic layer followed by a reddish, coarse-textured layer of sandy clay and water table at 30cm. Similar to the Upper Learning Garden this

site is also in the young to maturing seral stage with many even-aged, early-successional species and little coarse woody debris (see BC Ministry of Forests, 2010,p.16).

Trees

Figure 5: Sampling site 2, future Lower Learning Garden, looking east.

Cascara was the most abundant tree at this site by far and although each tree was small, this species made up almost 40% of the total basal area. Cascara is common in early to intermediate seral stage of secondary succession (Klinka et al., 1999). Western hemlock and red alder were also significant tree species contributing about 25 and 20% of the basal area respectively (see Graph 2, below). Also present but not as abundant were Douglas fir, bitter cherry and Sitka spruce. Only one Sitka spru was over 10cm in DBH to make it into the survey, but there were several more small individuals on site. Overall, there was a comparable total basal area of all trees for both sites.



Graph 2: Number of trees and basal area per hectare for tree species at Site 2.

Shrubs

There was less shrub cover at the lower site compared to the upper site. Oregon grape, oceanspray, salmonberry, red huckleberry, thimbleberry, and trailing blackberry were common to both sites but not as abundant in the lower area. Small hazelnut (*Corylus sp.*) and mountain ash (*Sorbus sp.*) were found here as well. No Himalayan blackberry was found.

Herbs

The lower site had a rich and diverse herb layer with almost no bare ground. Moss and swordfern covered the most area, followed by deer fern (*Blechnum spicant*), ladyfern (*Athryium felix-femina*),skunk cabbage (*Lysichiton americanus*), false lily of the valley (*Maianthemum dilatatum*) and horsetail (*Equisetum arvense*). Also present in small numbers were bracken fern (*Pteridium aquilinum*), foamflower and false bugbane (*Trautvetteria caroliniensis*). Most of these herb species can spread by underground rhizomes (Klinka, Krajina, Ceska & Scagel, 1989) which is a good strategy for reproduction in a stable environment. This further suggests to me that this site has been less disturbed .

Site 3: blackberry area

Along the northern edge of the park blackberries grew in a dense thicket that covered about 0.15 ha (see Figure 6, below). The patch was surrounded by red alder and Douglas fir to the south and east with a few small cottonwood sprouting near the western edge. The blackberries are periodically mowed along the fenceline of the school yard to prevent them taking over the field and to maintain visibility along the fence. On the western edge of the blackberry patch they are starting to climb into the Douglas fir and infiltrate into the young forest where there is enough light.

The land is relatively flat where the blackberry grows, and slopes down on the southeast sides. In places near the waterway blackberry has grown into the forest somewhat and intermixes with elderberry, salmonberry, alder etc.

Figure 6: Blackberry patch along fence line, looking east.

4.0 Restoration plan - timeline and site plan

Based on available time and budget resources, I chose to focus plantings of native plants in a few small areas instead of addressing the whole site. These areas are based on ‘ecosystem anchors’ such as old stumps or other habitat features (snag, wetland area, etc) and create obvious definition so there are clear areas for play and clear areas for respect. This plan respects the multiple uses for the park by the human community in terms of play and recreation.

4.1 Recommendation map and summary

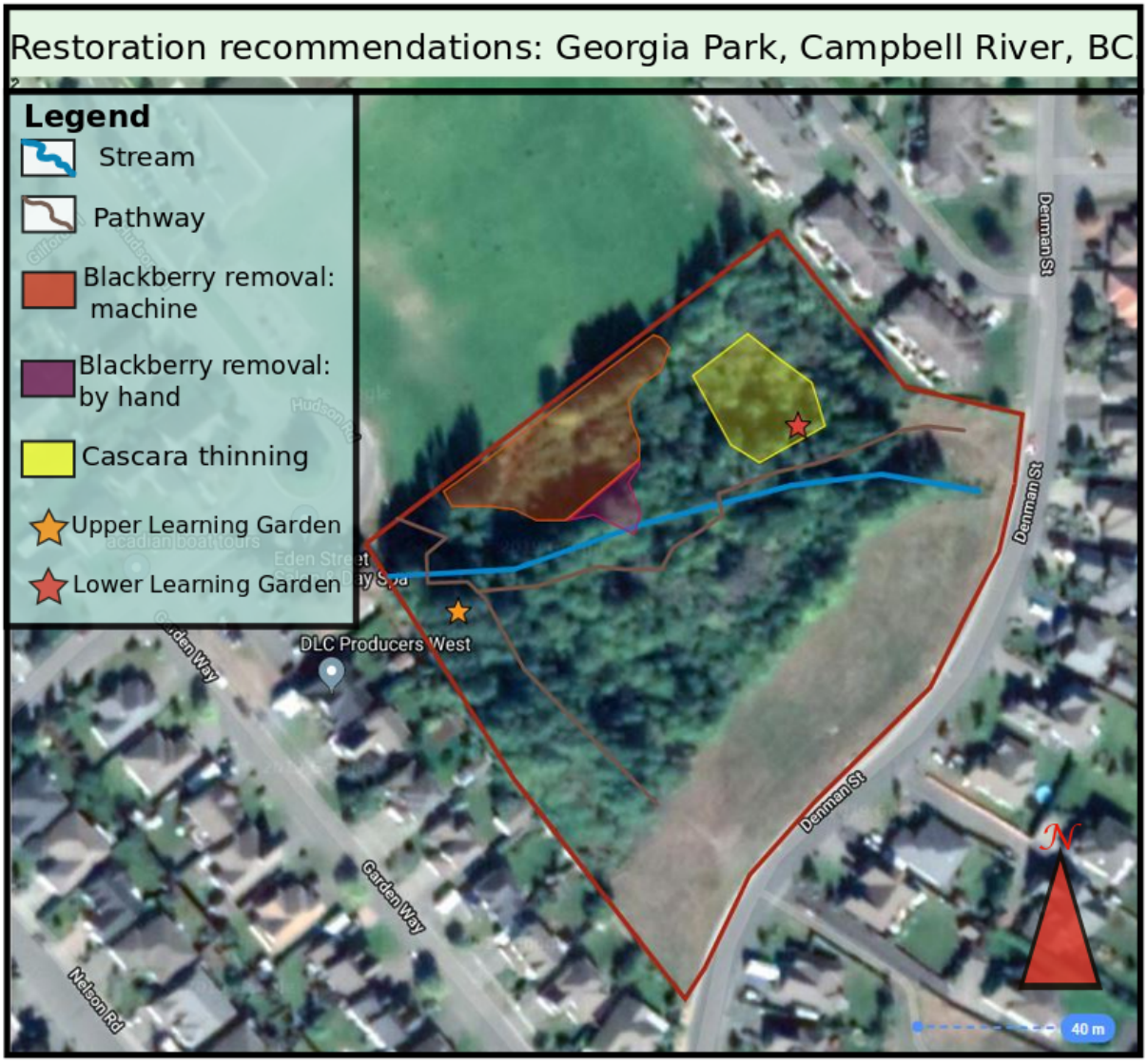
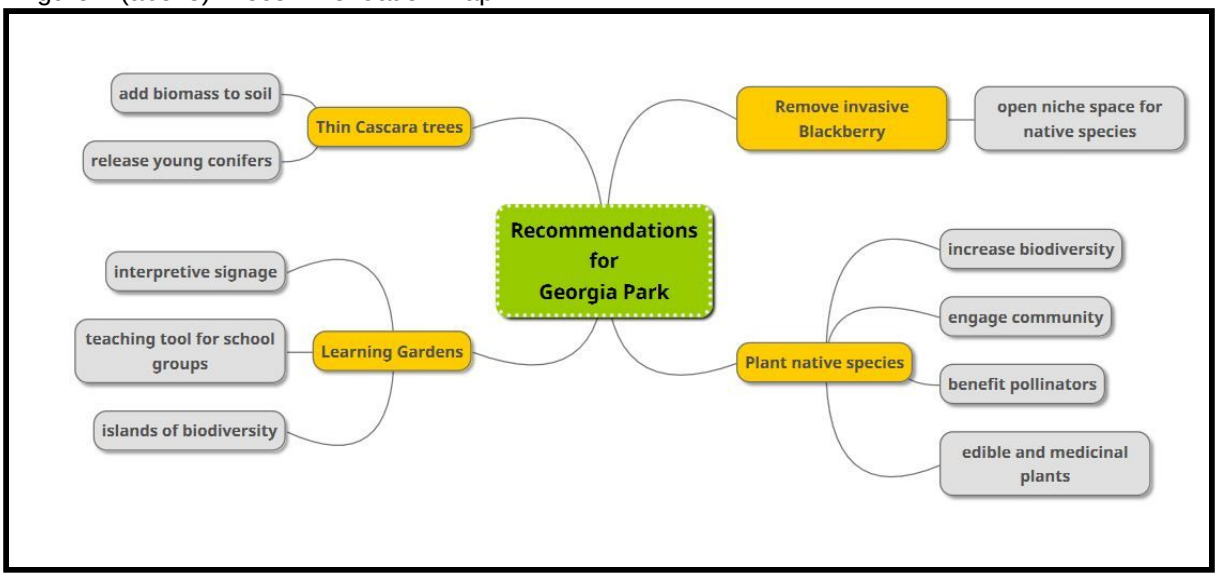


Figure 7 (above): Recommendation map



4.2 Recommendation details and rationale

A. Thin Cascara trees

- Fall a few small (<10cm DBH) cascara near the lower learning garden
- Release some young conifers such as sitka spruce (Deal & Tappeiner, 2002)
- Add woody debris to the forest floor

B. Remove invasive blackberry

- Use a small backhoe if possible to remove above ground plants and below ground roots and root crowns
- Leave site rough and loose to create micro-niches for native plantings
- Engage students to remove blackberry in sensitive habitat close to stream and within the forested area where a machine is inappropriate

C. Plant native species to replace blackberry

- Plant pioneer and sun-loving shrubs to provide ground cover
- suppress the blackberry while the conifers are growing
- Plant conifers intermixed with shrubs
- Increase structural and biological diversity
- Provide forage for pollinators
- provide a point of interest for park users with edible and useful
- The alder/conifer mix has been shown superior to pure conifer stands in terms of structural diversity, (Deal, Hennon, Orlikowska & D'Amore, 2004).

D. Learning Gardens

- Highlight two habitats - 'upland' drier forest and lower moist forest
- focus plantings in smaller, well-marked areas to create nuclei of biodiversity (Corbin & Holl, 2012; Corbin et al., 2016) and obvious play and non-play areas.
- Keeping plantings concentrated makes it easy for teachers to use the site as a teaching tool while respecting the human uses of the site in terms of existing pathways and play areas.
- Interpretive signage

4.3 Planting plan

Upper Learning Garden			**Lower Learning Garden**	
Common name	**Latin name**		**Common name**	**Latin name**
Baldhip rose	*Rosa gymnocarpa*		False bugbane	*Trautvetteria caroliniensis*
False azalea	*Menziesia ferruginea*		Highbush cranberry	*Viburnum edule*
Grand fir	*Abies grandis*		Hooker’;s fairybells	*Prosartes hookeri*
Honeysuckle	*Lonicera ciliosa*		Twinberry	*Lonicera involucrata*
Oregon grape	*Mahonia nervosa*		Vanilla leaf	*Achlys triphylla*
Red huckleberry	*Vaccinium parvifolium*		Western trillium	*Trillium ovatum*
Salal	*Gaultheria shallon*		Wild ginger	*Asarum caudatum*
Foamflower	*Tiarella trifoliata*		False solomon's seal	*Smilacina racemosa*
Rosy twistenstalk	*Streptopus lanceolatus*			

Blackberry removal area

Common name	**Latin name**
Red alder	*Alnus rubra*
Blue elderberry	*Sambucus cerulea*
Conifers	*misc.*
Oceanspray	*Holodiscus discolor*
Pacific ninebark	*Physocarpus capitatus*
Red elderberry	*Sambucus racemosa*
Salmonberry	*Rubus spectabilis*
Saskatoon	*Amelanchier alnifolia*
Thimbleberry	*Rubus parviflorus*

Figure 8: Oregon grape (*Berberis nervosa*) with new growth.

4.4 Rough Timeline

Activity	**When**	**Who**	**Tools**	**Materials/other needs**	**Cost**
Clearing blackberry	Late summer-early fall	GWT staff, machine operator,	Excavator with grappling attachment	City approval and possible financial support/machine	depends
Hand clearing of site	Early fall	GWT staff, Rhia, school group	Loppers, shovels, rakes, gloves, tarps		GWT staff hourly rate
Planting priority area to suppress blackberry	fall	Lynnette, Rhia, school group	Shovels, pickaxes, wheelbarrows, gloves	Shrubs from Streamside; conifers from GWT stash	300
Thinning alder/cascara	anytime				
Mark off learning gardens	After thinning	Whoever does thinning	Gloves, saw		
Plantings in learning gardens	fall	GWT, Rhia, school group	Shovels, loppers, gloves	Plants from Streamside	300
Live staking	Late fall-winter (wet, dormant season)	School groups, GWT staff	Loppers, saws, shovels,	Red Osier dogwood and Cottonwood on site	
Make interpretive signs	anytime				

Install interpretive signs	anytime				

5.0 Afterwards: Implementation

Following consultation with the City of Campbell River, work began on the site on October 1, 2018 with the falling of some selected cascara in the area indicated in Figure 7, above. The Carihi Secondary School forestry class was engaged to help with the thinning under the careful eyes and instruction of Rick Buchannan, a retired faller and Greenways volunteer. Figure 9, to right, shows students getting a saw safety lesson.

Figure 9: Carihi school forestry class near Lower Learning Garden.

Students also moved some larger logs to mark out the learning garden perimeter and removed some blackberry by hand in more sensitive areas.

On October 2, Mr. Minidig partially donated time with a small excavator to remove the dense blackberry patch. The city of Campbell River contributed the pickup and disposal of the plant matter. Having machinery on the site caused some soil

compaction. The excavator left the site rough and loose and ready for native plants.

Figure 10: the now ex-blackberry patch, looking south.

Although best practices for blackberry removal focus on prioritizing mostly intact ecosystems with little blackberry, we chose to start with the most dense growth. The reason for this was to take advantage of timing with the excavator company. Removing the sparse blackberry in other areas of the site is a great ongoing project that Greenways community engagement coordinator Lynnette Hornung is using to engage student groups throughout the year.

In November 2018, native plants were planted on the site with school groups and volunteers. Interpretive signage was added later.

6.0 Monitoring and future work

Greenways has installed photopoint stakes around Georgia Park and will monitor the development for at least the next year. Due to limited long-term funding for this project, monitoring may not continue past that point.

Future work on this site could include:

- Monitoring survival of plantings
- Replanting plants that die or planting more of those that are doing well
- Trying new species to further enhance biodiversity
- Anticipating range shifts due to climate change and using southern populations as source for new plantings to conserve genetic diversity and use plants that may be better adapted to the future climate
- Creating educational signage for different plant and animal species found on site

7.0 Acknowledgements

This project took place on the territory of the We Wai Kai First Nation which is still in treaty negotiations with the Government of Canada.

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8.0 References

BC Ministry of Forests and Range. (2010). *Field manual for describing terrestrial ecosystems* (2nd edition). Land Management Handbook 25:1–286.

Bennett, M. (2007). Managing Himalayan Blackberry in western Oregon riparian areas. Retrieved from Oregon State University Extension Service website: https://catalog.extension.oregonstate.edu/em8894

Best Practices for Invasive Species Management in Garry Oak and Associated Ecosystems [webpage]. (2002). Retrieved from http://www.goert.ca/documents/Best_Practices_for_Blackberry_revised.pdf

Bullock, J.M., Aronson, J., Newton, A.C., Pywell, R.F. & J.M. Rey-Benayas. (2011). Restoration of ecosystem services and biodiversity: conflicts and opportunities. Trends in Ecology and Evolution, 26(10), 541-549.

Clark, J.S., Silman, M., Kern, R., Macklin, E. & J. HilleRisLambers. (1999). Seed dispersal near and far: patterns across temperate and tropical forests. Ecology, 80(5), 1475-1494.

Cook, W.M., Yao, J., Foster, B.L., Holt, R.D. & L.B. Patrick.n (2005). Secondary Succession in an Experimentally Fragmented Landscape: Community Patterns across Space and Time. Ecology, 86(5), 1267-1279.

Corbin, J.D. & K.D. Holl. (2012). Applied nucleation as a forest restoration strategy. Forest Ecology and Management, 265, 37-46.

Corbin, J.D., Robinson, G.R., Hafkemeyer, L.M. & S.N. Handel. (2016). A long-term evaluation of applied nucleation as a strategy to facilitate forest restoration. Ecological Applications 26(1), pp. 104-114.

Deal, R.L., Hennon, P.E., Orlikowska, E.H. & D.V. D'Amore. (2004). Stand dynamics of mixed red alder - conifer forests of southeast Alaska. Canadian Journal of Forest Research 34, 969-980.

Deal, R.L. & J.C. Tappeiner. (2002). The effects of partial cutting on stand structure and growth of western hemlock - Sitka spruce stands in southeast Alaska. Forest Ecology Management, 159, 173-186

Eick, C.J. (2011). Use of the outdoor classroom and nature-study to support science and literacy learning: A narrative case study of a third-grade classroom. Journal of Science Teacher Education, (23)7, 789-803.

Fuller, T.C. & G.D. Barbe. (1985). The Bradley Method of eliminating exotic plants from natural reserves. Fremontia, 13(2), 24-26

Green, R. and K. Klinka. (1994). A field guide to site identification and interpretation for the Vancouver Forest Region. BC Ministry of Forests, Research Branch: Vancouver, BC. https://www.for.gov.bc.ca/HFD/Pubs/Docs/Lmh/Lmh28.pdf

Harris, J.A., Hobbs, R.J., Higgs, E. & J. Aronson. (2006) Ecological restoration and global climate change. Restoration Ecology, 14,170-176

Johnson, L.R. & S.N. Handel. (2016). Restoration treatments in urban park forests drive long-term changes in vegetation trajectories. Ecological Applications, 26(3), pp. 940–956

Klinka, K., Krajina, V.J., Ceska, A. & A.M. Scagel. (1989). Indicator Plants of Coastal British Columbia. Vancouver, BC: UBC Press.

Klinka, K., Worrall, J., Skoda, L., Varga, P. & C. Chourmouzis. (1999). The distribution and synopsis of ecological and silvical characteristics of tree species of British Columbia's forests. Vancouver, BC: Forest Sciences Department, UBC.

Morrison, E.B. & C.A. Lindell. (2010). Active or passive restoration? Assessing restoration alternatives with avian foraging behaviour. Restoration Ecology, 19(201), 170 -177.

Murphy, M. (2006). Evergreen blackberry, Himalayan blackberry. In Boersma, P.D., Reichard, S.H. & A.N. Van Buren (Eds.), Invasive Species in the Pacific Northwest (pp.30-31). Seattle, WA: University of Washington Press.

Piper, J.K. (1986).Germination and growth of bird-dispersed plants: effects of seed size and light on seedling vigor and biomass allocation. American Journal of Botany, 73(7), 959-965.

Richardson, B.A. & L. Chaney. (2018). Climate-based seed transfer of a widespread shrub: population shifts, restoration strategies, and the trailing edge. Ecological Applications, 28(8), 2165-2174.

Richardson, J.S. & R.J. Danehy. (2006) A synthesis of the ecology of headwater streams and their riparian zones in temperate forests. Forest Science, 53(2), 131-147.

Society for Ecological Restoration. (2004). The SER International primer on ecological restoration. Retrieved from www.ser.org.

Soll, J. & B. Lepinski. (2003). Controlling himalayan blackberry in the Pacific Northwest. The Nature Conservancy. Retrieved from https://www.invasive.org/gist/moredocs/rubarm01.pdf

USDA Forest Service [website]. Retrieved from https://www.fs.fed.us/wildflowers/plant-of-the-week/asarum_caudatum.shtml

Vitousek, P. M., D'Antonio, C. M., Loope, L. L., Rejmanek, M., & R. Westbrooks. (1997). Introduced species: a significant component of human-caused global change. New Zealand Journal of Ecology, 21, 1-16.

9.0 Appendices

9.1 Raw Data

Plant Survey Data: Trees

Site 1: Upper Learning Garden Tree Data. May 28, 2018					
Tree code	Common name	Species	Circumference (m)	DBH (m)	Basal area (m2)
DF1	Douglas fir	Pseudotsuga menziesii	1.4	0.4456	0.155976
DF2	Douglas fir	Pseudotsuga menziesii	1.15	0.3661	0.105244
DF3	Douglas fir	Pseudotsuga menziesii	0.71	0.2260	0.040116
A1	Red alder	Alnus rubra	0.47	0.1496	0.017579
A2	Red alder	Alnus rubra	0.4	0.1273	0.012733
A3	Red alder	Alnus rubra	0.57	0.1814	0.025855
A4	Red alder	Alnus rubra	0.48	0.1528	0.018335
A5	Red alder	Alnus rubra	0.44	0.1401	0.015407
A6	Red alder	Alnus rubra	0.41	0.1305	0.013377
A7	Red alder	Alnus rubra	0.36	0.1146	0.010314
CW1	Cottonwood	Populus balsamifera	0.47	0.1496	0.017579
CW2	Cottonwood	Populus balsamifera	0.42	0.1337	0.014038
CW3	Cottonwood	Populus balsamifera	0.6	0.1910	0.028649
CW4	Cottonwood	Populus balsamifera	0.7	0.2228	0.038994
CW5	Cottonwood	Populus balsamifera	0.57	0.1814	0.025855
CW6	Cottonwood	Populus balsamifera	0.47	0.1496	0.017579
CW7	Cottonwood	Populus balsamifera	0.63	0.2005	0.031585
CW8	Cottonwood	Populus balsamifera	0.42	0.1337	0.014038
CW9	Cottonwood	Populus balsamifera	0.58	0.1846	0.026771
CW10	Cottonwood	Populus balsamifera	0.39	0.1241	0.012104
CW11	Cottonwood	Populus balsamifera	0.32	0.1019	0.008149
CW12	Cottonwood	Populus balsamifera	0.39	0.1241	0.012104
CW13	Cottonwood	Populus balsamifera	0.49	0.1560	0.019107
CW14	Cottonwood	Populus balsamifera	0.4	0.1273	0.012733
CW15	Cottonwood	Populus balsamifera	0.6	0.1910	0.028649
BC1	Bitter cherry	Prunus emarginata	0.78	0.2483	0.048416
BC2	Bitter cherry	Prunus emarginata	0.49	0.1560	0.019107
BC3	Bitter cherry	Prunus emarginata	0.54	0.1719	0.023205
BC4	Bitter cherry	Prunus emarginata	0.54	0.1719	0.023205
C1	Cascara	Rhamnus purshiana	0.3	0.0955	0.007162
C2	Cascara	Rhamnus purshiana	0.32	0.1019	0.008149
C3	Cascara	Rhamnus purshiana	0.53	0.1687	0.022354
BLM1	Bigleaf maple	Acer marcrophyllum	0.78	0.2483	0.048416
BLM2	Bigleaf maple	Acer marcrophyllum	0.59	0.1878	0.027702
BLM3	Bigleaf maple	Acer marcrophyllum	0.66	0.2101	0.034665
BLM4	Bigleaf maple	Acer marcrophyllum	0.71	0.2260	0.040116
BLM5*dead	Bigleaf maple	Acer marcrophyllum	0.46	0.1464	0.016839
BLM6	Bigleaf maple	Acer marcrophyllum	0.63	0.2005	0.031585
BLM7	Bigleaf maple	Acer marcrophyllum	0.49	0.1560	0.019107
BLM8	Bigleaf maple	Acer marcrophyllum	0.62	0.1974	0.030590
BLM9	Bigleaf maple	Acer marcrophyllum	0.86	0.2738	0.058857

Site 2: Lower Learning Garden Tree Data. May 28, 2018					
Tree code	**Common name**	**Species**	**Circumference (m)**	**DBH (m)**	**Basal area (m2)**
DF1	Douglas fir	Pseudotsuga menzies	0.63	0.200541	0.031585
DF2	Douglas fir	Pseudotsuga menzies	0.44	0.140060	0.015407
DF3	Douglas fir	Pseudotsuga menzies	0.4	0.127328	0.012733
DF4	Douglas fir	Pseudotsuga menzies	0.61	0.194175	0.029612
DF5	Douglas fir	Pseudotsuga menzies	0.74	0.235556	0.043578
H1	Western hemlock	Tsuga heterophylla	1	0.318319	0.079580
H2	Western hemlock	Tsuga heterophylla	0.88	0.280121	0.061627
H3	Western hemlock	Tsuga heterophylla	0.6	0.190992	0.028649
H4 - dead	Western hemlock	Tsuga heterophylla	0.33	0.105045	0.008666
H5	Western hemlock	Tsuga heterophylla	0.83	0.264205	0.054823
H6	Western hemlock	Tsuga heterophylla	0.35	0.111412	0.009749
H7	Western hemlock	Tsuga heterophylla	0.7	0.222823	0.038994
H8	Western hemlock	Tsuga heterophylla	0.54	0.171892	0.023205
C1	Cascara	Rhamnus purshiana	0.34	0.108229	0.009199
C2	Cascara	Rhamnus purshiana	0.32	0.101862	0.008149
C3	Cascara	Rhamnus purshiana	0.52	0.165526	0.021518
C4	Cascara	Rhamnus purshiana	0.48	0.152793	0.018335
C5	Cascara	Rhamnus purshiana	0.39	0.124145	0.012104
C6	Cascara	Rhamnus purshiana	0.55	0.175076	0.024073
C7	Cascara	Rhamnus purshiana	0.42	0.133694	0.014038
C8	Cascara	Rhamnus purshiana	0.47	0.149610	0.017579
C9	Cascara	Rhamnus purshiana	0.66	0.210091	0.034665
C10	Cascara	Rhamnus purshiana	0.53	0.168709	0.022354
C11	Cascara	Rhamnus purshiana	0.44	0.140060	0.015407
C12	Cascara	Rhamnus purshiana	0.52	0.165526	0.021518
C13	Cascara	Rhamnus purshiana	0.44	0.140060	0.015407
C14	Cascara	Rhamnus purshiana	0.44	0.140060	0.015407
C15	Cascara	Rhamnus purshiana	0.65	0.206908	0.033622
C16	Cascara	Rhamnus purshiana	0.34	0.108229	0.009199
C17	Cascara	Rhamnus purshiana	0.36	0.114595	0.010314
C18	Cascara	Rhamnus purshiana	0.41	0.130511	0.013377
C19	Cascara	Rhamnus purshiana	0.3	0.095496	0.007162
C20	Cascara	Rhamnus purshiana	0.6	0.190992	0.028649
C21	Cascara	Rhamnus purshiana	0.32	0.101862	0.008149
C22	Cascara	Rhamnus purshiana	0.56	0.178259	0.024956
C23	Cascara	Rhamnus purshiana	0.52	0.165526	0.021518
C24	Cascara	Rhamnus purshiana	0.39	0.124145	0.012104
C25	Cascara	Rhamnus purshiana	0.4	0.127328	0.012733
C26	Cascara	Rhamnus purshiana	0.68	0.216457	0.036798
A1	Red alder	Alnus rubra	0.65	0.206908	0.033622
A2	Red alder	Alnus rubra	0.56	0.178259	0.024956
A3	Red alder	Alnus rubra	0.5	0.159160	0.019895
A4	Red alder	Alnus rubra	0.44	0.140060	0.015407
A5	Red alder	Alnus rubra	0.33	0.105045	0.008666
A6	Red alder	Alnus rubra	0.56	0.178259	0.024956
A7	Red alder	Alnus rubra	0.49	0.155976	0.019107
A8	Red alder	Alnus rubra	0.38	0.120961	0.011491
A9	Red alder	Alnus rubra	0.44	0.140060	0.015407
A10	Red alder	Alnus rubra	0.31	0.098679	0.007648
A11	Red alder	Alnus rubra	0.46	0.146427	0.016839
A12	Red alder	Alnus rubra	0.45	0.143244	0.016115
A13	Red alder	Alnus rubra	0.57	0.181442	0.025855
BC1	Bitter cherry	Prunus emarginata	0.74	0.235556	0.043578
BC2	Bitter cherry	Prunus emarginata	0.42	0.133694	0.014038
BC3	Bitter cherry	Prunus emarginata	0.55	0.175076	0.024073
BC4 - dead	Bitter cherry	Prunus emarginata	0.5	0.159160	0.019895
BC5	Bitter cherry	Prunus emarginata	0.47	0.149610	0.017579
S1	Sitka spruce	Picea sitchensis	0.25	0.079580	0.004974

Plant Survey Data: Shrubs and Herbs

Site 1: Upper Learning Garden Shrub and Herb Cover, May 28 2018		
Common name	**Species**	**percent cover**
Oceanspray	*Holodiscus discolor*	7
Low Oregon grape	*Berberis nervosa*	5
Ninebark	*Physocarpus capitatus*	7
Himalayan blackberry	*Rubus armeniacus*	1
Thimbleberry	*Rubus parvifolium*	3
Salmonberry	*Rubus spectabilis*	3
Trailing blackberry	*Rubus ursinus*	5
Red huckleberry	*Vaccinium parvifolium*	5
Herbs		
Swordfern	*Polystictum munitum*	10
Dandelion	*Taraxacum sp.*	1
Wall lettuce	*Lactuca muralis*	1
Starflower	*Trientalis latifolia*	1
Foamflower	*Tiarella trifoliata*	1

Site 2: Lower Learning Garden Shrub and Herb Cover, May 28 2018		
Shrubs		
Common name	**Species**	**Percent cover**
Salmonberry	*Rubus spectabilis*	1
Red huckleberry	*Vaccinium parvifolium*	1
Oregon grape	*Berberis nervosa*	3
Thimbleberry	*Rubus parvifolia*	1
Trailing blackberry	*Rubus ursinus*	1
Oceanspray	*Holodiscus discolor*	2
Hazelnut	*Corylus sp.*	1
Ash	*Sorbus sp.*	1
Herbs		
Common name	**Species**	**Percent cover**
Swordfern	*Polystichtum munitum*	15
Skunk cabbage	*Lysichiton americanus*	4
Deer fern	*Blechnum spicant*	7
Horsetail	*Equisetum arvense*	2
Foamflower	*Tiarella trifoliata*	1
Ladyfern	*Athyrium felix-femina*	5
Moss spp.		20
Bracken fern	*Pteridium aquilinum*	1
False lily of the valley	*Maianthemum dilitatum*	3

9.2 Planting plan and budget

Species	Latin	Price	Amount	Total	
Upper Learning Garden					
Baldhip rose	Rosa gymnocarpa	4.75	5	23.75	
False azalea	*Menziesia ferruginea*	6	3	18.00	
Grand fir	*Abies grandis*	0	0	0.00	
Honeysuckle	*Lonicera ciliosa*	6	4	24.00	
Oregon grape	*Mahonia nervosa*	5.5	10	55.00	
Red huckleberry	*Vaccinium parvifolium*	6	5	30.00	
Salal	*Gaultheria shallon*	4.75	10	47.50	
Twinflower	*Linnea borealis*	2.75	18	49.50	
Total			**55**	**150.75**	
Lower Learning Garden					
Highbush cranberry	*Viburnum edule*	9.5	2	19.00	
Hookers fairybells	*Prosartes hookeri*	2.75	5	13.75	
Twinberry	*Lonicera involucrata*	8.5	2	17.00	
Vanilla leaf	*Achlys triphylla*	2.25	36	81.00	
Western trillium	*Trillium ovatum*	13	1	13.00	
wild ginger	*Asarum caudatum*	5	3	15.00	
Total			**49**	**158.75**	
Blackberry site					
Alders	*Alnus rubra*		40		
Blue elderberry	*Sambucus cerulea*	4.75	2	9.50	
Conifers	misc.		200	0.00	
Oceanspray	*Holodiscus discolor*	8.5	10	85.00	
Pacific ninebark	*Physocarpus capitatus*	4.75	5	23.75	
Red elderberry	*Sambucus racemosa*	4.75	5	23.75	
Salmonberry	*Rubus spectabilis*	4.75	10	47.50	
Saskatoon	*Amelanchier alnifolia*	4.75	5	23.75	
Thimbleberry	*Rubus parvifolium*	4.75	10	47.50	
Total			**287**	**260.75**	
Grand total					**570.25**

9.3 Letters to the City

Georgia Park Restoration Recommendations (sent to City of Campbell River in September 2018 prior to work on site)

Letter RE: Georgia Park (sent to City of Campbell River in September 2018 prior to work on site)

(See following pages)