The Assessment and Restoration of Seven Parks in North Saanich, B.C.

A multi-faceted project combining Terrestrial Ecosystem Mapping, hands-on invasive species removal and community partnership

12/01/21 Katrina Adams – V00024512 ER 390: RNS Final Project

TABLE OF CONTENTS

1 ABSTRACT

The spread of invasive plant species is a global threat to biodiversity and ecosystem health. This issue is particularly critical in urban parklands due to their long history of disturbances, as well as their high visitor traffic which can significantly increase the spread of invasives. Restoration of these urban parks often falls to community organizations, and success will depend on the resources and dedication of the communities. The Friends of North Saanich Parks (FNSP) is one such group who work in seven parks in North Saanich, B.C. with the goal of restoring the natural habitats within the parks. By removing invasive species, planting native species and conducting community education, FNSP has had remarkable success to date. To support their future goals of expanding their restoration strategies, this study took on mapping the ecosystems within each park using the Terrestrial Ecosystem Mapping (TEM) protocol developed by the BC Ministry of Forests. This resulted in an extensive source of data which included parameters such as soil characteristics, indicator plant species as well as any topography features of note. These biotic and abiotic parameters will better support and inform future restoration activities in each of the parks. Additionally, extensive invasive removal was done to support FNSP in bringing the parks to a monitoring phase, which implies active invasive removal is no longer required. Out of the seven parks, three parks were officially in the monitoring phase by the end of summer 2021, and another one was close. To promote community outreach, a workshop teaching the FNSP volunteers about the importance and methods of TEM was given in September 2021.

2 INTRODUCTION

North Saanich, located in the northern part of the Saanich Peninsula and part of the W̱SÁNEĆ First Nations territory, is home to 29 local parks which provide not only essential habitat for countless species, but also vital greenspaces for the community. All parks in North Saanich, however, are heavily impacted by several factors, though one of the largest threats for these parks is the spread of invasive species. Invasive species can outcompete native plant species and can eventually result in a loss of biodiversity (Higgens et al. 1999, Wiedlich et al. 2020). Consequently, this loss impacts the ecosystem by altering ecosystem processes and functions, as well as impacting the overall resilience of the ecosystem (Chapin et al. 2000). The uncontrolled spread of invasive species can also result in detrimental effects to human health (Rai and Singh 2020), as many species have toxic properties (e.g., Giant Hogweed (*Heracleum mantegazzianum*)), as well as increase fire hazards (e.g., Gorse (*Ulex europaeus)* which contains volatile oils). It is therefore imperative that the pervasive spread of invasive species in local parks be controlled as best as possible.

Removing and controlling invasive species can take many forms and will often depend on the species that is being removed and resources available. But for all species, the complete removal from an area will take time and dedication, as the invasives can return quickly. One of the most common methods is mechanical removal (Wiedlich et al. 2020). For most species, it is necessary to remove the root ball or roots to prevent the plant from growing back, however this requires a high amount of effort. To fully eliminate an invasive species from an area, it is often necessary to undergo several years of consistent removal events, followed by a monitoring program (DiTomaso et al. 2010).

Removing invasive species is an important step in ecological restoration; however, it is just one step out of several to improve the ecological integrity of a community park. Another step is to replace invasive species with native ones, and to determine which native species compositions are most

suited to local site conditions within each park, a useful tool in British Columbia is using Terrestrial Ecosystem Mapping (TEM) (Cadrin and von Sacken 1999). This tool provides an overall greater insight of both the abiotic and biotic parameters that are present including climate, vegetation, physiography, surficial material, bedrock geology and soil. Combined, this information reveals the type of ecosystem (and its associated vegetation) that would be found, in the long absence of disturbance and without the pressures of invasive species (Resources Inventory Committee 1998). Overall, TEM provides vital information and results in a comprehensive repository of data that can be used for resource management, land use planning and restoration.

Ecological restoration is an extremely difficult task and has been made harder by the fact that many parks have experienced hundreds of years of anthropogenic impacts. However, by using tools such as TEM combined with a better understanding of the historical usage of the land, and a dedicated community, restoring the ecological integrity of an area can be successful.

One objective of this project was to develop a partnership with a local community group and help support their goals in restoration. The "Friends of North Saanich Parks "(FNSP) is made up of volunteers who work within seven small parks in North Saanich and have dedicated themselves to maintaining the ecosystems within them. Their primary method is the mechanical removal of invasive species, followed by replanting native species when possible. FNSP have been extremely successful in nearly completely removing invasives from several of the parks they currently steward. Despite this major success, there is still a lot that needs to be understood about the specific ecological processes of the parks to design effective future restoration strategies. Therefore, the main objective of this study was to produce a TEM for each of the main parks, which provides FNSP with vital information about the ecosystems they steward. Another objective of the project was to aid FNSP in reaching their goal of having the seven parks in the "monitoring" phase, which means the majority of invasives have been removed, and they are regularly monitored for regrowth.

3 STUDY AREA

The seven parks (RO Bull Park, Denham Till Park, Green Park, Lillian Hoffar Park, Nymph Point Park, Quarry Park and Gulf View Park) are all located in the territory of the W̱SIḴEM (Tseycum) First Nation (North Saanich, B.C.), which is a part of the W̱SÁNEĆ territory (Figure 1).

The biogeoclimatic zone for all parks is Moist Maritime Coastal Douglas-fir, characterized by a climate with warm, dry summers and mild, wet winters. The seven parks are all relatively small, with areas ranging from 0.7 hectares to 4 hectares. The parks have been heavily impacted by anthropogenic activities throughout history, including forestry, agriculture and development, all resulting in varying amount of disturbance within each park. The parks are affected by the spread of invasives particularly Himalayan blackberry (*Rubus armeniacus)*, English ivy (*Hedera helix)*, English holly (*Ilex aquifolium)* and Daphne (*Daphne laureola)*. The parks have also undergone some previous restoration by FNSP, and as of February 2021 (before this study started), the invasive plant estimated removal completion rate for each park is as follows: RO Bull - 95%, Quarry - 90%, Nymph Point 78%, Gulf View - 75%, Lillian Hoffar - 65%, Green Park - 30%, and Denham Till - 65%. Other restoration includes planting native vegetation, which has been done in Nymph Point and Lillian Hoffar parks. To determine the rate of regrowth of invasive species, FNSP implemented 10 x 10 m treatment plots in Lillian Hoffar, Nymph Point, Gulf View and Denham Till in 2020, where they removed all the invasives present, then monitored the plot over time for any regrowth.

Some of the parks also have features that show evidence of First Nations activities, such as substantial shell middens found in Nymph Point and Lillian Hoffar parks. FNSP had archeologist Darcy Matthews assess several of the parks, and he noted that both Nymph Point and Lillian Hoffar also have several possible burial sites, which were identified by a cluster of rocks indicating burial cairns. Further investigation of these sites will be conducted next year.

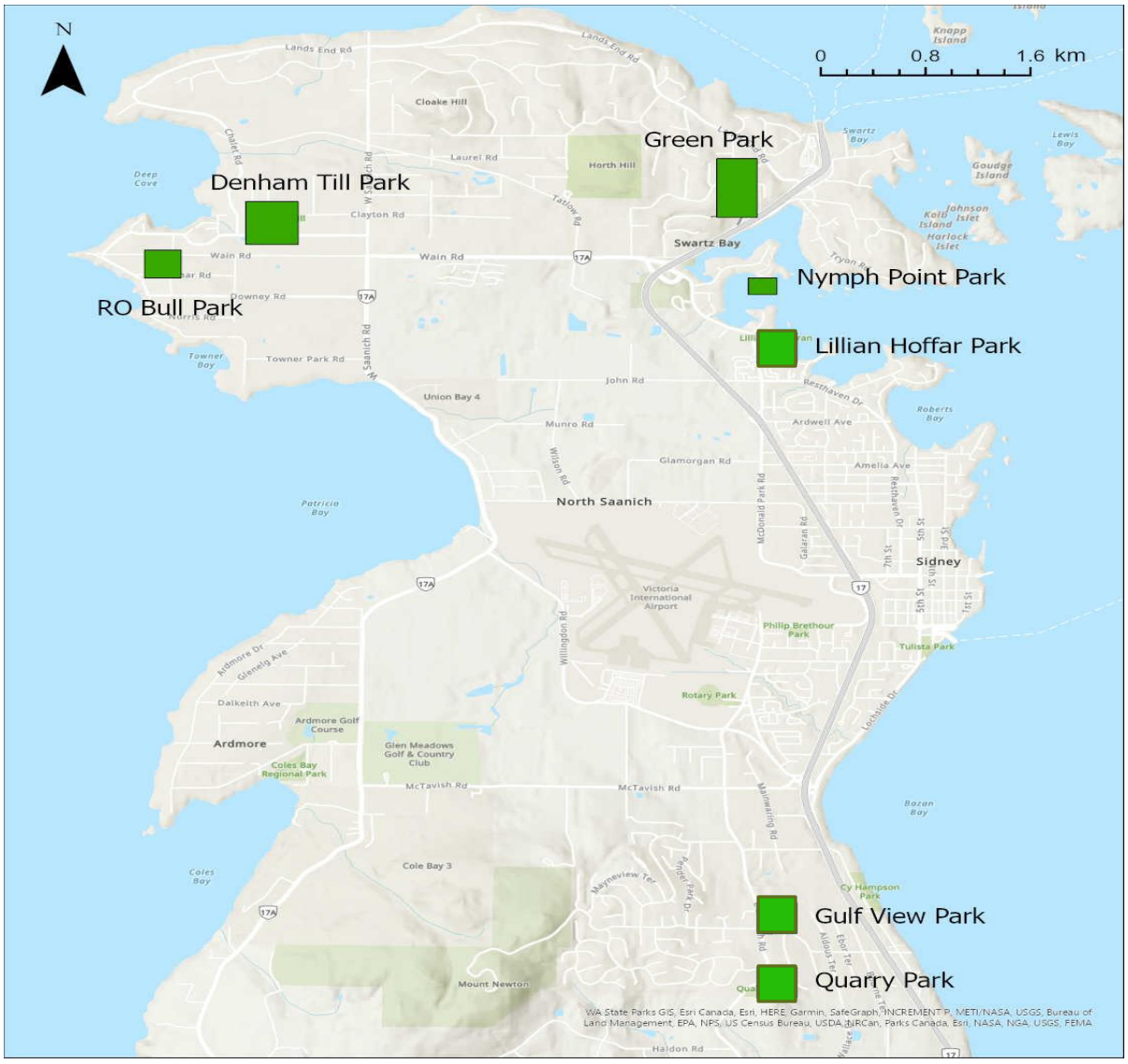


Figure 1: Location of the Study Parks. Note: the size of the polygons is not an accurate representation of the size of the parks, they are just merely making it easier to see the location of each park.

4 METHODS

To map the ecosystem units found in the parks, the method of Terrestrial Ecosystem Mapping (TEM) described by the B.C. Ministry of Forests (2010) was utilized. This involved using satellite images of each park, and a preliminary walk-through to identify different ecosystems by any major changes in vegetation type, crown cover and moisture of the soil. From these observations, rough polygons were drawn on a map, and then a 20 m X 20 m study site representing the ecosystem unit was laid out using a tape measure. To determine the site series codes, a soil pit of ~ 50 cm was dug in each of the proposed ecosystems, and a Ground Inspection Form (GIF) was filled out using the protocols outlined in the Field Manual for Describing Terrestrial Ecosystems (B.C. Ministry of Forests 2010). The soil pit depth varied by park, as some sites had extremely shallow soils. Soil pits were also prohibited in Nymph Point and Lillian Hoffar Park due to the presence of First Nations historical sites, therefore a visual inspection was done to determine changes in ecosystem, as well as using bare soil found on a steep bank when possible.

From the soil pits, the soil moisture regime (SMR) and soil nutrient regime (SNR) was determined using keys described in the Field Manual, and combined with the indicator vegetation species, the site series was determined. Site modifiers (e.g., very shallow soils, steep slopes, drier than typical, etc.) were added if pertinent. The structural stage and stand composition were also determined for each unit and an appropriate code for each was added. Combined, all the codes form the site series code that represents the entire ecosystem unit. Using GPS points taken in the field along the perimeter of the units, each of the polygons were drawn onto a map using ArcGIS Pro. Other features of note, such as the FNSP treatment plots were also identified using GPS and added to the final maps. All the shapefiles created will be shared with FNSP, providing them with a comprehensive database.

In addition to the TEMs, removal of invasive species was also done in each of the parks. Depending on the species, different removal techniques were utilized. For Himalayan blackberry, loppers were used to remove most of the branches, then a shovel and pickaxe were used to remove the root ball from the soil. For both Daphne and ivy, the plants were pulled, and then the roots removed using a small shovel. Approximately 100 hours was spent removing species within the parks over a four-month period. The debris was collected by the City of North Saanich, as coordinated by FNSP. The removal rates described for each park in the report were given by FNSP and was done by estimating the cover of each invasive species over the entire park area.

Finally, a community outreach event was conducted in September, where a TEM workshop was done with the FNSP volunteers. The workshop included a discussion of the importance of TEM to restoration and taught the volunteers how to classify the ecosystems they work in by going through a simplified site series coding exercise. Approximately 15 volunteers took part in the workshop.

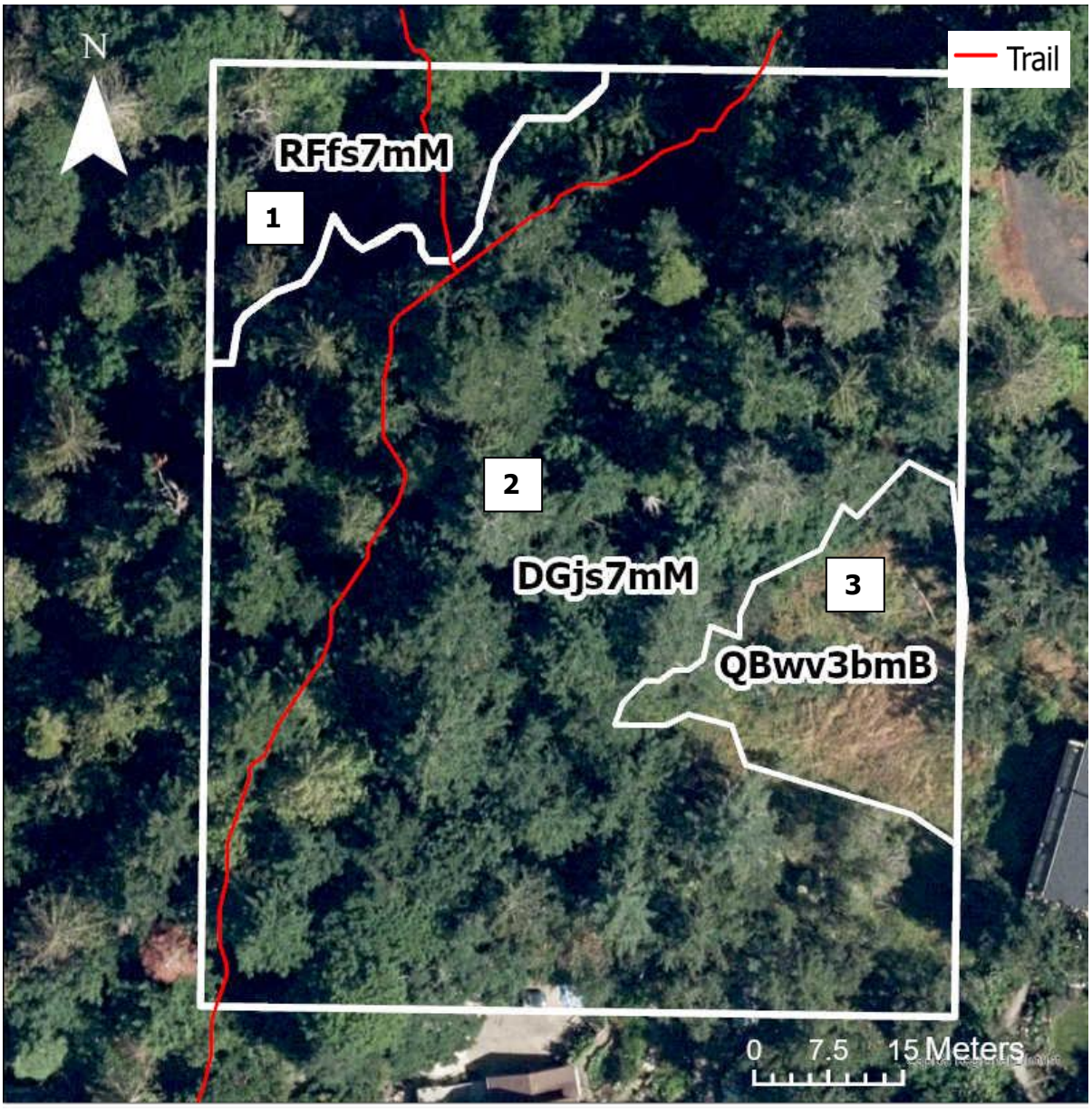
Figure 2: Tools of the trade for removing invasive species, as well as an example of a debris pile containing blackberry and ivy from a few hours work.

5 RESULTS

5.1 RO BULL PARK

RO Bull Park is one of the smallest of the parks, having an area of ~2 hectares. It contains one of the only remaining stands of old growth forest on the Saanich Peninsula, consisting of several 350-year-old Douglas-fir (*Pseudotsuga menziesii),* as well as several large Western Red Cedar (*Thuja plicata*) and Grand fir (*Abies grandies)*. There is also a small pocket Garry oak meadow present in the south-east corner of the park. Out of the seven parks, RO Bull Park is in the best shape in terms of invasive species presence, with ~ 95% of the park cleared. This park also has the least amount of disturbance, and therefore is highly diverse in native species.

The TEM revealed the presence of three different ecosystem units (Figure 3). The three distinct ecosystems of RO Bull Park were easily identified by the change in the tree and shrub layers. The sloped topography of this park, with Polygon 3 having the highest elevation leading down to Polygon 1, affects the soil moisture and nutrient regimes, and subsequently affects the types of vegetation found. For example, Polygon 3 which is found on the upper slope, has soil that is drier, which is typical for Garry oak ecosystems (Fuchs 2001). Conversely, Polygon 1 and 2 have slightly deeper and more moist soil, resulting in the presence of older and larger Douglas-fir and Western red cedars. The following section provides more details of the ecosystems.



The ecosystem units of RO Bull Park:

1. RFfs7mM

RF: Western red cedar - Grand fir - Foamflower
f: fine textured soil
s: shallow soil
7: Old forest
m: Multi-storied stand
M: Mixed stand composition modifier

2. DGjs7mM

DG: Douglas-fir - Grand fir - Oregon grape
j: gentle slope
s: shallow soil
7: Old forest
m: Multi-storied stand
M: Mixed stand composition modifier

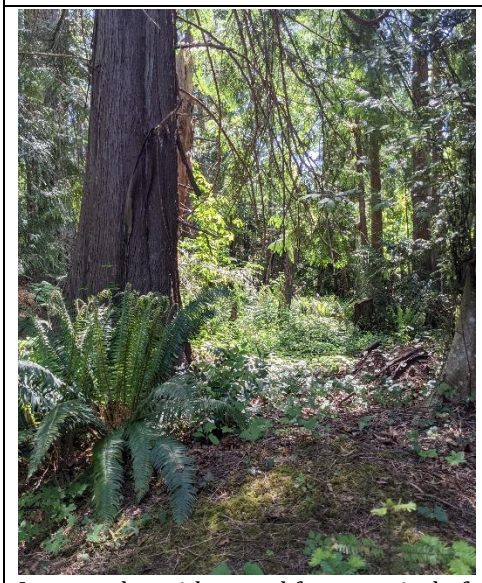
3. QBwv3bmB

QB: Garry oak - Brome/ Mixed grasses
w: warm aspect
v: very shallow soil
3b: Tall shrub (2-10 m)
m: Multi-storied stand
B: Broadleaf dominated stand

Figure 3: TEM of RO Bull Park

5.1.1 Terrestrial Ecosystem Mapping

Polygon 1

TEM Map Code	CDFmm Site series	Location
RFfs7mM	06 – Western red cedar – Grand fir – Foamflower	48.67666°N, 123.479639°W
 Large cedar with sword ferns, typical of RF sites.	 Foamflower (*Tiarella Cordifolia)* – an indicator species of RF sites	 Barred owl (*Strix varia)* overlooking the digging of a soil pit

Site Description

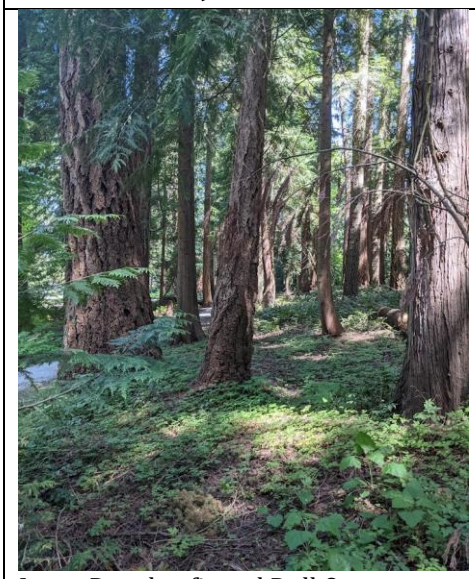
This rich and productive ecosystem was separate from Polygon 2 due to the higher concentration of Western red cedar (*Thuja plicata)* combined with an understory of sword fern (*Polystichum munitum)*. This ecosystem was also moister, with the soil having a high clay content and a high soil moisture level (5 out of 7). The forest stand within this polygon was multi-storied, with all three crown classes well developed, though the herb layer was particularly diverse. Due to the higher closure of the canopy the intermediate crown class was less developed, with a few shade-tolerant shrubs.

Modifiers used: f – fine-textured soil, s – shallow soil
Structural Stage: 7 – Old Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: M – mix of Coniferous and Broadleaf trees

Any species highlighted in red are invasive species that were found within the polygons.

Polygon 1GIF Results		
Site Series Code	RFfs7mM	
Site Characteristics		
Elevation	21 m	
Meso Slope Position	Toe	
Course Fragment Content	< 20%	
Slope	3%	
Aspect	146 °	
Mineral Soil Texture	Clayey	
Humus Form	Moder	
SMR	Subhygric	
SNR	Very Rich	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Western Red Cedar (*Thuja plicata)*	Salmonberry (*Rubus spectabilis)*	Pathfinder (*Adencaulon bicolor)*
Red alder (*Alnus rubra)*	Sword fern (*Polystichum munitum)*	Broad-leaved Star flower (*Trientalis latifolia)*
Grand fir (*Abies grandis)*	Dull Oregon grape (*Mahonia nervosa)*	Foamflower (*Tiarella cordifolia*)
	Bracken fern (*Pteridium aquilinum)*	Trailing blackberry (*Rubus ursinus)*

Polygon 2

TEM Map Code	CDFmm Site series	Location
DGjs7mM	04 – Douglas-fir- Grand fir – Oregon grape	48.67663°N, 123.47961°W
 Large Douglas-fir and Dull Oregon grape, indicative of DG sites	 Dull Oregon grape (*Mahonia nervosa*)	 Fallen trees providing habitat and providing the soil with nutrients

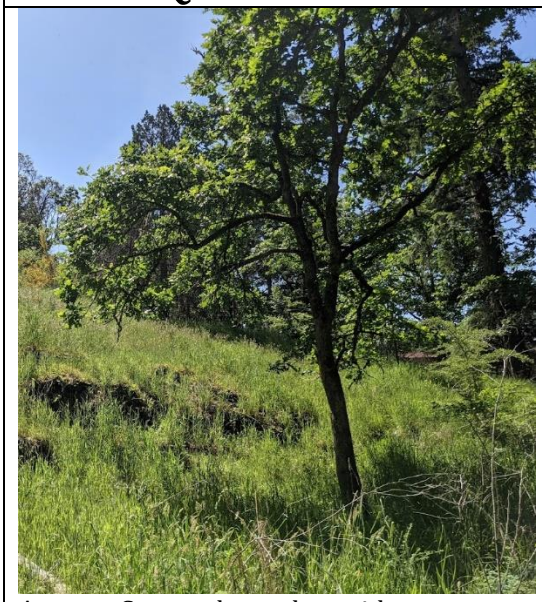
Site Description

This ecosystem was classified by the large old-growth Douglas-fir, cedar, and Grand firs present, with a dominant undergrowth of Oregon grape. The soil within this ecosystem was more course than in Polygon 1 and had a siltier texture. The presence of younger bigleaf maple (*Acer macrophyllum*), Indian plum (*Oemleria cerasiformis)* and oceanspray (*Holodiscus discolor)* created a more diverse B-layer than that found in Polygon 2.

Modifiers used: j – gentle slope, s – shallow soil
Structural Stage: 7 – Old forest
Structural Stage Modifier: m – multi-storied
Stand Composition: M – mix of Coniferous and Broadleaf trees

Polygon 2 GIF Results		
Site Series Code	DGjs7mM	
Site Characteristics		
Elevation	26 m	
Meso Slope Position	Mid Slope	
Course Fragment Content	< 20%	
Slope	17%	
Aspect	140 °	
Mineral Soil Texture	Silty	
Humus Form	Moder	
SMR	Subhygric	
SNR	Rich	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Western Red Cedar (*Thuja plicata)*	Bigleaf maple (*Acer macrophyllum)*	Dull Oregon grape (*Mahonia nervosa*)
Douglas-fir (*Pseudostuga menziesii)*	Indian plum (*Osmaronia cerasiformis)*	Trailing blackberry (*Rubus ursinus)*
Grand fir (*Abies grandis)*	Oceanspray (*Holodiscus discolor)*	Pathfinder (*Adencaulon bicolor)*
	Salal (*Gaultheria shallon)*	Foamflower (*Tiarella cordifolia*)
	Sword fern (*Polystichum munitum)*	Bracken fern (*Pteridium aquilinium)*

Polygon 3:

TEM Map Code	CDFmm Site series	Location
QBwv3mB	00- Garry Oak – Brome/mixed grasses	48.67662°N, 123.47960°W
 An open Garry oak meadow with a warm aspect	 Common Camas (*Camassia quamash)*	 Stunted Garry oak trees due to very shallow soils

Site Description

This polygon was easily identified due to its more open meadow-like ecosystem, with the indicator species of Garry oak (*Quercus garryana),* Common Camas (*Camassia quamash)* and various grass species. The trees present within this ecosystem were stunted, probably due to the presence of the very shallow soils and rocky outcrops. The intermediate crown class is not as distinct from the overstory (due to the short height of the trees); however, it was quite diverse. The herb layer was immensely diverse, containing a wide variety of wildflowers and grasses This polygon had invasives present, with a few Scotch broom (*Cytisus scoparius*) individuals.

Modifiers used: w – warm aspect, v – very shallow soil
Structural Stage: 3b – Tall shrub (2-10 m)
Structural Stage Modifier: m – multi-storied
Stand Composition: B – Broadleaf dominated

Polygon 3 GIF Results		
Site Series Code	QBwv3mB	
Site Characteristics		
Elevation	30 M	
Meso Slope Position	Upper Slope	
Course Fragment Content	< 20%	
Slope	12%	
Aspect	159 °	
Mineral Soil Texture	Loamy	
Humus Form	Moder	
SMR	Subxeric-Submesic	
SNR	Rich	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Garry Oak (*Quercus garryana)*	Saskatoon berry (*Amelanchier alnifolia)*	Common Camas (*Camassia quamash)*
Bigleaf Maple (*Acer Macrophyllum)*	Nootka Rose *(Rosa nutkana)*	Brome spp.
	Common Snowberry (*Symphoricarpos albus)*	Miner's lettuce (*Claytonia perfoliate)*
		Sword fern (*Polystchum munitum)*
	Scotch Broom (*Cytisus scoparium)*	Dull Oregon grape (*Mohonia nervosa)*
		White Fawn lily (*Erythronium oregonum)*
		Small-flowered nemophila (*Nemophila parviflora)*
		Gairdner's yampah (*Perideridia gairdneri)*

5.2 DENHAM TILL PARK

The 3.5 hectare Denham Till Park contains younger Grand fir and Douglas-fir stands with a dominant salal understory. The park was a farm in the 1940s (S. Hope, personal communication, February 2021), an extensive garden which is evidenced by the presence of domestic ornamental plants as well as a historic hazelnut orchard. In the eastern section of the park, there is an open grassy area with an old remnant building (Figure 4). The rest of the park is relatively uniform, mostly consisting of Douglas-fir, Grand fir and salal (*Gaulthoria shallon)* as indicator species (Figure 5). There is a very small section on the eastern edge of the park that has a presence of oceanspray (*Holodiscus discolor)* and Nootka rose (*Rosa nutkana)*, however it was not included as a separate ecosystem. The treatment plot showed that after one year, there was little regrowth of ivy or other invasives.

Figure 4: Dilapidated shed in the grassy area of Denham Till - remnants of an agricultural history

5.2.1 Invasive Removal

Before the project started in May, the level of completeness of invasive removal for Denham Till was at ~65%. The main invasive species that are found in this park are Himalayan blackberry, English ivy as well as Canada Thistle (*Cirsium arvense)*. Approximately 18 hours was spent in this park removing invasives. By October, the level of completeness rose to ~80%.

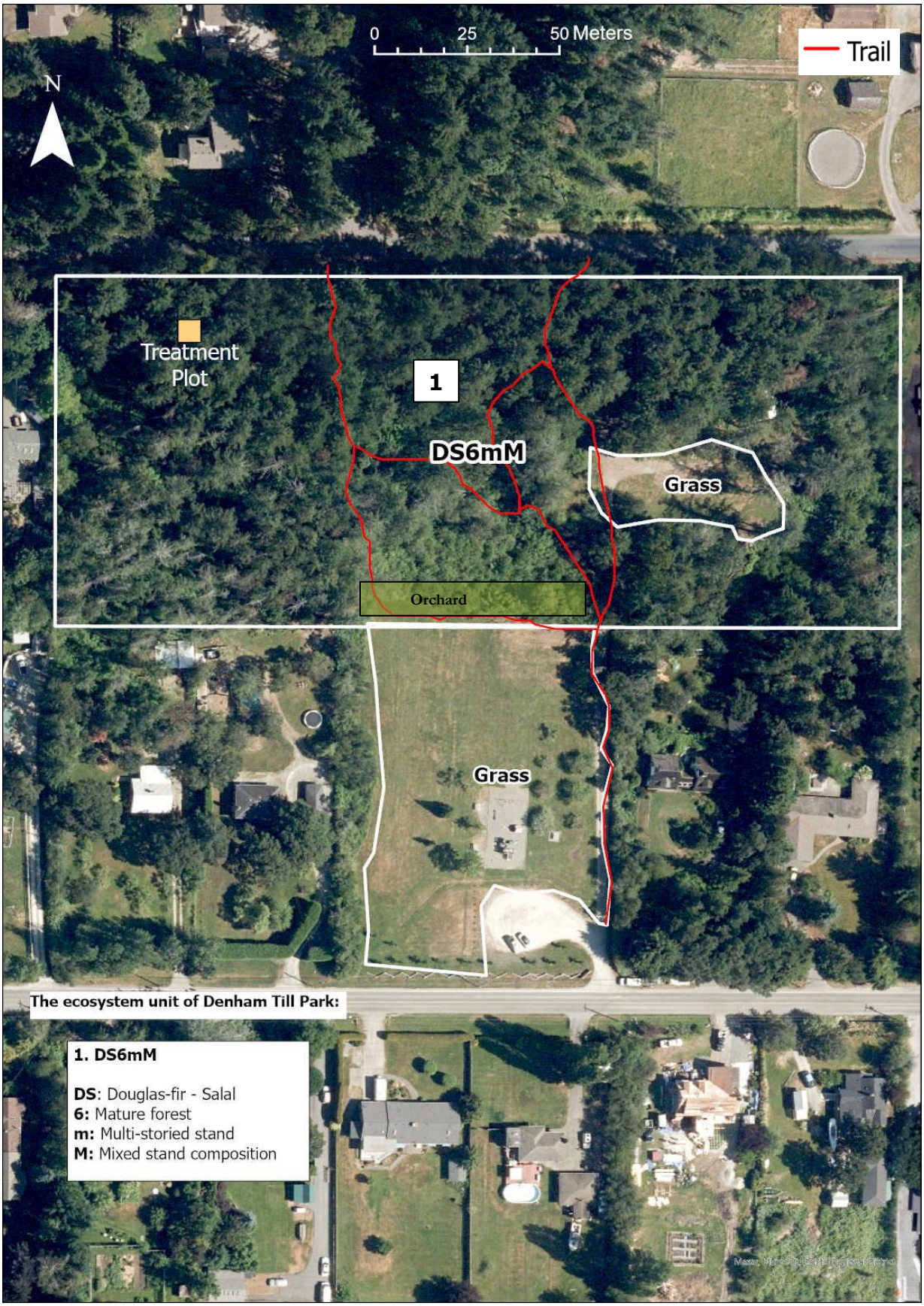
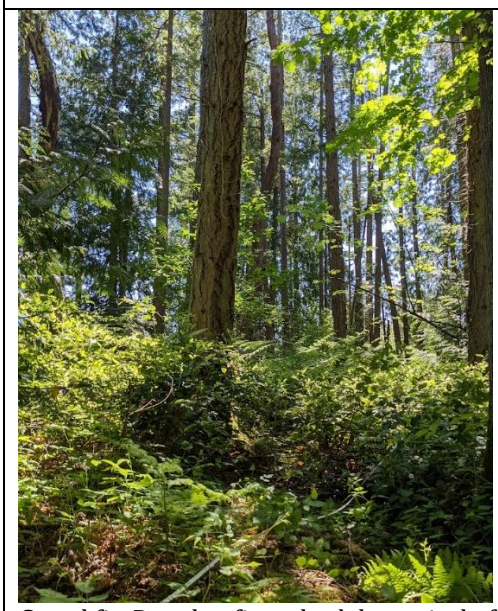


Figure 5: TEM of Denham Till Park

5.2.2 Terrestrial Ecosystem Mapping

Polygon 1

TEM Map Code	CDFmm Site series	Location
DS6mM	01- Douglas-fir - Salal	48.68015°N, 123.46826°W
 Grand fir, Douglas-fir and salal – typical of DS sites	 Salal (*Gaultheria shallon)*	 The start of the soil pit - lighter gray soils indicating a clayey texture

Site Description

Denham Till Park is made up of a single ecosystem unit and with the presence of Douglas-fir and Grand fir combined with a dominant understory made up of salal, the site series was easily identified as DS. The trees are roughly 65-85 years old (S. Hope, personal communication, February 2021). The soil was classified as Mesic, very fine, and clay rich, which is typical of DS sites. The nutrient level was classified as poor, which is also typical of sites dominated with salal (Fisher et al. 2020). The few scattered Arbutus, as well as Garry oak on the southern edge of the forested area indicate a drier site, though due to the presence of the orchard, it was not quite distinct enough to be a separate ecosystem. The eastern edge of the polygon (to the right of the smaller grassy area) had the highest density of invasive species, with an immensely dense cover of Himalayan blackberry and ivy. This is probably due to the high amount of disturbance that has occurred in this park, and this section should be the focus for future restoration efforts.

Structural Stage: 6 – Mature Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

5.2.3 Denham Till Park GIF Results

Polygon 1		
Site Series Code	DS6mM	
Site Characteristics		
Elevation	30 M	
Meso Slope Position	Level	
Course Fragment Content	< 20%	
Slope	2%	
Aspect	135°	
Mineral Soil Texture	Clayey	
Humus Form	Moder	
SMR	Mesic	
SNR	Poor	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Douglas-fir (*Pseudostuga menziesii)*	Salal (*Gaultheria shallon)*	Broad-leaved starflower (*Trientalis latifolia)*
Bigleaf maple (*Acer Macrophyllum)*	Bracken fern (*Pteridium aquilinum)*	Trailing blackberry (*Rubus ursinua)*
Western red cedar (*Thuja plicata)*	Common Snowberry (*Symphoricarpos albus)*	Vanilla leaf (*Achlys triphylla)*
Grand fir (*Abies grandis)*	Huckleberry (*Vaccinium parvifolium)*	Western trillium (*Trillium ovatum)*
Arbutus (*Arbutus menziesii)*	Nootka Rose (*Rosa nutkana)*	
Garry oak (*Quercus garryana)*	Huckleberry (*Vaccinium parvifolium*)	Reed canary grass (*Phalris arundinacea)*
		Himalayan Blackberry (*Rubus ameniacus)*

5.3 GREEN PARK

Green Park is ~4 hectares in size and split into two sections located north and south of Salal Place. This park has the highest variety of ecosystems among all study parks with a total of seven (Figure 7). The history of the park shows that it was originally a dairy farm, which has resulted in the presence of two artificial ponds. Green Park is the only park of the study sites that has a major freshwater source. The dominant tree cover consists of Douglas-fir, Western red cedar, red alder (*Alnus rubra)*, Grand fir and black cottonwood (*Populus trichocarpa)*. The trees, aged at about 45-65 years, are younger than those in Denham Till. The two ponds (Figure 6) are small and have very fine silty sediments as substrates. The ponds are also vegetated and provide excellent habitat for waterfowl. The ecosystem surrounding the ponds are classified as seral young forest (PS5) containing mostly alder. A seral community is an intermediate stage of ecological succession, and often contains fast growing species that establish quickly after a disturbance. Other species found within the ecosystem surrounding the ponds include willow and smaller bigleaf maple and cedars.

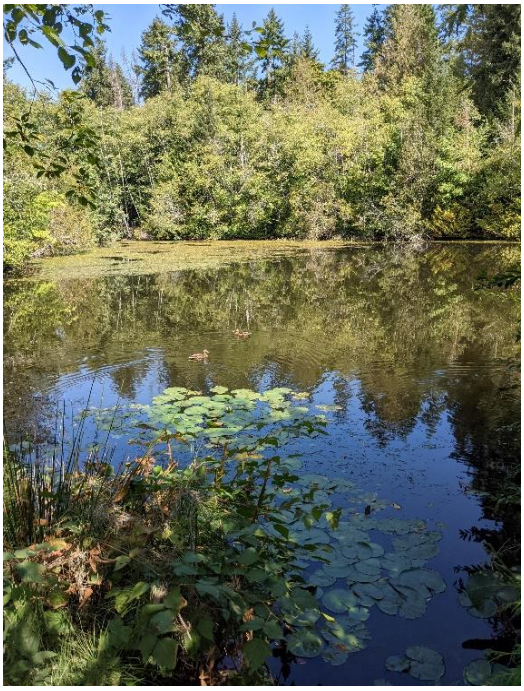


Figure 6: One of the two ponds present in Green Park

5.3.1 Invasive Removal

The southern part of Green Park contains the majority of the invasives, including a massive area of Himalayan blackberry on the western edge. There is also English ivy, English holly and Daphne present. In May 2021, the level of completeness for invasive removal was ~30%. 18 hours was spent in this park removing invasives, and in October, the level of completeness had risen to ~ 50%.

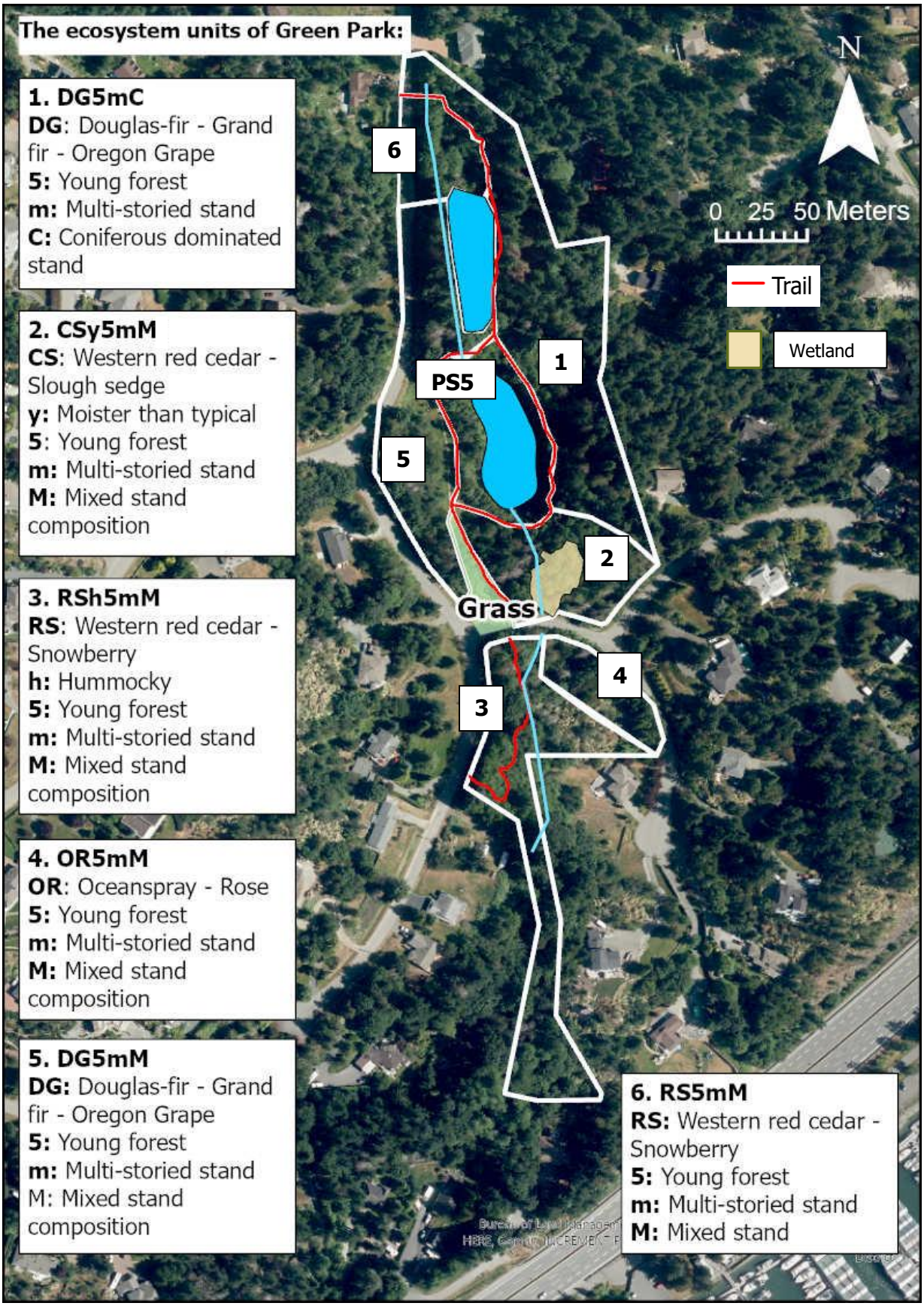


Figure 7: TEM of Green Park

5.3.2 Terrestrial Ecosystem Mapping

Polygon 1

TEM Map Code	CDFmm Site series	Location
DG5mC	04 – Douglas-fir –Grand fir – Oregon Grape	48.68462°N, 123.41888°W
 Polygon 1 having an open understory as well as lots of fallen trees and branches	 A wildlife tree found in Polygon 1	 A typical DG ecosystem with Douglas and Grand fir with Oregon grape understory

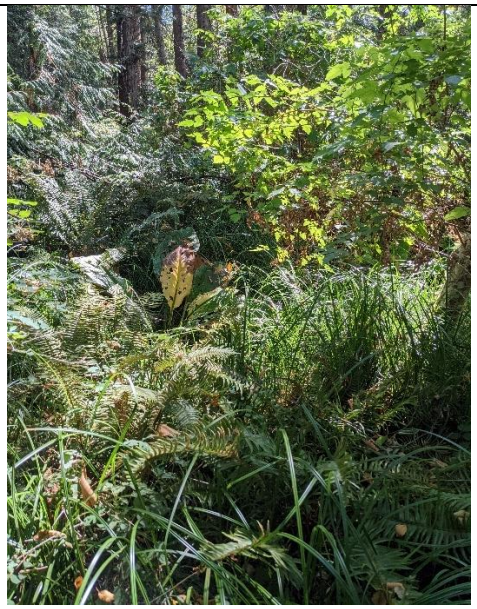
Site Description

This ecosystem is the largest of all the ecosystem units found within Green Park and was easily identifiable with Douglas-fir, Grand fir and Dull Oregon grape dominating the vegetation. Most of the trees are younger (structural stage of 5), though there are a few larger and older specimens of Douglas-fir and cedar present. This ecosystem was quite sloped, with the upper slope leading up to a residential area above the park. The walking trail is located midslope. Much of this section also had a less dense understory than many of the other ecosystems, with several sections of bare earth present. In the northern section of the ecosystem, there are several large stumps of large trees present, representing a substantial disturbance having occurred in the past. There is also a fair amount of large woody debris on the ground, providing vital habitat for many species. The soil was quite sandy, and on the drier side, which is typical of Douglas-fir – Oregon grape ecosystems.

Structural Stage: 5 – Young Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: C – Coniferous dominated

Polygon 1 GIF Results		
Site Series Code	DG5mC	
Site Characteristics		
Elevation	41 m	
Meso Slope Position	Lower Slope	
Course Fragment Content	35-70%	
Slope	8%	
Aspect	230°	
Mineral Soil Texture	Sandy	
Humus Form	Moder	
SMR	Mesic	
SNR	Rich	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Douglas-fir (*Pseudostuga menziesii)*	Dull Oregon grape (*Mahonia nervosa)*	Pathfinder (*Adencaulon bicolor)*
Bigleaf maple (*Acer Macrophyllum)*	Salal (*Gaultheria shallon)*	Trailing blackberry (*Rubus ursinua)*
Western red cedar (*Thuja plicata)*	Bracken fern (*Pterdium aquilinum)*	Vanilla leaf (*Achlys triphylla)*
Grand fir (*Abies grandis)*	Oceanspray (*Holodiscus discolor)*	
	Snowberry (*Symphoricarpos albus)*	English ivy (*Hedera helix)*
	Sword Fern (*Polystichum munitum)*	

Polygon 2

TEM Map Code	CDFmm Site series	Location
CSy5mM	14 – Western red cedar – Slough sedge	48.68339°N, 123.41879°W
 Smaller cedars, alders and bigleaf maples were the most common trees in this ecosystem	 Wetland area found in the Ecosystem – skunk cabbage and slough sedge present	 Slough Sedge (*Carex obnupta)*

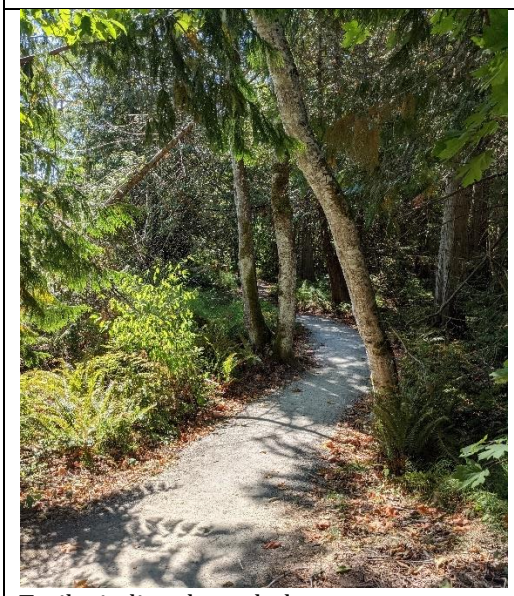
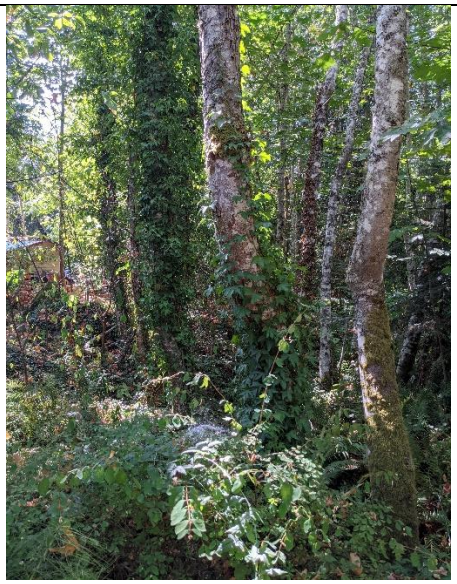
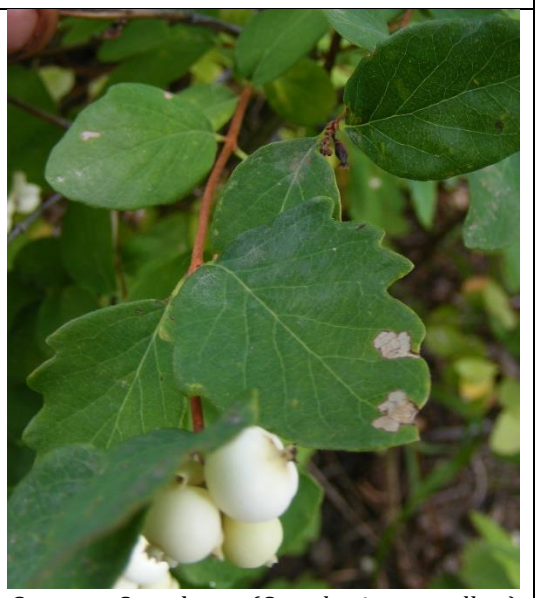
Site Description

This ecosystem was the most unique of the sites found in Green Park. Within the lower south-east side of the park is a large wetland that surrounds the stream that drains from one of the ponds. Within this wetland, Slough sedge (*Carex obnupta*) and skunk cabbage (*Lysichiton americanus)* was dominant. Even during drought conditions, there was still some standing water present within this area. Around the wetland, cedars and alders form the dominant tree cover.

Modifiers used: y -moister than typical
Structural Stage: 5 – Young Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

Polygon 2 GIF Results		
Site Series Code	CSy5mM	
Site Characteristics		
Elevation	42 m	
Meso Slope Position	Level	
Course Fragment Content	20-35%	
Slope	3%	
Aspect	175°	
Mineral Soil Texture	Clayey	
Humus Form	Mull	
SMR	Hygric	
SNR	Rich	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Douglas-fir (*Pseudostuga menziesii)*	Snowberry (*Symphoricarpos albus)*	Slough sedge (*Carex obnupta)*
Bigleaf maple (*Acer Macrophyllum)*	Salal (*Gaultheria shallon)*	Skunk cabbage (*Lysichiton americanus)*
Western red cedar (*Thuja plicata)*	Sword fern (*Polystichum munitum)*	Pathfinder (*Adencaulon bicolor)*
Black Cottonwood (*Populus trichocarpa)*	Red-osier dogwood (*Cornus stolonifera)*	Vanilla leaf (*Achlys triphylla)*
Red Alder (*Alnus rubra)*		

Polygon 3

TEM Map Code	CDFmm Site series	Location
RSh5mM	07-Western red cedar– Snowberry	48.68200°N, 123.41892°W
 Trail winding through the ecosystem	 Ivy covered trees – common within this ecosystem	 Common Snowberry (*Symphoricarpos albus)*

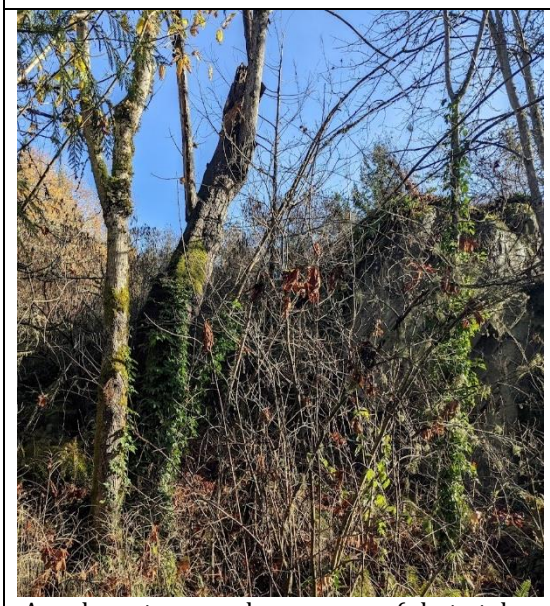
Site Description

This ecosystem makes up most of the southern half of Green Park and contained the highest number of invasive species. Nearly the entire western edge of the unit was made up of Himalayan blackberry. The dominant tree cover in this ecosystem is cedar and alder, and the shrub layer was quite pronounced with abundant snowberry, sword ferns and thimbleberry (*Rubus parviflorus)*. The stream that runs through Polygon 4 has an abundance of horsetail (*Equisetum arvense)* surrounding it. On either side of the trail, the topography is sloped and creates a hummocky terrain.

Modifier used: h - hummocky
Structural Stage: 5 – Young Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

Polygon 3 GIF Results		
Site Series Code	RSh5mM	
Site Characteristics		
Elevation	37 m	
Meso Slope Position	Depression	
Course Fragment Content	20-35%	
Slope	8%	
Aspect	138°	
Mineral Soil Texture	Clayey	
Humus Form	Moder	
SMR	Hygric	
SNR	Rich	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Western red cedar (*Thuja plicata)*	Snowberry (*Symphoricarpos albus)*	Horsetail (*Equisetum arvense)*
Bigleaf maple (*Acer Macrophyllum)*	Thimbleberry (*Rubus parviflorus)*	Trailing blackberry (*Rubus ursinua)*
Red Alder (*Alnus rubra)*	Sword fern (*Polystichum munitum)*	
		English holly (*Ilex aquifolium)*
		English Ivy (*Hedera helix)*
		Daphne (*Daphne laureola)*
		Himalayan blackberry (*Rubus ameniacus)*

Polygon 4

TEM Map Code	CDFmm Site series	Location
OR5mM	00 – Oceanspray - Rose	48.68542°N, 123.41970°W
 A rocky outcrop and oceanspray (photo taken in the fall)	 Oceanspray (*Holodiscus discolor)*	 This polygon contained a high density of Daphne (*Dahpne laureola)*

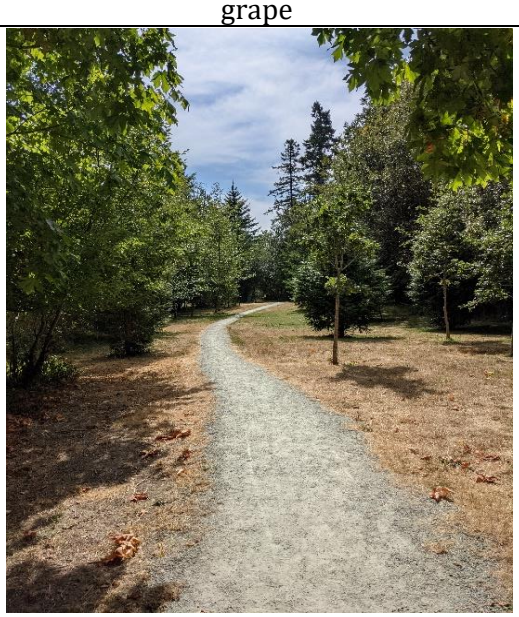
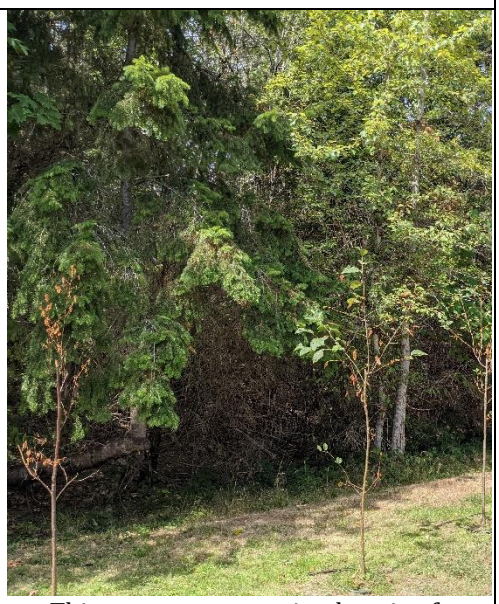
Site Description

This ecosystem is quite small and is located at the top half of the southern section of Green Park. This ecosystem was separated from Polygon 3 due to its higher elevation and drier conditions. The mesic soil leads to an ecosystem with oceanspray and Nootka rose being more dominant. This section also had quite a few invasives present including a very dense cluster of Daphne.

Structural Stage: 5 – Young Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

Polygon 4		
Site Series Code	OR5mM	
Site Characteristics		
Elevation	41 m	
Meso Slope Position	Upper slope	
Course Fragment Content	<20%	
Slope	4%	
Aspect	190°	
Mineral Soil Texture	Sandy	
Humus Form	Moder	
SMR	Mesic	
SNR	Rich	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Western red cedar (*Thuja plicata)*	Oceanspray (*Holodiscus discolor)*	Foamflower (*Tiarella cordifolia*)
Bigleaf maple (*Acer Macrophyllum)*	Nootka rose (*Rosa nutkana)*	Trailing blackberry
Red Alder (*Alnus rubra)*	Red alder (*Alnus rubra)*	
		Daphne (*Daphne laureola)*
		English holly (*Ilex aquifolium)*
		English Ivy (*Hedera helix)*

Polygon 5

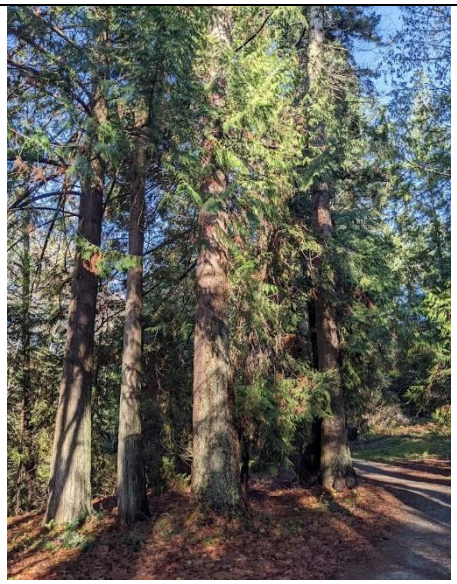
TEM Map Code	CDFmm Site series	Location
DG5mM	04 – Douglas-fir –Grand fir – Oregon grape	48.68423°N, 123.41978°W
 Rocky outcrop and small salal understory (photo taken in the fall)	 This ecosystem was more open than the other DG ecosystem	 This ecosystem contained a mix of Coniferous and Broadleaf trees

Site Description	Site Characteristics	
This ecosystem is essentially a small strip between the road and the grassy area around the pathway. It is like Polygon 1 except it has a mix of broadleaf and coniferous trees rather than coniferous dominant. The Douglas-fir and cedar trees in this section are also smaller than those found in Polygon 1, probably due to the higher disturbance occurring next to the roadway. This polygon also has a more open overstorey than that found in the denser forest of Polygon 1. With a sandy soil texture, and a medium-dry moisture regime, the dominant vegetation includes Douglas-fir, Oregon grape and salal. Structural Stage: 5 – Young Forest Structural Stage Modifier: m – multi-storied Stand Composition: M – Mix of Coniferous and Broadleaf	Elevation Meso Slope Position Course Fragment Content Slope Aspect Mineral Soil Texture Humus Form SMR SNR	48 m Level 35-70% 6% 135° Sandy Moder Mesic Rich

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Douglas-fir (*Pseudotsuga menziesii)* Bigleaf maple (*Acer macrophyllum)* Western red cedar (*Thuja plicata)* Red alder (*Alnus rubra)*	Dull Oregon grape (*Mahonia nervosa)* Salal (*Gaultheria shallon)* Oceanspray (*Holodiscus discolor)* Snowberry (*Symphoricarpos albus)*	Trailing blackberry (*Rubus ursinua)* Vanilla leaf (*Achlys triphylla)*

Polygon 6

TEM Map Code	CDFmm Site series	Location
RS5mM	07-Western red cedar – Snowberry	48.68542°N, 123.41970°W
 Polygon 6 contained moisture tolerant species including cedars and sword ferns	 Salmonberry (*Rubus spectabilis)*	 A stand of older Western red cedars can be found in this ecosystem

Site Description

This ecosystem is found at the toe of a slope on the North-West part of Green Park, and is a small cedar dominated section nestled between two Douglas-fir dominated ecosystems. Similarly, to all the forested areas in the park, it is a younger forest, though it does contain a few old and large cedars. Other vegetation found included snowberry, salmonberry as well as Sword ferns. The soil in this section was quite moist and rich. At a second visit in November, there was a lot of standing water found in this polygon, which help explains the more moisture tolerant species found.

Structural Stage: 5 – Young Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

Site Characteristics

Elevation	48 m
Meso Slope Position	Toe/Depression
Course Frag. Cont.	<20%
Slope	6%
Aspect	135°
Mineral Soil Texture	Clayey
Humus Form	Moder
SMR	Mesic - Subhygric
SNR	Rich – Very Rich

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Western red cedar (*Thuja plicata)* Douglas-fir (*Pseudotsuga menziesii)* Red alder (*Alnus rubra)*	Sword fern (*Polystichum munitum)* Salal (*Gaultheria shallon)* Snowberry (*Symphoricarpos albus)* Salmonberry *(Rubus spectabilis)*	Trailing blackberry (*Rubus ursinua)* Vanilla leaf (*Achlys triphylla)*

5.4 NYMPH POINT PARK

Nymph Point Park is a 2.5 hectare park overlooking Tsehum Harbour near Sidney, B.C. This park contains several significant First Nations archeological sites, including extensive shell middens on the beachside as well as at least three burial cairns (Figure 8). A part of the W̱SIḴEM territory, Tsehum Harbour was used historically as a winter home, and the park would have been used for traditional fishing and shellfish harvesting.

Figure 8: Shell middens found along the beachside (left) and a possible burial cairn (right) are remnants of W̱SIḴEM First Nations fishing and shellfish activities that occurred in Nymph Point Park

The park has two ecosystems which differ quite significantly (Figure 10), indicating varied levels of disturbance within the area. The northern section of Nymph Point contains a seral community of alder and other similar species and has a high concentration of invasive species. This polygon contained a drainage ditch that had been recently dug, and at the time of assessment was completely dry. The construction of the ditch had resulted in some heavy disturbance, where several areas had vegetation cleared completely. The municipality had attempted to negate this disturbance by planting cedar saplings, which were doing quite poorly during the drought.

The southern section on the rocky promontory contains an older and more established community of Douglas-fir and Arbutus (*Arbutus menziesii)*. At the most southern section, there is a very small Garry oak meadow, though it was not deemed large enough to be a separate ecosystem. The understory in this section is also much more diverse in native species than the seral community in Polygon 1. Disturbance within this section include trampling as well as some clearing of vegetation, including the pruning of an uncommon seaside juniper (*Juniperus maritima)*. Again, plantings were done by the municipality, but the saplings had been planted within a native wildflower meadow that contained very shallow soils, resulting in an overall negative impact to both the native species as well as the saplings.

5.4.1 Invasive Removal

Nearly 30 hours was spent in Nymph Point Park to remove invasives and to help FNSP bring this park into the monitoring phase. A significant amount of blackberry, ivy and Daphne was removed from this park. Efforts were focused on removing the blackberry and ivy from the northern section of the park, as well as the shoreline along the southern section which was overgrown with Daphne and ivy (Figure 9). Before the summer started the approximate level of invasive removal was at 80%, and it is now currently in the monitoring phase as the majority of invasives have now been removed. The focus for monitoring will be ensuring that Daphne seedlings do not take root. The two treatment plots that were installed in 2020 FNSP revealed that Daphne seedlings were also the first to return.

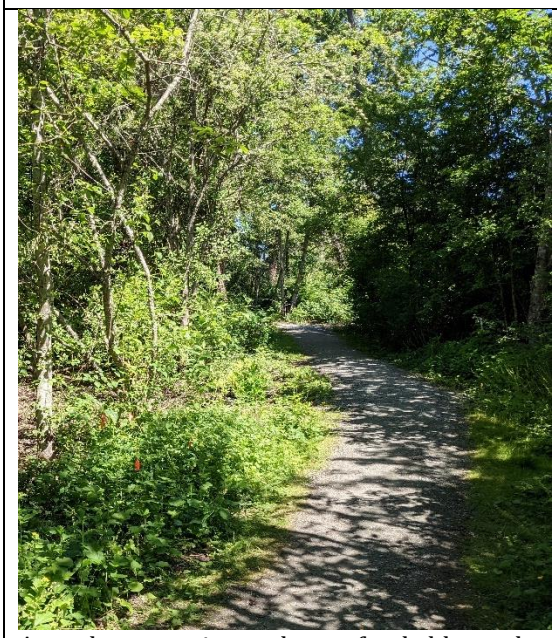
Figure 9: Daphne and ivy along the cliffside in Nymph Point Park. The invasives help prevent the bank from failing, resulting in an issue for removal

Figure 10: TEM of Nymph Point Park

5.4.2 Terrestrial Ecosystem Mapping

Polygon 1

TEM Map Code	CDFmm Site series	Location
PS3biB	Seral stage – Alder Dominated	48.67602°N, 123.41735°W



A seral community made up of red alder and willow

Creeping buttercup (*Ranunculus repens)* – an invasive flowering plant common in Polygon 1

Signs of disturbance are associated with a seral ecosystem.

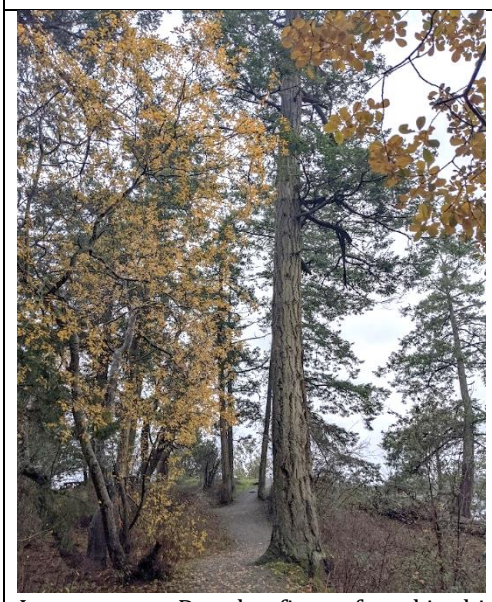
Site Description

Polygon 1 was a highly disturbed site that contained a seral community made up of young red alders, willow species and various smaller shrubs such as hawthorne (*Crataegus monogyna*) and red-osier dogwood (*Cornus stolonifera)*. There was a high level of invasive species within this polygon, which is congruent with the level of disturbance. This has also resulted in the vegetation being classified as 3b which represents tall shrubs 2-10 m in height. The soil (visible within the newly dug ditch) was quite clayey and had a fairly high moisture regime (subhygric), therefore this site would support moisture-loving species within its climax community. Coupled with a nutrient level rated at Rich-Very Rich, the climax community may be RF (CwBg-Foamflower).

Structural Stage: 3b – Tall shrub (2-10 m)
Structural Stage Modifier: i – irregular
Stand Composition: B –Broadleaf dominated

Polygon 1 GIF Results		
Site Series Code	PS3biB	
Site Characteristics		
Elevation	1 m	
Meso Slope Position	Level	
Course Fragment Content	<20%	
Slope	0%	
Aspect	185°	
Mineral Soil Texture	Clayey	
Humus Form	Moder	
SMR	Subhygric	
SNR	Rich – Very Rich	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Red alder (*Alnus rubra)*	*Prunus spp*	Fringe Cup *(Tellima grandiflora)*
Scouler's Willow (*Salix scouleriana)*	Common Hawthorne (*Crataegus monogyna*)	Trailing blackberry (*Rubus ursinua)*
	Red-osier dogwood (*Cornus stolonifera)*	Wood Avens *(Geum urbanum)*
	Cascara (*Rhamnus purshiana)*	Brome Spp.
	Common Snowberry (*Symphoricarpos albus)*	
	Salmonberry *(Rubus spectabilis)*	Creeping buttercup *(Ranunculus repens)*
		English Ivy (*Hedera helix)*
		Himalayan blackberry (*Rubus ameniacus)*
		Daphne (*Daphne laureola)*

Polygon 2

TEM Map Code	CDFmm Site series	Location
DAs6mM	02 – Douglas-fir – Shore pine – Arbutus	48.67502N, 123.41662°W
 Large mature Douglas-fir are found in this ecosystem, along with a more developed intermediate crown class	 Oceanspray (*Holodiscus discolor)*	 Small Garry oak meadow on southern most tip of Nymph Point Park.

Site Description

This polygon represented a more established and diverse ecosystem, containing a wide variety of native species including a small pocket Garry oak meadow on the southern-most end. Typical of DS sites, this ecosystem was drier, with the sandy, and well-drained soil* that had a much drier moisture regime as well as a nutrient regime classified as medium. Together, this ecosystem supports species such as Arbutus, Douglas-fir and snowberry, which dominated the main forested area of this polygon. The promontory is quite rocky, and has very shallow soils, resulting in stunted individuals of Garry oak, seaside juniper and Douglas-fir. Overall, the forest canopy was open, indicating the limited moisture and nutrient resources of these sites.

Site modifiers used – s – shallow soils
Structural Stage: 6 – Mature Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

* Soil parameters were determined by using exposed steep banks along the shoreline

Polygon 2 GIF Results		
Site Series Code	DAs6mM	
Site Characteristics		
Elevation	2 m	
Meso Slope Position	Toe	
Course Fragment Content	35-70%	
Slope	5%	
Aspect	170°	
Mineral Soil Texture	Sandy	
Humus Form	Moder	
SMR	Subxeric	
SNR	Medium	
Indicator Species		
A -Tree Layer	**B -Shrub Layer**	**C- Herb Layer**
Douglas-fir (*Pseudotsuga menziesii)*	Saskatoon serviceberry (*Amelanchier alnifolia)*	Wood Avens *(Geum urbanum)*
Arbutus (*Arbutus menziesii)*	Bigleaf maple (*Acer macrophyllum*)	Trailing blackberry (*Rubus ursinua)*
Big leaf maple (*Acer macrophyllum)*	Garry oak (*Quercus garryana)*	Pathfinder (*Adenoacaulon bicolor)*
Seaside Juniper (*Juniperus maritima)*	Oceanspray (*Holodiscus discolor)*	Nodding onion (*Allium cernuum)*
	Tall Oregon grape (*Mahonia aquifolium)*	Wall lettuce (*Lactuca muralis)*
	Orange honeysuckle *(Lonicera ciliosa)*	
	Cascara *(Rhamnus purshiana)*	Daphne (*Daphne laureola)*

5.5 LILLIAN HOFFAR PARK

Lillian Hoffar Park is 4 hectare waterfront park located near Tsehum Harbour and has experienced a long history of disturbance. Subsequently, there is a range of ecosystems reflecting different stages of succession (Figure 11). The south-eastern corner of the park (Polygon 3) contains the oldest section of park, with several large and older Douglas-fir and cedars with a typical Oregon grape dominated understory. The western side of the park is made up of a large, forested section, split into two separate ecosystems (Polygon 1 and 2), though both are dominated by more moisture tolerant indicator species, such as black cottonwood, red alder, and several pockets of slough sedge. This is a resultant from an ephemeral stream that flows through this section, creating several small wetland-like sections. Both ecosystems are younger and have thus experienced more disturbance in the past including agricultural activities and forestry. Despite the overall younger ages of the vegetation in this part of the park, there is a small pocket of remnant old growth cedars found in the northern section of the park. A large grassy meadow containing a picnic area is in the middle of the park and is surrounded by historic gardens containing several ornamental shrubs and flowering plants.

Lillian Hoffar contains several W̱SIḴEM First Nations archeological features scattered throughout the park. Along the eastern edge of the park, are several shell middens that are exposed along the bank leading down to the beach. There are also several burial cairns, indicated by rock piles placed next to certain trees. Similar to Nymph Point Park, further studies will be conducted on these sites in the future. Due to the presence of these sites, soil pits were not permitted, therefore soil attributes were not determined, however some parameters were estimated using pits that were already present, or exposed soil on a bank.

5.5.1 Invasive Removal

Due to the high level of disturbance that has occurred in the park, Lillian Hoffar has a high density of invasive species present. The main species are Himalayan blackberry and ivy, and the largest density is found in Polygon 2, and then Polygon1. Polygon 3 has mostly been cleared. Before the project started, the level of removal was at ~65%, and in October the level had risen to ~ 75-80%. Around 13 hours was spent in Lillian Hoffar removing invasives, but FNSP has held many removal events and has been the biggest proponent in the restoration success of this park.

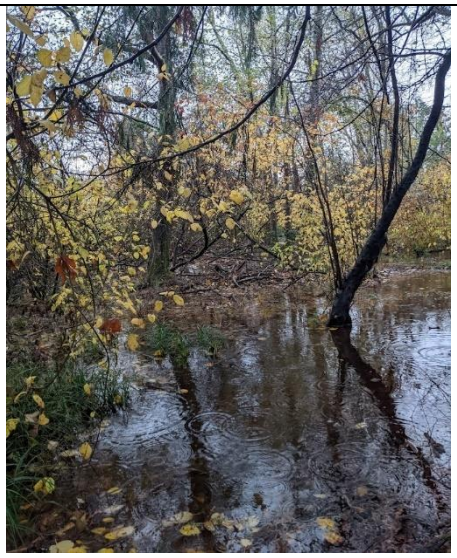
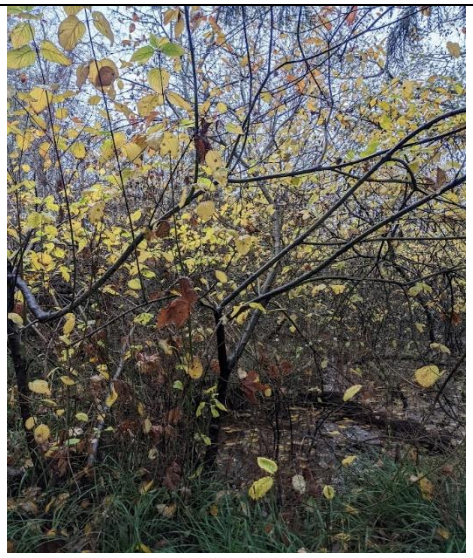
The ecosystem units of Lillian Hoffar Park:

1. CSy4mM	2. CD3iB	3. DG5mC
CS: Cedar-slough sedge **y:** Moister than typical site modifier **4:** Structural Stage of pole/sampling **m:** Multi-storied stand **M:** Mixed stand composition modifier	**CD**: Black Cottonwood - Red-osier Dogwood **3b:** Tall shrub (2-10 m tall) **i:** Irregular stand (Open overstorey) **B:** Broadleaf dominated stand	**DG**: Douglas-fir, grand fir and oregon grape **5:** Young Forest **m:** Multi-storied stand **C:** Coniferous dominated stand

Figure 11: Results from the TEM for Lillian Hoffar Park

5.5.2 Terrestrial Ecosystem Mapping

Polygon 1

TEM Map Code	CDFmm Site series	Location
CSy4mM	14 – Western red cedar – Slough sedge	48.66992°N, 123.41578°W
 Taken in the fall, this photo shows the presence of standing water, leading to more moisture tolerant species	 Slough sedge (*Carex obnupta)* flourishing in wetter conditions (photo taken in the fall)	 This ecosystem contained a thick shrub cover made of red-osier dogwood, alders and snowberry

Site Description

This polygon contained a few small wetland-type areas, though no standing water was present at the time of assessment. The tree cover was dominated by young cedars and alders, and with the understory of slough sedge, the site series code was classified as CS. This section of the park had a very dense intermediate story, with thick shrubs made up of shorter alder, red-osier dogwood, willow, and snowberry. From an exposed shallow pit, the soil was quite clayey, and moist despite the dry conditions at the time of assessment.

Modifiers used: y – moister than typical
Structural Stage: 4 – Pole/Sapling
Structural Stage Modifier: m – multi-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

Site Characteristics

Elevation	7 m
Meso Slope Position	Level
Course Frag. Cont.	-
Slope	0%
Aspect	150°
Mineral Soil Texture	Clayey
Humus Form	-
SMR	-
SNR	-

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Western red cedar (*Thuja plicata)*	Sword fern (*Polystichum munitum)*	Slough sedge (*Carex obnupta)*
Red alder (*Alnus rubra)*	Red-osier dogwood (*Cornus stolonifera)*	Trailing blackberry (*Rubus ursinua)*
Grand fir *(Abies grandis)*	Choke cherry (*Prunus virginiana)*	Vanilla leaf (*Achlys triphylla)*
Bigleaf maple (*Acer macrophyllum)*	Common Snowberry (*Symphoricarpos albus)*	English Ivy (*Hedera helix)*
	Nootka rose (*Rosa nutkana)*	Creeping buttercup *(Ranunculus repens)*

Polygon 2

TEM Map Code	CDFmm Site series	Location
CD3biB	08 – Black Cottonwood – Red Osier dogwood	48.66922°N, 123.41558°W
 Black cottonwood (*Populus trichocarpa)* – indicative of a CD ecosystem	 Dense thickets of snowberry are common in this ecosystem (photo taken in the fall)	 A very open crown cover was an influencing factor in this ecosystem

Site Description

This polygon was difficult to differentiate from Polygon 1, but due to the presence of black cottonwoods and the lack slough sedge, this section was separated out as CD rather than CS. This section also had an open overstory, and thick shrub layer, leading to the tall shrub structural stage, and irregular modifier. This ecosystem also had the highest density of invasives, with a dense thicket along the trail leading from the parking lot (found just outside the bottom left corner of Figure 11).

Structural Stage: 3b – Tall shrub (2-10 m)
Structural Stage Modifier: i - irregular
Stand Composition: B –Broadleaf dominated

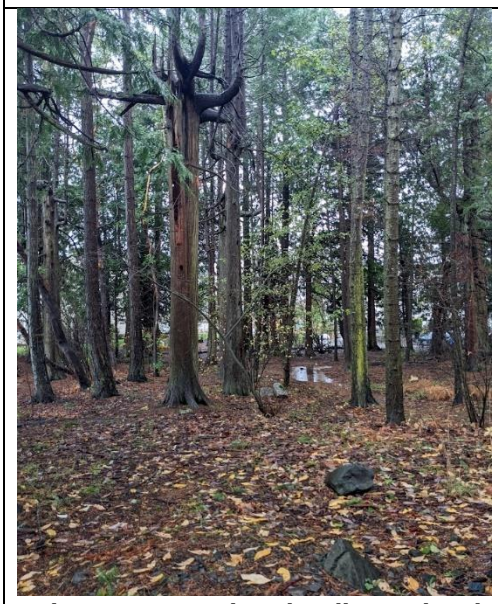
Site Characteristics

Elevation	7 m
Meso Slope Position	Level
Course Frag. Cont.	-
Slope	0%
Aspect	150°
Mineral Soil Texture	Clayey
Humus Form	Moder
SMR	-
SNR	-

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Western red cedar (*Thuja plicata)* Red alder (*Alnus rubra)* *Populus* Black Cottonwood (*Populus trichocarpa)* Bigleaf maple (*Acer macrophyllum)*	Red-osier dogwood (*Cornus stolonifera)* Indian plum (*Oemleria cerasiformis)* Nootka rose (*Rosa nutkana)* Oceanspray (*Holodiscus discolor)* Snowberry (*Symphoricarpos albus)* Sword fern (*Polystichum munitum)*	Horsetail (*Equisetum arvense)* *Trail* Trailing blackberry (*Rubus ursinua)* Creeping buttercup *(Ranunculus repens)* English Ivy (*Hedera helix)* *Himalayan blackberry* (*Rubus ameniacus)*

Polygon 3

TEM Map Code	CDFmm Site series	Location
DG5mC	04 – Douglas-fir – Grand fir – Oregon grape	48.66927°N, 123.41473°W
 This ecosystem, though still considered multi-storied, had a low density understory	 A possible burial cairn found next to a tree in Lillian Hoffar Park	 This ecosystem contained some of the oldest trees within the park - with larger cedars and Douglas-firs

Site Description

This polygon was easy to identify as a DG ecosystem due to the presence of older Douglas-fir, Grand fir and an understory of Oregon grape. There was not a major presence of an intermediate crown class, but oceanspray, snowberry and Nootka rose were dominant in this layer. This ecosystem had the lowest density of invasives present.

Structural Stage: 5 – Young Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: C – Coniferous dominated

Site Characteristics

Elevation	9 m
Meso Slope Position	Level
Course Frag. Cont.	-
Slope	2%
Aspect	160°
Mineral Soil Texture	-
Humus Form	-
SMR	-
SNR	-

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Douglas-fir (*Pseudotsuga menziesii)* Grand fir (*Abies grandis)* Western red cedar (*Thuja plicata)* Red alder (*Alnus rubra)* Bigleaf maple (*Acer macrophyllum)*	Dull Oregon grape (*Mahonia nervosa)* Oceanspray (*Holodiscus discolor)* Snowberry (*Symphoricarpos albus)* Nootka rose (*Rosa nutkana)*	Trailing blackberry (*Rubus ursinua)* Vanilla leaf (*Achlys triphylla)* Wall lettuce (*Lactuca muralis)* Broad-leaved Star flower (*Trientalis latifolia)*

5.6 GULF VIEW PARK

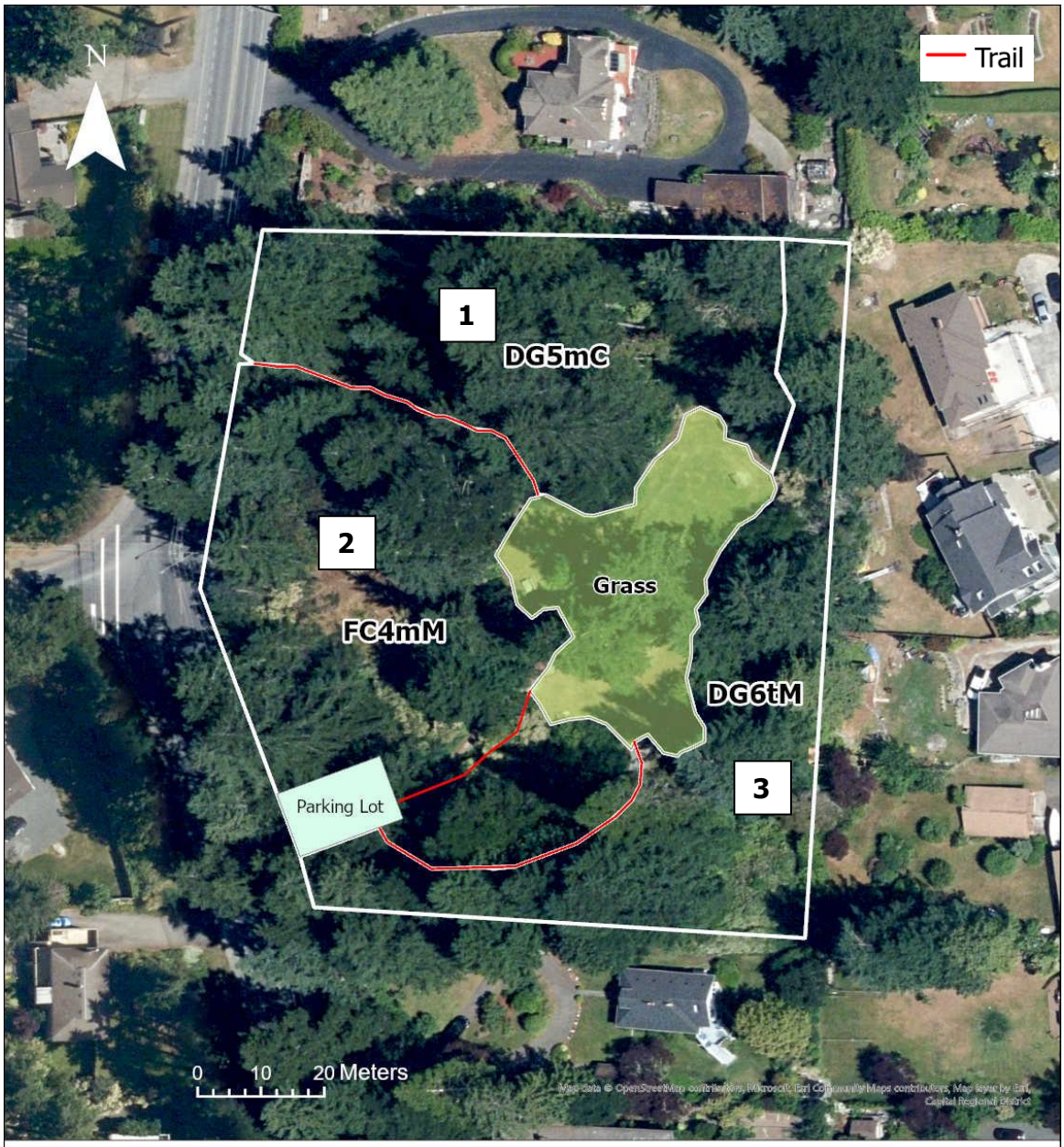
This small 1.5 hectare park is a popular picnic area for local residents as it provides a beautiful view over the Saanich Peninsula and out to Haro Strait. Gulf View Park was used as farmland in the 1930's but it became a part of the larger John Dean Park before being given to the municipality. Today, it has a small, forested area surrounding a grassy meadow (Figure 12), which contains a high diversity of wildflowers in the spring. The forested area is split into three ecosystems (Figure 14), with a variety of tree ages. Polygon 3 contains the oldest and largest trees, with several massive Douglas-firs, which means that this small pocket had probably remained during the time when agricultural activities were occurring. Polygon 2 represent a more unique ecosystem, with the presence of a grassy knoll with several species typical of Garry oak ecosystems, though there are no actual Garry oak trees present. Gulf View Park provides important habitat for several species, including large families of California quails (*Odocoileus hemionus*).

Figure 12: Grassy meadow with a view in Gulf View Park

5.6.1. Invasive Removal

This park underwent a massive restoration effort over the past few years, with an enormous amount of ivy, Daphne and Himalayan blackberry removed. Approximately 16 hours was spent in this park over the summer, and by October, the percentage of invasives removed had gone from ~65% to ~ 90-95%. Gulf View will most likely enter the monitoring phase next year.

Figure 13: Large Grand fir found in the meadow



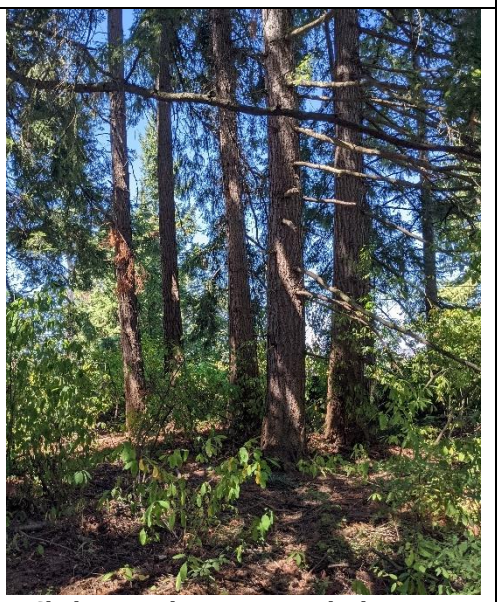
The ecosystem units of Gulf View Park:

1. DG5mC	2. FC4mM	3. DG6tM
DG: Douglas-fir - Grand fir - Oregon grape **5:** Young forest **m:** Multi-storied stand **C:** Coniferous dominated stand	**FC:** Fescue - Camas **4:** Pole/Sapling **m:** Multi-storied stand **M:** Mixed stand composition	**DG:** Douglas-fir - Grand fir - Oregon grape **6:** Mature forest **t:** two-storied stand **M:** Mixed stand composition

Figure 14: TEM results for Gulf View Park

5.6.2. Terrestrial Ecosystem Mapping

Polygon 1

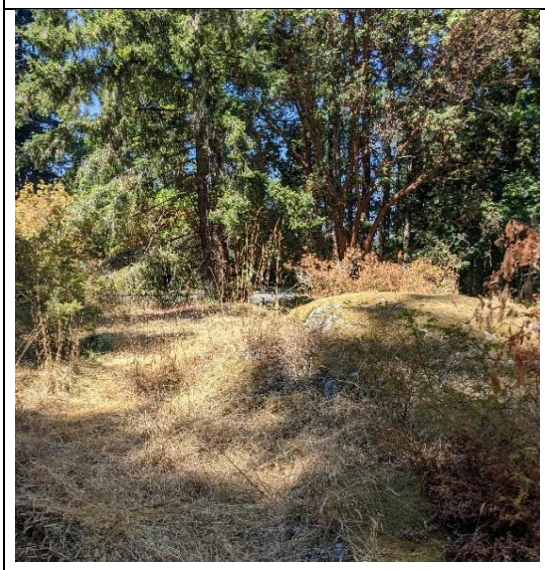
TEM Map Code	CDFmm Site series	Location
DG5mC	04 – Douglas-fir – Grand fir – Oregon grape	48.61787°N, 123.41588°W
 Younger Douglas and Grand fir	 Broad-leaved starflower (*Trientalis latifolia)*	 Shelterwood ecosystem – little to no intermediate crown class

Site Description	Site Characteristics	
This polygon is in the northern section of Gulf View Park and contains a Douglas-fir dominated forest. The trees in this section are much younger than those found in Polygon 3. Though still classified as multi-storied, this ecosystem had a much lower presence of an intermediate crown class than that found in Polygon 3 but did contain more of an understory. Though the intermediate class was regenerating, with several individuals of Indian plum as well as smaller alders. This section of the park contained a high amount of invasives, with Daphne seedlings, ivy and blackberry taking over the far northern edge of the park. Structural Stage: 5 – Young Forest Structural Stage Modifier: m – multi-storied Stand Composition: C – Coniferous dominated	Elevation Meso Slope Position Course Frag. Cont. Slope Aspect Mineral Soil Texture Humus Form SMR SNR	82 m Level 35-70% 5% 150° Loamy Moder Mesic Rich

Indicator Species		
A - Tree Layer	**B – Shrub Layer**	**C – Herb Layer**
Douglas-fir (*Pseudotsuga menziesii)* Bigleaf maple (*Acer macrophyllum)* Western red cedar (*Thuja plicata)* Red alder (*Alnus rubra)*	Dull Oregon grape (*Mahonia nervosa)* Oceanspray (*Holodiscus discolor)* Indian plum (*Oemleria cerasiformis)*	Miner's lettuce (*Clatonia perfoliata)* Trailing blackberry (*Rubus ursinua)* Broad-leaved starflower (*Trientalis latifolia)*

Polygon 2

TEM Map Code	CDFmm Site series	Location
FC4mM	00 – Fescue - Camas	48.61745°N, 123.41619°W



An open and dry meadow

Grassy meadow – dry in the drought conditions

Remnant cement feature found in the meadow

Site Description

Polygon 2 represented a unique and rare Fescue-Camas ecosystem growing on a rocky knoll in the western section of Gulf View. This ecosystem was much drier than the other ecosystems and had a much less developed overstory, though it still contained all three crown classes. On the knoll itself, the ecosystem was an open and dry meadow containing several grass and wildflower species growing amongst small rocky outcrops.

Structural Stage: 4 – Pole/Sapling
Structural Stage Modifier: m – multi-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

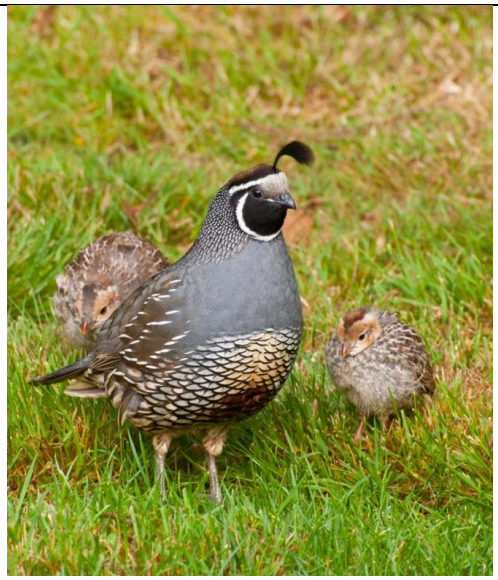
Site Characteristics

Elevation	83 m
Meso Slope Position	Upper slope
Course Frag. Cont.	20-35%
Slope	8%
Aspect	150°
Mineral Soil Texture	Sandy
Humus Form	Moder
SMR	Subxeric-xeric
SNR	Medium - Rich

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Arbutus (*Arbutus menziesii)* Grand fir (*Abies grandis)* Douglas-fir (*Pseudotsuga menziesii)*	Oceanspray (*Holodiscus discolor)* Snowberry (*Symphoricarpos albus)* Tall Oregon grape (*Mahonia aquifolium)* Dull Oregon grape *(Mahonia nervosa)* Nootka rose *(Nutkana rosa)*	Fescue Grass spp. Harvest brodiaea (*Brodiaea coronaria*) Few-flowered shooting star (*Dodocatheon pulchellum*) Sweet-scented bedstraw (*Galium triflorum*) White fawn-lily (Easter lily) (*Erythronium oregonum*) Common camas (*Camassia quamash)*

Polygon 3

TEM Map Code	CDFmm Site series	Location
DG6tM	04 – Douglas-fir – Grand fir – Oregon grape	48.61734°N, 123.41554°W
 Douglas fir – Oregon grape dominated ecosystem with spare herb layer	 Red huckleberry (Vaccinium parvifolium)	 California quail with chick nest within this ecosystem (Photo: Albert Aanensen nzbirdsonline.org.nz)

Site Description

Polygon 3 represented a more mature Douglas-fir – Oregon grape ecosystem than that found in Polygon 1. It had a more developed intermediate crown class, but had little to no understory, and was therefore classified as two-storied. The eastern edge of the park contained a higher density of oceanspray and fewer trees (cut down to open the view).

Structural Stage: 6 – Mature Forest
Structural Stage Modifier: t – two-storied
Stand Composition: M – Mix of Coniferous and Broadleaf

Site Characteristics

Elevation	82 m
Meso Slope Position	Level
Course Frag. Cont.	35-70%
Slope	5%
Aspect	135°
Mineral Soil Texture	Loamy
Humus Form	Moder
SMR	Mesic-
SNR	Subhygric Rich

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Douglas-fir (*Pseudotsuga menziesii)*	Dull Oregon grape (*Mahonia nervosa)*	Broad-leaved starflower (*Trientalis latifolia)*
Western red cedar (*Thuja plicata)*	Salal (*Gaultheria shallon)*	Trailing blackberry (*Rubus ursinua)*
Bigleaf maple (*Acer macrophyllum)*	Sword fern *(Polystichum munitum*)	Vanilla leaf (*Achlys triphylla)*
Grand fir (*Abies grandies)*	Oceanspray (*Holodiscus discolor)*	Wall lettuce (*Lactuca muralis)*
	Snowberry (*Symphoricarpos albus)*	
	Huckleberry (*Vaccinium parvifolium)*	

5.7 QUARRY PARK

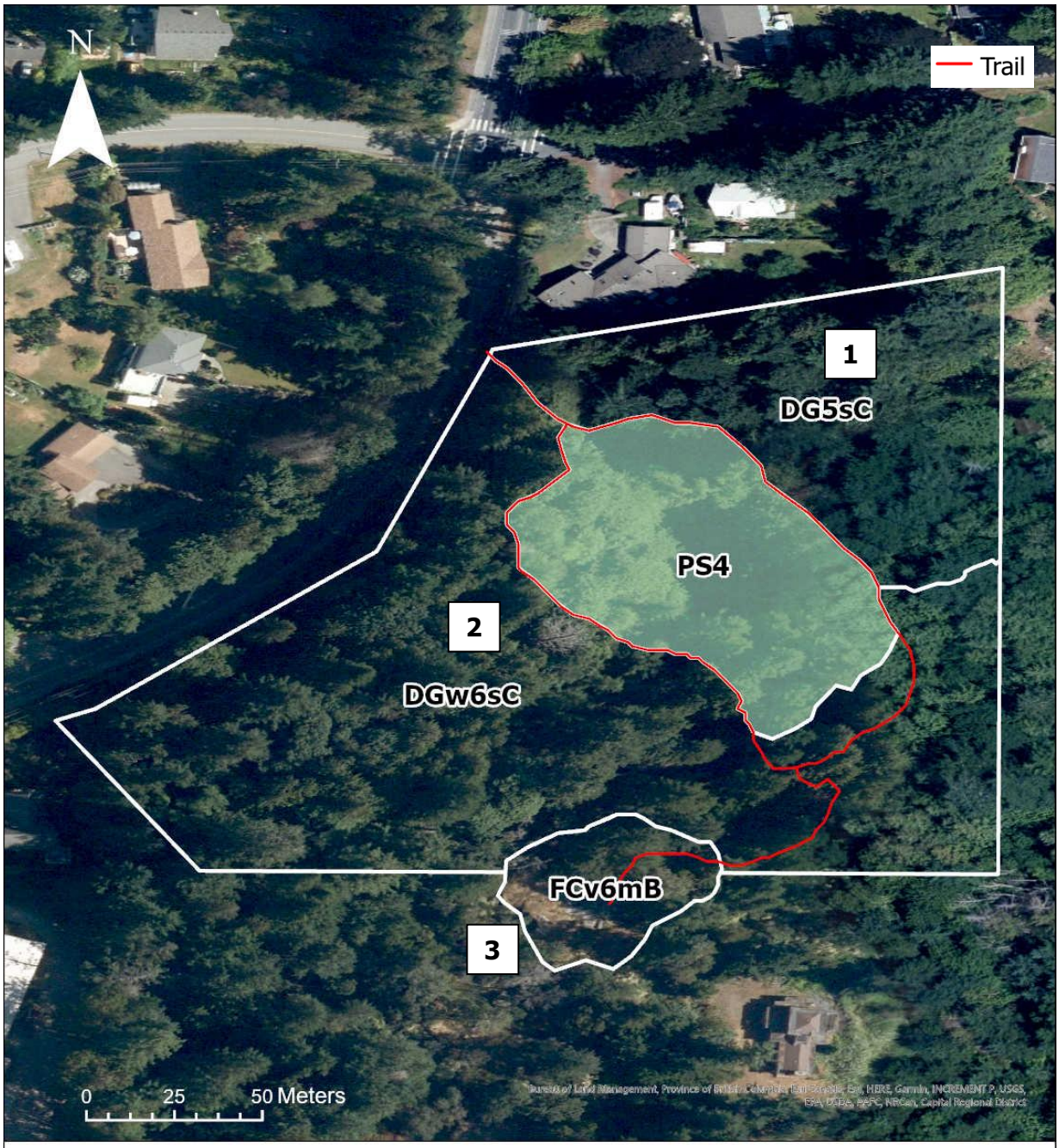
Quarry Park is a 2 hectare park that occupies a former quarry (Figure 15) that had stopped production in 1930 and is now a popular picnic and hiking spot. The TEM revealed that there are three main ecosystems (Figure 17), in which the sloping nature and the range of disturbance levels played a significant role in determining the soil and vegetation types of each of the ecosystems. The area where the extraction activities occurred is now a seral (structural stage of 4 – Pole/Sapling) ecosystem made up of younger alder, small cedars as well as a sparse understory of sword fern. The north-eastern polygon contained a stand of Douglas-fir trees that were quite uniform in size and age, and little to no understory, whereas Polygon 3 had much more developed crown classes. The southernmost polygon found at the top of the slope, had another example of a rare Fescue-Camas ecosystem, and had a large rocky outcrop. Quarry Park has had a long history of disturbance, which has shaped the ecosystem within the park greatly. Besides the risk of invasive species spreading, the park is also facing threats from trampling, particularly from mountain bikes going through the sensitive Fescue-Camas ecosystem. FNSP has attempted at mitigating this by placing large woody debris in the sections where mountain bikes had caused disturbances off-trail.

Figure 15: The decommissioned quarry containing a seral community

5.7.1 Invasive Removal

The seral community where the quarry had been contained a high density of invasives, which included Himalayan blackberry, ivy, as well as Curly dock (*Rumex crispus*). Polygon 2 also contained a high density of ivy along the upper slopes. This park was in good condition before the summer, with the level of invasive removal estimated at 90% and by the end of the summer, Quarry park entered the monitoring phase. Approximately 5 hours was spent removing ivy and dock in this park.

Figure 16: A field of licorice fern (*Polypodium glycyrrhiza*) leading to Polygon 3



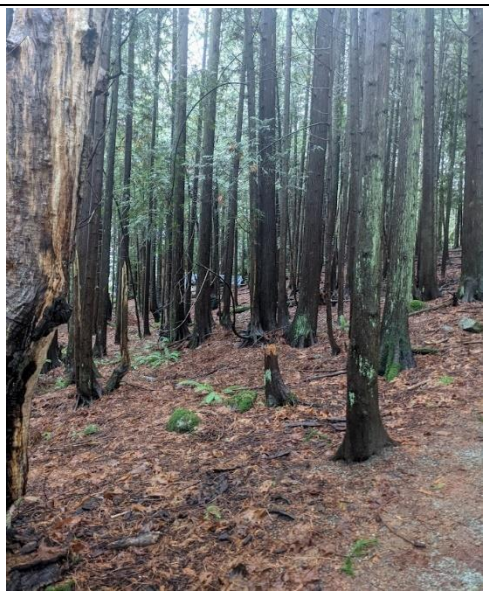
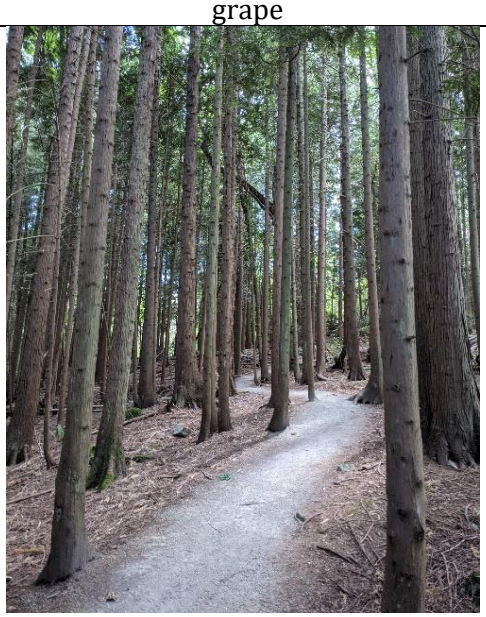
The ecosystem units of Quarry Park:

1. DG5sC	2. DGw6sC	3. FCv6mB
DG: Douglas-fir - Grand fir - Oregon grape **5:** Young forest **s:** Single-storied stand **C:** Coniferous dominated stand	**DG:** Douglas-fir - Grand fir - Oregon grape **w:** Warm aspect **6:** Mature forest **s:** Single-storied stand **C:** Coniferous dominated stand	**FC:** Fescue - Camas **v:** Very shallow soils **6:** Mature forest **m:** Multi-storied stand **B:** Broadleaf dominated stand

Figure 17: TEM results for Quarry Park

5.7.2 Terrestrial Ecosystem Mapping

Polygon 1

TEM Map Code	CDFmm Site series	Location
DG5sC	04 – Douglas-fir – Grand fir – Oregon grape	48.61325°N, 123.41503°W
 Polygon 1 was found on a north facing slope	 Young uniform forest with little to no understory	 A few sections contain a more developed understory with Oregon grape and salal

Site Description	Site Characteristics	
This polygon is an ecosystem made up of relatively uniform young Douglas-fir that have grown after a recent disturbance. This ecosystem also has little to no intermediate crown class and no understory, resulting in the single-story classification. There were a few sections where Oregon grape and salal were spreading, and given time, this ecosystem will develop into a multi-storied stand. Similar to the other ecosystems, this polygon was quite sloped, resulting in well-drained soil, though it was still moist and had a clayey texture. Structural Stage: 5 – Young Forest Structural Stage Modifier: s – single-storied Stand Composition: C – Coniferous dominated	Elevation Meso Slope Pos. Course Frag. Cont. Slope Aspect Mineral Soil Text. Humus Form SMR SNR	80 m Mid-lower slope 20-35% 10% 35° Clayey Moder Subhygric Medium

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Douglas-fir (*Pseudotsuga menziesii)* Bigleaf maple (*Acer macrophyllum)* Western red cedar (*Thuja plicata)*	Dull Oregon grape (*Mahonia nervosa)* Salal (*Gaultheria shallon)* Sword fern *(Polystichum munitum)*	Trailing blackberry (*Rubus ursinua)* Vanilla leaf (*Achlys triphylla)*

Polygon 2

TEM Map Code	CDFmm Site series	Location
DGw6sC	04 – Douglas-fir – Grand fir – Oregon grape	48.61248°N, 123.41575°W
 Cedar – Douglas-fir dominated tree cover, Oregon grape dominated understory	 Tall Oregon grape (*Mahonia aquifolium)*	 Lots of windthrow down present in this polygon

Site Description

Polygon 2 contained a more developed DG ecosystem that had larger and older Douglas-fir, Grand fir and cedars. It also contained more of an understory than in Polygon 1, but it was still quite sparse and there were several areas with bare soil. The polygon is also sloped, but has a warm aspect, with sections facing either west or south-west, which may be the reason for the slightly higher understory than that found in Polygon 1. This polygon had a high amount of windthrow present, with lots of large woody debris scattered on the ground.

Modifiers used: w – warm aspect (135°-285°)
Structural Stage: 6 – Mature Forest
Structural Stage Modifier: s – single-storied
Stand Composition: C – Coniferous dominated

Site Characteristics

Elevation	96 m
Meso Slope Position	Midslope
Course Frag. Content	20-35%
Slope	7%
Aspect	270°
Mineral Soil Texture	Clayey
Humus Form	Moder
SMR	Subhygric
SNR	Medium

Indicator Species

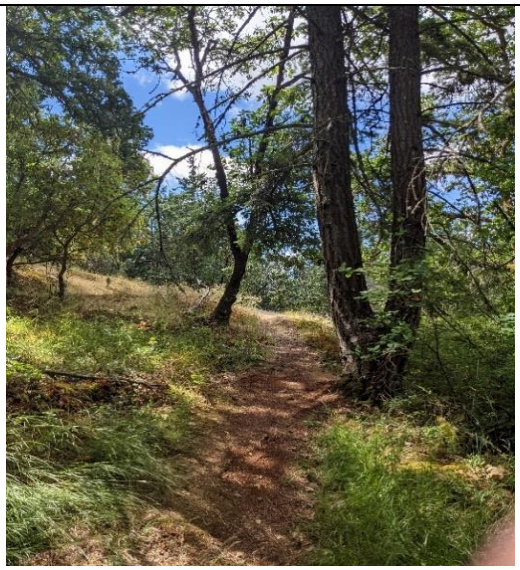
A - Tree Layer	B – Shrub Layer	C – Herb Layer
Western red cedar (*Thuja plicata)* Bigleaf maple (*Acer macrophyllum)* Douglas-fir (*Pseudotsuga menziesii)*	Tall Oregon grape (*Mahonia aquifolium)* Dull Oregon grape (*Mahonia nervosa)* Swordfern (*Polystichum munitum)* Salal (*Gaultheria shallon)*	Broad-leaved starflower (*Trientalis latifolia)* Foamflower (*Tiarella cordifolia*) Wall lettuce (*Lactuca muralis)* Trailing blackberry (*Rubus ursinua)* Mountain sweet-cicely (*Osmorhiza chilensis)* English Ivy (*Hedera helix)*

Polygon 3

TEM Map Code	CDFmm Site series	Location
FCv6mB	00 – Fescue - Camas	48.61222°N, 123.41530°W

Open rocky outcrop surrounded with grasses

Licorice fern (*Polypodium glycyrrhiza)* carpet this ecosystem



Trail leading up to the meadow

Site Description

Polygon 3 contained the rarer and sensitive Fescue-Camas meadow found around a rocky outcrop on the uppers slope within the park. The Garry oak and Arbutus trees in this polygon were stunted, probably due to the very shallow and rocky soil that is present. Several of the Arbutus are also dying, likely from the increasing amount of prolonged drought conditions that are occurring due to climate change. There was a high diversity of wildflowers found in this ecosystem, as well as a high coverage of licorice fern and grass species.

Modifiers used: v – very shallow soils
Structural Stage: 6 – Mature Forest
Structural Stage Modifier: m – multi-storied
Stand Composition: B – Broadleaf dominated

Site Characteristics

Elevation	100 m
Meso Slope Position	Upper slope
Course Frag. Content	<20%
Slope	8%
Aspect	200°
Mineral Soil Texture	Loamy
Humus Form	Moder
SMR	Submesic-Mesic
SNR	Medium-Rich

Indicator Species

A - Tree Layer	B – Shrub Layer	C – Herb Layer
Garry oak (*Quercus garryana)* Arbutus (*Arbutus menziesii)* Douglas-fir (*Pseudotsuga menziesii)*	Oceanspray (*Holodiscus discolor)* Salal (*Gaultheria shallon)* Snowberry (*Symphoricarpos albus)*	Licorice fern (*Polypodium glycyrrhiza)* Broad-leaved starflower (*Trientalis latifolia)* White fawn-lily (*Erythronium oregonum*) Fescue spp. Common Camas (*Camassia quamash)*

6. RECOMMENDATIONS AND CONCLUSION

The results from the TEM assessments of each of the parks have revealed that despite the parks' small sizes and proximity to one another, there is an enormous diversity of ecosystems present, and an even larger diversity of native species found within these ecosystems. This amount of diversity makes it particularly important that these pockets of green space are restored and protected as they provide vital habitat for countless species. One of the biggest threats to the ecosystems is climate change, in which the drastically changing climate not only affects the vegetation's ability to survive, but also increases the risk of more problematic invasive species of spreading (Beaury et al. 2020, D'Antonio and Meyerson 2002). To help plan for these eventualities, the data of the current soil and vegetation conditions provided by the TEM provides the essential information required to develop restoration strategies that will help improve resiliency of these areas. For example, the prolonged summer droughts that have been occurring on Vancouver Island in the past few years have had serious impacts on many plant species, particularly species like Western red cedar which experienced major die-offs (Ryan 2019), including several within the study parks. After gaining a better understanding of the type of ecosystem and its associated soil that is present using TEM, choosing species to plant that are more drought tolerant but that are still associated with the ecosystem should be included in any restoration plan that involves plantings. The results from the TEM can also reveal which ecosystems might be more impacted by climate change, for example the cedar dominated polygons in Green Park (Polygon 2 and 6) may be significantly affected in future years, therefore restoration plans should include these considerations.

A further study looking at the vulnerabilities of each ecosystem within the parks would undoubtedly be beneficial for FNSP. In addition, a more thorough study of the soil types would be immensely useful for the design and implementation of restoration strategies, particularly when choosing which native species to plant. Another recommendation would be to increase the public's knowledge of these diverse parks and their ecosystems. The implementation of signage that

discusses the threats (climate change, invasive species, trampling, etc.) would help educate and promote better practices for people visiting the parks. Particularly sensitive ecosystems (i.e., the rocky promontory of Nymph Point Park, and the Old Growth stand of RO Bull Park) would also benefit from fencing that would ensure visitors stay on the trails and help reduce trampling of native vegetation.

Overall, the work that FNSP does in terms of reducing the invasive species, as well as maintaining an effective monitoring program has had an immense impact on promoting native species to flourish. Their continued efforts are essential for these parks to thrive and coupled with the increased understanding and extensive data from this study, there is potential for creating a long-term restoration strategy that would help ensure the protection of these essential habitats for decades to come.

Acknowledgements

I would first like to acknowledge that all the work for this study was done within the territories of the W̱SÁNEĆ peoples, known today as W̱JOŁEŁP (Tsartlip), BOḰEĆEN (Pauquachin), SṮÁUTW̱ (Tsawout), W̱SIḴEM (Tseycum) and MÁLEXEŁ (Malahat) Nations.

I would also like to acknowledge Sharon Hope, and Anne Zerrath, from the Friends of North Saanich Parks, as without their passion, knowledge, and guidance, I would not have been able to complete such an extensive project as this. I would also not have had the amazing experience of working in such beautiful areas, nor have gotten the opportunities that led me to my current job.

7. REFERENCES

B.C. Ministry of Forests and Range B.C. Ministry of Environment (2010). Field Manual for Describing Terrestrial Ecosystems 2nd Edition. Victoria: Province of British Columbia.

Beaury, E. M., Fusco, E. J., Jackson, M. R., Laginhas, B. B., Morelli, T. L., Allen, J. M., ... & Bradley, B. A. (2020). Incorporating climate change into invasive species management: insights from managers. *Biological Invasions*, *22*(2), 233-252.

Cadrin, C., & von Sacken, B. (1999, February). Gap Analysis for Ecosystems and Species at Risk Using Terrestrial Ecosystem Mapping. In *Proceedings of a Conference on the Biology and Management of Species and Habitats at Risk, Kamloops, BC* (pp. 15-19).

Chapin Iii, F. S., Zavaleta, E. S., Eviner, V. T., Naylor, R. L., Vitousek, P. M., Reynolds, H. L., ... & Díaz, S. (2000). Consequences of changing biodiversity. *Nature*, *405*(6783), 234-242.

D'antonio, C. A. R. L. A., & Meyerson, L. A. (2002). Exotic plant species as problems and solutions in ecological restoration: a synthesis. *Restoration ecology*, *10*(4), 703-713.

DiTomaso, J. M., Masters, R. A., & Peterson, V. F. (2010). Rangeland invasive plant management. *Rangelands*, *32*(1), 43-47.

Fisher, B., Kim, J., Campbell, M., & Tudor, H. (2020). Tracking Salal (Gaultheria shallon) and Western Red Cedar (Thuja plicata) Dieoff in Pacific Spirit Regional Park.

Fuchs, M. A. (2001). *Towards a recovery strategy for Garry oak and associated ecosystems in Canada: ecological assessment and literature review* (p. 106). Environment Canada, Pacific and Yukon Region.

Higgins, S. I., Richardson, D. M., Cowling, R. M., & Trinder-Smith, T. H. (1999). Predicting the landscape-scale distribution of alien plants and their threat to plant diversity. *Conservation biology*, *13*(2), 303-313.

Rai, P. K., & Singh, J. S. (2020). Invasive alien plant species: Their impact on environment, ecosystem services and human health. *Ecological indicators*, *111*, 106020.

Resources Inventory Committee. (1998). Standard for terrestrial ecosystem mapping in British Columbia. *Province of British Columbia, Victoria, BC*.

Ryan, S. (2019, May 16). Cedar die off impacts many on Vancouver Island. *Chek News. https://www.cheknews.ca/cedar-die-off-impacts-many-on-vancouver-island-561118/*

Weidlich, E. W., Flórido, F. G., Sorrini, T. B., & Brancalion, P. H. (2020). Controlling invasive plant species in ecological restoration: A global review. *Journal of Applied Ecology*, *57*(9), 1806-1817.