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State of Kiwanis Ravine



EarthCorps
LOCAL RESTORATION • GLOBAL LEADERSHIP

State of Kiwanis Ravine

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1. INTRODUCTION

1.1 Purpose

The purpose of this document is to assist the Seattle Department of Parks and Recreation (SDPR) and the Green Seattle Partnership (GSP) in their planning efforts for ongoing maintenance and monitoring of Kiwanis Memorial Preserve Park (Kiwanis Ravine), by providing a synthesis of monitoring data and information relating to numerous ecological restoration efforts that have taken place in the ravine over the period of 2006-2011. In 2011, SDPR contracted EarthCorps (EC) to synthesize the information from these projects into a single document describing the “State of Kiwanis Ravine”, and to provide recommendations for future monitoring of restoration in the ravine. The data collected in this plan, such as current native plant species and associations present in the ravine and current invasive plant cover and distribution, will serve as baseline information with which future monitoring data may be compared.

1.2 Overview of Park

Kiwanis Ravine is an approximately 16-acre green space, located one block east of Discovery Park and a few blocks south of the Lake Washington Ship Canal, on the north side of the Magnolia neighborhood in Seattle, WA. The main portion of the preserve is bounded by West Government Way to the south and east, 36th Ave West to the west, and the railroad tracks to the north. The land is owned and managed by SDPR. Surface jurisdiction of several street and alley rights-of-way that border or cross the ravine was transferred from the Seattle Department of Transportation to SDPR in 2006. (1)

Kiwanis Ravine is home to the largest nesting site of great blue herons in Seattle, with over 80 active nests in 2010. Kiwanis Ravine is also home to a variety of other wildlife, including raccoons, mountain beaver and other smaller mammals, and a wide range of insect, bird and plant life. The great blue herons make their nests in the large deciduous trees of the central ravine from February through July or August each year. Conservation and protection of the heronry has long been a top priority for management of the ravine, leading to the formation of the community non-profit organization Heron Habitat Helpers (HHH) who have been working to protect and advocate for the herons and the ravine since 2001 (2). In 2010, SDPR established Kiwanis Memorial Preserve Park as the first wildlife sanctuary in the city (9). To avoid disturbances to the heronry, the ravine is largely closed to public use, with very short public trails that do not descend into the central ravine near the nesting site.

1.3 History of Restoration Efforts

Kiwanis Ravine was first established as a park in 1956, with additional land acquired and added through the period of the 1980s-2000s. Prior to the establishment of HHH in 2001, the land saw little active management, and the forest was overgrown with invasive species (especially English ivy, *Hedera helix*). The Kiwanis Ravine Management and Monitoring Plan/Report was

adopted by HHH and SDPR in 2003, and defines goals and objectives for restoration and monitoring of the ravine:

The goals and objectives of this Plan were developed in consultation with the Heron Habitat Helpers (HHH) and Seattle Parks, and are consistent with Seattle Parks Urban Wildlife and Habitat Management Plan (Miller 1994, 2000).

The goals for wildlife habitat management in Kiwanis Ravine are:

Goals

1. Provide contiguous, high-value, native wildlife habitat and a wildlife corridor in Kiwanis Ravine from the headwaters of Kiwanis Ravine to Salmon Bay
2. Maintain the long term viability of the existing great blue heron colony
3. Provide increased protection for wildlife habitat in the Ravine
4. Protect and enhance native wildlife populations
5. Promote volunteer involvement in wildlife and habitat protection and enhancement
6. Promote interdepartmental and interagency cooperation to protect wildlife and wildlife habitat.

These goals are overlapping and thus efforts to achieve one will serve to achieve others. In this they form an integrated vision for the future of the natural resources of Kiwanis Ravine as a sustainable urban preserve that supports native wildlife (1).

In the period of 2006-2011, ecological restoration efforts in the ravine moved forward rapidly, with several projects occurring simultaneously in different areas of the ravine and through different funding sources. These projects specifically address Goal 1: to provide contiguous, high-value, native wildlife habitat and a wildlife corridor in Kiwanis Ravine from the headwaters of Kiwanis Ravine to Salmon Bay. The objectives for Goal 1, as defined in the KRMMP, are as follows:

Objectives for Goal 1

1. Promote and enhance the integrity of native plant communities, wildlife habitats and ecosystems by removing non-native invasive plants from the Ravine
2. Replant areas with species that are native to appropriate Puget Sound lowlands plant communities
3. Enhance habitats by increasing the structural diversity of plant communities
4. Restore an open, natural connection from Wolfe Creek to Puget Sound

The projects described in this report include removal of invasive plants (objective 1) and replanting with native species (objectives 2 and 3). Though not a comprehensive list of all restoration efforts, the projects included below are of particular interest due to their scale and because they incorporated monitoring to measure the success of the project. This report summarizes the data collected through these various monitoring efforts. These data can be used to assess the progress made on objectives 1-3. Objective 4, to restore an open connection

to Puget Sound, was studied in 2008 by WR Consulting Inc. For further information on this subject, please refer to the Wolfe Creek Daylighting Study (2).

The ravine has been subdivided for planning and monitoring purposes into 25 distinct restoration sites. A map of these sites is in Appendix 1, page 22. Though these sites do not precisely correspond with the boundaries of the various restoration projects, the site names are used throughout this report to identify specific locations within the ravine.

1.3.1 Green Seattle Partnership Restoration and Monitoring

The 2008 Parks and Green Spaces Levy allocated \$600,000 over a six-year period for Kiwanis Ravine Restoration. As of January 2012, initial restoration has begun in all areas of the ravine. Two types of monitoring have occurred on an annual basis from 2010 and 2011. First, GSP inventory monitoring includes site-by-site assessment of general site characteristics, tree overstory and regenerating information, and shrub and herbaceous vegetation information (see section 2.1 for methodology). Second, the GSP Forest Monitoring Team has installed four permanent plots in the ravine to collect additional data (see section 2.2 for methodology).

1.3.2 Aquatic Habitat Grants

In 2006, 2007, and 2008, Heron Habitat Helpers applied for and received three consecutive grants from Seattle Public Utilities through the Aquatic Habitat Matching Grant program. HHH contracted with EarthCorps to use these funds for restoration in the southern portion of the ravine. Phase 1 (2006) concentrated on the west fork of Wolfe Creek, in partnership with neighbors along Brygger Drive (portions of sites KRW 1, 2, 3, 7, 8, KRSb, and KRE 7, as well as private property). Phase 2 (2007) focused on the riparian headwaters of both the east & west forks (portions of sites KRW1 and KRE1). Phase 3 (2008) connected these areas with the Sound Transit project, creating a contiguous restored riparian zone along Wolfe Creek (portions of sites KRE 3 and 4 and KRW 3 and 8). (7) (8) (9)

1.3.3 Sound Transit Mitigation.

In 2006, Kiwanis Ravine was selected as an off-site mitigation site for Sound Transit's Golden Gardens Track Improvements Project. Sound Transit contracted with EarthCorps to enhance three wetland areas (including a 50-foot buffer zone) in the central ravine. The project was originally planned for 2006 through January 2009, but the contract was later extended through January 2011. The total area restored through this project was 3.1 acres, including 0.43 acres of wetlands. The project area was located within the site KRM1. Performance standards for the project included achieving less than five percent coverage (on average) by invasive species at the end of the third year (January 2009). (4) (5) (6)

2. MONITORING METHODOLOGY

Monitoring methodologies varied between projects due to the different agencies, funding requirements, and goals of each project.

2.1 Green Seattle Partnership Site Inventory

GSP site inventory methods used qualitative and quantitative observations across the entire site to assess general site characteristics, tree overstory and regenerating information, and shrub and herbaceous vegetation information. This data provides general information about the physical condition of the entire site, provides estimates across the entire site describing the structure and composition of the existing tree canopy and regeneration layer, and describes the overall vegetative composition of the site, including native and invasive shrub, herb, and vine cover. This inventory was completed for all Kiwanis Ravine sites in the fall of 2009 as part of the city-wide inventory process. For sites where significant restoration occurred in the period 2010-2011, sites were re-inventoried in fall 2011. Results and findings included in section 3 below are based on the most recent available data. The full list of information collected during site inventory is included in Appendix B, page 22.

2.2 Green Seattle Partnership Forest Monitoring Plots

GSP Forest Monitoring Plots are typically 1/10-acre plots established and monitoring by volunteers trained through the GSP Forest Monitoring Team program. In addition to the basic inventory data described above, these plots provide objective and quantitative data on the species diversity and composition (diversity of native plants and trees, extent of invasive plant cover, and percent cover for each species of shrubs, vines and ground covers) and structural diversity of the forest (overstory and regenerating tree density, standing dead wood size and density, and coarse woody debris size and volume). “Tier 2” data refers to the first collection of baseline data on a site, before initiating a new restoration project, and provides more in depth information, while “Tier 1” data covers a subset of this information and can be used to measure the success of the invasive species removal and planting efforts over time. After the plot is established and “Tier 2” data collected, the plot can be resampled for “Tier 1” data on a yearly basis (for up to 5 years) to monitor forest health following management actions. For more information on this methodology, please refer to the GSP Forest Monitoring Protocols. (10)

2.3 Aquatic Habitat Grants

The Aquatic Habitat Grant projects used permanent transects to assess percentage cover by species as well as survivorship of native plants. Three to six 50-foot transects were installed each year (a total of 13 transects for all three projects). The transects were established prior to initial restoration, and oriented perpendicular to Wolfe Creek (and usually across the creek) in order to represent the full range of elevation, hydrology and vegetation types present in the area. A “sub plot” method was used to determine percentage cover by species: at 10-foot

intervals along each transect, a circular plot with 3-foot radius was established, and percent cover by species was measured by visual estimate. A “belt transect” method was used to measure survivorship: a rectangle or “belt” of width six feet was established along the length of the transect, and installed plants within this belt were recorded as healthy, stressed or dead. (7) (8) (9)

2.4 Sound Transit Mitigation

The Sound Transit project used randomly located plots to assess percentage cover by species. A 600-foot permanent baseline was established running along Wolfe Creek through site KRM1, marked at intervals of 50 feet. Each year, 12 to 14 monitoring plots were selected. Plot locations were determined by selecting either the 50 or 100-foot baseline markers, then measuring out either 20 or 50 feet (randomly selected) in each direction perpendicular from the baseline (creating 6-7 new plots each year on each side of the ravine). Each plot was 10 square meters. Percentage coverage by species was measured by visual estimate in each plot, and averaged to find overall percentage cover for the restoration site. (5)

2.5 Private Property Invasive Species Analysis

In 2011, EarthCorps was contracted by SDPR to conduct an analysis of the threat of invasive plant species encroaching into the ravine from surrounding properties. In the fall of 2011, EarthCorps ecologists performed a survey of all properties surrounding Kiwanis Ravine. The survey consisted of a visual assessment and occurred from public property locations. The results of this survey can be found in Appendix C.

2.6 Photo Monitoring

In 2011, EarthCorps established eight photo-monitoring points in recently restored areas of the ravine. At each location (see map in Appendix A), a capped piece of rebar was placed in the ground to aid in relocation. In addition, GPS coordinates were recorded for each point. Photos were taken on October 28th, 2011 and can be found in Appendix D.

3. RESULTS AND FINDINGS

The results and findings section provides a summary of collected field data for each monitoring project, and analysis as well as comparison (where possible) between the different data sets.

3.1 Overview

Kiwanis Ravine is dominated by deciduous forest, including riparian forest along the stream corridor at the bottom of the fifty to seventy-foot deep ravine, and upland forests on the steep ravine walls. Wolfe Creek, a perennial stream, flows northward through the ravine. Several tributaries feed the creek along its course, and forested wetlands are nested on the ravine slopes along the tributaries and where water seeps from the ravine walls. Many ravine slopes are unstable due to very steep grades and loose soil and dumped materials. At the north end of the ravine, Wolfe Creek flows into the collector to the West Point Treatment Plant. A small scrub-shrub wetland habitat surrounds the collector culvert.

3.2 Green Seattle Partnership Site Inventory Results and Findings

The following data tables and summaries provide an overview of conditions across the ravine, based on the inventory data collected for each of the 25 sites in the ravine. For site-specific information, please refer to EarthCorps' Interactive Habitat Map (3).

Throughout the forested areas of the ravine, the overstory is dominated by bigleaf maple (*Acer macrophyllum*) and red alder (*Alnus rubra*). Though 18 different overstory tree species are found in the ravine, these two species make up the vast majority of the overstory. Native conifer species including western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), and Douglas fir (*Pseudotsuga menziesii*) are present in some areas in the ravine, at very low density. Invasive trees including primarily sweet cherry (*Prunus avium*), black locust (*Robinia pseudoacacia*) and cherry laurel (*Prunus laurocerasus*) are also present in some areas. Full data on overstory tree species is found in Table 1.

Table 1. Overstory tree species found in Kiwanis Ravine, 2009-2011. GSP Site Inventory Data. (N=25)

Scientific Name	Common Name	Average Percent Cover (where present)	Frequency (percent of sites where present)
Native Species:			
<i>Abies grandis</i>	grand fir	2	4
<i>Acer macrophyllum</i>	bigleaf maple	50	100
<i>Alnus rubra</i>	red alder	24	92
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	black cottonwood	10	4
<i>Prunus emarginata</i>	bitter cherry	10	4
<i>Pseudotsuga menziesii</i>	Douglas fir	4	12
<i>Thuja plicata</i>	western red cedar	6	28
<i>Tsuga heterophylla</i>	western hemlock	4	16
Non-native species:			
<i>Chamaecyparis</i> sp.	cedar	3	12
<i>Chamaecyparis lawsoniana</i>	Port Orford cedar	3	4
<i>Ilex aquifolium</i>	English holly	2	4
<i>Malus domestica</i>	domestic apple	1	4
<i>Prunus avium</i>	sweet cherry	4	20
<i>Prunus cerasifera</i>	cherry plum	15	4
<i>Prunus laurocerasus</i>	cherry laurel	6	8
<i>Prunus</i> sp.	horticultural cherry species	10	4
<i>Prunus x pugetensis</i>	hybrid bitter cherry	2	4
<i>Robinia pseudoacacia</i>	black locust	3	12

Regenerating trees show a greater diversity of species than those found in the overstory (25 total species, 16 of them native), but stem density of regenerating trees is very low among native species. Significant species of regenerating native trees include bigleaf maple (68 stems/acre where present) and western red cedar (55 stems/acre where present).

Regenerating invasive trees are found at similar densities, including primarily English holly (*Ilex aquifolium*) at 51 stems/acre where present, and cherry laurel at 68 stems/acre where present. Invasive trees pose a serious threat to the future integrity of the forest, with non-native tree regeneration on par with native tree regeneration across the ravine as a whole. English holly and cherry laurel 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 (4). Full data on regenerating tree species is found in Table 2.

Table 2: Regenerating tree species found in Kiwanis Ravine, 2009-2011. GSP Site Inventory Data. (N=25)

Scientific Name	Common Name	Native	Density where present (stems/acre)	Frequency (percent of sites where found)
Native Species:				
<i>Abies grandis</i>	grand fir	Yes	10	36
<i>Acer macrophyllum</i>	bigleaf maple	Yes	68	100
<i>Alnus rubra</i>	red alder	Yes	28	52
<i>Arbutus menziesii</i>	Pacific madrone	Yes	10	8
<i>Betula papyrifera</i>	paperbark birch	Yes	35	8
<i>Cornus nuttalli</i>	Pacific dogwood	Yes	60	4
<i>Frangula purshiana</i>	cascara	Yes	22	48
<i>Fraxinus latifolia</i>	Oregon ash	Yes	10	16
<i>Picea sitchensis</i>	Sitka spruce	Yes	41	60
<i>Pinus contorta</i>	shore pine	Yes	10	8
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	black cottonwood	Yes	10	4
<i>Prunus emarginata</i>	bitter cherry	Yes	27	12
<i>Pseudotsuga menziesii</i>	Douglas fir	Yes	27	60
<i>Quercus garryana</i>	Garry oak	Yes	10	4
<i>Thuja plicata</i>	western red cedar	Yes	55	88
<i>Tsuga heterophylla</i>	western hemlock	Yes	22	68
Non-native species:				
<i>Aesculus hippocastanum</i>	horse chestnut	No	10	8
<i>Chamaecyparis</i> sp.	cedar	No	10	4
<i>Crataegus monogyna</i>	oneseed hawthorn	No	10	12
<i>Ilex aquifolium</i>	English holly	No	51	76
<i>Malus</i> sp.	horticultural apple species	No	35	8
<i>Prunus avium</i>	sweet cherry	No	15	44
<i>Prunus cerasifera</i>	cherry plum	No	51	16
<i>Prunus laurocerasus</i>	cherry laurel	No	68	68
<i>Prunus</i> sp.	horticultural cherry species	No	60	12
<i>Quercus</i> sp.	oak	No	10	4
<i>Robinia pseudoacacia</i>	black locust	No	22	16
<i>Sorbus aucuparia</i>	European mountain ash	No	17	28

A wide range of shrubs and herbaceous or groundcover species are present in the ravine. There are 34 native species and 5 non-native species of shrubs, and 35 native and 29 non-native species of herbaceous or groundcover plants. Dominant shrubs include salmonberry (*Rubus spectabilis*), beaked hazelnut (*Corylus cornuta*) and Indian plum (*Oemlaria cerasiformis*). Significant herbaceous/groundcover species include sword fern (*Polystichum munitum*) and stinging nettle (*Urtica dioica*). Full data on shrub species is found in Table 3, page 9, and full data on herbaceous and groundcover species is found in Table 4, page 10.

Non-native invasive plant species are present throughout the property. Of the 34 non-native species of shrubs and groundcovers, many are considered invasive, and a number of them have been given a legal designation by the King County Noxious Weed Control Board. Without active management these species will continue to spread and detrimentally affect the natural areas of the property.

Garlic mustard (*Alliaria petiolata*) has been listed as a Class A Noxious Weed by the state weed board (4). Control of this weed is required throughout Washington State. Found primarily in the west fork of the ravine (sites KRW 1, 2, and 3), this species has been observed to be spreading over the past few years and should be considered a top priority for control. Several other invasive species are also listed as noxious weeds, though not required for control in King County. Knotweed (*Polygonum spp.*) poses a significant threat to the ravine's ecosystem due its fast rate reproduction and ability to rapidly dominate the understory. Additionally, Himalayan blackberry, English ivy, wild clematis, and others all pose significant threats. Blackberry and ivy in particular have been tremendously reduced across the ravine thanks to the concerted restoration efforts described in section one above, but their continued presence should be noted and considered in future stewardship plans.

Table 3: Shrub species in Kiwanis Ravine, 2009-2011. GSP Site Inventory Data.

Scientific Name	Common Name	Native	Percent Cover where found	Frequency (% of sites where found)
Native species:				
<i>Acer circinatum</i>	vine maple	Yes	2	48
<i>Amelanchier alnifolia</i>	serviceberry	Yes	0	4
<i>Cornus sericea</i>	red-osier dogwood	Yes	1	32
<i>Corylus cornuta</i>	beaked hazelnut	Yes	15	84
<i>Crataegus douglasii</i>	Pacific hawthorn	Yes	2	8
<i>Gaultheria shallon</i>	salal	Yes	1	28
<i>Holodiscus discolor</i>	oceanspray	Yes	1	28
<i>Lonicera involucrata</i>	twinberry	Yes	8	8
<i>Mahonia aquifolium</i>	tall Oregon grape	Yes	1	20
<i>Mahonia nervosa</i>	low Oregon grape	Yes	4	48
<i>Malus fusca</i>	western crabapple	Yes	1	8
<i>Morella californica</i>	pacific wax myrtle	Yes	0	4
<i>Oemleria cerasiformis</i>	indian plum	Yes	7	92
<i>Philadelphus lewisii</i>	mockorange	Yes	1	28
<i>Physocarpus capitatus</i>	Pacific ninebark	Yes	2	24
<i>Ribes bracteosum</i>	stink currant	Yes	1	8
<i>Ribes lacustre</i>	swamp gooseberry	Yes	0	12
<i>Ribes sanguineum</i>	red-flowering currant	Yes	2	16
<i>Rosa gymnocarpa</i>	baldhip rose	Yes	1	12
<i>Rosa nutkana</i>	Nootka rose	Yes	5	28
<i>Rubus leucodermis</i>	blackcap	Yes	0	44
<i>Rubus parviflorus</i>	thimbleberry	Yes	1	36
<i>Rubus spectabilis</i>	salmonberry	Yes	20	88
<i>Rubus ursinus</i>	creeping blackberry	Yes	6	52
<i>Salix hookeriana</i>	Hooker's willow	Yes	5	4
<i>Salix lucida</i> ssp.	Pacific willow	Yes	2	8
<i>Salix scouleriana</i>	Scouler's willow	Yes	2	20
<i>Salix sitchensis</i>	Sitka willow	Yes	0	12
<i>Sambucus racemosa</i>	red elderberry	Yes	2	72
<i>Spiraea douglasii</i>	hardhack	Yes	0	12
<i>Symphoricarpos albus</i>	snowberry	Yes	2	60
<i>Vaccinium ovatum</i>	evergreen huckleberry	Yes	1	36
<i>Vaccinium parvifolium</i>	red huckleberry	Yes	1	28
<i>Viburnum edule</i>	high-bush cranberry	Yes	1	8
Non-native species				
<i>Bambusa</i> sp.	bamboo	No	0	4
<i>Buddleja davidii</i>	butterfly bush	No	2	4
<i>Daphne laureola</i>	spurge laurel	No	0	24
<i>Ligustrum</i> sp.	privet hedge	No	2	8
<i>Rubus armeniacus</i>	Himalayan blackberry	No	3	84

Table 4: Herbaceous species in Kiwanis Ravine, 2009-2011. GSP Site Inventory Data, 2009-2011. GSP Site Inventory Data.

Native species:				
Scientific name	Common name	Native	Percent Cover where found	Frequency (% of sites where found)
Achillea millefolium	yarrow	Yes	5	4
Anaphalis margaritacea	pearly everlasting	Yes	0	4
Asarum caudatum	wild ginger	Yes	0	4
Athyrium filix-femina	ladyfern	Yes	2	60
Blechnum spicant	deerfern	Yes	0	24
Carex deweyana	Dewey sedge	Yes	0	24
Carex obnupta	slough sedge	Yes	1	24
Dicentra formosa	western bleedingheart	Yes	0	4
Elymus glaucus	blue wildrye	Yes	0	4
Epilobium ciliatum	fringed willowherb	Yes	1	20
Equisetum telmateia	giant horsetail rush	Yes	4	52
Fragaria chiloensis	beach strawberry	Yes	1	8
Fragaria vesca	woodland strawberry	Yes	0	4
Galium aparine	stickywilly	Yes	1	20
Geum macrophyllum	bigleaved avens	Yes	0	4
Glyceria elata	tall mannagrass	Yes	3	4
Hydrophyllum tenuipes	Pacific waterleaf	Yes	1	32
Juncus effusus	soft rush	Yes	0	4
Lonicera ciliosa	orange honeysuckle	Yes	0	4
Lonicera hispidula	hairy honeysuckle	Yes	0	8
Luzula parviflora	small-flowered woodrush	Yes	1	12
Lysichiton americanus	skunk cabbage	Yes	3	44
Maianthemum racemosum	false Solomon's seal	Yes	0	4
Oenanthe sarmentosa	water parsley	Yes	4	32
Oplopanax horridus	devil's club	Yes	3	20
Osmorhiza berteroi	sweet cicely	Yes	0	4
Oxalis oregana	redwood sorrel	Yes	1	8
Polypodium glycyrrhiza	licorice fern	Yes	0	8
Polystichum munitum	sword fern	Yes	15	92
Pteridium aquilinum	bracken fern	Yes	2	4
Symphotrichum subspicatum	Douglas aster	Yes	1	4
Tellima grandiflora	fringe cup	Yes	3	60
Tolmiea menziesii	piggy-back plant	Yes	3	36
Urtica dioica	stinging nettle	Yes	17	88
Veronica americana	American brooklime	Yes	0	12

Non-native species:				
Scientific name	Common name	Native	Percent Cover where found	Frequency (% of sites where found)
Alliaria petiolata	Garlic mustard	No	7	32
Arctium minus	lesser burdock	No	0	8
Calystegia sepium	hedge false bindweed	No	6	68
Cardamine hirsuta	hairy bittercress	No	1	20
Cirsium arvense	Canada thistle	No	0	4
Cirsium vulgare	bull thistle	No	1	8
Clematis vitalba	evergreen clematis	No	5	4
Conium maculatum	poison hemlock	No	0	8
Digitalis purpurea	foxglove	No	0	8
Geranium robertianum	herb Robert	No	1	52
Hedera helix	English ivy	No	5	64
Hypericum sp.	St. Johnswort	No	0	4
Hypochaeris radicata	hairy cat's-ear	No	2	4
Impatiens capensis	jewelweed	No	1	12
Lactuca serriola	prickly lettuce	No	0	4
Lamium album	yellow archangel	No	1	8
Lapsana communis	nipplewort	No	3	36
Lunaria annua	annual honesty	No	2	20
Mycelis muralis	wall-lettuce	No	0	28
Phalaris arundinacea	reed canarygrass	No	1	12
Polygonum xbohemicum	Bohemian knotweed	No	1	28
Polygonum cuspidatum	Japanese knotweed	No	3	12
Ranunculus repens	creeping buttercup	No	2	48
Rumex obtusifolius	bitter dock	No	1	8
Solanum dulcamara	deadly nightshade	No	1	64
Tanacetum vulgare	common tansy	No	2	4
Veronica officinalis	common gypsyweed	No	2	4
Vinca major	bigleaf periwinkle	No	0	4

3.3 GSP Forest Monitoring Plots

To date, four plots have been installed in Kiwanis Ravine by the GSP Forest Monitoring Team (see map in Appendix A). A 1/20th-acre plot was installed in 2010 in site KRW5, with Tier 2 data collected in November 2010 and Tier 1 data re-collected in September 2011. Three additional 1/10-acre plots were installed in October 2011, in sites KWC, KRSb, and KRM5. All three plots received Tier 2 data collection protocols. Full reports on each plot are available from the EarthCorps Interactive Habitat Map (3).

The monitoring plot in site KRW5 provides the first opportunity to compare data collected in Kiwanis Ravine by the Forest Monitoring Team that documents changes due to restoration work completed during the course of the year. A comparison of the two data sets shows several significant changes.

First, removal of invasive plant species is documented in each of the three categories: tree density, shrub cover, and groundlayer cover. The number of regenerating invasive trees was tremendously reduced, from over 250 stems/acre each for cherry laurel and holly, to only 40 stems/acre of cherry laurel and zero stems/acre of holly. The percent cover of invasive shrubs was also reduced, from 11% cover of Himalayan blackberry to zero percent. Finally, the percent cover of invasive groundcover was reduced from 77% to 41%. This change includes the complete removal of herb-Robert (*Geranium robertianum*) and nightshade (*Solanum dulcamara*), and more significantly, the reduction of English ivy from 50-75% cover to less than 5% cover. Field bindweed (*Calystegia sepium*) was present at 25% to 50% in 2011.

Second, planting of native species is documented in the category of native tree regeneration. Evergreen tree density increased from zero stems/acre in 2010 to 180 stems/acre in 2011. Four native conifer species were included: western red cedar, western hemlock, grand fir (*Abies grandis*) and Sitka spruce (*Picea sitchensis*).

Though this data is specific to the area of KRW5 where the data was collected, the type of changes documented are representative of the type of restoration work that has been completed across the ravine. Similar analysis will be possible for the other three plots once data is collected in 2012. Furthermore, when the KRW5 plot is resampled in 2012, survival rates of planted trees can be calculated. This information will be available for all future plots that receive successive Tier 1 data collection. However, accurate survival data will only be available for plots that have Tier 1 data collected closely following planting efforts. Survival of trees present at the time of plot sampling will be possible for all other existing or future plots.

3.4 Aquatic Habitat Grants

Much of the data collected through the Aquatic Habitat Grant projects is not directly comparable to the other data sets. For example, data on survivorship of installed plantings within a given belt transect, though an important criteria for judging the success of these projects at the time, is not very useful in the context of the entire ravine, nor is it comparable

with any other data collected by other projects. For this reason, we have only included here the relevant data on invasive species cover. For more complete monitoring data, as well as a deeper discussion of the challenges and successes of these projects, please refer to the project final reports (5) (6) (7). Table 5 compiles data on invasive species cover from these projects, by transect, over the period 2006-2011. The data shows the general trajectory of invasive species cover in these areas of the ravine, from 40-100% prior to restoration to 0-35% after restoration. GSP inventory data from 2011 is also included for comparison.

Table 5: Percent cover of invasive species, AHG sites 2006-2011. Aquatic Habitat Grant monitoring data.

Transect	Location	AHG data:						GSP inventory data:
		<i>percent cover, all invasive shrubs and groundlayer plants</i>						
		2006	2007	2008	2009	2010	2011	2011
East Fork:								
AHG07 EF-1	KRE1	-	57	3	< 1	5	-	11
AHG07 EF-2	KRE3	-	51	21	11	5	-	5
AHG08 EF-1	KRE3	-	-	44	9	22	30	
AHG08 EF-2	KRE3 and KRE4	-	-	65	42	18	33	3 to 5
AHG08 EF-3	KRE4	-	-	18	8	6	5	3
West Fork:								
AHG07 WF-1	KRW1	-	89	15	17	2	-	15
AHG07 WF-2	KRW1 and KRW2	-	45	21	15	32	-	15 to 35
AHG06-A	KRW2	98	5	7	9*	-	-	35
AHG06-C	KRW3	98	7	35	28**	-	-	8
AHG08 WF-1	KRW3	-	-	30	3	4	0	
AHG08 WF-2	KRW8	-	-	28	12	8	1	0
AHG08 WF-3	KRW8	-	-	21	4	2	< 1	
		- indicates no data collected this year						
		* not including garlic mustard, counted separately at 18%						
		** not including garlic mustard, counted separately at 23%						

3.5 Sound Transit Mitigation

The Sound Transit Mitigation project monitoring program provided additional data for the site KRM1, which is the largest single site in the ravine at approximately 4 acres. The monitoring measured percent cover by species for each species found within the area, over the period 2006-2010. Data collected is shown in table 6, below. This table is from the report *Kiwanis Ravine: Sound Transit Mitigation Project - Fall 2010 Monitoring and Maintenance Summary* (8), and additional discussion of the results can also be found in that report.

Table 6: Sound Transit Mitigation Project results (project area located within site KRM1). Numbers indicate percent cover by species in the given year.

		Baseline	Sep-07	Sep-08	Jan-09	Oct-09	Sep-10
	NATIVE SPECIES						
Trees	ACMA (<i>Acer macrophyllum</i>)	48	48.8	42.9	62.9	38.1	49
	ALRU (<i>Alnus rubra</i>)		25.6	7.5	21.5	10.4	30.1
	PISI (<i>Picea sitchensis</i>)		5.5	0.8	0.1		
	PSME(<i>Pseudotsuga menziesii</i>)				0.2		
	THPL (<i>Thuja plicata</i>)		6.7	22.1	8.3	9.6	5.9
	TSHE (<i>Tsuga heterophylla</i>)		0.1	0.4	1	0.1	0.1
Shrubs	BENE (<i>Berberis nervosa</i>)	10	0.1	0	0.4		
	COCO (<i>Corylus cornuta</i>)	63	1.6	6.7		3.5	10.4
	COSE (<i>Cornus sericea</i>)		0.1	0.4	0.6		0.2
	OECE (<i>Oemlaria cerasiformis</i>)	5	3.8	8.3	3.3	2.4	11.4
	OPHO (<i>Oplopanax horridus</i>)			2.1	2.1	2.5	1.4
	RIBR (<i>Ribes bracteosum</i>)		0.1				
	RUPA (<i>Rubus parviflorus</i>)	1		2.9			
	RUSP (<i>Rubus spectabilis</i>)	9	33.8	37.9	33.6	30	24.6
	Salix spp.		5	0.4	0.1	0.6	2.9
	SARA (<i>Sambucus racemosa</i>)		1.1	0.7	6.4	5.5	3.1
	VAPA (<i>Vaccinium parvifolium</i>)	3	0.6	0.3	0.7		
Groundcover / Emergent	ATFI (<i>Athyrium filix-femina</i>)		6.4	9.2	0.4	9.4	4.9
	Carex spp.		0.2	0.4			
	EQTE (<i>Equisetum telmateia</i>)		0.2			0.8	0.1
	HYTE(<i>Hydrophyllum tenuipes</i>)		0.1	0.4		0.5	2.4
	LYAM(<i>Lysichiton americanum</i>)		0.6			0.4	
	OESA (<i>Oenanthe sarmentosa</i>)		0.1				
	POGL(<i>Polypodium glycyrrhiza</i>)				0.7		
	POMU (<i>Polystichum munitum</i>)	10	8.8	26.1	40.4	26.4	32
	PTAQ (<i>Pteridium aquilinum</i>)				1.4		
	RULE (<i>Rubus leucodermis</i>)		0.1				
	RUUR (<i>Rubus ursinus</i>)	15	0.9	1.8	0.4	4.4	1.2
	TEGR (<i>Tellima grandiflora</i>)		1.2	1.8	8.9	11.3	11.6
	TOME (<i>Tolmiea menziesii</i>)		8.8	10.8		1.8	3.7
	URDI (<i>Urtica dioica</i>)	1	4	11.9	2.7	14.7	17.1
Invasive Species	AEHI (<i>Aesculus hippocastanum</i>)		0.3				
	PRLA (<i>Prunus laurocerasus</i>)	5			0.1	0.1	0.1
	ILAQ (<i>Ilex aquifolium</i>)	10	0.7	0.4	1.1		0.1
	POCU (<i>Polygonum cuspidatum</i>)			1.3			
	RUAR (<i>Rubus armenicus</i>)		0.8	1.7		0.6	0.5
	COAR (<i>Convolvulus arvensis</i>)		0.8	0.1		0.3	
	HEHE (<i>Hedera helix</i>)	93	1.4	0.3	0.1	0.3	0.3
	PHAR (<i>Phalaris arundinacea</i>)		5.1	4.6		0.4	0.4
	RARE (<i>Ranunculus repens</i>)		0.9	0.8	2.5	1.3	0.7
	SODU (<i>Solanum dulcamara</i>)		0.2	0.2		0.6	
	INVASIVE TOTAL	93 - 100%	9.1 - 11.5%	6.8 - 9.4%	2.7 – 3.8%	2.6 – 3.8%	1.4-2.1%

This data documents the reduction of invasive plant species, especially English ivy, from over 93% cover in 2006 to less than 3% in 2010. It also provides a list of all plant species, native and invasive, observed in this area over the five-year monitoring period.

This data can also be compared with the inventory collected for KRM1 in October 2009, though it should be noted that the site boundaries of the Sound Transit project, a total of 3.1 acres, do not encompass the entire area of KRM1. Inventory data shows a higher level of invasive species (8% invasive groundlayer; 140 stems/acre of invasive trees) which likely reflects the unrestored area in KRM1 around the edges of the Sound Transit site. The inventory also confirms the predominant native species: red alder, bigleaf maple, and western red cedar trees, salmonberry, beaked hazelnut, and Indian plum shrubs, and primarily sword fern at the ground layer.

4. MONITORING RECOMMENDATIONS

As of this writing, restoration has begun in all areas owned or currently managed by SDPR throughout the Kiwanis Ravine, through initial invasive plant removal and replanting with native species. This work meets several of the objectives listed in the KRMMP, including to promote and enhance the integrity of native plant communities, wildlife habitats and ecosystems by removing non-native invasive plants from the Ravine, to replant areas with species that are native to appropriate Puget Sound lowlands plant communities, and to enhance habitats by increasing the structural diversity of plant communities. The monitoring data summarized above demonstrates the significant progress made toward these objectives.

However, the ravine remains very fragmented in terms of the degree of work undertaken, the amount and species replanted, and the timeline of work. Some areas, such as the Sound Transit Mitigation Project site in KRM1, have been largely cleared of invasive plants for as much as six years, with native plantings rapidly growing to fill in the space left by invasive removal. Other areas, such as the shoulders of the ravine, were only just cleared in late 2011, and planted at the same time. The monitoring program in future years should take these differences into consideration, yet be designed to move in the direction of considering the ravine as whole, and the health of the ravine's forests as a single ecosystem, rather than in terms of a collection of unique restoration projects.

With that goal in mind, future monitoring should be done with a single consistent approach across the entire ravine. We recommend installing additional plots following the GSP Forest Monitoring Team protocols across the ravine. Twelve new plots, in addition to the four existing plots described above, will provide a ten percent sample of the ravine area. Because the data collected using these plots is directly comparable with the GSP site inventories collected in 2009 and 2011, the data included above in section 3.2 may be used as a baseline for comparison of data. This type of monitoring can be conducted by properly trained volunteers, staff or contractors. It should 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. 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.

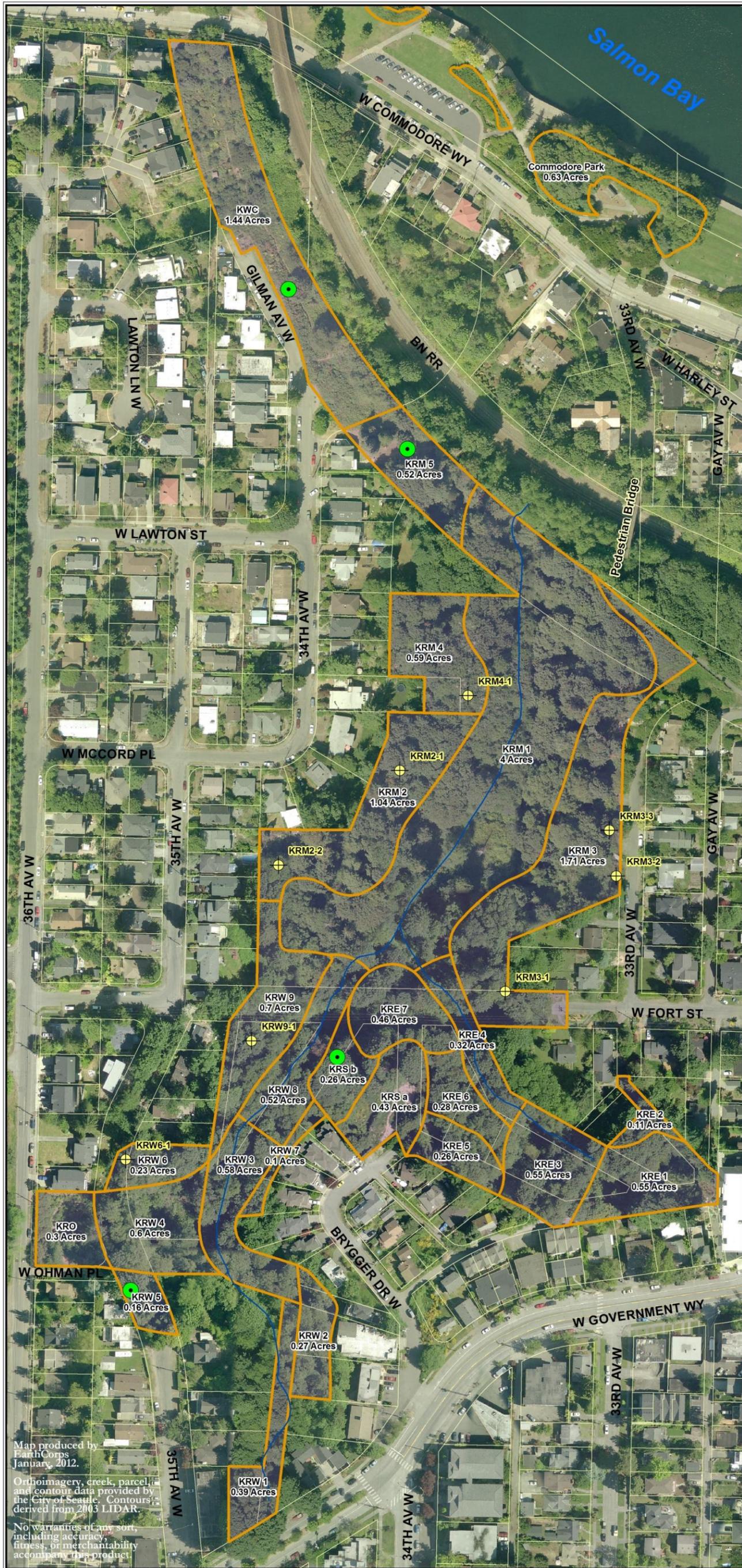
These plots will provide a comprehensive representation of the overall composition and structure of the ravine and allow for a quantitative analysis of changes over time. However, a plot level survey may not provide specific information on the conditions of the narrow riparian corridor adjacent to Wolfe Creek and its tributaries. It is recommended that different methodologies be considered if it is deemed necessary to monitor vegetation specific to the riparian corridor. Line-intercept transects perpendicular to the stream spanning the riparian corridor, or "greenline" transects parallel to the stream (or a combination of the two) could be

established throughout the ravine. Any methodology should collect data that would be comparable to the data collected following the GSP plot level monitoring methodology.

It should be noted that the existing GSP sites (as shown in Appendix A and on the EarthCorps Interactive Habitat Map) do not in all cases reflect areas with similar conditions on the ground (such as forest types, native plant associations, or hydrologic conditions). In some instances, sites were established based on the general area of previous restoration projects or in areas that are often worked on as a unit. In other cases, dissimilar habitats may be present in a single site due to the fragmented and often narrow situation of the public and private property boundaries. Plots should be installed so that the entire area encompasses a specific plant community and/or representative forest type, rather than based solely on site boundaries. Because sites are not similar in size, some will require more than a single plot while others may have no plots at all. The goal will be to have plots stratified across the ravine with approximately one plot per acre.

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Kiwanis Ravine GSP Restoration

Legend

- FMT Plots
- Photo Points (2011)
- Wolfe Creek
- Active GSP Site
- Parcel

Total Acres: 16.38

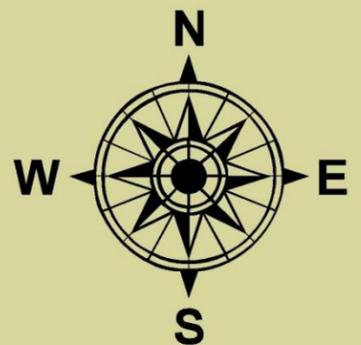
Key

Volunteer Sites

- KRS:** Kiwanis Ravine Stevens
- KRO:** Kiwanis Ravine Overlook
- KWC:** Kiwanis Wildlife Corridor

Non-Volunteer Sites

- KRM:** Kiwanis Ravine Main
- KRE:** Kiwanis Ravine East
- KRW:** Kiwanis Ravine West



Map produced by EarthCorps, January, 2012.
 Orthoimagery, creek, parcel, and contour data provided by the City of Seattle. Contours derived from 2003 LIDAR.
 No warranties of any sort, including accuracy, fitness, or merchantability accompany this product.

Appendix B. GSP Monitoring Protocols for site inventory

GSP Monitoring Protocols collect information about three distinct types of information:

- **General site characteristics**
 - Provides general information about the physical condition of the entire site.
 - Site boundaries are established with consideration for general ecological conditions such as dominant species associations, wetlands, etc.
- **Tree overstory and regenerating information**
 - Provides data averaged across the entire site describing the structure and composition of the existing tree canopy and regeneration layer.
- **Shrub and herbaceous vegetation information**
 - Describes the overall vegetative composition of the site, including native and invasive shrub, herb, and vine cover.

General Site Characteristics

The following information is collected:

- Park Name.
- Site Name
- Date
- Habitat type: Broadleaf Evergreen Forest (Madrone), Broadleaf Evergreen/Conifer Mixed Forest, Broadleaf Evergreen/Deciduous Mixed Forest, Conifer Forest, Conifer/Deciduous Mixed Forest, Deciduous Forest, Forested Wetland, Riparian Forest
- Slope: Measured in degrees
- Aspect: N, NE, NW, S, SE, SW, W, E, flat
- Overstory tree diameter: Visual estimate of diameter of dominant trees for the entire site (<5", 5-15", 15-20", 20-30", 30+")
- Canopy cover: Estimate for the entire site in percent
- Soil moisture: Sample just under the duff (dry, damp, saturated, standing water)
- Soil texture: clay, gravel, sand, silt
- Soil compaction: Look for evidence of compaction on the site from trails, etc. (none, light, moderate, heavy)
- Soil compaction notes: notes about what is causing compaction (e.g. trail)
- Bare ground: Estimate of bare ground or mulch covering entire site (1-20%, 21-40%, 41-60%, 61-80%, 81-100%)
- Soil stability: Evidence of erosion, if present (Stable soil, erosion, slumping, slides)
- Litter depth: Litter includes mulch, duff and litter. (0, .1-.5", 0.5-1", 1+")
- Special features: e.g. wetland, stream, etc.
- CWD cover: estimate for the entire site (0-5%, 6-10%, 11-25%, 26-50%, 51-100%)

Tree Overstory and Regenerating Information

Regeneration

For each species of regenerating tree (smaller than 5" DBH), provide the following information cumulatively across the entire restoration site:

- Species

- Density category (None – less than 20 stems/acre; Very low – between 20 and 100 stems/acre; Sparse – between 100-150 stems/acre; Stocked – between 150-250 stems/acre; Overstocked – more than 250 stems/acre).
- All native and non-native and invasive species such as English holly, cherry laurel, Portugal laurel, European mountain ash, one-seed hawthorn, horse chestnut, bird cherry, etc. should be included in this assessment.
- For example a site could contain very low quantities of Douglas-fir, sparse categories of western red cedar, very low big-leaf maple, very low English holly and none bird cherry, etc.

Overstory

For all sites, overstory cover by species needs to be collected for the entire site. Overstory trees are greater than 5" DBH. The following information should be included:

- Species
- Cover (% estimate)
- Density category (None – less than 20 stems/acre; Very low – between 20 and 100 stems/acre; Sparse – between 100-150 stems/acre; Stocked – between 150-250 stems/acre; Overstocked – more than 250 stems/acre).

Shrub and herbaceous vegetation

The goal of the assessment is to collect information about the dominant shrub and herbaceous vegetation on the site. If there are notable native species of interest present in small quantities, those should be noted as well.

Information to be collected includes:

- Species
- Percent cover over the entire site

Appendix C. Kiwanis Ravine Private Property Invasive Species Analysis

Great efforts have been taken to restore the ecological function and value of the habitat found in Kiwanis Ravine. As exemplified elsewhere in this report, a major component of these efforts has been to remove non-native invasive plant species from the park. In order to effectively manage and prevent the reintroduction of these species, a successful strategy must consider existing and potential plant seed and material sources in the vicinity of the park. To get a better understanding of the existing threat of reintroduction from properties adjacent to park, a qualitative survey was carried out to assess the presence of invasive plant species around the perimeter of the ravine. This information can be used to target eradication and control efforts and to educate the public about the threat that horticultural plant species can have on ongoing restoration efforts in the ravine and throughout our region.

Methodology

The survey consisted of a visual assessment and occurred from public property locations. All non-native invasive plant species observable from public property were noted for each parcel and indicated by relative cover using the following categories: Trace (<1%), Low (1-10%), Medium (10-25%), and High (>25%). These categories were determined by estimating what proportion of the approximate boundary between public and private property was occupied by each species. When a species was present on the property but not within this approximate boundary, it was noted as such and placed into one of the above categories based on the relative cover of the species in relation to the visible portion of the property. Public rights of way were included in this survey.

Results

A total of 78 parcels were surveyed, including 75 private residences and 3 public rights of way. Of these properties, 75 of 78 (96%) had at least one species of non-native plants considered invasive in this study. The three properties with no invasive plants are primarily hardscape with no visible vegetation. A total of 28 invasive plants were found during the survey (Table 1). Garlic mustard (*Allaria petiolata*) is a species designated by the King County Noxious Weed Control Board as a “Class A” noxious weed, requiring eradication throughout Washington State including King County. Thirteen other species are designated as “Non-regulated” noxious weeds which are non-designate class B and C weeds where control is recommended but not required in King County. Eight species are designated as “King County weeds of concern” which are species that are not classified as noxious weeds in Washington State. These species often impact and degrade native plant and animal habitat. Control is recommended where possible and new plantings are discouraged. For more information regarding invasive species classifications in King County, visit the noxious weed website at <http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/laws/list.aspx>. The remaining six species are not recognized by the county but pose a potential risk to the ravine because of their ability to reproduce and spread in urban natural areas. All of these species have the potential to impact and impede ongoing and future restoration efforts. Table 1 lists all invasive plant species and the percent of properties (including rights of way) that they were found on during the survey.

Table 1. List of all invasive plant species found on properties bordering Kiwanis Ravine during a survey conducted in the fall of 2011, and the percent of properties on which they occurred.

Scientific Name	Common Name	Life Form	2012 King Co. Designation	Percent (N=78)
<i>Ailanthus altissima</i>	tree-of-heaven	Tree	Not listed	1%
<i>Alliaria petiolata</i>	Garlic mustard	Herb	Class A	10%
Bamboo, horticultural	bamboo	Herb	Not listed	12%
<i>Buddleja davidii</i>	butterflybush	Shrub	Non-regulated	6%
<i>Calystegia sepium</i> and/or <i>C. silvatica</i>	hedge false bindweed	Herb	Weed of concern	56%
<i>Clematis vitalba</i>	evergreen clematis	Herb	Non-regulated	1%
<i>Conium maculatum</i>	poison hemlock	Herb	Non-regulated	6%
<i>Crataegus monogyna</i>	oneseed hawthorn	Tree	Weed of concern	4%
<i>Cytisus scoparius</i>	scotch broom	Shrub	Non-regulated	4%
<i>Daphne laureola</i>	Spurge laurel	Shrub	Non-regulated	12%
<i>Foeniculum vulgare</i>	sweet fennel	Herb	Non-regulated	1%
<i>Geranium robertianum</i>	herb Robert	Herb	Non-regulated	28%
<i>Hedera helix</i>	English ivy	Herb	Non-regulated	67%
<i>Ilex aquifolium</i>	English holly	Tree	Weed of concern	42%
<i>Impatiens capensis</i>	spotted jewelweed	Herb	Weed of concern	1%
<i>Lamium galeobdolon</i>	yellow archangel	Herb	Non-regulated	5%
<i>Phalaris arundinacea</i>	reed canarygrass	Grass	Non-regulated	3%
<i>Polygonum xbohemicum</i>	Bohemian knotweed	Herb	Non-regulated	23%
<i>Prunus avium</i>	sweet cherry	Tree	Not listed	1%
<i>Prunus laurocerasus</i>	cherry laurel	Tree	Weed of concern	47%
<i>Prunus lusitanica</i>	Portugal laurel	Tree	Not listed	3%
<i>Ranunculus repens</i>	creeping buttercup	Herb	Weed of concern	24%
<i>Robinia pseudoacacia</i>	black locust	Tree	Not listed	3%
<i>Rubus armeniacus</i>	Himalayan blackberry	Shrub	Non-regulated	62%
<i>Solanum dulcamara</i>	bittersweet nightshade	Herb	Weed of concern	21%
<i>Sorbus aucuparia</i>	European mountain ash	Tree	Weed of concern	1%
<i>Tanacetum vulgare</i>	common tansy	Herb	Non-regulated	1%
<i>Vinca minor</i>	periwinkle	Herb	Not listed	6%

English ivy (*Hedera helix*) is the most widespread species, present on 67% of all properties (Figure 1). Himalayan blackberry (*Rubus armeniacus*) (62%), bindweed (*Calystegia sepium* and/or *C. silvatica*) (56%), cherry laurel (*Prunus laurocerasus*) (47%) and English holly (*Ilex aquifolium*) (42%) are also prevalent. Figure 2 graphically shows the general locations of some of the more notable invasive plant species found on properties that border the ravine. Figure three shows the relative level of cumulative invasive plant cover for each property.

Figure 1. The percent of private and ROW properties bordering Kiwanis Ravine for nine selected invasive plant species found to be present during a survey conducted in the fall of 2011 (N=78).

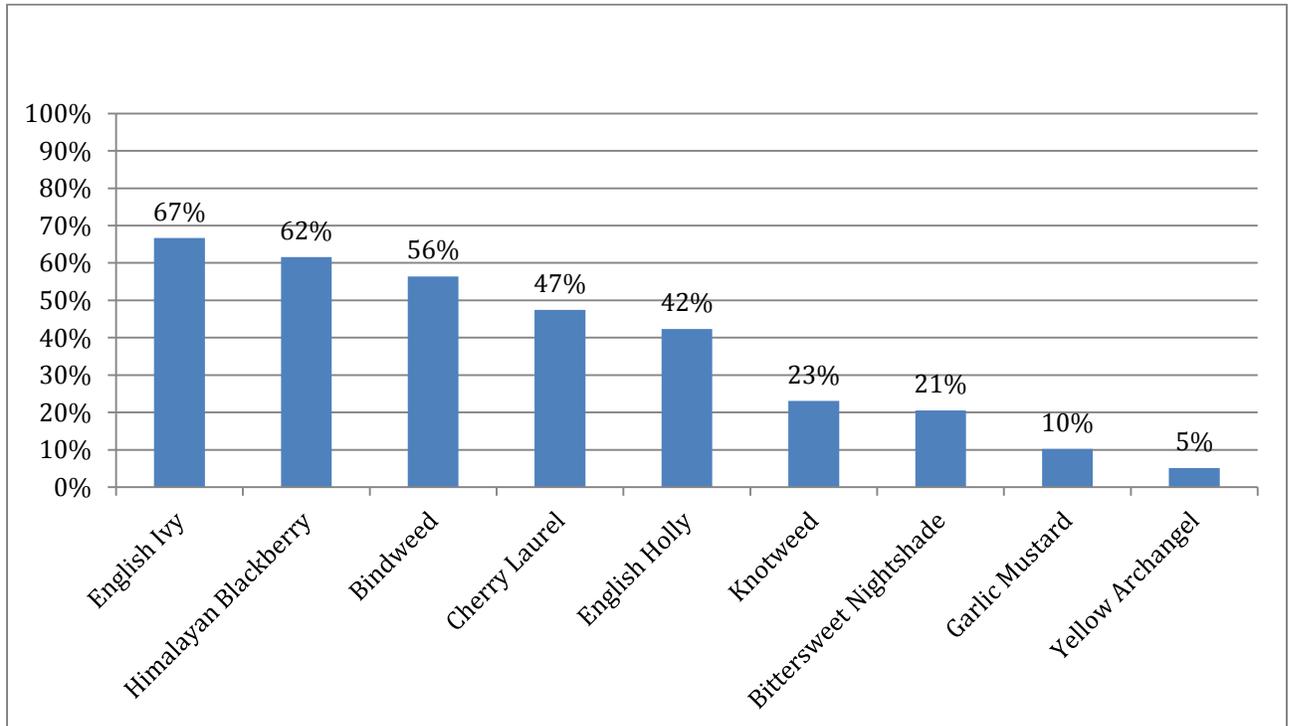


Figure 2. Maps showing general locations of eight selected invasive plant species found during a property survey completed during the fall of 2011.

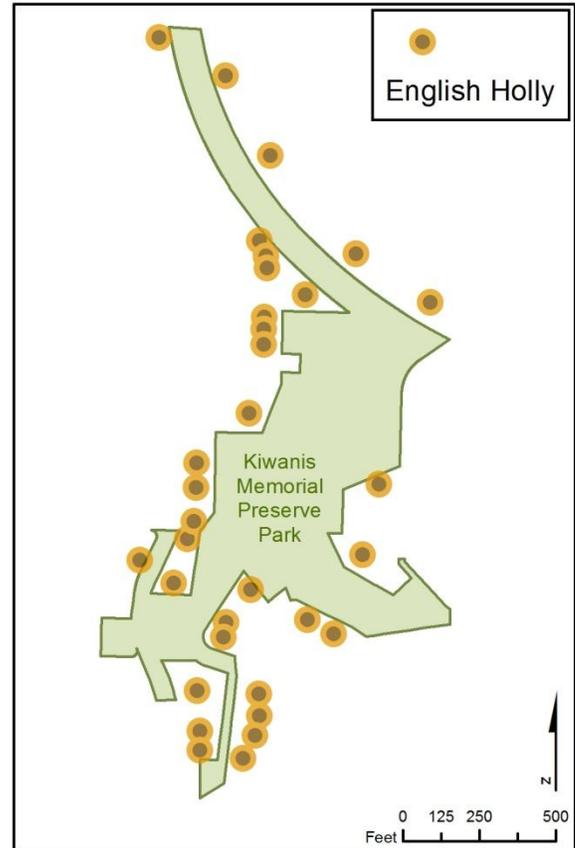
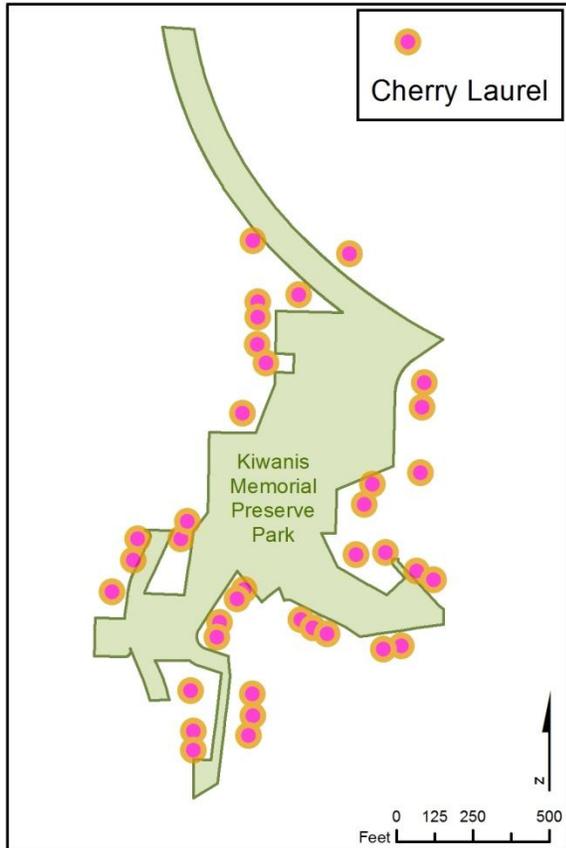
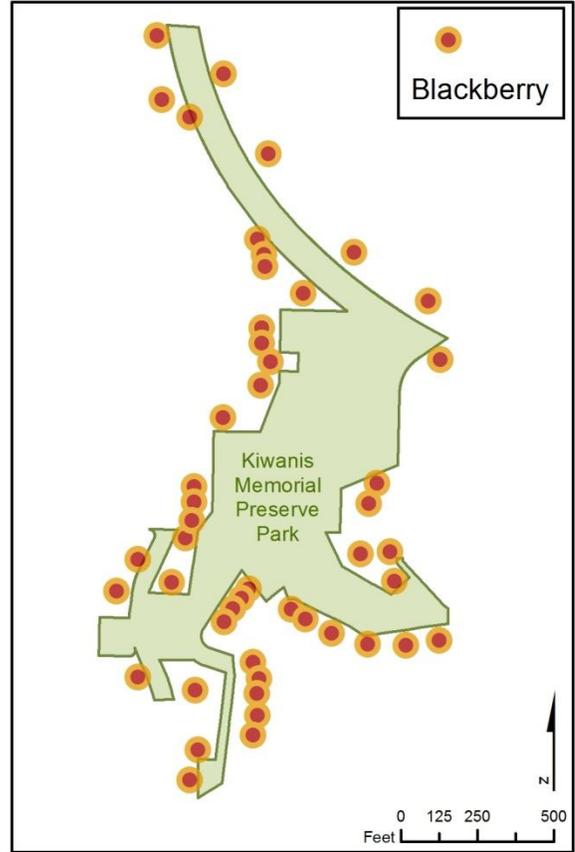
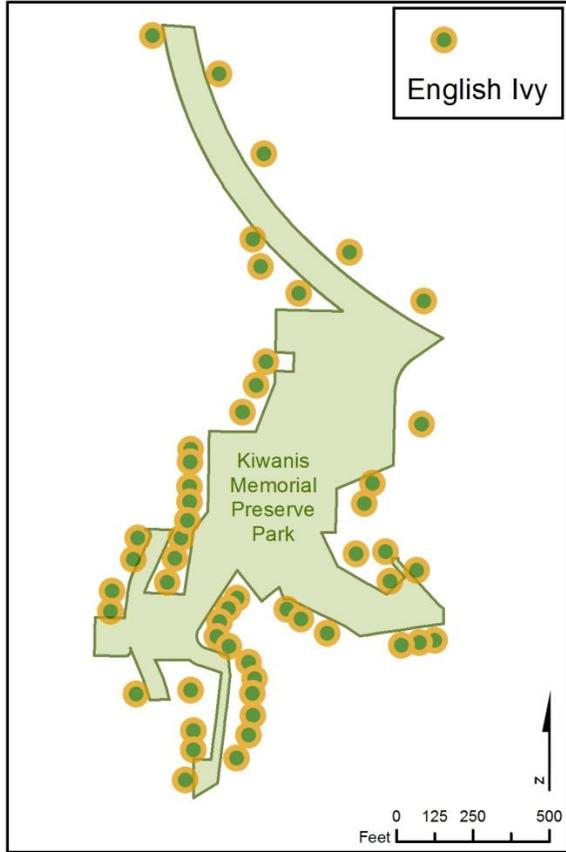


Figure 2. (Continued)

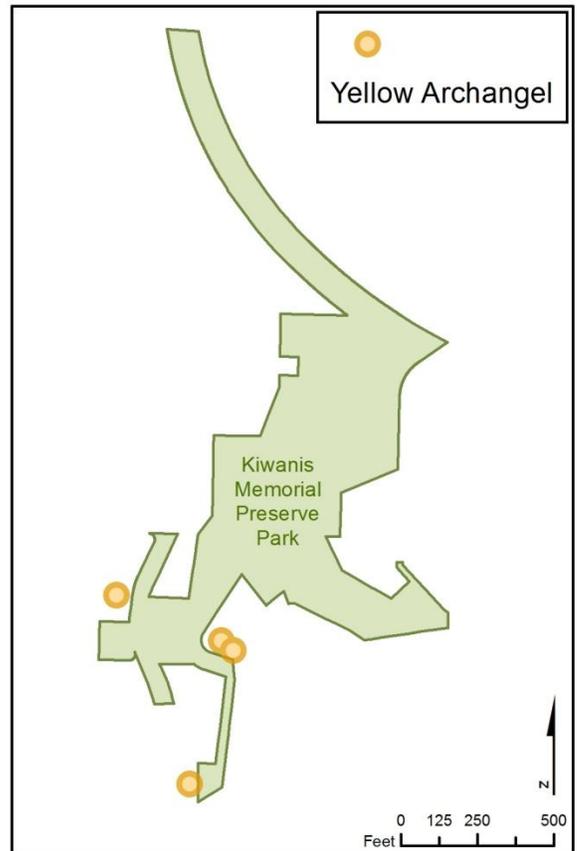
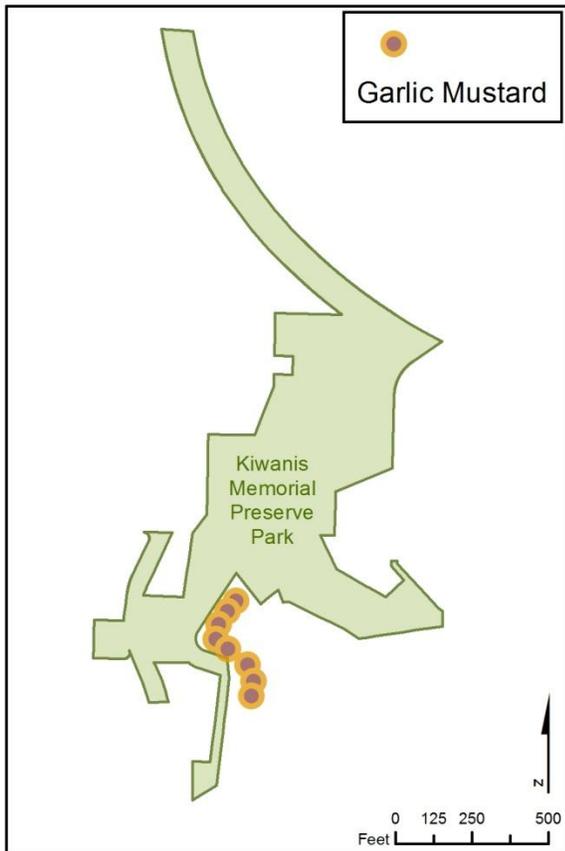
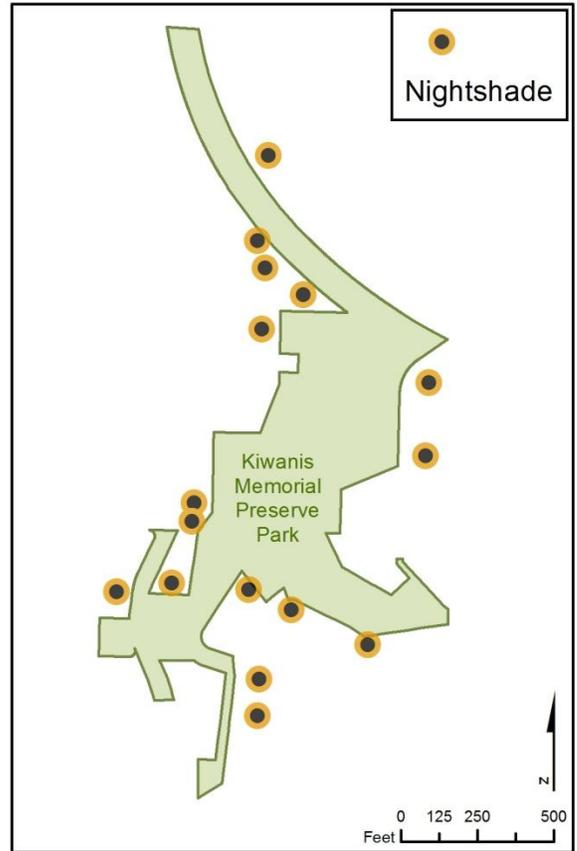
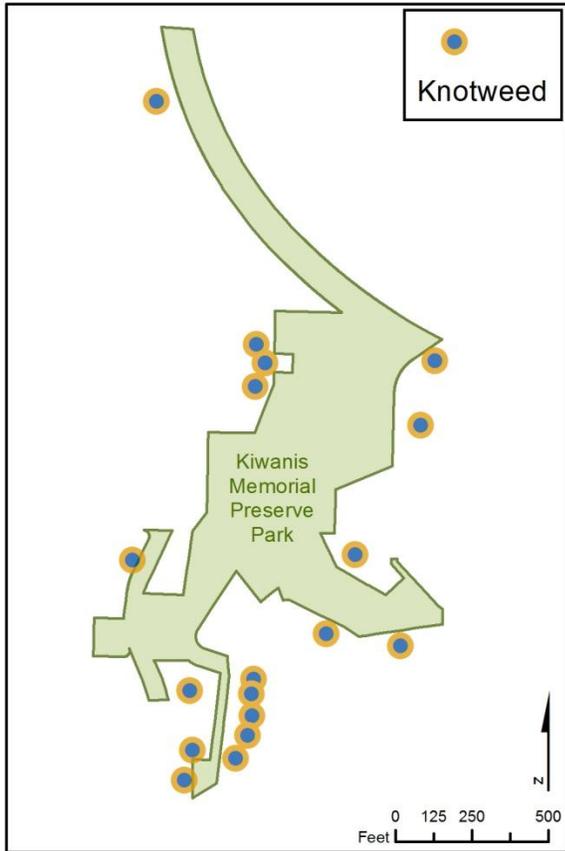
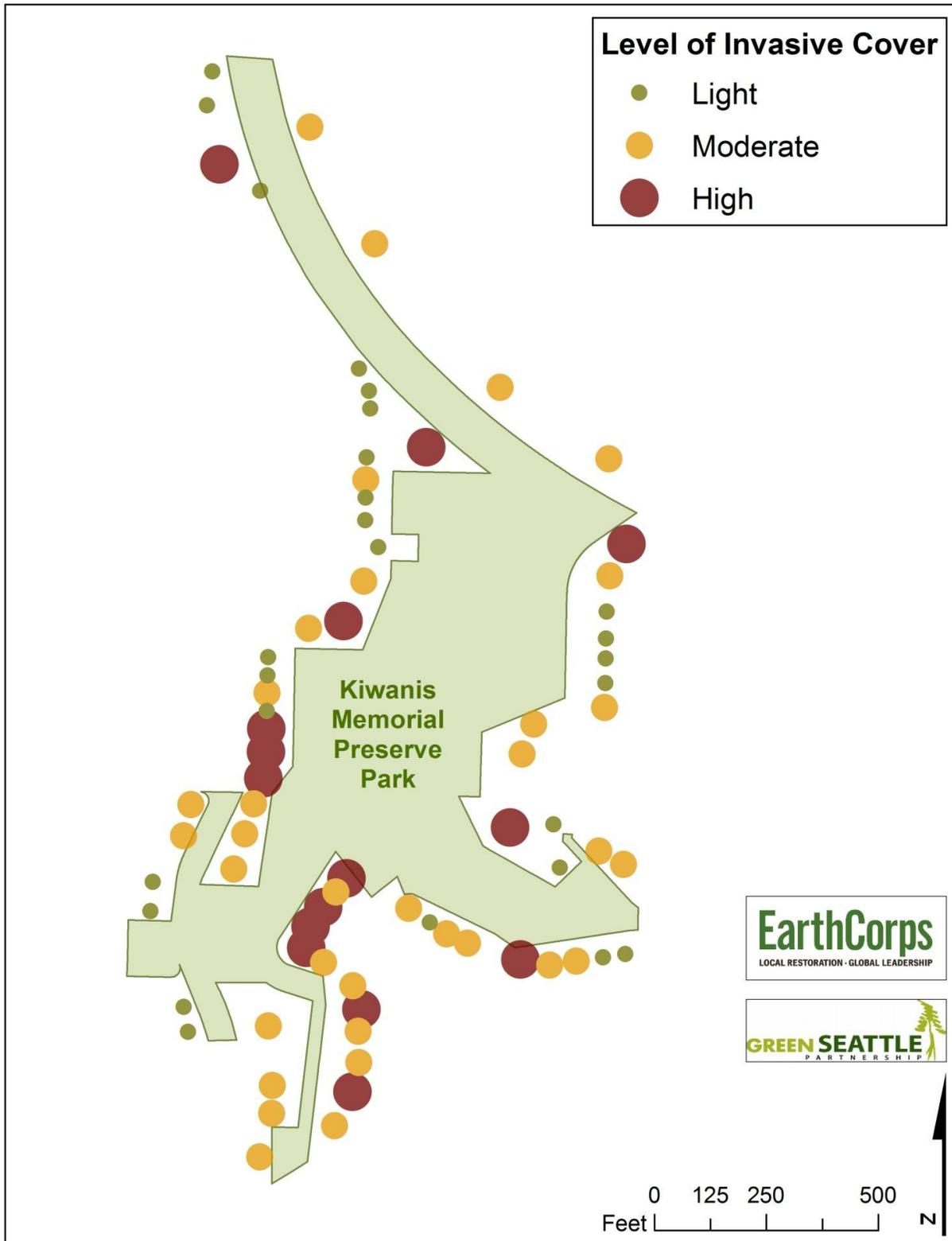


Figure 3. Map showing the relative level of cumulative invasive plant cover based on the midpoint of each cover class range for individual species found present on each surveyed property. Values represent the sum of one to nine species and were classified into three categories using the Jenks natural breaks classification method available in ESRI ArcMap GIS software applications.



Appendix D. Photo Monitoring October 28, 2011





KRM3-2 (SW)



KRM3-2 (W)



KRM3-2 (N)



KRM3-3 (S)



KRM3-3 (W)



KRM3-3 (N)







KRM2-2 (S)



KRM2-2 (W)



KRM2-2 (N)



KRM2-2 (E)



