Hamlin Park Vegetation Study
Final Report 2009

Prepared for: City of Shoreline

Prepared by:
Ella Elman, Ecologist
Nelson Salisbury, Ecologist

Seattle Urban Nature
5218 University Way NE
Seattle, WA 98105-4495

October 2009

Table of Contents

Executive Summary

Habitat mapping conducted by Seattle Urban Nature (SUN) (now EarthCorps Science) in 2007 in Hamlin Park showed that six separate areas distributed throughout the park are devoid of understory vegetation (Seattle Urban Nature 2008). These areas total approximately 15 acres, spanning different aspects and topographical elevations.

At the request of the City of Shoreline, EarthCorps Science designed and implemented a pilot study to test various re-vegetation treatments to see which are most effective in restoring healthy shrub and herbaceous layers in these areas. Six vegetation study plots were stratified throughout the six areas lacking understory vegetation in the spring of 2008 (Map 1). Soil analysis indicated that five out of six plots exhibited relatively low pH levels and that this condition was likely contributing to the lack of both species abundance and diversity.

Each of the six study plots was composed of four subplots consisting of different treatments. The treatments tested the effectiveness of altering both physical characteristics (such as soil amendments) and species suitability by tracking the survivability of a number of different shrub and herbaceous species. In addition, human impacts on plant establishment was examined by fencing off the study plots and looking at control portions of the sites to see whether vegetation would naturally re-colonize the bare areas. Monitoring of the study plots took place over two years, 2008 and 2009. Results from fall monitoring in October 2008 and 2009 are presented in this report.

Results from this study suggest that the most cost effective and successful strategy for re-establishing understory vegetation to the indicated areas is to:

1. Plant directly into the existing soil with no soil amendment
2. Choose plants tolerant of low pH levels (see plant survival rates in Table 8)
3. Expand into bare areas adjacent to existing vegetation where practical

It is recommended that new and expanded restoration efforts be fenced off wherever possible to protect plant installations form trampling and other disturbances. All new restoration areas should be watered for at least two growing seasons to allow for plants to become established.

Monitoring of existing test plots should continue in order to measure long term trends in plant establishment and survivability that may influence the methodology and maintenance of larger scale restoration efforts.

1. INTRODUCTION

Habitat mapping conducted by Seattle Urban Nature (SUN) (now EarthCorps Science) in 2007 in Hamlin Park showed that six separate areas distributed throughout the park are devoid of understory vegetation (Seattle Urban Nature 2008). These areas total approximately 15 acres, spanning different aspects and topographical elevations. Vegetation data collected in these areas in 2007 showed that tree densities are similar to those in adjacent forested areas that have a developed understory. However, the overstory in unvegetated areas is primarily dominated by Western hemlock (*Tsuga heterophylla)* trees as opposed to Douglas-fir (*Pseudotsuga menziesii*) trees which are prevalent in areas where understory vegetation exists (Seattle Urban Nature 2008).

At the request of the City of Shoreline, EarthCorps Science designed a study to look at the potential causes for the lack of understory vegetation and to set up a pilot study to test various treatments to see which are most effective in restoring healthy shrub and herbaceous layers in these areas. Six vegetation study plots were stratified throughout the six areas without understory vegetation in spring of 2008 (Map 1). Soil testing was conducted in each vegetation plot prior to planting to assess soil conditions for nutrients, heavy metals, organic matter and pH levels. Soil tests revealed that five out of six sampled areas have very low pH levels, ranging between 4.4 and 5. Soil pH between 5.5 and 7.5 is generally considered necessary for optimal growth of most Pacific Northwest plants, although conifer forests often sustain more acidic soils. Tests showed normal results for all other soil conditions.

Soil pH is most likely the leading explanation for why areas within the park are lacking understory vegetation. Other contributing factors potentially include heavy use and trampling by visitors, sandy soils that do not retain moisture and lack of decomposed coarse woody debris to act as nurse logs and promote vegetation establishment on the sites.

Each of the six study plots is composed of four subplots consisting of different treatments. The treatments tested the effectiveness of altering both physical characteristics (such as soil amendments) and species suitability by tracking the survivability of a number of different shrub and herbaceous species. Based on the soil test results, primarily ericaceous shrub species were selected for the field trials because of their general acid tolerance. In addition, human impacts on plant establishment was examined by fencing off the study plots and looking at control portions of the sites to see whether vegetation naturally re-colonized the bare areas.

The study was initiated in April 2008. Baseline vegetation data for all plots were collected prior to planting. The plots were planted and fencing was installed in mid-April and watered one to two times a week throughout the 2008 and 2009 growing seasons. Follow-up monitoring was conducted in October, 2008, May 2009 and October 2009.

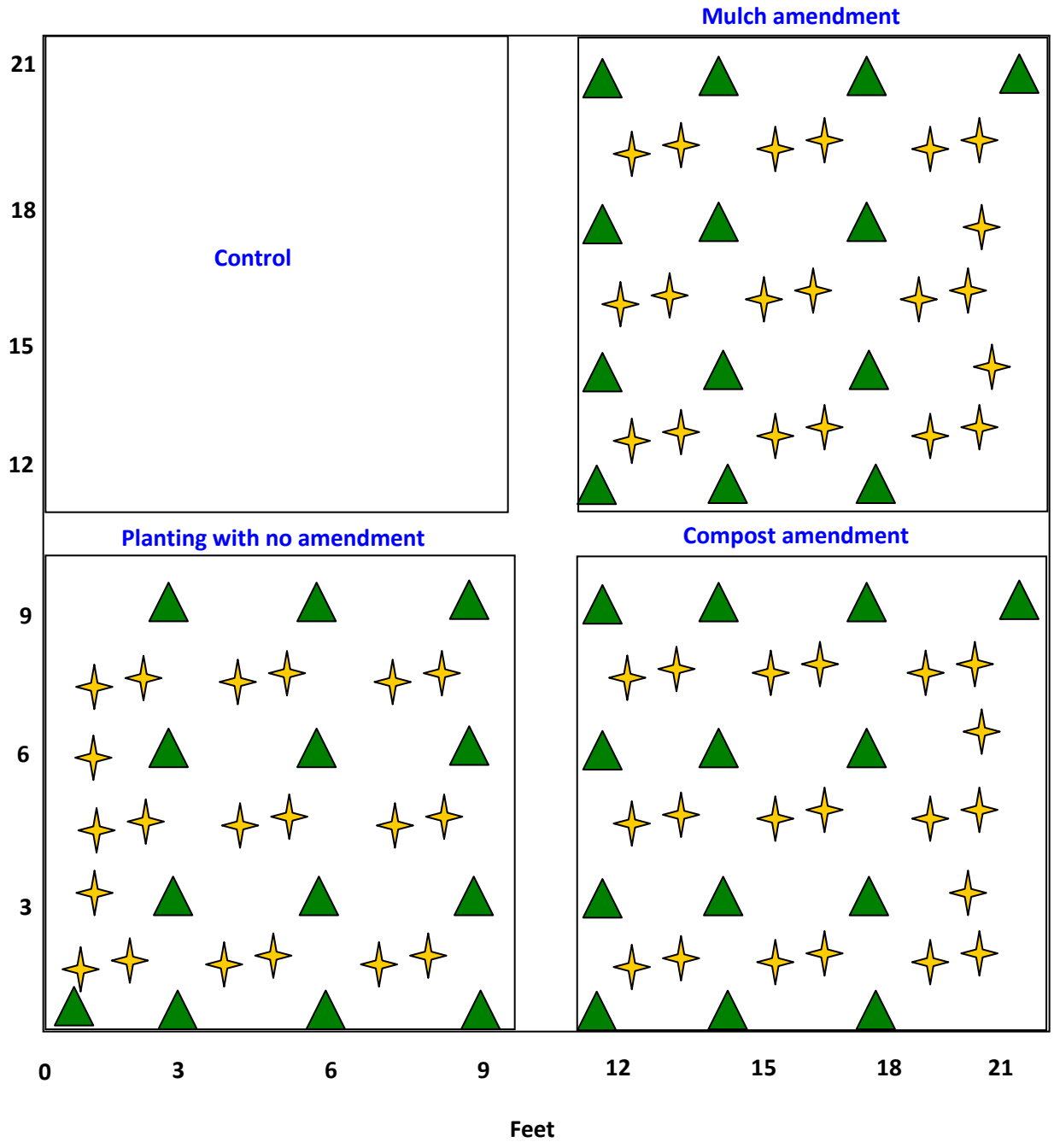
2. STUDY DESIGN

Six vegetation plots were established throughout the park and located in areas without understory vegetation (Map 1). All plots are fenced off to prevent trampling and human interference. In addition, three of the plots were placed on the edge of areas with existing understory vegetation and three of the plots were placed in the interior of bare areas without existing understory vegetation nearby. The goal of the plot placement was to ascertain whether natural recruitment from nearby vegetated areas can be an effective re-vegetation strategy. GPS coordinates were recorded for each plot. Each plot is 21 feet x 21 feet in size, and contains four 9 foot x 9 foot sub-plots with the following treatments:

1) Control – Each plot contains a control treatment in which nothing was planted and no amendments were added. This treatment will test for the effects of human exclusion on the sites. Three of the six plots were placed near the edges of vegetated sites, whereas three plots were placed in the center of un-vegetated areas not adjoining any vegetation. All sites were fenced off to prevent trampling and disturbance of plants. The goal is to see if vegetation will spread into the control plots from adjacent vegetated areas. This treatment will determine how the area would benefit from exclusion alone and whether keeping people out is sufficient to initiate the re-vegetation of the bare areas.
2) Direct planting into existing soil – This treatment will measure the survival and vigor of plants planted directly into existing soil with no soil amendments. Data will be compared with other treatments to test the effectiveness of direct planting against soil amendment treatments. Aside from promoting natural re-vegetation from adjoining areas, this is the most cost effective option for re-vegetating large areas.
3) Compost soil amendment – Soil tests performed on the site have indicated very acidic soil conditions within the study plots. Tested plots had pH levels ranging from 4.5-5. Adding 6-8 inches of compost soil amendment to the surface of the existing soil and allowing it to naturally decompose over a number of years will improve the organic matter content within these subplots and possibly buffer the pH levels slightly. Survival and growth data will be compared to those in other treatments. Clear success of plants in this treatment would indicate that lack or organic matter is a key limiting factor. Organic matter can be provided in numerous ways including placing decomposed coarse woody debris on the site.
4) Mulch soil amendment – This treatment will add 6-8 inches of mulch to the surface of the soil. This treatment will allow for greater water retention during the dryer months of the year and will test whether mulch can be an effective substitute for a compost amendment.

Subplot boundaries are demarked with 1” x 2” x 12” wooden stakes driven into the ground and labeled with the plot number and treatment. Each subplot with the exception of the control was planted with the same species and plant densities (Figure 1). The following plant material was installed in each 9 foot x 9 foot subplot, for a total of 33 plants per subplot and 99 plants in each plot:

Figure 1. Sample plot layout (not drawn to scale). = shrubs, = groundcovers



Shrub species:

- serviceberry (*Amelanchier alnifolia*) – 1 plant
- beaked hazelnut (*Corylus cornuta*) – 2 plants
- salal (*Gaultheria shallon*) – 2 plants
- low Oregon grape (*Mahonia nervosa*) – 2 plants
- Pacific rhododendron (*Rhododendron macrophyllum*) – 2 plants
- trailing blackberry (*Rubus ursinus*) – 2 plants
- evergreen huckleberry (*Vaccinium ovatum*) – 2 plants

Groundcover species:

- vanilla leaf (*Achlys triphylla*) – 3 plants
- wild ginger (*Asarum caudatum*) – 3 plants
- woodland strawberry (*Fragaria vesca*) – 3 plants
- sword fern (*Polystichum munitum*) – 2 plants
- fringecup (*Tellima grandiflora*) – 3 plants
- starflower (*Trientalis borealis)* – 3 plants
- inside-out flower (*Vancouveria hexandra*) – 3 plants

All plots were watered from one to two times per week during the dry season from April to September for two growing seasons to assure that plants received adequate moisture to properly establish on the sites.

3. BASELINE SURVEY

A baseline survey was conducted in mid-March, 2008 to collect vegetation data in all six study plots prior to study initiation.

3.1 Forest Assessment Methodology

Aspect and Slope

Aspect and slope were recorded for each plot.

Tree density measurement

All trees within each plot were identified and enumerated including non-native tree-like species such as cherry laurel (*Prunus laurocerasus*) and English holly (*Ilex aquifolium*). In order for a tree to be included in the sampling plot, more than half of its rooted trunk had to occur inside the plot. Diameter at breast height (dbh – breast height is defined as 4.5 feet from the ground surface) was recorded for each tree. For trees smaller than 4.5 feet in height, average stem diameter was recorded to the nearest ½ inch.

Snags and coarse woody debris (CWD) greater than five inches in diameter, consisting of standing and downed logs and stumps, were measured and placed into one of the three decay classes, I, II or III. Decay class I indicated a branch or trunk that recently died and frequently has intact bark and branches and hard wood. Decay class III characterizes wood in an advanced state of decay with little or no bark or branches left intact, softened crumbling wood and extensive epiphytes. Decay class II provides an intermediate designation between these two extremes.

Overstory canopy measurement

Overstory canopy was measured using a spherical densiometer, with four measurements per plot, one facing each cardinal direction. The four measurements were averaged to obtain an estimation of overstory canopy cover on each plot.

Vegetation cover measurement

All plant species occurring in the study plot were identified and percent cover was visually estimated for each species within each subplot. Percent cover was recorded separately for each of the four subplots. Species that were present in trace amounts were given a minimum value of 0.1%.

Data collection

Data collection was conducted by two staff ecologists at Seattle Urban Nature. Data was recorded using a TDS Recon PDA. Information from the PDA was transferred to a Microsoft Access Database, which was used for data analysis. A Trimble GeoXT unit with a ProXR antenna was used to collect GPS information in the field. Maps were produced using ESRI ArcMap version 9.1, which connects geographic information (e.g. maps, aerial photographs, topography) with tabular information (e.g. plot information in Access database).

3.2 Results

Overstory tree density and canopy cover

The forest overstory refers to the upper and mid-story canopies of a forest. Tree density data were recorded during baseline monitoring in March, 2008. Only trees with a diameter measuring greater than five inches (a standard measure for overstory) were considered for the purposes of this overstory analysis. A total of seven overstory trees were recorded in the six study plots, with the majority (71%) composed of western hemlock (*Tsuga heterophylla*), and one tree each of western red cedar (*Thuja plicata*) and Douglas-fir (*Pseudotsuga menziesii*). These trees ranged from five inches to 21 inches in diameter, with an average diameter of 12.3 inches.

Canopy cover measurements show that canopy cover was similar across all plots, ranging from 90.5% to 96.2%. All plots were located in forested areas with well-established canopy cover.

Regenerating tree density

This survey considered trees five inches or less in diameter at breast height to be regenerating tree species. The amount and composition of current tree regeneration will substantially influence the future makeup of the forest.

A total of five trees were recorded in the six study plots. Only one of the recorded trees is native, a western hemlock. Four of the trees are invasive non-native species consisting of English holly (*Ilex aquifolium*) (40% of regenerating trees), one-seed hawthorn (*Crataegus monogyna*) (20%) and sweet cherry (*Prunus avium*) (20%).

Snags and coarse woody debris (CWD)

No snags were recorded in any of the study plots. Only one small piece of CWD was recorded with a diameter of six inches.

Shrubs and herbaceous species

During the baseline survey, very little vegetation was present in the majority of the study plots (Table 1) (Map 1). A total of 13 shrub and herbaceous species were recorded within the six plots, of which six are native and seven are non-native (Table 1). Plot 2 had the lowest percent cover of vegetation, with no vegetation present within the plot, whereas plot 4 had the highest with at total of 33% cover (Table 1). The remaining plots all had a total of five percent cover or less.

Native species already present within the plots include salal (*Gaultheria shallon*), low Oregon grape (*Mahonia nervosa*), creeping blackberry (*Rubus ursinus*), snowberry (*Symphoricarpos albus*), red huckleberry (*Vaccinium parvifolium*) and evergreen violet (*Viola sempervirens*). Almost all of the non-native species were recorded in Plot 4, the only plot with a measured pH level greater than 5. Of the seven non-native species present, five are considered to be invasive. Himalayan blackberry (*Rubus armeniacus*) is listed as a Noxious Weed of Concern in King County, whereas herb Robert (*Geranium robertianum*) and English ivy (*Hedera helix*) are listed as Non-designated Noxious Weeds in King County (King County 2008). Nipplewort (*Lapsana communis*) and wall-lettuce (*Mycelis muralis*) are considered to be invasive species but do not have a legal designation at this time. Herb Robert and wall-lettuce were the most prevalent

species found in Plot 4 at the time of the baseline survey, making up 30 percent cover on the site (Table 1).

Table 1. Shrub and herbaceous species found in six study plots in Hamlin Park prior to planting. Values represent percent cover of each species found in each plot.

		Plot Number[2]					
Scientific Name[1]	**Common Name**	**1**	**2**	**3**	**4**	**5**	**6**
Agrostis stolonifera	**creeping bentgrass**				T		
Gaultheria shallon	salal			2		3	
Geranium robertianum*	**herb Robert**				19		
Hedera helix*	**English ivy**				T		
Lapsana communis**	**nipplewort**				1		
Mahonia nervosa	low Oregon grape	T			T	2	1
Mycelis muralis**	**wall-lettuce**				11	T	
Rubus armeniacus*	**Himalayan blackberry**				1		
Rubus ursinus	creeping blackberry				T		
Symphoricarpos albus	snowberry				T		
Taraxacum officinale	**dandelion**				T		
Vaccinium parvifolium	red huckleberry				T		
Viola sempervirens	evergreen violet				T		
Total percent cover		**T**	**0**	**2**	**33**	**5**	**1**

[1] Species in bold are non-native species. Species denoted by * are species which have been given a legal designation by the King County Noxious Weed Program (King County 2009). Species denoted by ** are nonnative invasive species which do not have a legal designation at this time.
[2] T=Trace presence of species (less than 1%).

4. MONITORING FOR YEARS ONE AND TWO

Follow up surveys were conducted in the middle of October, 2008 and 2009 to collect vegetation data in all six study plots after the first and second growing seasons. Data were collected independently for each of four subplots located within each study plot to compare plant survival and growth across subplots.

4.1 Plant Survival and Health Methodology

Planted Material

The following information was recorded for each individual native shrub and herbaceous plant found in each subplot: species name, number of stems (for shrubs only), height and health condition.

Vegetation cover measurement

All native and non-native shrub, vine and herbaceous plant species occurring in the study plot were identified and percent cover was visually estimated for each species within each subplot. Percent cover was recorded separately for each of the four subplots. Species that were present in trace amounts were given a minimum value of 0.1%.

Data collection

Data collection was conducted by two staff ecologists at EarthCorps Science. Data were recorded using a TDS Recon PDA. Information from the PDA was transferred to a Microsoft Access Database, which was used for data analysis.

4.2 Results

Each treatment is discussed separately below, and results are compared across all plots within each treatment. A summary of survival rates across all three treatments where plants were installed is presented in the Summary section of the document. These results provide an analysis for plant performance after two growing seasons. Ideally, monitoring should take place after several more growing seasons after watering has been terminated to adequately assess plant growth and survival.

Compost treatment - shrubs

The compost treatment consisted of adding 6-8 inches of compost on top of the soil prior to planting and installing plants directly into the existing soil beneath the compost. This treatment was replicated across six plots in Hamlin Park. Seven species of shrubs were planted in each of the six subplots (Table 2). Of the planted species, beaked hazelnut had the poorest survival rate, with only one out of 12 plants surviving through the second season. Likewise, only one out of six serviceberry plants was left following the second growing season. Western rhododendron and salal also had a poor survival rate, with one-third and one-half the plants surviving the second growing season respectively (Table 2). Of the remaining plants, creeping blackberry had a somewhat better survival rate (67%) (Table 2). Low Oregon grape and evergreen huckleberry had very good survival rates with 83% and 92% respectively) (Table 2).

Table 2. Shrub species found in six study plots in Hamlin Park from three treatments at the end of the second growing season. Values represent the number of surviving plants present during monitoring. Average percent cover of each species across all plots is in parentheses.

		Compost[1]		Mulch[1]		Plant[1]		
Scientific Name	**Common Name**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**Number Planted (per treatment)**
		Native Plants						
Amelanchier alnifolia	serviceberry	4 (1)	1 (T)	5 (1)	3 (1)	6 (1)	5 (1)	6
Corylus cornuta	beaked hazelnut	4 (1)	1 (T)	12 (5)	6 (4)	11 (5.5)	12 (5)	12
Gaultheria shallon	salal	12 (1)	6 (T)	19 (1.5)	19 (2)	46 (3)	46 (4)	12
Mahonia nervosa	low Oregon grape	10 (1)	10 (1)	15 (2)	11 (2)	18 (3)	19 (2)	12
Rhododendron macrophyllum	western rhododendron	6 (1)	4 (1)	11 (2)	8 (1)	11 (2)	13 (2)	12
Rubus ursinus	creeping blackberry	9 (1)	8 (2)	8 (1)	6 (1)	7 (1)	11 (T)	12
Sambucus racemosa	red elderberry	0	0	0	0	0 (T)	0	0
Vaccinium ovatum	evergreen huckleberry	11 (2)	11 (2)	10 (2)	11 (2)	10 (2)	11 (2)	12
Vaccinium parvifolium	red huckleberry	0	0	0	0	0 (T)	0 (T)	0

[1]T=Trace presence of species (less than 1%).

Compost treatment – herbaceous species

Seven native herbaceous species were planted in the compost subplots. Two additional native species, fringed willowherb (*Epilobium ciliatum*) and bracken fern (*Pteridium aquilinum*) which were not present in the plots prior to planting were also found during the monitoring effort. Of the planted species, woodland strawberry had the poorest survival rate, with only 11% of plants surviving past the second growing season (Table 3). Slightly more than half (56%) of the wild ginger plants survived, followed by inside-out flower and fringecup which had 72% and 78% plant survival respectively. Based on collected data, sword fern, vanilla leaf and starflower had the highest survival rates, particularly star flower, which was abundant in Plot 4 prior to study initiation and had an average cover of 4% during the second season monitoring (Table 3). Of the herbaceous species, sword fern, starflower and fringecup had the highest average percent covers by the end of the second growing season (Table 3).

Two non-native potentially invasive species were recorded. Both wall-lettuce and herb Robert were present in very small amounts (less than 1% cover) (Table 3).

Table 3. Herbaceous species found in six study plots in Hamlin Park from three treatments at the end of the second growing season. Values represent the number of surviving plants present during monitoring. Average percent cover of each species across all plots is in parentheses.

		Compost[2]		Mulch[2]		Plant[2]		
Scientific Name[1]	**Common Name**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**Number Planted (per treatment)**
Native Plants								
Achlys triphylla	vanilla leaf	14 (1.5)	18 (1)	15 (1)	0	19 (1)	34 (1)	18
Asarum caudatum	wild ginger	10 (T)	10 (T)	3 (T)	0	9 (T)	3 (0.5)	18
Epilobium ciliatum	fringed willowherb	0 (T)	0	0	0	0 (T)	0	0
Fragaria vesca	woodland strawberry	5 (T)	2 (T)	5 (T)	0	11 (T)	0	18
Lonicera ciliosa	orange honeysuckle	0	0	0	0	0 (T)	0 (T)	0
Polystichum munitum	sword fern	11 (3)	11 (6)	13 (4)	12 (5)	10 (3)	13 (4)	12
Pteridium aquilinum	bracken fern	0 (T)	0 (1)	0 (1)	0 (2)	0 (2)	0 (4)	0
Tellima grandiflora	fringecup	18 (3.5)	14 (4)	15 (1)	11 (1)	16 (1.5)	19 (1)	18
Trientalis borealis ssp. latifolia	starflower	64 (1)	209 (4)	25 (0.5)	63 (1)	51 (1)	257 (4.5)	18
Vancouveria hexandra	inside-out flower	13 (1)	13 (0.5)	8 (T)	8 (T)	18 (1)	15 (1)	18
Non-native plants (percent cover only)								
Geranium robertianum*	herb Robert	0	T	0	0	T	T	0
Lapsana communis*	nipplewort	0	0	0	0	T	0	0
Mycelis muralis*	wall-lettuce	T	T	T	T	T	T	0
Solanum dulcamara*	deadly nightshade	0	0	T	T	0	0	0

[1] Species in bold are non-native species. Species denoted by * are species which have been given a legal designation by the King County Noxious Weed Program (King County 2009). Species denoted by ** are nonnative invasive species which do not have a legal designation at this time.

[2] T=Trace presence of species (less than 1%).

Mulch treatment – shrubs

The mulch treatment consisted of adding 6-8 inches of mulch on top of the soil prior to planting and installing plants directly into the existing soil beneath the mulch. This treatment was replicated across six plots in Hamlin Park. Seven species of shrubs were planted in each of the six subplots (Table 2). Three of the shrub species had a fairly poor survival rate, including serviceberry (50%), beaked hazelnut (50%) and creeping blackberry (50%) (Table 2). Western rhododendron had a slightly higher survival rate of 67%. The remaining species had very good survival rates. Both low Oregon grape and evergreen huckleberry had a survival rate of 92%. Salal had survival rates of greater than 100% due to natural recruitment within the plots (Table 2).

Mulch treatment – herbaceous species

Several of the seven planted herbaceous species showed very poor survival rates including wild ginger (0%), woodland strawberry (0%), vanilla leaf (0%) and inside-out flower (44%) (Table 5). Fringecup was more successful with 61% of the plants surviving. Sword fern had a survival rate of 100%. As in the compost treatment, starflower had a survival rate of greater than 100% due to natural recruitment present on the sites. One additional species – bracken fern – was also found within this treatment as a result of natural recruitment (Table 3).

Two non-native invasive species were found in Plot 4. They consist of wall-lettuce and deadly nightshade (*Solanum dulcamara*). Deadly nightshade is listed as a Noxious Weed of Concern in King County (King County 2008). Both species were found in very small amounts (less than 1%).

Planted directly into soil – shrubs

All of the shrubs planted directly into the soil showed good survival rates of over 80% (Table 2). Salal and low Oregon grape in particular had survival rates of greater than 100% due to natural recruitment on the sites. Two species of native shrubs that were not planted include red elderberry (*Sambucus racemosa*) and red huckleberry, both present in small amounts.

Planted directly into soil – herbaceous species

Of the seven species planted directly into the soil, wild ginger and woodland strawberry had the worst survival rates, with 17% and 0% respectively (Table 3). Inside-out flower did much better with a survival rate of 83%. Vanilla leaf, starflower, sword fern and fringecup all had survival rates greater than 100% due to reproduction and natural recruitment in the plots. Two additional native herbaceous species were recorded during monitoring and were not planted. These species include orange honeysuckle (*Lonicera ciliosa*) and bracken fern. Bracken fern was found on three plots and covered an average of 4% across all plots (Table 3).

Two species of non-native invasive herbaceous plants were recorded in this treatment. These included herb Robert and wall-lettuce, all of which were found in very small quantities of less than 1% cover.

Control – shrubs

Shrubs were recorded in two plots during the baseline survey. The goal of this treatment is to see whether human exclusion is sufficient to re-vegetate bare areas within the park. Data collected following the second growing season show that no major differences exist within these plots. Salal, low Oregon grape, creeping blackberry and snowberry were recorded in the control treatment during baseline monitoring (Table 4). All of these species with the exception of the snowberry are still present at similar percent covers within the plots. The snowberry seedlings recorded during the baseline study were not seen after year one and probably did not survive the growing season.

One non-native species, Franchet cotoneaster (*Cotoneaster franchetti*) was recorded in trace amounts in 2009. This species can be potentially invasive, but does not have a legal designation at this time in King County.

Table 4. Shrub species found in six study plots in Hamlin Park within the control treatment at the end of the second growing season. Values represent the average percent cover of each species across all plots present during baseline, first year and second year monitoring.

Scientific[1]	Common	Baseline[2]	2008[2]	2009[2]
Native Plants				
Gaultheria shallon	salal	2	2	2
Mahonia nervosa	low Oregon grape	1	1	1
Rubus ursinus	creeping blackberry	T	T	1
Symphoricarpos albus	snowberry	T	0	0
Non-native plants				
Cotoneaster franchetti***	Franchet cotoneaster	0	0	T

[1] Species in bold are non-native species. Species denoted by * are species which have been given a legal designation by the King County Noxious Weed Program (King County 2009). Species denoted by ** are nonnative invasive species which do not have a legal designation at this time.
[2] T=Trace presence of species (less than 1%).

Control – herbaceous species

During the baseline survey, only one native herbaceous species, evergreen violet, was recorded in very small amounts (less than 1%) (Table 5). One growing season later, three additional native herbaceous species were recorded in the plots: orange honeysuckle (*Lonicera ciliosa*), bracken fern and starflower. Most of these species appear to be increasing within the control plots, although the increases can also potentially be attributed to watering or seasonal variability. Further monitoring will be necessary to find out whether these trends hold after watering stops in the plots. Bracken fern increased from an average of 1% cover per plot in 2008 to 4% cover per plot in 2009. Starflower increased from trace amounts in 2008 to an average of 8% cover in 2009 (Table 5).

Five non-native species were recorded during the baseline survey (Table 5), of which four were found following the second year of monitoring. These species include herb Robert, nipplewort, wall-lettuce and dandelion. During the baseline survey, herb Robert was present at a very high cover (35%) in one plot, Plot 4. Following the first growing season, the amount of herb Robert dropped to 1%, but was replaced by nipplewort, with was present at a 40% in the same plot. Overall the percent cover of non-native species is negligible within most plots.

Table 5. Herbaceous species found in six study plots in Hamlin Park within the control treatment at the end of the second growing season. Values represent the average percent cover of each species across all plots present during baseline, first year and second year monitoring.

Scientific Name[1]	Common Name	Baseline[2]	2008[2]	2009[2]
Native Plants				
Lonicera ciliosa	orange honeysuckle	0	T	0.5
Pteridium aquilinum	bracken fern	0	1	4
Trientalis borealis ssp. latifolia	starflower	0	T	8
Viola sempervirens	evergreen violet	T	T	T
Non-native plants				
Hedera helix*	English ivy	T	0	0
Geranium robertianum*	herb Robert	6	T	T
Lapsana communis **	nipplewort	T	7	3
Mycelis muralis **	wall-lettuce	T	T	T
Taraxacum officinale	dandelion	T	0	T

[1] Species in bold are non-native species. Species denoted by * are species which have been given a legal designation by the King County Noxious Weed Program (King County 2009). Species denoted by ** are nonnative invasive species which do not have a legal designation at this time.
[2] T=Trace presence of species (less than 1%).

5. Interior and Exterior Plots

One of the objectives of this study was to examine whether it is more productive to re-vegetate bare areas starting from a shared edge with existing vegetation as opposed to planting in the center of a bare area. One of the hypotheses was that planting near a vegetated edge would allow plants to spread into the planted area and allow for faster re-vegetation. In addition, the mycchorhizal associations of the existing plants should allow the new plantings to do better than those with no vegetation nearby. To test this idea, three of the six study plots were established in "edge" zones, adjacent to existing vegetation. Three other study plots were established in the "interior" of bare patches, far away from existing vegetation. Plots 1, 2 and 6 are interior plots whereas plots 3, 4 and 5 are edge plots (Map 1). Results from two years of monitoring were compared in both edge and interior plots (Tables 6 &7).

Overall, the results from both exterior and interior plots were similar in terms of the ratios of surviving plants. It is likely that conclusive results would take many years to become evident. One exception was starflower, which was higher on edge plots in all treatments due to natural recruitment (Table 7). Salal and Oregon grape were also higher on some of the edge plots due to plot placement next to existing vegetation. At this time, results are generally inconclusive regarding the benefits of positioning restoration sites adjacent to existing vegetation. However, it will likely make sense spatially in many locations to expand restoration efforts from existing vegetated areas and to take advantage of natural plant recruitment in planted areas.

Table 6. Planted shrub species found in three interior and three edge study plots in Hamlin Park in 2008 and 2009. Values represent the number of surviving plants present during monitoring.

		2008		2009	
Scientific	**Common**	**Edge**	**Interior**	**Edge**	**Interior**
Amelanchier alnifolia	serviceberry	8	7	7	2
Corylus cornuta	beaked hazelnut	13	14	12	7
Gaultheria shallon	salal	59	18	57	14
Mahonia nervosa	low Oregon grape	20	23	20	20
Rhododendron macrophyllum	western rhododendron	16	12	15	10
Rubus ursinus	creeping blackberry	14	10	19	6
Vaccinium ovatum	evergreen huckleberry	16	15	17	16

Table 7. Planted herbaceous species found in three interior and three edge study plots in Hamlin Park in 2008 and 2009. Values represent the number of surviving plants present during monitoring.

		2008		2009	
Scientific	**Common**	**Edge**	**Interior**	**Edge**	**Interior**
Achlys triphylla	vanilla leaf	25	23	33	19
Asarum caudatum	wild ginger	9	13	7	6
Fragaria vesca	woodland strawberry	17	4	2	0
Polystichum munitum	sword fern	19	15	21	15
Tellima grandiflora	fringecup	25	24	21	23
Trientalis borealis ssp. latifolia	starflower	116	24	498	31
Vancouveria hexandra	inside-out flower	20	19	16	20

6. SUMMARY

Results in the Hamlin Park Re-vegetation Study were analyzed following the first and second growing seasons for installed plants. Results show the following trends (Table 8):

Table 8. Survival rates for shrub and herbaceous species found in six study plots in Hamlin Park across three treatments. Values represent the survival rate (in percent) of each species present after the second year of monitoring.

Scientific Name	Common Name	Compost	Mulch	Direct Planting
Shrubs				
Amelanchier alnifolia	serviceberry	17	50	83
Corylus cornuta	beaked hazelnut	8	50	100
Gaultheria shallon	salal	50	>100	>100
Mahonia nervosa	low Oregon grape	83	92	>100
Rhododendron macrophyllum	western rhododendron	33	67	>100
Rubus ursinus	creeping blackberry	67	50	92
Vaccinium ovatum	evergreen huckleberry	92	92	92
Herbaceous Species				
Achlys triphylla	vanilla leaf	100	0	>100
Asarum caudatum	wild ginger	56	0	17
Fragaria vesca	woodland strawberry	11	0	0
Polystichum munitum	sword fern	92	100	>100
Tellima grandiflora	fringecup	78	61	>100
Trientalis borealis ssp. latifolia	starflower	>100	>100	>100
Vancouveria hexandra	inside-out flower	72	44	83

Compost treatment – Of the shrub species, salal, serviceberry, beaked hazelnut and western rhododendron had very poor survival rates of 50% or less. Creeping blackberry had a mediocre survival rate of 67%. The remaining two shrub species had survival rates of over 80%. Of the herbaceous species, woodland strawberry had the poorest survival rate, with only 11% of plants surviving past the second growing season. Wild ginger, inside-out flower and fringecup had mediocre survival rates of 56%, 72% and 78% respectively (Table 8). Based on these results, composting does not appear to be an effective method for large-scale re-vegetation efforts.

Mulch treatment – Of the shrub species, serviceberry, beaked hazelnut and creeping blackberry had poor survival rates of 50% each. Western rhododendron had a mediocre survival rate of 67%. The remaining shrubs had survival rates of greater than 90%. Several of the seven planted herbaceous species showed very poor survival rates including vanilla leaf (0%), wild ginger (0%), woodland strawberry (0%) and inside-out flower (44%). Fringecup fared slightly better with a survival rate of 61%. The remaining two species had good survival rates of 100% or greater (Table 8). The mulch treatment did not show better survivability for any species compared to direct planting and does not appear to be an effective method for large-scale re-vegetation efforts.

Planted directly into soil treatment – After the second growing season, all the shrubs planted directly into the soil showed high survival rates of over 80%. Of the seven herbaceous species planted directly into the soil, wild ginger and woodland strawberry had the worst survival rates, with 17% and 0% respectively. The remaining species all had survival rates of greater than 80% (Table 8). Direct planting showed the highest survivability of all but two species of herbaceous plants. Based on these results, direct planting appears to be the most effective method for large-scale re-vegetation efforts.

Control treatment – At the end of two growing seasons, no differences were apparent between shrub species present in the control plots. Of the herbaceous species, bracken fern and starflower increased considerably in percent cover in control plots. However, it is not apparent whether this was due to human exclusion or other factors such as the greater availability of water in the plot as a result of watering of adjacent plantings over the summer. It is too early to tell whether human exclusion will be an effective method of re-vegetation.

Overall – Following the second growing season, collected data seems to indicate that direct planting of both shrubs and herbaceous species is the most successful re-vegetation method. Among the shrub species, all those tested had good survival rates. However, creeping blackberry appeared the weakest after fall 2009 monitoring and had the smallest percent cover of all the shrub species. Among the herbaceous species, vanilla leaf, sword fern, starflower and inside-out flower exhibit the best survival rates in direct planting trials. Wild ginger and fringecup appeared to have better survival rates and/or greater percent cover within the compost treatments. It is recommended that these two species are provided with targeted compost applications if planted into the soil directly.

Analysis of plots located on the edge and in interior locations indicates that slightly better results might be achieved by initiating large scale re-vegetation efforts from edges of existing vegetation and taking advantage of existing plant stock. It is also recommended that test plots are re-sampled in subsequent growing seasons to form more definitive analyses and recommendations.

7. RECOMMENDATIONS

The overall purpose of the study was to determine the best approach for restoring shrub and herbaceous diversity to areas currently devoid of understory vegetation. Plant survival results after two years of monitoring suggest that, for most species, planting directly into the soil with no amendments will yield the best results. This approach is also the most cost effective and least labor intensive. General recommendations for expanding restoration efforts include the following:

1. Plant directly into the existing soil with no soil amendment
2. Choose plants tolerant of low pH levels (see plant survival rates in Table 8)
3. Expand into bare areas adjacent to existing vegetation where practical

It is recommended that new and expanded restoration efforts be fenced off wherever possible to protect plant installations from trampling and other disturbances. All new restoration areas should be watered for at least two growing seasons to allow plants to become established.

Monitoring of existing test plots should continue in order to measure long term trends in plant establishment and survivability that may influence the methodology and maintenance of larger scale restoration efforts.

8. REFERENCES

King County Noxious Weed Control Program. 2009. King County Noxious Weed List. Seattle, WA

Seattle Urban Nature. 2008. Hamlin Park Vegetation Management Plan. http://www.seattleurbannature.org/Projects/Shoreline/Hamlin_Park_vmp_final.pdf