# Controlling the Invasion:

## The Progress of the EcoBLITZ and EcoRESTORATION Monitoring Project in Pacific Spirit Regional Park

By: Raymond Hao, Meg Sheline, Megan Yu
ENVR 400, Group 1

# Executive Summary:

## Background:

With globalization and world travel becoming a commonplace in today's society, invasive species have become an increasing problem worldwide. Unique ecosystems such as the temperate rainforests of British Columbia are under attack by these invaders, threatening to replace the native flora. Invasive plants are particularly concerning. As of 2014, 849 invasive plant species have become established in British Columbia, which account for 86.8% of all alien species recorded in BC. One hotspot is the Coastal Western Hemlock Zone located on the west coast of British Columbia, notably Metro Vancouver (Figure A). These invasive species have taken over and dominated native forests, prompting extensive restoration efforts in order to preserve the natural ecosystems.

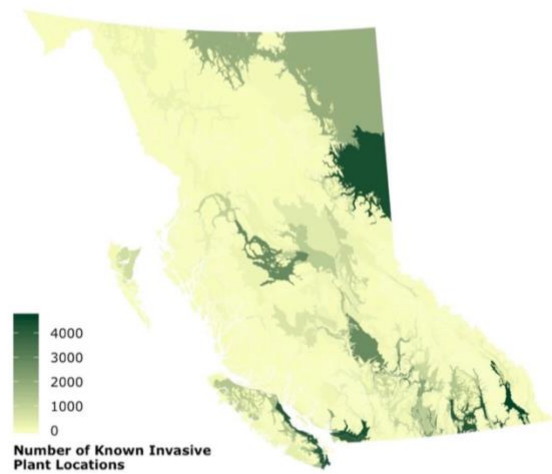


Figure A: Locations of known invasive plant species in BC. Take note of the hotspot shown in dark green around Metro Vancouver. Image from: Environmental Reporting BC. 2015. Status of Invasive Species in B.C. State of Environment Reporting, Ministry of Environment, British Columbia, Canada.

Starting in 2014, Metro Vancouver Regional Parks (MVRP) in partnership with Pacific Spirit Park Society (PSPS) restored five sites in Pacific Spirit Regional Park through their EcoBLITZ program through the removal of invasive plants and replacement with native plants in five sites with the goal of returning the site to its natural state (Figure B). Since 2018, PSPS has led teams of volunteers into the park to continually monitor the progress of their past restoration from 2018 - 2022. This monitoring includes taking note of the presence (or absence) of both common invasive plants and target native plants as well as tree health and general site characteristics.

- A Sasamat/Imperial Drive Trail
- B Camosun and 21st
- C Crown and 22nd
- D Southwest Marine Drive
- E Salish Trail/Chancellor Blvd


*Figure B: A map of PSRP showing the five restoration sites; Retrieved from Pacific Spirit Park Society, 2018.*

## Objectives:

With the purpose of providing a baseline and suggestions for future restoration efforts by MVRP and PSPS, we have undertaken this report during the third out of five total years of monitoring in partnership with MVRP. This report seeks to provide an analysis on the current state of these restoration efforts to establish a baseline for future projects.

1. Determine the current state of restoration efforts conducted by MVRP and PSPS at four established monitoring sites in PSRP (sites A, B, C, D) which were previously overrun with invasive species
2. Confirm the transition from primarily deciduous to primarily coniferous forest type of monitoring site E (primarily coniferous forest type is defined as at least 50% cover)
3. Consolidate physical and biotic characteristics of each site in a site profile
4. Identify the trend in the health of native deciduous and coniferous trees across all sites

## Results:

The data analysis conducted on sites A, B, C, and D reveal inconsistencies in the progress of the restoration, though overall, sites exhibited increases in invasive cover; site E saw no change in forest cover type (Figure C).

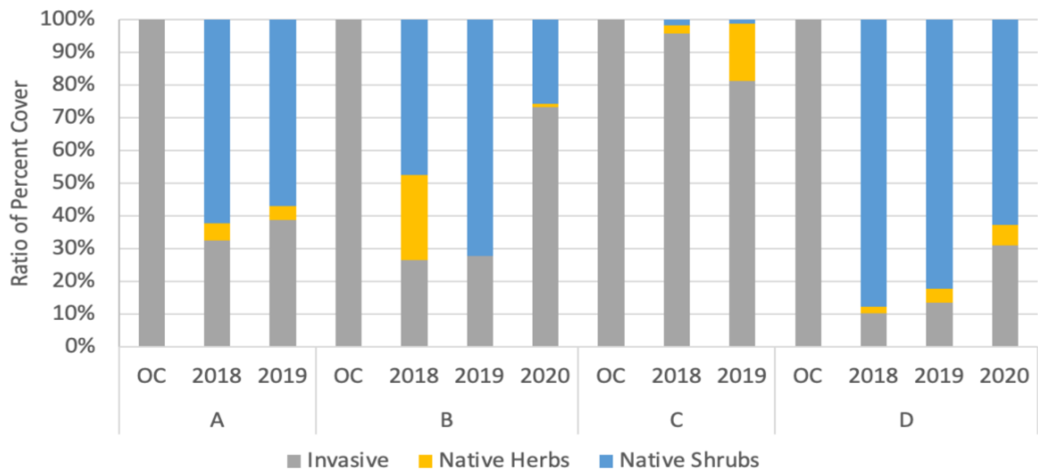


*Figure C: Overall ratio of percent cover across monitoring sites A, B, C, and D from 2018-2020 (plots A and C were not monitored during 2020 due to Covid-19 delays)*

A, B, D: Saw **increases** in invasive cover since the restoration treatment

C: Saw **fluctuations** in invasive cover year-by-year since the restoration treatment

E: Saw **no change** in forest cover type from deciduous to coniferous

For tree health, most trees planted during the restoration events are healthy. Over the three years of monitoring, coniferous trees **decreased** in dead trees and **remained the same** in unhealthy trees, while deciduous **increased** in dead trees and **decreased** in unhealthy trees (Table A).

*Table A: Health of coniferous and deciduous trees across all monitoring sites*

| ***Date*** | **Coniferous** | | | | |
|---|---|---|---|---|---|
| | **Dead** | **Healthy** | **Unhealthy** | **Total** | **Percent of Healthy Trees (%)** |
| 2018 | 8 | 83 | 4 | **95** | **87** |
| 2019 | 4 | 83 | 4 | **91** | **91** |
| 2020 | 5 | 63 | 4 | **72** | **88** |
| ***Date*** | **Deciduous** | | | | |
| | **Dead** | **Healthy** | **Unhealthy** | **Total** | **Percent of Healthy Trees (%)** |
| 2018 | 4 | 119 | 16 | **139** | **86** |
| 2019 | 13 | 143 | 11 | **167** | **86** |
| 2020 | 9 | 84 | 0 | **93** | **90** |

See appendix 7 for site profiles

## Conclusion:

Multiple explanations for the discrepancies in data exist, ranging from human errors to differences in climatic conditions. Monitoring data carried out by PSPS is collected mainly by volunteers and while there is a standardized procedure and list of data categories, it is still left open to human error. In some instances plants were recorded for one year, but not during the next year and then seemingly reappeared the following year after that.

With regards to the second objective, data from 2018 - 2020 suggest that the forest cover of site E has not shifted from primarily deciduous to primarily coniferous, as the percent cover of coniferous trees remained at a consistent 40% throughout the three years. This lack of a transition can be attributed to the slow growth rate and slow regeneration of most coniferous trees, with some having juvenile stages lasting 1 - 15 years. Three to seven years after initial planting is likely too early to see a significant shift in the primary forest type.

## Future Suggestions:

| |
|---|
| Instruct volunteers to specifically **look for plants observed** the prior year and to potentially create a **position diagram** for each plot showing the exact location of sparse plants so that they can be more easily checked during later monitoring sessions |
| To account for the still increasing invasive plant species recorded in most sites, we suggest **creating buffer zones** around the plots to help reduce leakage and spillover from the surrounding areas |
| Though the pandemic restrictions during the summer of 2020 caused delays in the monitoring process, in normal years, **standardizing the times** that monitoring and invasive removal takes place |
| Monitor **additional physical data** such as seasonal weather patterns, weather anomalies, soil pH, and soil infiltration |

# About the Team

Megan Sheline is a fourth year Environmental Science undergraduate student at the University of British Columbia concentrating in Ecology and Conservation with a focus on environmental policy and global affairs. She is currently a volunteer with Pacific Spirit Park Society's EcoRESTORATION Monitoring Program and has completed two courses focusing on ArcGIS. She has previous work experience in sustainable forest management with UBC's Asia Pacific Forestry Education Coordination Mechanism, writing presentations, executive summaries and progress reports.

Megan Yu is a fourth year Environmental Science undergraduate student at the University of British Columbia concentrating in Land, Air, and Oceans, with a specific focus in marine sciences and marine chemistry. She has also completed courses in plant ecology and conservation biology. Megan has worked as an environmental consultant for 12 months as a part of the marine team during her co-op program between 2019 and 2020, and has professional experience with report writing, data analysis, and data presentation.

Raymond Hao is a fourth year Environmental science Undergraduate student at the University of British Columbia concentrating in Land, Air and Oceans areas. Most of the courses he has studied are in ocean areas and in ecology. Raymond has also taken a basic course about ArcGIS. Raymond is good at data analysis and is willing to participate in group meetings. He has some work experience in the dispatch center of energy management and water treatment station.

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# 1. Background Information

## 1.1. History of Pacific Spirit Regional Park

Pacific Spirit Regional Park (PSRP) is located within the Metro Vancouver region bordered by the University of British Columbia, the University Endowment Lands, and the City of Vancouver (Figure 1). PSRP contains a multitude of environmentally sensitive habitats, including Camosun Bog, the oldest bog in the Lower Mainland, two small salmon and cutthroat trout bearing streams: Musqueam and Cutthroat Creek, marshes, and foreshore cliffs (BC Ministry of Forests, 1991). The regional park is also located on the traditional and ancestral lands of the xʷməθkʷəy̓əm (Musqueam) People (Musqueam Indian Band, 2020).


*Figure 1: Map of Pacific Spirit Regional Park. The areas of study include the South Park (labeled as 2 in the lower left-hand map) and the North Park (labeled as 3 in the lower left-hand map)*

Retrieved from Pacific Spirit Regional Park Map. Metro Vancouver

Prior to its establishment as a regional park by Metro Vancouver in April of 1989, PSRP was subject to logging operations throughout the past century. Natural resource and activity management within the park began with the release of the *Pacific Spirit Regional Park Management Plan* in October 1991 by Greater Vancouver Regional District Parks (BC Ministry of Forests, 1991). The plan set forth goals of achieving conservation objectives and recreation objectives. The conservation objectives were aimed at preserving the critical regional ecosystem of PSRP in its original and natural state in order to benefit both the surrounding environment and the community, providing recreation and forest activities. This then led into the recreational objectives established, which addressed the need to encourage outdoor recreation “in harmony” with the natural ecosystem and maintaining environmental stewardship (BC Ministry of Forests, 1991). Furthermore, the management plan covered the topic of natural resource management in the park, which included protection of the aforementioned environmentally sensitive habitats through frequent monitoring and limiting human traffic. In 1998, following a push by Metro Vancouver Regional Parks (MVRP) to involve citizens in the preservation of the park, Pacific Spirit Park Society (PSPS) was formed (Pacific Spirit Park Society, 2015). By promoting park stewardship, PSPS allows for public participation in achieving the objectives set out by the management plan.

## 1.2. Invasive Plants in PSRP

With increases in globalization resulting in the spread of invasive plant species, a noticeable decline in native plant cover in PSRP was observed. Invasive species such as the Himalayan blackberry (*Rubus armeniacus*) from Eurasia (left) and Scotch broom (*Cytisus scoparius*) from the UK (middle) have dominated regions of the forest, with some sites almost entirely covered by invasive plants. Another damaging invasive plant that poses a threat to the forest's preservation is the persistent Japanese knotweed (*Reynoutria japonica*) (right) (Figure 2). This invasive plant quickly outcompetes native plants, forming colonies and requires either shoot removal or herbicide treatments (Skinner, *et al.*, 2012). In-line with the management plan to maintain the integrity of the native ecosystems in PSRP, MVRP began initiating restoration projects to remove the invasive plants and replace them with native flora.

*Figure 2: Common invasive plants found in PSRP. (left)* Himalayan blackberry *(Rubus armeniacus); (middle)* Scotch Broom *(Cytisus scoparius); (right)* Japanese Knotweed *(Reynoutria japonica)*



For over a decade, MVRP has undertaken ecological restoration projects and PSPS has been involved with the removal of invasive plant species for several decades. Starting in 2014, MVRP coordinated and implemented their first EcoBLITZ program aimed at researching the effectiveness of potential restoration efforts in the park (Pacific Spirit Park Society, 2018). In partnership with MVRP, PSPS also hosted their own EcoBLITZ program shortly after in 2017

(Pacific Spirit Park Society, 2018). Between the two programs from 2014 - 2017, five different sites throughout the park were cleared of invasive species using a variety of methods including hand removal, herbicide, and machine grubbing via a contractor. Following the initial clearing, native flora were replanted in the restoration sites and subsequent manual removal of additional invasive plants in sites A - D continued every year by contractors and PSPS volunteers. These sites and their site code consisted of Sasamat Trail/Imperial Drive Trail in 2014 (A), Camosun Street at 21st Ave in 2015 (B), Crown Street at 22nd in 2016 (C), and South West Marine Drive Trail in 2016 (D) by MVRP, whereas Salish Trail at Chancellor Boulevard was cleared in 2017 (E) by PSPS (Figure 3; Pacific Spirit Park Society, 2018). A closeup view of each site showing their respective monitoring plots can be found in Appendix 1.


*Figure 3: A map of PSRP showing the five restoration sites: A) Imperial Drive Trail, B) Camosun at 21st, C) Crown at 22nd, D) SW Marine Drive, and E) Salish Trail.*

Retrieved from Pacific Spirit Park Society, 2018.

The original site conditions and the EcoBLITZ event's removal differed per site; however, most sites contained almost 100% invasive cover (Table 1). Site E (Chancellor) was unique in that it contained relatively sparse invasive cover already; however, the forest cover consisted of primarily deciduous trees. Though these deciduous trees are native to the area, the expected conditions of this site should be dominated (more than 50% of trees) by coniferous trees given the climatic zone of this region (see Section 1.3).

These efforts led to the implementation of the EcoRESTORATION Monitoring program designed by PSPS, which monitors the progress of abiotic and biotic factors of each of these five sites over the course of five years, starting from 2018 and completing in 2022 (Pacific Spirit Park Society, 2018).

*Table 1: Activity history of restoration sites in Pacific Spirit Regional Park*

| Site Code | Original Site Conditions | Year of Removal | Invasive Removal Treatment | Restoration Treatment |
|---|---|---|---|---|
| **A** | ~100% invasive blackberry | 2014 | Machine excavator grubbing of invasive blackberry | Native target species for this site planted; mulched at first but plants did not survive so final sites were not mulched |
| **B** | ~100% invasive blackberry with large patch of Japanese knotweed | 2015 | Machine excavator grubbing of invasive blackberry; herbicide treatment of Japanese knotweed | Native target species for this site planted; mulched at first but plants did not survive so final sites were not mulched |
| **C** | ~100% invasive blackberry with small patch of Japanese knotweed | 2016 | Machine excavator grubbing of invasive blackberry | Native target species for this site planted; mulched with composted mulch |
| **D** | ~70% Scotch broom and ~30% invasive blackberry, small amount of other invasive species present | 2016 | Machine excavator grubbing of invasive blackberry and Scotch broom | High density planting of target species for this site |
| **E** | Mature red alder stand with native shrubs and small amounts of invasive English holly and laurel | 2017 | Holly plants removed by hand; holly trees cut or injected with herbicide | Native target species for this site (mainly coniferous trees) planted |

Retrieved from Metro Vancouver, n.d.

## 1.3. Ecosystem and Ecoregion Classification in Vancouver

To identify target native species to be planted and used for restoration work, it is necessary to determine the climatic conditions of PSRP. The Biogeoclimatic Ecosystem Classification (BEC) system is a tool used by the BC Ministry of Forestry to identify and classify the fourteen different forest ecosystems in BC (see Figure 4; Ministry of Forests, Lands, Natural Resource Operations and Rural Development, 2015). BEC allows an understanding of "what grows where and how well" to assist with managing the diversity of each BC ecosystem as well as the ecosystem services they provide with changing climates (BC Ministry of Forests, 2015).

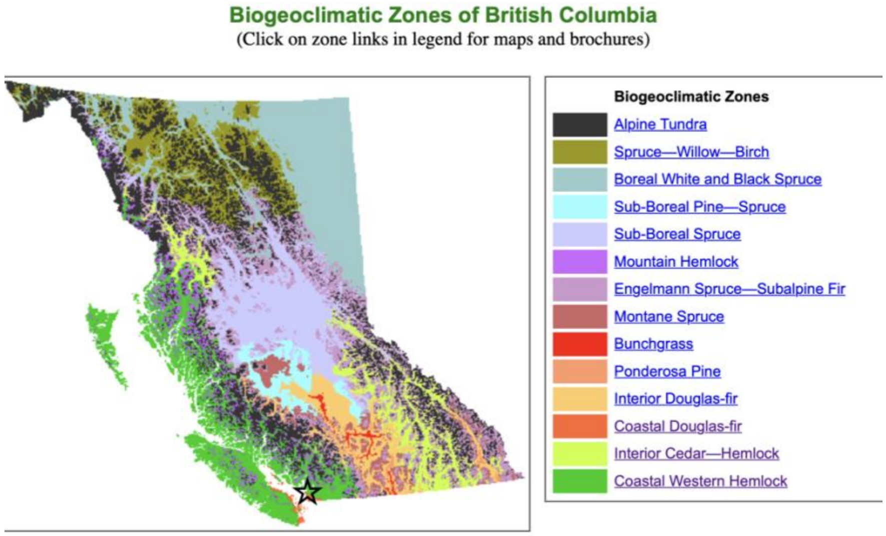



*Figure 4: Fourteen biogeoclimatic zones of British Columbia. PSRP, represented by the star on the figure, is in the coastal western hemlock zone (CWH), which dominates along the south-western coast of BC.*

Retrieved from Centre of Forest Conservation Genetics, 2015a.

Metro Vancouver is mainly within the Coastal Western Hemlock (CWH) BEC zone. Within this zone exists ten subzones, classified by continentality and precipitation (see Figure 5). BC Ministry of Forests, 1991). Vancouver is in the subzone CWHxm1; x for very dry, m for maritime, and 1 for eastern variant. The CWH zone is the rainiest biogeoclimatic zone with an average maximum annual rainfall of 4,386.8 mm, and an average minimum annual rainfall of 990.2 mm (BC Ministry of Forests, 1991). However, the Metro Vancouver region is classified as "very dry" because relative to the other regions within CWH, it is the driest section. As the name implies, western hemlock is the most common species in this zone. Other characteristics of this zone include a sparse herb layer and predominance of moss species such as step moss (*Hylocomium splendens*) and lanky moss (*Rhytidiadelphus loreus*) (BC Ministry of Forests, 1991).

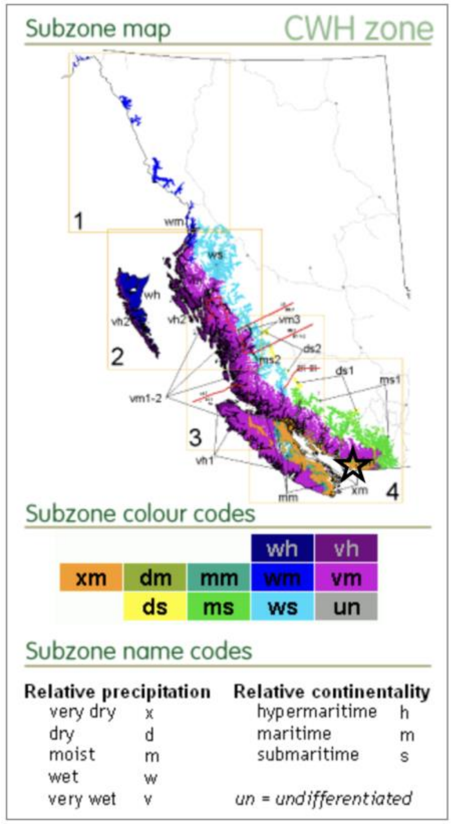



*Figure 5: Subzones within the coastal western hemlock BEC. Name codes describe the relative precipitation and continentality of each subzone. Metro Vancouver, represented by the star, is classified as very dry and maritime. The CWH zone has important ecosystem services for BC as forest development is highly productive, allowing BC to have a crucial role in global forestry (Marcoux, 2015).*

Retrieved from Centre of Forest Conservation Genetics, 2015b.

Salmon species in BC also utilize the freshwater rivers and brackish water estuaries formed by the CWH as spawning sites and migration routes, which is important for commercial salmon fishing and salmon farming (Marcoux, 2015).

Another system of identification for ecosystems in BC is the ecoregion classification tool, which classifies ecosystems based on hierarchical levels (Table 2).

*Table 2: BC ecoregion classification system*

| Level | Class Name | Description | Metro Vancouver classification |
|---|---|---|---|
| 1 | Ecodomain | An area of broad climatic uniformity, defined at the global level | Humid Temperate |
| 2 | Ecodivision | An area of broad climatic and physiographic uniformity, defined at the continental level | Humid Maritime and Highlands |

| Level | Class Name | Description | Metro Vancouver classification |
|---|---|---|---|
| 3 | Ecoprovince | An area with consistent climatic processes or oceanography, and relief, defined at the sub-continental level | Georgian Depression (GED) |
| 4 | Ecoregion | An area with major physiographic and minor macroclimatic or oceanographic variation, defined at the regional level | Lower Mainland (LOM) |
| 5 | Ecosection | An area with minor physiographic and macroclimatic or oceanographic variation, defined at the sub-regional level. | Fraser Lowland (FRL) |

Retrieved from BC Ministry of Environment, 2011.

Over millions of years, FRL was formed through deposition washed down the Fraser River. Due to the mountain ranges in the east, air from the Pacific Ocean is stalled over the FRL and leads to heavy precipitation, while summers bring hot, dry air from the south (BC Ministry of Environment, 2011).

Both ecoregion and BEC classification tools allow resource managers to place a focused BC ecosystem to a "local, regional, provincial, continental or global context" and thus provides a framework of the BC ecosystems (BC Ministry of Environment, 2011). The ecoregion classification describes regional ecosystems, whereas the BEC describes zonal ecosystems (BC Ministry of Environment, 2011). Both systems assist the government in land use planning on a provincial and regional scale. In regards to restoration, these tools can assist with taking into account the context of the ecosystem in terms of physical and biological aspects. Understanding the ecological context is important for restoration projects, such as the restoration efforts in PSRP, to create a methodology that would be the most efficient (in terms of ecology and costs) and robust in ridding the study area of invasive species and encouraging native plant growth.

### 1.4. Natural Disturbance Regime

Natural disturbance regimes explain the historic patterns (temporal, spatial, frequency, and extent) of natural processes that affect ecosystems or landscapes by reshaping said ecosystem/landscapes. There are five natural disturbance types (NDT) found in British Columbia (Table 3)

*Table 3: Natural disturbance types in BC*

| NDT | Description |
|---|---|
| NDT1 | Ecosystems with rare stand-initiating events |
| **NDT2** | **Ecosystems with infrequent stand-initiating events** |
| NDT3 | Ecosystems with frequent stand-initiating events |

| NDT | Description |
|---|---|
| NDT4 | Ecosystems with frequent stand-maintaining fires |
| NDT5 | Alpine Tundra and Subalpine Parkland ecosystems |

Retrieved from BC Ministry of Forests, 1995
Note: Bolded indicates natural disturbance type of Metro Vancouver

Metro Vancouver is type NDT2, which is also associated with the CWH BEC (BC Ministry of Forests, 1995). Wildfires are the major disturbance agents of this NDT. Disturbances are crucial to the maintenance of biodiversity of an ecosystem or landscape, which allows for the development of successional habitats after said disturbance (Cobb et al, 2007). Disturbance events can change the composition of species, nutrient cycle and characteristic of soil. Disturbance often has a negative impact on the resident plants in the ecology, but it also provides opportunities for fugitive organisms to re-enter the ecosystem (Paine, 2012). To know the type of natural disturbance an ecosystem goes through is crucial to help set restoration goals; resource managers can understand the patterns of ecosystem growth after a disturbance, as well as the types of ecosystems that were present prior to anthropogenic disturbances (anthropogenic disturbances include introduction of invasive species by European influence [BC Ministry of Environment, 2001]). Creating appropriate restoration activities for specific disturbance events can speed up the restoration of the ecosystem (Paine, 2012). As such, this can assist with choosing types of native species to plant in the five selected study sites within PSRP, and predicting the growth of the ecosystem. The native species chosen are specific indicator species that serve as a gauge for the health and quality of the habitat (Pacific Spirit Park Society, 2018; Appendix 2) and are planted across the sites.

# 2. Research Objective

## 2.1. Our Objectives

As of early 2021, three years of restoration monitoring has occurred, placing it 4-8 years (depending on the site) since the original removal and planting. The effectiveness of the past restoration efforts has become more apparent due to the growth stages of the planted native trees and return of invasive plants. At this point, it is necessary for MVRP and PSPS to establish a baseline for future restoration efforts, leading to the culmination of our project focusing on generating this baseline.

Our research objectives are as follows:

1. Determine the current state of restoration efforts conducted by MVRP and PSPS at four established monitoring sites in PSRP (sites A, B, C, D) which were previously overrun with invasive species
2. Confirm the transition from primarily deciduous to primarily coniferous forest type of monitoring site E (we defined primarily coniferous forest type as at least 50% cover)
3. Identify the trend in the health of native deciduous and coniferous trees across all sites
4. Consolidate physical and biotic characteristics of each site in a site profile

For research objective 1, we defined the effectiveness of restoration as a reduction in invasive plant cover and increased cover of the target native plants, thus reestablishing its original and natural conditions. For research objective 2, the coniferous forest type was defined to be having greater than 50% coniferous species present. Site E, addressed in research objective 2, had a different objective as set by MVRP because it did not contain as many invasive plants, but consisted of primarily deciduous trees instead of the target conditions of primarily coniferous trees (see Section 1.2).

To achieve this, we undertook three main courses of action throughout the duration of our project. First, we performed data analysis on the data collected by PSPS. The results were displayed on bar graphs to describe the current restoration situation (Research Objective 1) and forest tree types (Research Objective 2) from the elapsed time from 2018 to 2020 and, furthermore, laid out recommendations for future course of action. In conjunction with the data analysis, we constructed a consolidated table showing the health of trees across all sites (Research Objective 3). Lastly, we created site profiles (Research Objective 4), overviewing the physical and biological characteristics of each of the five sites.

## 2.2. MVRP and PSPS Objectives

PSPS has designed and managed its monitoring program (Pacific Spirit Park Society, 2018), in partnership with MVRP, to monitor and evaluate the impact of the joint restoration efforts between PSPS and MVRP by answering the following questions:

- What is the survival rate of the native trees and shrubs in [the] planting sites?
- What is the rate of invasive plant return?
- Are new invasive plants emerging in [the designated] restoration sites?
- How long do sites need to be maintained before the native vegetation outcompetes the invasive plants?
- Are native plants re-establishing in [the designated] restoration sites naturally?

The research objectives of MVRP are focused around maximizing native plants, minimizing invasive plants and collecting the baseline data of restoration, and our research objectives act as an extension of theirs; to analyze the preliminary data and find a pattern for the effectiveness of the restoration efforts.

## 2.3. Primary Stakeholders and Interested Parties

Our project's primary stakeholders are MVRP and PSPS. Our project aimed to show the relative effectiveness of the joint restoration efforts by MVRP and PSPS. There are other interested parties who may be affected by this project, such as residents near PSRP, as well as the Musqueam Indian Band whose territorial land this restoration and management of invasive plants takes place on, and affiliates of the bordering UBC. The Musqueam Indian Band were actively involved in partnership with MVRP in planning the restoration efforts at PSRP.

There are also many recreational activities in PSRP that are undertaken by the local residents, so maintaining and improving the native biodiversity of the park is crucial. PSRP also contains an ecological reserve, which has the purpose of preserving the second-growth forest ecosystem present there. It is also in a location of high demand by university professors to educate students, and researchers (BC Ministry of Forests, 1991). The improvement of the EcoBLITZ Program can better maintain the ecology in PSRP, benefitting many people.

# 3. Methods

## 3.1. Preliminary Data Collection

In the subsequent years following the EcoBLITZ events, PSPS monitored each of the plots within the five sites once per year for the duration of the evaluation, starting from 2018 and completing in 2022. Restoration monitoring in 2018 ran from June 2 until July 25 and from July 6 through October 6 in 2019. As a result of the COVID-19 pandemic, monitoring in 2020 was slightly delayed and ran from August 16 until November 1 and not all plots were monitored, resulting in a slight gap in data (see Section 5.4).

During each monitoring event, teams of volunteers collected five main categories of data: physical, tree mensuration, native shrubs, native ferns, and invasive species data (Pacific Spirit Park Society, 2018). The physical data consisted of information regarding the location and general abiotic and biotic characteristics of each site, such as percent rock cover, percent tree canopy cover, and percent cover of grass among others (Table 4; Appendix 3). For each plot, a tree diagram was created during each monitoring event, which provides the locations of every tree in the plot as well as the health and sizes of the trees (Appendix 4). The native ferns and shrubs data, as well as the invasive species data, consisted of indicator species.

*Table 4: Data collected by PSPS volunteers during monitoring events*

| Physical Data | Mensuration Data | Native Herbs | Native Shrubs | Invasive Herbs |
|---|---|---|---|---|
| Percent Cover Open Water | Tree Species | Species Name | Species Name | Species Name |
| Percent Cover Rock | Was the Tree Recently Planted? | Percent Cover | Percent Cover | Percent Cover |
| Percent Cover Woody Debris | If not present before or natural regeneration? | | | |
| Percent Cover Mineral Soil | DBH or RCD | | | |
| Percent Cover Organic Soil | Tree Health | | | |
| Percent Cover Tree Canopy | Cause of Damage? | | | |
| Percent Cover Grass | | | | |
| Percent Cover Moss | | | | |

Retrieved from Pacific Spirit Park Society, 2018.

## 3.2. Data Analysis

As of publishing this report, only the first three years (2018, 2019, and 2020) of monitoring data have been collected.

### 3.2.1. Research Objective 1 (RO1)

Monitoring data for “invasive”, “native shrubs”, and “native herbs” for sites A, B, C, and D from Table 4 were combined into one collective sheet. We altered the dates from day-month-year to year only as we are comparing data across years rather than the specific date the data was collected. We also created a new column which identified species as “invasive”, “native shrubs”, or “native herbs”. This allowed us to organize data into these three broad types instead of analyzing the data on a species-specific level.

For an overall summary, we created a table that summed the percent cover of the three species type across each sites’ plots, resulting in three total values of percent coverage for each year monitoring data was collected at a site. A percentage bar graph was used to show the change in ratio between invasive and native species across each year for each site.

For the site-specific summary, a similar method to the overall summary was used, but instead the percentage bar graph shows changes in ratio between invasive and native species across each year for individual plots of each site.

### 3.2.2. Research Objective 2 (RO2)

We used the tree mensuration data from Table 4 and isolated it for Site E only, due to the differing objective set by MVRP. Similar to RO1, we altered the dates from day-month-year to year only. Tree species were identified as either “deciduous” or “coniferous”. We then created a table that summed the number of deciduous and coniferous trees. A percentage bar graph was used to show the change in ratio between the two types over the three years at Site E. The analyzed data only considered trees that were considered “healthy” or “unhealthy”; trees that were “dead” would no longer grow and thus would not contribute to forest type.

## 3.3. Site Profiles (RO3)

Site profiles were created for each site and summarize physical and biological characteristics (Table 5).

*Table 5: Site characteristics summarized in the site profiles.*

| Physical Aspects | Biotic Aspects | Restoration Information |
|---|---|---|
| Aspect | Age, Class, or Date of Establishment | Initial Conditions |
| Slope | Habitat Type | Date of Invasive Removal |
| Site Series | Number of Healthy, Unhealthy, and Dead Trees | Type of Restoration |
| | Forest Cover Type | Target Species |
| | Habitat Type | |

For the purpose of identifying the target species from the current BEC conditions, maps provided by MVRP using the BEC subzone (CWHxm1) and the terrestrial ecosystem mapping (TEM) approach were analyzed. Maps generated using the TEM approach provided an aerial view of the forest separated into map units determined by geographical and ecological features collected from field samples (BC Ministry of Forests and Range & BC Ministry of Environment, 2010). Map units are presented as a compound starting with the site series, site modifier, and structural stage (BC Ministry of Forests and Range & BC Ministry of Environment, 2010). Site series are based off of soil moisture and nutrient regime classifications with series 01 representing the zonal site series, which is the site with conditions that best represent the regional climate. All subsequent series are ranked in order of driest to wettest (or nutrient poorest to nutrient richest if sites have the same or similar moisture regime) (Green & Klinka, 1994). The target species were then determined through an overlay of the aforementioned BEC zones and site series (Table 6).

Through this information, we obtained a list of the target species that should be present under the current climatic, soil, and moisture conditions (Green & Klinka, 1994). This provides information as to which native plants MVRP and PSPS planted at each site during restoration, and which species volunteers will look for during future monitoring events.

*Table 6: Target climatic conditions for each monitoring site*

| Site Code | BEC Zone | Site Series |
|---|---|---|
| A | BEC zone CWHxm1 | 05 |
| B | BEC zone CWHxm1 | 07 |
| C | BEC zone CWHxm1 | 07 |
| D | BEC zone CWHxm1 | 01 |
| E | BEC zone CWHxm1 | 07 |

Retrieved from Metro Vancouver, n.d.

### 3.4. Research Objective 4 (RO4)

To identify trends in tree health, the tree health raw data consisting of healthy, unhealthy, dead, and total were compiled in a table. The table outlines the tree health across all of the five sites over the three years of monitoring, classified by the tree type (i.e. coniferous vs. deciduous). The ratio of healthy trees to the total number of trees present was calculated to determine the overall trend.

# 4. Results

Data tables for Research Objective 1 are available in Appendix 5. Data tables for RO2 are available in Appendix 6.

## 4.1. Research Objective 1 - Invasive and Native Plant Cover

### 4.1.1. Combined Sites

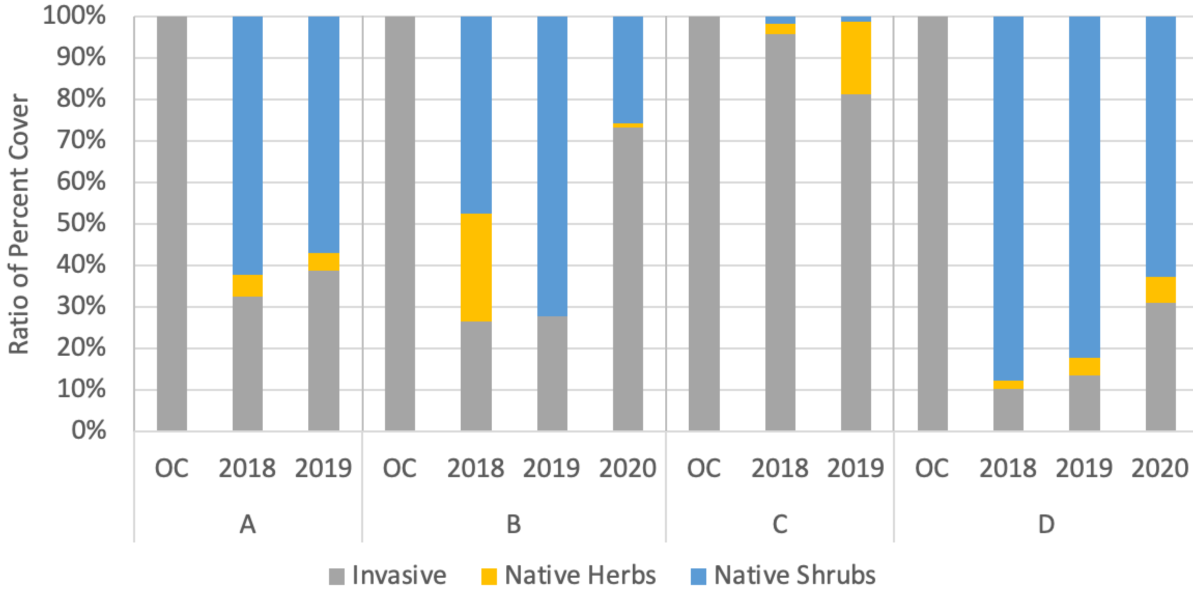



*Figure 6: Overall ratio of percent cover across monitoring sites A, B, C, and D from 2018-2020 (plots A and C were not monitored during 2020 due to Covid-19 delays). OC represent the sites' original conditions prior to restoration works*

Invasive species increased at sites A (33% to 39%), B (27% to 73%), and D (10% to 31%) but decreased only at site C (96% to 81%). Site B showed loss of total native herbs from 2018 to 2019 (26% to 0%), however some native herb species re-appeared in 2020 with 1% of the percent cover. Site C and D both had an increase in ratio (3% to 18% and 2% to 6%). Native Shrubs showed decreases in ratio at all sites (A: 62% to 57%, B: 48% to 26%, C: 2% to 1%, D: 88% to 63%)

### 4.1.2. Site A

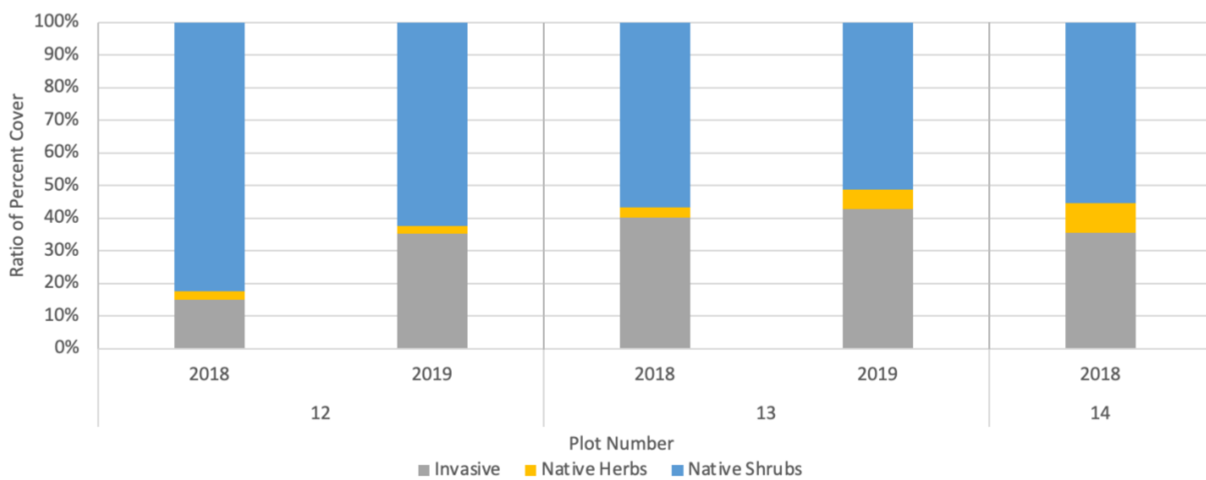



*Figure 7: Ratio of percent cover at site A, plot numbers 12, 13 and 14 from 2018-2019 (plot 14 was only monitored during 2018 and all plots were not monitored during 2020 due to Covid-19 delays)*

Only plots 12 and 13 were collected over multiple years. Both plots saw an increase in invasive species percent cover (15% to 35% and 40% to 43% respectively) and a decrease in native shrubs (83% to 62% and 57% to 51%). Native herbs remained consistent around 2% at plot 12, and increased at plot 13 from 3% to 6%.

### 4.1.3. Site B

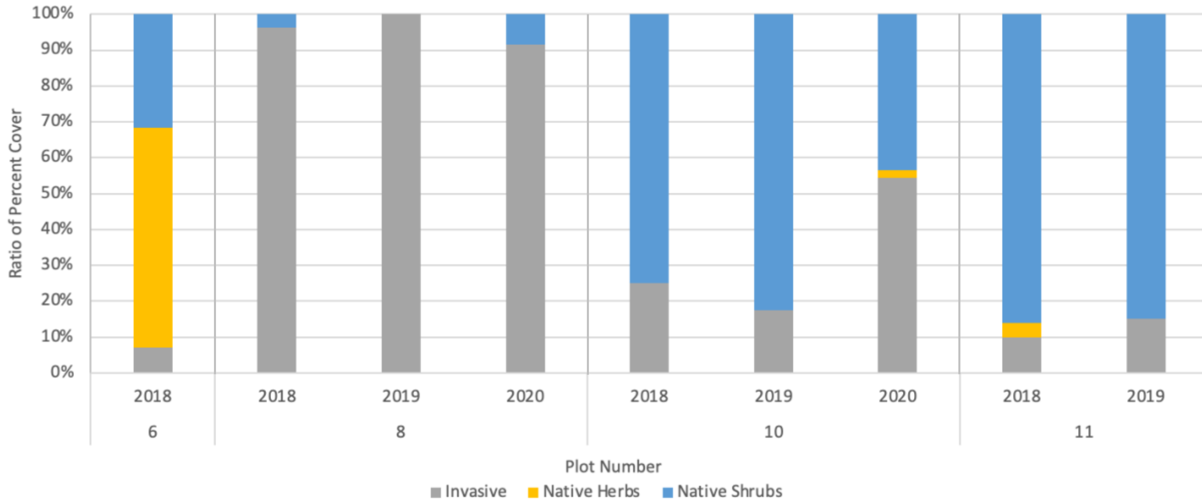



*Figure 8: Ratio of percent cover at site B, plot numbers 6, 8, 10 and 11, from 2018-2020 (plot 6 only was monitored during 2018 and plot 11 was only monitored during 2018 and 2019)*

Plot 8 had an increase in invasive species percent cover from 2018 to 2019 (96% to 100%), however decreased in 2020 to 92% with a simultaneous increase in native shrubs from 0% in 2019 to 8% in 2020. Oppositely, plot 10 saw a decrease in invasive species from 2018 to 2019 (25% to 17%), but a dramatic increase in 2020 to 44%. Native herbs were present only in 2020 in plot 10 with a 2% cover.

Invasive species increased in plot 11 from 2018 to 2019 (10% to 15%) while also losing native herb cover in 2019.

### 4.1.4. Site C

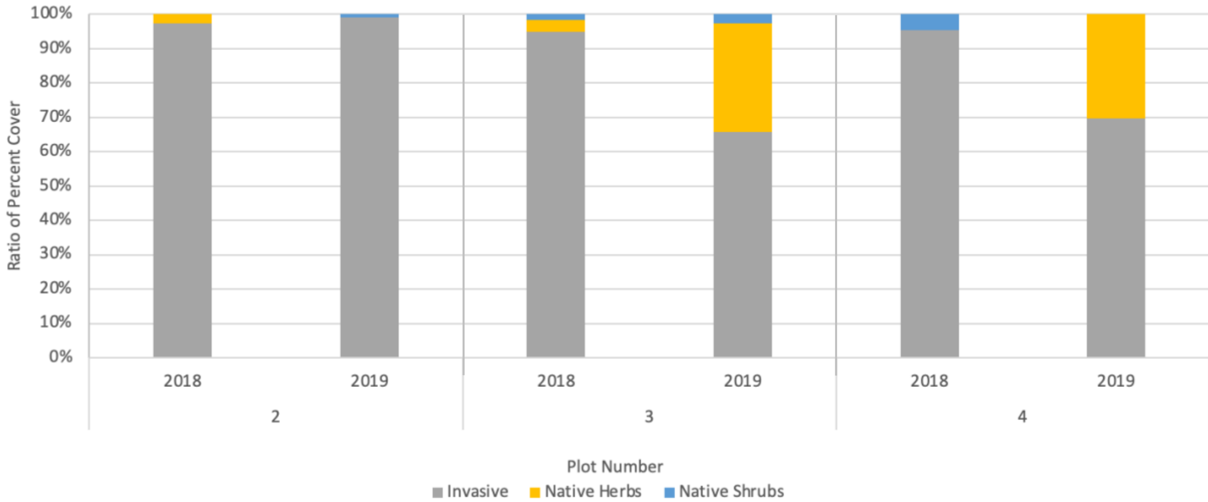



*Figure 9: Ratio of percent cover at site C, plot numbers 2, 3 and 4, from 2018-2019 (plots were not monitored during 2020 due to Covid-19 delays)*

Plot 2 showed little change in species percent cover over the two years, with invasive species increasing from 97% to 99%. However, in plots 3 and 4, invasive species decreased (95% to 66% and 95% to 70% respectively) while native herbs percent cover increased (3% to 31% and 0% to 30% respectively). All plots had less than 5% cover of native ferns during all monitoring years.

### 4.1.5. Site D

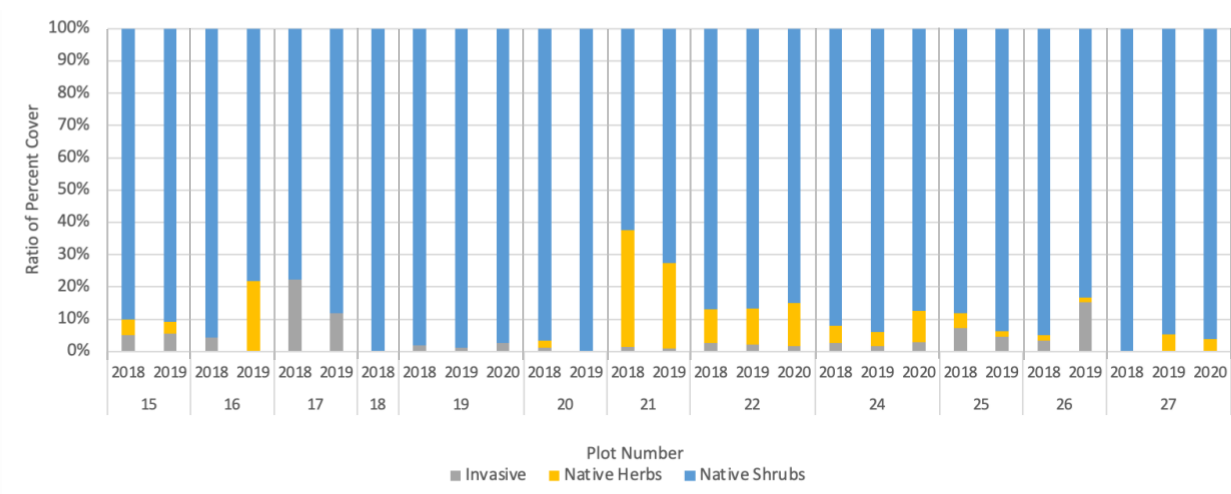



*Figure 10: Ratio of percent cover at site D, plot numbers 29, 30, 31, 35, 38, 40 and 49, from 2018-2020*

Invasive species increased from 2018 to 2020 in plots 29 (3% to 17%), 31 (0% to 35%), 35 (3% to 12%), 38 (26% to 53%), 40 (45% to 73%), and 49 (9% to 32%). Native herbs increased from 2018 to 2020 in plots 29 (0% to 8%), 35 (0% to 21%), and 49 (2% to 4%). Native shrubs decreased at all plots except for plot 30, which saw a small increase from 91% to 93%.

## 4.2. Research Objective 2 - Deciduous to Coniferous Forest

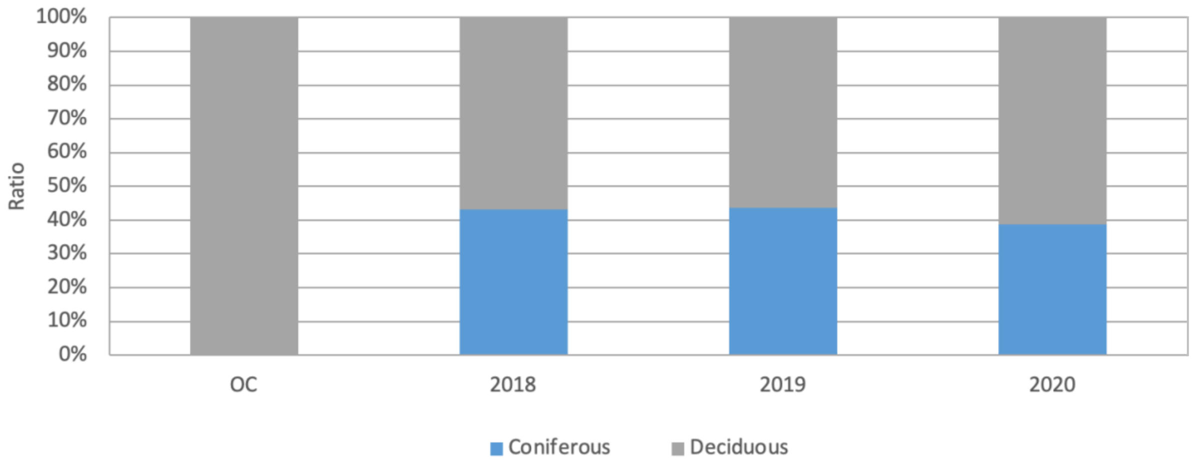



*Figure 11: Ratio of coniferous and deciduous trees at site E. OC represents the site's original conditions prior to restoration works*

Coniferous trees consistently made up around 40% of the tree types across all years. However, it is important to note that not all plots at Site E were monitored in 2020 due to Covid-19 delays, so the total number of trees in 2020 are significantly less than in 2018 and 2019. As such, data for 2020 may not be an accurate representation of the ratio of coniferous to deciduous trees.

*Table 7: Number of coniferous and deciduous trees in Site E*

| Year | Number of Coniferous Trees | Number of Deciduous Trees |
|---|---|---|
| 2018 | 28 | 37 |
| 2019 | 27 | 35 |
| 2020 | 12 | 19 |

## 4.3. Research Objective 3 - Tree Health

The number of healthy coniferous trees decreases slightly, as does the number of dead trees, though the percent of healthy trees out of the total trees remained relatively consistent with 87% healthy in 2018, 91% healthy in 2019, and 88% healthy in 2020. The number of unhealthy coniferous trees remained constant over the three years. The same pattern is seen with healthy deciduous trees with 86% healthy in 2018, 86% healthy in 2019, and 90% healthy in 2020. Though for deciduous trees, both the number of dead trees and the number of unhealthy trees decreased over the three years.

*Table 8: Health of coniferous and deciduous trees across all monitoring sites*

| ***Date*** | **Coniferous** | | | | |
|---|---|---|---|---|---|
| | **Dead** | **Healthy** | **Unhealthy** | **Total** | **Percent of Healthy Trees (%)** |
| 2018 | 8 | 83 | 4 | **95** | **87** |
| 2019 | 4 | 83 | 4 | **91** | **91** |
| 2020 | 5 | 63 | 4 | **72** | **88** |
| ***Date*** | **Deciduous** | | | | |
| | **Dead** | **Healthy** | **Unhealthy** | **Total** | **Percent of Healthy Trees (%)** |
| 2018 | 4 | 119 | 16 | **139** | **86** |
| 2019 | 13 | 143 | 11 | **167** | **86** |
| 2020 | 9 | 84 | 0 | **93** | **90** |

## 4.4. Site Profiles

# Site Location: Chancellor

### Physical Aspects

**Site Code:** E

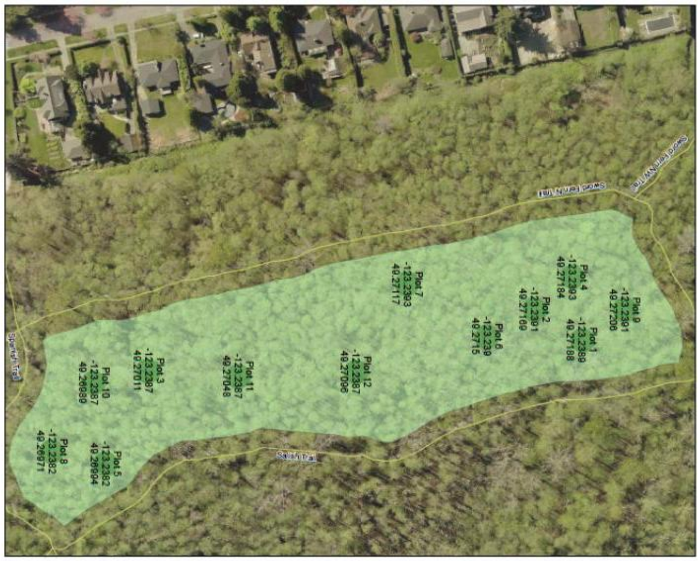
**BEC:** CWHxm1

**Site Series:** 07

**Slope Degree:** 1 – 10°

**Slope Aspect:** N, E, NE, NW, SW

**Number of Plots:** 12



### Restoration Information

**Initial Conditions:**

- Mature red alder
- Sparse understory of native shrubs
- English holly and laurel

**Date of Invasive Removal:** 2017

**Type of Restoration:**

- Removing holly plants.
- Cutting holly trees and painting or rejecting with herbicide.
- Planting Western Redcedar, Western Hemlock, Vine Maple

**Target Species:**

- Douglas-fir
- Western Hemlock
- Sword Fern

### Current State of Stand

**Age Class or date of establishment:** 2019

**Number of Healthy Trees:** 63

**Number of Unhealthy Trees:** 0

**Number of Dead Trees:** 9

**Forest Cover Type:**

- Both natural and new plantation

**Habitat Type:** Mixed forest

**Dominant Tree species:**

- Big Leaf Maple (28%)
- Grand Fir (22%)
- Western Red Cedar (19%)
- Douglas Fir (17%)

*Figure 12: Example site profile for Site E*

Site profiles for each site are provided in Appendix 7.

# 5. Discussion and Conclusion

## 5.1. Research Objective 1

Three years after the initial removal, the restoration efforts have not been entirely successful in ridding the monitoring plots of invasive plant species. The percent cover of invasive species has fluctuated between the plots in each site, though the fluctuations result in an overall increase in invasive cover in sites A, B, and D and an overall decrease in site C only (Figure 6, Figure 7, Figure 8, Figure 9, Figure 10).

As shown in Table 1, on top of native species planting, the mulching treatment was only applied to Site C. Site A and B had also received a mulch treatment, however the newly planted individuals did not survive and so no mulching occurred in the final treatment. Site D also had a higher density of new plantings compared to the other sites. The addition of the mulch treatment and lower density plantings compared to Site D may explain the decrease in invasive plants over the monitoring period in Site C, however more experimenting would need to occur to prove this statement.

Weather conditions are not recorded by volunteers during monitoring events (see Section 5.5) and so we cannot correlate between specific abiotic conditions to our data. However, comparing total annual precipitation to the Climate Normal from 1981 to 2010 (1,189 mm, Government of Canada, 2020) we see that 2017 (1,239 mm) and 2018 (1,343 mm) were above this normal, but 2019 (934mm) was below the normal (Weather Dashboard of Vancouver, 2021). Less precipitation in 2019 than the normal could have hindered growth of native plants, allowing invasive plants to outcompete the natives for water, thus seeing a large increase in invasive plant percent cover from 2019 to 2020 at sites B and D. Precipitation anomaly may be a result of climate change, which also has other implications to invasive species in the future (see Section 5.4).

It is also worth noting that Metro Vancouver and Pacific Spirit Park Society's monitoring objectives are to take place over the course of five years, whereas our project reflects the results over the first two and three years. This project is a part of a 100-year recovery timeline, with monitoring to continue even after 2022. In addition, the data was collected only a few years following removal, which is likely not a sufficient amount of time to clearly see the full results of the restoration work. This is especially relevant for some of the native trees like the western hemlock, which exhibit slow initial growth rates. In this case, monitoring after only three to six years is not sufficient to truly see progress. A 2019 study monitored and examined invasive species removal in eastern deciduous forests in Pennsylvania, US. Chemical removal treatments were applied to 20-m plots in 2009, and consistent physical removal treatments of invasive seedlings and resprouts. After seven years of monitoring, they found an increase in native understory plant abundance; invasive removal also encouraged passive, natural regeneration of native plants (Maynard-Bean & Kaye, 2019).

During the monitoring period, sites A - D are regularly maintained by PSPS volunteers and contractors and in a few situations, the maintenance unintentionally killed the planted stock in 2018 as reported by Metro Vancouver. However, generally plants are brushed twice a year to promote survival. Thus, although we cannot form a concrete conclusion from the data due to inconsistencies in the shifts in invasive species cover over the four target sites, we are optimistic about the recovery of the native plants through new plantings and regeneration after the full five years of monitoring. Our findings have established a baseline that can be built upon continuously throughout the remaining period of monitoring restoration, as well as after the completion of this project.

## 5.2. Research Objective 2

Data confirms that as of the 2020 monitoring period, Site E has not transitioned to a coniferous forest stand. No increase in coniferous tree types across the three years was observed (Figure 11). However, prior to restoration this site consisted mostly of mature red alders with a sparse cover of native understory plants like salmonberry (*Rubus spectabilis*) and trailing blackberry (*Rubus ursinus*). Percent cover of coniferous has been consistently around 40% over the three monitoring years, showing that even after restoration, deciduous trees had not been outcompeting the coniferous trees since planting of the trees in 2017. In other words, there is a very high rate of survival of coniferous trees planted that were planted prior to monitoring. Of all 67 coniferous trees present at site E, only one was marked as "unhealthy" (Table 7, Appendix 6); all "dead" trees were deciduous trees (Appendix 6). Within the whole site, two coniferous individuals existed prior to restoration, and only two coniferous individuals have naturally regenerated during the monitoring period as reported by MVRP and PSPS. Natural regeneration will likely not occur during the monitoring period as the recently planted coniferous trees are likely still juveniles and are thus unable to reproduce yet. The juvenile stage can last 1 to 15 years, depending on the tree species (Williams, 2009 p. 26).

With the current data available, the transition of site E from a deciduous to coniferous forest has not occurred as of yet. However, we remain hopeful that in the coming years, the newly planted coniferous trees will mature and begin to naturally regenerate the area, thus completing this transition.

## 5.3. Research Objective 3

The data shows an overall success in the survival rate of trees across all sites. Most of the trees in the plots are healthy with few unhealthy and dead trees (Table 8). The number of unhealthy or dead trees do not steadily increase across either type of trees, suggesting that the monitoring sites have favourable conditions for trees and trees are not being outcompeted for resources by invasive species.

## 5.4. Data Limitations

The sampling methodology created by PSPS is based solely on visual observations and is carried out by volunteers. Unfortunately, this can lead to inconsistency in data collection (ie. data gaps). In the raw, preliminary data, some species were recorded as present in 2018 but were not present in 2019, but then were present again in 2020. However, we do not know if this is due to natural fluctuations or human error. This potential inconsistency affects the ability to perform statistical tests on the data that has been collected and future collected data. As this is a five-year program, another issue that arose was ensuring a minimum sample size (n) is captured in order to perform said statistical tests.

Furthermore, due to provincial guidelines following the outbreak of COVID-19, monitoring of PSRP in 2020 began later in the year and in smaller groups, meaning that monitoring took twice as long and spanned over a greater time than prior monitoring years; volunteer monitoring started in early August and continued into early November, whereas monitoring typically takes place over the summer months (June to early October). Additionally, some 2020 monitoring occurred following a cold snap that brought temperatures to below freezing at night. This shift in monitoring time and the ensuing temperature drop could have influenced the 2020 data, potentially causing lower percent cover observed than in the previous years at a given plot or site due to fallen leaves or dead plants. Generally, dead plants are not counted in percent cover data and trees or plants without leaves lower the percent canopy cover or percent plant cover, something that would likely not have occurred in the summer months. Additionally, not every plot was monitored (specifically in Site E), resulting in some gaps in the data.

### 5.5. Suggestions

Through our analysis, we have noticed a few inconsistencies in the monitoring process that might benefit from being more standardized. This standardization would make the methodology and monitoring more replicable and the data clearer in the long run.

One suggestion for future monitoring is to review which plants (both native and invasive) were present before and, when conducting monitoring the following year, specifically look again to find those particular plants. This may prevent plants from being missed in subsequent years.

Another option to mitigate this inconsistency is to create position diagrams (like the tree position diagrams) for each identified plant so that they can be more easily identified and checked during later monitoring sessions. However, it may be too tedious or time consuming to create position diagrams for every plant present so a compromise may be to only create position diagrams for low density or scarce plants which are more easily missed than a large blackberry bush.

Below are some suggestions for monitoring for future restoration work:

- Create buffer zones around restoration plots to prevent potential leakage/spillover of invasive species from the bordering area
- Take note of the weather and temperature during that particular season/week, noting any irregularities or anomalies, such as cold snaps or draughts, that may impact plant survival
- Observe if planting style (densely planted vs. sparsely planted) has impacted restoration success in reducing invasive species and promoting native plants
- Monitor during the same months of the year when possible, as health, survival, and noticeable presence of plants may differ during the summer, fall, and winter months; may also help to reduce discrepancies
- Measure and record soil pH, which indicates the nutrient levels in the soil or any leaching or nutrient loading present and can impact plant health; compare these results with target site series to ensure consistency
- Measure and record moisture content in soil, which can be done using a two-ringed infiltrometer to indicate soil moisture content and infiltration capacity which can impact plant growth; this may help to identify which native fauna should be planted in a particular plot which may increase plant survival
- Consistent invasive removal during data collection

### 5.6. Implications

Monitoring the restoration efforts in PSRP can show us the relationship between the native and invasive species at these sites. We can also make predictions of how the site will look over the next couple of years. With these predictions, methods of restoration in other sites or parks around Metro Vancouver can be altered to be more efficient and/or effective as our results can serve as a baseline. The site profiles created during this project can also be used by resource managers or others interested in utilizing PSRP for ecological experiments as it will provide a consolidated overview of the biotic and abiotic conditions of each restoration site.

As noted previously, this restoration monitoring project is a part of a roughly 100-year recovery timeline and MVRP has stated that they plan to continue the monitoring and maintenance of the restoration plots for, at a minimum, 10 years post removal. When factoring in the changing climate, it is difficult to predict how the native plants will react over the 100-year timeline. Likely outcomes include changes in the growing and pollination season, increased heat stress on heat intolerant species, increase in tree diseases leading to a decrease in tree survival rates, increases in invasive plants, and shifts in the species demographics due to potential changes in the region's biogeoclimatic zone (City of Vancouver, n.d.; Diamond Head Consulting Ltd., 2016). Any noticeable changes or reactions to climate change should be carefully observed and monitored over the coming decades.

# 6. Summary

Based on the monitoring data provided by PSPS from 2018 to 2020, we interpreted total percent cover including invasive plants, native herbs, and native shrubs in four monitoring plots. The results indicated that most sites (A, B, D) had increased total invasive species percent covers. Only site C had a decreased total invasive species percent cover. Both sites C and site D had an increase in total native herb percent cover; as of current the restoration efforts have not been completely successful in the removal of the monitoring site invasive species. We also conclude that the transition from a deciduous forest to a coniferous forest has not been completed. The three years of monitoring data available is likely insufficient to show the whole efforts of the restoration, but we are confident that restoration efforts will succeed as will the transition of site E to coniferous forest cover. Due to some inconsistencies in the data, we suggest targeting the plants which were seen in the previous year and creating position diagrams so that each plant can be easily identified. For the general monitoring in the future, we advise to create buffer zone around each restoration plots, to take note of the weather on a particular season, to figure out how the planting style has impacted the restoration's success, to measure and record the soil pH, to measure and record the moisture in the soil, to consistently remove invasive species.

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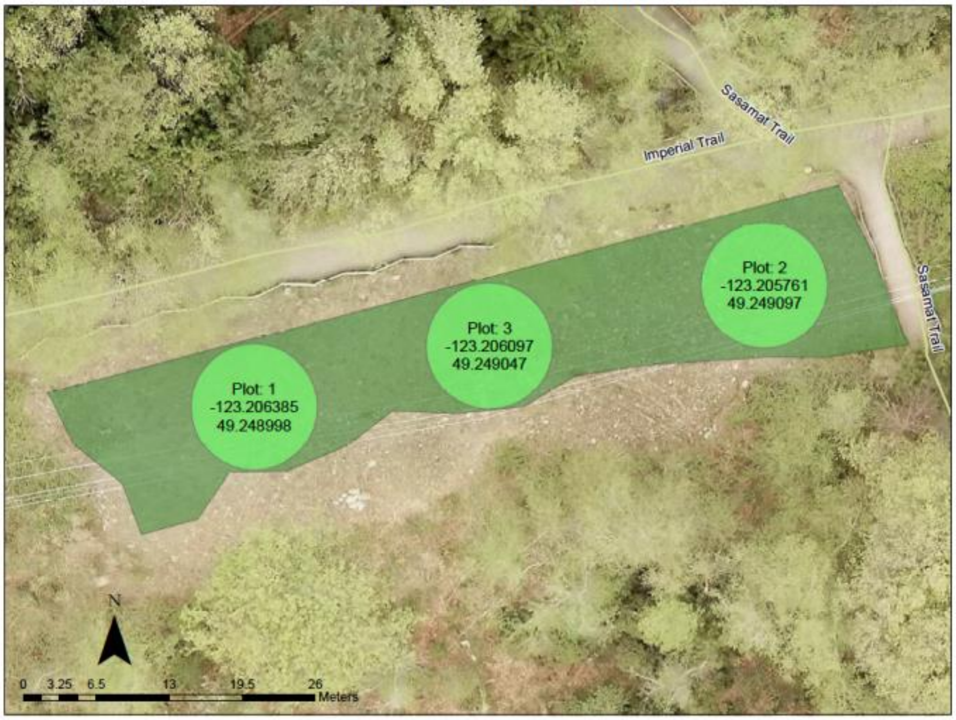
# Appendix 1: Monitoring Sites

Plot A:

EcoBlitz Site: Sasamat & Imperial




Plot B:

EcoBlitz Site: Camosun & 21st Avenue

Plot C:

**City of Vancouver Restoration Site: Crown & 22nd Avenue**


Plot D:

**EcoBlitz Site: SW Marive Drive**

Plot E:


Acadia Forest Restoration Monitoring
Plot 9
-123.2391
49.27206
Plot 4
-123.2393
49.27184
Plot 1
-123.2389
49.27188
Plot 2
-123.2391
49.27169
Plot 6
-123.239
49.2715
Plot 7
-123.2393
49.27117
Plot 12
-123.2387
49.27096
Plot 11
-123.2387
49.27048
Plot 3
-123.2387
49.27011
Plot 5
-123.2382
49.26994
Plot 10
-123.2387
49.26989
Plot 8
-123.2382
49.26971

# Appendix 2: Indicator Species

### Deciduous

| | |
|---|---|
| Bigleaf Maple | *Acer macrophyllum* |
| Bitter Cherry | *Prunus emarginata* |
| Black Cottonwood | *Populus balsamifera* ssp. *Trichocarpa* |
| Cascara | *Rhamnus purshiana* |
| Pacific Crabapple | *Malus fusca* |
| Pacific Dogwood | *Cornus nuttallii* |
| Paper Birch | *Betula papyrifera* |
| Red Alder | *Alnus rubra* |
| Vine Maple | *Acer circinatum* |

### Conifers

| | |
|---|---|
| Douglas Fir | *Pseudotsuga menziesii* |
| Grand Fir | *Abies grandis* |
| Pacific/Western Yew | *Taxus brevifolia* |
| Shore Pine | *Pinus contorta* |
| Sitka Spruce | *Picea sitchensis* |
| Western Hemlock | *Tsuga heterophylla* |
| Western Redcedar | *Thuja plicata* |

### Shrubs

| | |
|---|---|
| Alaskan Blueberry | *Vaccinium alaskaense* |
| Beaked Hazelnut | *Corylus cornuta* |
| Black Hawthorne | *Crataegus douglasii* |
| Black Huckleberry | *Vaccinium membranaceum* |
| Bog Cranberry | *Vaccinium oxycoccos* |
| Devil's club | *Oplopanax horridus* |
| Dull Oregon Grape | *Mahonia nervosa* |
| False Azalea | *Menziesia ferruginea* |
| Hardhack | *Spiraea douglasii* |
| Indian Plum | *Oemleria cerasiformis* |
| Kinnikinnick | *Arctostaphylos uva-ursi* |
| Mock Orange | *Philadelphus lewisii* |
| Nootka Rose | *Rosa nutkana* |
| Oceanspray | *Holodiscus discolor* |
| Oval-leaved Blueberry | *Vaccinium ovalifolium* |
| Pacific Ninebark | *Physocarpus capitatus* |
| Red Elderberry | *Sambucus racemosa* |
| Red Huckleberry | *Vaccinium parvifolium* |
| Red-Flowering Currant | *Ribes sanguineum* |
| Red-Osier Dogwood | *Cornus stolonifera* |
| Salal | *Gaultheria shallon* |
| Salmonberry | *Rubus spectabilis* |
| Saskatoon Berry | *Amelanchier alnifolia* |
| Sitka Mountain-Ash | *Sorbus sitchensis* |
| Snowberry | *Symphoricarpos albus* |
| Tall Oregon Grape | *Mahonia aquifolium* |
| Thimbleberry | *Rubus parviflorus* |
| Trailing Blackberry | *Rubus ursinus* |

## Ferns and Allies

| | |
|---|---|
| Bracken Fern | *Pteridium aquilinum* |
| Deer Fern | *Blechnum spicant* |
| Lady Fern | *Athyrium filix-femina* |
| Spiny Wood Fern | *Dryopteris expansa* |
| Sword Fern | *Polystichum munitum* |

## Herbs

| | |
|---|---|
| Bunchberry | *Cornus canadensis* |
| False Lily-of-the-Valley | *Maianthemum dilatatum* |
| False Solomon's Seal | *Maianthemum racemosum* |
| Fringecup | *Tellima grandiflora* |
| Large-leaved Avens | *Geum macrophyllum* |
| Skunk Cabbage | *Lysichiton americanus* |
| Stinging Nettle | *Urtica dioica* |
| Western Trillium | *Trillium ovatum* |

## Invasive

English Ivy
English Holly
Daphne/Spurge Laurel
Cherry/Common Laurel
Himalayan Blackberry
Cutleaf/Evergreen Blackberry
Scotch Broom
Common Periwinkle
Yellow/Variegated Lamium
Common Hop
Japanese Knotweed
Himalayan Balsan/Policemen's Helmet
Yellow Flag Iris
Purple Loosestrife

# Appendix 3: EcoRESTORATION Monitoring Form

11/12/2020 PSPS EcoWATCH: Restoration Monitoring Report

## PSPS EcoWATCH: Restoration Monitoring Report

**I hereby acknowledge that I am undertaking this EcoRestoration monitoring session at my own risk and will do my due diligence to minimize risk to myself and others. I will notify PSPS Project Coordinators or Leaders of any possible hazards I observe and follow safety protocols as instructed by EcoRestoration Team Leaders.**

☐ Yes, continue with data collection

### Plot: General Information

**Date:**

yyyy-mm-dd

**Plot Number:**

**New Surveyor Names**

**Surveyors:**

☐ David Bromley ☐ Alexander Coster ☐ Doug Crocker
☐ Andre-Philippe Drapeau ☐ Amanda Harrower ☐ Micheal Jerowsky
☐ Joyce Leung ☐ Ada Li ☐ Katie McMahen
☐ Teaghan Smith ☐ Wendy Thompson ☐ Joseph Yang
☐ Dexter Everett ☐ Austin Tahiliani ☐ Ken Lawrence
☐ Tommy Kuo ☐ Xinyu Zhang ☐ Joyce Leung
☐ Wetland Keeper Workshop Participant ☐ Shantanu Dutt
☐ Lisa Pourlak ☐ Katherine Yurkovich ☐ Sam Guyu

**GPS Unit No.**

**Slope Degree**

◯ 0 deg ◯ 1-5 deg ◯ 5-10 deg
◯ >10 deg

https://kf.kobotoolbox.org/#/forms/aynbDAQusEqHCgdjakRKBx/summary 1/12

**Slope Aspect**

- ◯ N
- ◯ NE
- ◯ E
- ◯ SE
- ◯ S
- ◯ SW
- ◯ W
- ◯ NW

**Photo Monitoring From North**

Click here to upload file. (< 5MB)

**Photo ID North**

*E.g. PlotID-N-MMDDYY (001-N-080818)*

---

**Photo Monitoring To East**

Click here to upload file. (< 5MB)

**Photo ID East**

*E.g. PlotID-E-MMDDYY (001-E-080818)*

---

**Photo Monitoring From South**

Click here to upload file. (< 5MB)

**Photo ID South**

*E.g. ID-S-MMDDYY (001-S-080818)*

---

**Photo Monitoring To West**

Click here to upload file. (< 5MB)

**Photo ID West**

*E.g. PlotID-W-MMDDYY (001-W-080818)*

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## Plot: Physical Characteristics

**Percent Cover Open Water**

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**Percent Cover Rock**

---

**Percent Cover Woody Debris**

________________

**Percent Cover Mineral Soil**

________________

**Percent Cover Organic Soil**

________________

**Site Notes**

________________

## Mensuration Data

1

**Tree Number:**

________________

**Tree Species**

- ◯ Douglas Fir (Pseudotsuga menziesii)
- ◯ Grand Fir (Abies grandis)
- ◯ Pacific / Western Yew (Taxus brevifolia)
- ◯ Shore Pine (Pinus contorta)
- ◯ Sitka Spruce (Picea sitchensis)
- ◯ Western Hemlock (Tsuga heterophylla)
- ◯ Western Red Cedar (Thuja plicata)
- ◯ Black Cottonwood (Populus balsamifera)
- ◯ Big Leaf Maple (Acer macrophyllum)
- ◯ Bitter Cherry (Prunus emarginata)
- ◯ Vine Maple (Acer circinatum)
- ◯ Pacific Dogwood (Cornus nuttallii)
- ◯ Paper Birch (Betula papyrifera)
- ◯ Pacific Crab Apple (Malus fusca)
- ◯ Red Alder (Alnus rubra)
- ◯ Cascara (Rhamnus purshiana)

**Was tree recently planted?**

◯ Yes ◯ No

**If not recently planted...**

- ☐ Tree was present before restoration
- ☐ Natural Regeneration
- ☐ N/A

**Size Measurement Method**

- ◯ DBH (cm)
- ◯ RCD (cm)

**Size Measurement (cm)**

______________________

**Tree Health**

◯ Healthy ◯ Unhealthy ◯ Dead

**Cause of Damage**

- ☐ Altered Growth or Development
- ☐ General Death
- ☐ Localized Death or Necrosis
- ☐ Physical Evidence

**Notes**

______________________

## Invasive Species Data

1

**Invasive Species**

- ◯ Daphne / Spurge Laurel (Daphne laureola) ◯ Cherry Laurel (Prunus laurocerasus)
- ◯ Common Hop (Humulus lupulus) ◯ Common Periwinkle (Vinca minor)
- ◯ Cutleaf Evergreen Blackberry (Rubus laciniatus) ◯ English Ivy (Hedera helix)
- ◯ English Holly (Ilex aquifolium) ◯ Giant Hogweed (Heracleum mantegazzianum)
- ◯ Himalayan Blackberry (Rubus armeniacus) ◯ Himalayan Knotweed (Persicaria wallichii)
- ◯ Morning Glory (Convolvulus arvensis)
- ◯ Policeman's Helmet / Himalayan Balsam (Impatiens glandulifera) ◯ Scotch Broom (Cytisus scoparius)
- ◯ Yellow Lamium (Lamium sp.) ◯ Reed Canary Grass (Phalaris arundinacea)

**Percent Cover**

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 10
- ◯ 15
- ◯ 20
- ◯ 25
- ◯ 30
- ◯ 35
- ◯ 40
- ◯ 45
- ◯ 50
- ◯ 55
- ◯ 60
- ◯ 65
- ◯ 70
- ◯ 75
- ◯ 80
- ◯ 85
- ◯ 90
- ◯ 95
- ◯ 100

**Notes**

______________________________

## Native Shrubs Data

1

**Native Shrub Species**

- ◯ Beaked Hazelnut (Corylus cornuta)
- ◯ Alaskan Blueberry (Vaccinium alaskaense)
- ◯ Black Hawthorne (Crataegus douglasii)
- ◯ Black Huckleberry (Vaccinium membranaceum)
- ◯ Bog Cranberry (Vaccinium oxycoccos)
- ◯ Cascara (Rhamnus purshiana)
- ◯ Devil's club (Oplopanax horridus)
- ◯ Dull Oregon Grape (Mahonia nervosa)
- ◯ False Azalea (Menziesia ferruginea)
- ◯ Hardhack (Spiraea douglasii)
- ◯ Indian Plum (Oemleria cerasiformis)
- ◯ Kinnikinnick (Arctostaphylos uva-ursi)
- ◯ Mock Orange (Philadelphus lewisii)
- ◯ Nootka Rose (Rosa nutkana)
- ◯ Oceanspray (Holodiscus discolor)
- ◯ Oval-leaved Blueberry (Vaccinium ovalifolium)
- ◯ Pacific Ninebark (Physocarpus capitatus)
- ◯ Red Elderberry (Sambucus racemosa)
- ◯ Red Huckleberry (Vaccinium parvifolium)
- ◯ Red-Flowering Currant (Ribes sanguineum)
- ◯ Red-Osier Dogwood (Cornus stolonifera)
- ◯ Salal (Gaultheria shallon)
- ◯ Salmonberry (Rubus spectabilis)
- ◯ Saskatoon Berry (Amelanchier alnifolia)
- ◯ Sitka Mountain-Ash (Sorbus sitchensis)
- ◯ Snowberry (Symphoricarpos albus)
- ◯ Tall Oregon Grape (Mahonia aquifolium)
- ◯ Thimbleberry (Rubus parviflorus)
- ◯ Trailing Blackberry (Rubus ursinus)

**Percent Cover Native Shrub Species**

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 10
- ◯ 15
- ◯ 20
- ◯ 25
- ◯ 30
- ◯ 35
- ◯ 40
- ◯ 45
- ◯ 50
- ◯ 55
- ◯ 60
- ◯ 65
- ◯ 70
- ◯ 75
- ◯ 80
- ◯ 85
- ◯ 90
- ◯ 95
- ◯ 100

**Notes**

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## Native Fern and Herb Data

1

**Native Fern and Herb Species**

- [ ] Bracken Fern (Pteridium aquilinum)
- [ ] Bunchberry (Cornus canadensis)
- [ ] Deer Fern (Blechnum spicant)
- [ ] False Lily-of-the-Valley (Maianthemum dilatatum)
- [ ] False Solomon's Seal (Maianthemum racemosum)
- [ ] Fringecup (Tellima grandiflora)
- [ ] Lady Fern (Athyrium filix-femina)
- [ ] Large-leaved Avens (Geum macrophyllum)
- [ ] Skunk Cabbage (Lysichiton americanus)
- [ ] Spiny Wood Fern (Dryopteris expansa)
- [ ] Stinging Nettle (Urtica dioica)
- [ ] Sword Fern (Polystichum munitum)
- [ ] Western Trillium (Trillium ovatum)

**Percent Cover Native Herb and Fern**

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 10
- ◯ 15
- ◯ 20
- ◯ 25
- ◯ 30
- ◯ 35
- ◯ 40
- ◯ 45
- ◯ 50
- ◯ 55
- ◯ 60
- ◯ 65
- ◯ 70
- ◯ 75
- ◯ 80
- ◯ 85
- ◯ 90
- ◯ 95
- ◯ 100

**Notes**

______________________________

## Stratification Data

**Percent Cover Tree Canopy**

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 10
- ◯ 15
- ◯ 20
- ◯ 25
- ◯ 30
- ◯ 35
- ◯ 40
- ◯ 45
- ◯ 50
- ◯ 55
- ◯ 60
- ◯ 65
- ◯ 70
- ◯ 75
- ◯ 80
- ◯ 85
- ◯ 90
- ◯ 95
- ◯ 100

**Percent Cover Grass**

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 10
- ◯ 15
- ◯ 20
- ◯ 25
- ◯ 30
- ◯ 35
- ◯ 40
- ◯ 45
- ◯ 50
- ◯ 55
- ◯ 60
- ◯ 65
- ◯ 70
- ◯ 75
- ◯ 80
- ◯ 85
- ◯ 90
- ◯ 95
- ◯ 100

**Percent Cover Moss**

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 10
- ◯ 15
- ◯ 20
- ◯ 25
- ◯ 30
- ◯ 35
- ◯ 40
- ◯ 45
- ◯ 50
- ◯ 55
- ◯ 60
- ◯ 65
- ◯ 70
- ◯ 75
- ◯ 80
- ◯ 85
- ◯ 90
- ◯ 95
- ◯ 100

# Appendix 4: Tree Plot Form

3. PLOT DATA COLLECTION

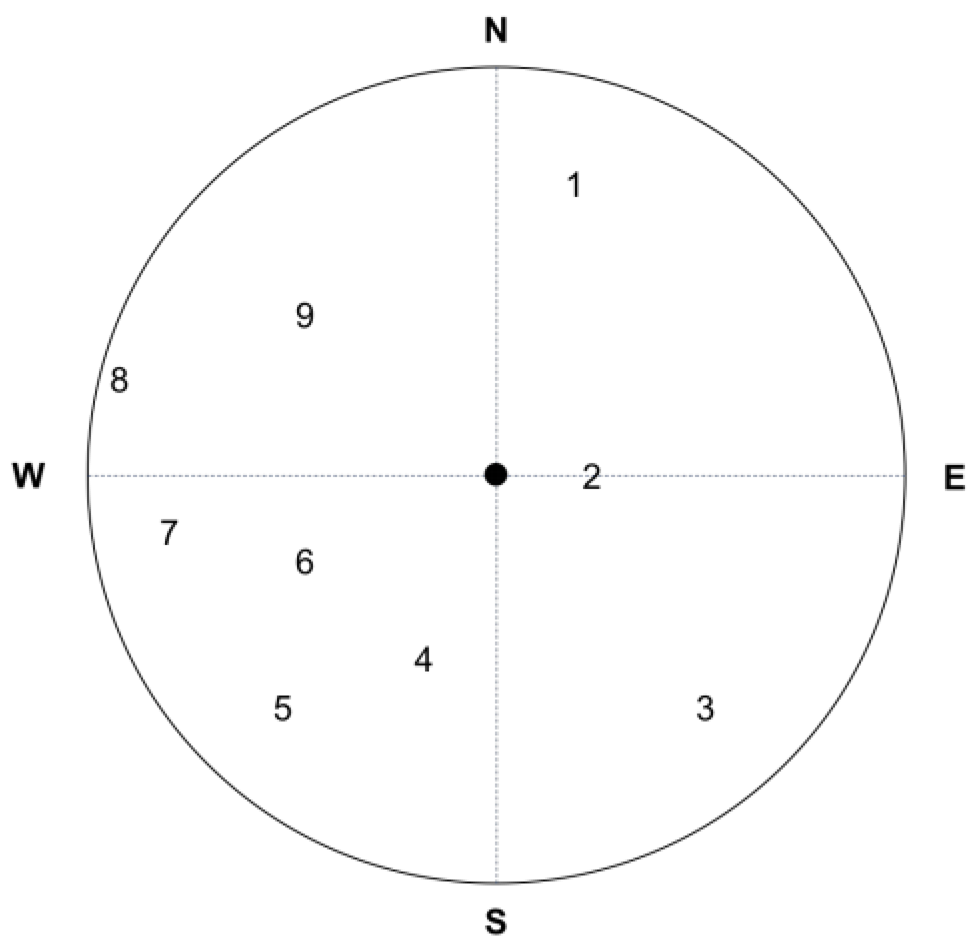



**Figure 2:** Example Tree Position Diagram

# Appendix 5: Data Tables for RO1

*Table A: Monitoring Sites Cumulative Percent Cover*

| *Site* | *Date* | **Cumulative Percent Cover** | | |
|---|---|---|---|---|
| | | **Invasive** | **Native Herbs** | **Native Shrubs** |
| A | 2018 | 56 | 9 | 107 |
| | 2019 | 65 | 7 | 95 |
| B | 2018 | 38 | 37 | 68 |
| | 2019 | 58 | 0 | 150 |
| | 2020 | 275 | 4 | 96 |
| C | 2018 | 115 | 3 | 2 |
| | 2019 | 208 | 45 | 3 |
| D | 2018 | 36 | 7 | 306 |
| | 2019 | 99 | 30 | 595 |
| | 2020 | 211 | 41 | 425 |

*Table B: Monitoring Plots Percent Cover*

| ***Site*** | ***Plot Number*** | ***Cumulative Plot Number*** | ***Date*** | **Percent Cover** | | |
|---|---|---|---|---|---|---|
| | | | | **Invasive** | **Native Herbs** | **Native Shrubs** |
| A | 1 | 12 | 2018 | 6 | 1 | 33 |
| | | | 2019 | 30 | 2 | 53 |
| | 2 | 13 | 2018 | 27 | 2 | 38 |
| | | | 2019 | 35 | 5 | 42 |
| | 3 | 14 | 2018 | 23 | 6 | 36 |
| B | 1 | 6 | 2018 | 4 | 35 | 18 |
| | 2 | 8 | 2018 | 27 | 0 | 1 |
| | | | 2019 | 30 | 0 | 0 |
| | | | 2020 | 175 | 0 | 16 |
| | 3 | 10 | 2018 | 2 | 0 | 6 |
| | | | 2019 | 8 | 0 | 38 |
| | | | 2020 | 100 | 4 | 80 |
| | 4 | 11 | 2018 | 5 | 2 | 43 |
| | | | 2019 | 20 | 0 | 112 |
| C | 1 | 2 | 2018 | 38 | 1 | 0 |
| | | | 2019 | 110 | 0 | 1 |
| | 2 | 3 | 2018 | 56 | 2 | 1 |
| | | | 2019 | 52 | 25 | 2 |
| | 3 | 4 | 2018 | 21 | 0 | 1 |
| | | | 2019 | 46 | 20 | 0 |
| D | 1 | 29 | 2018 | 1 | 0 | 30 |
| | | | 2019 | 12 | 10 | 76 |
| | | | 2020 | 12 | 6 | 54 |
| | 2 | 30 | 2018 | 4 | 2 | 61 |
| | | | 2019 | 2 | 1 | 92 |
| | | | 2020 | 6 | 1 | 93 |
| | 3 | 31 | 2018 | 0 | 0 | 32 |
| | | | 2019 | 2 | 0 | 39 |
| | | | 2020 | 15 | 0 | 28 |
| | 4 | 35 | 2018 | 2 | 0 | 59 |
| | | | 2019 | 10 | 16 | 177 |
| | | | 2020 | 15 | 27 | 86 |
| | 5 | 38 | 2018 | 6 | 1 | 16 |
| | | | 2019 | 10 | 0 | 40 |
| | | | 2020 | 63 | 0 | 55 |

| *Site* | *Plot Number* | *Cumulative Plot Number* | *Date* | **Percent Cover** | | |
|---|---|---|---|---|---|---|
| | | | | **Invasive** | **Native Herbs** | **Native Shrubs** |
| | 6 | 40 | 2018 | 13 | 2 | 14 |
| | | | 2019 | 13 | 2 | 79 |
| | | | 2020 | 55 | 2 | 18 |
| | 7 | 49 | 2018 | 10 | 2 | 94 |
| | | | 2019 | 50 | 1 | 92 |
| | | | 2020 | 45 | 5 | 90 |

# Appendix 6 Data Table for RO2

*Table C: Site E Tree Health Data*

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| 1 | 15 | 2018 | Douglas Fir (Pseudotsuga menziesii) | Coniferous | Yes | RCD (cm) | 1.1 | Healthy |
| | | | Douglas Fir (Pseudotsuga menziesii) | Coniferous | Yes | RCD (cm) | 1.1 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.2 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.1 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 31.8 | Healthy |
| | | 2019 | Douglas Fir (Pseudotsuga menziesii) | Coniferous | Yes | RCD (cm) | 2.1 | Healthy |
| | | | Douglas Fir (Pseudotsuga menziesii) | Coniferous | Yes | RCD (cm) | 1.8 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.2 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.6 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 94 | Healthy |
| 2 | 16 | 2018 | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 31.9 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 36.5 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 40.8 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 39.8 | Unhealthy |
| | | 2019 | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 32 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 40 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 39.4 | Healthy |
| 3 | 17 | 2018 | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 0.5 | Healthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| | | | Pacific / Western Yew (Taxus brevifolia) | Coniferous | Yes | RCD (cm) | 0.7 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.7 | Healthy |
| | | | Pacific Crab Apple (Malus fusca) | Deciduous | Yes | RCD (cm) | 1.1 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 25.3 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 31.7 | Healthy |
| | | | Vine Maple (Acer circinatum) | Deciduous | Yes | RCD (cm) | 1.2 | Healthy |
| | | | Vine Maple (Acer circinatum) | Deciduous | Yes | RCD (cm) | 1 | Unhealthy |
| | | 2019 | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | No | RCD (cm) | 0.4 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 31.3 | Healthy |
| | | | Vine Maple (Acer circinatum) | Deciduous | Yes | RCD (cm) | 1.6 | Healthy |
| | | | Vine Maple (Acer circinatum) | Deciduous | Yes | RCD (cm) | 1.3 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.2 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.6 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1.2 | Healthy |
| 4 | 18 | 2018 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 19.5 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 25 | Unhealthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| 5 | 19 | 2018 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 2 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 2.2 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 7.2 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 10 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 14.5 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 3.6 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 31.3 | Dead |
| | | 2019 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 14.9 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 1.3 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 7.3 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 9.9 | Healthy |
| | | | Pacific Crab Apple (Malus fusca) | Deciduous | No | RCD (cm) | 0.8 | Healthy |
| | | | Pacific Crab Apple (Malus fusca) | Deciduous | No | RCD (cm) | 0.99 | Healthy |
| | | 2020 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 14.9 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 7.3 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 10.1 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | No | DBH (cm) | 0.5 | Healthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | No | DBH (cm) | 0.8 | Healthy |
| | | | Western Hemlock (Tsuga heterophylla) | Coniferous | No | DBH (cm) | 1.4 | Healthy |
| | | | Western Hemlock (Tsuga heterophylla) | Coniferous | No | DBH (cm) | 1 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | No | DBH (cm) | 1.8 | Healthy |
| 6 | 20 | 2018 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 22.5 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 14.5 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.7 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.9 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.4 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | N/A | Unhealthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 31.8 | Unhealthy |
| | | 2019 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 23 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 14.8 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 0.8 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 20.2 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 33 | Healthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 2.1 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1.2 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| 7 | 21 | 2018 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 32.5 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 40.2 | Healthy |
| | | | Western Hemlock (Tsuga heterophylla) | Coniferous | Yes | RCD (cm) | 1.1 | Healthy |
| | | 2019 | Western Hemlock (Tsuga heterophylla) | Coniferous | Yes | DBH (cm) | 0.6 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 31.9 | Healthy |
| | | | Western Hemlock (Tsuga heterophylla) | Coniferous | Yes | DBH (cm) | 0.6 | Healthy |
| | | | Pacific Crab Apple (Malus fusca) | Deciduous | No | RCD (cm) | 0.4 | Healthy |
| 8 | 22 | 2018 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 8 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 13.2 | Healthy |
| | | 2019 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 10.3 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 13.9 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 10.1 | Healthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| 9 | 24 | 2018 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 1.5 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | Yes | RCD (cm) | 1.1 | Healthy |
| | | | Black Cottonwood (Populus balsamifera) | Deciduous | Yes | RCD (cm) | 0.7 | Healthy |
| | | | Pacific Dogwood (Cornus nuttallii) | Deciduous | Yes | RCD (cm) | 0.9 | Healthy |
| | | | Vine Maple (Acer circinatum) | Deciduous | Yes | RCD (cm) | 0.9 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 12 | Unhealthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.7 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| | | 2019 | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1.7 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1.7 | Healthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 1.1 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.5 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.7 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.9 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 1.8 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 1.8 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 11.6 | Healthy |
| | | 2020 | Sitka Spruce (Picea sitchensis) | Coniferous | Yes | DBH (cm) | 1.5 | Healthy |
| | | | Sitka Spruce (Picea sitchensis) | Coniferous | No | DBH (cm) | 11 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.9 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 2.1 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Western Red Cedar (Thuja plicata) | Coniferous | Yes | RCD (cm) | 0.7 | Healthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 0.4 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 1.5 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 9 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 2.2 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 1.9 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | RCD (cm) | 0.6 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | RCD (cm) | 1.2 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | DBH (cm) | 1.3 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Vine Maple (Acer circinatum) | Deciduous | Yes | RCD (cm) | 1.1 | Healthy |
| 10 | 25 | 2018 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 20.8 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 25.7 | Healthy |
| | | 2019 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 19.8 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 19.8 | Healthy |
| 11 | 26 | 2018 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | RCD (cm) | 0.5 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 31.5 | Healthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 34.5 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.2 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.3 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.1 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 0.6 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.1 | Unhealthy |
| | | 2019 | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.8 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 0.8 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 2 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1.1 | Healthy |
| | | | Grand Fir (Abies grandis) | Coniferous | Yes | RCD (cm) | 1 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | DBH (cm) | 1.4 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | DBH (cm) | 0.6 | Healthy |
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | DBH (cm) | 0.5 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | No | DBH (cm) | 31.2 | Healthy |
| | | | Red Alder (Alnus rubra) | Deciduous | Yes | DBH (cm) | 36.4 | Healthy |
| 12 | 27 | 2020 | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 22.4 | Healthy |
| | | | Big Leaf Maple (Acer macrophyllum) | Deciduous | No | DBH (cm) | 19.7 | Healthy |

| Plot Number | Cumulative Plot Number | Date | Tree Species | Tree Type | Was tree recently planted? | Size Measurement Method | Size Measurement (cm) | Tree Health |
|---|---|---|---|---|---|---|---|---|
| | | | Bitter Cherry (Prunus emarginata) | Deciduous | Yes | DBH (cm) | 2.2 | Healthy |

# Appendix 7: Site Profiles

## Sasamat & Imperial

### Physical Aspects

**Site Code:** A

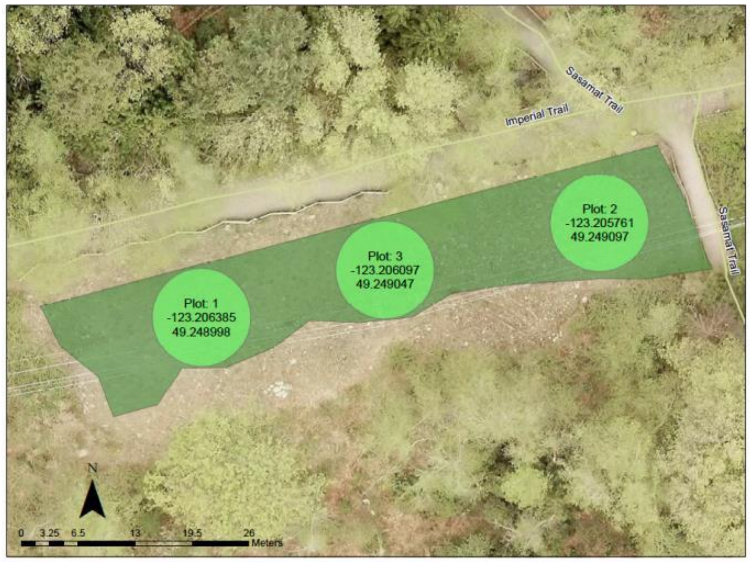
**BEC:** CWHxm1

**Site Series:** 05

**Slope Degree:** 1 – 5°

**Slope Aspect:** SW

**Number of Plots:** 3




### Restoration Information

**Initial Conditions:**

- Near 100% blackberry
- Smaller amounts of knotweed

**Date of Invasive Removal:** 2014

**Type of Restoration:**

- Blackberry grubbing.
- Japanese knotweed treatment annually (since 2014)

**Target Species:**

- Douglas-fir
- Western Hemlock
- Sword Fern

### Current State of Stand

**Age Class or date of establishment:** 2019

**Number of Healthy Trees:** 23

**Number of Unhealthy Trees:** 0

**Number of Dead Trees:** 0

**Forest Cover Type:**

- Both natural and new plantation

**Habitat Type:** Deciduous forest

**Dominant Tree species:**

- Red alder (87%)

# Camosun & 21st

## Physical Aspects

**Site Code:** B

**BEC:** CWHxm1

**Site Series:** 07

**Slope Degree:** 1 – 5°

**Slope Aspect:** South

**Number of Plots:** 4


## Restoration Information

**Initial Conditions:**

- Near 100% blackberry

**Date of Invasive Removal:** 2015

**Type of Restoration:**

- Blackberry grubbing
- Japanese knotweed treated with herbicide (since 2014)
- Planting of Douglas-Fir, Grand Fir, and Salmonberry

**Target Species:**

- Douglas-fir
- Western Hemlock
- Sword Fern

## Current State of Stand

**Age Class or date of establishment:** 2019

**Number of Healthy Trees:** 11

**Number of Unhealthy Trees:** 3

**Number of Dead Trees:** 0

**Forest Cover Type:**

- Mostly new plantation

**Habitat Type:** Mixed forest

**Dominant Tree species:**

- Vine Maple (29%)
- Pacific Crab Apple (14%)
- Western Red Cedar (14%)
- Shore Pine (14%)

# Crown & 22nd

## Physical Aspects

**Site Code:** C

**BEC:** CWHxm1

**Site Series:** 07

**Slope Degree:** 1 – 10°

**Slope Aspect:** SW

**Number of Plots:** 3


## Restoration Information

**Initial Conditions:**

- Near 100% blackberry
- Smaller amounts of knotweed

**Date of Invasive Removal:** 2016

**Type of Restoration:**

- Blackberry grubbing.
- Planting Douglas Fir, Western Red Cedar, Vine Maple

**Target Species:**

- Douglas-fir
- Western Hemlock
- Sword Fern

## Current State of Stand

**Age Class or date of establishment:** 2019

**Number of Healthy Trees:** 36

**Number of Unhealthy Trees:** 6

**Number of Dead Trees:** 0

**Forest Cover Type:**

- Mostly new plantation

**Habitat Type:** Mixed forest

**Dominant Tree species:**

- Big Leaf Maple (24%)
- Pacific Crab Apple (17%)
- Vine Maple (12%)

# SW Marine Drive

## Physical Aspects

**Site Code:** D

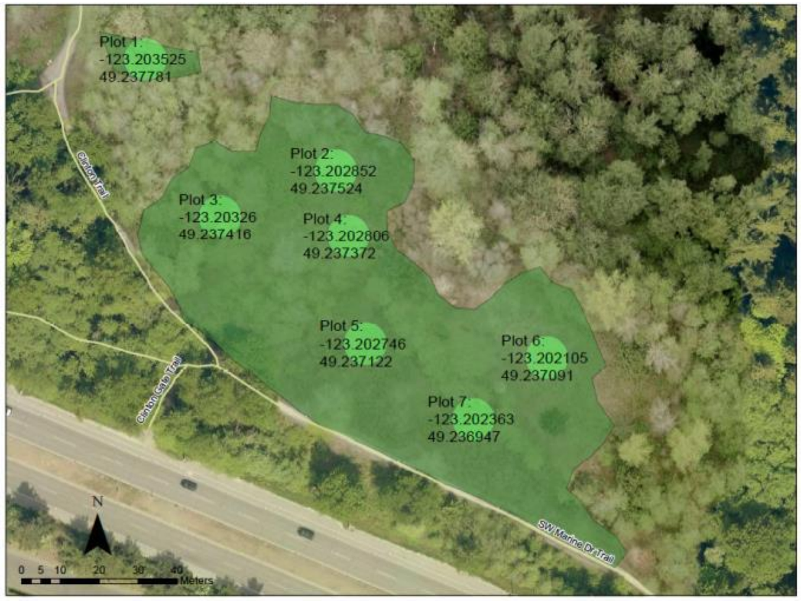
**BEC:** CWHxm1

**Site Series:** 01

**Slope Degree:** 1 – 10°

**Slope Aspect:** S, SW, NE, NW

**Number of Plots:** 7




## Restoration Information

**Initial Conditions:**

- Near 70% scotch broom and 30% blackberry
- Smaller amounts of red elderberry, bitter berry, red alder, mostly retained

**Date of Invasive Removal:** 2016

**Type of Restoration:**

- Blackberry and scotch broom grubbing.
- Hand pulling of invasive species.
- Planting Salmonberry, Red Elderberry, Vine Maple, Western Red Cedar

**Target Species:**

- Douglas-fir
- Western Hemlock
- Sword Fern

## Current State of Stand

**Age Class or date of establishment:** 2019

**Number of Healthy Trees:** 97

**Number of Unhealthy Trees:** 7

**Number of Dead Trees:** 8

**Forest Cover Type:**

- Both natural and new plantation

**Habitat Type:** Mixed forest

**Dominant Tree species:**

- Red Alder (18%)
- Douglas Fir (14%)
- Grand Fir (14%)
- Big Leaf Maple (13%)

# Chancellor

## Physical Aspects

**Site Code:** E

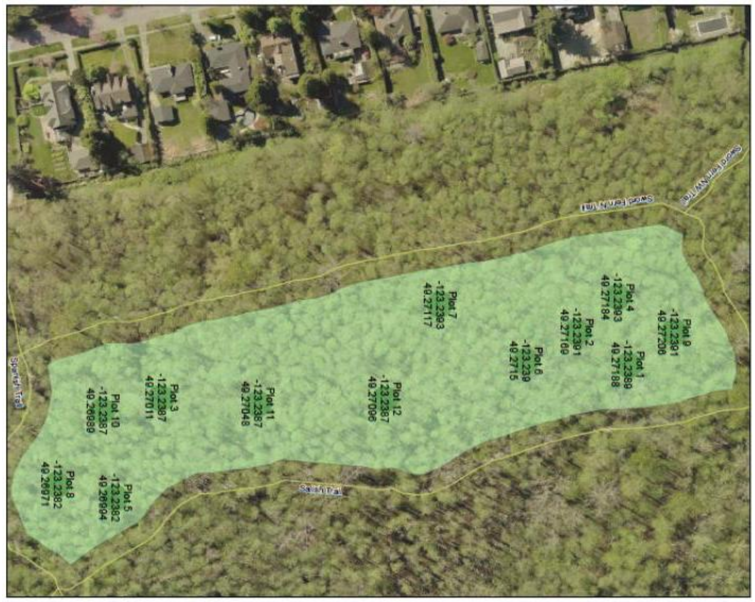
**BEC:** CWHxm1

**Site Series:** 07

**Slope Degree:** 1 – 10°

**Slope Aspect:** N, E, NE, NW, SW

**Number of Plots:** 12



## Restoration Information

**Initial Conditions:**

- Mature red alder
- Sparse understory of native shrubs
- English holly and laurel

**Date of Invasive Removal:** 2017

**Type of Restoration:**

- Removing holly plants.
- Cutting holly trees and painting or rejecting with herbicide.
- Planting Western Redcedar, Western Hemlock, Vine Maple

**Target Species:**

- Douglas-fir
- Western Hemlock
- Sword Fern

## Current State of Stand

**Age Class or date of establishment:** 2019

**Number of Healthy Trees:** 63

**Number of Unhealthy Trees:** 0

**Number of Dead Trees:** 9

**Forest Cover Type:**

- Both natural and new plantation

**Habitat Type:** Mixed forest

**Dominant Tree species:**

- Big Leaf Maple (28%)
- Grand Fir (22%)
- Western Red Cedar (19%)
- Douglas Fir (17%)