Everett Crowley Park

An assessment of current and future restoration efforts

Greenest City Scholar
Vancouver Park Board

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This GCS project was conducted under the mentorship of City staff. The opinions and recommendations in this report, and any errors, are those of the author, and do not necessarily reflect the views of the City of Vancouver or The University of British Columbia.

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Executive Summary

This project is part of the City of Vancouver's Greenest City Scholar program in partnership with the University of British Columbia. This project aims to support the Vancouver Park Board's (VPB) goals for urban forest restoration throughout city parks and the Greenest City 2020 Action Plan to plant 150 000 trees. Everett Crowley Park (ECP) was the focus of the data collection and analysis.

The primary goal was to establish a base level knowledge about the history of anthropogenic disturbance within the park area, assess the current conditions of restoration work completed and establish general guidelines for continuing and improving restoration efforts. Due to the similar ecology and threats (e.g. invasive plants) to VPB parks and forests, the conclusions and plans made for ECP can be inferred, to some degree, to other VPB parks.

This report includes three sections:

1. Historical context of Everett Crowley Park: A brief summary of the parks history, from the early 1800's to current day, described in a timeline with accompanying photos. Reference documents are listed in the works cited section (p. 60).
2. An assessment of the condition of restoration work and other areas within the park. This is mostly qualitative and includes: i) descriptions of the overall health and composition of both native and invasive shrub and tree species; ii) the leader length of all Douglas-fir in restored sites, as well as their health and any invasive plants in contact with them; iii) soil pits in both restored and natural areas (technical analysis results included) of the park; and iv) LiDAR based terrain attribute maps of the park
3. Future directions for restoration efforts; including: i) a generalized park-scale description of composition, health, invasive plants and soils; ii) operational recommendations; and iii) monitoring recommendations.

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Introduction

Everett Crowley Park (ECP) is approximately 40 hectares in size and is located within the dry maritime subzone of the Coastal Western Hemlock biogeoclimatic zone. It is located in southeast Vancouver, bounded primarily by SW Marine Drive to the south, Kerr St to the west and Boundary Road to the east. Fraserview Golf Course is adjacent to the park on the west.

The park is unique due to its history of heavy industrial land-use and alterations. Heavy anthropogenic use within the last century has resulted in several major alterations to its topography. It once was a sloping forest with a deep ravine and creek passing through it. Currently the land is positioned on an escarpment and the ravine only remains south of Marine Way.

Everett Crowley Park and its location within the City of Vancouver, BC.

Throughout the last few decades, there have been various efforts by many park users, organized groups and the VPB to restore the park into a healthy mixed forest, more representative of what it would occur naturally. Understanding the parks history is an important part of restoration, as is assessing the success of recent efforts to manage invasive plants and plant native seedlings. It is also important to evaluate where next efforts should focus and the areas that need immediate attention.

The objective of this paper is to summarize and analyse the forest data collected and observations made in ECP in the summer of 2017. Insights and conclusions made can be used to assess future success and inform restoration and monitoring. It can also be applied to other restoration work within the city.

1. Historical Context

The park is within the territories of the Musquem, Squamish and Tsleil-Waututh nations ancestors of the Tsukhulehmulth people. They have occupied the lower Fraser River for at least 8000 years. The area was a mature forest of western hemlock and western red cedar with an understory containing diverse shrubs, ferns and mosses. Pioneer species such as red alder and black cottonwood would have grown in small-scale gaps created through natural disturbance.

The ravine that was originally within the park's boundaries (named Kinross Creek Ravine by settlers), had a salmon bearing stream, which flowed into the Fraser River. The area provided habitat for many insects, amphibians and reptiles as well as a variety of birds and mammals, including larger species like bears, elk and mule deer.

An abbreviated timeline is provided in the following section. This timeline is of the area's history post settlement, when anthropogenic use caused the greatest disturbance to the area. Additionally, a series of aerial photographs taken from 1938 to current day are provided in Appendix 2.

1938 aerial image of the Everett Crowley Park area; 1: 5 000. Historical ravine boundaries drawn and data compiled by Synapse: Integrated Environmental Data Management System. Synergy Aspen Environmental 2014.

Historical Timeline-post settlement

This timeline does not include the long history of First Nations use of the park area and surrounding landscape

1870's	Settlers began to use the area for farming, growing fruit trees and logging.
1911	An interurban railway was completed, increasing suburban development in the vicinity.
1920's	Forest harvesting on a larger scale began in the area The Old Dominion Mill bought by H.R MacMillan and the Canadian White Pine Mill operated beside each other on the Fraser River near the bottom of Boundary Road. These mills employed thousands of workers.
1930's	Garbage was commonly dumped into the Kinross Creek Ravine A sand and gravel quarry operated in the northeast area of the current park boundaries. The area excavated was approximately 2 ha and 15 – 18 m deep, which was lower than the water table.
1944	A third wood mill was built on the Fraser River Kerr Road landfill officially opened
1946	Kinross stream was culverted to divert it around the eastern side of the ravine and away from the garbage that was filling in the western side Residential garbage was the dominate refuse and a secondary fill site was used for demolition material
Late 1940's	The White Mill introduced swing shifts, having employees work through the night to meet demand.
1952	The Old Dominion Mill closed.

Interurban rail

Early forest harvesting in Vancouver

Wood at a mill on the Fraser River

1950's	Oils and septic tank pumpings became prohibited
1967-1973	The land within the decommissioned landfill area, reportedly settled approximately 1 metre
1956	All of the City of Vancouver's waste was being deposited here and the landfill area occupied an area almost as large the current park boundaries. Total waste volume was estimated at 3.8 million-m^3. Yearly deposits more than doubled between 1946 and 1956.
1960's	Roofing companies were permitted to dispose unused barrels of tar into the landfill
After 1966	Heavy clay and demolition debris began to be disposed of in the landfill
1967	The landfill was officially closed Deposited waste was reportedly as high as 49 m in central areas over the original creek location, with an average of less than 12 m across the total landfill area.
Late 1960's	The landfill remained open for 2 to 3 years after its closure for the disposal of construction and 'clean' fill from city sewer excavation projects The landfill was decommissioned to the standards of the day and 1.5 m of fill was used to cap the entire area
Early 1970's	The area (unattended and growing up with vegetation), became a popular location for motocross riders. Reportedly, many of the current trails are a remnant from this time
1970's	The quarry was abandoned and groundwater and surface drainage filled the pit. This became what is now Avalon Pond. The drainage from the pond, which was a previous landfill drainage ditch, is the new Kinross Creek.

Workers during Kerr Street landfill strike in 1966

Cleaning landfill after the strike

Kerr landfill; 1963

Early 1980's	After many proposals for what should be done with the land, including one to create a pioneer farm, the BC Hang Gliding Association proposed to the Park Board that a temporary training facility be created
1983	Construction for hang gliding site began. Approximately 2000 truckloads of 'clean' fill from commercial excavations were dumped, and a large hill now known as Mount Everett, was created.
1984	The Kinross creek culvert was routed to the Metro Vancouver sanitary sewer due to rising concerns about the quality and potential toxicity of the water. The Vancouver Natural History Society (VNHS) made recommendations based on a survey they conducted, that ECP remain a low development natural park.
1965 - 1986	Several efforts to expand the Fraserview Golf Course were made and all defeated.
1985	The hang gliding facility was opened but closed shortly after when the hill was found to be too low and close to trees to be a good location for the sport The Kerr Road Park Committee was founded; this later became Everett Crowley Park Committee, (sub-committee of the Champlain Heights Community Association)
1987	The area was designated as Everett Crowley Park. Construction of Kerr St parking lot took place. Five kilometres of trails, including the Vancouver Park Board trail were built. Three viewpoints in the park were also established. An observation dock and three weirs to modify water flow at Avalon pond were also created.

The area recovering after the landfill was closed

Avalon Pond

Bench at lookout

1989 - 1991	The parking lot was enlarged, paved and lighting installed. Avalon Pond was enlarged. Some of the trails and viewpoints were improved. Native trees and wildflowers were planted.
1992 - 1995	Avalon Pond Trail was built
1993	A partnership with the Evergreen Foundation worked on a project to plant native shrubs and trees
1994 - 1995	Three major planting initiatives that took place. The focus was on reintroducing conifer species and an understory to the alder forest west of Avalon pond. These initiatives saw approximately 700 trees planted within the park and along Marine Drive and Marine Way
1995	The Evergreen Foundation recommended that enhancement efforts to enhance the park should be postponed until further information about the ecology of the park is established and a long-term plan put in place. As a result, the Community-Developed Ecological Stewardship Process (CDESP) for ECP was designed and initiated by the Evergreen Foundation
1996 - 1997	The creation of Manfred's Meadow took place by ECPC and the Park Board. Surveys were completed in the park to establish a baseline set of data from which recovery and changes to conditions could most accurately be assessed. The primary studies performed, which were also recommended for continual monitoring as part of park restoration, are: (1) vegetation (2) reptiles and amphibians (3) birds (4) birds (5) soil (6) steam vents and gas emissions (7) water

Planting on Mt. Everett

Restoration plot

ECP 1997

1996 - 1997	The creation of Manfred's Meadow took place by ECPC and the Park Board. Surveys were completed in the park to establish a baseline set of data from which recovery and changes to conditions could most accurately be assessed. The primary studies performed, which were also recommended for continual monitoring as part of park restoration, are: (1) vegetation (2) reptiles and amphibians (3) birds (4) birds (5) soil (6) steam vents and gas emissions (7) water
1998 - 1999	The Nature Nut Bench was installed at Manfred's Meadow, Avalon Pond signage was erected, a sidewalk was constructed along Kerr St, washrooms were built at the golf course, (crosswalk also placed on Kerr St. between Fraserview and Park for washroom access). Entech Environmental Consultants conducted an environmental assessment of Avalon Pond. ECPC produced the handbook, "Take a Little Walk in Everett Crowley Park".
2000 – 2001	ECPC produced a trail map brochure. The Everett Crowley Park Eco-Ed program was established within the park There was lobbying to prevent the proposed Fraserview Golf Course expansion into ECP from taking place.
2002 - 2004	Kiosks were constructed at Kerr St and Matheson Cr. Entrances. Annual musical concert, "Sounds of Summer", took place at Avalon Pond

Clearing blackberry

Restoration plot

Freshly cleared morning glory

2002 - 2004	There were also ongoing Earth Day celebrations and native species planting Planting of the Donna Tilley Grove took place
2004	LEES + Associates, ECPC, Evergreen and the Park Board collaborated to create The Everett Crowley DRAFT management plan. This involved an open house for public consultation and park issues and future restoration and park use were addressed
2005	LEES + Associates Consulting Ltd. prepared the park management plan (based on outcomes form 2004 efforts) for the Vancouver Park Board; it also included a preliminary assessment by Gartner Lee Limited of various landfill related issues.
2007	Braun Geotechnical Ltd. conducted a geotechnical assessment of Avalon Pond. This included measurements of surface water flows, laboratory tests of the water and a report of recommendations for rehabilitation of the pond.
2009	Environmental Youth Alliance installs bee lodge near Manfred Meadows
2012 - 2013	A water-quality analysis was collected by the City of Vancouver from the Kinross Ravine drain
2014	An environmental review of the park was conducted by SynergyAspen Environmental
2015	A landfill gas survey and a surface water and seepage water sampling were conducted by SynergyAspen to establish the current level of health and safety risk in the park as a result of its history as a landfill
2015 – 2017	Mulching, brushing, knotweed treatment and flail mowing were conducted throughout the park to prepare various sites for major planting initiatives, including Earth Day plantings.

Bee lodge near Mafred Meadows

Newly planted seeding in restoration plot

Historical context continued:

The heavy disturbance and alterations to the land have had significant effects on the establishment of invasive and other non native plants in the park and on the health of the soils.

A spring vegetation survey in 1997 reported 177 species of plants (The Evergreen Foundation 1997). Vegetation was reported to be predominantly deciduous woodlands with large patches of Himalayan blackberry and Japanese knotweed; the 1997 report indicates that Himalayan blackberry was covering 33% of the park's 40 hectares. Additionally, the presence of landfill gas and/or leachate in the root zone can affect vegetation growth with these effects diminishing over time (The Evergreen Foundation 1997).

The 1997 report also stated that 121 bird species had been identified within park boundaries. The park is adjacent to to Fraserview Golf Course, another large green space in the city, to the community of Champlain Heights, to Burnaby Central Park and Fraser River to the south. These connections are broken by busy city streets, but are likely especially important to migrating birds.

Soil depth in the park is inconsistent and ranges from minimal to several meters, with thin areas a consequence of uneven distribution when the 1.5 m cap was placed during decommission of the landfill (The Evergreen Foundation 1997). It is also possible that material has moved as a result of steeper terrain and vegetation taking longer to become established. Soil quality is considered poor and inconsistent, with low nitrogen levels, organic content and moisture levels. Time will be essential for the recovery of the soils.

Earth Day plantings and activities in Everett Crowley Park

2. Current Conditions

This section describes the nine sites (Fig 1) where restoration work has been done. These are sites where invasive plants have first been cleared, then mulch placed and finally native shrubs and trees planted. One objective of the project was to establish the current condition of each site, including the overall health of newly planted shrubs and trees, natural regeneration occurring and invasive plant establishment within each site. This information can be used in the planning of future restoration work.

A. At each site, the primary shrub and tree species and their general conditions were noted. A detailed report is provided in Appendix 1.
B. In each site the leader growth of the Douglas-fir trees was measured, the general health of Douglas-fir and any invasive plants in contact with the tree were noted.
C. Two soil pits were dug for each year restoration work was completed (2009, 2015, 2016). The goal with this was to get a sense of soil conditions and how the mulch soil was decomposing.

The information gathered about the current condition of each plot is not exhaustive and should not be treated as such. For each site the walk through to assess current conditions was not exact, nor was there an intent to note each species and its condition within the site. Generalized statements were made based on these observations. In some of the older sites, morning glory is completely covering over half of the native plants. In these cases, it is unlikely that all existing species have been noted; additionally, Douglas-fir may have been missed for measurement or even counted twice in certain circumstances.

Fig 1: Restoration plots within Everett Crowley Park overlaid on a 2015 orthorectified image.

Trails within Everett Crowley Park overlaid on a 2015 orthorectified image.

A. General Conditions of Restoration Plots

A detailed summary for each restoration site is provided in Appendix 1, including a photo of each. Below is a brief overview of general site conditions. Site assessment took place over several visits to the park between July 20th and Aug 8th 2017. The spring this season was late but the summer had been very dry, with few days of rain.

Overall, plant health and sapling survival of planted trees and shrubs of average or above average health on all sites. The greatest problem observed was that on drier sites the maples seemed to be suffering (e.g., site 2016 b) as indicated by 5 maples (1 big leaf and 4 vine) appearing to have died over the dry summer observation period. Shrubs were also, overall, in good health and seemed to be surviving. Shrub species such as rose, thimbleberry, red osier dogwood, ocean spray and snowberry were not within every planted site but seem to be surviving where they have been planted. It is unclear how they will fare within the shade of their neighbours when the trees grow.

A healthy big leaf maple sapling (left), a dead big leaf maple (middle) and a dead vine maple (right)

Western hemlock, big leaf maple, red osier dogwood and vine maple saplings in site 2015 a

In all restoration sites there are invasive plants. The primary invasive plants in the park are Himalayan blackberry, Japanese knotweed, clematis, English ivy, common hops. In restoration sites, Himalayan blackberry and morning glory were the most abundant invasive plants. Knotweed is also a problem in some sites, although currently it is mostly on the periphery of sites. Black locust is non-native species but in general is not considered an invasive; however, new saplings on sites should be removed and not allowed to become established. There are also various cleaver species, which are likely native but they are a problem on many sites because they are weedy and climb up neighbouring plants. These should be monitored and cleared away from new plantings until seedlings are well established and tall enough to not be smothered.

As would be expected, on the older sites (e.g. 2009) have the most growth and invasive plant encroachment. Immediate work is required on these sites or many of the planted shrubs and trees will be lost. There is no evidence that the 2009 sites had mulch put down after the sites were cleared. This could be influencing the heavy growth of weeds and invasive plants on these sites.

Invasive plant encroachment in a 2009 restoration site

Most sites were flail mowed and had mulch laid for site preparation (specifics for site preparation timing and methods are in Appendix 1). There was no strong indication that the timing of mowing or planting had a large effect on the success of sapling growth or preventing invasive plant growth. These sites have less invasive plant encroachment, which is expected since they were restored more recently. Many sites, however, have large patches of invasive plants along their perimeters; these are a threat to the sites and, ideally, should be cleared, providing a larger buffer between treated and untreated areas. At the very least, they should be monitored. All sites require maintenance and, if done soon, the problems will not become as severe as in the 2009 plots, making it less cumbersome to prevent invasive plant establishment.

Site 2016a with morning glory covering the ground and climbing several young trees. Blackberry on the periphery of the site is thick and staring to spread into the site.

Site 2016c with blackberry stalks across the ground. Matting and climbing is minimal and maintenance of the site would be quick and uncomplicated

B. Health and growth of planted Douglas-fir

Douglas-fir leader lengths (Fig 2) show the tree height growth for that year. Leader heights were measured for the majority or all Douglas-fir within each plot. Transects were visualized and walked within each site. The general health and any contact with invasive plants were also noted for each tree.

The aim was to quickly have each Douglas-fir in the site measured. It is possible that individuals may have been missed, especially in overgrown sites, and in some cases may have been counted twice. The goal was to provide an estimation of leader growth and the health of Douglas-fir in restoration sites. The survey was completed between July 28th and Aug 8th, which is not the end of the growing season; and took approximately 20 hours to complete by one person.

- The leader on a Douglas-fir is very distinguishable, which makes it easy to measure. The height of each leader was measured from the last lateral branch to the terminal bud. If there are more than one leader, the longer was measured. Douglas-fir that were too tall to be measured were not included in the survey.

- Any invasive plant in contact with the tree being measured were also noted.

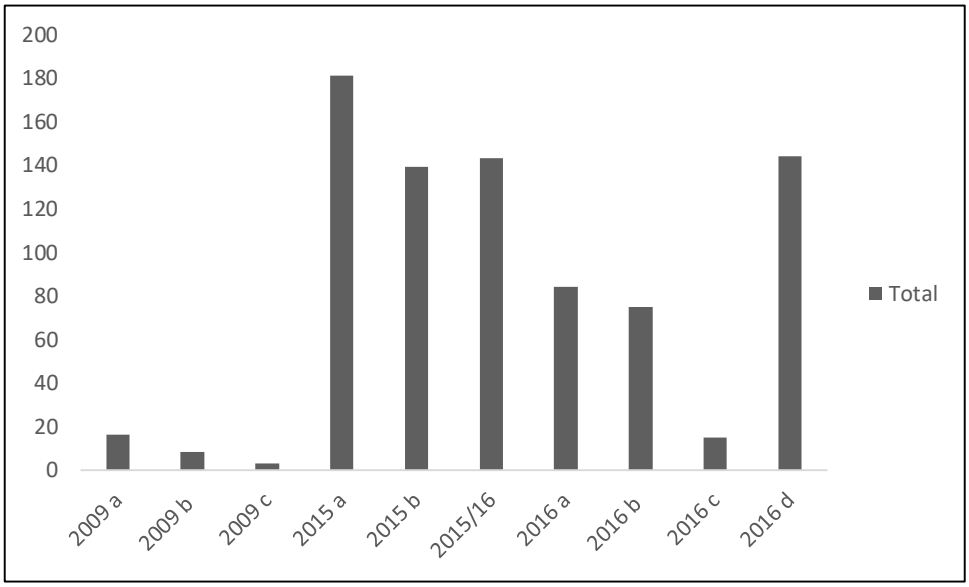
- The general health of the trees were recorded as either:

Fig 2: A leader on a young Douglas fir

Dead
Poor=many brown and/or dropped needles, or all yellow with dropping needles.
Moderate= some yellowing or brown needles but many green.
Good=the tree is reasonably full and mostly green.

Douglas-fir count

In total 808 Douglas-fir saplings were measured within the restoration sites. There were few Douglas-fir planted on sites in 2009 restoration efforts; however, far more were planted in 2015 and 2016. The 2009 sites were very overgrown and it is possible that individuals were missed or had been smothered and have died. Some of the newer sites were bigger and can hold more individuals overall. (Generally, the newer sites (i.e.2015 and 2016) had many other native species besides Douglas fir.)

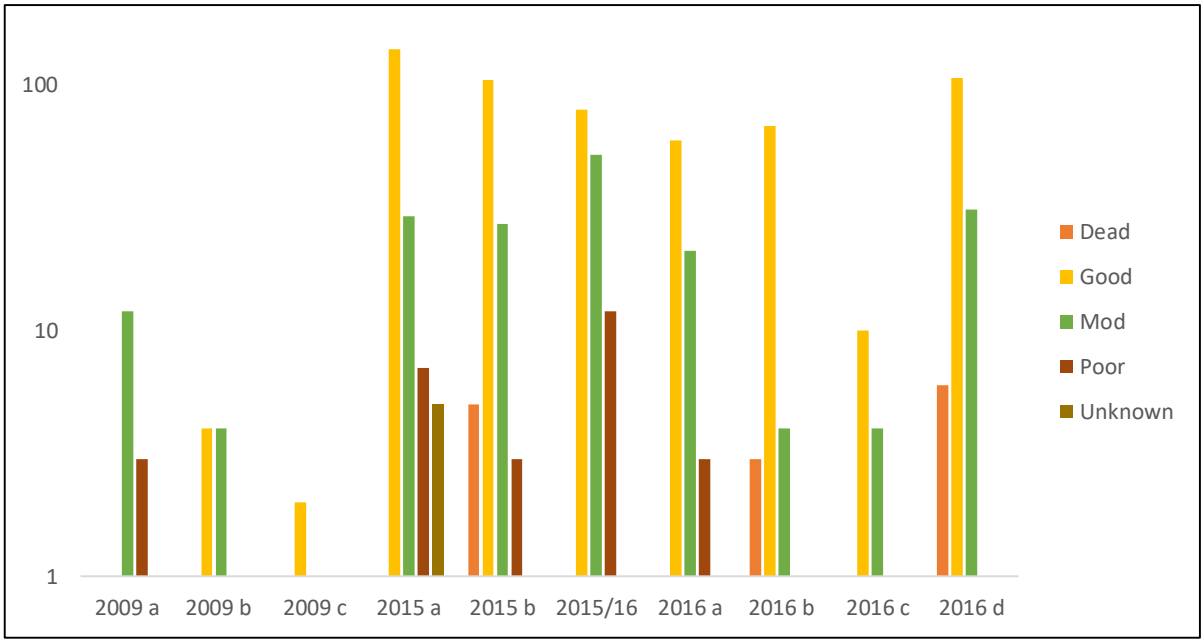


Douglas-fir count per restoration site

Douglas-fir saplings

Douglas-fir health

Overall, Douglas-fir health was good and survival was high. It is normal for about 30-40% of planted saplings not to survive their first year (Duncan & Richter 2012). There is no way to know the exact number of individuals planted in ECP that have survived or died because those that die may have been removed over the years and deaths are not recorded. Based on the Douglas-fir analysis observed in restoration plots, only 2% of the total were identified as dead and 4% were in poor condition. This is an excellent outcome. Additionally, 23% were considered in moderate condition and 71% were considered in good condition. Even if only those in good condition survive, it is within track of normal survivability (Duncan & Richter 2012). Trees in poor condition are unlikely to survive until the next growing season.

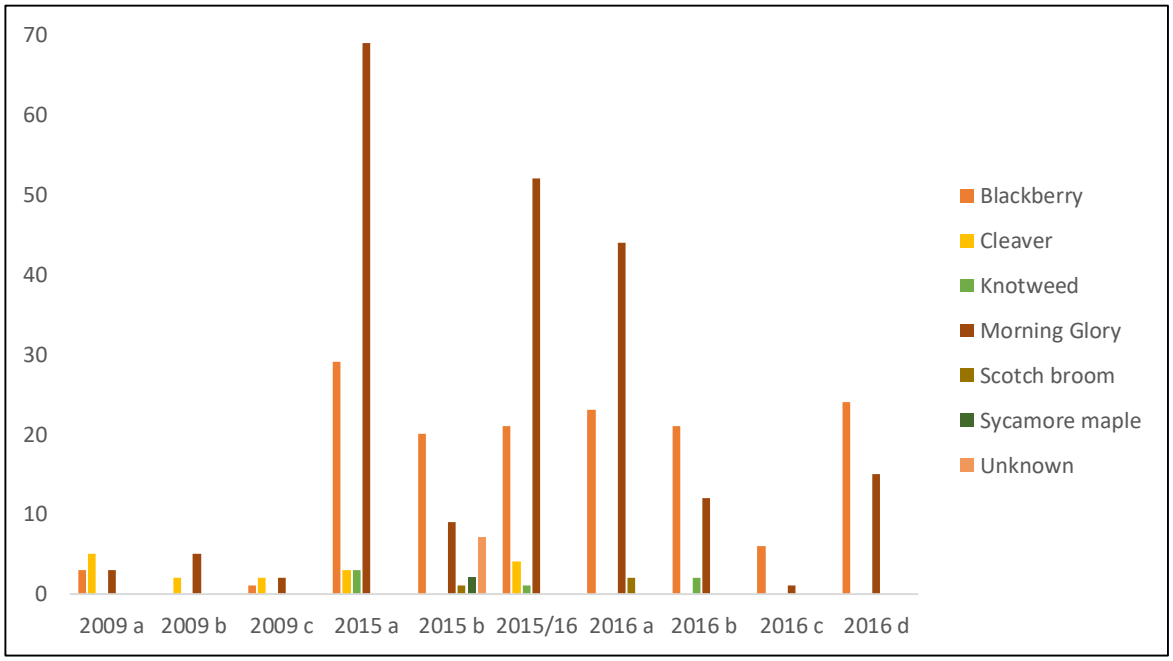


Douglas-fir health per restoration site

Douglas-fir health: **good** (left), **moderate** (middle) and **poor** (right)

Invasive plants contacting Douglas-fir

In the sites planted in 2009, invasive plants have established throughout the entire area and are smothering a large number of native plants. In the 2015 and 2016 sites, invasive plants are beginning to creep in from the periphery. Almost 50% of the Douglas-fir had an invasive plant in contact with it. Himalayan blackberry and morning glory are the greatest problem by a large margin, 38% of the invasive plants contacting the Douglas-fir were blackberry and 54% were morning glory. The proliferation of invasive plants is the worst in the 2009 sites; these plants will regain control and likely kill the majority of the planted individuals within the next year or two without intervention.

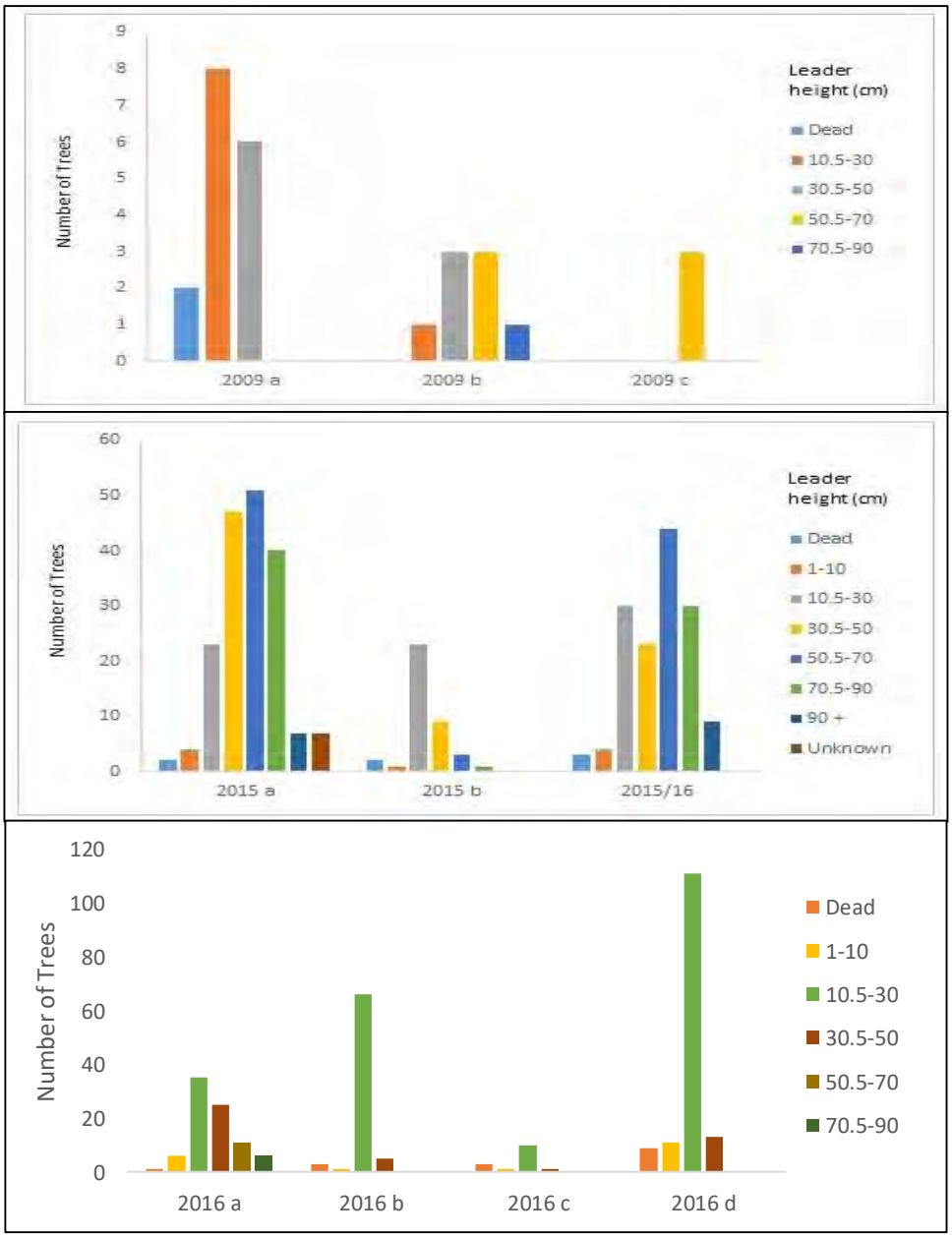


Number of Douglas-fir trees with an invasive plant in contact with it per restoration site

Morning glory and blackberry overtaking Douglas-fir and ocean spray

Douglas-fir growth

Douglas-fir height growth is slow for the first five years, numbers vary depending on site conditions (e.g., soil, rainfall, temperature). Annual height growth can be approximately 6 – 9 cm in the first year (U of C, n.d.) increasing to 10 to 30 cm per year by age 13 (Nabel et al. 2013), and by age 30 can average 61 cm growth annually (Hermann and Lavender, n.d.). Most Douglas-fir measured on restoration sites showed excellent growth; 44% of individuals had leader growth between 10.5 and 30 cm and another 33% experiencing between 30.5 and 70 cm growth. Over 50% of the growth in the 2009 and the 2016 sites was between 10.5 and 30 cm. Growth was spread more evenly in the 2015 (including 2015/16) sites with the categories 10.5-30 cm, 30.5-50 cm, 50.5-70 cm and 70.5-90 cm having 21%, 22%, 27%, and 20% of the individuals respectively.



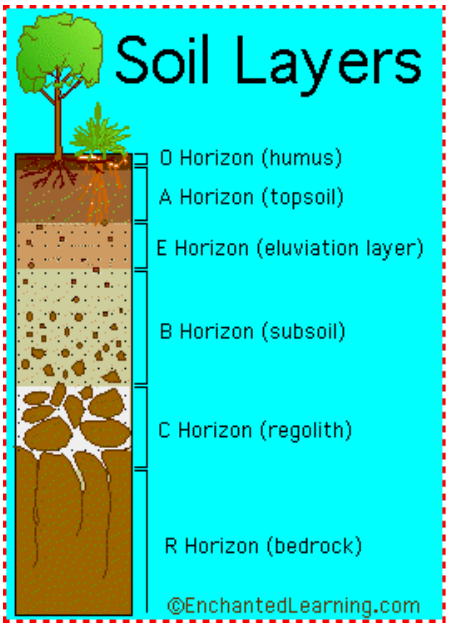
Leader height of Douglas-fir per restoration site

C. Soil Pits in Plots

Six soil pits were dug in restoration sites 2009 a, 2009 b, 2015 a, 2015 b, 2016 a and 2016 d (Fig 3).

Fig 3: Locations of soil pits within restoration plots

Most soil pits were dug until the top of the E horizon. In the 2015 and 2016 sites, the mulch layer had not yet decomposed and needed to be cleared to reach the soil horizons. In a few sites mulch was so deep that digging to soil layers was not feasible. The depth of the mulch somewhat obscures the actual O horizon. However, areas where the mulch is decomposing provides insight into how quickly the mulch is becoming soil. For simplicity, the mulch and O-horizon depth has been combined. The results and accompanying photos are described below.



O Horizon - The top, organic layer of soil, made up mostly of leaf litter and humus (decomposed organic matter).

A Horizon - The layer called topsoil; it is found below the O horizon and above the E horizon. Seeds germinate and plant roots grow in this dark-coloured layer. It is made up of humus (decomposed organic matter) mixed with mineral particles.

E Horizon - This eluviation (leaching) layer is light in colour; this layer is beneath the A Horizon and above the B Horizon. It is made up mostly of sand and silt, having lost most of its minerals and clay as water drips through the soil (in the process of eluviation)

Mulch decomposition into soil is a process dependant on moisture, temperature and if the wood chips were treated or not (Duncan & Richter 2012). In general, it takes 2-4 years, which the mulch in the pits dug appear to decomposing at. Mulch was no longer evident in the 2009 sites. The organic layer was not very deep within any of the plots, approximately 5 cm, but this should be expected given the park's history. The benefits of mulching are discussed in more detail in the next section.

Soil horizon depths within restoration plots

Plot	Mulched	Mulch and/or O-horizon depth (cm)	A-horizon depth (cm)	E-horizon depth (cm)	Comments
2009 a	N	5	10	NA	• Organic layer very dry • Hardpan at 15 cm
2009 b	N	2	4	37	
2015 a	Y	26	7	NA	• E-horizon smelled of sulphur
2015 b	Y	50	5 +	NA	
2016 a	Y	28	14	NA	• Hardpan at 35 cm
2016 d	Y	41	15	NA	

Soil pits for restoration sites 2009 a (left) and 2009 b (right)

Soil pits for restoration sites 2015 a (left) and 2015 b (right)

Soil pits for restoration sites 2016 a (left) and 2016 d(right)

D. Soil Pits in unrestored areas of park

Seven pits were dug throughout the park to collect soil samples for analysis on July 11, 2017. Locations were chosen in accessible areas and an attempt to collect a range of site types and areas representative of the park. Holes were dug 20 cm deep and 250 ml of soil was collected. Analysis was completed by Pacific Soil Analysis Inc.

Locations of soil pits within unrestored areas of the park

Soil analysis results:

Site	pH	Est. E.C.	% total O.M	% total N	C/N	P	K	Ca	Mg	Na	%>2mm (gravel)	%<2 mm
1	A	A	12.4 A	0.27 M	26.6A	32 M	130 A	M	M	A	27	73
2	A	A	9.2 A	0.23 M	23.2A	39 M	190 A	A	L	A	22	78
3	A	A	6.8 M	0.16 VL	24.6A	49 M	105 A	M	L	A	19	81
4	A	A	0.6 VL	0.03 VL	11.7A	8.7 VL	45 VL	L	L	A	NA	100
5	A	A	4.9 M	0.11 VL	25.8A	24 L	70 M	M	L	A	38	62
6	A	A	4.4 M	0.12 L	21.3A	51 M	53 L	VL	VL	A	50	50
7	A	A	8.0 M	0.21 L	22.1A	41 M	95 M	A	A	A	18	82

Soil analysis results for soil collected in unrestored areas of ECP. **A**=adequate; **M**=moderate; **L**=low; **VL**=very low. Qualities tested include: **E.C=**electric conductivity; **O.M**=organic matter; **N**=nitrogen; **C/N**=carbon/nitrogen; **P**=phosphorus; **K**=potassium; **Ca**=calcium; **Mg**=magnesium; **Na**=sodium.

Overall, all locations had adequate pH, electric conductivity (E.C.) and sodium (Na) levels. All locations had a pH in the range of 5.5 to 6.5, which is within range for tree planting. Of course specific species may vary. Ca is considered a secondary nutrient and its levels varied from very low to adequate for the sites.

Nitrogen (N), phosphorus (P) and potassium (K) are considered macronutrients and essential for plant growth. Adequate levels are 0.35-0.60% nitrogen, 60-200 ppm avail P. and 100-200 ppm K. All sites were below recommended levels for N, P and K (except sites 1-3 had adequate K). Magnesium is important for photosynthesis; it can easily be leached in gravelly or sandy soils. Mg was considered low or very low in all but sites 1 and 7.

Sites with more than 25% gravel will likely drain too quickly and will experience water stress if not irrigated. Additionally, organic matter should be in the 5-12% range, especially for sites with high gravel content. Sites 5 and 6 (mid to south end of ECP; still above the south slopes) had the highest gravel content and both had moderate organic levels. Sites 1 and 2 (more in the northern end of ECP) had adequate organic levels and gravel content near the

recommended max). Site 4 which was the closest to the south slopes had a very low organic content (gravel content unavailable). The south slopes have the thinnest soils in the park which is likely a contributing factor. Another factor that contributes to the speed of decomposition is the C/N ratio (carbon:nitrogen). A good ratio for decomposition is between 25-40 : 1. All C/N ratios are adequate.

E. LiDAR based terrain metrics

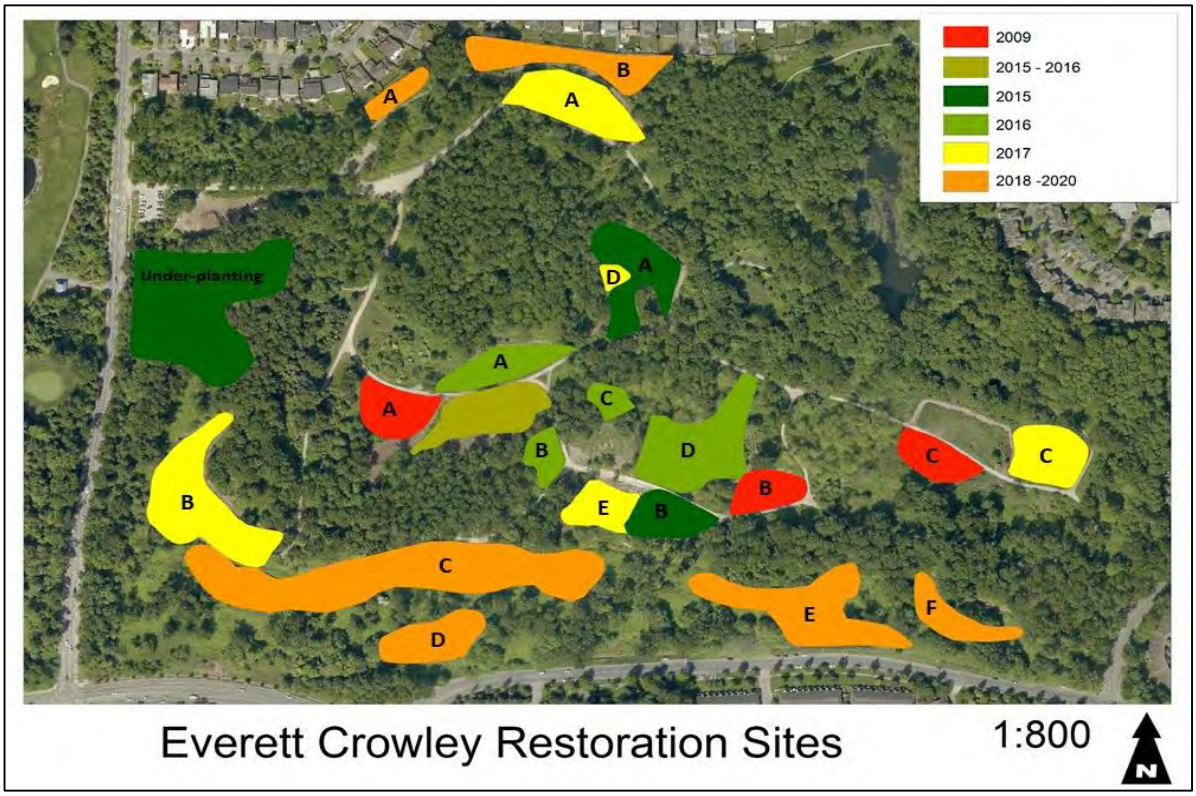
Light Detection and Ranging (LiDAR) data was collected with a resolution of 0.5 m for the City of Vancouver in 2013. From this data a Digital Elevation Model (DEM) was created. DEM's can be used to calculate various terrain based metrics that are indicators of site productivity. Condition, along with its potential vegetation composition and cover, are determined by attributes such as aspect, moisture, slope position and angle. The interaction of ecosystem attributes however, are connected and complex and sometimes attributes compensate for each other. For example, a south slope is typically warm, but depressions within it may experience cold air ponding. Depressions hold water longer but if they have sandy soils they will likely drain it quickly. Microtopography can allow islands of vegetation to grow on exposed ridge crests where the soils are thin and nutrient poor. The outcome, regardless of the factors at play, is the composition and structure of a site's vegetation (Swanson et al. 1988).

Terrain information can help us understand why sites are in the condition that they are and it can be utilized for planning future sites, especially for determining species to plant. Topographic Radiation Aspect (TRASP), slope angle, Topographic Wetness Index (TWI), Topographic Position Index (TPI) are specific variables that demonstrate these important environmental factors. How each of these metrics is calculated and how they are interpreted are described on the following page. Each metric was calculated for Everett Crowley Park and the outcome is represented on a map and in a graph showing the value ranges for each site. Sites included are both current restored sites and those identified for future work.

Upper slopes and/or steep slopes shed water more quickly and thus, usually are drier; lower slopes are water receiving and flat areas typically hold water longer; subsequently both are often wetter on a landscape. Additionally, dissolved nutrients make their way downhill with water, and lower slopes are consequently generally more productive. Middle slopes typically shed and receive water equally (Green and Klinka 1994). Slope indicates the steepness of an area; steeper slopes may also have thinner, less developed soils. Site moisture and nutrients are influenced by soil properties and drainage pattern (Swanson et al. 1988; Green & Klinka 1994). TWI has been found to correlate strongly with several soil properties such as horizon depth (r=0.55), silt percentage (r=0.61), organic matter content (r=0.57), and phosphorus levels (r=0.53) (Moore et al. 1993). Slope and flow accumulation are used to calculate TWI. Therefore, TWI, like slope position, is an excellent indicator of where water will move quickly through an area (steep slope) or where it will settle (depression). Unlike slope position, TWI also indicates where flow paths congregate or where there are only a few.

Terrain metrics calculated for ECP

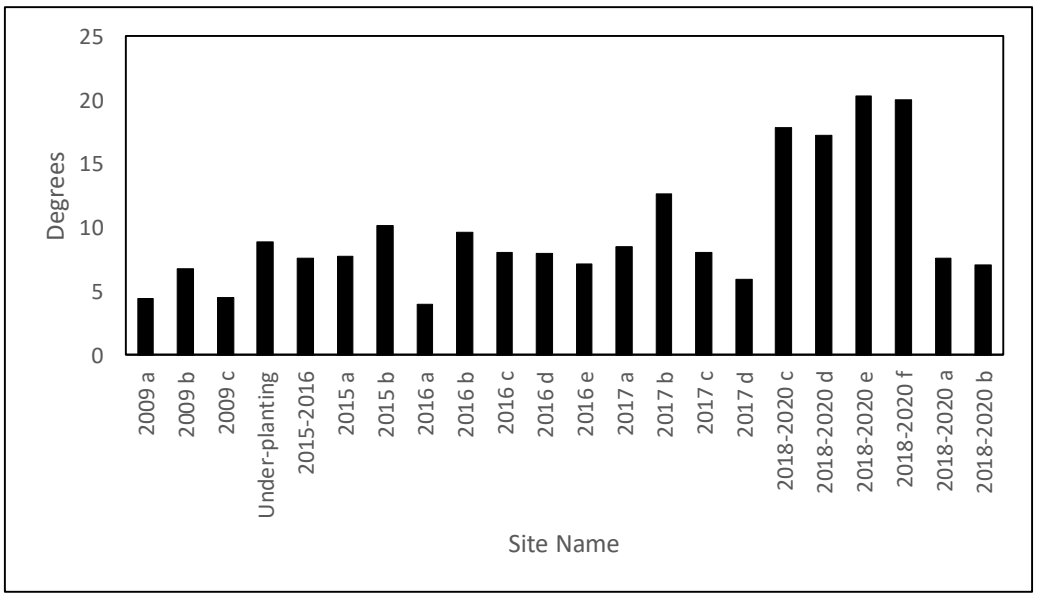
Variable	Derivation	Interpretation
Slope angle	The maximum rate of change between each cell and its neighbours.	Slopes in ECP range from level (0°) to steep (66°)
Topographic Position Index (TPI)	The difference between a cell elevation value and the mean elevation of its surrounding cells (Jenness 2006). A neighbourhood of 50 m was calculated.	Indicates slope position. Lower values are lower slope positions, higher numbers are higher slope positions and values near zero are flat
Topographic Wetness Index (TWI)	TWI = ln (flow accumulation)/tan(slope)) (Beven and Kirkby 1979)	Measure of wetness based on flow accumulation and slope. Higher values are increasingly wet and lower values are drier.
Topographic Radiation Aspect (TRASP)	TRASP = (1-cos (3.1416/180) (aspect-30)))/2, where aspect is in degrees (Roberts and Cooper 1989).	Measure of slope warmth based on aspect. Values closer to 0 are cooler (N, E, NE, NW) and values closer to 1 are warmer (S, W, SW, SE).



Sites of current restoration efforts (2009–2016) and locations of future restoration sites

Slope (degrees)

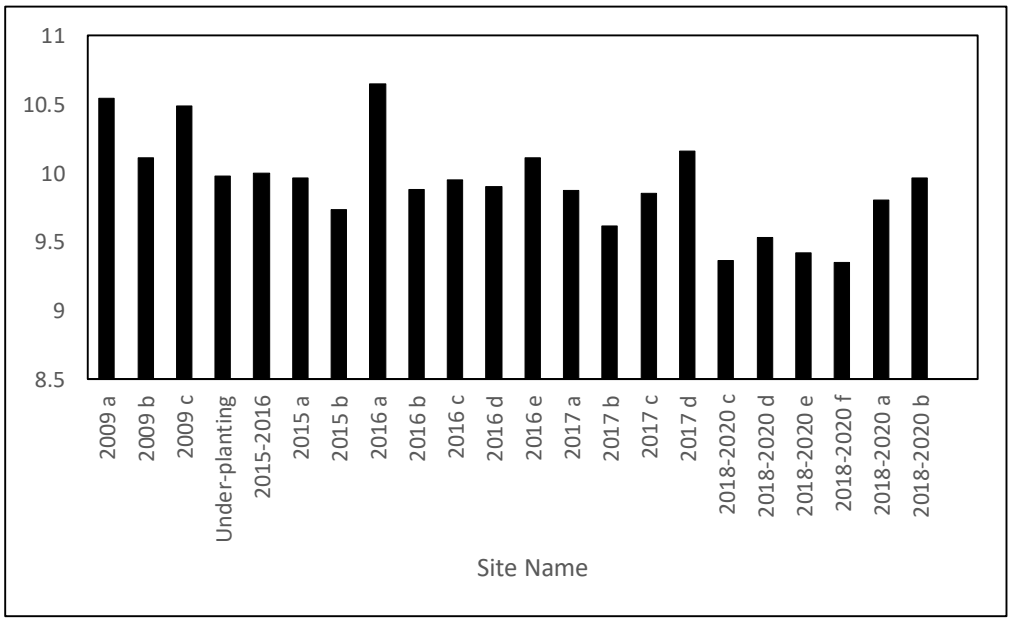
Slope map for ECP. Outline of current and proposed restoration sites shown. Refer to map on page 30 for associated names



Slope (degrees) for current and proposed restoration plots in ECP

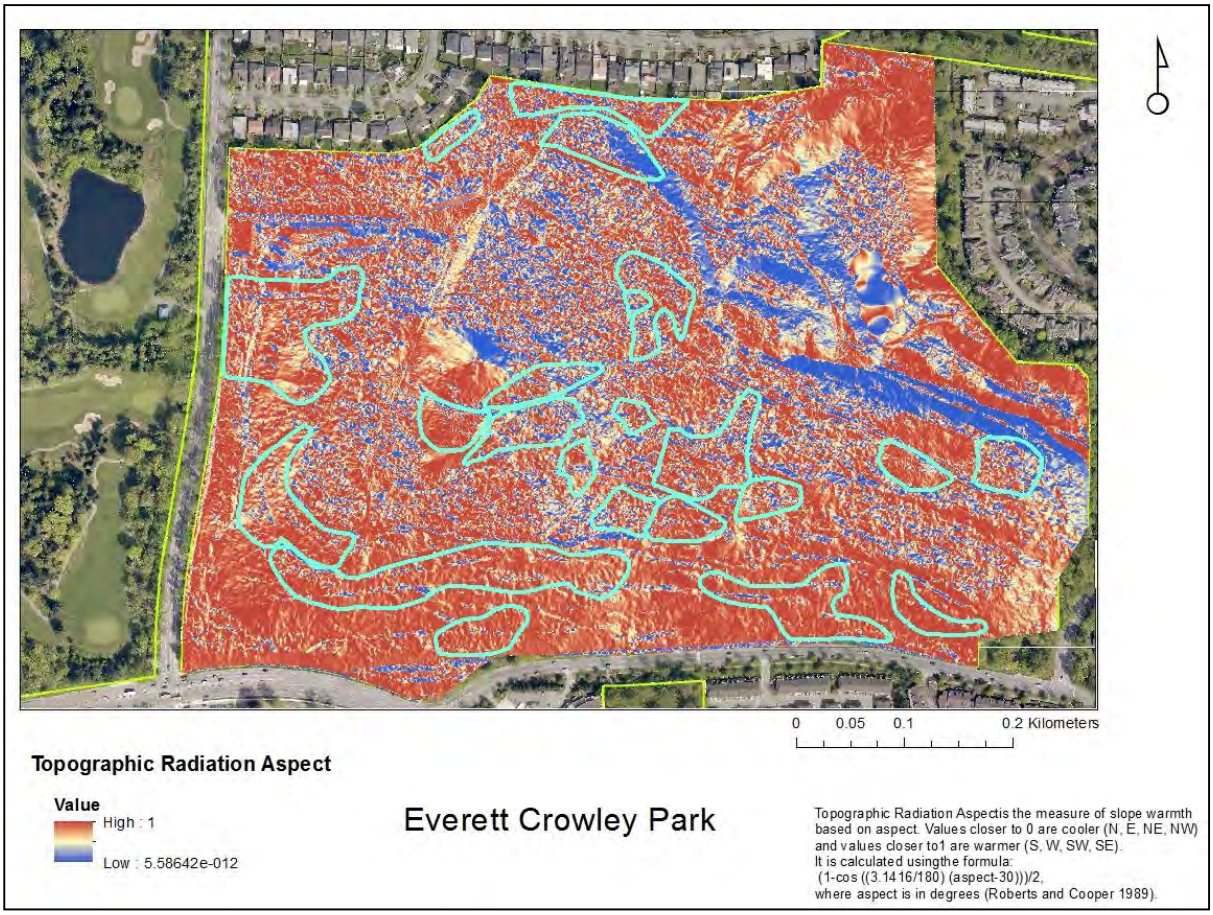
Topographic Wetness Index (TWI)

TWI map for ECP. Outline of current and proposed restoration sites shown. . Refer to map on page 30 for associated names

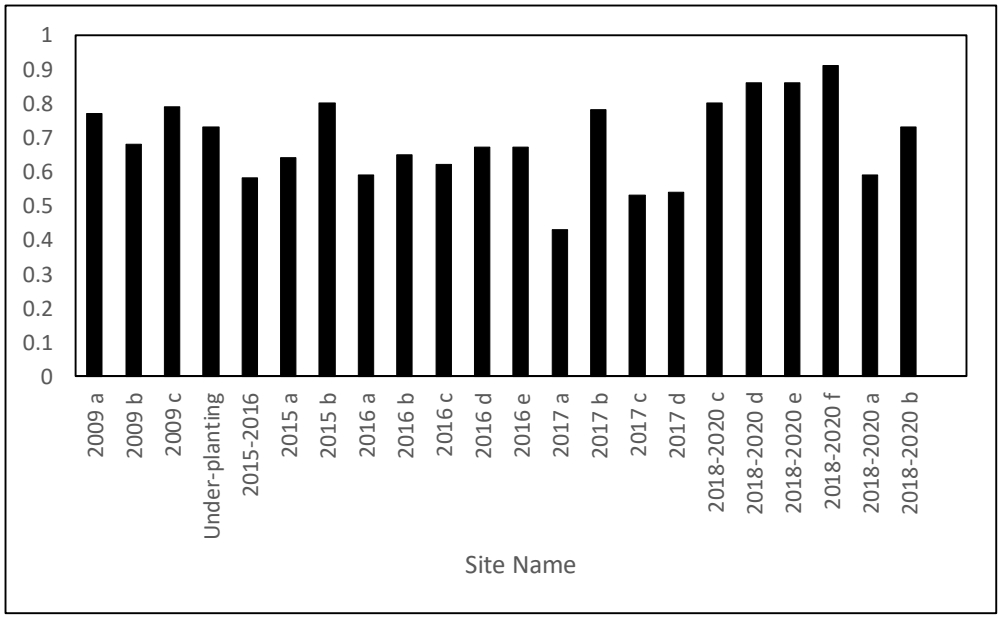


TWI values for current and proposed restoration plots in ECP

Topographic Radiation Aspect (TRASP)

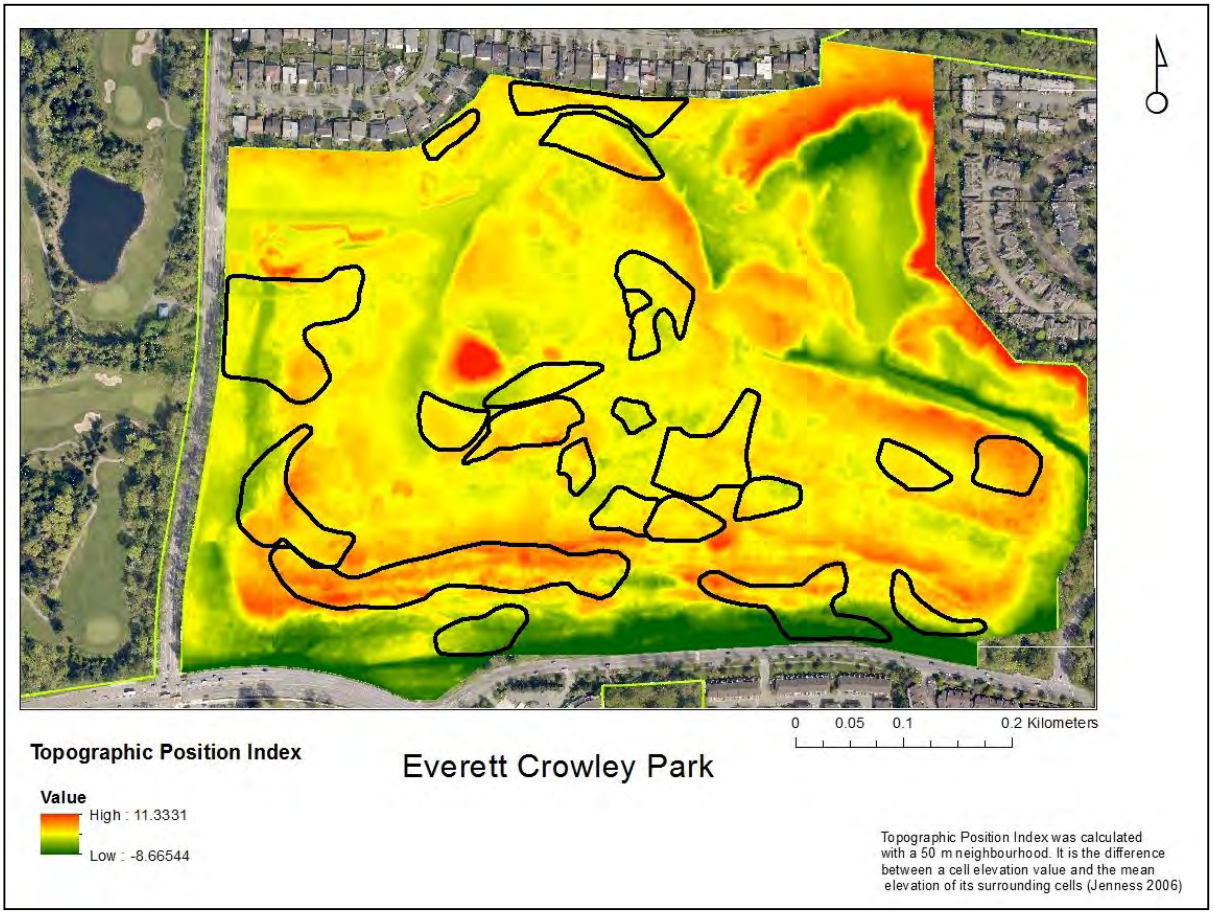


TRASP map for ECP. Outline of current and proposed restoration sites shown. . Refer to map on page 30 for associated names

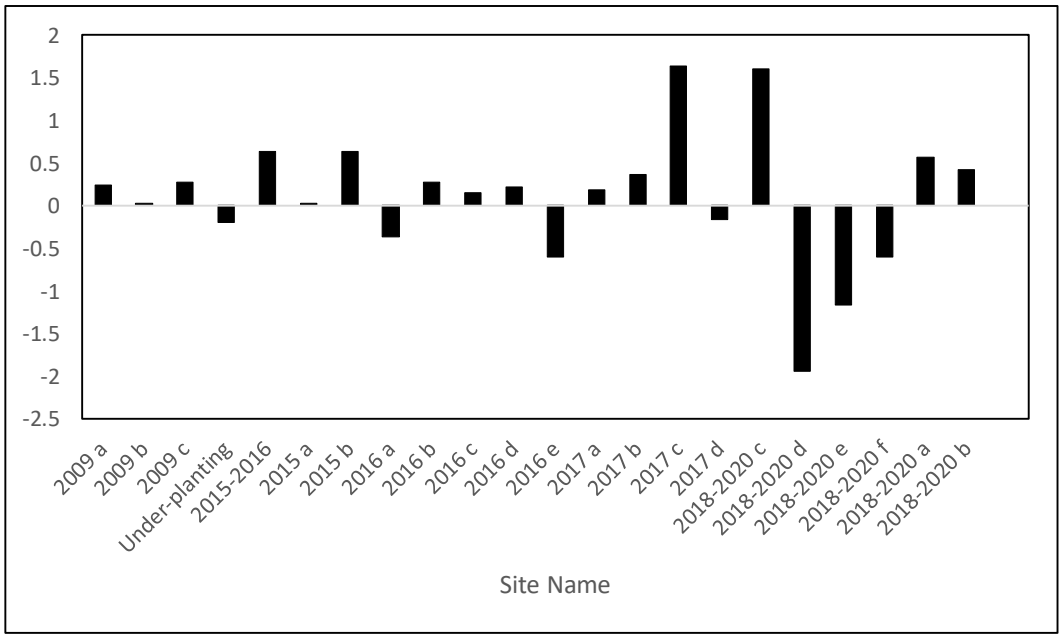


TRASP values for current and proposed restoration plots in ECP

Topographic Position Index (TPI)



TPI map for ECP. Outline of current and proposed restoration sites shown. . Refer to map on page 30 for associated names



TPI values for current and proposed restoration plots in ECP

Terrain metrics summary:

When a new site is proposed for restoration, analyzing the various terrain values and comparing them to the success of individual species on current restoration sites could aid in choosing appropriate species to plant. In general, higher TWI values will coincide with lower TPI and slope values. TRASP values indicate solar radiation and are not directly correlated with the other values. Of course, increased solar radiation can decrease moisture on a site if vegetation is lacking.

In general, steeper slopes are water shedding and will lose nutrients. The proposed 2018-2020 sites have the steepest slopes and species that require less water and can tolerate poorer soils should be planted. The TWI values for these proposed sites also confirm that these sites are drier. Sites 2018-2020 ‘a’ and ‘b’ are slightly wetter; however, they also have higher slope positions as indicated by the TPI value. In general, there are not major differences in the various terrain values for the current restoration sites. Based on observations, the current condition of site vegetation is most influenced by invasive plants rather than the specific terrain values.

3. Future Restoration Efforts

A. Park Summary

Overall, the park is recovering from its destructive history. Native trees such as red alder and black cottonwood have quickly re-established themselves since the landfill was decommissioned. There are however, at present few conifers naturally regenerating and invasive plants are rampant throughout the park. There are many "garden escapee" species such as black locust and common hawthorn, which can become problematic if they proliferate on the landscape. Currently their abundance seem to be much less harmful to native plants than other non-native plants such as blackberry and morning glory. There are also non-native cherry and apple species in the park; these are typically less of a threat.

Native shrubs such as red elderberry, Indian plum, thimbleberry, willows, vine maple, ocean spray and snowberry are present and in many areas doing very well. There are a few Garry oak saplings and larger trees within the park (e.g. along trail over south bank, south trail off Mt. Everett etc.). Other native shrubs such as cascara, Saskatoon, black hawthorn, pacific ninebark, Nootka rose, hardhack, and current were also found.

In general, some species that are were not noted or in low numbers which normally would be quite abundant within this BEC zone are salmonberry, salal, huckleberry, Oregon grape and various ferns. Sword fern and bracken are regenerating within the park and can be found scattered throughout, usually growing in clusters where they are found (some have been planted).

When walking along the primary and secondary trails, there are blackberry, morning glory, clematis, English ivy or knotweed problems almost consistently. These species grow in thickets and/or dense vines that climb and overtake native plants (see photo on following page). There are few areas unaffected by invasive plants and virtually all areas will require attention at some point. The west area of the park where underplanting was done in 2015, as well as the east side of the park near Avalon Pond and the outflow stream, in general, seem to be slightly more open and less affected by invasive plants.
The south slopes have minimal canopy cover and are thick with blackberry. These slopes also are likely to have thinner, less developed soils.

Morning glory completely overtaking trees within ECP

B. Operational Recommendations

1. Small black locust trees should be removed from sites being restored and common hawthorn monitored or removed form restoration sites as well.

2. Salal could be planted with consideration to the long-term goals and conditions of the particular location in question. It is uncertain why salal was not found in the park. Salal is a common species in the CWH BEC zone and it grows quickly in most light and soil conditions. It spreads vegetatively, often forming dense thickets. Due to its rapid spread and ability to form dense thickets, it could be a good barrier to some invasive plants (e.g. blackberry) However, salal can compete for moisture and nutrients. It can be a problem on drier sites and can restrict the ability for Douglas-fir to establish itself (Prescott & Sajedi 2008). On wetter sites, (salal-cedar sites), it competes mostly for nutrients with regenerating conifers. Western hemlock is more affected than western redcedar but in a study by Prescott & Sajedi (2008) growth in either were not significantly increased when salal was removed. However, salal planting should be restricted to moister area and in the understory locations where blackberry or knotweed are removed but mulch will not be used.

3. More shrubs should be planted in restoration sites. The shrubs that have been planted are doing well, provided invasive plants are managed. It is too early to tell if they will eventually become shaded out as their neighbouring saplings grow. However, becoming shaded out by a tree canopy is years in the future and this offers plenty of time for a seed base for the shrubs to become established and even naturally spread further into the park. Some of the shrubs that seem to be very successful are red osier dogwood, ocean spray, Nootka rose, elderberry, Indian plum and snowberry. Planting should not be restricted to these species however, and other native shrubs should also be planted, some of which have been planted in the sites already and are noted in the previous section under general site conditions.

4. Species such as red alder that fixes the nitrogen can help improve soil chemistry. Legume species such as black locust also do this; however, this is not a native species and should be not be encouraged to spread more throughout the park. In ECP, allowing key pioneer species to become established might be a requirement for restoration. Red alder can grow in conditions that are less than ideal for many native shrubs and conifers. The presence of alder will increase nitrogen and soil organic matter, soil acidity and a decrease in bulk density (B.C. Ministry of Forests 2002). It can improve conifer growth in nutrient poor to moderate soils if its densities remain somewhat low. Ecosystem modelling suggests that between 50 to 200 uniformly distributed red alder/ha, in a coniferous stand, are sufficient to improve soil nitrogen capital (B.C. Ministry of Forests. 2002). Alder live between 60 to 100 years, in which time they can help prepare the park for a healthy and long future. It is still reasonable to plant shrubs and conifers in restoration sites or in the understory, but allowing the focus to shift to the more natural successional process might be critical for this landscape where the soils were decimated and lack organic matter and nutrients.

5. Woody debris like stumps and logs should continue to be added to restoration sites to increase organic matter and nutrients into the soil.

6. Adding mulch to sites seems to be the best approach for site preparation. Mulching is reported to improve soil structure, prevents the germination and regrowth of some weed species, reduces erosion and evaporation, improves water filtration and reduces soil temperature fluctuations (GOERT n.d.). Plants grown in mulch vs. herbicide treated sites have been found to be larger, faster-developing and have higher survival (Cahill & Chalker-Scott 2001). Organic mulch should break down within a few years, especially in Vancouver's wet winters. A thick layer (5-10 cm) is usually required to combat weeds (MoF 1997). Mulching should take place in the autumn once the rains have begun and the soil is no longer as dry. It can also be done in spring when soils begin to warm and dry. It might be necessary to mulch every two to three years to best control the return of invasive plants. Mulching reduces soil nitrogen levels and adding fertilizer can improve seedling establishment.

7. Adding chemical fertilizer is inadequate to restore the soil nutrient capital in degraded soil (MoF 1997). However, it can improve early establishment and growth of planted seedlings, especially in nutrient deficient soils and when mulches are being used. Re-application is appropriate until the internal nutrient cycle of the site is re-established (MoF 1997). However, a restored site should not depend on fertilizer for vegetation survival in the long-term. A formula of N=P_2O_5= K_2O plus low S is a recommended formula for restoration sites (MoF, 1997)

8. Often invasive plants are creeping into restored sites on the periphery. Saplings close to the boundaries are quickly overtaken. A larger buffer should be maintained in restored sites (e.g., wide enough for flail mowing to allow for regular maintenance).

9. Priority should be to address the sites where restoration work and planting has already taken place. It will quickly become too late to recover some of these sites (2009 b and 2009 c especially) if efforts are not made immediately. Site 2015 a has some of the greatest plant diversity and should be prioritized for clean-up. These sites will require manual effort to work around the native saplings and free the ones that are completely entangled with blackberry or morning glory. Almost every other site requires work to clear invasive plants and most of the more recent sites can be quickly cleared with minimal effort.

10. Managing invasive plants is more difficult than growing native plants. The goal in restored sites is to allow the survival of the planted trees and shrubs. However, care should be taken to manage invasive plants appropriately and limit their ability to propagate even more. The timing and approaches for dealing with specific invasive plants are readily available. Managing for one species (e.g. tilling the soil for morning glory management) can allow another invasive plants to come in (e.g. blackberry establishing itself in newly exposed soil). Regular maintenance and monitoring is critical during such phases.

11. When sites have less common native species such as Gary oak (e.g. 2009 b, 2015a) or Mock Orange (2009 c), their locations should be noted and then they should receive regular care.

12. For future sites on the south slopes some considerations are that they are likely to have thinner, less developed soils. However, these slopes are also very sunny and could be a great place for establishing a variety of shrubs, deciduous trees and Douglas fir.

C. Monitoring Recommendations

1. Initial restoration focus should be on the areas where only a few invasive plants exist over more heavily infested areas. This is important for protecting the areas that have not yet become overrun with one or more invasive plants. A survey of the park should be done using transects within close proximity to each other to note the areas with minimal invasive plant establishment. These areas should be mapped or identified such that they can be identified and should monitored. Monitoring should occur monthly, but at a minimum, one to two times a year. It is likely that these areas will only be reached by foot and will require manual tools. This should not be a major issue since work in them should be minimal. These could also be good areas to under-plant various conifers and shrubs.

2. All sites where restoration sites have taken place should be regularly monitored for health and invasive plant encroachment. This ideally would take place monthly, but at a minimum twice a year could help identify issues before they become too large.

3. The methods used in this study to assess the health of restoration plots are easy to replicate. Measuring the leader growth on Douglas-fir is time consuming (approx. 3 days for 1 person) and noting the health of individuals (as noted in the previous section), and any invasive plants in contact with the trees, is likely to provide more meaningful information. This is a reasonably quick way to assess if sapling are surviving and any invasive plant problems existing within a site. Notes on the general health and possible efforts for improving health (fertilizing, thinning, troughs dug around the bases of trees in dry summers etc.) should also be recorded. This type of monitoring can easily be completed over a few days and should take place each summer.

4. Regular monitoring and maintenance in the park is a large task. Ideally, there would be a team of two or more staff who are dedicated to forest restoration within the VPB parks. They would monitor, plan and do manual maintenance, delegating additional efforts as required. Two full-time staff dedicated solely to ECP could likely be kept busy doing meaningful work to recover the park.

5. Volunteers are a critical part of maintaining and restoring city forests. When restoration sites are cleared and planted, they should be "adopted" by a volunteer group. Focusing a group to one site is likely a better way to keep sites from becoming neglected. It also establishes ownership from the individuals caring for it because it is focused and more manageable than an entire park where efforts become scattered and less effective.

6. A set of 41 360° images were taken throughout ECP (Appendix 3). With the appropriate application downloaded, the entire floor, canopy and surroundings of the person taking the photo can be viewed. Image quality mostly does not allow zooming in to identify individual species. Plants close to the centre or with obvious growth forms and structure (e.g. blackberry) are identifiable. These photos provide a good baseline for noting success or problems (e.g. is the canopy and understory filling in? Are invasive plants spreading?). These should be retaken every 3-5 years.

7. In time, thinning may be required and even desired in locations to allow for the understory shrubs to grow. Crowding on restoration plots should be monitored and thinning considered when appropriate.

Appendix 1: Restoration Site Conditions

2009 a

Site preparation: No mulching. Other information on site preparation and planting are unavailable.

Conditions: Limited natural regeneration occurring, likely, because invasive plants have matted the floor. Immediate attention required on this site involving manual brushing and pulling before natives that are still surviving succumb to smothering

Native plants include:

- Cedar; abundant and mostly healthy. One tall dead tree
- Grand fir; abundant and mostly healthy but smaller saplings are unhealthy and being smothered
- Sitka spruce

Non-native and invasive plants include:

- Cleavers; smothering and covering many saplings
- Himalayan blackberry; abundant and smothering small saplings and covering the floor
- Morning glory; abundant and smothering small saplings and covering the floor
- Black locust; a few smaller trees
- Knotweed; creeping in from stand outside of plot

❖ South end has complete smothering by blackberry, cleavers and morning glory

2009 b

Site preparation: No mulching. Other information on site preparation and planting are unavailable.

Conditions: All trees/shrubs in the plot are battling with weeds and invasives. This site has a lot of diversity and many native plants; however, it is extremely overgrown. Worth the effort to clean up manually.

Native plants include:

- Cascara; large, healthy tree in centre of plot
- Cedar; quite abundant in NE end
- Elderberry
- Garry oak sapling; people have been keeping clear of morning glory
- Grand fir; mostly healthy
- Lodgepole pine; in moderate to good health
- Maple (vine and big leaf); mostly moderate to good health
- Ocean spray; good health
- Pacific ninebark; healthy and abundant in SW edge
- Sitka spruce; abundant and healthy
- Snowberry; abundant and sending up many new shoots (mostly in south end of site)

Non-native and invasive plants include:

- Cleaver; abundant in NE end especially
- Himalayan blackberry; surprisingly little amounts
- Maple (sycamore?); large tree in plot producing many seedlings
- Morning glory; so thick in places that it is hard to even know what or if something is under it. It is thick amongst the snowberry.

❖ Various weeds and grasses

2009 c

Site preparation: No mulching. Other information on site preparation and planting are unavailable.

Conditions: All trees/shrubs in the plot are battling with weeds and invasive plants

Native plants include:

- Cottonwoods; some young naturally regenerated saplings
- Elderberry; a few nice, larger ones
- Sword fern and bracken fern outside plot on east end.
- Grand fir
- Mock orange; a few larger and smaller bushes. The larger are healthier than the small, which are wilting.
- Ocean spray; one large but dead bush
- Pacific ninebark
- Sitka spruce; abundant

Non-native and invasive plants include:

- Black locust
- Cleaver
- Himalayan blackberry; patches throughout and growing up onto many of the trees (e.g. Sitka spruce)
- Knotweed; signs of recent treatment
- Morning glory
- Various weeds and grasses
- Scotch

2015 a

Site preparation: Flail mowed in fall 2014, lightly mulched, and planted in January and April 2015

Conditions: The north end and centre east side of this plot may be the restored site with the greatest diversity. Blackberry and morning glory are creeping in and are growing over native plants, including full smothering of some; however, these plants remain relatively healthy.
The south handle is generally in poor health. Invasive plants have taken over much of the area and an aggressive approach will be required to clear the area and save the planted individuals.
NOTE: This site is described in three sections; 1) North 2) Centre East 3) South

North

Native plants include:

- Black hawthorn, which are still very small
- Cascara
- Cedar
- Current
- Douglas fir; these are mostly healthy
- Garry oak sapling; it looks very healthy
- Western hemlock; in good condition
- Maples; vine and big leaf
- Nootka rose; (especially in NW corner).
- Red alder naturally regenerating from nearby trees
- Red elderberry sapling
- Red osier dogwood

Non-native and invasive plants include:

- Fabaceae species (various woody and herbaceous)
- Himalayan blackberry creeping in, especially at the margins. Smothering some Douglas-fir and other species
- Morning glory, which is smothering some species including Nootka rose, Douglas-fir and black hawthorn
- Scotch broom (limited amounts)

Centre East

Native plants include:

- Black hawthorns; a few small ones
- Cedar
- Current
- Douglas fir; generally in good health
- Grand fir
- Hardhack; healthy
- Horse chestnut; healthy
- Oregon grape; healthy
- Red osier dogwood in good shape
- Thimbleberry; healthy and many are flowering
- Vine maple; mostly doing poorly (insect attack?)
- Western hemlock; healthy

Non-native and invasive plants include:

- Cherry species; a few
- Himalayan blackberry
- Knotweed; small patch
- Morning glory; smothering species including cedar, current and Douglas fir

South

Native plants include:

- Cedar
- Douglas-fir
- Grand fir; doing moderately well
- Hardhack; is doing quite well

Non-native and invasive plants include:

- Himalayan blackberry; throughout site
- Morning glory; smothering many of the trees, including Douglas fir

2015 b

Large cottonwood near north end (close to trail) used to differentiate West/East

Site preparation: Flail mowed in fall 2014; mulched summer 2015; planted fall 2015; infill planting fall 2016.

Conditions: Mostly clear of invasive plants but some are starting to re-establish, especially in the south end

Native plants include:

- Cascara; many small in moderate condition (some larger cascara doing well)
- Cedar; south end of plot,
- Cottonwood
- Douglas fir; primary conifer in site
- Grand fir; in south end of plot
- Maples (big leaf and vine); appear mostly healthy but currently experiencing wilt (especially in west end of plot). Big leaf seems to also be naturally regenerating
- Red alder
- Red elderberry; large tree in good condition in NE corner
- Willow sp. growing from stumps that had been dropped off in west side of plot

Non-native and invasive plants include:

- Himalayan blackberry; floor on the south end of site is completely covered
- Morning glory, patch around elderberry in NE corner
- Scotch broom

❖ North end mostly clear except for the occasional invasive shooting up.

❖ Unknown woody species is quite abundant and appears to have killed 5 or more saplings, potentially by shading

2015/16

The boundary was determined by dividing the area west and east (2016 and 2015 respectively) at the large cottonwood (drawing line north to south from it)

Site preparation: Flail mowed fall 2014; mulched winter 2015; planted April 2015

NOTE: This site is described in two sections; 1) West 2) East

West

Native plants include:

- Douglas fir; abundant and most is in moderate to good healthy
- Ocean spray; have many new shoots regenerating and look healthy and getting large
- Red osier dogwood have many new shoots regenerating and look healthy and getting large.
- Maple (vine and big leaf); moderate to healthy
- Willow species; healthy

Non-native and invasive plants include:

- Black locust regenerating; should be removed
- Himalayan blackberry; is covering much of the floor in the south end and spotty in west corner
- Morning glory: it is abundant and smothering some of the Douglas fir; it is growing thick amongst the ocean spray and red osier and it is covering much of the floor
- Scotch broom; spotty throughout west corner

East

Native plants include:

- Cedar
- Douglas fir; abundant
- Maple (vine and big leaf)
- Ocean spray; have many new shoots regenerating and look healthy and getting large
- Red elderberry; large, healthy on in NE corner
- Red osier dogwood have many new shoots regenerating and look healthy and getting large.
- Willow species; mostly towards south end

Non-native and invasive plants include:

- Himalayan blackberry; is covering much of the floor
- Knotweed
- Scotch broom
- Morning glory: it is abundant and smothering some of the ocean spray and red osier and encroaching onto the willow

2016 a

The boundary was determined by dividing the area west and east (2016 and 2015 respectively) at the large cottonwood (drawing line north to south from it

Site preparation: Flail mowed in fall 2014; mulched winter 2015; planted April 2016

Conditions: This site has a large area that has died. After a conversation with park workers they said that it had been covered in morning glory, which they cleared, after this clearing everything turned brown and most saplings (maples, alder etc.) have appeared to have died.

Native plants include:

- Bitter cherry sapling; good health
- Cascara; quite a few, mostly in good health with a few large ones also in good health
- Cedar; healthy
- Cottonwood; healthy
- Douglas fir; mostly is good health with some tall health trees
- Grand fir; good health
- Horse chestnut; large tree in good health
- Lodgepole pine; good health
- Maples (big leaf and vine); moderate to good health
- Ponderosa pine; larger and in good health
- Red alder; moderate health
- Sequoia; one sapling in reasonable health (top needles have died but bottom of tree is full and green)
- Sitka spruce; both larger trees and saplings; good health
- Willow sp.; healthy

Non-native and invasive plants include:

- Himalayan blackberry creeping in from outside plot (it covers adjacent slopes of Mt. Everett). Some has been cut down in the NW corner and is starting to re-sprout.
- Morning glory; abundant throughout site and covering most of the floor. It is smothering many of the Douglas-fir and other species
- Scotch broom scattered throughout the plot

2016 b

Site preparation: Flail mowed fall 2016; mulched spring 2017; planted February 2017

Native plants include:

- Douglas fir; good health
- Maple (big leaf and vine); moderate health. However, many are experiencing wilt and 5 or more have died
- Sitka spruce; good health

Non-native and invasive plants include:

- Himalayan blackberry is in a large patch in centre to NE corner of plot
- Knotweed; small patch near centre
- Morning glory is in a large patch in centre to NE corner of plot

2016 c

Site preparation: Flail mowed fall 2016; no mulching; planted spring 2017

Conditions: Blackberry has not started to grow as a vine , it is mostly sporadic shoots throughout the site

Native plants include:

- Big leaf maple; generally good health
- Cedar; generally good health
- Douglas fir; generally good health
- Sitka spruce; generally good health

Non-native and invasive plants include:

- Himalayan blackberry; predominantly covering entire floor in new shoots. Not spreading in vine form very much yet.
- Morning glory

2016 d

Site preparation: Flail mowed in fall 2014 and again summer 2016; mulched summer 2016; planted fall 2016

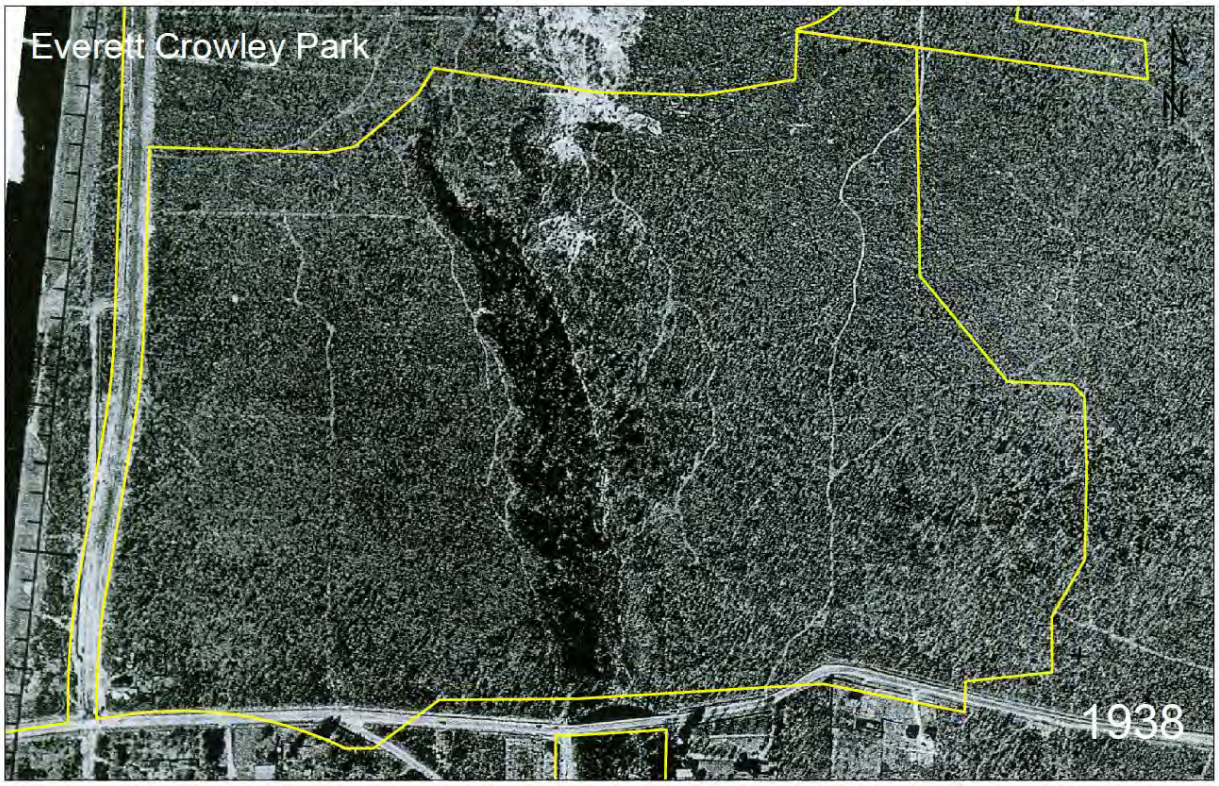
Native plants include:

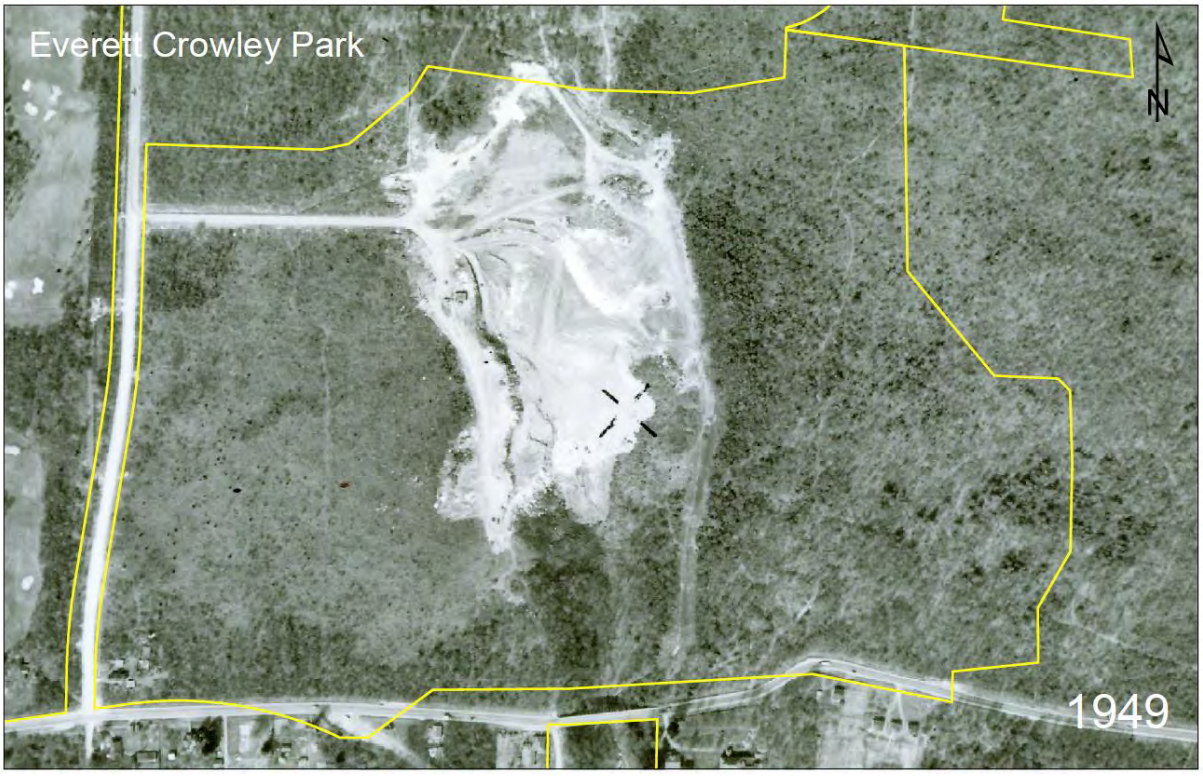
- Cedar; generally good health
- Douglas fir; generally good health
- Maple (vine and big leaf); generally good health
- Red alder; generally good health
- Sequoia; one sapling in decent health
- Yew; one sapling in poor health

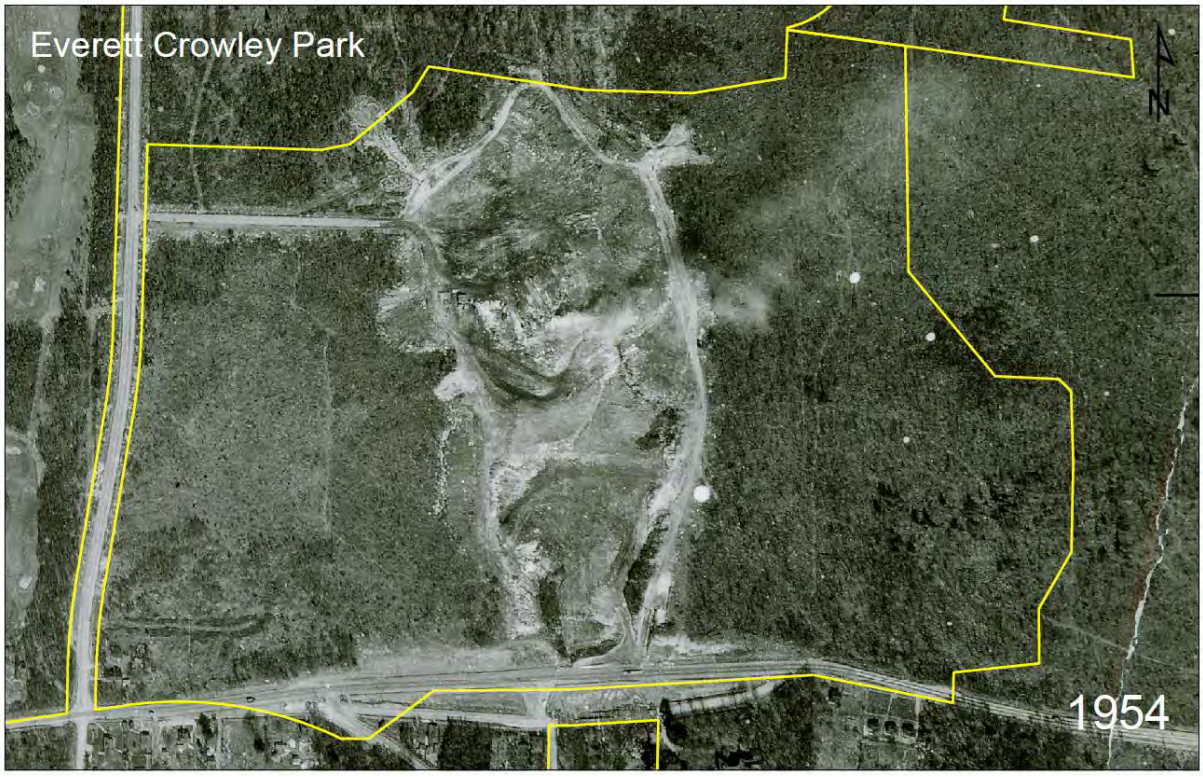
Non-native and invasive plants include:

- Hay (or straw) has been put down by unknown people around some seedlings and is now sprouting.
- Himalayan blackberry; patches of sprouting blackberry throughout and a large patch in SW corner
- Morning glory; primarily in a large patch in SW corner and in the NW corner is starting to spread into site

Appendix 2: Historical Air Photos






Everett Crowley Park
N
1954


Everett Crowley Park
N
1963


Everett Crowley Park
N
1969

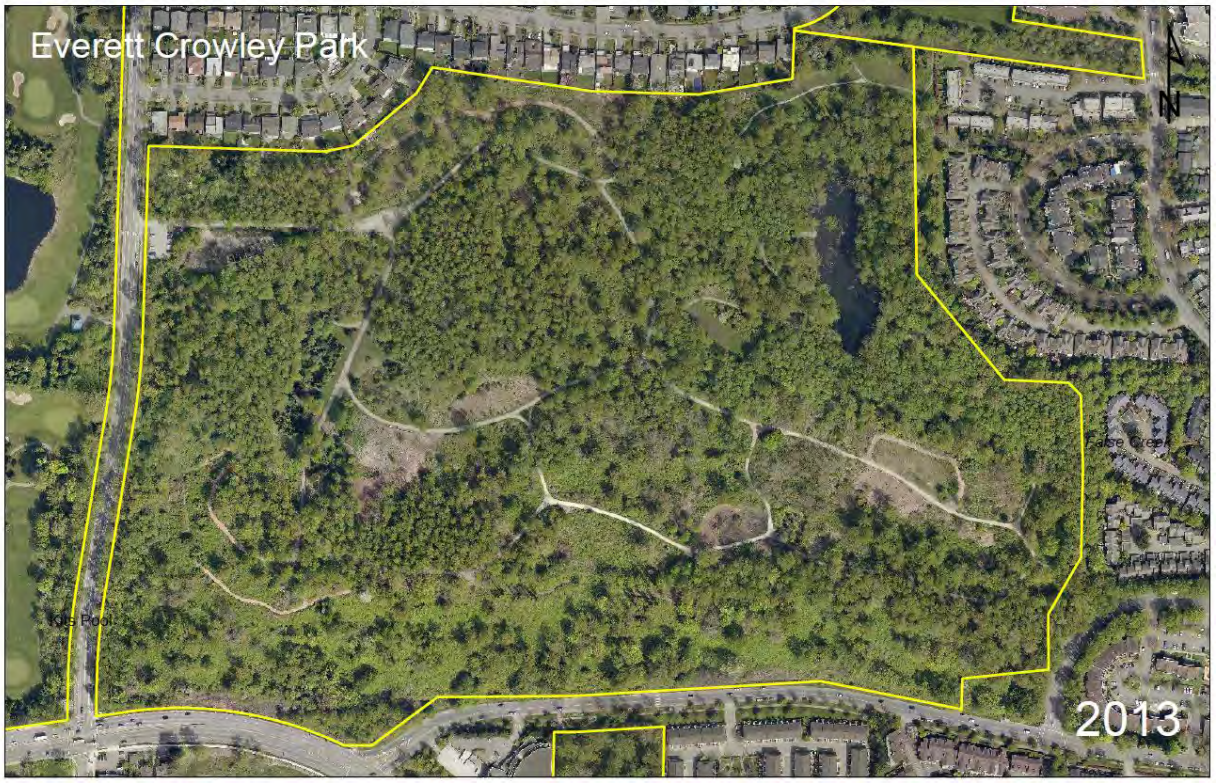

Everett Crowley Park
N
1974


Everett-Crowley Park
N
1979
KODAK SAFETY FILM

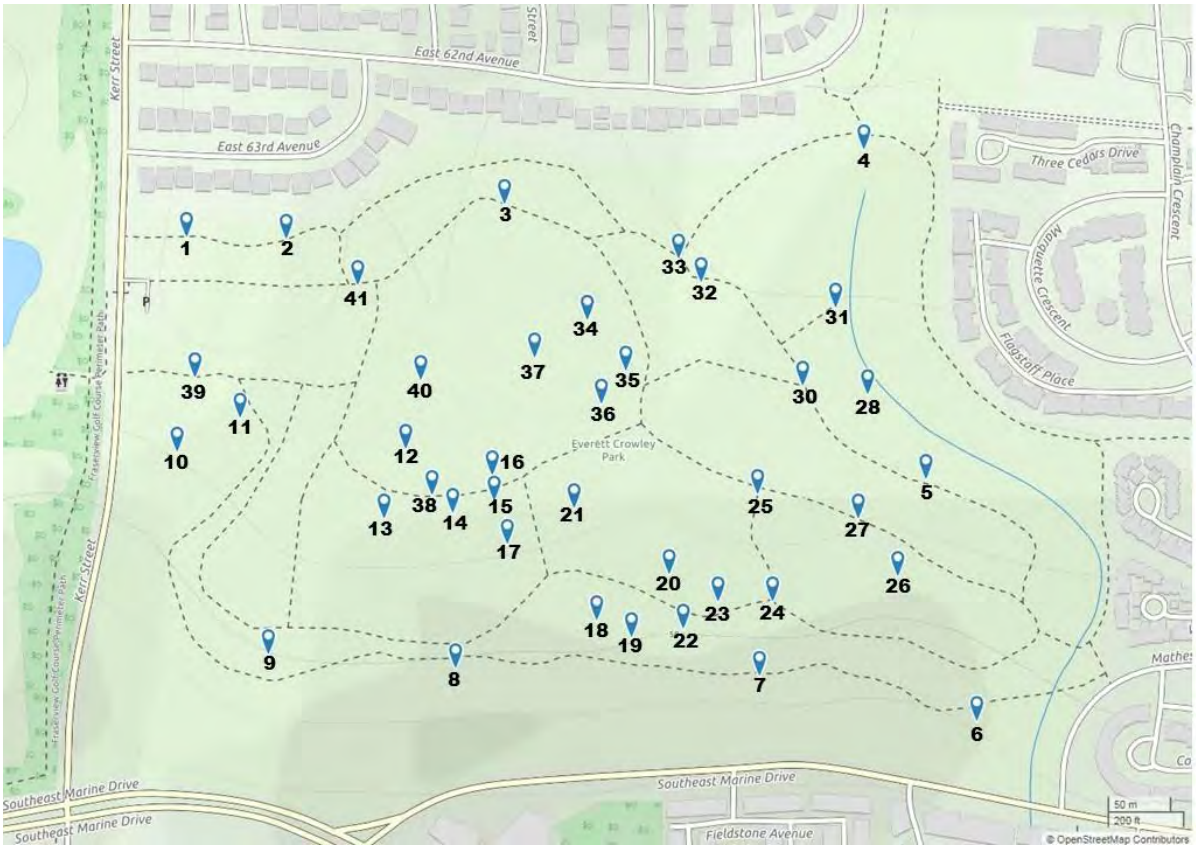

Everett Crowley Park
N
1986


Everett Crowley Park
N
1995


Everett Crowley Park
N
2005


Everett Crowley Park
N
Kids Pool
2013

Appendix 3: Map of 360° photo locations



Locations of the 360° photos taken throughout ECP, including both restoration sites and unrestored areas.

Appendix 3: Scientific names of shrubs and trees

Big leaf maple: *Acer macrophyllum*
Bitter cherry*: Prunus emarginata*
Black cottonwood: *Populus trichocarpa*
Black hawthorn: *Crataegus douglasii*
Black locust: *Robinia pseudoacacia*
Bracken: *Pteridium aquilinum*
Cascara: *Rhamnus purshiana*
Cherry sp.: *Prunus sp.*
Cleaver: *Galium aparine*
Clematis: *Clematis vitalba*
Common hawthorn: *Crataegus monogyna*
Common hops: *Humulus lupulus*
Current sp.: *Ribes sp.*
Douglas fir: *Pseudotsuga menziesii*,
English ivy: *Hedera helix*
Garry Oak: *Quercus garryana*
Grand fir: *Abies grandis*
Hardhack*: Spiraea douglasii*
Himalayan blackberry: *Rubus armeniacus*
Horse chestnut: *Aesculus hippocastanum*
Red huckleberry: *Vaccinium parvifolium*
Indian plum: *Oemleria cerasiformis*
Japanese knotweed: *Fallopia japonica*
Lodgepole pine: *Pinus contorta*
Mock orange: *Philadelphus lewisii*
Morning glory: *Convolvulus arvensis*
Nootka rose: *Rosa nutkana*
Ocean spray: *Holodiscus discolor*
Dull Oregon grape: *Mahonia nervosa*
Pacific ninebark: *Physocarpus capitatus*
Ponderosa pine: *Pinus ponderosa*
Red alder: *Alnus rubra*
Red elderberry: *Sambucus racemosa*
Red osier dogwood: *Cornus stolonifera*
Salal: *Gaultheria shallon*
Salmonberry: *Rubus spectabilis*
Saskatoon: *Amelanchier alnifolia*
Scotch broom: *Cytisus scoparius*
Sequoia: *Sequoiadendron giganteum*
Sitka spruce: *Picea sitchensis*
Snowberry: *Symphoricarpos albus*
Sword fern: *Polystichum munitum*
Sycamore maple: *Acer pseudoplatanus*
Thimbleberry: *Rubus parviflorus*
Vine maple: *Acer circinatum*
Western hemlock: *Tsuga heterophylla*
Western red cedar: *Thuja plicata*
Willows: *Salix sp.*
Western yew: *Taxus brevifolia*

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