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State of Kiwanis Ravine
2013 Addendum

LOCAL RESTORATION
EARTH CORPS
GLOBAL LEADERSHIP

State of Kiwanis Ravine – 2013 Addendum

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1. Introduction

This report is an addendum to the "State of Kiwanis Ravine" report written and published by EarthCorps for the Seattle Department of Parks and Recreation in March 2012: http://www.seattle.gov/parks/projects/kiwanis/files/state_of_ravine_report_march_2012.pdf. Following up on the recommendations given in that report, eight new permanent monitoring plots were installed in Kiwanis Ravine in the fall of 2012. In addition, EarthCorps collected monitoring data on four existing plots (five had been previously installed by the Green Seattle Partnership (GSP) Forest Monitoring Team). The purpose of this addendum is to summarize the data collected through this additional monitoring, and to update the findings of the "State of Kiwanis Ravine" report to include the 2012 data.

2012 Accomplishments

- Eight new permanent 1/10th acre plots installed and baseline data collected.
- Four existing plots were monitored, making the overall sampled area for 2012 approximately seven percent (1.15 acres sampled out of 16.38 total acres) of the total ravine area. Refer to Table 1 below and Appendix A for a map of plot locations.

Table 1. Kiwanis Ravine forest monitoring plots indicating dates when baseline and monitoring data have been collected. Note that monitoring data was not collected on plot KRM 3 in 2012 as the location could not be verified at the time of monitoring.

Plot Name	Site	Plot size (acres)	Date(s) Monitored	Monitoring Stage	Restoration Stage
KRE 1	KRE 1	0.1	10/04/12	Baseline	Cleared and planted
KRE 3	KRE 3	0.1	10/04/12	Baseline	Cleared and planted
KRM 1	KRM 1	0.1	10/05/12	Baseline	Cleared and planted
KRM 1-2	KRM 1	0.1	10/05/12	Baseline	Cleared and planted
KRM 2	KRM 2	0.1	10/05/12	Baseline	Cleared and planted
KRM 3	KRM 3	0.1	11/10/11	Baseline	Not in restoration
KRM 4	KRM 4	0.1	10/05/12	Baseline	Cleared and planted
KRM 5	KRM 5	0.1	10/21/11	Baseline	Clearing only (no planting)
			09/03/12	Monitoring	Cleared and planted
KRS a	KRS a	0.1	10/04/12	Baseline	Cleared and planted
KRS b	KRS b	0.1	10/10/11	Baseline	Cleared and planted
			09/16/12	Monitoring	Cleared and planted
KRW 4	KRW 4	0.1	10/04/12	Baseline	Cleared and planted
KRW 5	KRW 5	0.05	11/11/10	Baseline	Not in restoration
			09/26/11	Monitoring	Cleared and planted
			09/16/12	Monitoring	Cleared and planted
KWC	KWC	0.1	10/21/11	Baseline	Part of site cleared and planted
			09/03/12	Monitoring	Cleared and planted

All of the eight baseline monitoring plots that were installed in 2012 were in areas where restoration had already occurred. As a result, data from these plots can only describe existing conditions as they were in September and October 2012. Combined with the data from the four existing plots that were resampled, this information provides a representative state of the overall current condition of the Ravine (**section 2.1**). We can compare these data to the park-wide inventory data that was collected in 2009-2011 (see "State of Kiwanis Ravine" 2001 report). Overall trends from a comparison of these data sets can provide a summary of the changes that resulting from the substantial restoration efforts recently occurring throughout the ravine (**section 2.2**). We can also compare data collected from the four monitoring plots in 2012 with baseline data collected on these same plots (**section 2.3**). This will provide a direct comparison of the changes between years on these four plots. Baseline data was collected in 2010 for KRW 5 and in 2011 for the remaining plots.

All monitoring conducted in 2012 followed the protocols of the Green Seattle Partnership Forest Monitoring program. For more information on monitoring methodology, please refer to the GSP Forest Monitoring protocols: http://greenseattle.org/forest-steward-resources-1/monitoring/draft-monitoring-protocols.

2. Results and Findings

2.1. 2012 Data summary

Plot level data was collected on a total of 12 plots (eight baseline and four monitoring) in 2012. Overall, we now have baseline data on a total of 13 plots throughout the ravine (including KRM 3 that was installed in 2011 but not monitored in 2012 because the site location had not been verified at the time of monitoring). These data can be used to indicate the general forest structure and species composition of the ravine. For specific plot-level density and cover data, refer to the FMT data summary reports for each plot available at http://www.earthcorps.org/interactive-map-popup.php.

Overstory trees: Plot level data shows that the overstory (>5 inched DBH) is predominantly deciduous. Overall, native overstory density averages 64 stems/acre (ranging from 20-130 stems/acre) and dominated by bigleaf maple which was present on 11 of 13 plots at an average density of 45 stems/acre park-wide (Table 2). Other species present at lower densities include red alder (14 stems/acre), bitter cherry (2 stems/acre), western red cedar (2 stems/acre), and western hemlock (1 stem/acre). Three species of invasive overstory trees were also present in low densities throughout the park (Table 2).

Table 2: Native and non-native overstory (>5 inches DBH) tree density found in FMT plots located in Kiwanis Ravine, 2010-2012 (N=13).

Scientific Name[1]	Common Name	Average Density per Acre (where present)	Average Density per Acre (park-wide)	Frequency (percent of sites where present)
Native Species				
Acer macrophyllum	bigleaf maple	53	45	85
Alnus rubra	red alder	26	14	54
Prunus emarginata	bitter cherry	30	2	8
Thuja plicata	western red cedar	10	2	15
Tsuga heterophylla	western hemlock	10	1	8
			64 Total stems/acre	
Non-Native Species				
Prunus avium	sweet cherry	10	1	8
Prunus laurocerasus	cherry laurel	60	5	8
Robinia pseudoacacia	black locust	10	1	8
			7 Total stems/acre	

[1]Species in bold are invasive species that have been given a designation by the King County Noxious Weed Control Program.

Regenerating trees: Regenerating (<=5 inches DBH) tree data was collected on eight baseline plots and four monitoring plots in 2012. One plot established in 2011 (KRM 3) was not monitored in 2012 because the site location had not been verified at the time of monitoring. Because restoration (invasive removal and native planting) occurred in this area after the plot was installed, regenerating tree information collected during baseline monitoring is no longer accurate. This plot originally had substantial non-native invasive trees (observed to no longer be present during the time of photo monitoring) and very sparse native tree regeneration (five stems of bigleaf maple). Therefore, the following analysis looks only at regenerating tree densities from the 12 plots where updated information is available.

Overall, plot data indicates that there are approximately 400 average native regenerating stems/acre park-wide, 290 deciduous and 109 coniferous. These regenerating trees are dominated by bigleaf maple (168 stems/acre) and red alder (90 stems/acre), while planting efforts have substantially increased the conifer component with western red cedar (64 stems/acre), Douglas fir (19 stems/acre), and lesser amounts of western hemlock, grand fir, and Sitka spruce (Table 3). Non-native tree regeneration averages 58 stems/acre park-wide dominated by cherry laurel and English holly found at 25 and 21 stems/acre respectively (Table 3).

Table 3: Native regenerating (<=5 inches DBH) tree density found in FMT plots located in Kiwanis Ravine, 2012 (N=12).

Scientific Name[1]	Common Name	Average Density per Acre (where present)	Average Density per Acre (park-wide)	Frequency (percent of sites where present)
Native Species				
Abies grandis	grand fir	28	9	33
Acer macrophyllum	bigleaf maple	251	168	67
Alnus rubra	red alder	360	90	25
Crataegus douglasii	Pacific hawthorn	65	11	17
Frangula purshiana	cascara	24	10	42
Malus fusca	western crabapple	60	5	8
Picea sitchensis	Sitka spruce	12	4	33
Prunus emarginata	bitter cherry	15	3	17
Pseudotsuga menziesii	Douglas fir	115	19	17
Quercus garryana	Garry oak	50	4	8
Thuja plicata	western red cedar	86	64	75
Tsuga heterophylla	western hemlock	30	13	42
			399 Total stems/acre	
Non-Native Species				
Ilex aquifolium	English holly	62	20.833	33
Prunus avium	sweet cherry	20	1.667	8
Prunus laurocerasus	cherry laurel	50	25	50
Prunus sp.	horticultural cherry species	100	8.333	8
Robinia pseudoacacia	black locust	10	0.833	8
Sorbus aucuparia	European mountain ash	20	1.667	8
			58 Total stems/acre	

[1]Species in bold are invasive species that have been given a designation by the King County Noxious Weed Control Program.

Snags: Overall, there are relatively low snag (standing dead tree) densities present throughout the park. Plot data indicate that there are approximately 18 snags/acre park-wide. However, snags were only recorded in six of 13 plots and only one plot had more than 20 snags/acre: 170 snags/acre are located in plot KRM 5 (Table 4). Of all snags recorded, 83% were 8.5 inches DBH or less while only one snag (4%) was recorded taller than 30 feet. According to the plot level data, average snag diameter is eight inches and average snag height is 20 feet park wide.

Table 4: Snag density by plot measured in six of 13 FMT plots located in Kiwanis Ravine, 2010-2012. No snags were recorded in the remaining 7 plots.

Plot Number	Snags/Acre	Average Diameter (In)	Average Height (Ft)
KRM 1-2	10	6	10
KRM 4	10	15	10
KRM 5	170	6.4	20.9
KRS a	20	17.8	37.5
KRS b	10	5	10
KRW 4	10	16	10

Coarse woody debris: Coarse woody debris (CWD) was found on 11 of 13 baseline plots at an average volume/acre of 2,175 cubic feet where present (Table 5). Volumes ranged from 162 to 6,390 cubic feet/acre across these plots.

Table 5: CWD volume (cubic feet /acre) by plot measured in 11 of 13 FMT plots located in Kiwanis Ravine, 2010-2012. No CWD was recorded in the remaining two plots.

Plot Number	Volume/Acre	Average Diameter (In)	Average Length (Ft)
KRE 1	1304	13.3	16.4
KRM 1	162	14	7
KRM 1-2	2582	11	24
KRM 2	690	11.6	13.8
KRM 3	6333	24.2	55.3
KRM 4	1699	12.5	14.7
KRS a	198	14	18.5
KRS b	332	8.8	4.2
KRW 4	4083	16.4	19.5
KRW 5	6390	15	17.1
KWC	157	12	20

Shrubs: Native shrub cover averages 39% across all plots from a total of 27 species (Table 6). Dominant species include salmonberry (9%), beaked hazelnut (9%), Indian plum (4%), creeping blackberry (3%), and red elderberry (3%). Only two non-native (or unknown) shrub species were identified: Himalayan blackberry and an unknown *Ribes* sp. (Table 6). Himalayan blackberry was found on eight of 12 plots (67%) at an average cover of 8% where present.

Table 6: Percent cover of native and non-native shrub vegetation from 12 FMT plots sampled in Kiwanis Ravine, 2012. Cover values were derived using the midpoints of cover class ranges.

Scientific Name	Common Name	Average Cover (where present)	Average Cover (park-wide)	Frequency (percent of sites where present)
Native Species				
Acer circinatum	vine maple	2.17	1.08	50
Cornus sericea	red-osier dogwood	2.38	0.79	33
Corylus cornuta	beaked hazelnut	13	8.67	67
Holodiscus discolor	oceanspray	6.75	1.12	17
Lonicera involucrata	twinberry	3	0.5	17
Mahonia aquifolium	tall Oregon grape	5.5	0.92	17
Mahonia nervosa	low Oregon grape	3	1	33
Morella californica	pacific wax myrtle	0.5	0.04	8
Oemleria cerasiformis	Indian plum	5.5	4.12	75
Philadelphus lewisii	Mock orange	0.5	0.12	25
Physocarpus capitatus	Pacific ninebark	3.83	0.96	25
Rhododendron macrophyllum	western rhododendron	0.5	0.04	8
Ribes bracteosum	stink currant	0.5	0.04	8
Ribes lacustre	swamp gooseberry	0.5	0.04	8
Ribes sanguineum	red-flowering currant	1.75	0.29	17
Rosa nutkana	Nootka rose	3	0.25	8
Rubus leucodermis	blackcap raspberry	1.33	0.33	25
Rubus parviflorus	thimbleberry	1.75	0.29	17
Rubus spectabilis	salmonberry	11.25	9.38	83
Rubus ursinus	creeping blackberry	4.56	3.04	67
Salix hookeriana	Hooker's willow	3	0.25	8
Salix lucida ssp. lasiandra	Pacific willow	10.5	0.88	8
Sambucus racemosa	red elderberry	5.5	2.75	50
Spiraea douglasii	hardhack	0.5	0.04	8
Symphoricarpos albus	snowberry	3	1.75	58
Vaccinium ovatum	evergreen huckleberry	0.5	0.17	33
Vaccinium parvifolium	red huckleberry	3	0.25	8
		Average Native Cover	**39**	
Non-Native Species				
Rubus armeniacus	Himalayan blackberry	8	5.33	67
Ribes sp.	currant	3	0.25	8
		Average Non-Native Cover	**6**	

Herbaceous vegetation and groundcovers: Total native herbaceous and groundcover vegetation cover averages 48% across all plots comprised of 22 species (Table 7). This layer is dominated by sword fern (15%) and stinging nettle (16%), with lesser amounts of ladyfern (3%) and fringecup (3%). A number of wetland associated species were recorded including water parsley, skunk cabbage, slough sedge, tall managrass, small-seeded bulrush, and devil's club. A total of 21 non-native herbaceous and groundcover species were recorded, with hedge false bindweed, creeping buttercup, and deadly nightshade being the most dominant. Garlic mustard, a Class A noxious weed, was found on one plot with an average cover of 11%. English ivy was found on eight plots but at relatively low cover (Table 8).

Table 7: Percent cover of native herbaceous and groundcover vegetation from 12 FMT plots sampled in Kiwanis Ravine, 2012. Cover values were derived using the midpoints of cover class ranges.

Scientific Name	Common Name	Average Cover (where present)	Average Cover (park-wide)	Frequency (percent of sites where present)
Native Species				
Achillea millefolium	yarrow	0.5	0.04	8
Athyrium filix-femina	ladyfern	5.19	3.46	67
Blechnum spicant	deerfern	0.5	0.04	8
Bromus vulgaris	Columbia brome	0.5	0.04	8
Carex deweyana	Dewey sedge	0.5	0.08	17
Carex obnupta	slough sedge	2.17	0.54	25
Dicentra formosa	western bleedingheart	0.5	0.04	8
Dryopteris expansa	wood fern	0.5	0.08	17
Epilobium ciliatum	fringed willowherb	10.5	1.75	17
Equisetum arvense	scouring rush	10.5	1.75	17
Equisetum telmateia	giant horsetail rush	4.25	1.42	33
Geum macrophyllum	bigleaved avens	0.5	0.04	8
Glyceria elata	tall mannagrass	0.5	0.04	8
Hydrophyllum tenuipes	Pacific waterleaf	2.58	1.29	50
Lysichiton americanus	skunk cabbage	4.88	1.62	33
Oenanthe sarmentosa	water parsley	10.5	1.75	17
Oplopanax horridus	devil's club	0.5	0.04	8
Polystichum munitum	sword fern	16.41	15.04	92
Scirpus microcarpus	small-seeded bulrush	0.5	0.04	8
Tellima grandiflora	fringecup	3.94	2.62	67
Tolmiea menziesii	piggy-back plant	1.5	0.62	42
Urtica dioica	stinging nettle	15.5	15.5	100
		Average Native Cover	**48**	

Table 8: Percent cover of non-native herbaceous and groundcover vegetation from 12 FMT plots sampled in Kiwanis Ravine, 2012. Cover values were derived using the midpoints of cover class ranges.

Scientific Name[1]	Common Name	Average Cover (where present)	Average Cover (park-wide)	Frequency (percent of sites where present)
Non-Native Species				
	Unknown herb sp.	0.5	0.04	8
	grass	85.5	7.12	8
Alliaria petiolata*	Garlic mustard	10.5	0.88	8
Calystegia sepium	hedge false bindweed	18.42	9.21	50
Cardamine hirsuta	hairy bittercress	0.5	0.04	8
Digitalis purpurea	foxglove	2.17	0.54	25
Geranium robertianum	herb Robert	4.5	1.88	42
Hedera helix	English ivy	1.12	0.75	67
Holcus lanatus	velvetgrass	3	0.25	8
Hypericum sp.	St. Johnswort	0.5	0.04	8
Impatiens capensis	jewelweed	1.75	0.29	17
Lapsana communis	nipplewort	7.58	3.79	50
Lunaria annua	annual honesty	0.5	0.08	17
Luzula multiflora	common woodrush	0.5	0.04	8
Mycelis muralis	wall-lettuce	0.5	0.21	42
Ranunculus repens	creeping buttercup	10.92	5.46	50
Rumex crispus	curly dock	0.5	0.04	8
Rumex sp.	dock	0.5	0.04	8
Solanum dulcamara	deadly nightshade	8	4.67	58
Taraxacum officinale	dandelion	3	0.25	8
Trifolium sp.	clover	0.5	0.04	8
		Average Non-Native Cover	**36**	

[1]Species in bold are invasive species that have been given a designation by the King County Noxious Weed Control Program. *Indicates a species where eradication is required by law throughout Washington.

2.2. Inventory Data and Plot Data Comparison

Substantial restoration efforts have been underway in Kiwanis Ravine over the past several years. Some of these changes can be reflected in comparing the park-wide data collected in 2009-2011 with the current plot level data collected in 2012. It should be noted that inventory data were qualitatively collected on entire Management Units compared to the quantitative data that were collected in localized plots in 2010-2012. The most substantial trends are the reduction of invasive tree density and the increase in native tree density. Inventory data estimated an average of approximately 120 invasive trees/acre throughout Kiwanis Ravine at

the end of 2011. Plot level data now estimate invasive tree density to be reduced to less than half of this value (Table 3). The continued presence of these invasive tree species (particularly cherry laurel and English holly) after initial restoration efforts, however, iterates the importance and necessity of ongoing maintenance of restoration areas. These data also suggest that planting efforts have successfully increased native tree density across the park from an average of 214 stems/acre in 2011 (from inventory data) to nearly 400 stems/acre in 2012 (Table 3).

2.3. Monitoring Plot Data Comparison

Plot Level Data Trends: A total of four plots were re-sampled or monitored in 2012: KRM 5, KRS b, KRW 5, and KWC (Table 1). An analysis of these data can provide an overview of changing trends throughout the ravine. Similar to the comparison with inventory data described above, these data show an overall broad reduction in invasive tree density and an increase in native tree density. These data provide a more accurate analysis of changing conditions as the data was collected from permanent plots using repeatable methodology. However, these trends only represent the changes on four of the 12 plots. Invasive species density was shown to drop by 90% across all plots from an average of 458 stems/acre during baseline conditions to an average of 48 stems/acre in 2012 (Tables 9 &10).

Table 9: Native and non-native regenerating (<=5 inches DBH) tree density found in baseline FMT plots located in Kiwanis Ravine, 2010-2011 (N=4).

Scientific Name[1]	Common Name	Average Density per Acre (where present)	Average Density per Acre (park-wide)	Frequency (percent of sites where present)
Native Species				
Abies grandis	grand fir	40	10	25
Acer macrophyllum	bigleaf maple	55	27.5	50
Crataegus douglasii	Pacific hawthorn	10	2.5	25
Frangula purshiana	cascara	30	7.5	25
Picea sitchensis	Sitka spruce	20	5	25
Prunus emarginata	bitter cherry	10	2.5	25
Thuja plicata	western red cedar	70	35	50
Tsuga heterophylla	western hemlock	25	12.5	50
			103 Total stems/acre	
Non-Native Species				
Ilex aquifolium	English holly	235	117.5	50
Prunus laurocerasus	cherry laurel	650	325	50
Prunus sp.	horticultural cherry species	60	15	25
			458 Total stems/acre	

[1]Species in bold are invasive species that have been given a designation by the King County Noxious Weed Control Program.

Table 10: Native and non-native regenerating (<=5 inches DBH) tree density found in monitoring FMT plots located in Kiwanis Ravine, 2012 (N=4).

Scientific Name	Common Name	Average Density per Acre (where present)	Average Density per Acre (park-wide)	Frequency (percent of sites where present)
Native Species				
Abies grandis	grand fir	40	20	50
Acer macrophyllum	bigleaf maple	1000	250	25
Alnus rubra	red alder	1000	250	25
Crataegus douglasii	Pacific hawthorn	120	30	25
Frangula purshiana	cascara	70	17.5	25
Malus fusca	western crabapple	60	15	25
Picea sitchensis	Sitka spruce	10	2.5	25
Prunus emarginata	bitter cherry	20	5	25
Thuja plicata	western red cedar	60	60	100
Tsuga heterophylla	western hemlock	25	12.5	50
			663 Total stems/acre	
Non-Native Species				
Ilex aquifolium	English holly	20	5	25
Prunus laurocerasus	cherry laurel	35	17.5	50
Prunus sp.	horticultural cherry species	100	25	25
			48 Total stems/acre	

[1]Species in bold are invasive species that have been given a designation by the King County Noxious Weed Control Program.

These data also suggest a substantial increase in native regenerating tree densities, although much of this increase comes from a single plot where numerous species of bigleaf maple and red alder sprouts were counted (Table 10). If these trees are excluded from the analysis, native tree regeneration is still shown to increase by nearly 60% from an average of 103 stems/acre to an average of 163 stems/acre (Tables 9 &10).

Monitoring data from these four plots also shows an increase in native shrub and herbaceous species cover. Average native shrub cover increased from 29% in 2011 to 50% in 2012 (Tables 11 & 12), while native herbaceous cover increased from 25% to more than 60% in 2012 (Table 13 & 14). However, these data also suggest that overall average invasive species cover may be increasing. Himalayan blackberry was found in more plots (three out of four) during monitoring and was recorded as increasing from 6-15% in 2011 to 26-50% in 2012 in one plot (KWC). English ivy was reduced from 51-75% in 2010 to 1-5% in 2012 on the only monitoring plot where this species was recorded (KRW 5). However, measured increases were noted in other invasive herbaceous and groundcover species. Of particular concern are the increases in hedge

false bindweed (3% to 27%), creeping buttercup (2% to 12%), and deadly nightshade (<1% to 12%) (Tables 13 & 14).

Table 11: Native and non-native shrub species found in baseline FMT plots located in Kiwanis Ravine, 2010-2011 (N=4).

Scientific Name	Common Name	Average Cover (where present)	Average Cover (park-wide)	Frequency (percent of sites where present)
Native Species				
Acer circinatum	vine maple	0.5	0.25	50
Amelanchier alnifolia	serviceberry	0.5	0.12	25
Cornus sericea	red-osier dogwood	0.5	0.12	25
Corylus cornuta	beaked hazelnut	19.25	9.62	50
Holodiscus discolor	oceanspray	3	0.75	25
Mahonia aquifolium	tall Oregon grape	0.5	0.12	25
Mahonia nervosa	low Oregon grape	0.5	0.25	50
Oemleria cerasiformis	indian plum	7.17	5.38	75
Philadelphus lewisii	mockorange	0.5	0.12	25
Physocarpus capitatus	Pacific ninebark	0.5	0.12	25
Rosa nutkana	Nootka rose	0.5	0.12	25
Rubus parviflorus	thimbleberry	3	0.75	25
Rubus spectabilis	salmonberry	13	9.75	75
Rubus ursinus	creeping blackberry	0.5	0.25	50
Symphoricarpos albus	snowberry	1.75	0.88	50
Vaccinium ovatum	evergreen huckleberry	0.5	0.12	25
		Average Native Cover	**29**	
Non-Native Species				
Rubus armeniacus	Himalayan blackberry	10.5	5.25	50
		Average Non-Native Cover	**5**	

[1]Species in bold are invasive species that have been given a designation by the King County Noxious Weed Control Program.

Table 12: Native and non-native shrub species found in monitoring FMT plots located in Kiwanis Ravine, 2012 (N=4).

Scientific Name	Common Name	Average Cover (where present)	Average Cover (park-wide)	Frequency (percent of sites where present)
Native Species				
Acer circinatum	vine maple	1.75	0.88	50
Cornus sericea	red-osier dogwood	3	0.75	25
Corylus cornuta	beaked hazelnut	25.5	19.12	75
Holodiscus discolor	oceanspray	10.5	2.62	25
Lonicera involucrata	twinberry	3	0.75	25
Mahonia aquifolium	tall Oregon grape	5.5	2.75	50
Mahonia nervosa	low Oregon grape	0.5	0.25	50
Oemleria cerasiformis	indian plum	7.17	5.38	75
Philadelphus lewisii	mockorange	0.5	0.12	25
Physocarpus capitatus	Pacific ninebark	10.5	2.62	25
Rosa nutkana	Nootka rose	3	0.75	25
Rubus leucodermis	blackcap raspberry	0.5	0.12	25
Rubus parviflorus	thimbleberry	3	0.75	25
Rubus spectabilis	salmonberry	10.5	5.25	50
Rubus ursinus	creeping blackberry	3	0.75	25
Sambucus racemosa	red elderberry	10.5	2.62	25
Spiraea douglasii	hardhack	0.5	0.12	25
Symphoricarpos albus	snowberry	5.5	4.12	75
Vaccinium ovatum	evergreen huckleberry	0.5	0.25	50
		Average Native Cover	**50**	
Non-Native Species				
Rubus armeniacus	Himalayan blackberry	16.33	12.25	75
Ribes sp.	currant	3	0.75	25
		Average Non-Native Cover	**13**	

[1]Species in bold are invasive species that have been given a designation by the King County Noxious Weed Control Program.

Table 13: Native and non-native herbaceous and groundcover vegetation found in baseline FMT plots located in Kiwanis Ravine, 2010-2011 (N=4).

Scientific Name	Common Name	Average Cover (where present)	Average Cover (park-wide)	Frequency (percent of sites where present)
Native Species				
Athyrium filix-femina	ladyfern	0.5	0.25	50
Equisetum arvense	scouring rush	0.5	0.12	25
Equisetum telmateia	giant horsetail rush	0.5	0.12	25
Hydrophyllum tenuipes	Pacific waterleaf	3	0.75	25
Polystichum munitum	sword fern	18.62	18.62	100
Pteridium aquilinum	bracken fern	0.5	0.12	25
Stachys cooleyae	Cooley's hedge-nettle	0.5	0.12	25
Tellima grandiflora	fringecup	3.83	2.88	75
Urtica dioica	stinging nettle	2.38	2.38	100
		Average Native Cover	**25**	
Non-Native Species				
Alliaria petiolata	Garlic mustard	0.5	0.12	25
Calystegia sepium	hedge false bindweed	10.5	2.62	25
Cirsium vulgare	bull thistle	0.5	0.12	25
Conium maculatum	poison hemlock	3	0.75	25
Convolvulus sp.	bindweed	3	0.75	25
Digitalis purpurea	foxglove	0.5	0.25	50
Geranium robertianum	herb Robert	1.33	1	75
Hedera helix	English ivy	63	15.75	25
Holcus lanatus	velvetgrass	0.5	0.12	25
Lapsana communis	nipplewort	1.75	0.88	50
Mycelis muralis	wall-lettuce	0.5	0.25	50
Ranunculus repens	creeping buttercup	3	1.5	50
Rumex obtusifolius	bitter dock	0.5	0.12	25
Solanum dulcamara	deadly nightshade	0.5	0.38	75
Sonchus sp.	sowthistle	0.5	0.12	25
Taraxacum officinale	dandelion	0.5	0.12	25
	grass	0.5	0.12	25
Agrostis sp.	bentgrass	63	15.75	25
Galium sp.	bedstraw	5.5	2.75	50
Rumex sp.	dock	0.5	0.12	25
		Average Non-Native Cover	**44**	

[1]Species in bold are invasive species that have been given a designation by the King County Noxious Weed Control Program.

Table 14: Native and non-native herbaceous and groundcover vegetation found in monitoring FMT plots located in Kiwanis Ravine, 2012 (N=4).

Scientific Name	Common Name	Average Cover (where present)	Average Cover (park-wide)	Frequency (percent of sites where present)
Native Species				
Athyrium filix-femina	ladyfern	3	1.5	50
Epilobium ciliatum	fringed willowherb	20.5	5.12	25
Equisetum arvense	scouring rush	10.5	5.25	50
Hydrophyllum tenuipes	Pacific waterleaf	6.75	3.38	50
Polystichum munitum	sword fern	16.75	16.75	100
Tellima grandiflora	fringecup	20.5	5.12	25
Urtica dioica	stinging nettle	24.25	24.25	100
		Average Native Cover	**61**	
Non-Native Species				
Calystegia sepium	hedge false bindweed	53	26.5	50
Digitalis purpurea	foxglove	1.75	0.88	50
Geranium robertianum	herb Robert	20.5	5.12	25
Hedera helix	English ivy	3	0.75	25
Holcus lanatus	velvetgrass	3	0.75	25
Impatiens capensis	jewelweed	3	0.75	25
Lapsana communis	nipplewort	20.5	10.25	50
Ranunculus repens	creeping buttercup	24.25	12.12	50
Rumex crispus	curly dock	0.5	0.12	25
Solanum dulcamara	deadly nightshade	24.25	12.12	50
		Average Non-Native Cover	**69**	

3. Data Analysis and Quality Control Discussion

The data collected in the GSP monitoring plots provides important information regarding the structure and composition of the Ravine, as well as provides the foundation for measuring changing conditions over time. Some procedures inherent in the data collection methodology, however, require us to make certain assumptions and considerations when we analyze the data. This combined with the inescapable variance in human error and observer bias (perhaps increased where volunteers and other non-professionals are utilized), can lead to a number of potential data quality issues. The following discussion aims to address several of these assumptions.

Data analysis: Plot cover data is collected in cover classes that utilize percent ranges. While this makes it easier for observers to collect cover data and may increase the confidence that we have in their estimations, it makes it difficult to analyze aggregated information across multiple plots. The preceding analyses use the midpoint of the cover class as an estimation of the actual cover (that could vary anywhere within the range). This allows us to add percent covers of different species (such as all native herbaceous vegetation) and average this information across multiple plots. It is important to remember that these numbers may provide a false sense of accuracy, especially because they are often displayed at a seemingly precise number of significant digits. It is therefore recommended that these numbers be taken in consideration of their proportions, and not necessarily at face the value of what the absolute numbers may suggest. For example, it is reasonable to infer that stinging nettle is more prevalent than fringcup (both in cover and frequency). However, we would be less confident inferring that stinging nettle actually averages 15.5% across the park with any specific level of accuracy (Table 7). Larger datasets (citywide for example) will help to minimize the potential error, especially when looking at general data trends (such as the average overall reduction of invasive species cover). Because we are using an assumed midpoint value, it also becomes less plausible to determine actual significance or variance. This is compounded by the fact that the distances of the ranges are not equal, making the potential for the actual cover to be at varying distances from the midpoint depending on the particular class. This becomes even more error prone when you then sum or average these midpoints (from individual or aggregates of species across multiple plots). To avoid another conversion, it was determined to display the midpoint values in these results as opposed to re-assigning these values back into their respective cover classes.

Another data analysis issue regards plant survivorship. FMT plots are capable of providing data regarding plant survival. However, this requires a certain level of timing that is not always feasible to carry out. In order for accurate tree survival to be determined, it is necessary for the plot to be monitored immediately following planting efforts. Subsequent monitoring data can then be compared to these “as-planted” numbers and survival rates can be calculated. If, on the other hand, the plots are not monitored until sometime following planting, it is not possible to determine how many plants may have not survived this initial period. Because monitoring in Kiwanis Ravine in 2012 took place after a full growing season following planting, no accurate as-planted data was obtained. While some mortality was noted on a number of sites, it was not possible to record accurate numbers of individual trees or determine what species of tree had not survived. If survival rate information is desired from FMT plot data in the future, it is recommended that monitoring actions are closely coordinated with planting efforts.

Data integrity: Data is often collected by different individuals and over varying lengths of time. The data methodology was developed to try to limit potential discrepancies between monitoring visits. However, because of the varying levels of experience and plant identification skills (in combination with general observer biases), some error is expected. It is difficult to know with any certainty if discrepancies between data from different years are a result of actual changes

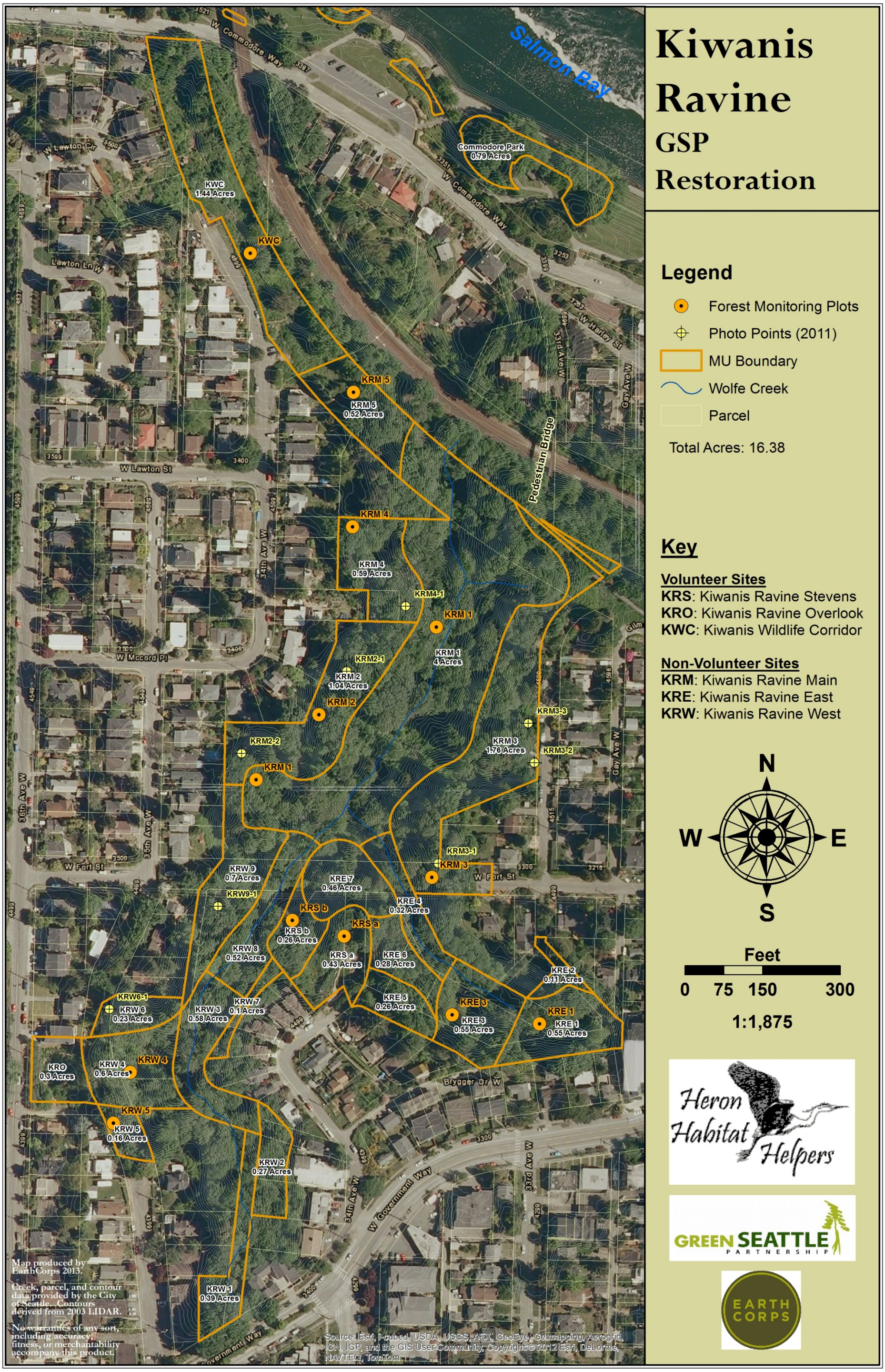
on the ground as opposed to potential visual error or misidentification between the two monitoring cycles. The protocol suggests that previous data should be compared, in the field, during iterant data collection cycles. This can allow for a comparison of previously recorded data to current conditions and can help reduce the chance of misidentification and potential false assumptions of change. Changes (either a revision of the previous data or a deviation from what was previously recorded) should only be made if there is a clear and probable indication that these changes have actually occurred.

There can be a substantial difference in year to year comparisons if even a single species is changed from one cover class to another, especially in the higher cover class ranges and if midpoints of the categories are used for analysis. For example, let's assume that a plot has approximately 75% cover (actually) of beaked hazelnut. During baseline data collection, the observer places this species into the 76-95% cover class category (which corresponds to a midpoint of 85.5%). The following year, the next (or the same) observer places the same species into the 51-75% category (midpoint of 63%). During analysis, the data will suggest that the cover of this species has declined by 22.5%. Remember, there is no empirical way to determine which cover class is actually correct, even if you were to revisit the site you would still have to make a determination one way or the other, and in this example both choices would be equally accurate. It is possible for this to happen with several species of shrubs and herbs on any given plot, leading to apparent large changes in cover that cannot be verified and do not accurately represent actual conditions on the ground. It is therefore recommended that changes only be made to existing data if it is clear that these changes are verifiable and substantial.

4. Summary

Plot level data was collected across 12 plots located throughout Kiwanis Ravine in 2012, eight baseline plots and four monitoring plots. These data create an updated depiction of the structure and function of the forested areas of the ravine. Comparing to previous inventories gives us an idea of how the ravine is changing as a result of forest restoration efforts. Overall, we see a major reduction in invasive tree density, an increase in native tree density and richness, and an increase in native shrub and herbaceous cover. However, the continued presence of select invasive species and the potential increase in hedge false bindweed, creeping buttercup, and deadly nightshade reiterates the need for active and continued maintenance and monitoring throughout the ravine.

Appendix A: Map of Kiwanis Ravine



Appendix B: Photo Monitoring - October 5, 2012


KRM3-1 (S)


KRM3-1 (W)


KRM3-1 (N)

KRM3-2 (SW)

KRM3-2 (W)

KRM3-2 (N)

KRM3-3 (S)

KRM3-3 (W)

KRM3-3 (N)


KRM4-1 (S)


KRM4-1 (W)


KRM4-1 (N)


KRM4-1 (E)


KRM2-1 (S)


KRM2-1 (W)


KRM2-1 (N)


KRM2-1 (E)


KRM2-2 (S)


KRM2-2 (W)

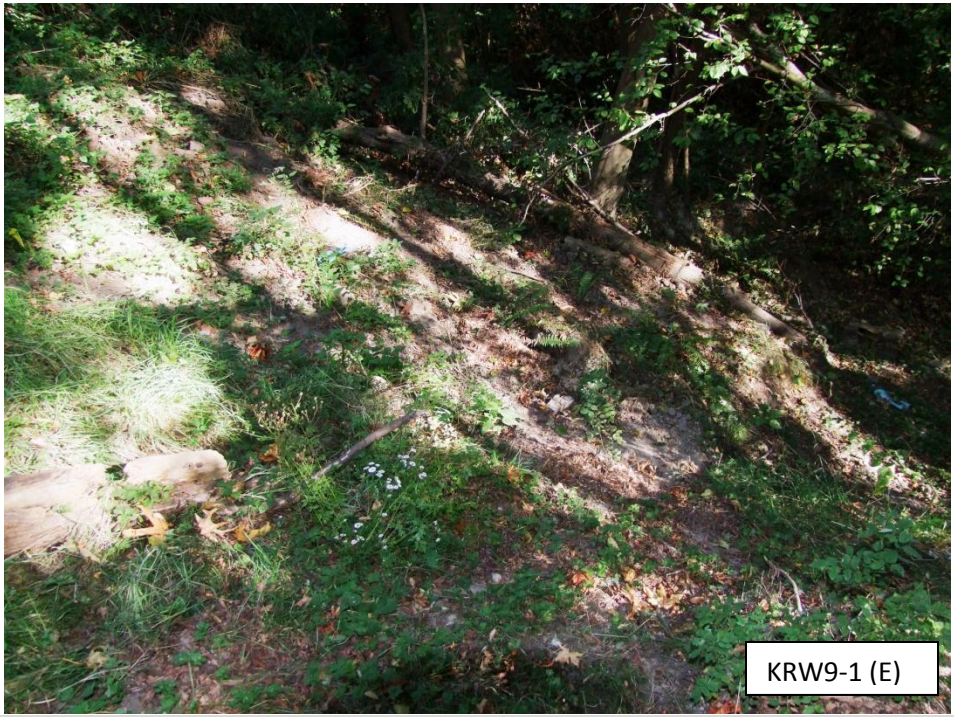

KRM2-2 (N)


KRM2-2 (E)

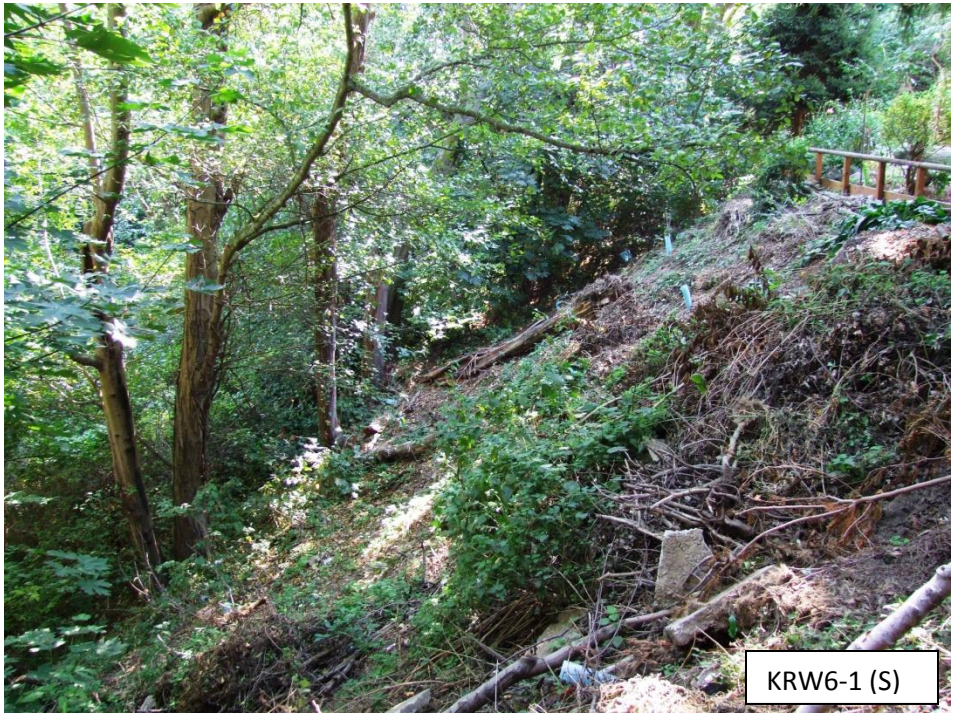

KRW9-1 (S)


KRW9-1 (W)


KRW9-1 (N)


KRW9-1 (E)

KRW6-1 (E)



KRW6-1 (S)