Cotton Hill Park Restoration Project

Figure 1: "Working hands" flagging *A. circinatum bare root.* Photo courtesy of Kevin Martin.

Final report

Location:
110th Ave NE & NE 98th Street, Kirkland WA.

Project partners:

Karen Story, Highlands Neighborhood
Sharon Rodman, City of Kirkland

Cotton Hill 1 Team members:

Jo-Ann Antoun ~ UW Bothell ~ BA Environmental Studies
Larisa Curta ~ UW Bothell ~ BS Environmental Science
Ali Mainayar ~ UW Bothell ~ BS Environmental Science
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Restoration Ecology Network Capstone
2010-2011

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Project Summary

Overview

The purpose for this report is to describe the Cotton Hill Park Restoration Project implemented in 2011 for Highlands Neighborhood Association, Karen Story, and Sharon Rodman. A team of six students in the University of Washington Restoration Ecology Network (UWREN) Capstone course designed and installed the project between October 2010 to May 2011 with the support of our project partners, Karen Story and Sharon Rodman, the Highlands Neighborhood Association and the University of Washington professors.

The Cotton Hill Restoration Project is an extension of another restoration project occurring simultaneously, in addition to three years of UWREN projects prior to 2010. By the end of the spring quarter in 2011, five restoration projects will have taken place at Cotton Hill Park, totaling approximately 2.5 acres of restored area, leaving approximately 1.5 acres left to restore.

Figure 2: Cotton Hill Team 1 site before and after photo.

The Site before Project Implementation:

- The 2010 restoration site is in Kirkland, WA in the Cotton Hill Park. The park is an undeveloped, 4.1-acre natural area located within the Forbes Creek Watershed. The exact location is at the corner of 98th Street and 110th Ave. Prior to the restoration efforts beginning in 2007, the park was dominated by invasive species and was bordered by a railroad, which students in the neighborhood used as a trail to get home.

Over the years, Cotton Hill Park as a whole has suffered moderate degradation. The pre-settlement landscape of the lower Puget Sound area was significantly altered through timber harvest, agriculture and urbanization; therefore exerting a profound effect on the structure and function of the natural landscape. During the 1870's the Kirkland highlands area was mainly divided up into homesteads. These homesteads worked primarily in logging and agriculture. Throughout the period of 1910-1930, Kirkland underwent a rapid population increase that encompassed the conversion of homesteads into housing developments, septic systems, outhouses and roads (History of Kirkland, 2006).

A stream runs through the park from the northeast to the southwest end. Rainwater, storm water and groundwater seeps contribute to the stream's water source. It meanders through the park at a slow and confined pace, running under the raised gravel trail through a culvert built by the community. Just after the culvert the stream becomes wider and the soil begins to change. There is much more silty clay in the low, moist areas of the park and in the upper, dry portions there is much more sandy clay to loamy sand. This drastic soil and moisture change limits native species ability to grow successfully in specific sites around the park.

Our specific site within Cotton Hill Park was covered in invasive species and littered with trash ranging in variety from candy wrappers to beer cans and bottles to tires that were blocking the flow of water. They are all a cause for concern as they imply heavy human traffic off of the designated trails.

Why Restoration was required:

- Cotton Hill Park and our site specifically have a high non-native population consisting of *Rubus armeniacus* (Himalayan blackberry), *Ilex aquifolium* (English holly), *Polygonum cuspidatum* (Japanese knotweed) and *Hedera helix* (English ivy). As Cotton Hill Park is connected to another green space, Crestwoods Park and Crestwoods Park is connected to Juanita Bay Park, it is important to keep these invasive species from spreading to nearby green spaces, only perpetuating the problem of an invasive species monopoly.

  In addition, storm water runoff that transports pollutants from the surrounding neighborhoods and roads to the stream that travels through the site is a cause for concern.

Reference Site:

<u>St. Edward's Park</u>

- The present environmental setting of our site has some similarities to St. Edward's Park in Kenmore, WA. Various sections of this park were cut at different times over the past 100 years allowing for the formation of a more mature coniferous stand. Thus, we are

using this park as a present and long term reference site. Its vegetation setting, similar to our restoration site, includes evergreen and deciduous ecosystems that encompass associations of black cottonwood, red alder, big leaf maple, salmonberry, and Douglas-fir (Smith, 2006). We aim to modify the present vegetation of our site and steer the successionary trajectory of Cotton Hill 1 site towards a comparable structural complexity to the one at St. Edwards Park.

The approach taken to solve the problem:

The initial restoration of the Cotton Hill 1 site involved the creation of three polygons that facilitated a physical as well as conceptualized framework and provided a general description of each area in terms of vegetation structure, water as well as light conditions, and soil chemistry. The basic restoration approach involved the removal of invasives followed by native plant installation aimed at enhancing habitat diversity and improving ecosystem functions such as storm water management, erosion control and invasive species suppression. Moreover, native plant selection involved ground cover species, shrub species, as well as canopy species so that a multi-layered horizontal as well as vertical structure will be created through time. The restoration team improved water flow by planting moisture-adapted vegetation with fibrous roots on the streamside and placed rocks and logs to reestablish the stream corridor. The team further cleared the culvert in polygon 2 that slowed the stream's water flow onto the site.

A major component of the team's restoration efforts included the incorporation of the human element into the restoration process in order to ensure long-term restoration success. Community collaboration in terms of volunteer participation during work party events as well as the education of school students located within the area regarding restoration efforts at Cotton Hill promoted the importance of the creation and maintenance of natural native plant communities for the benefit of current as well as future generations.

Project goals addressed during restoration included:

- The establishment of a diverse native vegetation community that will thrive in a lowland forest ecosystem
- The promotion of a regulated wetland environment through the improvement of stream hydraulics
- The incorporation of hardscape features in order to foster an enhanced understanding of the relationship between man and nature as well as to increase site maintenance access
- The generation of a maintenance plan that will ensure the success of the restoration project
- The promotion of community involvement and encouraged participation

Major Accomplishments:

- 502 Plants installed successfully

- 500 m² of invasive species removed
- 23 m□ of mulch applied
- 4 community involved work parties with over 70 volunteers attending each party
- Weirs effectively installed to facilitate amphibian habitat
- Rocks applied to the stream to encourage aquatic invertebrate habitat
- Seventy five 6.25 mm holes drilled in large woody debris to promote mason bee habitat
- We provided a productive educational tour for UW Bothell Intro to Restoration class.
- One week education plan developed for Peter Kirk Junior High 7th grade Biology classes
- 5 periods of 7th grade classes were taken to the field for developing education in restoration
- All work, set forth to do, has been achieved

Contact information

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Figure 3: Cotton Hill Team 1 members (from left to right): Paige Saffle, Jo-Anne Antoun, Ally Shea, Ali Mainayar, Larisa Curta, Melody and Michelle Rosecrans.

Acknowledgments

We would like to thank our committed project partner Karen Story for providing us with constant support and resources as well as ensuring the success of our restoration work parties. Also, we want to thank Sharon Rodman and the City of Kirkland for providing tools as well as support when needed.

This project was implemented with support and constant guidance from the UW-REN instructors Warren Gold, Kern Ewing, Jim Fridley. We would also like to thank our UW-REN TA Rodney Pond. This project was made possible with his guidance, advice and endless resources.

We want to thank all the hardworking volunteers that have participated in weeding, mulching and planting parties. The implementation of all our project goals was made possible with their help. Also, we thank the Earth Corps for helping us guide our volunteers during our first planting party.

University of Washington
Restoration Ecology Network
Bothell - Seattle - Tacoma

As-built report

This section presents the approach that was taken in order to reach the goals, objectives and tasks of this project. The addendums in green describe the actual implementation and any other amendments to the original work plan.

I. Background

1. Site description

Cotton Hill Park is an undeveloped, 4.1-acre natural area located within the Forbes Creek Watershed in Kirkland, Washington (Figure 1). The exact location is at the corner of 98th Street and 110th Avenue. The park is bordered on three sides (north, east, south) by residential housing. Along the western edge of the park there is a railroad track, and it is a hope that the site between Cotton Hill Team 1 site and the railroad will be a future Capstone project. Within the park, there are two main access trails, one that runs north to south and is a raised gravel path, which was constructed by the community. It runs through the wetland area, allowing travelers to pass through on dry land during the rainy, wet season. The second trail gives access to pedestrians by way of a gravel staircase, running east to west, connecting to the main gravel trail at the north end of the park.

A stream runs through the park from the northeast to the southwest end. Rainwater, storm water and groundwater seeps contribute to the stream's water source. It meanders through the park at a slow and confined pace, running under the raised gravel trail through a culvert built by the community. Just after the culvert the stream becomes wider and the soil begins to change. There is much more silty clay in the low, moist areas of the park and in the upper, dry portions there is much more sandy clay to loamy sand. This drastic soil and moisture change limits the native species ability to grow successfully in specific sites around the park. As such, we will work with native plants adapted to a low aeration and high water content soil structure in much of our specific site, which is mostly sand and clay. Our site is almost consistently wet throughout with the exception of a few high, dry points.

Throughout the park, the vegetation consists of a mixed deciduous-conifer forest. The predominant canopy species on the Cotton Hill team 1 site are *Alnus rubra* (red alder), *Acer macrophyllum* (big leaf maple), *Pseudotsuga menziesii* (Douglas-fir) *and Populus balsamifera* (black cottonwood), though snags have created gaps, allowing sunlight to hit the forest floor. The sub-canopy consists of *Equisetum arvense* (field horsetail), *Polystichum munitum* (sword fern), *Corylus cornuta,* (California hazelnut), *Rubus ursinus* (trailing blackberry), *Athyrium felix-femina* (lady fern), *Rubus spectabilis* (salmonberry), *Oemleria cerasiformis* (Indian plum) and *Lysichiton americanum* (skunk cabbage) as well as invasive species like *Rubus armeniacus* (Himalayan blackberry), *Ilex aquifolium* (English holly), *Polygonum cuspidatum* (Japanese knotweed) *and Hedera helix* (English ivy).

Over the years, Cotton Hill Park as a whole has suffered moderate degradation. The pre-settlement landscape of the lower Puget Sound area was significantly altered through timber harvest, agriculture and urbanization; therefore exerting a profound effect on the structure and function of the natural landscape. During the 1870's the Kirkland Highlands area was mainly divided up into homesteads. These homesteads worked primarily in logging and

agriculture. Throughout the period of 1910 to 1930, Kirkland underwent a rapid population increase that encompassed the conversion of homesteads into housing developments, septic systems, outhouses and roads (History of Kirkland, 2006).

Currently, there is a cause for concern pertaining to storm water runoff that transports pollutants from the surrounding neighborhoods and roads to the stream. Restoration efforts have taken place at the park over the past few years and things are looking up. There are three previous UWREN restoration sites and with the two groups placed there this year, there will be a total of five sites restored. Before we began, 2.1 acres of the 4.1-acre park remained to be restored, though the current URWEN restoration projects (Cotton Hill 1 and 2) are putting a large dent in that number.

As the park is situated between urban neighborhoods and is fragmented from most other green spaces in the urban area, wildlife has limited ability to disperse and forage, as food may be limited due to size and human impact. However, there are populations of birds and amphibians that have made Cotton Hill their home. These include common species of urban wildlife in our region, such as the Pileated Woodpecker (*Dryocopus pileatus*) and salamanders. Since the park's restoration efforts began and the raised, gravel trail was built in 2008, foot traffic has heavily increased, though the trail encourages people to stay on path and there is little evidence of off-trail use. It is our hope that this continuous responsible use of the park and the restoration efforts taking place, will allow the populations of birds and amphibians to flourish.

The restoration site that has been selected is near the southern edge of the park and runs perpendicular to 98th Street (Figure 1). The site encompasses approximately 600m^2 and has a maximum slope angle of 58 percent (though it is a minor component), with other lower angles spaced around the site. We divided the site into three polygons based on the diversity of existing vegetation, soil moisture content, topography and hydrology. Polygon 1 (~290 m²) has the highest native vegetation cover and low ground level light availability due to canopy cover provided by three mature Douglas- fir trees and one big leaf maple. Shade adapted species such as sword fern characterize the understory. Polygon 2 (~270 m²) has a higher percentage of invasive species and the ground level receives more light, especially seasonally, than polygon 1, due to its deciduous canopy. The dominant species present include salmonberry and Himalayan blackberry. The ground level of polygon 3 receives full light and is dominated by English holly and Himalayan blackberry.

The above-mentioned stream flows southwest through the proposed site and splits into two smaller streams. Two drainage pipes feed into the stream at the northeastern section of the site during heavy rains. Wet marsh conditions exist on the southeastern section of the site, taking up at least half of the area of polygon 2 where we will plant a community of sedges. The level of rainfall determines moist conditions on the rest of the site. During the winter months, polygon 3 is also wet after rains but dries up during the summer months. These moist conditions are something that we have had to take into account and consider when making choices on what species will be planted.

The present environmental setting of our site has some similarities to St. Edward's Park in Kenmore, WA. Various sections of this park were cut at different times over the past 100 years allowing for the formation of a more mature coniferous stand. Thus, we are using this park as a present and long term reference site. Its vegetation setting, similar to our restoration

site, includes evergreen and deciduous ecosystems that encompass associations of black cottonwood, red alder, big leaf maple, salmonberry, and Douglas-fir (Smith, 2006). We aim to modify the present vegetation of our site and steer the successionary trajectory of Cotton Hill 1 site towards a comparable structural complexity to the one at St. Edwards Park (Objective 1.2, 1.3, Task 4.1a).

2. Restoration needs and opportunities

With depleting natural areas present in western Washington, we are faced with the challenge of preserving and enhancing what is left. Human impact has left natural areas in Seattle and the surrounding areas in an arrested state of succession by cultivating non-native species, disregarding water quality, logging and much more. The purpose of restoration, and our purpose for restoring this particular site is to promote a more natural, mature, and structurally diverse forest by removing the invasive species present and creating the most hospitable habitat for the species planted, increasing their possibility of survival.

Cotton Hill Park has become an integral part of the Green Kirkland Partnership's 20-year forest restoration plan and is utilized by children, adults, pets, and wildlife. It is attached to two other natural landscapes and presents the opportunity to widen those spaces and educate the public on the health of their watershed. Crestwood Park is a 27-acre forested area and is just north of Cotton Hill, while an abandoned railroad corridor connects to Cotton Hill on the west side. This space provides the public with "wild" spaces in an urban setting, which has become a rarity in this industrial age. It would be in the best interest of the neighborhood and its citizens to create a space that is inviting and creates opportunities for connection and solitude.

II. Tasks and approaches

Goal 1: Establish a diverse native vegetation community that will thrive in a lowland forest ecosystem

Objective 1.1: Remove invasive species so that a complex native landscape can thrive.

Task 1-1a: Remove all *R. armeniacus* entirely on the site and partially on the area adjacent to Polygon 1 and 3.

Approach: *R. armeniacus* removal will include two steps. First, trimming stems at 15 cm above the ground so that they are still visible for the second step of the process which involves digging up the root crown. For younger plants, the root wad can be hand pulled, while for older stems digging out the root ball is required (King County, 2010). After removal, stems and root crowns will be placed on tarps and transferred onto a woody debris compost bed constructed on the Cotton Hill 2 site for decomposing. This will prevent re-sprouting.

Task 1-1b: Remove all *H. helix* found on site.

Approach: Vegetation and roots of *H. Helix* that grows on the ground will be pulled out. The *H. helix* that grows on the *P. menziesii* will be removed by cutting a ring around the

tree to disconnect the stems from the trunk of the host plant. Enabling the remaining stems on the tree to eventually dry, while the ones on the ground will be pulled out and the area affected by them, mulched to prevent reinvasion (King County, 2010).

Task 1-1c: Remove both young and mature *I. aquifolium* plants found on site.

Approach: For the young *I. aquifolium* plants, mechanical removal will suffice. Plants and the roots can be easily pulled out of the ground. For more developed and mature trees it is necessary to trim the stems to the ground and paint the remaining stumps with a glyphosate solution (King County, 2010). The trimming will be performed by UW-REN students and volunteers while the City of Kirkland Parks Department carry out the application of glyphosate.

Task 1-1d: Remove *P. cuspidatum* at the edge of Polygon 2.

Approach: After identifying *P. cuspidatum* the Cotton Hill 1 team will mark the plants with orange tape and the City of Kirkland Parks Department will inject the plants located at the edge of Polygon 2 with a glyphosate solution (Story, personal communication, 2011).

AD1: *P. cuspidatum* was not injected with glyphosate and has been allowed to grow. Per Karen Story, the City of Kirkland will not be out to inject *P. cuspidatum* until late summer because it is supposed to be more effective at that time. Marking plants was not necessary because it has grown into a very large visible mass.

Task 1-1e: Apply a thick layer of organic mulch on all areas where invasive plants were removed.

Approach: Cover areas that underwent invasive removal with 16 cm of organic mulch to smother any remaining invasive growth. Moreover, mulch provides soil stability and aids in moisture retention (Chalker-Scott, 2011). The mulch will be brought on site by the City of Kirkland Parks department (Story, personal communication, 2011).

Task 1-1f: Construct two hummocks in polygon 1, and two hummocks in polygon 3, to facilitate the establishment of woody plant species.

Approach: Hummocks create a raised bed with favorable microclimate for conifers and woody plant saplings within riparian environments. We will collect woody debris on site in order to construct triangular and rectangular beds. The hummock bases are to be filled with a compost/sandy soil mixture, then surrounding saplings with 16 cm of mulch after being planted in the hummock bases.

Objective 1.2: Assemble a plant community that will deter the reinvasion of non-native plant species and improve hydrologic functions.

Task 1-2a: Plant an intermediate layer of fast growing shrubs that will form thickets and shade out invasive species as well as provide erosion control.

Approach: Shrubs such as *Ribes sanguineum* (Red flowering currant)*, Rubus parviflorus* (Thimbleberry)*, Symphoricarpus albus (*Snowberry) and *Physocarpus capitatus* (Pacific ninebark) will be planted in order to form a wall capable of deterring the re-invasion of Polygons 1 and 3 by *R. armeniacus*. These shrubs will be planted in dense masses at 0.5 m apart in order to suppress the *R. armeniacus*. The shrubs will be brought over in the form of bare root and planted at the level at which they were in the soil prior harvesting.

AD2: *R. sanguineum* and *P. capitatus* where not because there was not a supply of these species available at the nurseries. We installed *Aruncus dioicus* (Goats beard), *Corylus cornuta* (California hazelnut) and *Spirea douglasii* (Hardhack spirea), as replacements for the above mentioned species.

Task 1-2b: Plant riparian compliant vegetation that will grow and shade out invasive species.

Approach: Live stakes of *Salix lucida* ssp. *Lasiandra* (Pacific willow)*, Salix sitchensis* (Sitka willow)*,* and *Cornus sericea* (Red osier dogwood) will be planted in the bankfull channel edge of Polygons 1 and 2 in order to provide stream side shade. The live stakes will be planted in clumps situated at 0.2 m from each other with a depth of 0.3 m (Pond, personal communication, 2010).

AD3: *S. sitchensis* was not planted because there was not any nursery stock availability.

Objective 1.3: Enhance horizontal and vertical vegetation complexity that will lead to a more diverse habitat structure for wildlife.

Task 1.3a: Install ground cover species that enhance the horizontal vegetation complexity of the site.

Approach: In shadier areas of Polygon 1, fern species such as *P. munitum* and *A. filix - femina* will be installed to provide dense cover. These two species will be planted in groups around the *P. menziesii* trees already present on the site. These fern species grow rapidly when they are exposed to favorable moisture and light conditions; therefore, *P. munitum* and *A. filix – femina* will establish cover as well as provide erosion control under satisfactory ecological conditions (Gold, 2010). In the bankfull zone of Polygon 2, *Carex obnupta* (Slough sedge)*,* will stabilize the soil structure with its rhizomes. Sedges are capable of providing cover and a food source for bird species that may potentially inhabit the site (Cooke, 1997). Planting of *C. obnupta* will occur in the open, saturated, soil areas on site to ensure survival (Gold, personal communication, 2011).

AD4: *P. munitum* was not planted because it is already prevalent on the site. Instead *Tolmiea menziesii* (Piggyback plant) and *Tellima grandiflora* (Fringecup) were planted as alternatives to *P. munitum*.

Task 1-3b: Enhance both horizontal and vertical diversity by planting intermediate layer species.
Approach: Shrub species such as *O. cerasiformis*, *R. parviflorus, S. albus, P. capitatus, R. spectabilis, Rhododendron macrophyllum* (Rhododendron) *, Lonicera involucrata* (Twinberry), *Sambucus racemosa* (Red elderberry)*, Rosa pisocarpa (*Swamp rose) *, and R. sanguineum* will be planted throughout Polygon 1 and 3 after the complete removal of invasive species and mulching. The shrubs will be obtained in the bare root form and planted at the grade at which they were initially planted before harvesting between 0.2 m and 1 m away from each other. These shrubs will provide nest sites, cover and food for wildlife (Gold, 2010).

AD4: *S. racemosa, P capitatus and S. racemosa* were not planted because they were not available at any of the nurseries that we worked with. We installed *Aruncus dioicus* (Goats beard), *Corylus cornuta* (California hazelnut) and *Spirea douglasii* (Hardhack spirea), as replacements for the above mentioned species.

Task 1-3c: Enhance the vertical complexity of the forest by planting plant species that will mature and provide canopy coverage and therefore increase habitat diversity.

Approach: Install species such, *Fraxinus latifolia* (Oregon-ash) *, Rhamnus purshiana* (Cascara), *Acer circinatum* (Vine-maple), *A. rubra, Thuja plicata* (Western Red Cedar), *Taxus brevifolia* (Pacific Yew)and *Tsuga heterophylla* (Western hemlock) in Polygons 1 and 3 in order to provide foliage, roosting and nesting sites as well as woody debris and organic matter. The trees will be obtained as small-containers plants and planted by the Cotton Hill 1 students and volunteers. The plants will be carefully taken out of the container, the roots will be trimmed and cleaned and inserted into a hole that should be no larger than twice the diameter of the root ball (Chalker-Scott, 2010).

Goal 2: **Promote a regulated wetland environment by improving stream hydraulics.**

Objective 2.1: Plant vegetation adapted to extremely moist conditions with fibrous roots to minimize erosion and to channelize the flow of water.

Task 2-1a: Remove all *R. armeniacus* biomass above and below ground.
Approach: *see task 1-1a.*

AD5: *R. armeniacus* was removed beyond the borders of polygon 3 during the first work party, creating an enhanced buffer between the restoration area and *R. armeniacus.*

Task 2-1b: Spread organic mulch over areas that were treated for invasives.

Approach: Wood chip mulch will be acquired by the community partner through the city and be held close to the site boundary. Mulch will be transported with buckets and spread accordingly the area and will be a designated depth.

Task 2-1c: Plant *A. circinatum* for bank establishment.

Approach: Plant *A. circinatum* upstream to ensure good quality soil to hold back erosion. Holes will be made using shovels. Water will be used in plantings. Plant will be acquired in the form of bare root and will be planted apart within 2m.

Task 2-1d: Establish a community of *C. sericea.*

Approach: Stem cuttings of *C. sericea* will be obtained from the Union Bay Natural Area during the dormant season. Cuts will be made with knives off the parent plant with stakes being around 18-20 inches long. Plants will be stored in sawdust beds until ready for use. Stakes will be driven into the stream bank area that is most affected by erosion in the middle of Polygon 1. Stakes will be one foot deep within the soil (King County, 2011).

Task 2-1e: Install a dense *C. obnupta* patch for sediment retention

Approach: Plugs of *C. obnupta* will be planted in the standing water area of polygon 2. Rhizomes will be planted along the natural stream meander patterns of the area. Rhizomes will be planted .2m apart from each other which enable sediment retention through thickets.

Objective 2-2: Incorporate rocks and logs as weirs alongside and in the present stream channel to create a cascading appearance and to prevent movement of sediment.

Task 2-2a: Use rocks to establish the stream bank

Approach: Set aside large rocks that are acquired from all polygons closer to the stream banks. Arrange rocks along the stream banks that enter polygon 1 in a “stone toe” pattern to protect stream bank from heavy storm flows and to help prevent future erosive flow (Montgomery, 2011).

Task 2-2b: Create standing pools with rocks.

Approach: Using shovels the ground at the middle of the stream in Polygon 1 will be expanded to create standing water. Soil will be taken to Polygon 2’s standing island which has very similar soil characteristics. Large rocks that are currently found on site will be arranged in the stream to create small standing pools. The depth of the water will vary from 0.5-2.0 in. in the standing pool. Water will flush through that pool to the rest of the stream in a short drop from the pool to the rest of the stream.

Task 2-2c: Establish a stream flow that can be clearly seen in polygon 2.

Approach: Plant plugs of *C. obnupta* in heavy flooded areas to encourage stream flow and direction by holding of soil and sediment. Stream flow will become more apparent while still having the ability to flood in Polygon 2 if needed. Water will be channeling through thickets of *C. obnupta* which will meander along the stream (East Multnomah Soils& water conservation district, 2011).

AD6: The flow of water was not improved through channelization, but through the reinforcement of the stream banks by logs and rocks as well as through the clearing of the culvert that enters polygon 2 along the site's eastern border.

Goal 3: Incorporate hardscape features in order to foster enhanced understanding of connection between humans and nature as well as increase recreational options

Objective 3.1: Add signage to increase awareness of native plant populations and historical references of that vegetation.

Task 3-1a: Design signage following design specifications according to guideposts that are installed at prior Cotton Hill restoration sites.

Approach: A uniform approach to signage design elements will ensure that the park resembles one site, and not a compilation of several sites. Sign information need to be informative, but easy to appreciate and understand by the larger community. Each sign should include a picture of the plant and flower (where applicable), scientific and common names, as well as a summary of the particular plant's ecology, natural history, and Native American usage. The inclusion of such information will be applicable to casual passersby, middle and high school groups, as well as undergraduate students.

Task 3-1b: Install signage that will withstand time, weather conditions, and normal wear and tear.

Approach: The project partner will provide signage design information as well as ideas of how and where to obtain materials. Signage will be placed at critical locations in proximity to the trail to-be-constructed through the Cotton Hill 1 site (objective 3.2).

AD7: The addition of signage was not approved by Cotton Hill's community partner as multiple signage installations across Cotton Hill Park provides ample information regarding native plants and includes information that explains restoration efforts and partnerships between the City of Kirkland and the UW-REN.

Objective 3.2: Design a trail in order to increase recreational enjoyment as well as to provide understory access in the forest for educational groups.

Task 3-2a: Design and build a trail connecting to Cotton Hill 2 site.

Approach: Delineate trail using woody debris collected from our site and neighboring sites. The outline created by the woody debris will be filled up with 16 cm of organic mulch. Organic materials used for the trail construction will ensure that the ecological integrity of the Cotton Hill 1 site remains intact as no impervious surface will be created and no materials that could potentially introduce toxins to the site will be used.
The starting point of the trail will connect to the Cotton Hill 2 site through Polygon 1 and will cross over Polygon 1 into Polygon 3, ending with a bench that is situated within the interior of the site. Cotton Hill 1 is looking into the possibility of building a bench in order to reduce costs.

AD8: The trail was implemented but it is not developed for public use. The revised purpose for the trail is to provide maintenance access to the site.

Objective 3.3: Design habitat features to attract a variety of wildlife to the Cotton Hill 1 site.

Task 3-3a: Carve several cavities in existing snags

Approach: Cavities within snags provide essential shelter and nesting locations for wildlife. Snags that are currently located on Cotton Hill 1 do not have large cavities. Creating a few cavities will assist in attracting wildlife.

Task 3-3b: Construct brush piles and rock piles to enhance wildlife habitat features

Approach: Rock piles and brush piles provide essential habitat for reptiles, amphibians, small mammals, insects, some birds, slugs, and snails. Use and collect on-site and off-site woody debris and plant materials to create small brush piles in desired locations on site. Collect rocks on and off site and construct rock piles near the stream.

Goal 4: Generate a maintenance plan that will ensure the success of the restoration project
Objective 4.1: Develop a plan that will assist with monitoring and maintenance of the site for neighborhood volunteers.

Task 4-1a: Evaluate the restored ecosystem according to the Society for Ecological Restoration (SER) attributes of a restored ecosystem (SER, 2004). Evaluate the 2010-2011 restored Cotton Hill Team 1 site according to the following SER attributes:

- Is the Cotton Hill community structure similar to the development trajectory of the Saint Edward's Park reference system?
- Does the restored site mainly contain native plant species?
- How many woody and herbaceous vegetation and animal functional groups necessary for system stability are present within the restored ecosystem?
- What is the capability of the Cotton Hill ecosystem to sustain reproducing populations?
- Is the restored site functioning in accordance with its ecological stage of development?

- To what extend is the restored site integrated with surrounding landscapes?
- What is the status of potential threats to the restored ecosystem?
- How resilient is the restored ecosystem to normal periodic stress events?
- How does the restored site compare in terms of self-sustainability to the reference ecosystem (St Edwards Park)? (SER, 2004)

Approach: The list of attribute evaluation criteria according to the SER Primer provides a conceptual framework by which to assess the success of a restored ecosystem. Restoration success is obtained when the restored ecosystem possess the desired biotic and abiotic resources to persist (SER, 2004). However, ongoing maintenance may be required as Cotton Hill is geographically isolated from a larger ecological matrix.

Task 4-1b: Establish minimum thresholds after 3 – 5 years that will indicate the attainment of objectives 1.2 and 1.3: the creation of a diverse wildlife habitat structure and the assemblage of a native plant community that will deter the re-growth of invasive species.

Approach: A compact shrub species community in the form of thickets after 3 – 5 years of initial restoration accompanied by a substantial tree species density, tree height, and canopy closure that signifies significant growth and mortality will be an indication that these objectives are successful. We will research specific appropriate performance standards for the species and plant communities involved and measurement approaches for the volunteer monitors.

Objective 4.2: Create a list of plants that should be installed as the restored plant community will develop and appropriate additions or changes will be required.

Task 4-2a: Create a list of plants for installation in accordance with the developing plant community.

Approach: Develop a list of later stage forest successional species appropriate for installation. This list will be based upon plant species present in Saint Edward's park in Kenmore, WA – our reference site. Possible species for future installation include, but are not limited to *A. macrophyllum, Gaultheria shallon* (Salal), *P. capitatus, P. menziesii, P. sitchensis, T. heterophylla*, *T. plicata and Vaccinium parvifolium* (Red Huckleberry). The aforementioned species require later successional forest characteristics including canopy shade as well as nutrient-rich soils.

Goal 5: Promote community involvement and encourage participation
Objective 5-1: Plan, instruct and supervise volunteer work parties that will help during restoration.

Task 5-1a: Instruct volunteers depending on the tasks that need to be accomplished.

Approach: Volunteers will be divided into groups according to their preference on the site conditions and projects. During the first work party which will target invasive species removal the volunteers will work in groups and each group will be assigned to a particular invasive species. During the mulching party, volunteers will be instructed on where to place the mulch, as well as the quantity that is needed depending on the site conditions. As far as the planting parties, volunteers will be assigned to specific polygons and plant species. There will be groups in charge of planting the ground layer, intermediate layer, as well as trees. Cotton Hill 1 team will make sure that the volunteers are comfortable with the amount of work as well aware of the fact that there work is very much appreciated.

AD9: Volunteers were not assigned to specific polygons or plant species rather what they were most interested in working with during planting parties.

Objective 5.2: Collaborate with Kirkland Junior High teachers that show interest in the restoration project and work toward creating a classroom presentation and field trip, incorporating species identification, natural art, and data gathering with the help of Cotton Hill team 2.

AD10: The students did not participate in gathering data. They planted, took photographs, sketched drawings of plants and built eco-art exhibits.

Task 5-2a: Contact instructors at Kirkland Junior High and express our interest in working with their students.

Approach: Contact social as well as earth science, art, and math instructors, especially instructors whom engaged in prior UW-REN educational excursions that would be interested in allowing Cotton Hill 1 to conduct a class session focused on learning simple scientific and ecological principles and apply them in the field at the restoration site. E-mail them in advance (at the end of the fall quarter) and let them know about our interest in conducting a class activity during spring quarter.

Task 5-2b: Plan and conduct in-class activity.

Approach: Create and present lesson plans in collaboration to Kirkland Junior High instructors (see Section III) that would explore nature concepts in a fun and creative manner. The design of lesson plans will strive to foster an ongoing collaboration between neighboring schools, the Highlands community, as well as the Cotton Hill project partner.

III. Specific work plans

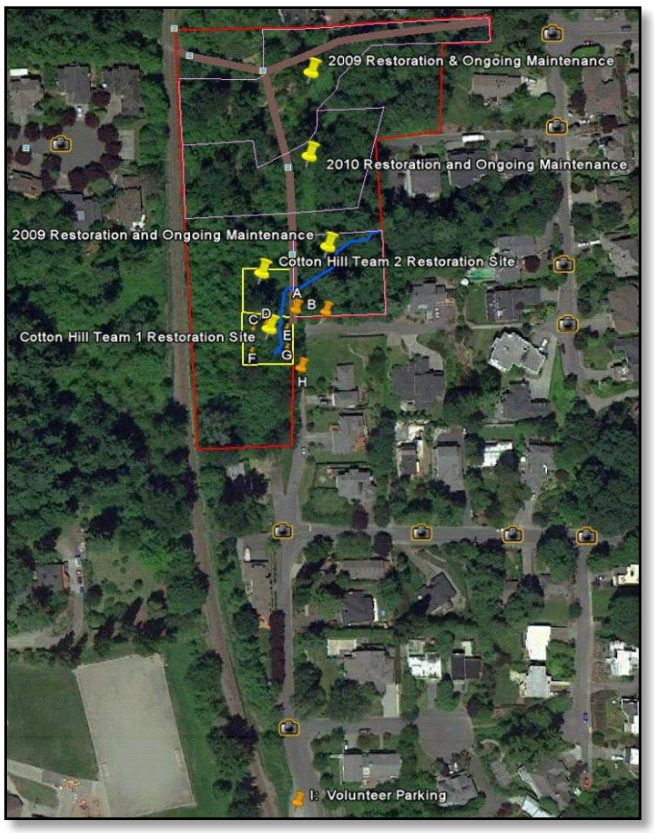


Figure 1: Aerial photograph of Cotton Hill Park showing past and current restoration sites. Letters refer to specific locations referenced in the text. Retrieved from:

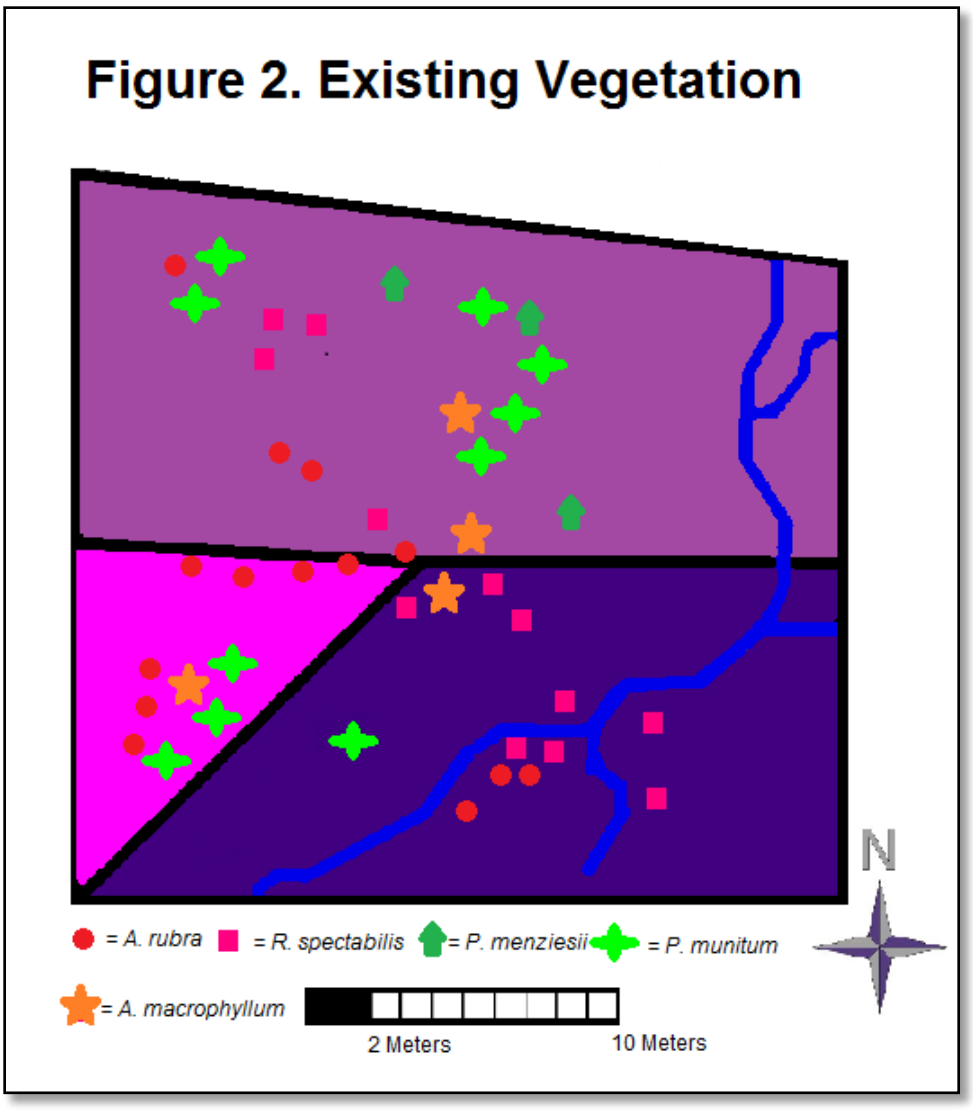
1. Site preparation plan

Site vegetation

Polygon 1 is composed of three *P. menziesii* and one *A. macrophyllum* in the over story. Furthermore the understory is peppered with several native species which include *A. rubra*, *P. munitum, R. spectabilis*, and *R. ursinus*. The dominant invasive species are *R. armeniacus* and *H. helix* are throughout polygon one.

Polygon 2 has the highest overall percentage of invasive species in the understory, consisting of *R. armeniacus*, *I. aquifolium*, *H. helix*, and *P. cuspidatum*. Native species present are *A. rubra*, *R. spectabilis* and *P. munitum*.

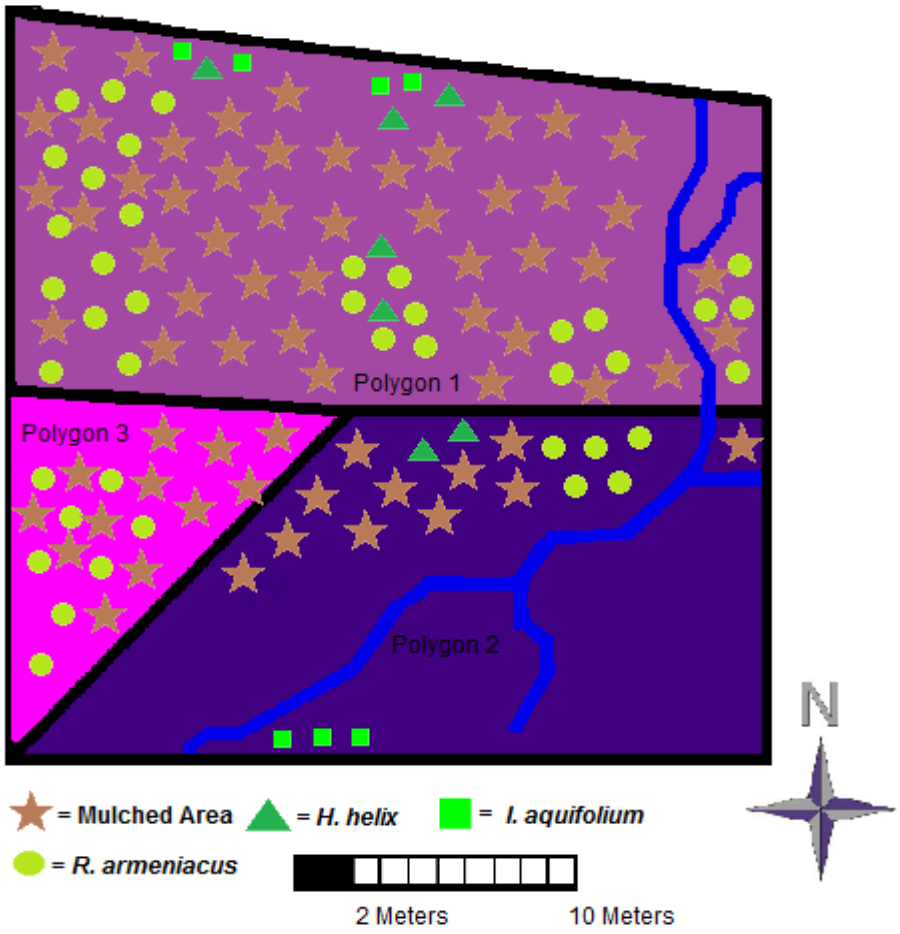
Polygon 3 is strongly dominated by *R. armeniacus* polygon three also consists of a few intermittent colonies of *R. spectabilis* (Figure 2).



Site preparation activities:

Our site preparation activities will begin with a volunteer work party on 1/15/2011. We will first be building an onsite compost area by laying down large woody debris (logs) side by side to cover an approximate 10 m² area (Task 1-1a). The majority of our waste from invasive species removal will be placed on this constructed plat form, excess debris will be put on 110th Ave. at the main entrance of Cotton Hill Park for the City of Kirkland to pick up. All invasives are going to be removed per King County Noxious Weed Control protocol as presented by Sasha Shaw (11/19/2010). *R. armeniacus* is present in polygons 1, 2 and 3. Removal is conducted by cutting down canes with loppers and digging up root crowns, per King County Noxious Weed Control protocol (Task 1-1a). *H. helix* will be cut back from the base of a *P. menziesii*, in polygon 1, and root wads dug up (Task 1-1b). *H. helix* also resides in polygon 2 and will be removed as previously mentioned. Within polygon 2 there is a very large (approximately 5 m tall) *I. aquifolium* tree; due to the size it will be cut down to the stump and flagged for City of Kirkland personal to sterilize (Task 1-1c). In regards to the rapidly spreading tendencies of *P. cuspidatum*,

Figure 3. Site Preparation Activities



c

currently in polygon 2, we will not be cutting it down, but using chemical methods (1-1d). 3-5ml of concentrated glyphosate will be stem injected into each plant as recommended by the King County Noxious Weed Control program. After removal of invasives another work party will be conducted on 2/6/2011 to apply approximately 30 sq yards of mulch on site (Figure 3). Our hopes are to apply the mulch at a consistent depth of 16 centimeters throughout polygons 1, 2 and 3 excluding the marsh area (Task 2-1b).

Hummocks will be built in polygons 2 and 3 during our third work party on 3/5/2011 (Task 1-1f). In an effort to promote better soil conditions for some of the woody species that we will plant that are not as successful in growing in highly saturated moist soils.

Logistical considerations

Points of access and delivery and distribution pathways: The main point of access to the restoration site is located at the northern end of 110th Avenue NE (Figure 1, point A). Mulch delivery is to be deposited at the intersection of NE 98th Street and 110th Avenue NE bordering

the 2010 restoration site (Figure 1, point B). Plants and other large loads can be deposited next to the mulch pile for easy distribution.

Staging areas for materials: Staging areas for placing of materials will be located at points C, D, E, F, and G as indicated on Figure 1. This will ensure an even distribution of the necessary materials during work party events.

Parking for volunteers: The parking area for volunteers is located at point I (Figure 1), towards the southern portion of 110th Avenue NE west of the railroad. Additional parking is along the western side of 110th Avenue NE (Figure 1, point H).

1. Planting plan

Table 1: Plant material form and installation density in all three polygons.

	Polygon 1			Polygon 2			Polygon 3		
	#	Form	Spacing (m)	#	Form	Spacing (m)	#	Form	Spacing (m)
Aruncus dioicus	**20**								
Abies grandis	8	1 gal container					**4**		
Acer circinatum	~~5~~ **2**	Bare root	2.0				~~2~~ **3**	Barefoot	2.0
Athyrium f. femina	6	~~Salvage~~ **Tree Frog Farm**							
Carex obnupta	~~40~~ **50**	Plugs	0.2	~~60~~ **110**	Plugs	0.2			
Corylus cornuta	**1**						**2**		
Cornus sericea	~~2~~ **22**	Bare root	1.0	~~3~~ **6**	Bare root	1.0			
Crategus douglasii	~~3~~ **7**	1 gal container	1.0						
Dicentra formosa	**15**								
Fraxinus latifolia	2	~~Ball & Burlap~~ Bare root		3 **2**	~~Ball & Burlap~~ Bare root	2.0			
Lonicera involucrata	12 **16**	Bare root	1.0				8	Bare root	1.0
Oemlaria cerasiformis	4	Barefoot	1.0				6	Barefoot	1.5
Philadelphus lewisii							2	~~Ball & Burlap~~ **Bare root**	4.0
~~*Physocarpus capitatus*~~	~~3~~	~~Bare root~~	~~1.0~~				~~2~~	~~Bare root~~	~~1.5~~
Picea sitchensis	10	1 gal container					**4**		

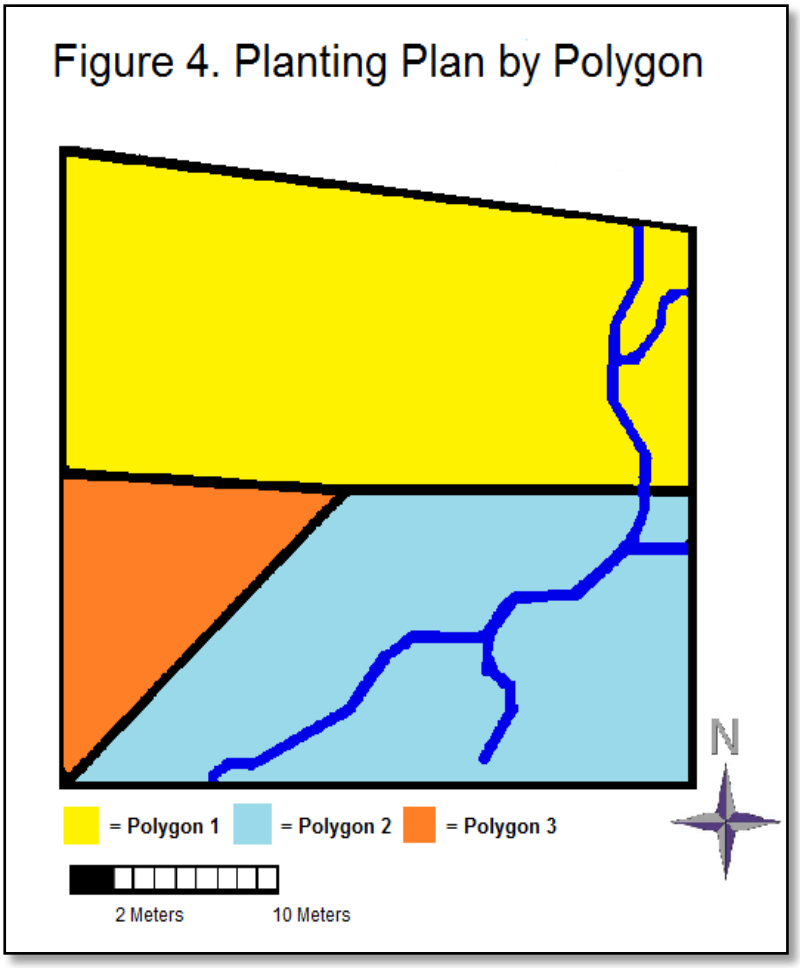
~~*Polystichum munitum*~~	~~6~~	~~Salvage~~							
Pseudotsuga menziesii	**8**						**2**		
Rhamnus purshiana	~~2~~ **4**	1 gal container	4.0				**3**		
Rhododendron macrophyllum	~~2~~ **1**	1 gal container	2.0				**1**		
~~*Ribes sanguineum*~~	~~5~~	~~Bare root~~	~~0.5~~						
Rosa pisocarpa	**13**	Bare root		~~3~~ **1**	Small container		~~3~~	Small container	
Rubus parviflorus	3	Bare root	1.0				2	Bare root	3.0
~~*Rubus spectabilis*~~	~~6~~	~~Transplant~~	~~1.0~~				~~2~~	~~Transplant~~	~~3.0~~
~~*Sambucus racemosa*~~	~~3~~	~~Bare root~~	~~1.0~~				~~2~~	~~Bare root~~	~~1.0~~
Salix lucida lasiandra	**44**			~~10~~ **3**	Live stakes	2.0			
Sitka sitchensis	8	1 gal container		3	1 gal container		4	1 gal container	
Spirea douglasii	**4**			**11**			**1**		
Symphoricarpus albus				**4**			~~4~~ **2**	Bare root	1.0
Taxus brevifolia							4	1 gal container	1.5
Tellima grandiflora	**25**								
Thuja plicata	4	1 gal container		4	1 gal container		3	1 gal container	1.5
Tolmiea menziesii	**20**								
Tsuga heterophylla	~~4~~ **4**	Bare root	1.0	**2**			~~1~~ **5**	Bare root	1.0
Vaccinium parvifolium	~~3~~ **5**	Bare root	1.5						

Polygon narratives:

Polygon 1 is our largest polygon at ~290 m² contains coniferous trees with a complex vertical structure and low ground level light. The topography of polygon 1 is characterized by an east-west 15˚ slope located near the start of the main entrance trail and by the first drainage pipe. As part of the Forbes creek watershed there is a stream that flows through both polygons 1 and 2 (Figure 3). A horizontal slope measurement at the narrowest part of the stream is approximately 13 cm with 23 cm at its widest point. Due to primarily moist and highly saturated sandy loam – sandy clay loam soils covered by a deep organic layer ranging from 3 to 11 cm in depth we are selecting plants adapted to the above listed conditions. We will begin with planting five *A. circinatum* in bare root form spaced 2 m apart and eight *S. sitchensis* based on their known ability to help stabilize erosion prone soils with their fibrous root systems (Task 1-2b). In order to develop a more variegated structure we will also be planting three *C. douglasii* at 1 m spacing, three *V. parvifolium* in bare root form at 1.5 m apart, three S. racemosa in bare root at 1 m apart, three *R. parviflorus* by bare root spaced 1 m apart, two *S. albus* by bare root with 1 m spacing, three *P. capitatus* in bare root form with 1 m spacing, six *R. spectabilis* by transplant method and two *C. sericea* in bare root form also with 1 m spacing. These species also deter of invasive species like *R. armeniacus* which can be shaded out (Task 1-2b, 1-3b), and they can help to filter soil water with their roots, therefore improving hydrologic functions. To further improve hydrologic functions, 40 *C. obnupta* plugs are to be placed along the eastern side of the stream. According to the U.S EPA plants like sedges have the ability to filter "pollutants such as suspended matter, undissolved metals, and bacteria from storm water." To enable an even more complex horizontal and vertical structure and promote wildlife habitat we will be planting twelve *L. involucrata* in bare root form at 1 m apart, two *R. purshiana* in 1 gal containers at 4 m apart, ten *P. sitchensis*, five bare root *R. sanguineum* with 0.5 m spacing, two ball & burlap *F. latifolia* and four bare root *O. cerasiformis* 1 m spaced. Next, we will install two *R. macrophyllum* from 1 gal container at 2m apart, 4 *T.plicata* 1 gal container form at 1 m apart, as well as four *T. heterophylla* from 1 gal containers at 1 m apart. Not only will these plants work together towards increasing the vegetation complexity but, several species also provide food sources for wildlife (Task 1-3 a, b, c). Lastly, six *P. munitum* and six A*. filix-femina* are to be planted to enhance the ground cover layer (Task 1-3a).

AD 11: We also installed 20 *A. dioicus,* 1 *C. cornuta,* 50 *C. obnupta* instead of 40, 15 *D. formosa*, 16 *L. involucrata* instead of 12, 22 *C. sericea* instead of 2 ,8 *P. menziesii*, 13 *R. pisocarpa*, 44 stakes of *S. lucida ssp. lasiandra*, 4 *S. douglasii*, 25 *T. grandiflora*, 20 *T. menziesii*, 5 *T.heterophylla* instead of 4 and 5 *V. parvifolium* instead of 5 to increase diversity. We were not able to install *P. capitatus, P.munitum, R. sanguineum, R. spectabilis* and *S. racemosa* due to stock unavailability.

Polygon 2 measures □ 270 m², encompassing more of a deciduous canopy layer. In the middle of the polygon lies a marsh area approximately 30 cm in depth. The flow of the stream from polygon 1 continues through polygon 2 and feeds into the marsh (Figure 4). A slope of 5˚ runs from the south end of the swamp further south into an area adjacent to polygon 2. Highly saturated silty clay and sandy clay soils are present. The organic layer ranges from 8 to 14 cm thick and considered mainly an Oe horizon because of the complex litter structure. To support



the soil structure of polygon 2 we have decided to plant ten live stake *S. lucida ssp. lasiandra*, sixty rhizomes of *C. obnupta* 2 m spaced, 3 *C.sericea* live stakes at 1m distance, and 3 S. sitchensis live stakes at 1m distance. These species will filter the water, as mentioned above, and contribute towards a more stable soil structure with their fibrous root systems (Task 1-2b, 1-3a). We will also be adding three *R. pisocarpa* from 1 gal containers spaced at 1m, three ball & burlap *F. latifolia* 2 m apart, four *T. plicata* from 1 gal containers the combination of all listed plants will not only support the soil but give rise to a complex stand with diversity that enhances wildlife habitat (Task 1-3c). In order for *F. latifolia and T. plicata* to establish successfully a hummock will be built (Task 1-1f).

AD 12: We installed 110 plugs of *C. obnupta* instead of 60, 6 stakes of *C. sericea* instead of 3, 2 *F. latifolia* in bare root form instead of 2 in ball and burlap. We also planted 1 *R. pisocarpa*, 3 *S. lucida ssp. Lasiandra,* 11 *S. douglasii,* 4 *S. albus* and 2 *T. heterophylla.*

Polygon 3 is our smallest polygon at only ~ 40 m² and receives the most sun light. Topographically this area is flat. Polygon 3 experiences the greatest amount of ground layer light due to its sparse vertical vegetation structure leading to a litter layer depth range from 2 to 4 cm in thickness. The organic layer is an Oa horizon with a faster rate of organic matter decomposition due to the light source. The soil is a mixture of sandy and silty clays that range

from moist to highly saturated, conclusive of clay soil types during the Fall/Winter season. Due to the presence of clay and the lack of an overhead canopy in this polygon we will be planting species that can withstand the shrink and swell patterns indicative of clay soil types. Furthermore, steering the vegetation structure towards a more complex stand will allow for an increased litter layer and slowed organic decomposition rate to nourish the acidic soil loving plants of the Pacific Northwest. In bare root form we will be planting two *A. circinatum* at 2 m apart, three *O. cerasiformis* with 1.5 m spacing, four *S.albus* at 1 m apart, two *S. racemosa* at 1 m spacing, three *R .pisocarpa* at 1 m spacing, eight *L.involucrata* at 1 m apart, and two *R. parviflorus* 3 m spaced in order to enhance structural diversity (Task 1-3b) as well as deter invasive species (Task 1-2a). Three *T. plicata* from 1 gal containers with 1.5 m spacing and two *P. lewisii* with 4 m spacing in ball & burlap form , four *T. brevifolia* at 2m apart, one *T. heterophylla* will be planted to induce more shade, as well as two *R. spectabilis* transplanted from Polygon 1 spaced 4 m apart (Task 1-3b,c). A hummock will be built in this polygon to provide a better micro site for woody plant species such as *P. lewisii, S. albus*, *T. plicata, T. heterophylla and T. brevifolia* (Task 1-1f).

AD13: Due to nursery stock availability *R. pisocarpa, R. spectabilis, S. racemosa* and *P. capitatus* were not planted in polygon 3. Instead we have planted: 4 *A. grandis*, 3 *A. circinatum*, 3 *C. cornuta*, 4 *P. sitchensis*, 2 *P. menziesii*, 3 *R. purshiana*, 1 *R. macrophyllum* and 1 *S. douglasii*. Furthermore, changes were made to the amount of certain species composition. 2 *S. albus* instead 4 were planted, 5 *T. heterophylla* instead of just 1 and *P. lewisii* was only available in bare root form, rather than ball and burlap. To facilitate the additional woody plant species a second hummock was installed in polygon 3.

Table 2: General materials table

Task	Materials	Qty	Source		Tools	Qty	Source
1-1a	Tarp	4	CKPD*		Loppers	8	CKPD
					Shovels	8	CKPD
					Mattocks		CKPD
					Gloves	20	CKPD
					Rakes	4	CKPD
1-1b	Tarp		CKPD		Gloves	20	CKPD
					Hand prunners	4	CKPD
					Shovels	8	CKPD
1-1c	Tarp		CKPD		Hand saw		CKPD
					Loppers	8	CKPD
					Gloves	20	CKPD
1-1d	Glyphosate		CKPD				
1-1e	Mulch	~~11~~30 yds	CKPD		Shovels	8	CKPD
	Buckets	10	CKPD		Gloves	20	CKPD

	Wheelbarrow	~~2~~ 5	CKPD				
1-1f	Woody debris		On site				
	Soil	3 cubic yds	Karen Story				
1-2a	~~*P. capitatus*~~	~~5~~	~~Karen Story~~				
	R.macrophyllum	~~2~~ 3	Nursery		Gloves	20	CKPD
	~~*R.sanguineum*~~	~~5~~	~~Karen Story~~	~~-~~	~~Shovels~~	~~8~~	~~CKPD~~
	R.parviflorus	5	Karen Story				
	L. involucrata	**24**	**Salvage**				
	S. albus	~~4~~ 6	Karen Story				
1-2b	*S. lucida lasiandra*	10	UBNA		Gloves	10	CKPD
	~~*S.sitchensis*~~	~~6~~	~~Nursery*~~				
	C. sericea	~~6~~ 28	~~UBNA~~ UWB				
1-3a	*A. filix femina*	6	salvage		Gloves	10	CKPD
	~~*P. munitum*~~	~~6~~	~~salvage~~	~~-~~	~~Shovels~~		
1-3b	*O. cerasiformis*	5	Karen Story		Gloves	20	CKPD
	C. douglasii	3	Nursery				
See 1-2a	*L. involucrata*	~~20~~ 30	Salvage				
	~~*P. capitatus*~~	~~-~~	~~Karen Story~~	~~-~~	~~Shovels~~	~~8~~	~~CKPD~~
	R. parviflorus		Karen Story				
	~~*R. sanguineus*~~	~~-~~	~~Karen Story~~				
	S. albus	6	Karen Story				
	~~*S. racemosa*~~	~~5~~	~~Nursery~~				
	V. parvifolium	5	Nursery				
1-3c	*F. latifolia*	~~7~~ 4	Karen Story		Shovels	10	CKPD
	P. lewisii	2	Karen Story		Gloves	20	CKPD
	P. menziesii	~~Tbd~~ 8	Karen Story				

	R. purshiana	~~2~~ **7**	Karen Story				
	T. heterophylla	~~5~~ **11**	Karen Story				
	T. brevifolia	~~4~~	Nursery				
	T. plicata	4	Karen Story				
2-1					Loppers	8	CKPD
					Shovel	8	CKPD
					Gloves	10	CKPD
					Maddock	6	CKPD
	Mulch		CKPD				
					~~Utility Knife~~	~~5~~	~~CKPD~~
2-1 a	*A. circinatum*	~~2~~ **5**	Karen Story				
2-1 b	*C. sericea*	~~10~~ **28**	UWB				
2-1c	*C. obnupta*	~~100~~ **160**	Nursery				
2-2							
	Rocks	20-30	On Site				
3-1a	~~Design Templates~~	~~1 set~~	~~Karen Story~~	-	-	-	-
3-1b	~~Wood Posts~~	~~8~~	~~CKPD~~	-	~~Mallet~~	~~2~~	~~CKPD~~
	~~Printed Informational Material~~	~~8~~	~~CKPD~~	-	~~Nails~~	~~40~~	~~CKPD~~
	~~Wood Board~~	~~8~~	~~CKPD~~	-	~~Screws~~	~~24~~	~~CKPD~~
					Gloves	2	CKPD
3-2a	Mulch	6 yds	CKPD		Pails	4	CKPD
	Woody Debris	tbd	On site		Shovels	2	CKPD
3-3a	Woody Debris	tbd	On site		Utility knife	2	CKPD
3-3b	Rocks	tbd	On site				

CKPD= City of Kirkland Parks Department
Nursery= Woodbrook Nursery, ~~Four Corners Nursery,~~ Tree Frog Farm, Tadpole Haven

As built map

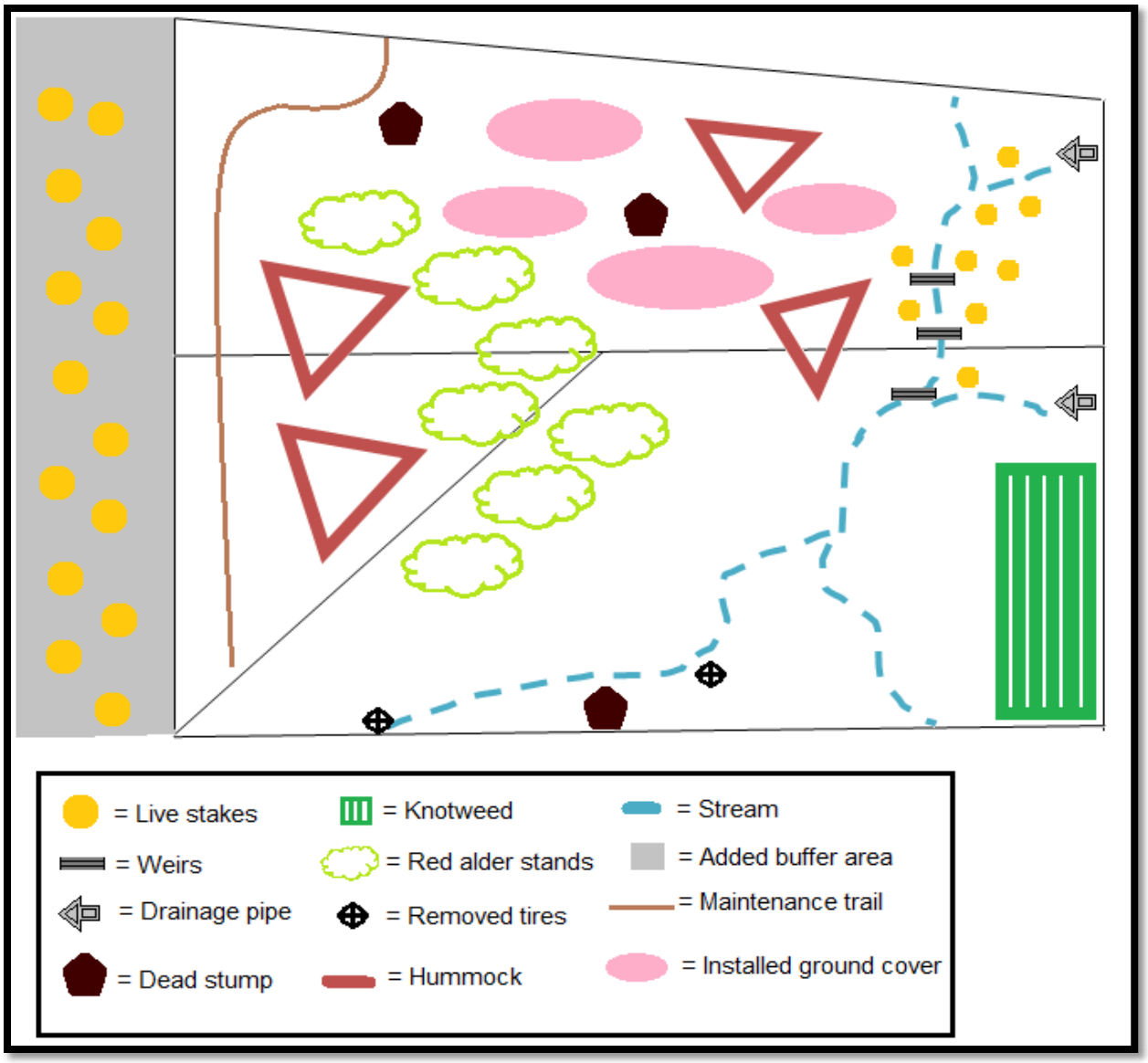


Figure 5: As-built map indicating the additional installation of hummocks, live stakes, ground cover and other features not included in the planting plan map or the site preparation map, such as the maintenance trail that we built, the patch of Japanese knotweed and the tires that we removed from the stream.

2. Budget plans

Labor budget

Labor by activity(Expenditure)	Team	Volunteers	Total
Subtotal site preparation	12	0	12
Invasive plant removal			
Himalayan blackberry	2	10	12
English Holly	3	15	18
Japanese Knotweed	0	2	2
English Ivy	1	5	6
Subtotal invasive plant removal	**6**	**32**	**38**
Plant acquisition			
Planning	4	0	4
Salvage	8	0	8
Nurseries	8	0	8
Live stakes	3	0	3
Subtotal for plant acquisition	**23**	**0**	**23**
Planting			
Polygon 1	20	100	120
Polygon 2	14	70	84
Polygon 3	8	40	48
Subtotal for planting	42	210	252
TOTAL	**71**	**242**	**313**

Labor by revenue	Total Hours
Team	71
Volunteers 1/17	32
Volunteers 3/19	210
Total volunteers	242
Total	313

Financial budget:

Expenditures by major category	Dollar amount
Plants	
conifer trees	$82
deciduous trees	$80
shrubs	$388
grasses and sedges	$70
Subtotal plants	**$620**
Subtotal mulch	**$350**
Tool rental	
tool rental for 1/17	$340
tool rental for 2/21	$229
Subtotal for tool rental	**$569**
Subtotal for food	**$200**
Subtotal for transportation	**$100**
Project total	**$1,839**

Revenue by fund source	Dollar amount
Course fee allotment	$700
Cash donations	
by team members	$50
by neighborhood group	$179
Total cash donations	**$229**
In-kind donations	
tool rental waiver	$460
mulch	$350
food	$100
Total in kind donations	**$910**
Project total	**$1,839**

4. Other plans

As communication between the junior high teacher and Cotton Hill 1 has been minimal and the previous UW-REN students did not begin their work with her until the spring quarter, which is what she is anticipating this year, we are including a sketch as opposed to something set in stone. We are attaching two example lessons that could potentially be used with the students if they match with the unit they are studying. The lesson format is based on the curriculum instruction approaches, understanding by design and differentiated instruction.

These lessons integrate ecology, community, and language arts and after these introductory lessons, we believe that they would be ready to do an on-site restoration lesson.

These particular lessons were chosen because they encourage team building and classroom engagement, two characteristics of a class that are necessary in order to take them outside and maintain trust. These lessons are based in the ecology of the student's local environment, giving them a basis to begin to understand the purpose behind restoration efforts and incorporating Place-Based learning, a term David Sober has coined to reference educating students about their local environment.

Once we have had a chance to sit down with the teacher, we will have a better idea about the direction she wishes to go and lessons will be developed and utilized accordingly. Once the UWREN team and the teachers have decided on the appropriate lessons, they will be matched with the EARLS to ensure that the Washington State Science Standards are being met. As of now, we are including lessons that have taught in environmental programs over and over with students from 3rd-8th grade, which have proven to be successful as the students have participated and been engaged learners.

Lesson 1: Leaf in a Bag

Understanding:

Students develop senses other than sight to identify plants/trees located in their natural environment. In addition, they continue to develop skills in art and poetry, creating an interdisciplinary lesson where all students can feel successful.

Time: 1 hour

Materials: Enough plant/tree leaves and paper bags so that each student has one. Watercolor paper, watercolors or watercolor pencils, writing paper and a pencil.

Anticipatory Set:

Discuss with the students the idea of our senses and facilitate a conversation about which sense they use the most in their own lives. I like to point out that for myself, I rely on my sight more than any of my other senses, (after they have discussed their opinions). Explain that they are going to be doing a project that requires them to use their sense of touch rather than sight. Explain that they need to resist the urge to "peak" as it will ruin the essence of the assignment.

Lesson:

Give each student a paper bag with a leaf, twig or cone inside of it (pick things up from the ground as you enter the building). The more variety the better! The students should take some time to feel their object... you can put some "to think about" questions on the board for them to ponder or take notes about while they are exploring their object. Ask, "does your object have hard, prickly, soft edges, etc..." Does your object feel like it has veins?" "Is your object layered?" "Is your object attached to anything?" The questions are endless but their purpose is to require students to think about their object more deeply than they did as they walked into the building.

Instruct your students to draw an edge of their object on their scratch paper, (continuing to rely on their sense of touch alone). Have the students brainstorm words to describe their object (that will later be used in a poem/simile/analogy) so make sure to ask them to list at least 5 or 6 adjectives. With younger students I like to brainstorm what an adjective is on the board to ensure that everyone understands the directions. After they have sketched an edge of their object and listed description words, the unveiling of their object may finally occur. At this point ask your students to get their painting materials. They will need one sheet of watercolor paper and their watercolors. This is a perfect instance to discuss stewardship with your students. Ask them to make sure that their watercolors and their area looks as clean as they did when they began so that others can have just as joyful of an experience.

Once the students have completed their watercolor painting it is time for them to begin on their poem. You can choose for them to write a haiku, simile, metaphor, etc... whatever you happen to be studying in writing will lend itself wonderfully to this project! Have fun with it and if it is a beautiful day... take the students outside for the entire project and collect the materials before you leave the room. If not, just make sure to take them out after they have completed their writing so that they can have a chance to be a scientist and locate their plant.

Lesson 2: Web of Life

Understanding:

Students will gain a deeper understanding of the interconnections in nature and will begin to understand the meaning of interdependency.

Time: 30 minutes

Materials:

Enough bandannas for each student to have one.

Anticipatory Set:

This lesson is an amazing introductory or concluding activity when talking about the interconnections in nature and in life. It relates to the circle of life and really nails the hammer in the head, giving the students a tangible way to grasp the concept. Begin a discussion with the students surrounding things that are connected in nature. Draw a web on the board, allowing students to see their connections.

Lesson:

Have your students get into a circle (if your class is larger than 12 then they will be in two separate circles). Give them each a label that is something from nature, for example; water, river, black tailed deer, bald eagle, Chorus Tree Frog, Sphagnum Moss, etc... It is even more meaningful if the elements are specific to your region. Attach the labels to student's shirts either as a necklace with string or yarn or with tape. Give students a handkerchief and instruct them to hold it in their left hand. The only rules of the game are that they cannot connect handkerchiefs with the same person twice, they cannot connect handkerchiefs with a person that is directly beside them and once connected, they CANNOT, under any circumstances, let

go! (Do not forget to talk with your students about emotional and physical safety and continue to give the students reminders throughout the activity.)

Once the directions have been delivered... students may begin going around the circle holding their left hand (the hand holding the handkerchief) out to students whom they feel they are connected to. The sentence needs to sound like this, "I am a river and I am connected to the Chorus Tree Frog because I provide shelter and food." The Chorus Tree Frog proceeds to take the handkerchief from the river with her right hand and the students continue to go around the circle until everyone is holding a handkerchief in their right and left hands and it looks like a huge knotted mess. Now, tell the students to work together to become untangled! This can take anywhere from 5 minutes to 45 minutes depending on your group of students and depending on your group, you may want to continue to remind them about safety both emotionally and physically.

AD 14: The following pages will illustrate the actual lesson plan and activities that were used during out education activity with students from Kirkland Junior High. We conducted 2 class activities and 1 field day with activities such as planting, drawing, taking photographs as well as building eco-art.

Day 1:

Lesson Title: Nature's ABCs

Ally Shea
Maxine Luna

Overview: Students learn about the abiotic, biotic, and cultural parts of an ecosystem through a series of categorizing activities.
Vocabulary: abiotic, biotic, cultural, ecosystem, decomposer, producer, consumer

Introduction: What is restoration? PowerPoint
(15 minutes)

The Core Lesson: Give students a label with their new identity printed on it. Inform the students that they are not allowed to look at their own label; they must hold it to their forehead, facing out. On each label is something that is present in nature in a NW ecosystem. They will turn to their neighbor, and begin to ask yes or no questions (ONLY) to discover what their new identity is. (Ally and Maxine model.) Inform the students that they have 4 minutes to complete this activity. (Ally and Maxine circulate the room to identify the students who may be struggling. Help them form questions that will help them get closer to identification.)
(5 minutes)

After all students have identified their label, instructors place 10 more labels at each group's table. Instructors inform the students to take all 14 of their labels and place them into

categories, any categories that make sense to them. Inform the students that they have 5 minutes to complete this activity.
(5 minutes)

After students have their categories, ask students to share what their categories are and why they decided to categorize in that manner.
(5 minutes)

After students have shared, explain that scientists have their own way of categorizing things in nature. Instructor uses the document camera to show the ABC categories, (create smaller labels that will fit underneath the document camera). Ask students to make their labels look like the ones on the board. Give them blank labels to write the category names, abiotic, biotic, and cultural. (Give the students a worksheet so that they can copy their categories down.
(10 minutes)

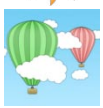
If time allows: Introduce another even smaller way to categorize the things that are present in nature. Introduce the terms producer, consumer, and decomposer. Take apart your newly formed categories and put your labels into these new categories and allow the students to do the same. After, give the students time to add the new categories to their worksheets.
(10 minutes)

Day 1 Worksheet:

Nature's ABCs _____

A _____ means _____


L _____


A _____


W _____


S _____

B _____ means _____

P _____

Some examples are: _____

C _____

Some examples are: _____

D _____

Some examples are: _____

C _____ means _____

Some examples are: _____

Day 2 Worksheet following lecture:

Names: _____

Plant Observations Worksheet

Species Name	Status	Characteristic Differences
Himalayan blackberry *(Rubus armeniacus)*	Non-native and Invasive	

Trailing blackberry *(Rubus ursinus)*	Native	
Salmonberry *(Rubus spectabilis)*	Native and can be Invasive	
Lady Fern *(Athyrium filix-femina)*	Native	
Oregon Grape *(Mahonia aquifolium)*	Native	
Japanese Knotweed *(Polygonum cuspidatum)*	Non-native and Invasive	

English ivy *(Hedera helix)*	Non-native and Invasive	
salal *(Gaultheria shallon)*	Native	
Indian plum *(Oemleria cerasiformis)*	Native	
Field horsetail *(Equistum arvense)*	Native can be Invasive	

IV. Work timeline

1) Proposed work timeline:

Task	Jan 1-14	Jan 15-29	Jan 30-Feb 12	Feb 13-Feb 27	Feb 28-Mar 14	Mar 14-28	Mar 29-Apr 12	Apr 13-Apr 27	Apr 28-May 12	May 13-27	May 28-Jun 11
1-1a: *R. armeniacus* removal											
1-1b: *H. helix* removal											
1-1c: *I. aquifolium* removal											
1-1d: *P.cuspidatum* removal											
1-1e: Spread mulch											
1-1f: Build hummocks											
1-2a: Plant shrubs in Polygon 1 and 3											
1-2b: Plant live stakes in Polygon 1 and 2											
1-3a: Plant ground cover											
1-3b: Plant intermediate layer											
1-3c: Plant trees											
2-1a: Remove invasive species											
2-1b: Spread mulch											
2-1c: Plant *A. circinatum*											
2-1d: Plant *C. sericea*											
2-1e: Plant *C. obnupta*											
2-2a: Establish stream bank with rocks											
2-2b: Create standing											

pools using rocks											
2-2c: Create standing pools using woody debris											
3-1a: Create signs											
3-2a: Design and build trail											
3-3a: Design habitat features											
3-3b: Construct brush and rock piles											
4-1a: Site evaluation											
4-1b: Determine threshold											
5-1a: Instruct volunteers											
5-2a: KJH activity planning											
5-2b: KJH activity											

2) Actual Work timeline

Task	Jan 15-29 Jan 17th	Jan 30-Feb 12	Feb 13-Feb 27	Feb 28-Mar 14 March 5	Mar 14-28 March 19	Mar 29-Apr 12	Apr 13-Apr 27 April 26th	Apr 28-May 12 May 7	May 13-27	May 28-Jun 11 June 3
1-1a: *R. armeniacus* removal										
1-1b: *H. helix* removal										
1-1c: *I. aquifolium* removal										
1-1d: *P.cuspidatum* removal	n/a									
1-1e: Spread mulch										
1-1f: Build hummocks										
1-2a: Plant shrubs in Polygon 1 ~~and~~ , 2 and 3										
1-2b: Plant live stakes in Polygon 1 and 2 and buffer										
1-3a: Plant ground cover										
1-3b: Plant intermediate layer										
1-3c: Plant trees										
2-1a: Remove invasive species										
2-1b: Spread mulch										
2-1c: Plant *A. circinatum*										
2-1d: Plant *C. sericea*										

2-1e: Plant *C. obnupta*										
2-2a: Establish stream bank with rocks										
~~2-2b: Create standing pools using rocks~~					—					
2-2c: Create ~~standing pools~~ weirs woody debris										
~~3-1a: Create signs~~							n/a			
3-2a: Design and build trail							n/a			
3-3a: Design habitat features										
~~3-3b: Construct brush and rock piles~~										
4-1a: Site evaluation										
4-1b: Determine threshold										
5-1a: Instruct volunteers										
5-2a: KJH activity planning										
5-2b: KJH activity										

Design for the Future

1. Stewardship Expectations and Development Plan

Karen Story, our community partner and head of the Highlands Park Association, has been a part of the Cotton Hill Project for many years now and has led capstone teams and volunteer groups in clearing invasive species, planting native species, building trails and addressing water quality concerns. She continues to work with the neighborhood and has a following through a mailing list that goes out to over 400 homes, an e-mail list that goes to over 700 community members, a blog that is widely read in addition to news put in the local paper. Many community members, including children and students at the high school look forward to her work parties and bring friends and food to share with others. As she has such a dedicated group of volunteers, Cotton Hill Team 1 is not worried about the maintenance of the site, though we will create an educational and stewardship brochure to inform the community how important a healthy ecosystem is and how crucial volunteer involvement is to ensure maintenance and monitoring will continue for years to come. We are dedicating our year to giving the site a solid foundation so that the volunteers are supporting the progress of the site as opposed to continuing to fight for a healthy ecosystem.

The solid foundation discussed above involves proper removal of invasive species, including painting the base of the removed holly trees with glyphosate and injecting the same material into the Japanese knotweed to prevent them from returning. Furthermore, we will be going beyond the border of the site in order to avoid encroachment and planting fast growing native shrubs to fight off invasive movement into the site. The proper planting of native species, taking into account the moisture, soil type and light availability, will give each plant its best chance at survival and growth. Proper mulching of the site, suffocating any invasive species that might have been left behind is essential to native plant health. Lastly, continuing the education and community outreach of the other Cotton Hill teams and Karen's efforts, in order to keep the neighbors involved and excited about what is happening at the site and educating children who have not yet been made aware.

As mentioned above we will continue to focus our energy on neighborhood partnership in maintenance and monitoring. We have also focused our energy on creating stimulating and engaging work parties, where all volunteers feel included and are happily busy. We have also made it a priority to make volunteers feel comfortable, we ask what invasive species they would prefer to remove, if they would like to stay dry or if they came to get muddy and check in regularly. We also had one group dedicated to young children, giving them the opportunity to make new friends while finding activities that would keep them interested in the project. Enthusiasm was high at our first work party and we will maintain that enthusiasm through our year, eventually passing the responsibility over to the community, a caring and dedicated group of people.

2.Project Design and Stewardship

Nature Deficit Disorder is a term that has been coined by Richard Louv that directly links the absence of nature in the lives of humans to the rise of obesity, diabetes, attention disorders, and depression. “A widening circle of researchers believes that the loss of natural habitat, or the disconnection from nature even when it is available, has enormous implications for human health... They say the quality of exposure to nature affects our health at an almost cellular level” (Louv 2006). If it is truly the case that we are affected in such a core shaking way, it is imperative that all neighborhoods have a piece of green space to call their own. Students and adults walk through Cotton Hill Park daily and our restoration efforts present an opportunity for them to learn just by watching the transformation and hopefully, they make a decision to be a part of that change.

The design of the site, while it is a natural space and we are planting native species that have the highest chance for success, is geared toward human enjoyment. Cotton Hill Team 1 has incorporated a meandering mulch trail that branches off of from the north to south gravel trail. It connects to Cotton Hill Team 2’s site, which gives the public an even longer trail to enjoy. At the end of the trail, we are incorporating a simple bench, allowing neighborhood citizens an escape from city life, if even for a moment.

Live stakes of species such as *C. sericea*, *S.lucida lasiandra*, *S. sitchensis* and C. *obnupta* will be planted for stream bank stabilization and to provide habitat and food for birds (KC Native Plant Guide, 2008). Other deciduous species to be planted such as red-flowering current, Indian plum and salmonberry will not only provide fruit for animals but shed their leaves in the autumn which will decompose and provide nutrients for the soil.

Coniferous trees such as *P. sitchensis*, *T. plicata*, *and T. heterophylla* will be planted in partial shade to provide canopy cover to promote the health of groundcover species such as sword fern as well as provide habitat and potential winter refuge for animals. Due to the invasive R. armeniacus encroaching on the back of polygon 1, we will plant *R. sanguineum*, *R. parviflorus*, *S. albus* and *P. capitatus* to create a natural hedge that will help reduce *the R. armeniacus* invasion. Our hope is that these species will successfully reduce the encroachment as well as provide berries for birds.

The combination of deciduous and coniferous species will not only provide food and habitat for animal species, organic leaf and pine matter for soil health, and the ability to help control invasive species but provide other ecosystem services such as air and water filtration. A healthy ecosystem is paramount and we believe that our selected native species will improve the health of our section of Cotton Hill Park as well as reconnect the neighborhood to natural habitat.

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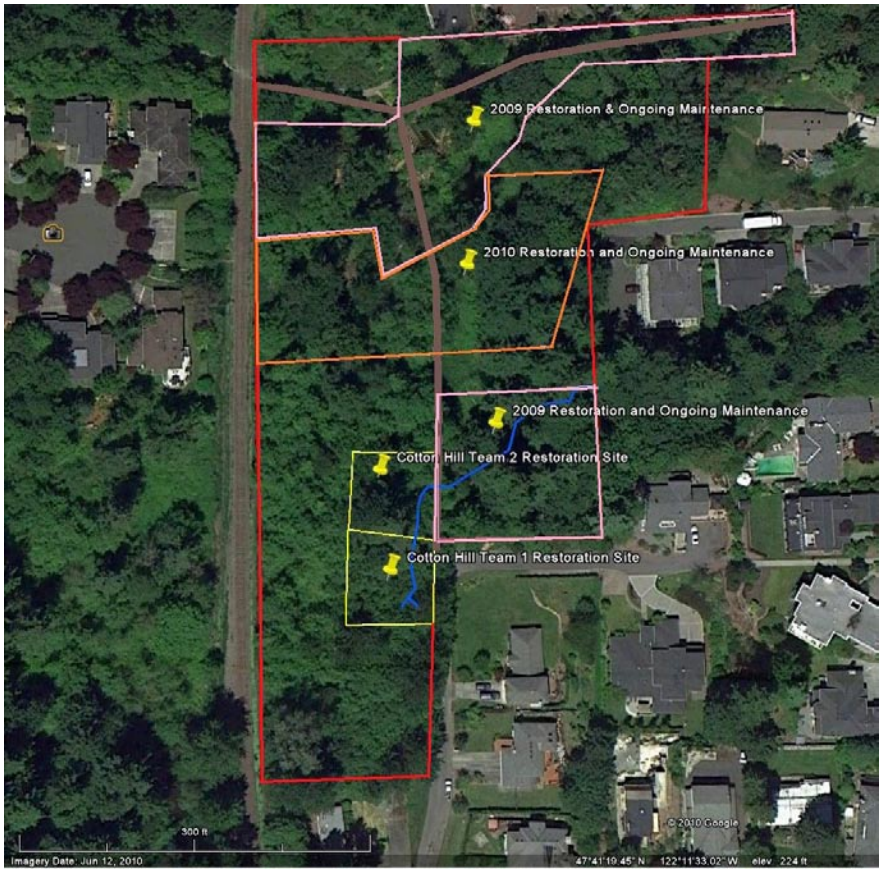
University of Washington Restoration Ecology Capstone
Cotton Hill Team 1 Stewardship Plan
2010-1011
Community Partner: Karen Story, Highlands Neighborhood Association and Sharon Rodman with the city of Kirkland



Aerial photograph of Cotton Hill Park in Kirkland, WA showing previously restored sites, ongoing maintenance as well as the current 2010-2011 Cotton Hill Team 1 and 2 sites.

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Ali Mainayar ~ UW Bothell ~ BS Environmental Science
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Project Description

Cotton Hill Park is an undeveloped, 4.1-acre natural area located within the Forbes Creek Watershed in Kirkland, Washington. The exact location is at the corner of 98th Street and 110th Avenue. The park is bordered on three sides (north, east, and south) by residential housing. The purpose of restoration, and our purpose for restoring this particular site, is to promote a more natural, mature, and structurally diverse forest by removing the invasive species present and by creating the most hospitable habitat for the species planted, increasing their possibility of survival. Pre- project site conditions were characterized by a degraded forest consisting of deciduous as well as evergreen trees with a dense understory of invasive species; including *R. armeniacus, H. helix, I. aquifolium, P. arundinacea,* and *P. cuspidatum*. Water that reached the site was partially blocked at the culvert located on the eastern border of the site, creating flooding in some areas and dry conditions in others.

The main goal of Cotton Hill Team 1's restoration efforts was to establish a native vegetation community that will thrive in a lowland forest ecosystem. Our approach to making this goal come to fruition included the removal of invasive species located within the site, in addition to removal just outside of the site, creating a buffer zone. The assemblage of a plant community was designed to deter reinvasion of non-native species. An intermediate layer of fast growing shrubs will form thickets and will shade out invasive species while providing erosion control. An additional approach designed to deter and shade out invasive re-growth included the planting of vegetation that thrives in wet soil conditions and that will have the highest rate of survival on this seasonally saturated site. The planting of select ground cover, intermediate layer, and potential canopy cover species were aimed at enhancing vertical and horizontal structural complexity, which is needed in order to increase habitat diversity.

The second goal was aimed at promoting a healthy wetland environment by improving stream hydraulics. The planting of vegetation adapted to extremely moist conditions with fibrous roots is needed in order to minimize erosion. Species for this purpose include *A. circinatum* for bank establishment*, C. sericea* for erosion prevention,

and *C. obnupta* for sediment retention. Furthermore, the integration of rocks and logs is required to create weirs in the stream channel to create a cascading appearance and to prevent movement of sediment.

The third goal involved the incorporation of hardscape features in order to foster an enhanced understanding of the connection between humans and nature as well as provide an access path for maintenance purposes. Hardscape features include the design of habitat features in the form of brush piles and carved cavities in order to attract wildlife. The access path is raised and will allow access to the backside of the site year round, also giving volunteers an advantage while monitoring the site's progress.

Evaluation of the restored ecosystem can be achieved through the use of a conceptual framework laid out according to the Society for Ecological Restoration attributes of a restored ecosystem. Furthermore, the creation of a list of plants is required for installation purposes as the restored plant community develops and appropriate additions or changes are needed. The species listed will need to be considered for their shade and moisture tolerance, in addition to their ability to persist in the clay soil that is present on the site. Moreover, selected species must set the stage for current as well as future seral stages of succession, selected species must satisfy the expected level of maintenance that can be provided, and it must satisfy restoration goals and objectives (Gold, In-class lectures, Nov 2010).

The fifth goal requires the support of community involvement and the encouragement of volunteer participation. This goal involves the planning, instruction, and supervision of volunteer parties that facilitate restoration. In addition to work parties, Cotton Hill Team 1 has collaborated with Kirkland Junior high teachers who have showed an interest in the restoration project. We created classroom presentations, hands-on activities, and field trip opportunities, incorporating species identification, natural art, and data gathering with the help of Cotton Hill team 2. These activities allowed the students to continue their classroom learning in an authentic manner, while maintaining focus on WA state standards. These actions will foster long-term stewardship initiatives for Cotton Hill Park and the students we worked with.

Cotton Hill Park has become an integral part of the Green Kirkland Partnership's 20-year forest restoration plan and is utilized by children, adults, pets, and wildlife. The park space, in addition to the connecting Crestwood Park area, provides the public with rare "wild" spaces in an urban setting. Ongoing restoration and management initiatives are imperative for the preservation of these areas for future generations to enjoy.

Post-Installation Site Description

The site has been divided into 3 polygons based on the type of vegetation that occurs in each division. Polygon 1 is a lowland forest vegetation community, polygon 2 is typical of western Washington wetland vegetation, and polygon 3 was dominated with invasive plants.

The site has been separated into three polygons based upon soil and light availability (~290m^2). Polygon 1 begins at the northeast corner indicated by the signpost from the City of Kirkland. The polygon extends westward until reaching the raised clay soil. The southern border of the polygon is between the drainage pipe along the street and the *Acer macrophyllum* (Big leaf maple). This border extends westward to the raised clay soil as well. It is the largest of the three polygons. Previously, this polygon was covered with *R. armeniacus*, *H. helix*, and a few *I. aquifolium* trees. These invasive species were removed and the whole area was heavily mulched. This polygon has the most canopy cover due to three *Pseudotsuga menziesii* (Douglas-fir). The eastern area of the polygon has a small stream running through it, which keeps the soil around this area saturated year round. This area also floods annually during the rainy season. *C. obnupta* was planted along the stream banks to control erosion and create animal habitat. Stakes of *C. sericea* and *Salix lucida* (Pacific willow) were installed between the stream and the street for visual aesthetics as well as to stabilize the stream bank. Patches of *Athryium filix-femina* (Lady fern) have begun to emerge through the mulch in the eastern portion of polygon 1 along both stream banks.

Toward the western half of polygon 1, there is a 15-20% slope. The higher areas of this polygon are where the majority of the coniferous species were planted. Between the *P. menziessii* trees we brought in nutrient rich soil and built a hummock. The

hummock will enable species to establish that would not be able to otherwise, as they cannot tolerate a large amount of moisture in the soil in their younger years. Within the hummock, young *Tsuga heterophylla* (Western hemlock), *P. menziesii*, *A. circinatum*, *Thuja plicata* (Western red cedar) and *Taxus brevifolia* (Pacific yew) were planted. This hummock receives a fair amount of sunlight. Plants were selected to create vertical complexities to form new habitats and to shade out any lingering *R*. *armeniacus* Along the western edge of polygon 1, *Rubus parviflorus* (Thimbleberry) and *Lonicera involucrate* (Twinberry) were planted to compete with any *R. armeniacus* encroachment that could occur. Soil in this area of the polygon is very claylike. A small damp drainage stream runs only when there are heavy rains, although it can be very moist year round. *Spirea douglasii* (Hardhack) was planted within the moistened drainage area with a limited amount of sun throughout the day.

The southern boundary of the polygon is side by side a swamp like ecosystem that is wet annually. Species were planted along this border that can handle a small amount of flooding. In addition, *Rosa pisocarpa* (Swamprose) was installed along the edge to establish a strong root system. The species that were selected to live in the potential flood conditions were *L. involucrate*, *Oemleria cerasiformis* (Indian plum), and *Fraxinus latifolia* (Oregon ash). These species were planted along the entire edge of polygon 1, reaching from the western boundary to the stream's edge. Proceeding north from the southern edge of polygon 1, ground cover plants were planted to attract pollinators and to provide shelter for organisms. Species within this area include *Trllima grandiflora* (Fringe cup), *Tolmiea menziesii* (Piggyback plant), and *Arnucus dioicus* (Goatsbeard). The two stumps that reside within polygon 1 were mimicked to have features growing within the trunk as would a natural occurring stump in nature. *Vaccinium parvifolium* (Red huckleberry) was installed within each stump.

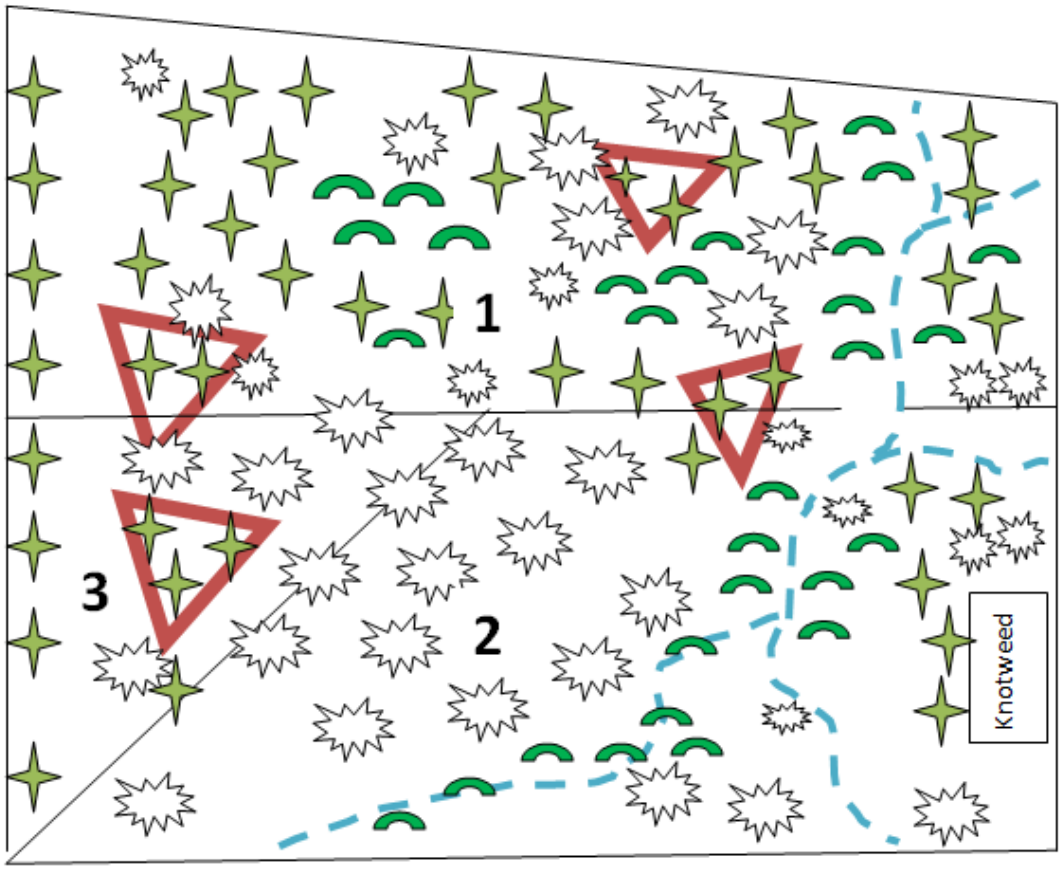
Polygon 2 extends westward from the street, where a patch of young *P. cuspidatum* has made a home, to where the second stream ends. Polygon 2 measures the second largest of our three polygons (~270m^2). From there, the boundary for polygon 2 extends northeast toward the large *A. macrophyllum* tree. Polygon 2 was

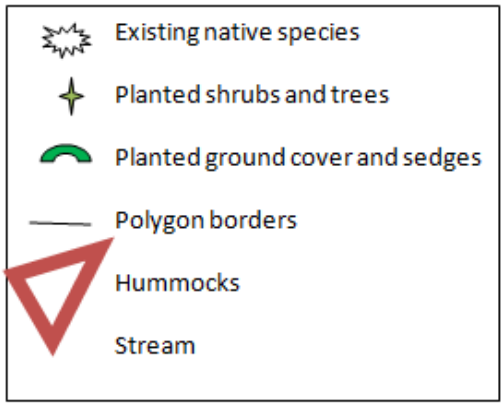
covered in patches by *R. armeniacus* and *H. helix* along the southwestern corner. All of the above- ground and belowground *R. armeniacus* and *H. helix* biomass were removed from the polygon. After removal, large thickets of *Rubus spectablis* (Salmonberry) and *O. cerasiformis* were exposed. Natural occurring *Lysichiton americanus* (Skunk cabbage) covers polygon 2 and seems to be multiplying daily. The soil in all of polygon 2 is sandy. Before cleanup in polygon 2 began, the polygon was one moist mudflat. Post cleanup, the removal of a tire, which had been blocking the stream's drainage, gave the stream shape and allowed most of the standing water from the area to drain. Along the western stream on both banks, *C. obnupta* was planted to maintain stream form and to allow fibrous roots to grow, which will maintain soil stability. Along with the slough sedge, *R. pisocarpa* was planted within the thickets to allow for root system growth and deter erosion. Polygon 2 exhibits many naturally occurring native species, which were not planted. Thickets of *O. cerasiformis*, *Pteridium aquilinum* (Bracken fern), and *A. felix-femina* have established themselves in great quantities. A major encouraging feature of this polygon is the stream system that supports native plant growth.

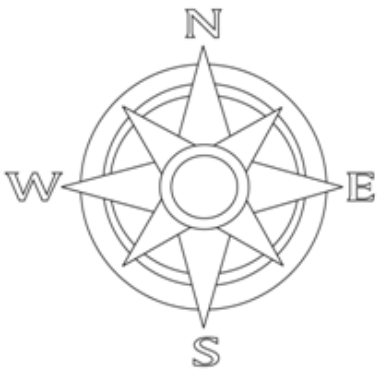
Polygon 3's boundary extends diagonally from the southwestern corner of polygon 2 towards the large *A. macrophyllum* tree. From the maple tree, the polygon extends westward until just past the raised, clay like soil. Polygon 3 is the smallest of our three polygons (~40m²). Prior to invasive removal, polygon 3's cover was 100% *R. armeniacus*. The *R. armeniacus* was removed and the polygon was heavily mulched. Polygon 3 features partial gaps in the canopy, which allows sunlight to reach the forest floor. This polygon has large stands of *Alnus rubra* (Red alder) trees already established in the area. Along the polygon's western edge, species were planted to deter the re-growth of *R. armeniacus*. Species planted along the western edge for this purpose were *R. parviflorus*, *A. circinatum*, *O. cersiformis* and *Rhamnus purshiana* (Cascara). Within the polygon, two raised hummocks were installed to give species a better chance of survival while establishing themselves in the ecosystem. Plants within these hummocks include *T. heterophylla*, *P. menziesii*, *T. brevifolia*, *Rohdodendron macrophyllum* pacific rhododendron and *Abies granis* (grand fir).

Beyond the western boundary of the site stakes of *S. lucida* were installed. The purpose for this was to establish a shade canopy as quickly as possible to inhibit the growth of *R. armeniacus*. Prior to removal, the entire area was covered with *R. armeniacus*. There is still a thick wall of *R. armeniacus* that remains further west and our intention is to hinder its movement back onto our site.

As-Built Map


1
2
3
Knotweed


Existing native species
Planted shrubs and trees
Planted ground cover and sedges
Polygon borders
Hummocks
Stream


N
W
E
S

Maintenance Plan

Through community outreach, volunteers from the Highlands neighborhood of Kirkland will learn about and understand the value and importance of urban restoration projects. Cotton Hill Team 1's site will require a dedicated group of volunteers and stewards to maintain the urban lowland forest-wetland ecosystem, February thru September of each year. During these months, stewards will work to control and remove invasive species, maintain hardscape features, and provide basic plant care such as watering and replacing dead natives with new ones. It is critical to locate a group of volunteers that understand the structure and dynamics of the ecosystem and who are eager to make a difference in their community. Maintaining Cotton Hill 1 will not only enable volunteers to become ecosystem stewards but also provide critical habitat for local flora and fauna and increase biodiversity in an urban setting. These volunteers will need to have time and either a skill set or willingness to develop a skill set surrounding ecology and restoration. It will be essential to the success of the project that they are dedicated individuals, willing to take on challenges and celebrate small successes.

Plant Care

Watering

Why: It is important to keep plants as moist as possible while they are immature to encourage healthy growth.

Where: Polygon 3 is the driest polygon on site, followed by polygon 1, and lastly polygon 2. It is important to ensure that plants, especially in polygon 3, stay moist and healthy to prevent the encroachment of invasive *R. armeniacus* on site. Hummocks in all three polygons will also need to be checked for appropriate moisture levels as they are elevated and may not retain water in the way that the clay soil does.

When: In the warm, dry, summer months of June through September. Two volunteers should assess the site by checking the hummocks especially for moisture level once every two weeks. If the hummocks are

visibly dry watering will be necessary. If there is a hot spell once a week may be required.

Resources & tools: The stream on site will provide water. Two buckets are needed, one for each volunteer.

How: Volunteers will assess polygon 3 and the hummocks for moisture. The season and plant species will determine how much water is needed. More water will be needed in the summer and fall and less in the winter and spring. Depending upon the season and species' needs, pour water from the stream at the base of the species' stem. Avoid pouring water over the whole plant, as this will likely damage its structure.

Plant Replacement

Why: While plant mortality is inevitable, replacing those that do not survive at the onset will maintain ecosystem diversity on site and continue to provide habitat for wildlife.

Where: Polygons 1, 2, and 3 with special attention to the hummocks as they may become dry too easily.

When: Once a year in March and/or April when native plants in nurseries become available.

Resources & tools: Gloves, shovels, labeling tape, Sharpie pen, and a wheelbarrow to transport live and dead plants.

How: Inventory the site and note what species did not survive. Order the same species if available. If the same species are not available, order a species appropriate for that particular area on site with moisture and light levels in mind. If there is high mortality of a specific species, assess the reasons for mortality and order a different species suitable for the particular area on site as long as that species meets said restoration goals.

Invasive Control

Removal

Why: Removing invasive species such as *R. armeniacus*, *H. helix*, and *P. cuspidatum* will decrease plant mortality by allowing natives appropriate access to sunlight, water, and space.

Where: At the back of polygon 3 where *R. armeniacus* will encroach as well as polygons 1 and 2 where blackberry has been removed previously. *P. cuspidatum* will be found along the East border of polygons 1 and 2 adjacent to 110th Ave NE. Monitor the southwest corner of polygon 2 near the swamp as invasive *I. aquifolium* has been removed there before. Monitor polygons 1,2, and 3 for *H. helix* as it has been found and removed from all three locations.

When: March thru September as necessary.

Resources & tools: Gloves, shovels, buckets, and pruners. Use the buckets to hold plants that have been removed. Gloves and a shovel are required to dig up *R. armeniacus* and gloves and pruners can be used to remove *H. helix* and *I. aquifolium*. *P. cuspidatum* will need to be injected with glyphosate by the City of Kirkland during the summer.

How: To remove *R. armeniacus* dig up as much as the plant structure as possible. If the plant is immature, less than one foot, you may be able to pull it out of the ground with your hands. If not, dig it out with a shovel and remove as much of the root system as possible. This will help prevent future growth and spread. If the stem is tall, use pruners to cut it to a reasonable height then use the shovel to dig it up. Small *I. aquifolium* plants can be pulled out or dug up when the soil is moist (kingcounty.gov). If *H. helix* is growing on the ground you can pull or dig out the plant (kingcounty.gov). If the *H. helix* is growing up a tree on site, cut and remove the vines growing around the tree in a life-saver shape. This will cause the vines above the cut to die. Vines below the cut will

need to be removed by pulling or digging (kingcounty.gov). Try to remove as much of the root system as possible.

Mulching

Why: Mulching helps prevent the growth and spread of invasive species as well as retains moisture and warmth for immature, native plants.

Where: Throughout polygons 1, 2, and 3.

When: In the springtime when invasive species have been removed and native species have been planted.

Resources & tools: Gloves, shovels, rakes, buckets, and wheelbarrows are needed. Give as much notification as possible to Karen Story, at least two weeks, for her to order mulch.

How: Using a bucket or wheelbarrow to haul, spread the mulch that the City of Kirkland provides with a rake to about 15 cm thick throughout all three polygons. Areas that are especially saturated with water may require more than 15 cm. These areas include the stream bank in polygons 1 and 2 and the dip in the maintenance trail in polygon 1. When placing mulch around newly planted species, remember to create a doughnut shape in order to keep the roots of the plant warm and moist.

Hardscape Features

Maintenance Path

Why: It is important to maintain the trail to ensure a clear access path to all polygons by removing debris so materials can be transported throughout the site. The path also deters volunteers from accessing the site by way of walking through or jumping over the stream, which damages wetland plants and the streams' structure.

Where: Polygons 1 and 3.

When: In February before volunteers begin to work on site.

Resources & tools: Gloves and a wheelbarrow or buckets and rake.

How: Spread mulch on entire path about 15 cm thick. Rake the mulch so the trail is fairly even. More may need to be applied in polygon 1 where the dip is as this area tends to become saturated. If the tree limbs that serve as the paths border rot, replace as necessary. If a tree or limb is down it may be necessary to contact the City of Kirkland for safe removal.

Hummocks

Why: Hummocks serve as elevated mounds to provide a more suitable habitat for plant species. It is important to replace tree limbs that border the hummock as necessary for aesthetic purposes and to preserve the structure of the mound.

Where: Polygons 1, 2, and 3.

When: In February when the maintenance path is cleared and mulched. New tree limbs for the hummock borders can be brought in at the same time those for the path are.

Resources & tools: Gloves and a wheelbarrow to transport limbs.

How: Carefully bring down limbs found in the park and place them around the border of the hummock in a triangular shape while maintaining stability of the soil in the hummock.

Storm Pipe Clean Up

Why: To ensure adequate stream flow, it is important to keep the mouth of the pipe free of debris and root masses.

Where: Polygon 2, adjacent to 110th Ave NE.

When: Twice a year, in March and May, and whenever blockage occurs.

Resources & tools: Gloves, rain boots, and a small hatchet.

How: To remove roots, use a small hatchet to chop at them. Standing in the water flow and pulling them may also be necessary. Remove as much of the root mass as you can, as they tend to grow back quickly. Remove any twigs and leaf matter from the drainage path and place elsewhere on

the site. Be sure the drainage path to the stream is clear of any other debris such as litter.

Community Outreach

Maintenance Work Parties

Why: Volunteer work parties are essential for site maintenance, education purposes, and to keep the Highlands neighborhood interested in Cotton Hill Park's ecosystem.

Where: Polygons 1, 2, and 3.

When: Two or three times a year especially on MLK Day and Earth Day.

Resources & tools: Tools from the Kirkland Parks Department and rain boots.

How: Karen Story and Sharon Rodman with the Highlands Neighborhood Association will recruit volunteers through their volunteer database. Before volunteers arrive on-site they must sign in and then sign out upon departure.

Maintenance Timetable

Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Watering						x	x	x	x			
Plant Replacement			x	x								
Invasive Removal			x	x	x	x	x	x	x			
Mulching			x		x							
Maintenance Path		x										
Hummocks		x										
Work Parties	x		x	x								

Monitoring Methods

Method 1

In order to ensure that the vegetation composition of the Cotton Hill site 1 will thrive to develop into a lowland forest ecosystem, active monitoring will have to be performed on the growth of both native and invasive species found on the site. Monitoring forms including a vegetation assessment made available in the Appendices. Appendix C illustrates the layout of the monitoring plots established on site for the purpose of assessing vegetation development over time. There are two (4m-x4m) monitoring plots situated in Polygon 1 and one (4m-x4m) monitoring plots in both Polygon 2 and 3. The monitoring plots have been marked on the site using flags and were placed in a location that comprises a representative sample of canopy coverage, understory species as well as groundcover species. Monitoring forms are made available in the appendix so that the survival and development of both native and invasive species can be recorded and accurate data will be represented. In addition, photo points have been included so that the visual estimate of growth performed during future monitoring can be compared to a baseline. The photo points are located at the corner of all three polygons, as well as the center of the site in order to provide an accurate view of the present vegetation. The photo points were marked using wooden stakes painted with bright green paint.

In order for a complex native landscape to thrive, invasive species will have to be controlled, especially during the early stages of native vegetation development (Objective 1.1, Appendix D). As far as our specific site is concerned, the invasive species that have been removed prior to the mulch application and planting were: *R. armeniacus*, *I. aquifolium* and *H. helix*. The only invasive species that was left pending removal is *P. cuspidatum*, which is currently present on the site but will be removed with help from the City of Kirkland this coming August (Story, personal communication, 2011). Monitoring the invasive species will be critical for the survival of the native species that were recently installed.

a) ***R. armeniacus*** growth should be monitored using visual measurement and comparison to the site assessment performed at the end of the plant installation and illustrated in the photo points that can be found in the Appendix A. If the invasive has returned on site and it covers over 5 % of the 4m-x4m sampling plots or surrounding areas removal of both the above- and below-ground biomass is advised. After removal, a 6 in layer of mulch should be applied.

b) ***I. aquifolium*** growth needs to be visually evaluated in each of the four (4m-x4m) sampling plots and compared to the vegetation site assessment conducted at the end of the plant installation, as well with the photo points that can be found in Appendix C. If the coverage is estimated to be greater than 5% of each sampling plot or adjacent areas, the plant should be cut and treated with a glyphosate application.

c) ***H. helix*** growth must be visually assessed in all four of the sampling plots in the spring following the completion of the restoration project. The visual estimate must be compared to the vegetation site assessment performed at the end of the plant installation. If the *H. helix* present on site takes up more than 25% of each of the four sampling plots, removal is required as well as application of mulch.

d) ***P. cuspidatum*** is indicated as a separate monitoring plot on the Appendix C map. This plot contains over 85% *P. cuspidatum* and removal by application of glyphosate solution is pending. The treatment will be performed by the City of Kirkland. This plant is particularly difficult to control due to its fast regeneration. Visual monitoring should be performed and new growth should be suppressed as soon as possible.

The native vegetation installed on site will require monitoring in order to thrive and eventually out-compete invasive species. In the long run it will lead to a more diverse

habitat structure for wildlife (Objective 1.3, Appendix D). The sampling plots that have been established on site contain groundcover and under-story species that have been installed. The monitoring forms attached in Appendix A contain information on the survival of these species as well as the type of coverage that is provided. These monitoring forms should be used for the assessment of the site in the spring following the plant installation. Appendix B also contains a list of all plants installed on site and the abbreviations used in the monitoring forms. Appendix G features a blank form that should be used for monitoring purposes.

a) Canopy species

The survival of coniferous species such as *T. heterophylla*, *T. plicata, T. brevifolia, P. menziesii*, *A. grandis*, *Picea sitchensis as* well as *F. latifolia*, *R. purshiana* and should be monitored using the forms attached as Appendix A and compared to the site assessment performed at the end of the plant installation. Most of these species were planted in hummocks that are included in the sampling plots. The monitoring assessment should be performed by counting both the dead and living individuals and recording them using the forms provided. The survival rates are expected to be around 90%, but some species will be more successful than the other based on their tolerance (Harrington, 2006).

b) Intermediate layer species

The survival of intermediate layer species is vital for suppressing the invasive species but also to enhance both vertical and horizontal diversity of the vegetation present on site. The shrub species that were installed such as *L. involucrata*, *O. cerasiformis, Symphoricarpus albus R. spectabilis, R. macrophyllum, R. pisocarpa, R. parviflorus*, *C. sericea*, *Holodiscus discolor* and *S. douglasii* should be monitored by taking a count of both dead and living individuals in the spring following the completion of the project and compare the rates with the ones from the vegetation assessment performed after the plant installation. The rate of survival after the first year following plant installation should be over 80% (Chan, 2006).

c) Groundcover species

Most of the groundcover species such as *E. arvense*, *Polystichum munitum, L. americanus*, *and A. filix-femina* found on site are native to the site and emerged after the removal of invasive species. However, species such *P. munitum*, *A. filix-femina*, *Carex obnupta* and *Dicentra spectabilis* have been installed. Groundcover species are prone to lower survival rates due to on-site traffic created during maintenance, herbivory and lack of light. The survival of the groundcover species should be monitored by counting the dead and living individuals using the 4m-x4m monitoring plots and survey forms found in Appendix A and photo points from Appendix C as a reference. Many of these species are seasonal so the assessment should be performed during spring time for comprehensive data collection.

Method 2

To facilitate stream hydraulic improvement, riparian adapt vegetation has been planted along the stream bankfull area (see Appendix D objective 2.1). River rocks, as well as, log weirs were placed as a preventative for sediment travel (see Appendix D objective 2.2). The success of meeting goal two will require monitoring of vegetation health. Furthermore, watching that weirs have not been removed or that overflowing of the stream beyond natural occurrence is not happening is also necessary. This is important because; functional landscapes have the capacity to capture high proportions of rainwater by the process of infiltration, because they typically have a high density and cover of vegetation that obstructs, contorts, and slows down overland flows (Tongway et al. 2011). Dense vegetation allows more time for water to soak or infiltrate into the soil and for trapping the litter and the sediments and nutrients often carried in runoff (Tongway et al. 2011).

To monitor vegetation around the stream a, in person, on the ground approach is ideal. Appendix C: Map of Monitoring Plots and Photo Points, describes where photo points beneficial to stream and stream area vegetation monitoring are. Photo points 1, 2, and 3 incorporate the stream and can be used as part of a continuum for landscape functionality. This is also an important diagnostic tool for comparing and contrasting successional site conditions. Keep in mind these photos were taken April 24, 2011 so

seasonal changes can make a dramatic difference in how things appear when comparing future photos. You have been provided these photos at the end of this document; we recommend that you add to these photos by taking new pictures from the corresponding spring photo points every season. On site, lime green wooden stakes have been placed in the ground as permanent fixed photo monitoring points; these stakes are fluid with Appendix: C. The groundcover vegetation planted along the stream is to be monitored on a yearly basis by using a percent coverage schema. Currently there is ~5% ground cover of installed *C. obnupta*, ~10% existing native *P. munitum* and ~5% *E. arvense*. By year 4 you should see ~80-90% groundcover from the overall installed and pre-existing vegetation. Percent coverage schema is administered by visually assessing the percent of species presently covering the area and using increments of 5%. Appendix A can be used as a baseline for estimating coverage, as well as, the map in Appendix C that formulates were the permanent monitoring sites are. However, some mortality is possible. If this occurs replanting of the above-mentioned species may be necessary.

Method 3

Monitoring of the maintenance trail and wildlife habitat features will support goal 3 objectives 3.1 and 3.2 (see Appendix D). The trail needs to be monitored for safety issues and for environmental impact. If you should decide to minimize use of the trail or close the trail completely, suggestions for doing so are mentioned further down the document. A part of restoring a wetland site is not only providing for successful plant growth, but also making the area inviting for wildlife. Not only is this aesthetically pleasing, providing an educational opportunity for nearby schools, but also native biotic and abiotic organisms are important in the grand scheme of a fully functioning ecosystem.

Photo points 5, 7, 9 and 10 incorporate the maintenance access/educational trail (also available in Appendix: C). On site, lime green wooden stakes have been placed in the ground as permanent fixed photo monitoring points; these stakes are fluid with Appendix: C. Stakes are a valuable tool for assessing the trails post installation

conditions along with monitoring for changing conditions over time. However, keep in mind that these photos were taken April 24, 2011, so seasonal changes can make a dramatic difference in how things appear in the photo. You have been provided these photos at the end of this document; we recommend that you add to these photos by taking new pictures from the corresponding, spring photo points, every season. The National Trails Training Stewardship program recommends photo monitoring while applying the below descriptive characteristics as a method of ranking and defining trail condition (Marion 2008).

Class 0: Trail barely distinguishable; no or minimal disturbance of vegetation and/or organic litter.
Class 1: Trail distinguishable; slight loss of vegetation cover and/or minimal disturbance of organic litter.
Class 2: Trail obvious; vegetation cover lost and/or organic litter pulverized in primary use areas.
Class 3: Vegetation cover lost and/or organic litter pulverized within the center of the tread, some bare soil exposed.
Class 4: Nearly complete or total loss of vegetation cover and organic litter within the tread, bare soil widespread.

discourage or encourage use and maintain the trail. Estimate how intact the trail is compared to the baseline data of the original conditions of installment. A score class of 0 – 1 requires no immediate response. A score class of 2 – 3 needs attention, a new layer of bark mulch should be applied at least 20 cm deep. If the score class ranks 4 – 5 the trail needs to be closed and either rebuilt with soil and mulch or naturalized. See monitoring form Appendix A.

To inhibit the use or close the trail by actions that naturalize and hide tread disturbance, particularly along initial visible sections where visitors make the decision to venture down them; effective actions include raking organic debris such as leaves onto the path, along with randomly placed rocks, gravel, and woody debris from the site to naturalize and hide the trail (Marion 2008). These actions also lesson soil erosion and speed natural recovery. When the trail has been effectively closed, transplanting plugs of vegetation at the beginning of wet seasons can hasten natural recovery (Marion 2008). It is ill advised to re-vegetate the path before successful closure is accomplished, if visitors continue use of the trail and trample the transplanted vegetation, valuable money and time may be lost.

In monitoring wildlife habitat, plenty of down woody debris and snags are essential. The pools created by the log weirs and rocks will create ideal amphibian habitat. Following the methods above for monitoring weirs will simultaneously ensure habitat. Installed habitat elements (down woody debris and large stumps) should remain 90% intact at a minimum. Estimate how intact features are compared to baseline data on original conditions of installed habitat features.

The onsite stream flows year round and because it is in an urban environment, it is susceptible to dynamic fluctuations. According to Anoka Natural Resources (2011), streams with a highly urbanized watershed will typically have a "flashy" hydrograph, rising quickly and intensely in response to rain and then receding just as quickly. A stream with a less urbanized watershed would likely respond more gradually and have lower maximum water levels. Monitoring will include checking stream conditions after a heavy rain event. If the weirs are displaced from a “flash” event or from human misconduct, it may need to be reinstalled. The U.S. Geological Survey recommends installing the weir by pushing it down into the streambed. A shovel or pick may be necessary in order to remove stones and debris from the area the weir will be placed (USGS 2008). A level can be used to insure that the weir is being placed appropriately. Simply place the level on top of the weir, length wise, and push down on the weir until it is at a level state. Soil or streambed material should be utilized to avert seepage around or under it (USGS 2008). With the weir properly in place, a small pool should form upstream and a slight cascading of the stream over the weir should be present.

(There is not a method 4 as it simply stated that we would develop a maintenance plan.)

Method 5

The long-term success of this site will highly rely on the community participation. Volunteer participation should be monitored using the sign-up sheets during the maintenance/ planting parties (Objective 5.1, Appendix D) Previous work parties have had up to 60 volunteers in attendance. Granted, volunteers were split between Cotton Hill 1 and Cotton Hill 2 teams. Volunteers could also be asked for feedback and input. Maintenance parties should contain instructions that emphasize the importance of

invasive removal, mulching and plant re-installment. Planting parties also need to have an inviting feel to both returning volunteers and newcomers.

Kirkland Junior High can continue to conduct fieldtrips to our site and ideally bring back students that were involved in the planting event so that they get a feel of the progress that the site has made over the years. The lesson plans that we came up with could be used in the future with other generations. Activities such as plant identification, photography, drawings and eco-art using resources found on site could be part of organized field trips to our site. Education related activities could also promote volunteer awareness and involvement. (Objective 5.2, Appendix D)

Long-Term Site Management Plan

<u>Goal 1:</u> Establish a diverse native vegetation community that will thrive in a lowland forest ecosystem.

The long-term vision for the successional trajectory of our site is to establish an ecological community that represents evergreen and deciduous ecosystems comparable to select portions of St. Edwards Park in Kenmore, WA. The vegetation setting of St. Edwards Park includes evergreen and deciduous ecosystems that encompass associations of *P. trichocarpa, A. rubra, A. macrophyllum, R. spectablis* ,and *P. menziesii* (Smith, 2006). Native vegetation planted on our site is adaptable to low aeration and high water content soil conditions; therefore, successional planting events need to incorporate native species that are adaptable to the unique soil and moisture conditions of the site. Long-term site management requires the adoption of an adaptive management framework in order to facilitate the development of a structurally diverse setting that will in turn, beget an increase in overall biodiversity. Initial plantings of *P. menziesii* and *P. sitchensis* trees will reach an approximate diameter of 6’ – 8’ while *T. plicata* and *T. heterophylla* trees will reach an approximate diameter of 3’ – 6’ in diameter after 10 years (R. Pond, personal comm.). Moreover, trees planted in polygon 3 and at the western border of polygon 1 on our site will tend to spread out due to space availability, while trees planted in polygon 2 and the remainder of polygon 1 will

invest in vertical growth due to lack of space availability after a 10 year period (R. Pond, personal comm.).

The creation of a diverse and structurally complex native vegetation community relevant to a lowland forest ecosystem will require thinning and successional planting procedures. Thinning is an effective strategy aimed at accelerating succession through the removal of trees in dominant lower crown classes in order to open the forest canopy and thereby allowing ambient light to reach the forest floor (Chan et al, 2006). Thinning procedures promote the growth of understory vegetation as well as natural tree regeneration of *P. menziesii*, *T. heterophylla*, and *A. rubra* due by diminishing competition for light resources. Our Cotton Hill site would require light targeted thinning at 10 year intervals in order to maintain live-tree crown ratios (LCR), as the entire park is relatively small – 1.91 acres (Chan et al, 2006). Light thinning is defined as ~ 250 trees/ha left on a particular stand (Chan et al, 2006).

The person responsible must tag all overstory trees before thinning. Trees less than 6" in diameter can be removed with a bow saw (Christopherson, 2006). Clear an area of about 2 m in diameter around overstory conifers for thinning purposes (Chalker-Scott, 2011). Thinning on the Cotton Hill 1 site should be focused on central areas in polygons 1 and 2 as the live *C. sericea* and *S. lucida* stakes on the western border of polygons 2 and 3 are designed to act as a barrier for *R. armeniacus* invasion.

One detrimental side-effect of thinning is that it increases the re-establishment of invasive plants due to increased light availability (Chan et al, 2006). However, this side-effect is dependent upon method and timing of thinning. Invasive removal and monitoring should therefore persist as a long-term management strategy initiative. Exotic invasion can obstruct the development of native old-growth understory plant communities (Chan et al, 2006). Moreover, thinning can increase a stand's vulnerability as some overstory trees may succumb to storm damage.

Survival rate of conifer seedlings in mature, un-thinned stands is very low. Most P. menziessii seedlings die off within the first year and 95% of T. heterophylla seedlings succumb to mortality within 4 years (Chan et al, 2006). New tree saplings increase

structural diversity as it adds another dense vertical vegetation layer between tall woody shrubs and large overstory canopy trees. Moreover, shrub and herbaceous cover initially decreases after thinning; however, long-term (8 years) response to thinning is positive, as shrub height increases by ~0.2m and species richness increase from 11 to ~ 18 species (Chan et al, 2006).

Successional planting of *P. menziesii*, *G. shallon*, *H. discolor*, *P. lewisii* , *R. sanguineum*, and *R. nutkana* saplings can occur in thinning areas (central portions of polygons 1 and 2) as these species require significant light resources for growth. Successional planting of *P. sitchensis*, *D. formosa, T. plicata*, *T. heterophylla, T. brevifolia, C. cericea, L. involucrata, O. cerasiformis, M. nervosa, V. parvifoium, R. spectabilis* and other native species that require shade and relative moist conditions should be concentrated in areas where thinning has not been Implemented. These shade tolerant species should be added when young *P. menziesii* trees provide ample shade cover. Seedlings should be planted in late winter or early spring and should be protected with 0.6m tall plastic mesh tubing at time of planting (Chan et al, 2006). A decline in ground-dwelling mosses was reported after thinning events; therefore, an increase in bryophytes should therefore be implemented after thinning (Ares et al, 2010).

<u>Goal 2:</u> Promote a regulated wetland environment by improving stream hydraulics.

Long-term maintenance designed for ensuring satisfying stream hydraulics on our site would include the continuing management of *A. circinatum* and *C. sericea* to prevent upstream erosion and management of *C. obnupta* to retain sediment. Moreover, the continuous addition of large woody debris on a particular site is a vital component for sediment retention purposes. Large woody debris from conifers is better for such purposes than that of deciduous trees as wood from conifers decays at a slower rate (Gray, 2000). Additionally, the ongoing management of roots that block the culvert in polygon 2 should be cleared periodically in order to ensure free-flowing addition of water on our site.

<u>Goal 3:</u> Incorporate hardscape features in order to foster enhanced understanding of the connection between humans and nature as well as increase maintenance options.

Long-term preservation of the maintenance trail is required in order to provide ongoing access to the inner portion of the forest without damaging or disturbing vegetation and wildlife. The maintenance trail will remain intact through the bi-annual addition of mulch and by ensuring that the trail boundary (fallen logs) remains in place.

<u>Goal 4:</u> Maintenance Plan

Long-term maintenance is aimed at creating a natural environment that will maximize wildlife habitat as well as simulate a later seral stage forest setting. The addition of snags and down woody debris to lowland conifer forests requires a minimum of 175 to 250 years and prime old growth forest conditions can take between 350 to 750 years (Kruckeberg, 1991). Anthropogenic interference will therefore be required in order to accelerate succession. Girdling, a procedure that is designed to kill trees and create standing snags by tying a strong wire mesh around a tree or by cutting a groove or notch into the trunk of a tree in order to interrupt the flow of sap between the roots and crown of the tree, can be introduced to create standing snags for habitat creation purposes. Moreover, long-term management would require the addition of more down woody debris at random on-site locations to provide habitat as well as nurse-log and decaying functions to the forested environment.

A model later seral stage lowland forested environment would include: at least two or more tree species that range in both age and size; at least 20 *P. menziesii* trees/ha with dbh > 80 cm in diameter; 30 or more shade-tolerant tree species/ ha > 40 cm dbh – including *T. heterophylla, T. plicata*, and *A. macrophyllum*; a well-developed multilayered canopy; 10 + conifer snags/ ha; and about 34 or more logs/ha where 10 pieces exhibit a diameter larger than 60 cm, and about 15 m in length (Gray, 2000).

Goal 5: Community Involvement

Ongoing community involvement is vital in order to ensure that the park will be maintained as an ecologically important area. Successful community involvement completes a holistic view of ecological restoration, where all community members share a vested interest in their surroundings and each other. Long-term community involvement would require the selection of a community partner representative that is as dedicated and committed to the ecological integrity of Cotton Hill Park as the current community partner, Karen Story. Future community involvement will be of vital importance as more land may succumb to development pressure. A community that values the park and its ecosystem services in terms of aesthetics and ecological importance will ensure that the park will retain its ecological integrity. Moreover, an ongoing relationship between the community, the community partner, and schools within the area need to be fostered in order to transfer stewardship sentiments to later generations.

A strong relationship between Kirkland Junior High and the University of Washington restoration students has already been formed. The teachers look forward to our participation each year and become more involved than they did the year before. With our support and their continued effort, a project could eventually develop that allows the teacher to take charge, creating a space where the UW-REN students could be involved but they don't have to be. A project of this magnitude would give the teacher freedom to create a longitudinal study of the stream and involve the students in the monitoring and maintenance of the plants and trees that they were a part of planting. This kind of project would take effort on the teacher's part to get underway and would require the assistance of UW students, particularly those with a restoration and/or education background. Once set in motion though, the teacher can follow the student's interests and create a truly unique and authentic learning experience for the future restorers and caretakers of our planet.

Appendix A: Vegetation Assessment in sampling plots and example monitoring form

Plot	Common name	Species	# Live	# Dead	% Cover	Recruit?	Layer
1-A	Indian plum	OECE	10	0	15	existing	S
	Common horsetail	EQAR	53	0	20	exisitng	G
	Grand fir	ABGR	1	0	0.3	installed	G
	Western Red Cedar	THPL	1	1	0.3	installed	C
	Douglas -fir	PSME	2	0	0.3	installed	C
	Sword fern	POMU	1	0	10	existing	G
	Trailing blackberry	RUUR	1	0	0.3	existing	G
Total	**native**		69	1	46.2		
	invasive		0	0	0		
Total	**canopy**				**0.6**		**C**
	understory				**15**		**S**
	groundcover				**30.6**		**G**
1-B	Swamp rose	ROPI	1	0	1	installed	S
	Sitka spruce	PISI	2	0	2	installed	C
	Vine maple	ACCI	1	0	1	installed	C
	Twinberry	LOIN	3	0	2	installed	S
	Hardhack spirea	SPDO	5	0	5	installed	S
	Red alder	ALRU	1	0	40	existing	C
	Douglas- fir	PSME	1	0	15	existing	C
	Grand fir	ABGR	2	0	3	installed	C
	Cascara	RHPU	1	0	0.2	installed	C
	Salmonberry	RUSP	3	0	15	existing	S
Total	**native**		20	0	84.2		
	invasive		0	0	0		
Total	**canopy**				**61.2**		**C**
	understory				**23**		**S**
	groundcover				**0**		**G**

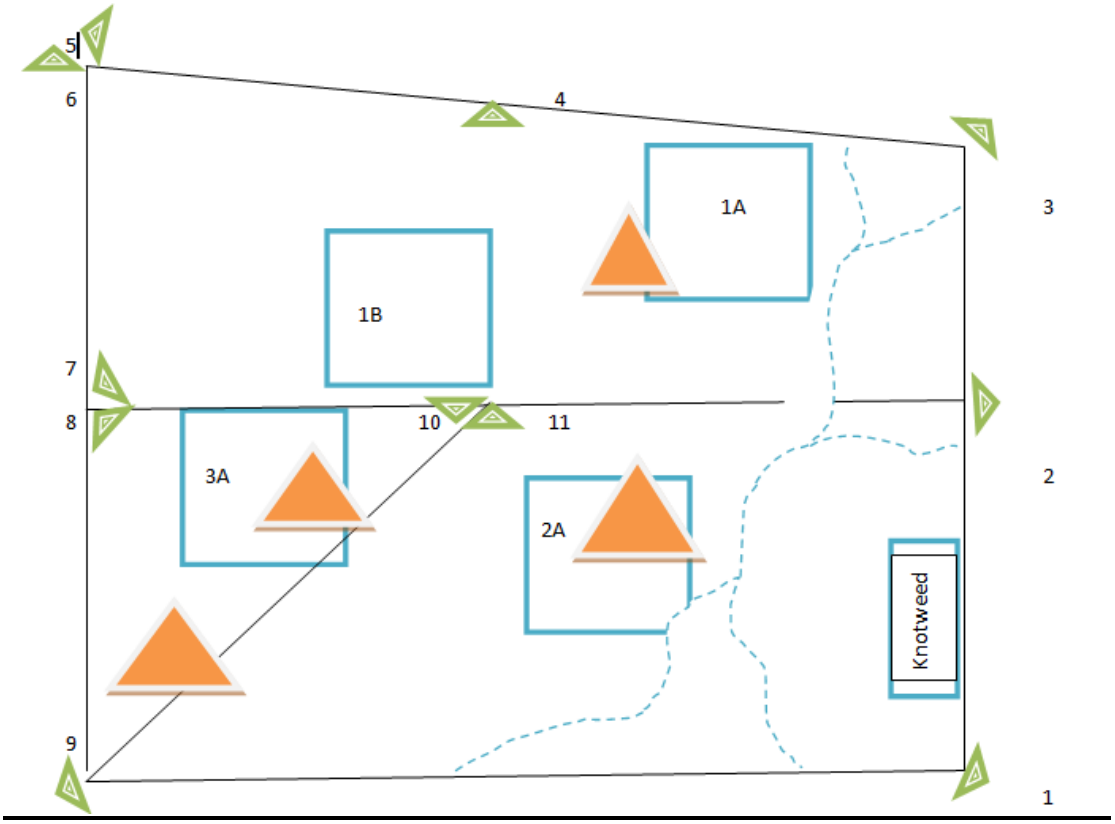
2-A	Skunk cabbage		4	0	10	existing	C
	Salmonberry	RUSP	4	0	30	existing	S
	Douglas -fir	PSME	1	0	80	existing	C
	Common horsetail	EQAR	41	0	30	existing	G
	Red alder	ALRU	1	0	40	existing	C
	Western Red Cedar	THPL	2	0	10	installed	C
	Western hemlock		1	0	1	installed	C
Total	**native**		54	0	201		
	invasive		0	0	0		
Total	**canopy**				**141**		**C**
	understory				**30**		**S**
	groundcover				**30**		**G**
3-A	Red alder	ALRU	3	0	75	existing	C
	Indian plum	OECE	3	0	20	existing	S
	Snowberry	SYAL	5	0	15	installed	S
	Cascara	RHPU	1	0	0.2	installed	S
	Thimbleberry	RUPA	1	0	1	installed	S
	Western hemlock	TSHE	2	0	5	installed	C
	Pacific yew	TABR	1	1	2	installed	C
	Beaked hazelnut	COCO	1	0	1	installed	S
	Rhododendron	RHMA	1	0	1	installed	S
	Mock orange	PHLE	1	0	0	installed	S
Total	**native**		19	1	120.2		
	invasive		0	0	0		
Total	**canopy**				**82**		**C**
	understory				**38.2**		**S**
	groundcover				**0**		**G**

Appendix B: List of plant species found on site and their abbreviations

Common name	Scientific name	Code	Polygon	Installed/Existing
Douglas-fir	*Pseudotsuga menizesii*	PSME	1,2	Both
Grand fir	*Abies grandis*	ABGR	1,2	installed
Big leaf maple	*Acer macrophyllum*	ACMA	1	existing
Sitka spruce	*Picea sitchensis*	PISI	1,3	installed
Vine maple	*Acer circinatum*	ACCI	1,3	installed
Red alder	*Alnus rubra*	ALRU	1,2,3	existing
Western red cedar	*Thuja plicata*	THPL	1,2	Installed
Swamp rose	*Rosa pisocarpa*	ROPI	1	installed
Red-twig dogwood	*Cornus sericea*	COSE	1,2	installed
Snowberry	*Symphoricarpos albus*	SYAL	1,3	installed
Indian plum	*Oemleria cerasiformis*	OECE	2,3	installed
Slough sedge	*Carex obnupta*	CAOB	1	installed
Fringecup	*Tellima grandiflora*	TEGR	1,2,3	Installed
Cascara	*Rhamnus purshiana*	RHPU	2,3	installed
Bleeding heart	*Dicentra formosa*	DOFP	2	installed
Hazelnut	*Corylus cornuta*	COCO	1,2	both
Salmonberry	*Rubus spectabilis*	RUSP	2,3	installed
Mock Orange	*Philadelphus lewisii*	PHLE	3	Installed
Rhododendron	*Rhododendron macophyllum*	RHMA	1,3	Installed
Twinberry	*Lonicera involuncrata*	LOIN	1,2,3	installed
Cascade Oregon grape	*Mahonia nervosa*	MANE	3	installed
Japanese knotweed	*Polygonum cuspidatum*	POCU	2	existing
Red huckleberry	*Vaccinium parvifolium*	VAPA	2	installed
Black cottonwood	*Populus balsamifera trichocarpa*	POBA	2	existing
Douglas hawthorn	*Crataegus douglasii*	CRDO	1	installed
Common horsetail	*Equisetum arvense*	EQAR	1,2	existing
Lady fern	*Athyrium filix-femina*	ATFI	1,2	Both
Skunk cabbage	*Lysichiton americanus*	LYAM	2	existing

Pacific willow	*Salix lucida lasiandra*	SALU	1,3	installed
Hardhack spirea	*Spirea douglasii*	SPDO	1	installed
Pacific yew	*Taxus brevifolia*	TABR	1,3	installed
Trailing blackberry	*Rubus ursinus*	RUUR	1	existing

Appendix C: Map of Monitoring Plots and Photo Points



Legend:

- Hummocks
- Monitoring plots
- Photo points
- Polygon boundary
- Stream

Photo points:

1. 290° NW, 5'
2. 250° W, 5'
3. 210° SW, 5'
4. 150° SE, 5'
5. 120° SE, 5'
6. 180° S , 5'
7. 30° NE, 5'
8. 125° SE, 5'
9. 5° N, 5'
10. 335° NW, 5'
11. 180° S, 5'

Appendix D: Goals and Objectives

Goal 1: Establish a diverse native vegetation community that will thrive in a lowland forest ecosystem

Objective 1.1: Remove invasive species so that a complex native landscape can thrive.

Objective 1.2: Assemble a plant community that will deter the reinvasion of non-native plant species and improve hydrologic functions.

Objective 1.3: Enhance horizontal and vertical vegetation complexity that will lead to a more diverse habitat structure for wildlife.

Goal 2: **Promote a regulated wetland environment by improving stream hydraulics.**

Objective 2.1: Plant vegetation adapted to extremely moist conditions with fibrous roots to minimize erosion and to channelize the flow of water.

Objective 2.2: Incorporate rocks and logs as weirs alongside and in the present stream channel to create a cascading appearance and to prevent movement of sediment.

Goal 3: Incorporate hardscape features in order to foster enhanced understanding of the connection between humans and nature as well as increase maintenance options

Objective 3.1: Design a trail in order to increase maintenance accessibility as well as to provide informal understory access in the forest for educational groups.

Objective 3.2: Design habitat features to attract a variety of wildlife to the Cotton Hill 1 site.

Goal 4: Promote community involvement and encourage participation

Objective 4.1: Plan, instruct and supervise volunteer work parties that will help during restoration.

Objective 4.2: Collaborate with Kirkland Junior High teachers that show interest in the restoration project and work toward creating a classroom presentation and field trip, incorporating species identification, natural art, and data gathering with the help of Cotton Hill team 2.

Appendix E: Monitoring Photos

Above: Photo Point 1. April 24, 2011

Above: Photo Point 2. April 24, 2011

Above: Photo Point 3. April 24, 2011

Above: Photo Point 4. April 24, 2011

Above: Photo Point 5. April 24, 2011

Above: Photo Point 6. April 24, 2011

Above: Photo Point 7. April 24, 2011

Above: Photo Point 8. April 24, 2011

Above: Photo Point 9. April 24, 2011

Above: Photo Point 10. April 24, 2011

Above: Photo Point 11. April 24, 2011

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Appendix G: Blank Monitoring Form

Plot	Common name	Species Code	# Live	# Dead	% Cover	Recruit?	Layer

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