2009

Eagle Landing Park
Vegetation Inventory & Management Plan

"The day is done, and the darkness,

Falls from the wings of Night,

As a feather is wafted downward,

From an eagle in his flight"

~Henry Wadsworth Longfellow

BURIEN

KCD

WASHINGTON STATE DEPARTMENT OF Natural Resources

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

EarthCorps

LOCAL RESTORATION · GLOBAL LEADERSHIP

Eagle Landing Park

Vegetation Inventory & Management Plan

Prepared for: City of Burien, WA: Parks, Recreation, and Cultural Services

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Executive Summary

Eagle Landing Park is a small forested property managed by the City of Burien Parks, Recreation, and Cultural Services. The park consists of approximately 5.4 acres of forested natural areas with additional saltwater beach property. In 2009, the City of Burien, WA contracted with EarthCorps Science to survey and map the natural areas that make up Eagle Landing Park in order to create a detailed vegetation management plan to help guide the ongoing restoration of this unique site. The intent of this report is to enable the City of Burien to conduct restoration in a methodical and effective manner and provides specific data and findings which can be used to document and track on-the ground progress.

During the 2009 field season, EarthCorps Science mapped five habitat types and sampled 10 forest inventory plots throughout the property. During the course of the survey, a total of 51 plant species were found in Eagle Landing Park. Of these species, 15 are trees (nine native species, five non-native species and one unknown species), 18 are shrubs (16 native and two non-native species) and 18 herbaceous species (12 native, five non-native and one unknown species). The natural areas are deciduous dominated forests with varying levels of conifer and Pacific madrone (*Arbutus menziesii*) trees. Dominant shrubs include beaked hazelnut, salmonberry, and salal. The terrain transitions from upland forests in the east to steep coastal bluffs and wetlands in the west, terminating at the Puget Sound coastline. Several large conifer trees are present in the park, one with a bald eagles nest that has been active since 1989.

The natural areas at Eagle Landing Park provide important benefits to city residents. These benefits are directly dependent on the health and long-term viability of the forests and natural areas. Unfortunately, the existing forests are either threatened or in some stage of decline and have become heavily invaded with non-native invasive plant species. The most dominant invasive species found on the property are English ivy (*Hedera helix*) which was present at 65.8% average cover and cherry laurel (*Prunus laurocerasus*) which was found at an average density of 338 stems per acre. Without active management, existing conditions will continue to decline as invasive species spread and their detrimental effects further degrade the system.

Overarching management goals to help guide the ongoing restoration and management of Eagle Landing Park include:

1. Increasing the structural diversity of the forest with park-wide native tree planting to occur in phases over a number of years
2. Eradication and control of invasive trees (cherry laurel, English holly and other species) to occur in phases as resources become available
3. Enactment of comprehensive invasive removal and habitat restoration to occur in a step-wise fashion beginning in areas where restoration has already been initiated

Priority management recommendations in this report are detailed by habitat type zones, as well as timing for short, medium and long-term priorities. Proposals for initial restoration efforts are presented and best management practices for removing invasive species are included.

1. INTRODUCTION

In 2009, the City of Burien, WA contracted with EarthCorps Science to survey and map the natural areas that make up Eagle Landing Park. The nearly 6 acre property is managed by the City of Burien parks department, with active community stewardship participation. EarthCorps is a non-profit organization whose mission is to build global community through local environmental service. EarthCorps Science assists community groups, governments, non-profit organizations and private citizens in their efforts to survey, map, restore and maintain urban forests in the Puget Sound region.

The purpose of this report is to assist the City of Burien in their planning efforts for the ongoing stewardship and maintenance of the natural areas located at Eagle Landing Park. Because of the ongoing and increasing use and pressure from human impacts and invasive species, these natural areas will require active restoration and management to maintain and improve their aesthetic and ecological value. This report presents the findings of a scientific inventory of forest resources and evaluates the actions required for effective vegetation management of the property. This effort also establishes baseline information with which future surveys and monitoring may be compared. Specific goals of the project are to:

1) Identify and map the natural areas at Eagle Landing Park;
2) Provide an inventory of current vegetation conditions on the property;
3) Create management recommendations based on data collected during the inventory to specifically guide the restoration and revitalization of the natural areas located on the property.

Funding for this effort was provided by the Washington State Department of Natural Resources, the King Conservation District, and the City of Burien.

1.1 Overview

Eagle Landing Park is a small forested property located in a quiet residential neighborhood. The park consists of approximately 5.4 acres of forested natural areas with additional saltwater beach property. The park was acquired by the city on June 15th, 2005, and it is located in west-central Burien, WA along the Puget Sound coast. Eagle Landing Park extends from upland forests along the ridge overlooking the Sound down a steep bluff to the shoreline. A gravel trail takes visitors through the forest to a series of elevated stairs that zigzag down the bluff to provide access to the rocky beach. The beaches at both Eagle Landing Park and Seahurst Park were declared by the Burien City Council as Marine Reserves in 2005. The walk from the parking lot to the beach is about a third of a mile, dropping 290 feet in elevation from Southwest 149th Street to sea level. The park is open between 8:00 am and dusk.

Eagle Landing provides visitors with an opportunity to experience nature within the city of Burien. A large tree near the center of the park has had an active eagles nest since 1989, owing to the parks namesake. The park is home to over fifty species of native plants and a variety of wildlife including woodpeckers, hawks, raccoons, Douglas squirrels, otters, and foxes (http://eaglelandingpark.org 2009). A native plant garden was installed at the entrance of the

park following the construction of the parking lot and the installation of the informational kiosk. In addition, a drainage ditch was constructed along the southern edge of the property to divert storm water runoff. This area now supports a high variety of plants native to the Pacific Northwest, which in turn attracts considerable bird activity to the area.

The natural areas at Eagle Landing Park provide important benefits to city residents including recreational and learning opportunities, along with vital ecosystem services such as improved air and water quality. These benefits are directly dependent on the health and long-term viability of the forests and natural areas. Unfortunately, the existing forests are either threatened or in some stage of decline. As a result of past logging efforts coupled with the lack of historical maintenance, ongoing human disturbances, and the fragmented nature of the property, these natural areas have become heavily invaded with non-native invasive plant species. These pressures have hindered natural tree regeneration and compromised the structural integrity of the forest. Invasive species reduce the overall biodiversity and ecosystem function of the urban forest and suppress native plant growth, vigor, and natural reproduction. Without active management, existing conditions will continue to decline as invasive species spread and their detrimental effects further degrade the system.

Fortunately, Eagle Landing Park currently has active community stewardship involvement and restoration efforts are well underway. Ongoing efforts are targeting areas for invasive species removal and native trees, shrubs, and herbs have been planted throughout the park. However, considerable community effort will be required to fully reduce the impact of invasive species and reestablish the forest to a more self-sustaining natural state.

The purpose of this plan is to assess the existing vegetative conditions of the natural areas located on the property and to provide the initial framework for developing and implementing a long-term strategy for comprehensive restoration and maintenance. Recommendations for restoration efforts will focus on creating and restoring healthy ecosystem functions and processes while increasing species and structural diversity within the forests.

2. SITE LOCATION AND CONTEXT

2.1 Area Description

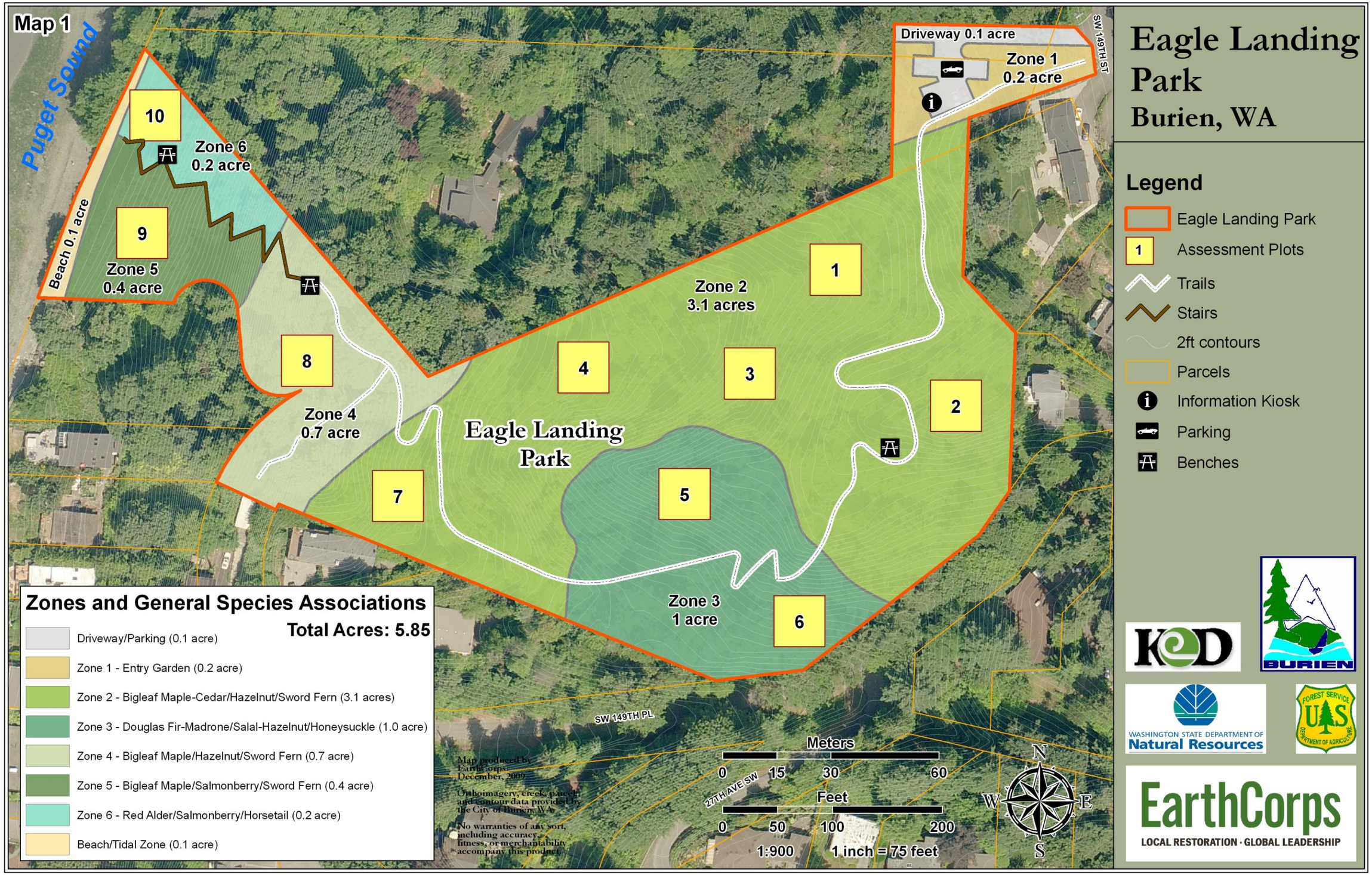
Eagle Landing Park is located at the west end of Southwest 149th Street, where it meets 25th Avenue Southwest (Map 1). The park is bordered on the north and south by residential properties. The west edge of the park includes shoreline along Puget Sound. There is an undeveloped property along the shoreline to the southwest that is maintained by the neighborhood association as natural open space which is adjacent to the park property. Eagle Landing Park is located west of downtown Burien and approximately one quarter of a mile south of Seahurst Park.

2.2 Geology and Hydrology

Most of Eagle Landing Park consists of generally dry forested uplands with well draining soils. The bluff and areas above are predominantly composed of advance outwash deposits comprised

of sandy/gravelly soils deposited by streams issuing from the advancing ice sheets during the last glacial period (Booth, 2004). The till-derived soils that developed on top of the outwash (generally referred to as "Alderwood") support the normal upland suite of coastal Pacific Northwest native plant species, and the well draining sandy conditions are particularly conducive to Pacific madrone habitats. From the parking area, there is a nominal valley depression that collects rainwater and runoff to the southwest and towards the sound. The drainage ditch that was constructed during the parking lot installation currently diverts water into the mouth of this valley. Below this ditch, there is no visible stream channel or other indications of surface flow.

The glacial outwash deposits overlay fine-grained deposits made up predominantly of silt and clay accumulated prior to the last glacial period (Booth, 2004). Particularly compacted clay deposits can be seen exposed in some areas where the beach transitions into the bluffs. Groundwater that has permeated through the glacial deposits emerges to the surface when it reaches this hardpan layer. As a result, the lower areas of the bluffs have numerous wet seeps. The lower part of the slope is designated by the King County Sensitive Area Ordinance as a wetland.


Map 1
Eagle Landing Park
Burien, WA
Puget Sound
Driveway 0.1 acre
Zone 1
0.2 acre
SW 149TH ST
Zone 6
0.2 acre
Beach 0.1 acre
Zone 5
0.4 acre
Zone 2
3.1 acres
Zone 4
0.7 acre
Eagle Landing Park
Zone 3
1 acre
SW 149TH PL
27TH AVE SW
1
2
3
4
5
6
7
8
9
10
Legend
Eagle Landing Park
Assessment Plots
Trails
Stairs
2ft contours
Parcels
Information Kiosk
Parking
Benches
Zones and General Species Associations
Total Acres: 5.85
Driveway/Parking (0.1 acre)
Zone 1 - Entry Garden (0.2 acre)
Zone 2 - Bigleaf Maple-Cedar/Hazelnut/Sword Fern (3.1 acres)
Zone 3 - Douglas Fir-Madrone/Salal-Hazelnut/Honeysuckle (1.0 acre)
Zone 4 - Bigleaf Maple/Hazelnut/Sword Fern (0.7 acre)
Zone 5 - Bigleaf Maple/Salmonberry/Sword Fern (0.4 acre)
Zone 6 - Red Alder/Salmonberry/Horsetail (0.2 acre)
Beach/Tidal Zone (0.1 acre)
Meters
0 15 30 60
Feet
0 50 100 200
1:900
1 inch = 75 feet
N
W
E
S
Map produced by Earthcorps December, 2009
Orthoimagery, creek, parcel, and contour data provided by the City of Burien, WA
No warranties of any sort, including accuracy, fitness, or merchantability accompany this product.
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3. FOREST ASSESSMENT METHODOLOGY

The purpose of the forest inventory is to:

1) Delineate and map habitats in Eagle Landing Park
2) Provide an inventory of current vegetation conditions in the park

The following section describes methodology used in this forest assessment.

3.1 Habitat Type Delineation

The project area was initially divided into areas of similar habitat types based on dominant plant species associations. Prevailing habitat types were delineated in the field using recent aerial orthoimagery maps and utilized a GPS unit to locate boundaries and principal reference points. This information was used to create a GIS base layer of the property in order to geographically represent the arrangement of each habitat type and to quantify the spatial area of each individual habitat. The initial delineations were revised and updated during the course of the plot-level survey. The final map displays the locations and distributions of each habitat type accompanied by the corresponding combined acreage for each habitat (Map 1).

3.2 Sampling Intensity

Vegetation management plans generally aim to sample three to ten percent of the forested area of interest. Using this guideline, EarthCorps surveyed 9% of the forested area during the summer of 2009. Eagle Landing Park is surrounded on three sides by private property and on the fourth by Puget Sound, resulting in a long and narrow shape for the park. Because two of the five forested habitat types are smaller than ½ acre in size and are irregularly shaped, it was determined that standard 0.1 acre forest assessment plots would not be able to fit within these forest types. As a result, 10 smaller 0.05 acre plots were established, allowing for greater variability to be recorded across the forested area.

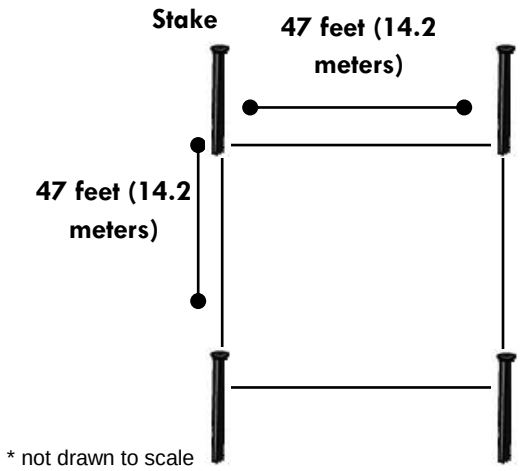
Non-forested portions of Eagle Landing Park totaling 0.4 acres were not included in the survey. These areas include the parking area and driveway, the native plant entry garden, and the beach/tidal zone (Map 1).

3.3 Plot Layout

Plots were distributed proportionately among all habitat types and randomly located within a particular habitat type. Of the 10 sample plots, five were located in the bigleaf maple-Douglas fir/hazelnut/sword fern forest, two in the Douglas fir-madrone/salal-hazelnut/honeysuckle forest, one in the bigleaf maple/hazelnut/sword fern forest, one in the bigleaf maple/salmonberry/sword fern forest, and one was located in the red alder/salmonberry/horsetail forest (Map 1)

The plots are square and cover an area 47 feet (14.2 meters) wide by 47 feet (14.2 meters) long (Figure 1). These dimensions equal approximately 0.05 acre in size. All four corners were marked with a 1”x 2” x 12” wooden stake driven into the ground and a capped piece of rebar inserted flush with the ground at each corner. GPS point locations have been recorded to within one meter accuracy at one corner of the plot (Appendix C).

Figure 1. Dimensions and layout of sampling plots in Eagle Landing Park*



3.4 Assessment Procedures

Two general categories of attributes, tree density and vegetation cover, were recorded at each plot. The average slope and aspect for each plot was also estimated and recorded.

Tree density: All trees with trunks occurring within the 1/20th acre plot were identified and enumerated including non-native tree and tree-like species such as cherry laurel (*Prunus laurocerasus*), English holly (*Ilex aquifolium*) and European mountain ash (*Sorbus aucuparia*). 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. Height and diameter at breast height (dbh – breast height is defined as 4.5 feet from the ground surface) were recorded for each tree. In addition, trees were assessed for colonization by English ivy. 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 5 inches in diameter, consisting of standing and downed logs and stumps, were measured and placed into one of three decay classes, I, II, or III. Decay class I indicated a branch or trunk that recently died and frequently had intact bark and branches and hard wood. Decay class III characterizes wood in an advanced state of decay with little to no bark or branches left intact, softened crumbling wood and extensive epiphytes. Decay class II provides an intermediate designation between these two extremes. CWD measurements from sampling plots were used to extrapolate an estimate of cubic feet of wood per acre (ft^3/acre) for further analysis.

Tree density was considered a key measure in this survey, as it allows for analysis of several aspects of forest functionality, including tree regeneration, forest structure, conifer to deciduous ratios, and the presence and frequency of exotic tree species.

Vegetation cover: All plant species occurring in, or with foliage overhanging the 1/20th acre plot, were identified and percent cover was visually estimated for each species. Overstory tree

cover was also estimated for each tree species overhanging the plot. Species that were present in trace amounts were given a minimum value of 0.1%. This allowed for a comprehensive floristic survey (i.e. species richness) for each plot location.

Cover and richness were chosen as measurable attributes in order to provide an estimate of species and structural diversity. These attributes can be extrapolated to provide an estimate of the extent that an area has been invaded by non-native species.

3.5 Data Collection and Management

Data collection was conducted by a staff ecologist at EarthCorps Science and a volunteer park steward for Eagle Landing Park. 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 9.3, which connects geographic information (e.g., maps, aerial photographs, topography) with tabular information (e.g., data plot information in Access database).

4. PROPERTY-WIDE RESULTS AND FINDINGS

The results and findings section provides a summary and analysis of collected field data. The following information is presented: property-wide vegetation trends (section 4.1); tree density (section 4.2); snags (section 4.3), coarse woody debris (section 4.4), shrub composition (section 4.5); and herbaceous and vine composition (section 4.6).

4.1 Property-wide Vegetation Trends

Eagle Landing Park includes a variety of habitats and plant species assemblages. The natural areas surveyed in 2009 consist of 5.4 acres, or 93% of the 5.8 acre property (Table 1). Due to the steep and varied topography within the park, many different habitat types are present. The park slopes from east to west, with a generally dry upland area in the eastern section of the park and descending to the Puget Sound in the west, where wetter conditions and seeps are present (Map 1). This change in the water regime is evidenced by the differing dominant plant associations between zones. The eastern portions of the property (Zones 2 and 3) contain a mixed conifer/deciduous forest, dominated by bigleaf maple (*Acer macrophyllum*) and Western red cedar (*Thuja plicata*) overstory with a beaked hazelnut (*Corylus cornuta*) and sword fern (*Polystichum munitum*) understory along with a conifer/madrone forest dominated by a Douglas fir (*Pseudotsuga menziesii*) and Pacific madrone (*Arbutus menziesii*) overstory with a salal (*Gaultheria shallon*), beaked hazelnut and hairy honeysuckle (*Lonicera hispidula*) understory. In the western section of the park, the upland forests transition into a mesic deciduous forest (Zone 4) dominated by bigleaf maple with a beaked hazelnut and sword fern understory. Further west in zones 5 and 6, the forest becomes wetter. Zone 5 is dominated by a bigleaf maple overstory with a salmonberry (*Rubus spectabilis)* and sword fern understory, whereas Zone 6 is dominated by a red alder (*Alnus rubra*) overstory with a salmonberry and scouring-rush horsetail (*Equisetum hyemale*) understory (Table 1).

A total of 51 plant species were found in Eagle Landing Park during the survey. Of these species, 15 are trees (nine native species, five non-native species and one unknown species), 18 are shrubs (16 native and two non-native species) and 18 are herbaceous species (12 native, five non-native and one unknown species) (Appendix A).

Table 1. Management zones in Eagle Landing Park are shown with dominant tree/shrub associations, total acreage and number of plots sampled in each zone.

Zone	Habitat Type	Acres	Percent of Total Area	Number of Sampled Plots
2	Bigleaf Maple-Cedar/ Hazelnut/Sword Fern	3.1	53.4%	5
3	Douglas Fir-Madrone/ Salal-Hazelnut/Honeysuckle	1	17.2%	2
4	Bigleaf Maple/ Hazelnut/Sword Fern	0.7	12.1%	1
5	Bigleaf Maple/ Salmonberry/Sword Fern	0.4	6.9%	1
6	Red Alder/ Salmonberry/Horsetail	0.2	3.4%	1
Subtotal		**5.4**	**93.1%**	**10**
Developed Areas and Unsurveyed Habitats				
1	Entry Garden	0.2	3.4%	
	Driveway/Parking	0.1	1.7%	
	Beach/Tidal Zone	0.1	1.7%	
Subtotal		**0.4**	**6.9%**	
Total		**5.8**	**100%**	

4.1.1 Native species overview

As noted above, the overstory trees present in Eagle Landing Park are made up predominantly of bigleaf maple (Table 2). Other native overstory trees were recorded at a cumulative average of more than 40 trees per acre and include red alder (12 stems per acre), Pacific madrone (12 stems per acre), western red cedar (10 stems per acre), and Douglas fir (8 stems per acre). (Table 2).

Overall, there is relatively low native tree regeneration occurring on the property, particularly in Zones 2, 4 and 6. All zones are lacking any substantial conifer tree regeneration (Table 3). Bigleaf maple was the most commonly found regenerating native tree, present at an average of 102 stems per acre. All other native trees were present at less than 10 stems per acre on average (Table 3).

Native shrub cover throughout all management zones averages 72% across the property (Table 4). Beaked hazelnut (24% average cover), salmonberry (18% average cover) and salal (16% average cover) are the most dominant native shrub species and are present in all management zones.

Native cover of herbaceous, grass and vine species is relatively low throughout the property, averaging 39.5% across all zones (Table 5). Most of the total cover is attributable to the prevalence of sword fern at an average of 29% across all management zones. Other common herbaceous species include hairy honeysuckle (4.5% average cover) and scouring-rush horsetail (*Equisetum hyemale*) (1.5% cover).

4.1.2 Invasive species overview

A number of non-native plant species have invaded the forested areas of the park. Ten of the 12 non-native species recorded are considered potentially invasive, and seven of these have been given a legal designation by the King County Noxious Weed Control Board. Some of these species have become heavily invaded within the park. Without active management these species will continue to spread and detrimentally affect the natural areas of the property.

Non-native invasive plant species are abundantly present throughout the property. The most prevalent of these is English ivy (*Hedera helix*), which was found at an average property-wide cover of nearly 66% (Table 5 & Map 3). Other dominant invasive species include cherry laurel (*Prunus laurocerasus*) found at an average of 346 stems per acre, English holly (*Ilex aquifolium*) averaging 260 stems per acre and European mountain ash (*Sorbus aucuparia*) averaging 48 stems per acre (Tables 2 and 3). Invasive trees in general pose a serious threat to the future integrity of the forest, with non-native tree regeneration greatly outnumbering native tree regeneration (Figure 2 & Map 2).

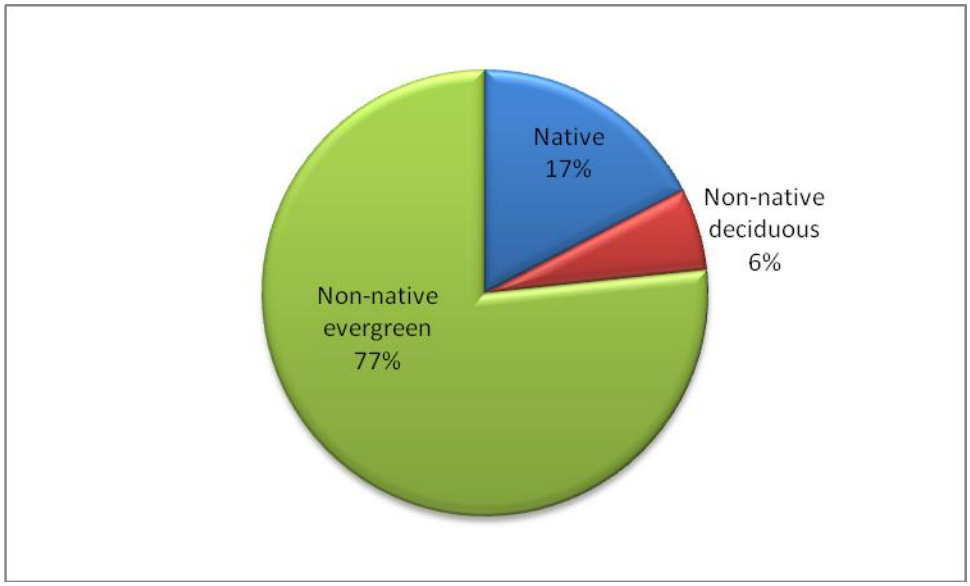
Other invasive species found on the property in small amounts include:

Trees: Portugal laurel (*Prunus lusitanica*), sweet cherry (*Prunus avium*), and sycamore maple (Acer pseudoplatanus, not sampled during survey).

Shrubs: Franchet's cotoneaster (*Cotoneaster franchetti*) and Himalayan blackberry (*Rubus armeniacus*).

Herbaceous: herb Robert (*Geranium robertianum*) and wild clematis (*Clematis vitalba*).

Figure 2. Ratios of native to non-native tree regeneration found in Eagle Landing Park in 2009[1].



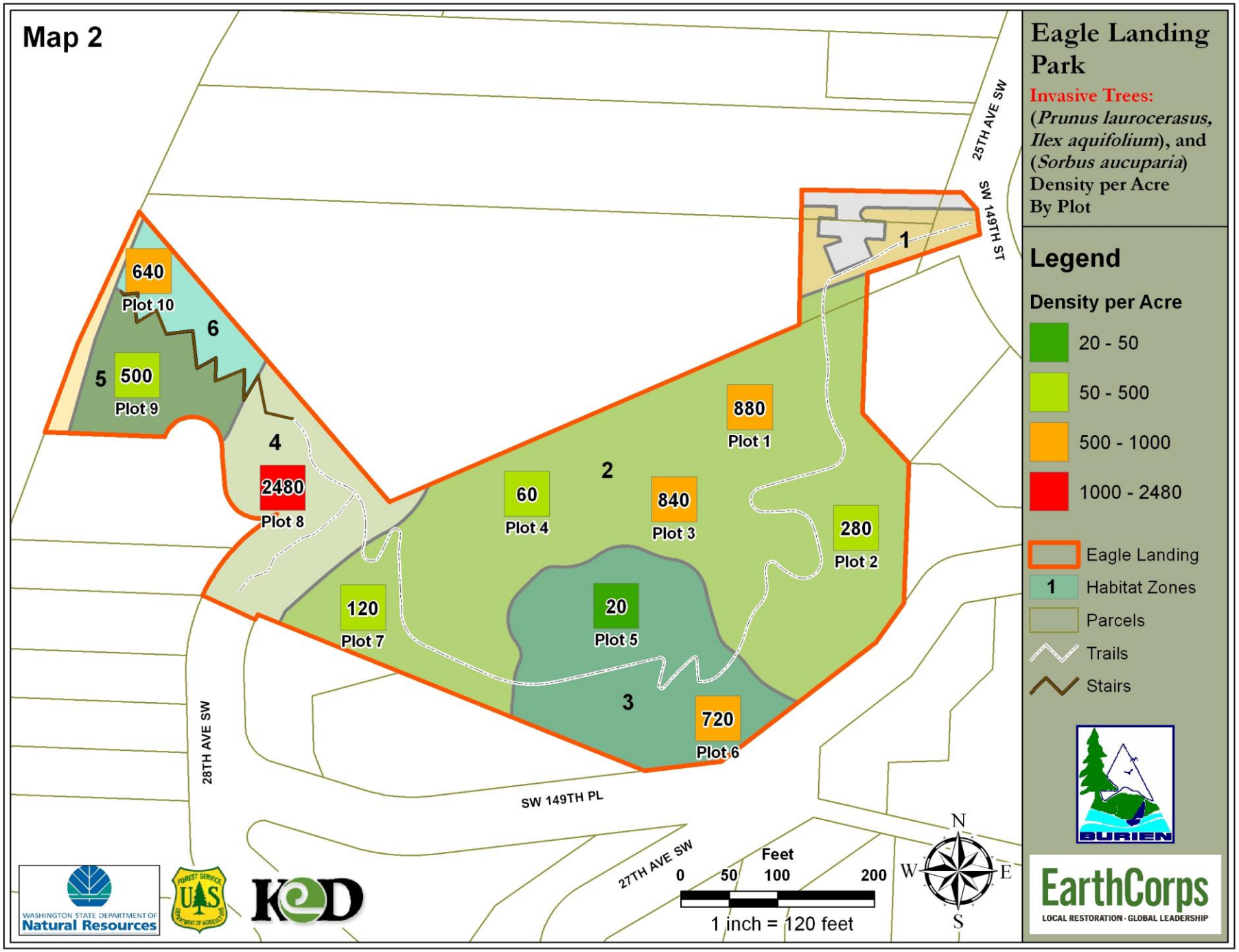
[1]Non-native evergreen trees consist of cherry laurel and English holly

Himalayan blackberry has been listed as a Class C Weed in King County for 2009 by the state weed board. This means that county weed boards have the option to require control of blackberry for all or parts of their county. In King County, Himalayan blackberry is a Non-regulated Noxious Weed (King County 2009).

English ivy, herb Robert and wild clematis are also listed as Non-designated Noxious Weeds in King County. These weeds are listed as noxious weeds on the Washington State Weed List but are so widespread in King County that control is highly recommended but not required by law (King County 2009).

English holly, cherry laurel and European mountain ash are designated as Weeds of Concern by King County. Weeds of Concern are widespread, unregulated species which impact and degrade native plant and animal habitat. Control and containment of existing populations is highly recommended but not required by law (King County 2008).

Portugal laurel, Franchet's cotoneaster and sweet cherry are non-native invasive tree and shrub species that have not been given a legal designation by the county or state governments. These species have the ability to colonize and reproduce in forested natural areas, competing with native plants for available resources.


Map 2
Eagle Landing Park
Invasive Trees:
(Prunus laurocerasus, Ilex aquifolium), and (Sorbus aucuparia)
Density per Acre
By Plot
Legend
Density per Acre
20 - 50
50 - 500
500 - 1000
1000 - 2480
Eagle Landing
Habitat Zones
Parcels
Trails
Stairs
640
Plot 10
500
Plot 9
2480
Plot 8
60
Plot 4
880
Plot 1
840
Plot 3
280
Plot 2
120
Plot 7
20
Plot 5
720
Plot 6
1
2
3
4
5
6
25TH AVE SW
SW 149TH ST
28TH AVE SW
SW 149TH PL
27TH AVE SW
Feet
0
50
100
200
1 inch = 120 feet
N
S
E
W
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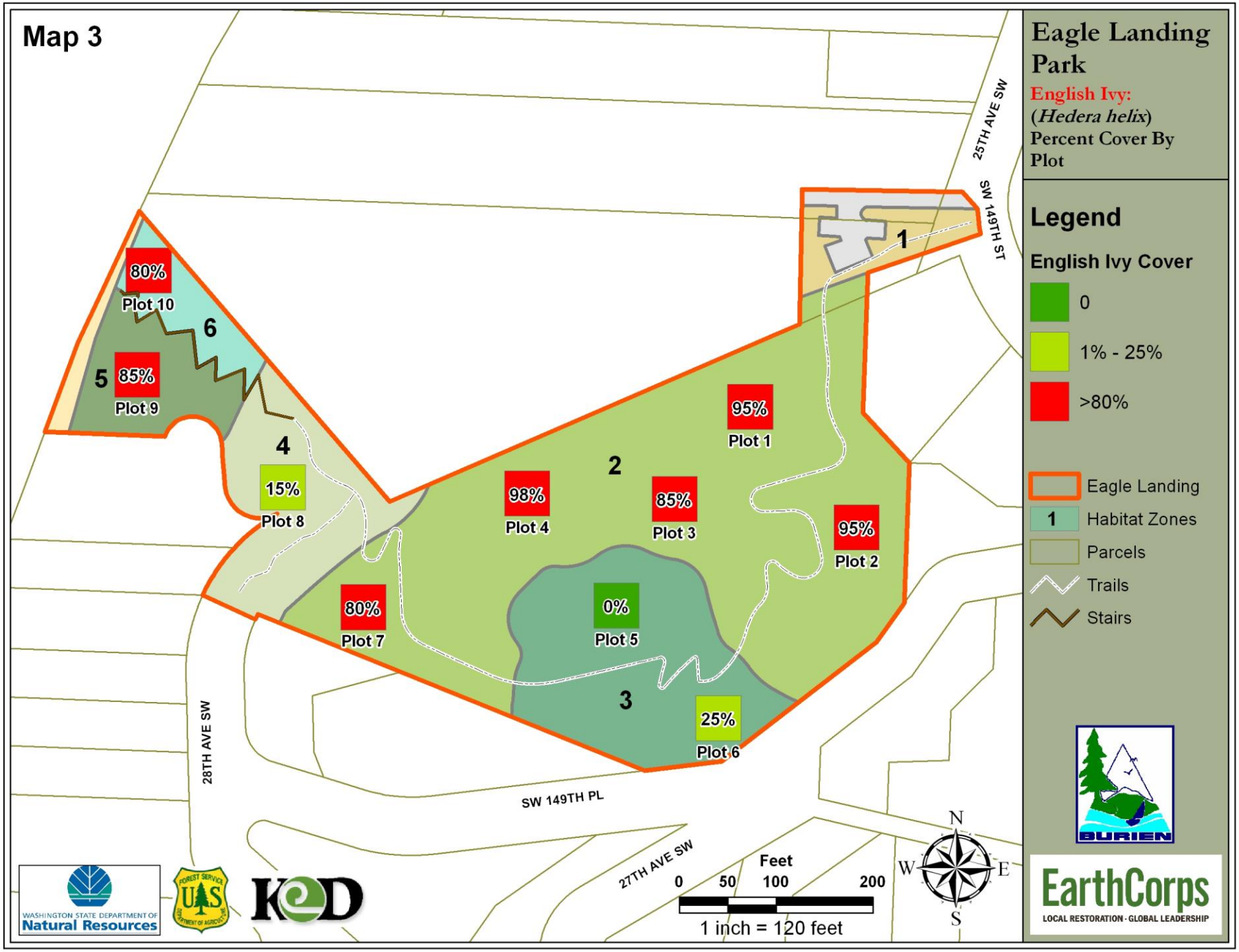
Map 3
Eagle Landing Park
English Ivy:
(Hedera helix)
Percent Cover By Plot
Legend
English Ivy Cover
0
1% - 25%
>80%
Eagle Landing
Habitat Zones
Parcels
Trails
Stairs
1
2
3
4
5
6
95% Plot 1
95% Plot 2
85% Plot 3
98% Plot 4
0% Plot 5
80% Plot 7
15% Plot 8
85% Plot 9
80% Plot 10
25% Plot 6
25TH AVE SW
SW 149TH ST
28TH AVE SW
SW 149TH PL
27TH AVE SW
Feet
0 50 100 200
1 inch = 120 feet
N
S
E
W
BURIEN
EarthCorps
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Table 2. Overstory tree species by nativity found in each of the management zones sampled in Eagle Landing Park in 2009. Values represent density (stems/acre) of each species averaged across all plots (N=10) in each zone with property wide averages in the last column.

Scientific Name[1]	Common Name	Native	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Property Wide Density
Acer macrophyllum	bigleaf maple	Yes	64	10	80	140	20	58
Alnus rubra	red alder	Yes	8	10			60	12
Arbutus menziesii	Pacific madrone	Yes	12	30				12
Pseudotsuga menziesii	Douglas fir	Yes	8	20				8
Thuja plicata	western red cedar	Yes	16	10				10
Tsuga heterophylla	western hemlock	Yes		10				2
Total Native Overstory:			**108**	**90**	**80**	**140**	**80**	**102**
*Prunus laurocerasus**	cherry laurel	No			80			8
*Prunus lusitanica***	Portugal laurel	No	4					2
*Sorbus aucuparia**	European mountain ash	No				40		4
Total Non-Native Overstory:			**4**	**0**	**80**	**40**	**0**	**14**
Total Overstory Tree Density:			**112**	**90**	**160**	**180**	**80**	**116**

[1]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 non-native invasive species which do not have a legal designation at this time.

Table 3. Regenerating tree species by nativity found in each of the management zones sampled in Eagle Landing Park in 2009. Values represent density (stems/acre) of each species averaged across all plots (N=10) in each zone with property wide averages in the last column.

Scientific Name[1]	Common Name	Native	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Property Wide Density
Abies grandis	grand fir	Yes	4					2
Acer macrophyllum	bigleaf maple	Yes	132		60	240	60	102
Alnus rubra	red alder	Yes		30				6
Arbutus menziesii	Pacific madrone	Yes		40				8
Prunus emarginata	bitter cherry	Yes	8					4
Pseudotsuga menziesii	Douglas fir	Yes	16					8
Thuja plicata	western red cedar	Yes	8			20		6
Total Native Regeneration:			**168**	**70**	**60**	**260**	**60**	**136**
*Ilex aquifolium**	English holly	No	152	320	600	20	580	260
*Prunus avium***	sweet cherry	No	4					2
*Prunus laurocerasus**	cherry laurel	No	256	30	1800	180	60	338
*Sorbus aucuparia**	European mountain ash	No	28	20		260		44
	unknown tree species	X	4					2
Total Non-Native Regeneration:			**444**	**370**	**2400**	**460**	**640**	**646**
Total Regenerating Tree Density:			**612**	**440**	**2460**	**720**	**700**	**782**

[1]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 non-native invasive species which do not have a legal designation at this time.

Table 4. Shrub species by nativity found in each of the management zones sampled in Eagle Landing Park in 2009. Values represent the percent cover of each species averaged across all plots (N=10) in each zone with property wide averages in the last column.

Scientific Name[1]	Common Name	Native	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Property Wide Average
Acer circinatum	vine maple	Yes	0.6					0.3
Corylus cornuta	beaked hazelnut	Yes	20.8	50.0	40.0			24.4
Gaultheria shallon	salal	Yes	6.2	61.5	7.0			16.1
Holodiscus discolor	oceanspray	Yes	1.4	1.0	5.0			1.4
Mahonia nervosa	low Oregon grape	Yes	0.1	2.5	3.0			0.9
Oemleria cerasiformis	Indian plum	Yes	2.6			12.0	0.5	2.6
Oplopanax horridus	devil's club	Yes					0.5	0.1
Ribes bracteosum	stink currant	Yes					1.0	0.1
Rosa gymnocarpa	baldhip rose	Yes	0.3	1.3	1.0			0.5
Rubus parviflorus	thimbleberry	Yes	2.8	5.0				2.4
Rubus spectabilis	salmonberry	Yes	10.8			30.0	95.0	17.9
Rubus ursinus	creeping blackberry	Yes	1.7	6.5	1.0	8.0		3.1
Sambucus racemosa	red elderberry	Yes				2.0	1.0	0.3
Vaccinium ovatum	evergreen huckleberry	Yes	1.6					0.8
Vaccinium parvifolium	red huckleberry	Yes	0.1					0.1
Viburnum opulus var. americanum	American cranberrybush	Yes	2.4					1.2
Total Native Shrub Cover:			**51.4**	**127.8**	**57.0**	**52.0**	**98.0**	**72.0**
*Cotoneaster franchetti***	Franchet's cotoneaster	No		0.3				0.1
*Rubus armeniacus**	Himalayan blackberry	No	0.2	4.0		3.0		1.2
Total Non-native Shrub Cover:			**0.2**	**4.3**	**0.0**	**3.0**	**0.0**	**1.3**
Total Shrub Cover:			**51.6**	**132.1**	**57.0**	**55.0**	**98.0**	**73.3**

[1]Species denoted by * are species which have been given a legal designation by the King County Noxious Weed Program (King County 2008). Species denoted by ** are non-native invasive species which do not have a legal designation at this time.

Table 5. Herbaceous, grass, and vining species found in each of the management zones sampled in Eagle Landing Park in 2009. Values represent the percent cover of each species averaged across all plots (N=10) in each zone with property wide averages in the last column.

Scientific Name[1]	Common Name	Native	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Property Wide Average
Athyrium filix-femina	ladyfern	Yes	0.4				10.0	1.2
Bromus vulgaris	Columbia brome	Yes	0.0			1.0		0.1
Dryopteris expansa	wood fern	Yes					2.0	0.2
Equisetum hyemale	scouring-rush horsetail	Yes					15.0	1.5
Equisetum telmateia	giant horsetail	Yes				6.0	1.0	0.7
Galium aparine	cleavers	Yes	0.1					0.1
Lonicera hispidula	hairy honeysuckle	Yes		22.5				4.5
Polypodium glycyrrhiza	licorice fern	Yes	0.4					0.2
Polystichum munitum	sword fern	Yes	35.4	32.5	10.0	35.0	6.0	29.3
Pteridium aquilinum	bracken fern	Yes	0.6	5.0				1.3
Tellima grandiflora	fringecup	Yes	0.4		0.1	0.5	0.5	0.3
Urtica dioica	stinging nettle	Yes				1.0		0.1
Total Native Herbaceous Cover:			**37.3**	**60.0**	**10.1**	**43.5**	**34.5**	**39.5**
	Unknown grass species	X	0.0					0.0
Cardamine hirsuta	hairy bittercress	No	0.0					0.0
*Clematis vitalba**	wild clematis	No	1.2					0.6
Digitalis purpurea	foxglove	No				0.1		0.0
*Geranium robertianum**	herb Robert	No	1.6					0.8
*Hedera helix**	English ivy	No	90.6	12.5	15.0	85.0	80.0	65.8
Total Non-native Herbaceous Cover:			**93.4**	**12.5**	**15.0**	**85.1**	**80.0**	**67.2**
Total Herbaceous Cover:			**130.8**	**72.5**	**25.1**	**128.6**	**114.5**	**106.7**

[1]Species denoted by * are species which have been given a legal designation by the King County Noxious Weed Program (King County 2008).

4.2 Tree Density

Tree density was considered a key measure in this survey, as it allows for analysis of several aspects of forest functionality, including tree regeneration, forest structure, conifer to deciduous ratios, and the presence and frequency of exotic tree species. Tree density can be used to draw inferences about overall forest development and succession. In general, older stands tend to have lower densities due to self-thinning through the process of competitive exclusion. These forests generally exhibit a variety of tree heights and diameters which creates a canopy with high structural diversity (trees of differing ages and size classes). Younger forests, on the other hand, generally have higher tree densities and limited structural diversity (Spies and Franklin 1991).

4.2.1 Overstory Tree Composition and Structure

The forest overstory refers to the upper and mid canopies of a forest. 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 six native tree species and three non-native tree species were recorded in Eagle Landing Park (Table 2), making up five distinct forest types on the property.

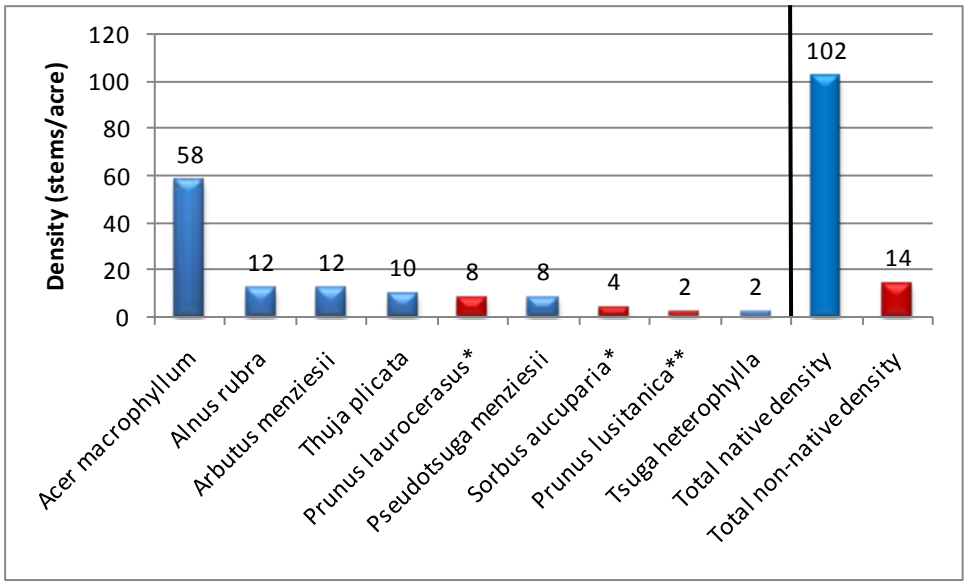
Zone 2 consists of a conifer/deciduous mixed forest dominated by bigleaf maple (averaging 64 stems per acre) and western red cedar (averaging 16 stems per acre). This zone also contains a smaller component of Pacific madrone trees (averaging 12 stems per acre), along with red alder and Douglas fir (averaging 8 stems per acre each) (Table 2). A small stand of Pacific dogwood (*Cornus nuttallii*) is also present in the zone near Plot 3, but was not captured in any of the plots during the survey. A very small amount of Portugal laurel, a non-native invasive tree species is present in the zone (averaging 4 stems per acre). In addition, small amounts of sycamore maple were noted near the trail entrance, although no trees were located within sample plots. The average native overstory tree density in Zone 2 is 108 stems per acre, compared to 4 stems per acre for non-native overstory trees (Table 2).

Zone 3 is primarily a conifer/madrone mixed forest with an average of 30 stems per acre of Pacific madrone and 20 stems per acre of Douglas fir (Table 2). This zone contains the highest native diversity of overstory trees, with small amounts of four other species (averaging 10 stems/acre each): bigleaf maple, red alder, western red cedar and western hemlock (*Tsuga heterophylla*). Based on the plot level survey, this zone does not contain any non-native overstory trees. Overstory tree density averages 90 stems per acre in this zone (Table 2).

Zones 4, 5 and 6 are deciduous forests, with no conifer trees sampled during the plot level survey. Zone 4 is a bigleaf maple forest with an average of 80 stems per acre of overstory bigleaf maple trees. This zone also contains an equivalent amount of invasive cherry laurel trees in the overstory, for a combined average of 160 trees per acre (Table 2). Zone 5 is also made up entirely of bigleaf maples trees, averaging 140 stems per acre in the zone. This zone has an additional 40 stems per acre of invasive European mountain ash trees in the overstory. Zone 5 is the densest zone in the park, averaging 180 stems per acre of overstory trees (Table 2). In contrast, Zone 6 is the least dense zone in the park, dominated by red alder (averaging 60 stems per acre) with a smaller component of bigleaf maple (20 stems per acre). There are no invasive overstory trees in this zone (Table 2).

Park-wide, bigleaf maple is the most prevalent species, with an average of 58 stems per acre (Figure 3). All other trees are present in much smaller quantities of 12 stems per acre of less. Total native overstory density averages 102 stems per acre, compared to an average of 14 stems per acre for non-native species (Figure 3).

Figure 3. Average overstory tree density by species property wide in Eagle Landing Park[1].



[1]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 non-native invasive species which do not have a legal designation at this time.

4.2.2 Regenerating Tree Composition and Structure

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 seven native, four non-native and one unknown tree species were recorded during the survey (Table 3). As noted in section 4.1.2, the regenerating tree layer of Eagle Landing Park is heavily dominated by non-native invasive tree species. The most common species encountered was cherry laurel, averaging 338 stems per acre and accounting for nearly half (43%) of all regenerating trees sampled (Table 3 & Figure 4). English holly is also reproducing at alarming rates throughout the property and averaging 260 stems per acre. Zone 4 has the highest regenerating invasive tree densities of 2,400 stems per acre (Table 3). In comparison, native tree regeneration averages 136 stems per acre across the property, made up predominantly of bigleaf maple (102 stems per acre on average) (Table 3).

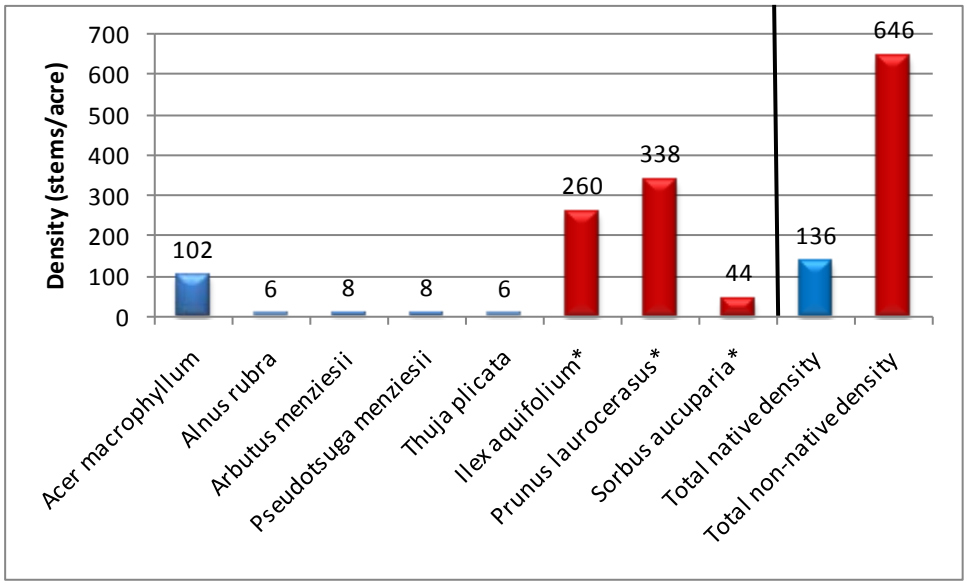
Zone 2, which is classified as a conifer/deciduous mixed forest, is dominated by bigleaf maple regeneration at an average of 132 stems per acre. Conifer trees combine for only 28 stems per acre in this zone, composed of Douglas fir (16 stems per acre), western red cedar (8 stems per acre) and grand fir (*Abies grandis*) (4 stems per acre). In addition, this is the only zone with a small amount of regenerating bitter cherry (*Prunus emarginata*), averaging 8 stems per acre.

The dominant invasive regenerating tree species in this zone are cherry laurel and English holly, averaging 256 and 152 stems per acre respectively. European mountain ash and sweet cherry are found in much smaller amounts, averaging 28 and 4 stems per acre respectively. Total native tree regeneration in this zone is found at an average of 168 stems per acre, whereas non-native tree regeneration averages 444 stems per acre. (Table 3).

Zone 3 which is classified as a conifer/madrone mixed forest contains only two regenerating native species: Pacific madrone (averaging 40 stems per acre) and red alder (averaging 30 stems per acre). No native conifer species are regenerating in this zone. Three invasive species are regenerating in this zone: English holly (320 stems per acre), cherry laurel (30 stems per acre) and European mountain ash (20 stems per acre). This zone contains an average of 70 regenerating native trees per acre and 370 non-native trees per acre (Table 3).

Zones 4, 5 and 6 are classified as pure deciduous forests. The dominant and only native regenerating tree found in these zones is bigleaf maple (240 stems per acre in Zone 5 and 60 stems per acre each in Zones 4 and 6), with the exception of small amounts of western red cedar trees found in zone 5 (Table 3). All of these zones contain high levels of invasive species, although the composition of these species varies by zone. Zone 4 contains extremely high levels of both cherry laurel and English holly (averaging 1,800 and 600 stems per acre respectively), for an average of 2,400 stems per acre in this zone. Zone 5 is dominated by regenerating European mountain ash and cherry laurel (averaging 260 and 180 stems per acre respectively). Zone 6 is dominated by regenerating English holly, with smaller amounts of cherry laurel (580 and 60 stems per acre respectively), adding up to an average of 640 stems per acre of invasive trees.

Figure 4. Average regenerating tree density of the eight most prevalent species property wide in Eagle Landing Park.[1]



[1] Species denoted by * indicate non-native species which have been given a legal designation by the King County Noxious Weed Program (King County 2008). Species denoted by ** are non-native invasive species which do not have a legal designation at this time.

Based on the recorded values of invasive tree densities per zone, it is possible to estimate the total number of these species present on the property. This information can be useful for the planning of eradication efforts. For example, we can estimate that 855 average stems per acre of non-native evergreen tree species corresponds approximately to a total of 3,699 total stems present on the 5.4 acres of natural areas. This type of analysis can estimate the number of total stems present in each management zone (Table 6).

Table 6. Average stems per acre and estimated stem counts (Total Stems) of overstory and regenerating invasive tree species (Cherry laurel, English holly, and European mountain ash) present in each management zone in Eagle Landing Park.

Zone	Acres	Average Stems/Acre	Estimated Total Stems
Zone 2	3.1	408	1,265
Zone 3	1	370	370
Zone 4	0.7	2,480	1,736
Zone 5	0.4	500	200
Zone 6	0.2	640	128
Total	**5.4**	**855**	**3,699**

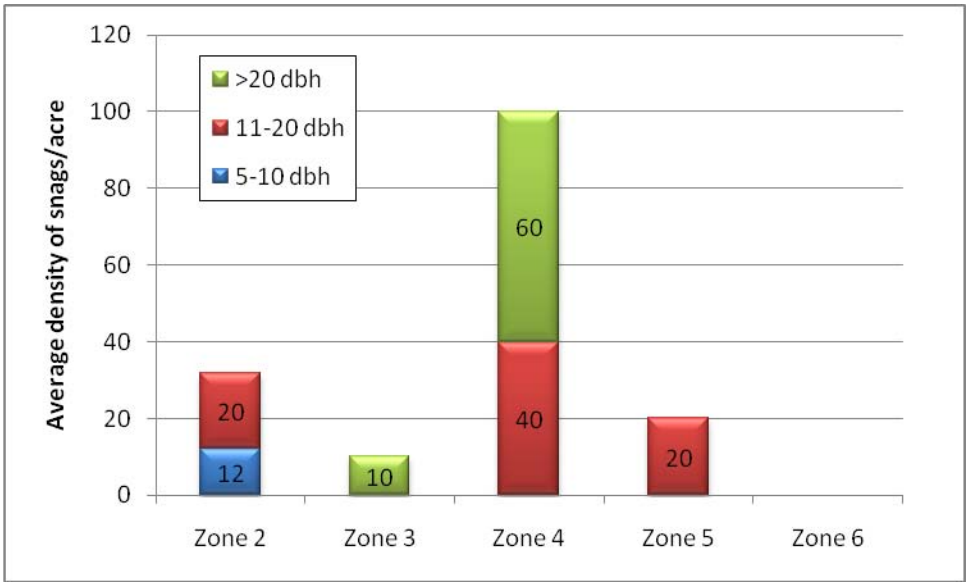
4.3 Snags

Large diameter standing dead trees (snags) are an important factor in providing wildlife habitat. A study by Mannan et al. (1980) found that hole-nesting birds usually use snags over 24 inches in diameter and over 50 feet tall. Only one of the snags measured in Eagle Landing Park met these criteria, recorded in Zone 4. Preserving large snags when practical will improve the structural diversity of the forest and provide wildlife habitat on the property that could help to attract species which are not currently present.

Snags were encountered at an average of 30 stems per acre, with a good distribution between diameter classes. The majority of snags in the park (53%) are between 11 and 20 inches in diameter, with 27% larger than 20 inches and 20% smaller than 10 inches. Snags averaged 46 feet tall and 18 inches dbh property wide. No snags were measured in Zone 6. Snag densities were highest in Zone 4 with an average of 100 stems per acre (Figure 5).

Standing dead trees (snags) play a crucial role in the structure and function of a forest system. Snags provide important habitat for wildlife, birds, insects, non-vascular plants such as mosses and fungi, and are a store of nutrients for the forest. In the Pacific Northwest, 69 vertebrate animal and bird species commonly use cavities excavated in snags (Bunnell et al. 2002).

Figure 5. Average snag density and diameter by management zone in Eagle Landing Park.



4.4 Coarse Woody Debris (CWD)

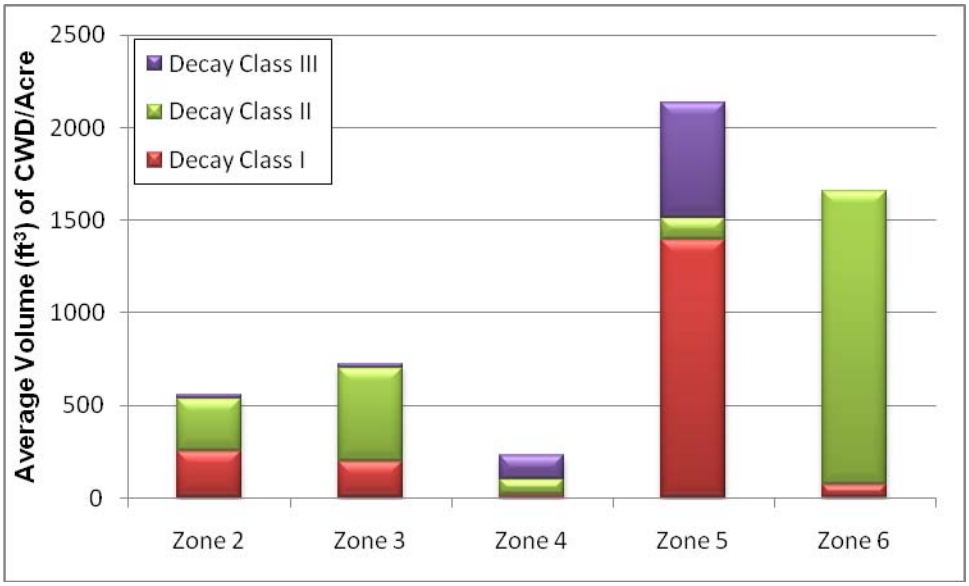
Coarse woody debris (CWD) can be defined as "sound and rotting logs and stumps that provide habitat for plants, animals and insects and a source of nutrients for soil structure and development" (Stevens 1997). CWD plays a vital role in forests by adding organic material and nutrients to the soil and providing habitat for decomposer fungi, animals, birds, bacteria and insects. In the Pacific Northwest, 47 vertebrate bird and animal species utilize downed wood for foraging, shelter and cover (Bunnell et al. 2002). CWD also acts as nurse logs for seedlings of plants such as western hemlock (*Tsuga heterophylla*) and red huckleberry (*Vaccinium parvifolium*), retains sediment and prevents erosion (Stevens 1997).

4.4.1 CWD distribution

CWD was measured on 9 of the 10 sampled plots. Overall, CWD averages 90 pieces per acre across all plots and averages 10.6 feet in length and 10.6 inches in diameter. The average volume of wood property-wide is 826 ft^3 per acre. Volumes of CWD vary across zones from a high of 2,133 ft^3 per acre (Zone 5) to a low of 230 ft^3 per acre (Zone 4) (Figure 6). In comparison, mature Douglas fir /western hemlock forests over 250 years old typically contain approximately 6,400 ft^3 per acre of CWD (Harmon et al.1986).

Zones 5 and 6, which have the highest volumes of CWD are located on steep bluffs, with sandy loose soils that provide less support for tree roots. As a result, trees in these soils are more prone to fall down due to erosion and disturbance events such as windstorms.

Figure 6. Average volume and decay class of coarse woody debris (CWD) by management zone in Eagle Landing Park.



As it decays, CWD provides a number of ecological functions that contribute to the diversity of species and processes in the forest. Large pieces in particular are important as significant stores of carbon and energy. This large material generally decays more slowly and provides a steady input of nutrients and long-lasting structural components to the forest system (Stevens 1997). CWD in the later stages of decay (class III) are present in four of the five zones, with the highest proportions measured in Zones 4 and 5 (Figure 6).

4.5 Shrub Composition and Diversity

A total of 18 shrub species were recorded in Eagle Landing Park during the 2009 survey, of which 16 are native to the Puget Sound lowlands and two are considered to be non-native species (Table 4). The most dominant native shrub is beaked hazelnut, found in 80% of all plots at an average cover of 24.4% across all plots. Salmonberry and salal are also prevalent within the park (averaging 17.9% and 16.1% across all plots) (Table 4 & Figure 7). Total combined cover of native shrubs averages 72% across all plots, with the highest covers occurring in Zones 3 and 6.

Zones 2, 3 and 4 are dominated by beaked hazelnut, which ranges in cover from 20.8% in Zone 2, 40% in Zone 4 and 50% in Zone 3 (Table 4). In Zone 2, salmonberry is the most prevalent shrub aside from beaked hazelnut with an average percent cover of 10.8%. Other shrubs present in smaller amounts in Zone 2 include salal (6.2% cover), thimbleberry (*Rubus parviflorus*) (2.8% cover), Indian plum (*Oemleria cerasiformis*) (2.6% cover), American cranberrybush (*Viburnum opulus var. americanum*) (2.4%), creeping blackberry (*Rubus ursinus*) (1.7% cover), evergreen huckleberry (*Vaccinium ovatum*) (1.6% cover) and oceanspray (*Holodiscus discolor*) (1.4% cover) (Table 4).

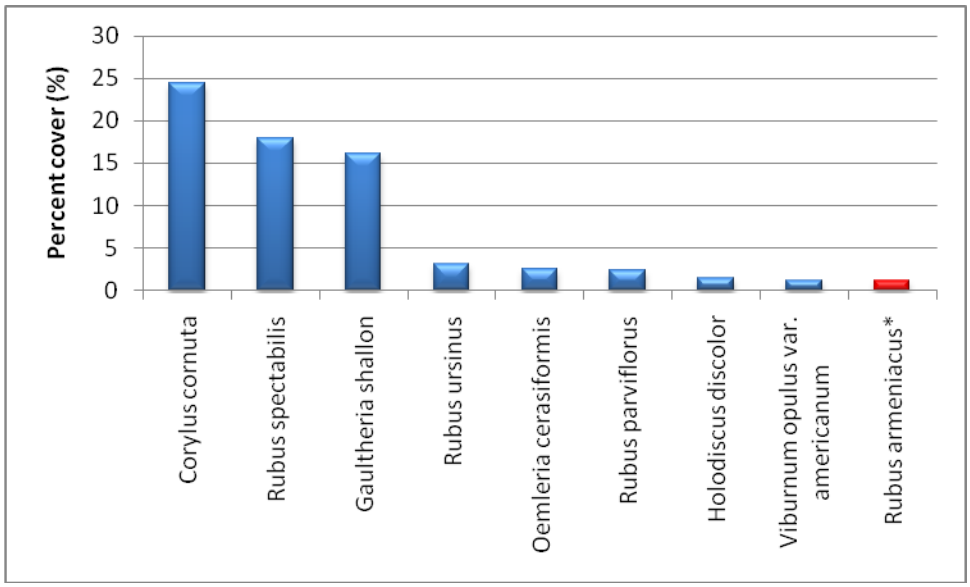
Zone 3 has the most dense shrub layer in the park, with a total shrub cover of 132%. This zone has a high cover of both salal (61.5%) and beaked hazelnut (50%), which account for the vast majority of shrub cover present in this zone. A smaller amount of creeping blackberry (6.5%) and thimbleberry (5%) are also present (Table 3). Zone 4 is primarily dominated by beaked

hazelnut (40% cover) with small amounts of salal (7%), oceanspray (5%) and low Oregon grape (*Mahonia nervosa*) (3%) (Table 4).

Zones 5 and 6 are both dominated by salmonberry. Zone 5 is composed primarily of salmonberry (30% cover), Indian plum (12% cover) and creeping blackberry (8% cover). There is also a small amount of red elderberry (*Sambucus racemosa*) present (2% cover) (Table 3). Zone 6 has a very dense layer of salmonberry, averaging 95% in this zone. In addition, there are very small amounts of stink currant (*Ribes bracteosum*) (1% cover), red elderberry (1% cover), Indian plum (less than 1% cover) and devil's club (*Oplapanax horridus*) (less than 1% cover) (Table 4).

Two non-native shrubs were identified and are considered to be potentially invasive. Himalayan blackberry (*Rubus armeniacus*) was found to be present primarily in Zones 3 and 5 at an average of 4% cover and 3% cover respectively (Table 4). Franchet's cotoneaster (*Cotoneaster franchetti)* was only found in Zone 3 in trace amounts of less than 1%. Himalayan blackberry is a Non-regulated Noxious Weed in King County (King County 2009), whereas Franchet's cotoneaster does not have a legal designation at this time.

Figure 7. Distribution of the nine most prevalent shrubs in Eagle Landing Park across all plots[1].



[1] Species denoted by * indicate non-native species which have been given a legal designation by the King County Noxious Weed Program (King County 2009).

4.6 Herbaceous and Vine Composition and Diversity

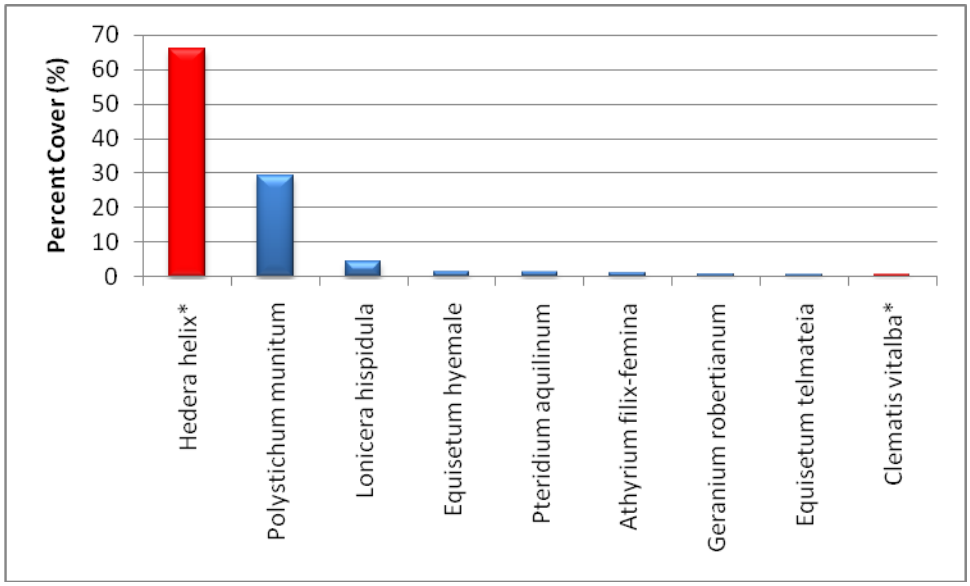
Herbaceous and vine species include forbs, grasses, and fern species. A total of 18 herbaceous and vine species (12 native, 5 non-native, and one that was not determined) were sampled in Eagle Landing Park during the 2009 survey (Table 5). The most prevalent native species is sword fern with an average cover across all plots of 29.3% (Table 5 & Figure 8). Other common native species include hairy honeysuckle (4.5%), scouring horserush (*Equisetum hyemale*)

(1.5%), bracken fern (*Pteridium aquilinum*) (1.3%), and ladyfern (*Athyrium filix-femina*) (1.2%) (Figure 8 and Table 5).

Although sword fern is the most common native herbaceous species and is found in all zones, species composition does vary considerably between the different zones. Zone 2 is dominated by sword fern, which averages 35.4% cover, with very small amounts of bracken fern, ladyfern, licorice fern (*Polypodium glycyrrhiza*) and fringecup (*Tellima grandiflora*) (all less than 1% cover) (Table 5). Zone 3 is composed of sword fern (32.5%), hairy honeysuckle (22.5%) and bracken fern (5%) (Table 5). Zone 4 has the most sparse herbaceous layer in the park, with only 10% native cover and two native species, sword fern (10% cover) and fringecup (less than 1% cover) (Table 5). Zone 5 is also dominated by sword fern (35% cover) with smaller amounts of giant horsetail (*Equisetum telmateia)* (6% cover), Columbia brome (*Bromus vulgaris*) (1% cover), stinging nettle (*Urtica dioica)* (1% cover) and fringecup (less than 1% cover) (Table 5). Zone 6 is the only zone in the park containing and dominated by scouringrush horsetail (15% cover) with a smaller component of ladyfern (10% cover), sword fern (6% cover) and wood fern (*Dryopteris expansa*) (2% cover) (Table 5).

Of the five non-native species, three are considered invasive and have been given a legal designation in King County (King County 2009) (Table 5). The most prevalent of these is English ivy which is present in all zones at an average cover of 65.8% and was the most dominant plant recorded in the park (Appendix A). The prevalence of English ivy varies by zone, from a high of more than 80% in Zones 2, 5 and 6 to a low of less than 15% in Zones 3 and 4 (Table 5). Also present in Zone 2 but in much smaller amounts are herb Robert (*Geranium robertianum)* and wild clematis (*Clematis vitalba*) at average percent covers of 1.6% and 1.2% respectively (Table 5). Both of these species are Non-regulated Noxious Weeds in King County (King County 2009).

Figure 8. Distribution of the nine most prevalent herb, grass, and vine species in Eagle Landing Park across all plots[1].



[1] Species denoted by * are non-native species which have been given a legal designation by the King County Noxious Weed Program (King County 2009).

5. MANAGEMENT RECOMMENDATIONS

Overarching management goals for the property are discussed in the first and second sections of this report in section **5.1 Management Priorities** and section **5.2 Property Wide Recommendations**. In addition, each of the six forested management zones identified in Eagle Landing during the 2009 survey are discussed in more detail in the third section of this report in section **5.3 Results and Specific Recommendations for Each Management Zone**.

The natural areas comprising Eagle Landing Park provide important ecosystem services and functions including improved water quality and filtration of pollutants from the air. Forests and wetlands clean and store stormwater runoff, retain sediment, provide groundwater recharge and discharge services, and provide important habitat for a variety of plant and animal species (Guntenspergen and Dunn 1998). In addition, these natural areas offer a valuable cultural resource to the Puget Sound community and provide important educational opportunities.

Eagle Landing Park functions as part of a larger system that includes undeveloped publicly and privately owned land in the close vicinity of the park. Together with Seahurst and Salmon Creek Parks, Eagle Landing Park represents a large area of public land managed as natural open space and represents a significant undeveloped habitat in an increasingly built-up environment. As urban pressures continue to intensify, areas of natural habitat are becoming progressively more important.

In addition to the ecological benefits of forested open space noted above, Eagle Landing Park offers visitors a unique opportunity to learn more about our natural environment. The interpretive signs already in place provide numerous educational opportunities for the interested public. Having an active bald eagles nest in the center of the park offers people an exceptional experience with nature within the core of our urban community.

Encroachment of invasive species, human activity and other disturbances make active stewardship vital to maintaining and increasing the natural function of the forests and wetlands at Eagle Landing Park. Invasive species in particular pose a serious threat to the future composition of the forest and wetland systems. These issues will need to be addressed with proactive management and sustained efforts over many years. The cover and density of invasive species were recorded during the plot level survey and the results are described in Section 4 above. The most common invasive species encountered during the survey (based on average cover and average density across all plots) are English ivy (66% cover), cherry laurel (346 stems per acre), and English holly (260 stems per acre). Other notable invasive species include: European mountain ash (48 stems per acre), Himalayan blackberry (1% cover), and herb Robert (1% cover) (Tables 2, 3, 4, 5). Other invasive trees on site include Portugal laurel, sycamore maple and sweet cherry.

5.1 Management Priorities

Management recommendations for Eagle Landing Park have been separated into three general categories based on the amount of time required to enact and resource availability. These

priorities are intended to be suggestions for specific tasks that could be completed as funding and resources become available.

- Short-term priorities. These are actions that are of high importance and could be completed within the earlier phases of restoration
- Medium-term priorities. These are actions that will take planning and could be completed within the secondary phase of restoration
- Long-term priorities. These are on-going activities that will take many years to accomplish.

Short-term priorities

1) Maintain the native plant entry garden in a way that provides a safe and inviting environment while preserving the ecological value of the native plantings (section *5.3.2*)
2) Plant initial phase of conifer trees throughout the park (recommended density is 50 trees per acre or approximately 275 total trees) (section *5.2.1*)
3) Remove invasive trees from active restoration sites in Zones 2 and 4 (section *5.2.2*)
4) Create "survival rings" by removing English ivy from the base of all canopy trees on the property (section *5.2.3*)
5) Remove Himalayan blackberry infestations from accessible locations (Zones 2, 3 and 4) (section *5.2.3*)
6) Locate and mark property boundaries to help identify extents of potential restoration sites

Medium-term priorities

1) Locate funding to conduct invasive tree eradication efforts, focusing on areas of active restoration (Zones 2, 3 and 4)
2) Remove English ivy from targeted areas accessible to volunteers and replant with native plants (Zones 2, 3 and 4)
3) Continue to monitor Himalayan blackberry on the property and remove any re-growth and remaining infestations
4) Plant second phase of conifer trees throughout the park (recommended density is 50 trees per acre or approximately 275 total trees)
5) Provide on-going maintenance and monitoring of restored areas

Long-term priorities

6) Locate funding to remove English ivy from inaccessible areas of the property (Zones 5 and 6) and replant with native plants
7) Plant final phase of conifer trees throughout the park (recommended density is 50 trees per acre or approximately 275 total trees)
8) Locate funding to conduct invasive tree eradication efforts in areas inaccessible by volunteers (Zones 5 and 6)
9) Provide on-going maintenance and monitoring of restored areas
10) Increase snags and coarse woody debris

5.2 Property Wide Recommendations

Restoration and management of the natural areas at Eagle Landing Park will require long-term, sustained efforts. Because of the high levels of invasive species, restoration will need to occur in

phases over a number of years. In addition to the priorities discussed above, it is recommended that restoration efforts focus on three general, overarching goals. The following section provides an overview of these objectives and provides recommendations for where to initiate restoration efforts specific to each goal. Overarching goals for property wide management include:

1) Increasing the structural diversity of the forest with park-wide native tree planting to occur in phases over a number of years
2) Eradication and control of invasive trees (cherry laurel, English holly and other species) to occur in phases as resources become available
3) Enactment of comprehensive invasive removal and habitat restoration to occur in a step-wise fashion beginning in areas where restoration has already been initiated

More specific information for each zone can be found below in section **5.3 Results and Specific Recommendations for Each Management Zone**.

5.2.1 Native tree planting

The first goal is to re-establish native conifer regeneration. This will provide structural diversity to the forest eventually helping to shade out invasive species and creates the foundation for a healthy natural system. Conifer tree planting can occur in areas of heavy English ivy cover providing that the necessary care and maintenance occur until these trees become established. Young trees will need to be cleared of ivy several times a year until they are well established, and may require watering depending on location. Initial planting efforts should focus on areas with relatively easy access by volunteers in Zones 2, 3 and 4. This goal can be accomplished with minimal cost and effort (assuming volunteer efforts can be utilized for maintenance and monitoring), and can occur in phases as resources become available.

As discussed in the results section of this report, there is currently limited native tree regeneration occurring on the property, with park-wide native conifer regeneration averaging less than 20 stems per acre (Table 3). In order to increase the structural diversity of the forest, it is recommended that native conifer trees are planted throughout the property. Increasing the conifer midstory and overstory will also help reduce the cover and recolonization of invasive species by providing year-round shading. Planting should occur in two to three phases to maintain a diversity of height and age classes. Studies of old growth forests in Washington and Oregon have measured densities of all trees in 250 year old forests at approximately 150 stems per acre (Franklin et al. 1981). Based on analyses of the existing structure of conifer and mixed conifer/deciduous urban forests in the greater Seattle area, the desired stem density of overstory trees in Eagle Landing Park is estimated at approximately 80 to 100 conifer trees per acre (Seattle Urban Nature 2006, 2008, 2009). This density should include a diverse distribution of tree heights and diameters. A density of 100 trees per acre translates to a spacing of approximately 20 feet on center. Given this target density, conifer trees should be planted at 150 to 200 trees per acre (17 to 20 feet on center) where deemed appropriate. This initial overplanting will allow for some expected tree mortality and natural thinning to occur. Denser tree plantings could take place in an effort to create more short-term shading, although future thinning would likely be necessary to improve the long-term structure of the forest. Typical

stocking of timber lands in the area, for example, often plant at densities around 400 stems per acre.

It is recommended that tree planting efforts can and should be enacted in areas where more intensive ivy removal may not occur for a number of years. This will provide future structure to the forest and help to shade out invasive species over time. Once a conifer understory is well established, restoration efforts can occur as resources allow. Larger trees, such as one to five gallon pots (as opposed to plugs), may be more effective when planted in areas with heavy English ivy ground cover. In these situations, an area should be cleared of ivy and sheet mulched with cardboard and mulch in the immediate vicinity of the planted tree. All trees will need regular maintenance to keep ivy clear until they are well established. This will likely consist of yearly ivy removal and re-mulching as necessary. A variety of tree species should be planted to increase species diversity and to account for site specific conditions that may favor certain species over others. A general conifer tree planting palette could include the following species: Douglas fir, Sitka spruce (*Picea sitchensis*), western red cedar, grand fir (*Abies grandis*), shore pine (*Pinus contorta*), western white pine (*Pinus monticola*), and western hemlock, depending on available light and soil moisture at a given site.

Although tree plantings should primarily consist of conifer trees, these plantings could be supplemented and diversified with native deciduous and broadleaf-evergreen species where appropriate. Depending on site conditions, species such as Pacific madrone (*Arbutus menziesii*), Oregon ash (*Fraxinus latifolia*), bitter cherry (*Prunus emarginata*), cascara (*Frangula purshiana*), paperbark birch (*Betula papyrifera*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and Pacific dogwood (*Cornus nuttallii*) may be appropriate. These species will help to increase the diversity of the forests and contribute additional habitat components to the site.

Trees should be planted in the fall or early winter to allow sufficient root establishment prior to the dry summer months. Trees should be flagged to allow for relocation and future maintenance, which should occur for the first two or more years following planting. Maintenance should include watering in dry areas during the summer months and the removal of weeds or other excessive vegetation within a five foot diameter of each tree to reduce the competition for light, water, and nutrients. Depending on the location, mulching may also be appropriate and should be renewed as required. During this time, tree mortality and vigor should be assessed and dead or dying trees be replaced.

5.2.2 Invasive tree eradication and control

The second goal is to begin targeted invasive tree eradication. This is an important step in freeing the understory and creating adequate conditions for conifer tree growth and establishment. Because of the very high density of non-native evergreen tree species in many parts of the property, eradication efforts will be ongoing and require many years of sustained effort. Eradication efforts should utilize a combination of herbicide treatments and manual removal efforts. A licensed herbicide applicator should be commissioned to carry out these treatments. Coordinating with the King County Noxious Weed Control Program or other resources is also recommended. Herbicide applications show the best results when applied

during the end of the growing season in late summer and early fall. If resources cannot be acquired for park-wide eradication efforts, invasive tree removal should occur in phases that are in concert with active restoration efforts. Follow-up maintenance should occur by volunteers in treated areas to hand-pull any new seedlings that have established. Zones 2, 3 and 4 should be considered priority areas for initial invasive tree eradication efforts, beginning in areas where existing restoration has occurred, mainly in Zone 2 near plot seven on both sides of the trail and Zone 4 to the west of the trail (Map 1).

Ideally, efforts would be coordinated with invasive species eradication from surrounding and adjacent properties whenever feasible. For example, efforts should be made to work with the neighborhood association responsible for the management of the forested open space bordering the park to the southwest. Combining efforts can save resources and help to reduce the recolonization of invasive trees from bordering properties.

These species of non-native evergreen trees are able to establish and reproduce in nearly any environment and can form very dense thickets, outcompeting native species for limited resources. These species are bird dispersed and are easily spread by seed, making eradication of mature trees a priority. If resources do not allow for the treatment or removal of all stems, larger mature specimens (stems greater than one inch diameter) should be targeted for priority removal. Stems greater than one inch should either be frilled or cut and treated with glyphosate applied immediately to the wound or stem injected using an herbicide lance injector such as the EZ-Ject Lance. Smaller stems (less than one inch diameter) should either be removed manually by hand or weed wrench or should be cut at a height of one foot and receive an immediate glyphosate application on the cut stem. See Appendix B for additional information and best management practices for treating invasive trees.

5.2.3 Comprehensive invasive removal and habitat restoration

The third goal will be to continue intensive restoration in localized areas of the park. This consists of establishing restoration sites where all invasive species are removed and planted with native trees and shrubs. Planning for these efforts will require careful consideration for the long-term maintenance and monitoring of these areas. These efforts are time and resource intensive, and should only be initiated if sustained volunteer commitment is probable.

English ivy eradication and control

English ivy removal efforts will require intensive efforts park-wide, as it is present throughout much of the property at generally high levels (Map 4). Initial restoration efforts should aim to sever all vines that are extending into the canopy of affected trees. This will help reduce the spread of this invasive plant by inhibiting fruiting and seed production which predominately occurs when the vines grow up a vertical surface. Vines should be cut and pried away from trunks creating “survival rings” as described in Appendix B.

Additional efforts should focus on maintaining and expanding areas where ivy removal efforts are already underway, mainly in Zone 2 near plot seven on both sides of the trail and Zone 4 to

the west of the trail (Map 1). This will help to prevent ivy from reestablishing in existing restoration sites and threatening the survival of installed plantings.

Once these restoration sites are well established they can be expanded as resources allow, with the goal of eventually bringing the entire park into full restoration. This will require long-term commitment and many years of effort. If resources allow, contractors should be utilized for effective invasive species clearing and sheet mulching, particularly in steep areas that are not easily accessible by volunteers. This can be particularly effective if volunteers are on hand for planting and site maintenance following contracted clearing.

Ivy eradication efforts in the wetland areas of Zones 5 and 6 will need to be carefully enacted. These delicate wetland habitats would greatly benefit from ivy removal, but care needs to be taken to prevent trampling. It is recommended that either a small group of volunteers or paid contractors are allowed in these areas. Finally, the central portion of Zone 2 in the vicinity of plot numbers one and three should be considered for future ivy eradication efforts as resources become available. This area is heavily invaded with ivy, but also exhibits some of the most extensive and mature conifer canopy found in the park (the eagle nest tree is in this vicinity). It should be a priority to protect these existing trees and to establish healthy conifer regeneration in this area.

Areas cleared of English ivy should be covered with cardboard and six to eight inches of mulch to protect the soil and inhibit re-establishment of invasive species. Cleared areas should be mulched and planted immediately following ivy removal to reduce erosion and inhibit ivy re-growth. Heavy infestations such as those occurring throughout most of the park will require sustained efforts. It is recommended that continued efforts to suppress ivy from growing into the canopy continue until full eradication efforts can be enacted park-wide. See Appendix B for additional information and best management practices for treating this species.

Himalayan blackberry eradication and control

Himalayan blackberry is only moderately present throughout the property, see Section 4.5 for more details. Based on the plot level survey, blackberry is most prevalent in Zone 3, where it averages 4% cover (Table 4). It is recommended that efforts be made to remove as much of these infestations as possible, before they are able to spread in size and to other areas of the park. Zone 3 in particular exhibits a high cover of native salal and beaked hazelnut shrubs, making access difficult. Blackberry is also present in Zone 5 where access is difficult due to the steep terrain. The relatively sparse nature of the infestations will require careful hand weeding to protect adjacent native vegetation that is growing intermixed with the blackberry. In some situations, cutting and carefully applying herbicide directly to the exposed canes may be warranted. This method allows for the targeted treatment of blackberry without disturbing the soil to remove the root ball. Herbicide will need to be administered by a licensed applicator. See Appendix B for additional information and best management practices for treating this species.

If access is manageable or if native species are less prevalent, canes can be cut manually and roots dug out. Once the majority of the roots have been removed, cardboard and mulch can then be applied before or after planting with native tree and shrub species.

5.3 Results and Specific Recommendations for Each Management Zone

This section discusses specific results and offers recommendations for each of the six management zones identified in Eagle Landing Park (Map 1). General recommendations have been separated into short-term, medium-term and long-term priorities and are presented in section **5.1 Management Priorities**. Overarching property wide restoration goals are discussed in section **5.2 Property Wide Recommendations.**

5.3.1 Zone 1 description and results

Zone 1 designates the area directly surrounding the driveway and parking area (Map 1). Much of this area was cleared during construction of the driveway, parking, and informational kiosk. During this time, a drainage ditch was created along the southern property boundary between private property and the main access trail originating at Southwest 149th Street.

Following construction, the area was planted with a high diversity of plants native to the Pacific Northwest (http://eaglelandingpark.org 2009). As a result, the park entrance was transformed from an area heavily invaded with invasive species to a unique native plant garden. These plantings provide an exceptional habitat that is utilized by a variety of native birds and wildlife. Because of its small size and landscaped character, no forest assessment plots were sampled in Zone 1.

For practical purposes, this section will also address issues associated with the trail. Beginning at Southwest 149th Street, the gravel trail winds down through the park for approximately 1500 linear feet and terminates at the top of the stairs overlooking the beach (Map 1). Shortly before the stairs, the trail forks in Zone 4 into a side trail approximately 160 feet long that heads southwest towards the 28th Avenue Southwest street right of way. This trail does not currently allow public access to or from the park, ending at locked gate along the property boundary.

5.3.2 Zone 1 management recommendations

The entry garden and trail system are an extremely important part of Eagle Landing Park. These features act as the primary interface between park visitors and the forest itself. Maintaining and enhancing these areas should be a management priority. The general management objectives for this zone are to maintain the native plant entry garden in a way that provides a safe and inviting environment while preserving the ecological value of the native plantings, and to provide safe access for visitors through the park.

The management goals for Zone 1 are to:

1. Actively maintain the native plant entry garden to allow visibility and provide sight corridors
2. Maintain a clear and unobstructed path along all trail corridors
3. Repair and maintain the gravel pathway for safe foot travel
4. Develop a plan to mitigate erosion potential at the end of the drainage ditch

The entry garden has a high diversity of native plants with perhaps more than 65 different species present (http://eaglelandingpark.org 2009). Since installation, these plantings have become well established and have grown rather robust. Concerns have arisen that the existing structure of these plantings has the potential to obstruct views into the parking area from the street. As a result, it is recommended that future maintenance of this area be directed in a fashion that reduces the overall height and concentration of the taller shrubs. Dense thickets of tall shrubs should be carefully pruned by hand to reduce and maintain a lower overall stature. Small tree species such as serviceberry or bitter cherry should be pruned to a single leader where necessary. Additionally, trees that have self seeded on the site which are inappropriate for their proximity to the parking area should be removed. Specifically, a cottonwood seedling growing near the eastern side of the parking area should be removed.

The trail corridor should be maintained for unobstructed foot access. Trailside plantings should be limited to smaller statured shrubs or herbaceous plants to facilitate future maintenance. Near the middle part of the trail in Zone 2 (just west of Zone 5), a row of cedars has been planted near the trail edge to the south. It is recommended that these trees be pruned as necessary to maintain an appropriate walkway and may need to be thinned in the future as they mature.

Care should be taken when performing routine maintenance of the entry garden and trail corridor to not damage the plantings. It is recommended that pruning, weeding and thinning be performed by someone knowledgeable in the care of northwest native plants.

Also of concern in Zone 1 is the existing problem of erosion near the area where the drainage ditch ends where it is carried in a pipe beneath the trail. In high flow situations, it appears that water is diverted over the trail, causing erosion of the trail and in the area directly below. It is recommended that a larger culvert be installed or other actions be taken to adequately carry the water through the drainage ditch and beyond the trail in a manner that does not cause the potential for further erosion.

Finally, repairs to several areas of the gravel foot path are required. The fabric material used to line the trail has become exposed in several locations throughout the trail, generally in steeper areas of the park. It is recommended that these hazards are quickly addressed to maintain safe access through the park.

5.3.3 Zone 2 description and results

Zone 2 makes up the largest area of the park at 3.1 acres, and accounts for more than half of the park area (Table 1). This zone is comprised of a mixed conifer and deciduous forest with a beaked hazelnut and swordfern dominated understory (Tables 2, 4, and 5). Although maple trees dominate the overstory, western red cedar and Douglas fir trees combine to account for more than 20% of the canopy. A notable feature of Zone 2 is the presence of numerous large conifer trees, especially in the central and northeastern part of the zone. The eagle's nest tree is located near the southwestern corner of plot 3 just north of the east/west ridge that runs down the center of the park (Map 1). Zone 2 tree regeneration is dominated by bigleaf maple, although limited amounts of Douglas fir, western red cedar, and grand fir were present within survey plots and accounted for a combined average of 28 stems per acre, with the majority appearing to have been

planted (Table 3). Native bitter cherry is also present at low levels in Zone 2. High levels of invasive evergreen trees are regenerating in the understory, with a combined average density of 408 stems per acre (Table 3). Low densities of Portugal laurel were also recorded in the overstory (Table 4). Smaller amounts of two invasive deciduous trees, European mountain ash and sweet cherry combine to total 32 stems per acre on average in this zone. In general, Zone 2 is relatively open and easily accessible by foot, although some salmonberry thickets are present in the valley depression to the northeast near the park entrance

English ivy is a dominant and ever-present understory species in Zone 2. It was measured in all five plots at an average cover of more than 90%, the highest average for all zones (Table 5). Herb Robert was only recorded in plot 4 at a moderate cover of 8%.

5.3.4 Zone 2 management recommendations

Zone 2 is made up of a generally intact upland forest in the east-central portion of the park (Map 1). The greatest threat to this zone is the high cover of English ivy found throughout, and the moderately high densities of invasive trees, especially in northeast part of the zone (Map 2). To reduce the cover of English ivy, a phased approach is recommended with intensive restoration efforts focused in targeted areas that can be expanded upon as time and resources allow.

The management goals for Zone 2 are to:

1. Treat English holly, cherry laurel, European mountain ash, and Portugal laurel trees
2. Remove ivy from trees and expand removal efforts throughout the zone and re-vegetate with native plants
3. Reestablish native conifer regeneration

English holly and cherry laurel are prevalent throughout this zone, with the highest densities occurring in the vicinity of plots 1 and 2 (Map 2). An aggressive invasive tree eradication strategy is recommended before these species continue to spread. Additional invasive tree species that are found at low densities throughout this habitat should be removed during these efforts. These species include European mountain ash, sweet cherry, Portugal laurel, and sycamore maple. Sycamore maple is present along the eastern edge of the park near the property boundary (not captured during the plot level survey) and should be eradicated before it spreads to other areas of the park. Control and management recommendations for these species can be found in Appendix B of this report.

English ivy management for Zone 2 should begin with the immediate removal of the vine from all overstory trees and create “survival rings”. This will prevent the vine from climbing into the canopy where it is more likely to produce seed and compromise the health of the trees. Efforts will need to be repeated, as vines are capable of quickly reestablishing. Additional efforts should focus on maintaining existing restoration sites. Past ivy removal efforts have been initiated at several locations throughout Zone 2, including areas in the vicinity of plots 4 and 7. New areas should only be considered for restoration if available resources can be directed to clearing, planting, and ongoing maintenance. Restoration of small sections at a time is recommended, with new sites expanding out from these areas. Because of the heavy infestation, reinvasion from surrounding areas should be expected and continual maintenance and monitoring will be

required. See Appendix B for additional information and best management practices for treating this species.

It is recommended that Himalayan blackberry be removed from this zone wherever encountered. From the plot level survey, it was measured in small amounts in plot 2. Early eradication of this species will help prevent its reinvasion, especially as new areas are cleared for ivy removal. Himalayan blackberry can quickly invade areas following restoration related disturbances. The small infestation of herb Robert near plot 4 should also be removed when possible prior to additional restoration clearing in the vicinity.

Refer to section 5.2.1 *Native tree planting* for information on the park-wide planting of conifer trees. Areas cleared of ivy should be planted with a mix of native tree and shrub species immediately following invasive removal where possible. If additional conifer trees are planted outside of active restoration sites, care should be taken to track and monitor their health and survival with regular maintenance to remove ivy from the vicinity of the new plantings until they are well established.

5.3.5 Zone 3 description and results

Zone 3 is comprised of a one acre conifer madrone mixed forest located in the south-central portion of the park (Map 1). A prominent ridge runs east-west along the length of the zone, to the north of and parallel with the trail. This ridge is likely affecting the soil composition and moisture holding capacity, resulting in generally more sandy, well-drained soil conditions indicative of Pacific madrone habitat. This zone is characterized by a relatively high density of both Pacific madrone trees (averaging 30 stems per acre) and native conifer trees (averaging 40 stems per acre) (Table 2). The only western hemlock tree sampled in the park was located in this zone in plot 6. This zone has the highest richness of overstory tree species, with six species present. Despite the dominant conifer overstory, no native conifer tree regeneration was measured (Table 3). However, moderate amounts of Pacific madrone regeneration are present at an average of 40 stems per acre. Zone three has an average of 370 stems per acre of non-native tree regeneration, with English holly the dominant invader. The vast majority of these invasive trees are located south of the trail in the vicinity of plot 6 (Map 2). High covers of both salal and beaked hazelnut are present in Zone 3 with the heaviest salal cover present in the section north of the stairs where it accounts for 98% cover in plot 5. In this vicinity, the heavy salal cover appears to be preventing invasive species colonization, including English ivy which becomes more prevalent south of the trail (Map 3). Creeping blackberry and thimbleberry are also prevalent in Zone 3 (Table 4). Himalayan blackberry has the highest average cover in Zone 3, generally growing tightly interspersed with the dense native shrub cover (Table 4). Hairy honeysuckle, a vining species commonly found associated with Douglas fir/Pacific madrone forests exhibits high average cover here as well (Table 4).

5.3.6 Zone 3 management recommendations

Zone 3 includes the central ridge of the upland forest and the southwest facing slope down to Southwest 149th Place (Map 1). Heavy infestations of invasive tree species are present especially in the southern portion of the zone. English ivy is also encroaching into the southern slope area,

while concentrations of Himalayan blackberry, although relatively moderate, are scattered throughout.

The management goals in the deciduous forest are to:

1. Treat English holly, cherry laurel, and European mountain ash trees
2. Remove or treat invasive blackberry
3. Prevent English ivy from invading unaffected areas of the zone and develop a strategy for eradication and re vegetation
4. Re-establish native conifer regeneration

Invasive tree eradication should take place in Zone 3 as described in section *5.2.2 Invasive tree eradication and control*. The moderate amounts of regenerating European mountain ash should be targeted for removal in the vicinity of plot 5 before they proliferate (Map 2). Other invasive trees should also be removed, with priority consideration being given to large seeding trees where necessary.

Restoration efforts in Zone 3 should also focus on the removal of Himalayan blackberry. As discussed in the invasive species section of this report, eradication using the cut and dab method may be warranted in areas with dense native shrub cover. Monitoring for resprouting and recolonization should follow any treatment efforts. Complete eradication of blackberry from at least the central portion of Zone 3 should be a targeted goal.

Zone 3 has the lowest cover of English ivy in the park, and management consideration should be given to prevent this species from spreading into these currently unaffected areas. The central portion of the zone has extremely dense thickets of salal, which appears to be preventing the colonization of most invasive species. Ivy eradication efforts could focus on "pushing back" from these areas to create a buffer between more intact areas of the forest and heavy ivy infestations. Invasive species cover in general appears to increase approaching the park boundary to the south. Non-native cotoneaster shrubs have established in this vicinity and should be dug out when encountered (Table 4). It may be possible to use native tree and shrub plantings to create a buffer between the road and the park in this vicinity.

Refer to section *5.2.1 Native tree planting* for information on the park-wide planting of conifer trees.

5.3.7 Zone 4 description and results

Zone 4 is a transitional zone from the generally mixed conifer deciduous upland areas in the east to the steep deciduous dominated bluffs that drop down westerly to the Sound (Map 1). This zone is characterized by a dominant bigleaf maple canopy with extremely high densities of invasive cherry laurel both in the canopy and regenerating layer (Tables 2 and 3). A notable feature in this area is the presence of numerous dead and dying maple trees (Figure 5). Further study is warranted to look into possible causes for this condition; however, these large snags should be retained where possible for the structural habitat that they provide. Moderate levels of regenerating maple seedlings are present in Zone 4 at 60 stems per acre, the only native tree species found to be regenerating in the single plot sampled here. High densities of both

regenerating cherry laurel and English holly were measured, totaling 2,480 stems per acre, with a number of cherry laurel stems reaching diameters at breast heights greater than 5 inches (Map 2). Native shrub cover is dominated by beaked hazelnut (40%), with lesser amounts of salal (7%), oceanspray (5%), and low Oregon grape (3%) (Table 4). Native herbaceous cover is made up almost exclusively of relatively small amounts of sword fern (10%), with higher cover of English ivy (15%) (Table 5 and Map 3). Efforts to remove ivy from this zone have been initiated in the narrow area northwest of the trail.

5.3.8 Zone 4 management recommendations

Zone 4 has the highest measured density of cherry laurel and English holly on the property. The management goal for this zone is to initiate an intensive strategy for the eradication of these invasive tree species. This could be accomplished in a park-wide approach, or alternatively, initial eradication efforts could begin here as a pilot study for replication throughout the park as resources become available.

The management goals in Zone 4 are to:

1. Treat English holly and cherry laurel trees
2. Maintain and expand efforts to eradicate English ivy and re-vegetate with native plants
3. Establish higher diversity of native tree regeneration

Specific tasks should focus on invasive tree eradication efforts and ivy removal. There are several large hedges of cherry laurel located in this zone that will require considerable effort to control. Removal of these large complexes should be accomplished by cutting the stems and applying herbicide immediately to the wounds. Branches can be piled and left to decompose or could also be chipped to create mulch. This procedure is recommended when standing dead trees would be unsightly and will allow for immediate planting of native trees and shrubs in these areas. Individual trees or clumps of trees can also be treated by frilling or stem injection as described in section *5.2.2 Invasive tree eradication and control*. Mulching and planting with native trees and shrubs following removal will help to reduce the reintroduction of invasive species in bare areas created by the removal of dense laurel thickets. These clearings will provide canopy openings providing potential opportunities for pioneer trees such as Douglas fir to become established. More information can be found regarding invasive tree eradication and conifer planting in section **5.1 Management Priorities and Property Wide Recommendations**.

5.3.9 Zone 5 description and results

Zone 5 includes the steep bluff area to the south of the elevated stairs and is approximately 0.4 acres in size (Map 1). This zone transitions from a moderately dry forest near the top of the slope to a progressively wetter environment with seeps located near the southern and eastern edges of the park. This zone is characterized by a bigleaf maple dominant canopy and exhibits the highest overstory density on the property with 140 maple stems per acre (Table 2). The regenerating tree layer has high densities of bigleaf maple (240 stems per acre) and very low western red cedar regeneration (20 stems per acre) (Table 3). The cedar regeneration is likely the result of planting efforts, although some mature cedar trees are present in Zone 5 that were not captured in the plot level survey. Also of significance in this vicinity is the presence of a

large Douglas fir that is located just south of the property boundary that is used by the nesting eagles as a prominent perch tree (http://eaglelandingpark.org 2009). Relatively low levels of cherry laurel and English holly are present in Zone 5 (200 combined stems per acre), although high densities of European mountain ash are present in the regenerating layer with some larger specimens present as well (Tables 2 and 3). The native shrub layer is moderately developed and dominated by salmonberry (30%) and Indian plum (12%), with substantial cover of creeping blackberry (8%) (Table 4). Himalayan blackberry is present at a cover of 3%. The herbaceous layer is dominated by sword fern (35%) and giant horsetail (6%) (Table 5). English ivy is very prevalent with 85% cover in plot 9 (Map 3). Access to Zone 5 is extremely difficult due to the steep terrain and the large amounts of downed coarse woody debris (Figure 6).

5.3.10 Zone 5 management recommendations

Due to the limited access in Zone 5, restoration efforts should initially focus on invasive tree eradication and maintaining the area directly adjacent to the elevated stairs.

The management goals in Zone 5 are to:

1. Treat European mountain ash, cherry laurel, and English holly
2. Remove ivy from trees and initiate removal efforts throughout the zone and re-vegetate with native plants
3. Remove or treat blackberry where accessible
4. Maintain areas near the stairs
5. Plant additional native conifer trees

Initial restoration efforts should focus on targeted removal of European mountain ash and other invasive tree species. Ivy is prevalent throughout the zone. Initial efforts should focus on removing vines climbing up the trunks of trees and creating "ivy rings" to protect against recolonization. The area directly adjacent to the elevated stairs is relatively free of ivy and should be maintained and planted as necessary. Additional ivy clearing could expand south from this area. Other potential areas for initial ivy clearing efforts include the seep above the large maple tree in the lower southwest corner of the property just up from the beach. Manual removal of Himalayan blackberry can occur in accessible areas, while cut and treat methods may be warranted in more difficult locations. Any use of herbicide should take into consideration the wetland status of this area. Because of the relatively high moisture content of the soil in this zone, tree species such as cedars and hemlocks should be panted throughout. Deciduous trees such as cascara, Oregon ash, and bitter cherry could supplement the conifer plantings. Care should be taken to place trees in appropriate locations, taking advantage of topography, hydrology, and existing coarse woody debris where possible. Plantings should be marked clearly so that they can be relocated for maintenance and monitoring of survivability. See section *5.2.1 Native tree planting* for more information.

5.3.11 Zone 6 description and results

Zone 6 is located in the north-western section of the property and is a small forested bluff located between the elevated stairs and the private property to the north (Map 1). The canopy is predominantly red alder with a smaller bigleaf maple component (Table 2). Like Zone 5, this

zone is particularly steep in the eastern uphill portion of the zone, leveling off slightly just before reaching the beach. There is a small perched wetland seep in the vicinity where the slope begins to level, just up from the beach where plot 10 is located. The wetland nature of this area is indicated by the high covers of salmonberry (95%), scouring-rush horsetail (15%), and ladyfern (10%) (Tables 4 and 5). A small spring-fed surface channel emerges directly to the north of the stairs and in the vicinity of the southeast corner of plot 10 (Map 1). English ivy is prevalent throughout Zone 6, with 80% cover measured in the sample plot (Map 3). No Himalayan blackberry was noted to be present in Zone 6.

5.3.12 Zone 6 management recommendations

The biggest threats to Zone 6 are the relatively high densities of regenerating English holly and high cover of English ivy (Maps 2 and 3).

The management goals in Zone 6 are to:

1. Treat English holly and cherry laurel trees
2. Remove ivy from trees and initiate removal efforts throughout the zone and re-vegetate with native plants
3. Monitor and assess potential hazard trees overhanging elevated stairs

English holly and laurel trees should be eradicated using a combination of manual and chemical methods as described in section *5.2.2 Invasive tree eradication and control* and other sections of this report. Priority consideration should be given to the wetland area before these species continue to spread. This area is also currently heavily invaded with English ivy that appears to be invading upslope from the beach area. Initial efforts should remove all ivy from trees until further eradication efforts can be enacted. This site should be considered a good candidate for future restoration efforts. Care will need to be taken to protect the delicate wetland soils and existing native plants. It is recommended that any restoration efforts take place late in the summer when soil water levels are at their lowest. Ivy should be carefully removed by hand beginning up-slope, followed by the addition of mulch where appropriate and native plantings. The high cover of native salmonberry should help to mitigate any soil disturbances and reduce invasive species recolonization. Regular maintenance and monitoring will be necessary for thorough ivy suppression.

A number of large red alder trees farther up slope and to the east of plot 10 are leaning substantially off their vertical axis. Due to the steep, unstable nature of the slope and their proximity and orientation to the elevated stairs, it is recommended that these trees be assessed and monitored as potential hazard trees.

6. MAINTENANCE AND MONITORING

6.1 Planting and Maintenance

Planting with native species is recommended following removal of invasive plants. Establishing shade and canopy cover can be important for the control of certain invasive species such as

Himalayan blackberry, which can quickly colonize disturbed areas. Due to the climate in the Pacific Northwest, the planting season extends from late fall to early spring during the rainy season when sufficient moisture exists to allow plants to establish. Newly installed plants should be monitored and watered during the hot summer months for the first several years to ensure proper establishment.

Maintenance is vital to the success of any restoration project. The removal and control of invasive species is a long-term commitment that requires regular weeding and maintenance for many years. Many of the invasive species present in Eagle Landing Park have a tendency to re-grow from deep roots and must have regular maintenance at least two or three times a year in order to achieve effective invasive control and protect any installed native plantings. Maintenance can involve removing any re-growing invasive plants (with the roots whenever possible), regular mulching of native plantings, replacing native plants that have died, and watering newly installed plants through at least the first two growing seasons.

6.2 Monitoring

Monitoring is equally important to the success of a restoration project. Regular monitoring is particularly important in urban areas where forested stands are surrounded by development and invasive species are able to quickly establish. Monitoring can take many forms including visual inspections, photo documentation and scientific monitoring.

A basic type of monitoring is the visual inspection of restored areas during regular intervals and making note of any maintenance that is required. This type of monitoring can be done by volunteers, staff or contractors in charge of the restoration project. It should be conducted at least twice a year and more often if possible. This type of monitoring can generate information quickly, but generally does not provide a documented record of changing conditions or trends. Quantifiable data is usually not collected in this type of monitoring.

Another type of monitoring that can easily be implemented is establishing photo points throughout specific restoration areas and photographing the same geographic areas each year. Photo monitoring allows for long-term documentation and comparison of site conditions from year to year. This type of monitoring can also be conducted by volunteers, but the photographs must be taken at the same time each year for accurate comparison. Photo monitoring can be effective in documenting site conditions and is not time intensive. However, the photographs must be analyzed and compared to those from previous years to track changes over time. In addition, it is difficult to generate quantifiable data from this monitoring method.

As part of the plot-level data collection conducted in 2009, two photographs were taken at each plot corner (eight photos per plot) in an effort to establish a basis for photo monitoring. Photos were taken standing directly at each corner with the camera held at approximately five feet above the ground. One side of the plot was captured along the edge of each photograph, allowing for the full range of the plot to be represented. Plot photographs were provided to the City of Burien.

A third type of monitoring, which is more labor intensive and rigorous than the first two types, involves setting up permanent plots and collecting scientific data similar to that gathered during the 2009 forest inventory discussed in this report. The data can include any number of parameters deemed to be useful to the forest stewards but at a minimum should include survival data, tree density data and cover data for native and invasive shrubs and herbaceous species present. This type of monitoring can be conducted by properly trained volunteers, staff or contractors. This type of monitoring can occur on an annual basis for the first three to five years, and then can be conducted on a bi-annual basis or more frequently depending on site conditions. Using permanent plots to monitor restoration sites allows for evaluation of site conditions and regular opportunities to evaluate the effectiveness of management techniques. In addition, it will allow for a quantitative comparison of site conditions and an evaluation of planting and maintenance techniques over time. Plots established during the 2009 survey can be used for this purpose. Comparing data collected on these plots in the future to the information in this report would provide quantifiable information on changes to the vegetation as a result of restoration and management actions.

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Appendix A. Average density of trees (stems/acre) and cover of shrub, herb and grass species where present in Eagle Landing Park (on 2009 surveyed plots) and frequency (N=10) property-wide.

Scientific Name[1]	Common Name	Native	Average cover or density in sampled plots (where present)	Frequency property wide (Percent)
Trees				
Abies grandis	grand fir	Yes	20 stems/acre	10
Acer macrophyllum	bigleaf maple	Yes	180 stems/acre	90
Alnus rubra	red alder	Yes	45 stems/acre	40
Arbutus menziesii	Pacific madrone	Yes	40 stems/acre	50
Ilex aquifolium*	English holly	No	325 stems/acre	80
Prunus avium**	sweet cherry	No	20 stems/acre	10
Prunus emarginata	bitter cherry	Yes	40 stems/acre	10
Prunus laurocerasus*	cherry laurel	No	384 stems/acre	90
Prunus lusitanica**	Portugal laurel	No	20 stems/acre	10
Pseudotsuga menziesii	Douglas fir	Yes	40 stems/acre	40
Sorbus aucuparia	European mountain ash	No	96 stems/acre	50
Thuja plicata	western red cedar	Yes	32 stems/acre	50
Tsuga heterophylla	western hemlock	Yes	20 stems/acre	10
	Unknown tree species	X	20 stems/acre	10
Shrubs				
Acer circinatum	vine maple	Yes	1.6	20
Corylus cornuta	beaked hazelnut	Yes	30.5	80
Cotoneaster franchetti**	Franchet's cotoneaster	No	0.5	10
Gaultheria shallon	salal	Yes	26.8	60
Holodiscus discolor	oceanspray	Yes	3.5	40
Mahonia nervosa	low Oregon grape	Yes	2.8	30
Oemleria cerasiformis	Indian plum	Yes	6.4	40
Oplopanax horridus	devil's club	Yes	0.5	10
Ribes bracteosum	stink currant	Yes	1	10
Rosa gymnocarpa	baldhip rose	Yes	1	50
Rubus armeniacus*	Himalayan blackberry	No	3	40
Rubus parviflorus	thimbleberry	Yes	4.8	50
Rubus spectabilis	salmonberry	Yes	35.8	50
Rubus ursinus	creeping blackberry	Yes	3.8	80
Sambucus racemosa	red elderberry	Yes	1.5	20
Vaccinium ovatum	evergreen huckleberry	Yes	8	10
Vaccinium parvifolium	red huckleberry	Yes	0.5	10
Viburnum opulus var. americanum	American cranberrybush	Yes	12	10

Ferns, forbs and vines				
Athyrium filix-femina	ladyfern	Yes	6	20
Bromus vulgaris	Columbia brome	Yes	0.6	20
Cardamine hirsuta	hairy bittercress	No	0.1	10
Clematis vitalba*	wild clematis	No	6	10
Digitalis purpurea	foxglove	No	0.1	10
Dryopteris expansa	wood fern	Yes	2	10
Equisetum hyemale	scouring-rush horsetail	Yes	15	10
Equisetum telmateia	giant horsetail	Yes	3.5	20
Galium aparine	cleavers	Yes	0.5	10
Geranium robertianum*	herb Robert	No	8	10
Hedera helix*	English ivy	No	73.1	90
Lonicera hispidula	hairy honeysuckle	Yes	22.5	20
Polypodium glycyrrhiza	licorice fern	Yes	2	10
Polystichum munitum	sword fern	Yes	29.3	100
Pteridium aquilinum	bracken fern	Yes	3.3	40
Tellima grandiflora	fringecup	Yes	0.6	50
	Unknown grass species	X	0.1	10
Urtica dioica	stinging nettle	Yes	1	10

[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 non-native invasive species which do not have a legal designation at this time.

Appendix B. Invasive Species BMPs.

English Ivy

English ivy is one of the most invasive species in the Pacific Northwest. This evergreen climbing vine is capable of forming dense mats in the forest understory and excluding all other understory species. It can also climb up trees, preventing light from reaching the leaves and adding weight to the tree canopy, causing trees to weaken and fall during wind storms.

The most effective method for controlling English ivy is manual removal. Because English ivy can impact tree health by growing vertically, the first priority is to remove any vines growing on tree trunks and in the canopy. Install "survival rings" around trees by cutting or prying vines at shoulder height with the aid of a hand tool, killing any upper vines on the tree. Lower vines then need to be cleared, along with roots and vines found within at least a five foot radius of the base of the tree. For ivy growing along the ground, use hands or a small tool such as a hand tiller to pull or dig out the leaves and vines growing above the soil, as well as the woody roots growing just below the surface of the soil (King County 2004).

For disposal of hand-removed English ivy, several options are available. Disposal at a municipal vegetation waste facility is preferred. If the site will be monitored regularly, ivy can be piled on site on top of a paved area or tarp to prevent stems from re-rooting. Allow the pile to dry out, flipping periodically to ensure complete decomposition. Chemical methods of controlling English ivy are typically ineffective. The waxy leaves of the plant do not easily absorb herbicides, and herbicide run-off from the leaves results in risk to non-target plants (King County 2004).

Best Management Practices for this plant can be found at:
http://dnr.metrokc.gov/wlr/lands/weeds/pdf/english-ivy-control.pdf

English holly, cherry laurel and Portugal laurel

Cherry laurel, Portugal laurel and English holly are evergreen trees that can reach up to 50 feet in height, but are usually shorter when present in the forest understory. All three species can form thickets in the forest understory, reproducing in low-light conditions and excluding native plant species. These trees can be difficult to control as they form extensive root sprouts after being cut down. The most effective method of control is to remove the entire root while the plant is small and can be pulled. If the plant is larger, it is possible to remove it using a weed wrench. If the tree is too large to be either hand pulled or removed with a weed wrench, cutting the stem at or above ground level and applying an herbicide such as 100% concentration of glyphosate directly to the cut portion of the stem as soon as possible is usually effective. Other methods of herbicide application include frilling (cutting into the cambium and applying herbicide to the wounds) and stem injection where time-release dosages are placed directly into the stem. These methods kill the trees in place which can be left to fall and naturally decompose. Due to the fact that these trees tend to root sprout and have many seedlings, monitoring around the infested areas on a regular basis will be necessary for several years after removal. It is very important not to cut the

trees down without herbicide application, as this can lead to numerous root sprouts and re-growth from the stem (King County 2007a).

Best Management Practices for these plants can be found at:
http://dnr.metrokc.gov/wlr/lands/weeds/holly.htm

European mountain ash and sycamore maple

European mountain ash and sycamore maple are deciduous trees that can form dense thickets in the forest understory and exclude native trees and shrubs. Manual means of controlling these tree species include hand pulling small seedlings and removing young trees with a weed wrench where possible. It is easier to implement manual control when the soil is moist. If the tree is too large for manual removal, girdling can be an effective means of control. Girdling can be accomplished by cutting through the bark and growing layer (cambium) in a complete ring around the trunk. This method is most effective in the spring. An herbicide such as 100% concentration of glyphosate applied directly to the cut portion of the stem as soon as possible is usually effective. Other methods of herbicide application include frilling (cutting into the cambium and applying herbicide to the wounds) and stem injection where time-release dosages are placed directly into the stem. These methods kill the trees in place which can be left to fall and naturally decompose. Larger trees can also be cut down although re-growth should be monitored and removed for several years after the tree is cut down to prevent re-sprouting (USDA Forest Service 2005, USDA Forest Service 2006).

Best Management Practices for these plants can be found at:
http://www.na.fs.fed.us/fhp/invasive_plants/weeds/european-mountain-ash.pdf
http://www.na.fs.fed.us/fhp/invasive_plants/weeds/sycamore_maple.pdf

Herb Robert

Herb Robert is a fall and spring annual flowering plant in the geranium family. This low growing ground cover can spread vigorously in the forest understory and displace native plants. It is most often found along trail corridors and other disturbed areas. Herb Robert is most successfully controlled throughout several growing seasons. In order to prevent spreading, it is necessary to remove the plant before it produces any flowers or seeds. Due to the weak root system of Herb Robert, manual removal methods are often effective. Wearing gloves to prevent skin irritation from the sticky oils of the plant, pull gently at the base to pull up the roots. A mechanical method such as a string trimmer can also be effective if used before the plant sets seed. Do not dispose of Herb Robert in on site compost piles, as seeds can survive and spread from composting. Utilize municipal yard waste facilities, as commercial high heat composting prevents germination of seeds. Chemical methods such as a systemic herbicide can be effective, especially if combined with monitoring for surviving plants. Such herbicides are absorbed by the foliage of the plant and travel through the plant to kill the roots. It is important to select an herbicide that is appropriate for the particular site, either aquatic or terrestrial. Take care to properly identify the plant prior to removal, because bleeding heart (*Dicentra formosa*), a Pacific Northwest native, is a strong look-alike (King County 2007b).

Best Management Practices for this plant can be found at:
http://dnr.metrokc.gov/wlr/lands/weeds/pdf/Herb_Robert_Factsheet.pdf

Himalayan blackberry

Himalayan blackberry is a vigorous evergreen shrub armed with prickles on the stems. This plant thrives in open, disturbed areas but can also invade forested areas on both wet and dry sites. Invasive blackberries often form large thickets that exclude all other species and can also climb and smother small trees.

Control of invasive blackberries requires management over a number of years. Based on the size of the site, various strategies can be effective. For small infestations of invasive blackberries, manual removal is appropriate. For larger infestations, mechanical methods such as mowing or brush cutting can be effective. Manual control consists of cutting blackberry canes with loppers or pruners one foot above the ground. Depending on the size of the plants, dig up the root balls using tools such as a hand tiller, shovel, pulaski, or pick mattock. Canes can be piled on site on top of a tarp or an impervious surface and left to decompose. Place any root balls on top of the pile to avoid re-rooting. Due to possible vigorous re-sprouting from the root crown, monitoring the infested area on a regular basis will be necessary for several years after removal. Removal procedures are repeated as necessary for complete control. After removing invasive blackberries, the area should be replanted with natives and mulched to help deter future invasive growth (King County 2005). Another potential chemical control method being tested on steep slopes and in areas with dense cover of native species is the cut and dab method. This technique involves the application of herbicide directly to freshly cut blackberry canes. The advantages of this method include minimizing soil disturbance and damage to existing vegetation.

Biological methods of controlling blackberry are also an option. The introduction of animals such as goats or pigs can be useful in controlling infestations from one to four years old. Chemical methods of controlling large blackberry infestations are also known to be effective, especially if combined with other methods such as mechanical control and monitoring (King County 2005).

Best Management Practices for this plant can be found at:
http://dnr.metrokc.gov/wlr/lands/weeds/pdf/blackberry-control.pdf

Appendix C. GPS plot locations

GCS WGS 1984 - Decimal Degrees			
Plot	Corner	Latitude	Longitude
1	NE	47.47037436000	-122.36623575200
1	NW	47.47037181500	-122.36642415100
1	SE	47.47024660500	-122.36623199800
1	SW	47.47024405900	-122.36642045700
2	NE	47.47003968500	-122.36578182500
2	NW	47.47003714100	-122.36597022300
2	SE	47.46991193000	-122.36577807200
2	SW	47.46990938500	-122.36596653000
3	NE	47.47011022200	-122.36654416400
3	NW	47.47010767600	-122.36673256300
3	SE	47.46998246700	-122.36654040900
3	SW	47.46997992000	-122.36672886800
4	NE	47.47011706300	-122.36715846300
4	NW	47.47011451600	-122.36734686200
4	SE	47.46998930800	-122.36715470800
4	SW	47.46998676000	-122.36734316600
5	NE	47.46980525100	-122.36677643400
5	NW	47.46980270500	-122.36696483200
5	SE	47.46967749600	-122.36677267900
5	SW	47.46967494900	-122.36696113600
6	NE	47.46949261100	-122.36634284100
6	NW	47.46949006600	-122.36653123700
6	SE	47.46936485600	-122.36633908700
6	SW	47.46936231000	-122.36652754300
7	NE	47.46978633700	-122.36783299000
7	NW	47.46978379000	-122.36802138800
7	SE	47.46965858200	-122.36782923300
7	SW	47.46965603400	-122.36801768900
8	NE	47.47012016600	-122.36817846300
8	NW	47.47011761700	-122.36836686200
8	SE	47.46999241100	-122.36817470500
8	SW	47.46998986200	-122.36836316300
9	NE	47.47043145700	-122.36879600000
9	NW	47.47042890800	-122.36898440000
9	SE	47.47030370200	-122.36879224000
9	SW	47.47030115200	-122.36898069900
10	NE	47.47072618900	-122.36875671600
10	NW	47.47072364000	-122.36894511700
10	SE	47.47059843400	-122.36875295600