North Creek Forest

Bothell, WA

University of Washington
Restoration Ecology Network Capstone
2011-2012

Final Report

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Project Summary

Overview

This report describes the 2011-2012 North Creek Forest University of Washington Restoration Ecology Network (UW-REN) Restoration Project, implemented for Tom and Jeanie Robinson and the Friends of North Creek Forest (the community partner, hereafter FNCF) on a section of North Creek Forest owned by Tom and Jeanie Robinson. A team of six students designed and installed the restoration project over the course of 3 academic quarters from October 2011 through June 2012 with the support of FNCF, UW-REN instructors, and volunteers in the community. The 2011-2012 project implemented restoration over a 0.25 acre area and is the first project in the effort to completely restore the ecologically degraded areas of the Robinson property.

Summary

The 2011-2012 project site is located in a section of the North Creek Forest that was cleared for settlement and then abandoned during the 1960's, leaving behind dilapidated house and garage foundations, orchard trees and 368 square meters of land heavily invaded by Himalayan blackberry. The Himalayan blackberry had arrested natural regeneration of native Puget Trough lowland coniferous forest in the cleared area. In addition, roughly 80 square meters of native bigleaf-maple forest was invaded with non-native plant species herb-Robert (*Geranium robertianum*) and English holly (*Ilex aquifolium*) which negatively impacted native biodiversity.

We referenced the native forest vegetation communities in Saint Edward State park to select the native plant palette to suit our site conditions and manage succession to the target community of a Puget Trough coniferous forest, and developed the following goals for the project:

- **Goal 1.** Restore a structurally and biologically diverse suite of native plant species typical of Puget Trough lowland forest.
- **Goal 2**. Enhance wildlife habitat for native forest fauna.
- **Goal 3.** Engage local groups and individuals in the project to help build ongoing stewardship and environmental education opportunities within the community.
- **Goal 4.** Evaluate existing old housing structures on site for the opportunities and constraints that they pose in future restoration of this site and the adjacent area.

Implementation of restoration took place between March and June 2012. 26 native plant species were installed, and over 400 square meters of land was cleared of invasive species. A public art installation, signage, and video presentation were produced by project artist Teppei Sato, adding an engaging and unique aesthetic to the project. Members of the team organized community outreach to recruit new community interest in the preservation and stewardship of the Robinson property restoration and the North Creek Forest as a whole. Lectures and hands-on education were provided to two college classes. Overall, more than 100 members from the community lent a hand in restoration activities.

Team photo

The 2011-2012 UW-REN capstone team. Pictured, front row, left to right: Darryl Nevels, Danee' Moesch, Sarah Witte; Back row, left to right: Elliott Church, Teppei Sato, and Freddie Hensen.

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As-Built Report

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1. Background

1.1 *Site description*

Location: The 2011 – 2012 project site is located within the Puget trough region of the Pacific Northwest in Bothell, Washington. The project site is located in the North Creek Forest (Figure 1), which sits in the North Creek watershed. The North Creek Forest is bordered to the east by interstate highway 405 and to the north, south, and west by residential development. The project site is a section of the North Creek Forest (Figure 1) that was purchased for conservation by Tom and Jeanie Robinson. The properties to the north and south of the Robinson property are also privately owned.

The Robinson property contains two general types of canopy cover – one is a native tree canopy cover and the other is a canopy of non-native Himalayan blackberry (*Rubus armeniacus*) which dominates on the eastern edge of the property. Little native tree canopy exists in this eastern section of the property.

Figure 1. Project site location within North Creek Forest (highlighted in red), and in the greater Puget Trough region (inset). Images: Google Earth.

The North Creek Forest was logged in the early 1900's and has been regenerating since. There are still a number of small areas within North Creek Forest which were clear-cut for limited settlements. Such is the case for the previously cleared Himalayan blackberry dominated area that is contained in part of our project site. A house and garage were built in the cleared area in the eastern section of the property, which has since been abandoned and these structures have decayed down to each concrete foundation. Part of the garage foundation is located in our project site.

The project site is placed within the Robinson property to include segments of both native deciduous tree canopy and the Himalayan blackberry area (Figure 2). The northern border of the project site is marked on the property by a row of Sitka willow (*Salix sitchensis*). This border is approximately 30 feet south from the property lines displayed in orange by King County's *ParcelViewer 2.0* (estimated using the provided scale).

Basis for selection: There are a couple of ecological reasons for selecting a site that includes both existing deciduous forest vegetation and part of the opening dominated by Himalayan blackberry, as

opposed to placing the site next to the road (112th street). One is that the proximity to the forest of the heavily invaded portion of the project site (polygon 1, Figure 3) makes the colonization of the forest plant community that we want to promote much more likely and will aid restoration of this part of the project site. Starting the project next to the road would lower the chances for native species to colonize the project site from the deciduous forest. Another is the shade that the forest canopy offers polygon 1, an important factor in controlling invasive species and facilitating the restoration of a native forest canopy on polygon 1.

Figure 2. Site boundaries within the Robinson property. "Buffer" refers to the 50' buffer described in the Tasks and Approach section. Orange lines are property lines. Image: King County.

Habitat value: The young forest canopy in polygon 2 is dominated by deciduous big-leaf maple, with a scattering of evergreen Douglas-fir (*Psuedotsuga menzesii)* and western redcedar (*Thuja plicata*). The mixed coniferous evergreen and deciduous tree canopy, shrub and groundcover layer offers structurally diverse habitat features for a multitude of animal, lichen, fungi, and microbial species. The mixed tree canopy of varying age provides feeding, nesting, resting, and offspring rearing opportunities at a variety of canopy levels (Sutherland 2005). Mature trees with varying trunk diameters and branch sizes drop different sizes of large woody debris onto the forest floor that serves as both refuge and a nutrient-rich micro-site habitat for colonizers (Kruckeberg 1991; Sutherland 2005). These trees also provide a host for a healthy epiphyte community of ferns, lichens,

and mosses to capture water and air particulates (Kruckeberg 1991). Underneath the trees, variability in environmental factors such as temperature, light, and soil moisture creates an interspersion of dense under story along with more open travel corridors. Canopy layers provide roosting, and refuge opportunities for both predator (e.g., Sharp-shinned Hawks; *Accipiter striatus*) and prey (e.g., chipping sparrow; *Spizella passerina*) (Swanson 2005). The ample native vegetative groundcover of dominantly sword fern (*Polystichum munitum*) and piggy-back plant (*Tolmiea menzesii*) catches and holds rainfall and dew for the water needs of both plants and animals like deer mouse (*Peromyscus keeni*), and provides important cover for such small mammals. Organic matter decomposition in the North Creek Forest is facilitated by the small animals, insects, fungi and microbes that thrive in the moderate temperature, moisture conservation, and organic substrate created by the ample vegetative groundcover (Kruckeberg 1991; Clewell & Aronson 2007). Some scattered rocks in the area (including the concrete foundation) offer sunning, hiding, and hibernating spaces for reptiles like garter snakes (*Thamnophis elegans*), amphibians, birds, and small animals. Large predators (e.g., Red-tailed Hawk; *Buteo jamaicensis*) can also use the concrete foundations and tree branches at the clearing edges to perch while eating their captured prey.

At the current time, polygon 1 is overrun by a monoculture of invasive Himalayan blackberry, which offers a thorny bramble-like habitat and a food source for a few weeks of the summer. Small birds like house finches (*Carpodacus mexicanus*) and mammals such as brush rabbits (*Sylvilagus bachmani*) can use the monoculture of invasive Himalayan blackberry for shelter and nutrition, but the open space above the monoculture is inhospitable and perilously vulnerable to predation by aerial predators. Himalayan blackberry does not offer the structure for safe nesting or ready feeding, and although small birds and animals can travel through the Himalayan blackberry bramble, it is not sensible to remain inside the bramble for purposes other than passage (Swanson 2005).

The Himalayan blackberry community lacks the structural complexity to nurture diversity in the forest (Clewell & Aronson 2007). Some individual native plants are inside the Himalayan blackberry stands, but without connectivity to the rest of the forest, provide limited practical habitat value (Clewell & Aronson 2007; Swanson 2005).

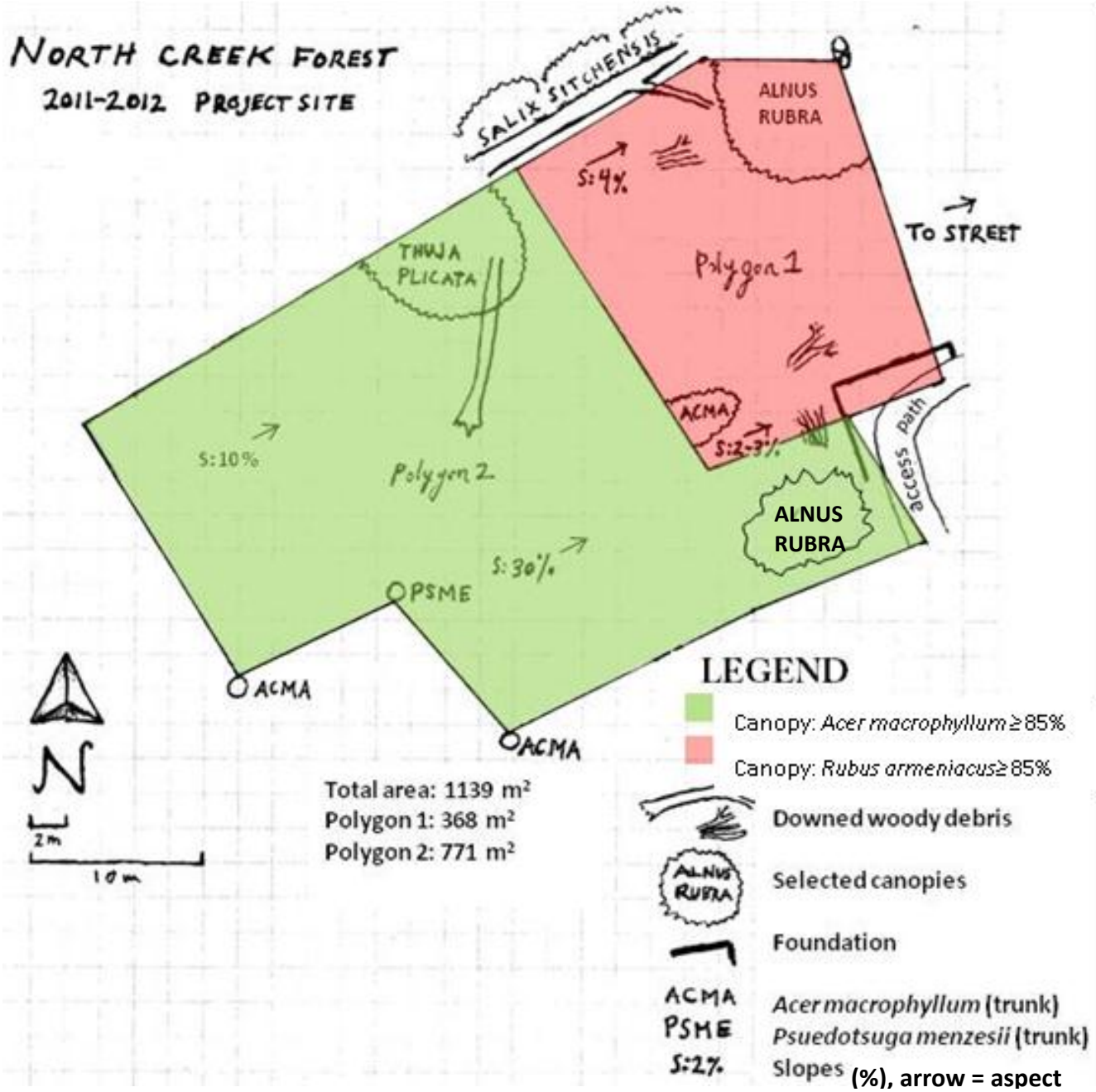


Figure 3. General site map with physical characteristics and polygons.

1.2 Restoration needs and opportunities

Invasive species are the major threat to the native forest on this property. The Himalayan blackberry invasion has arrested the natural succession of the forest in the eastern section of the

property-native vegetation is unable to establish under the dense canopy of Himalayan blackberry. herb-Robert (*Geranium robertianum*), a non-native herbaceous groundcover has a significant presence under the deciduous canopy in the northern part of polygon 2, and a cluster of invasive English holly (*Ilex aquifolium*) plants is present there as well. Both of these non-native species have the ability to spread under the conditions of the target native plant community and suppress native vegetation (King County, 2007 & 2008). However, the presence of an intact native forest community gives the Robinson property good chances for autogenic repair, given a dedicated maintenance effort.

As the North Creek forest is surrounded by urban development, it is susceptible to edge effects (Groom et al 2006) and its small size limits the quality of habitat that can be found here. Habitat area has a positive influence on the number of species a habitat patch can support (Molles 2008). By restoring native vegetation in the Robinson property, we are enlarging both the population of native species and the area of native Puget lowland forest habitat. Each is vital to the viability of native species populations in an isolated habitat patch like the North Creek Forest.

1. Tasks and approaches

Goal 1: *Restore a structurally and biologically diverse suite of native plant species typical of Puget Trough lowland forests.*

Objective 1-1: *Remove and suppress the reoccurrence of invasive plant species.*

Task 1-1a: Remove all Himalayan blackberry above and below ground biomass.

Approach: In both polygons, Himalayan blackberry canes will be cut no lower than .25 m from the ground so that they are visible for root wad removal. Root wads will then be manually dug out using shovels and pick mattocks. All above and belowground biomass will be composted on site with root-wads placed in the upper layers of compost piles to prevent re-establishment until hauling can be arranged. We will remove Himalayan blackberry within 50' of the northern border of polygon 1 to create a buffer zone against re-invasion.

Justification: According to Sasha Shaw from the King County Noxious Weed Control Program in her presentation, "Invasive Plants: Identification and Management," manual control through pruning the canes and removing the root crown is a recommended method of Himalayan blackberry control in addition to cultural control (see Task 1-1b).

AD1: Himalayan blackberry was removed 25' from the northern border of polygon one (Figure 7). The decision to reduce the original goal of a 50' buffer was made by the team for three reasons: a) time constraints, b) safety; at 25' distance from the northern border, a large

downed tree obstructed easy access to the remaining 25'; and c) capstone professors suggested that 10' was adequate to fulfill the function of a buffer zone.

Task 1-1b: Remove all herb-Robert above and below ground biomass.

Approach: in all polygons where herb-Robert is present, individual plants will be pulled and transported off site in buckets for disposal. Disposal options are being explored at this time.

AD2: The team disposed of herb-Robert biomass in the garbage and made the decision to defer the search for herb-Robert disposal options to the CP due to time constraints.

Justification: King County (2007) reports that herb-Robert is easily uprooted, and does not recommend composting on site as seeds can survive and spread from compost piles.

Task 1-1c: Uproot all English holly where possible and devise a control plan for the community partner for the English holly too large for pulling.

Approach: We will pull out younger English holly individuals, taking care to get as much of the root system as possible out of the soil. Above and below ground biomass will be placed on top of compost piles to dry it and prevent contact with the soil until disposal can be arranged. At least one English holly individual is too large for removal by uprooting, and we will devise an herbicide treatment plan to aid the community partner in controlling these plants.

Justification: King County (2008) reports that younger English holly trees can be removed manually with a weed wrench for minimal soil impact, however attempting to dig out the larger English holly can be highly destructive as English holly develops an extensive root system.

AD3: The English holly was cut down by the community partner without having herbicide applied. Re-sprouted holly must be treated with herbicide within thirty (30) seconds of being cut as per instructions outlined in the stewardship plan.

Task 1-1d: Mulch in invasive control sites post-removal to suppress re-occurrence.

Approach: In areas where invasive species are removed, we will apply a 4-6" woodchip/arborist's mulch to suppress re-occurrence of invasive species.

Justification: Chalker-Scott (2009) reports that a thick mulch layer suppresses weeds and has a conditioning effect on the soil, probably because it creates a supporting environment for soil microorganisms.

Task 1-1e: Install a multi-layer native canopy.

Approach: We will quickly establish a stratified and diverse canopy of plant cover by planting a variety of herbaceous and woody plants in each canopy layer, as outlined in the planting plan (section 3.2) using shovels for bare root and container stock. In polygon 1, we will plant conifers and quickly growing sun-tolerant plants to establish shade over the site. In polygon 2, we will augment existing forest cover by planting midcanopy shrubs and trees to cultivate concurrent and consecutive increases in shade over the years. We will plant slower growing conifers to regenerate and eventually establish a healthy overstory of evergreen canopy cover and provide a dense shade that Himalayan blackberry cannot thrive in.

Justification: Shaw (2011) suggests cultural control as the preferred method of weed control in most situations. This is accomplished through changing the environment in which invasive plants have gained prevalence in order to slowly allow native plants to out compete with them and eventually eliminate them from the system. Our plantings outlined in the planting plan will establish a year-round shade that aids in suppressing Himalayan blackberry and resisting new invasions from other non-native species.

Objective 1-2: *Modify site conditions to ensure success of plantings and biological diversity.*

Task 1-2a: Apply mulch to the areas of the site with removed Himalayan blackberry, primarily in polygon 1 to stabilize soil surface prior to planting.

Approach: The amount of Himalayan blackberry removed from polygon 1 accounts for an area of land near the entire expanse of the polygon. We will apply a one to three inch layer of mulch across all areas of exposed soil to protect topsoil in the event of severe rainstorms between invasive removal and native plant installation.

Justification: Applying mulch after Himalayan blackberry removal in both polygons will help to protect against losing native topsoil in the event of rainstorms after Himalayan blackberry removal and prior to planting.

AD4: No mulching was done prior to planting, due to time constraints on the team.

Task 1-2b: Install mounds in both polygons.

Approach: We will use coarse woody debris (CWD) to construct 1 m^2 mounds, using soil existing on the project site. A soil auger will be used to auger out a hole for CWD, which will be inserted into the hole and soil will be washed or tamped down around the CWD. Using this method we will

create a crib which will be filled with soil to create a mound. We will place three micro mound features in polygon 1.

Justification: Using debris to build micro-mounds will increase topographic diversity which fosters long term biodiversity (Gold 2011) and provide microhabitat sites that create soil and moisture conditions favorable to plant germination (Leigh 1999).

AD5: Mounds were created using a different method, and averaged around 2.5 square meters in size: Wood was cut to around 2.5 m length from windthrow and used to build a simple wall between .3 and .6 m tall. Three walls created a triangular mound, and each wall was secured with stakes also cut from windthrow. Topsoil was not used from the project site, but purchased from Pacific Topsoil at wholesale through an extended discount from King Landscaping and Yard Maintenance as a donation. The team decided to purchase soil to fill the mounds on the advice from instructors. A sandy loam soil was used to create a better drained microsite suitable to the establishment of young Douglas-firs.

Objective 1-3: *Install a structurally and biologically diverse palette of native plant species representing early, mid, and late successional stages of Puget Trough lowland forests.*

Task 1-3a: Install a diverse, multi-layer native canopy in a clump gap mosaic pattern.

Approach: Plant material outlined in the planting plan will be installed in a clump gap mosaic/forest thicket pattern using shovels for container and bare root stock.

Justification: Anderson (1997) reports that a clump gap mosaic pattern increases the chances of developing a "multi-layered, sustainable covering of the ground." A clump-gap mosaic also fosters the horizontal complexity that is closer to nature, and that is also characteristic of old growth habitat, as opposed to a grid/tree plantation pattern (Norse 1990). The forest thicket pattern is a high density version of the clump-gap mosaic, used when re-invasion of non-native species is a concern (GSP n.d.). Planting density will be higher near to sources of invasive species propagules outside our project site borders.

Task 1-3b: Water and mulch plantings.

Approach: Plantings will be watered after installation to settle soil around the roots, and soil may be added to compensate for soil settling if needed. Water will be transported on-site using buckets for immediate watering. Woodchip or arborist mulch will be applied around the plantings manually where the post-invasive removal mulch layer does not fulfill coverage of at least 2 m out from the trunks/stems of plantings, using rakes and gloved hands. Care will be taken to ensure that mulch does not come in contact with the stems/trunks.

Justification: Mulching retains water and provides nutrients to the plant as the mulch is broken down and helps to suppress weeds around the plant (GSP n.d.; Chalker-Scott 2009).

AD6: At the time of writing, mulch is spread in a thickness of at least two inches and in some areas as thick as six inches; the team plans to continue to spread mulch through the end of the academic quarter to ensure a thickness of at least six inches throughout most areas of the site.

Task 1-3c: Aid community partner in devising and installing an irrigation system.

Approach: We have been discussing the possibility of installing an irrigation system on site with our community partners. After talking to our community partners we currently find that the solution to the installation and management of this systems in still in negotiation. Currently the city does not own this section of the forest thus they are not willing to pay for the installation or any water that we would use. What we have devised is a potential plan to install a meter and pump on the Robinsons' property funded by donations given to the Friends of North Creek Forest, the community partner (CP). We would then need to run a 1300" hose from the Robinsons' property through the forest and down the hill to our site. We would then have to connect the hose to a number of PVC pipes with attached sprinkler heads. The Friends of North Creek Forest would contribute monetary funds in regards to water consumption.

Due to the large scale of this irrigation project it might not be feasible to complete it within the time frame of our restoration project. It is important for us to realize the need for such a system and create a plan for future groups to implement it if we are unable to do so. This plan will include schematics and parts lists. The Friends of North Creek Forest are in the process of turning the land over to the city, and there is the possibility that once this is done that city funds and experts can be used help install this system and pay for water usage. We will continue to work on this task with our community partners to devise a plan of action.

Justification: Irrigating the project site for the first three summers after planting will help our plantings overcome transplant shock and greatly increase their chance of survival (GSP n.d.; Chalker-Scott 2009).

AD7: The community partner used a well on site and a siphoning hose to bring water to polygon 1 (Location; Figure 7). We are working with the CP to install a drip hose that runs along the forest edge and in theory allow water to run downhill to polygon 1 where the majority of the plants are more susceptible to drought during the first two summers.

Task 1-3d: Devise maintenance and monitoring plan for community partner and volunteers.

Approach: A comprehensive guide for stewardship will be drafted during the spring that will outline maintenance and monitoring of plantings. This

plan will be delivered in the last two weeks of the spring academic quarter (first half of June).

Justification: Long term stewardship is essential to the success of restoration efforts (UW-REN faculty pers. comm.).

Goal 2: *Enhance wildlife habitat for native forest fauna.*

Objective 2-1: *Create new habitat features and enhance existing ones for forest fauna.*

Task 2-1a: Install brush piles and distribute coarse woody debris if needed to bring coverage up to 15%.

Approach: Along the forest edge (on the western boundary of polygon 1) and under the mature western redcedar canopy in the northeast of polygon 2 we will install brush piles (approx. 10m apart in polygon 1 and 15m apart in polygon 2), and we will distribute coarse woody debris to bring overall coverage up to 15%. The snow storm of January 16-20, 2012 resulted in a considerable amount of knockdown within our site, and may have already raised total CWD cover to 15%.

Justification: Carey and Harrington (2001) recommend coarse woody debris cover of 10-15% including features such as brush piles to enhance habitat for small forest mammals in western Washington forests. We want to attract small forest mammals to our site as they spread mycorrhizal fungi, which important to our long term vision. In addition, coarse woody debris increased the trapping of moisture, sediment, and detritus at points of contact between materials and creates habitat for microbes, fungi, and invertebrates. It provides diverse ecological functions that create structural complexity and unique niches for habitat, and can be used to drive interactions of forest resiliency and sustainability. Ecosystem services and functions of erosion control, soil formation, nutrient cycling, refuges, raw materials, and food production are also provided by large woody debris, downed trees, and hummocks (Constanza et al. 1997). We will be strategic in our placement of the habitat features because installments can a be placed to close or too far from one another to provide adequate open space or cover for insects, birds, animals, or other organisms to properly move about the forest and we also need to allow for the circulation of volunteers, wheelbarrows and maintenance workers.

Our habitat installations will reverse the historical forest simplification and promote higher biodiversity of both plant and animal species, enhancing the habitat potential of the forest (Wright 2010).

Task 2-1b: Manage negative impacts to existing habitat during restoration activities.

Approach: Closely monitor all human activities within the restoration site to prevent unwanted harmful impacts on the existing and installed habitat features.

Justification: The physical activity involved with carrying out restoration tasks will cause both beneficial and negative effects to the basic hydrologic, vegetative, and soil structure of both polygons. We don't want our human involvements in the forest to cause more harm than good, because we are attempting to restore the positive features of healthy forest succession and increase biodiversity (Louks, et al. 1970).

The volunteer activities need to be closely monitored in order to accomplish the restoration goals for the site, and prevent negative effects that jeopardize the success of the restoration. We will direct any activity on the site to cause the minimal amount of damage, and maximum amount of positive changes to the site structures. We don't want to destroy habitat in our attempts to create habitats. We also will direct human traffic through the site to access paths, and prevent "social trails" that can cause damage. We will be strategic in making exterior access to working trails on the project site in such a way as to prevent them from becoming general social trails. We may not be able to prevent foot traffic through the site, however, but we can use the actions to create favorable conditions for certain species to thrive. Established and clearly marked working pathways will direct people through the site in predetermined patterns, and decrease the likelihood of new social trails from being created that could damage the new plantings (Marion 1998). Unwanted soil compaction can cause water drainage problems, which can work against the restoration of the forest on the most basic level of water availability for the plants, which sustain animal activities and ability to thrive in the habitat.

Objective 2-2: *Install native Puget lowland understory plant species that provide specific wildlife value for native fauna (e.g. food, cover).*

Task 2-2a: Install native plant species outlined by the planting plan section (3.2)

Approach: Plant material outlined in the planting plan will be installed in a clump gap mosaic using shovels for container and bare root stock.

Justification: Anderson (1997) reports that a clump gap mosaic pattern increases the chances of developing a "multi-layered, sustainable covering of the ground." A clump-gap mosaic also fosters the horizontal complexity that is closer to nature, and that is also characteristic of old growth habitat, as opposed to a grid/tree plantation pattern (Norse 1990).

Task 2-2b: Water and mulch plantings

Approach and Justification: See Task 1-3b & c.

Task 2-2c: Devise and maintenance and monitoring plan for the community partner and volunteers

Approach and Justification: See Task 1-3d

Objective 2-3: Install a structurally diverse palette of native plant species to increase habitat diversity.

Task 2-3a: Install native species that enhance structural complexity in the project site.

Approach and Justification: see Task 1-3a.

Task 2-3b: Water and mulch plantings.

Approach and Justification: See Task 1-3b.

Task 2-3c: Devise maintenance and monitoring plan for community partner and volunteers.

Approach and Justification: see Task 1-3d

Goal 3*: Engage local groups and individuals in the project to help build ongoing stewardship and environmental education opportunities within the community.*

Objective 3-1*: Utilize media and technology approaches to provide outreach of the project and ongoing North Creek Forest conservation effort.*

Task 3-1a: Film and produce educational documentary and video.

Approach: Film interviews with professors, members of Friends of the North Creek Forest, members of the team, and volunteers to build a story describing the meaning and impact of this project. The video should include shots of work parties and illustrate how the site is being transformed. It should also include video showing the wider impact of this project on the Puget Sound and inhabitant species such as salmon that rely on its health.

Justification: This task is specifically requested by our community partner to be a tool in building recognition, awareness, and a sense of public ownership for this land and the stewardship of this land as a public resource. Also, interactive media has been shown to be a more effective way to recruit participation and share ideas with people than traditional paper mailings and flyers.

AD8: Preliminarily, Teppei Sato planned to have interviews with professors, members of Friends of North Creek Forest, members of the team, and volunteers. However, he decided to make a documentary-style of video clip based on a presentation of Jim Freese so he videotaped his presentation in the forest that goes along with description of Friends of North Creek Forest and UW-REN, history of North Creek Forest. Teppei Sato has photographed volunteer workers at events and the vibrantly growing plants that we installed as well as other flora species on the site. In addition, he has videotaped volunteer and work party events and presentations given by Sarah Witte and Jim Freese in the class of Professor Amy Lambert.

The video clip is now in the process and will be eventually about 5-10 minutes long. The team will present the finished product to Friends of North Creek Forest before the end of the Spring academic quarter 2012.

Task 3-1b: Take advantage of social media outlets to recruit volunteers and community land stewards to engage with this project and the North Creek Forest at large.

Approach: Use the Friends of North Creek Forest Facebook page to promote work party events, and likewise, help build a network on the Facebook page to build a community and sense of ownership of this land.

Justification: Social media has quickly become an essential tool to connect people around important causes and also share ideas with people. We plan to employ this tool to help build awareness in the local Bothell community and Puget Sound area.

Objective 3-2*: Communicate with the community about the project, engage the public, and promote conservation efforts through local press and media outlets.*

Task 3-2a: Issue press releases through Friends of the North Creek Forest.

Approach: Communicate with our community partner, the local Bothell Reporter, and with the University of Washington Bothell to issue press releases to the community regarding various milestones and events with which to get involved.

Justification: Many people in the community rely on press, not just social and online media, for information.

Objective 3-3*: Enlist members of the community to assist in restoration tasks.*

Task 3-3a: Engage with University of Washington Bothell and Cascadia Community College student groups and organizations.

Approach: Communicate with the UWB Sustainability Organization, ASUWB, and others to help recruit and volunteer for work parties and events.

Justification: Many student groups have already pledged support for community service hours and are excited to work in the community to show civic engagement and community connection.

Task 3-3b: Build and call upon a growing network of volunteers from local churches, high schools, and other organizations.

Approach: The MLK Day of Service we held was a success, and many of the volunteers of the day were enthusiastic about returning for more invasive plant removal. We will continue to bring back these volunteers thereby building upon our volunteer network. We will also reach out to local churches and high schools as well as community organizations that may have an interest in volunteering and environmental sustainability.

Justification: Word of mouth is the strongest advertisement. By building a strong network of volunteers by repeatedly engaging our network and providing meaningful and rewarding work, we will grow this network and continue to engage greater numbers of people in our community.

Objective 3-4*: Create a long-term maintenance and monitoring plan (stewardship plan) for this site that can be used by the community partners.*

Task 3-4a: Database our volunteer contacts.

Approach: Keep a database of volunteer activists to pass on to our community partner and to future UW-REN Capstone teams.

Justification: Capturing volunteer information and maintaining engagement with these volunteers is the key to building a legacy of community stewardship. By entering every volunteer into a database, we can easily re-connect and re-engage with an ever-growing network of volunteers.

AD9: The team found as the framework for volunteer work parties developed it was inefficient to keep a database on volunteer contacts and then hand it over to the CP; rather, the Friends of North Creek Forest used volunteer liability waivers to build the volunteer network database. The organization is managing the volunteer network to keep active volunteer contact information in one place and coordinate network communications and work party volunteer requests.

1. Specific work plans

3.1 Site preparation plan

3.1.1 *Current conditions*

The project site is approximately 1,139 square meters, and is divided into 2 polygons based on vegetation and topography. The entire project site slopes at an eastern aspect. polygon 1 is approximately 368 square meters, and contains 2-4% slopes (Figure 3). Soils in polygon 1 are loams; from the center to the north of polygon 1 soils range from silty clay loams to silty loams, soils in the southern section are sandy loams. There is some variation in organic layer depth (range 1-3.5") at all

sampling sites, and the northwest corner has the best drainage. polygon 1 receives varying light levels, from full to sun to partial shade in some sections. polygon 2 is within the forest canopy. It is approximately 771 square meters in size. It contains moderately rising slopes (10-30%).Soils in polygon 2 are loams, with a 1" deep organic layer consisting of big-leaf maple leaf litter. Soil in the southeast of polygon 2 contains a substantial alluvial component.

Vegetation

Polygon 1

Polygon 1 is heavily invaded by Himalayan blackberry, which has arrested the natural succession of the forest in this polygon. There is about 20% deciduous canopy cover from native trees comprised of red alder (*Alnus rubra*) and big-leaf maple (Figure 3). Native shrub and groundcover plant species are present sporadically. Vegetation was surveyed in two $100m^2$ quadrats (Figure 4), which yielded an average of 92.5% Himalayan blackberry coverage and 1.8% and 9.0% sword fern and salmonberry (*Rubus spectabilis*) coverage, respectively.

Polygon 2

The canopy coverage in polygon 2 is dominated by big-leaf maple (*Acer macrophyllum*; greater than or equal to 85% coverage), with occasional Douglas-fir (less than or equal to 15% coverage), three young western redcedar (*Thuja plicata*) coming up under the deciduous canopy and three mature western redcedar providing a deep shade in the north of polygon 2. One large downed Douglas-fir lies in the northern half of polygon 2. Dominant sub-canopy natives are vine maple (*Acer circinatum*), Indian plum (*Oemlaria cerasiformis*), and salmonberry collectively comprising 80% coverage. Dominant groundcovers are piggy-back plant (*Tolmiea menzesii*) and sword fern, collectively comprising 95% coverage. The understory species in polygon 2 are not dispersed evenly across the polygon (Figure 4).

Invasive, non-native species in polygon 2 are sparse (about 10% coverage, collectively) and include Himalayan blackberry, herb-Robert, and English holly.

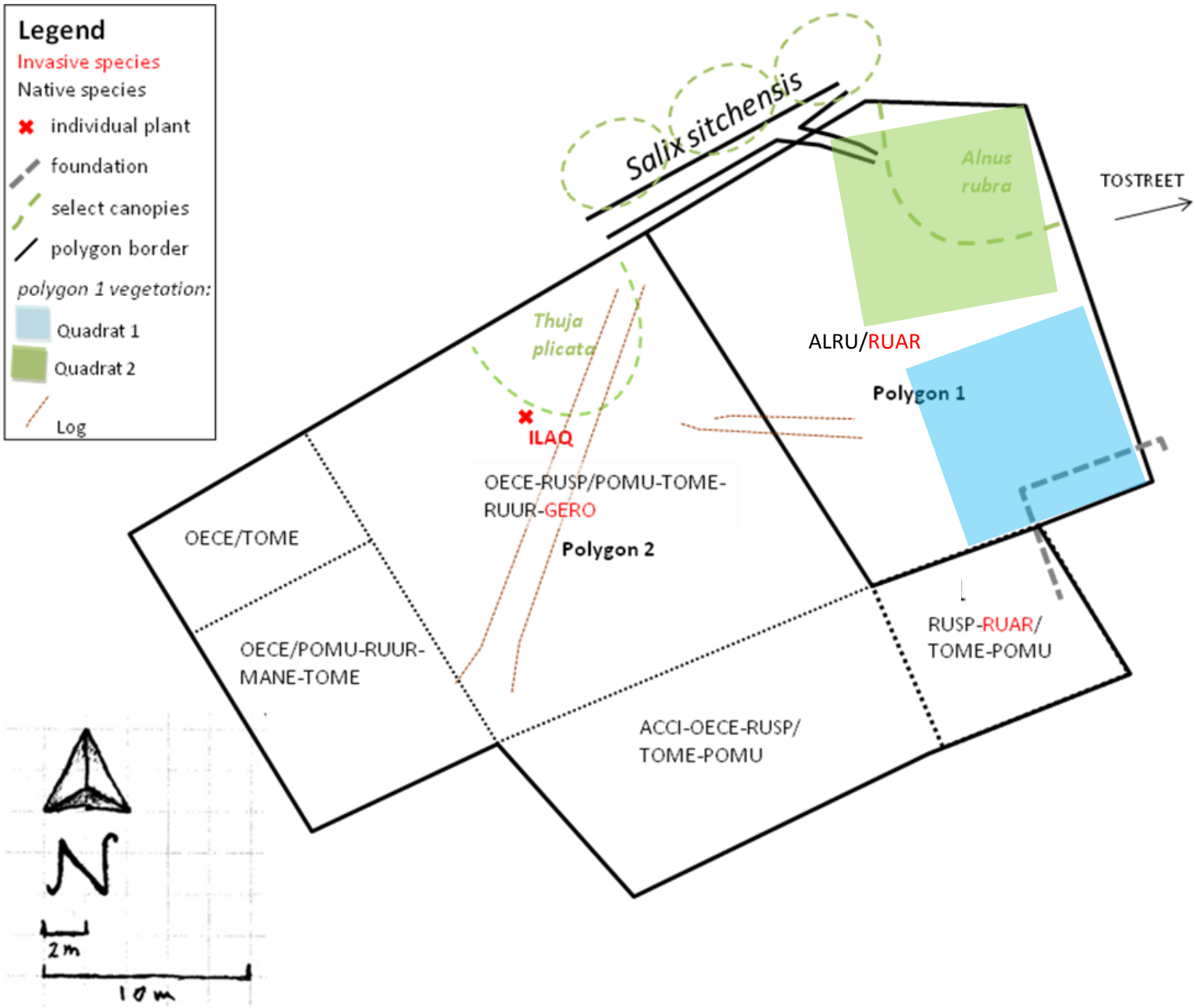


Figure 4. Project site vegetation map, updated 1/27/2012 with newly discovered logs. For species name abbreviations used in this map, see appendix 1.

3.1.2 *Site preparation activities*

Our first action will be to clear the remaining trash from the project site and mark the boundaries. We plan to do this immediately and prior to any volunteer events.

The next activity will be to clear invasive species and apply a thin mulch (1-3") to the control area to protect soil prior to planting (Task 1-1a—d). We plan to utilize volunteers in addition to team labor during this phase. Invasives will be mulched on-site north of the project boundary in the buffer zone (figure 2) until disposal can be arranged. The city of Bothell has declined to haul away invasives, and we are currently looking into other options.

After invasives have been cleared, we will install small (~1m^2) mounds (Task 1-2b) and asses the level of coarse woody debris coverage. If coverage is below 10% we will add coarse woody debris to bring coverage to our 10-15% benchmark (explained in more detail in section 3.4).
See AD4 & 5.

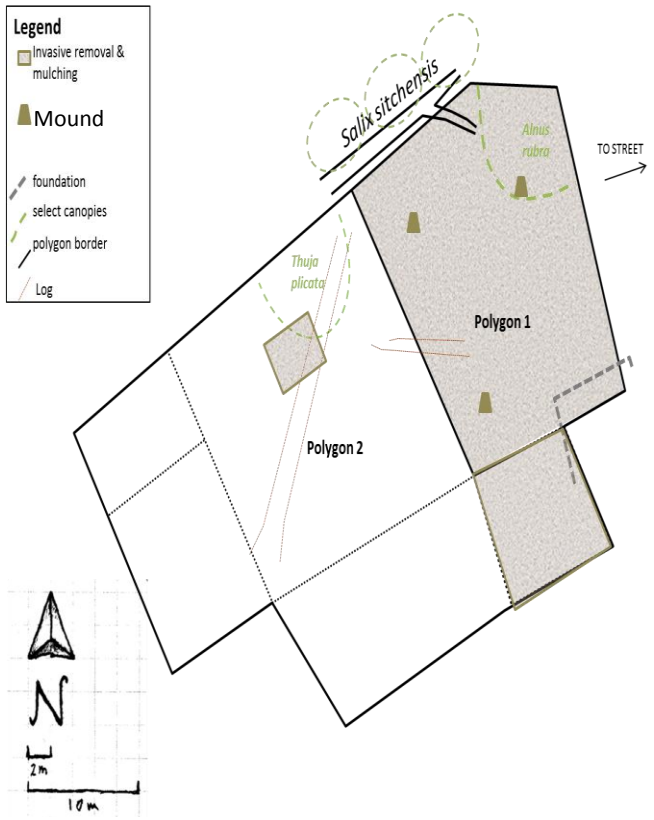


Figure 5. Site preparation map.

Table 1: General materials for site preparation.

Task	Materials	Quantity		Source	Tools (Qty)	Source
		Polygon 1	*Polygon 2*			
1-2b	Coarse woody debris	8 y^3	4 y^3	Local arborists, WSDOT	Shovels(6)	UW-REN
	~~Rocks~~	~~4~~	~~4~~	~~Local landscapers~~	Pick mattocks(2)	UW-REN
2-1a	Coarse woody debris	14 y^3	10 y^3	~~Local arborists, WSDOT~~ **On site windthrow**	Loppers(4)	UW-REN
1-2a	Wood chip mulch	27.7 y^3	9 y^3	Local arborists	Hard Rakes(2)	UW-REN
					Gloves(12)	UW-REN
					Spades (4)	UW-REN
					Hand Trowels (6)	UW-REN
					Pitch forks (3)	UW-REN
					Folding hand saw (4)	UW-REN
					Heavy duty tarps (3)	UW-REN
					First aid kit (1)	UW-REN
					~~Weed Wrench (1)~~	~~King County~~

3.1.3 *Logistical considerations*

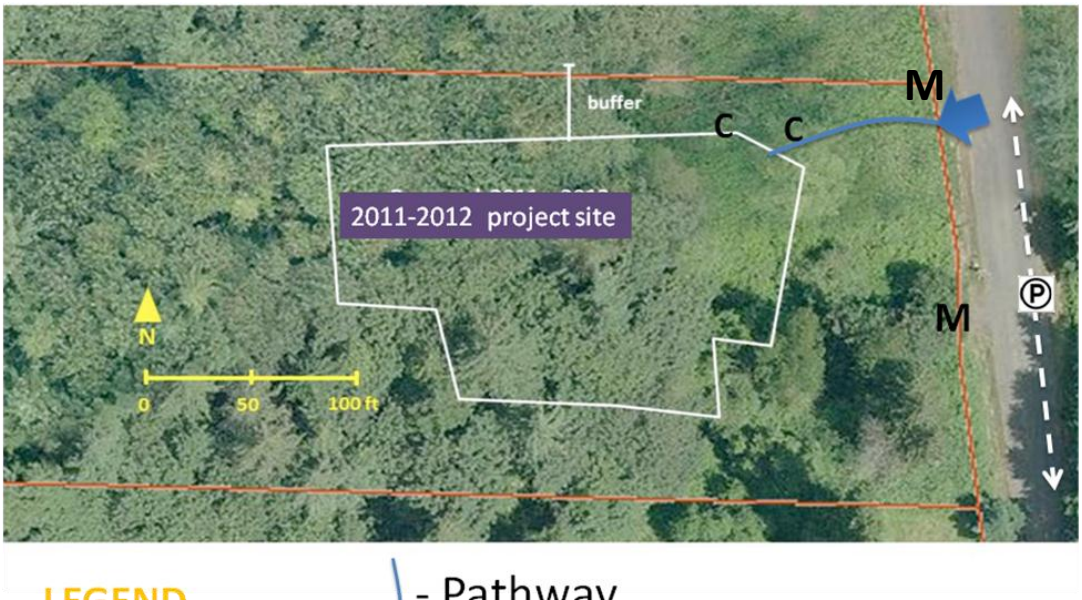


Figure 6. Site logistics map.

Entryways, parking and noise

The access to our project site is located in the northeast corner of the Robinson property on 112th St (Figure 6). From this access point a pathway leads to the northeast corner of polygon 1, the entrance to our project site. Parking for our UW-REN team and volunteers is located on 112th St. on the opposite side of the road from the Robinson property. Bothell police will be contacted prior to work parties and other days when we expect more than 1-3 vehicles will be present. We do not anticipate noise being an issue because of the proximity of the highway.

Material staging areas

Our staging area for mulch is the driveway located in the southwest corner of the property. Other materials (plants, tools) will be stored on the project site until use. A lockbox is being used to store tools during the project. We will compost invasive species biomass in the buffer zone north of our polygon 1 border.

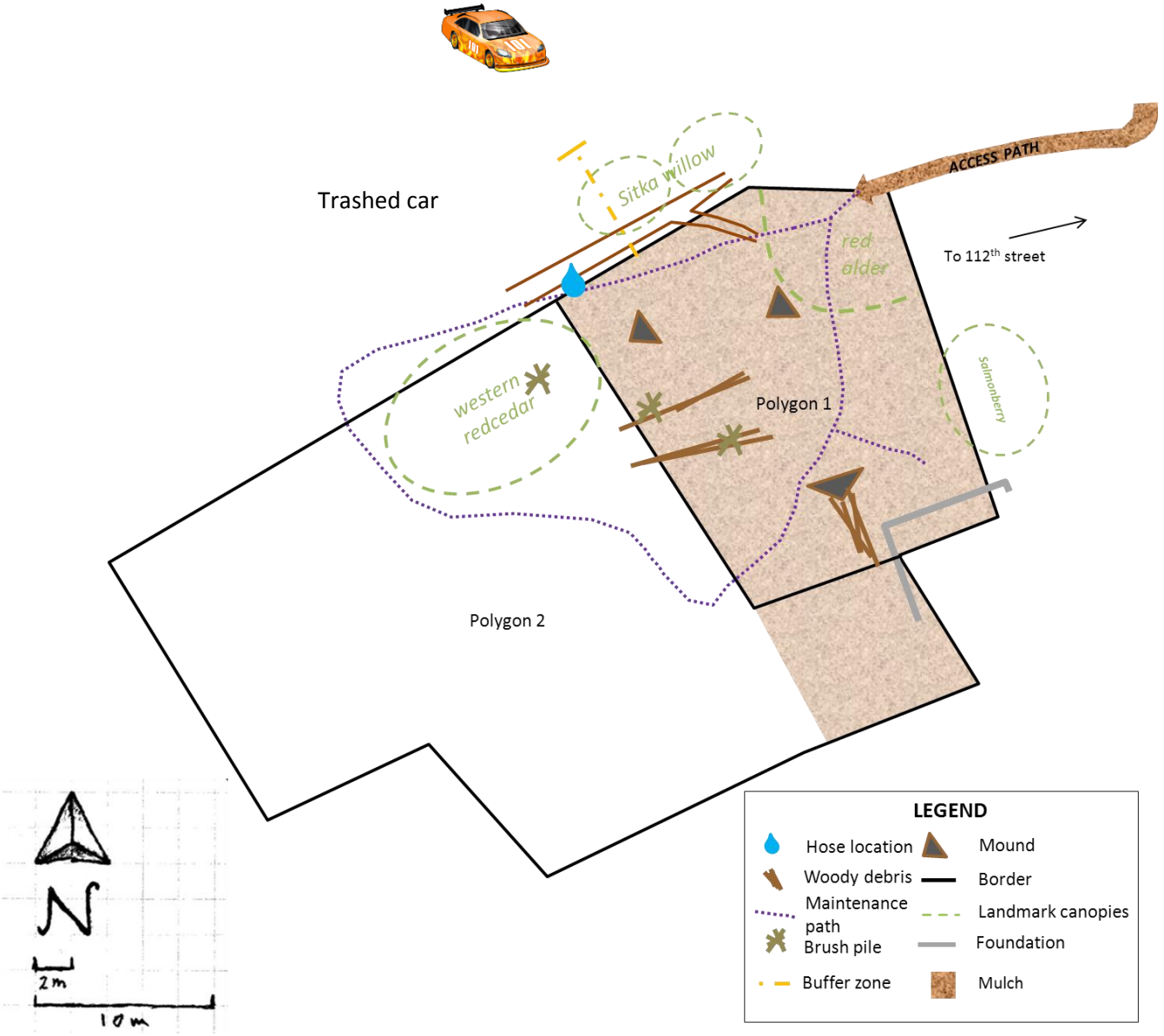


Figure 7. As –built map.

3.2 Planting plan

3.2.1 *Polygon 1.*

In polygon 1, we will install a Douglas-fir – western redcedar forest plant community, as well as subcanopy and understory species that are typical of the red alder – big-leaf maple plant association. Plantings will be dispersed in a dense clump-gap mosaic/forest thicket pattern, spaced generally as follows: Trees at 3 meters, shrubs and groundcovers at 1 meter. Due to budget constraints, we are obtaining most of our planting material in inexpensive bare-root form. Chalker-Scott (2009) reports

that bare-root plants have the highest mortality in the first year after planting (we have figured this into our planning), but those that survive outperform both container and ball & burlap plants.

AD10: Trees were spaced at least 2 meters in polygon 1, and in some areas closer to 1 meter. Time constraints led to the team being unable to stage materials before some work parties, creating some difficulty ensuring the planned spacing was used by volunteers.

Plants that represent early-, mid-, and late-successional stages of Puget lowland forests will be installed in polygon 1 (objective 1-3). Early successional plant associations are suited to the current conditions of polygon 1, and include oceanspray (*Holodiscus discolor*), thimbleberry (*Rubus parviflorus*), salmonberry, tall Oregon-grape (*Mahonia aquifolium*), fireweed (*Epilobium angustifolium*), and red elderberry (*Sambucus racemosa* ssp. *Pubens*), snowberry (*Symphoricarpos albus*), woodland penstemon (*Nothochelone nemorosa*), and bracken fern (*Pteridium aquilinum*) (Table 2) (Chappel 2006; Franklin and Dyrness 1988). As Himalayan blackberry re-invasion is a concern in polygon 1, a dense spacing will help to exclude Himalayan blackberry. We want a more immediate effect from our sun tolerant plants, and we plan to obtain container stock for these species; however due to budget constraints we anticipate we will also utilize bare root form and live stakes for these species as well. While container stock will have an immediate shading effect in polygon 1, bare-root and live stake forms can also produce these same effects quickly (Gold pers. comm.).

Planted Mid succession Douglas-fir will create a year-round shade that enables the later succession, shade tolerant western redcedar and western hemlock (*Tsuga heterophylla*) to thrive and guide the project site towards the target community, a mature western hemlock zone coniferous forest.

AD11: Additional salmonberry plants were not installed, as per capstone instructor recommendation with the reasoning that salmonberry already has a significant presence in the project site and is an aggressive species. Some salmonberry was transplanted to make room for the art installation. The team was unable to obtain western hemlock, woodland penstemon and bracken fern due to time constraints and availability. 2 Sitka spruces (*Picea sitchensis*) were planted in the east of polygon 1 were soil was more poorly drained. 1 spruce tree was planted that possibly is a non-native Colorado spruce (*Picea pungens*). It is not recommended that the tree be removed at this time, rather, let the tree grow to a point where it can be identified with certainty and then evaluate whether the potential negative impacts of the tree outweigh the habitat, carbon sequestration, and other beneficial functions that the tree provides. If the tree is indeed a Colorado spruce, that species is not known to be invasive in the Pacific Northwest; rather, they have a hard time surviving (Gold pers. comm.).

Shade tolerant subcanopy, shrubs and groundcovers will also be installed in polygon 1 where conditions are appropriate, and in the interior of planting clumps, so that these species will have a presence when Douglas-fir grows and creates enough shade for them to take over a dominant role in the understory. These include cascara (*Rhamnus purshiana*), Pacific dogwood (*Cornus nuttallii*), deer fern (*Blechnum spicant*), lady fern (*Athyrium filix-femina*), vine maple (*Acer circinatum*), beaked hazelnut

(*Corylus cornuta var. californica*)**,** redwood sorrel (*Oxalis oregona*)*,* salal (*Gaultheria shallon*)*,* low Oregon-grape (*Mahonia nervosa*)*,* and sword fern.

AD12: Pacific dogwood, beaked hazelnut, and lady fern were not installed due to availability and time constraints on the team.

Grand fir (*Abies grandis*) and Pacific rhododendron (*Rhododendron macrophyllum*) were selected to increase biological diversity, and as they are tolerant of shade, provide long term diversity.

In addition to selecting groundcovers, shrubs, and tree species, we selected three sub-canopy trees to provide as much vertical structural complexity as possible (objective 1-3). These species are cascara*,* Pacific dogwood*,* and bitter cherry (*Prunus emarginata*). Increasing structural complexity is also an important component of creating habitat diversity for local wildlife (objective 2-3).

AD13: We obtained two salvaged trees which were suspected to be bitter cherry. One turned out to be a non-native rowan tree (*Sorbus aucuparia*) and was removed by the team. Availability and time constraints reduced the number of bitter cherry that the team was able to procure.

We selected our plant species for polygon 1 to provide as much habitat value for wildlife as possible (objective 2-2), such as food and shelter. Species with considerable food value include western redcedar*,* bitter cherry*,* cascara, and red huckleberry (*Vaccinium parvifolium*) which provide fruit, seeds, browse, insects, and cover (Stinson 1998). Nearly all plantings provide cover for a variety of native fauna. Western redcedar and western hemlock will provide important nesting sites as they mature.

Plantings will be watered and mulched afterwards to give them the best chances of establishment.

3.2.2 *Polygon 2.*

For polygon 2 we hope to enhance biological diversity by installing both a diverse palette of native species that occur in the surrounding native forest community and specific species that will drive forest succession forward after the invasive species impeded its healthy aging process.

We plan to use already-existing species of Indian plum, salmonberry, and sword fern that we know thrive in the environment, because they are already doing so. Polygon 2 is very thickly populated with native forest plants, so we will mainly focus on strong understory plants and a few later successional conifer species to support the forest in the direction of maturation and enhance the strengths of the forest to defend against present and future invasive assault. We also are planting later-succession species in polygon 2 with an eye toward these species spreading into polygon 1 when conditions are appropriate. Our plantings will be installed among the native community with as little harm as possible caused to the existing vegetation. Trees will be installed in the same spacing arrangement as polygon 1, with trees placed with 3 square meters per plant, and shrubs with 1 square meter per plant. The plant species will most likely be obtained in bare-root form, and we will space them in favorable special arrangements towards one another and surrounding vegetation types.

Polygon 2 contains 85% big-leaf maple canopy cover, which provides 50%+ shade, so we plan to choose shade-tolerant, later successional tree species in this polygon. Following the succession guidelines explained in 3.2.1, polygon 2 will be planted with 7 Grand fir 6 western redcedar, 5 western hemlock and 5 Douglas-fir where conditions are appropriate for each specific species, (Table 1) to initiate coniferous regeneration from underneath the currently established deciduous canopy and advance forest succession towards a mature western hemlock zone coniferous forest, our long-term vision.

When the planted vegetation matures, the increased upper-canopy shade will help suppress invasive species growth and prevent new invasive species infiltration when transient invasive seeds cannot find a suitable habitat to colonize in the healthy forest (Task 1-1-b). We will plant Indian plum and thimbleberry shrubs to help build a more robust strata of canopy layers which provide deeper shade to the understory, further enhancing natural resistance to our dominant and shade intolerant invasive on-site, Himalayan blackberry, that grown in the site and surrounding area. Installed native shrub species will also work to exclude Himalayan blackberry and herb-Robert through resource competition.

We consulted Stinson et al. (1998) for guidance on selecting under story species that have high value for native wildlife such as cover, nesting sites, food, insects, seeds, and browse. Planting shrubs and groundcovers such as vanilla leaf (*Achlys triphylla*), lady fern, deer fern; tall Oregon-grape and low Oregon-grape provide cover and food. Salal is an particularly important species for providing cover for small mammal species which are important to the restoration of a coniferous forest in our project site, as they spread mycorrhizal fungi (Carey and Harrington, 2001), and 1 gallon containers will be installed in polygon 2 in order to hasten the positive effect that the plants have on the healthy forest structures an increase the restoration's chances of long-term success.

AD14: The team was unable to obtain vanilla leaf due to time constraints and availability.

All plant material will be installed by manual labor by team members or volunteers under direct team member supervision (objective 1-3). The plant form will be treated with the handling and planting techniques specific to that form, such as container plants being removed from the container and planted without container soil materials with the roots separated and spread radially in the hole. In accord with Task 1-3b, plantings will be watered after installation and mulch applied around the surrounding area to provide water retention, nutrients, and weed suppression (GSP n.d.). Future habitat installation and human activity will be directed to protect the new vegetation (Task 2-1a, b) from harm.

Table 2: Plant material for planting plan.

Species denoted with a * serve art purposes and are discussed later in the art plan (section 3.6).

	Polygon 1			Polygon 2		
Species	#	Spacing (m)	Form	#	Spacing (m)	Form
Abies grandis	5	4	bare root or container	7	8	bare-root
Acer circinatum	21	1	bare root			
~~*Achlys triphylla*~~	~~5~~	~~1~~	~~container/salvage/bare root/seed~~	~~10~~	~~2~~	~~container/salvage/plugs~~
~~*Athyrium filix-femina*~~	~~16~~	~~1~~	~~container/bare root/seed~~	~~20~~	~~2~~	~~container~~
Blechnum spicant	~~16~~ 4	1	container/bare root/seed	~~10~~ 2	2	container
*Brachythecium asperrimum**	5	1	clumps/salvage			
~~*Cornus nuttallii*~~	~~4~~	~~3~~	~~bare root &/or container~~			
Cornus stolonifera	19	1	bare root &/or live stakes			
~~*Corylus cornuta var. californica*~~	~~21~~	~~2~~	~~bare root~~			
~~*Dicranum scoparium**~~	~~5~~	~~1~~	~~clumps/salvage~~			
Epilobium angustifolium	~~1 seed packet~~ Salvaged seed	1	seed			
Gaultheria shallon	~~15~~	~~1~~	~~bare root~~	~~25~~ 40	2	~~bare root~~ Plugs
Holodiscus discolor	~~26~~ 20	1	~~1 gal container &~~ bare root ~~& live stakes~~			

Philadelphus lewisii	10	1	~~1 gal container &~~ bare root ~~& live stakes~~			
Mahonia aquifolium	~~21~~ **20**	1	bare root ~~or container~~	~~5~~	~~4~~	~~1 gallon container~~
Mahonia nervosa	~~11~~ **5**	1	~~bare root or container~~	25	4	bare root or container
~~***Nothochelone nemorosa***~~	~~16~~	~~1~~	~~container/bare root/seed~~			
Oemlaria cerasiformis	~~19~~ **2**	1	bare root ~~& live stakes~~	~~24~~	4	~~bare root & live stakes~~
Oplopanax horridus	~~4~~ **3**	1	container &/or salvage	~~6~~ **1**	4	container &/or salvage
Oxalis oregana	~~16~~ **12**	1	container/bare root/seed			
Physocarpus capitatus	~~0~~ **5**		container	~~5~~	~~4~~	~~bare root &/or container~~
Picea sitchensis	~~1~~ **2**	3	container			
Polystichum munitum	16	1	container/bare root/seed	20	2	1 gallon container or plug
***Prunus emarginat*(??)**	~~4~~ **1**	4	~~bare root &/or container~~ **Salvage**			
Pseudotsuga menziesii	~~26~~ **21**	3	5-gal container	5	8	5 gallon container
~~***Pteridium aquilinum***~~	~~21~~	~~1~~	~~container/bare root/seed~~	~~10~~	~~2~~	~~container/salvage/plugs~~
Rhamnus purshiana	~~21~~ **20**	2	~~1 gal container or~~ bare root			
~~***Rhytidiadelphus loreus****~~	~~5~~	~~1~~	~~clumps/salvage~~			
Rhododendron macrophyllum	~~2~~	2	~~bare root~~ **1 gallon container**	~~3~~ **0**	4	~~bare root~~

	3					
Rosa gymnocarpa	~~8~~ 7	2	bare root &/or container			
Rubus parviflorus	~~26~~ 27	1	1-gal container & Bare root & live stakes	~~20~~ 10	4	1 gallon container or Bare-root
~~***Rubus spectabilis***~~				~~10~~	~~4~~	~~1 gallon container or bare-root or live stakes~~
Sambucus racemosa ssp. ***pubens***	~~23~~ 17	1	1-gal container & bare root & live stakes			
~~***Spirea douglasii***~~	~~4~~	~~2~~	~~container~~			
Symphoricarpos albus	24	1	bare root			
~~***Tellima grandiflora***~~	~~16~~	~~1~~	~~container/bare root/seed~~	~~25~~	~~2~~	~~container~~
Thuja plicata	~~16~~ 7	2	bare root &/or live stakes	~~6~~ 13	8	bare-root
Tsuga heterophylla	4	2	bare root	5	8	Bare root
Vaccinium parvifolium				~~10~~ 4	2	Bare root

Table 3. General materials for planting plan.

Task	Materials	Quantity *Polygon 1*	Quantity *Polygon 2*	Source	Tools (Qty)	Source
1-3a, 2-2a, 2-3a					Shovels(6)	UW-REN
					Loppers(4)	UW-REN
					Gloves(12)	UW-REN
					Spades (4)	UW-REN
					Hand Trowels (6)	UW-REN
					Folding hand saw (4)	UW-REN
					First aid kit (1)	UW-REN
1-3b, 2-2b, 2-3b	Arborist's mulch	61.15 y^3	-	Local arborists	Hard rakes (2)	UW-REN
	Buckets	10	-	UWB/CCC		
	~~20-gal tubs/ trash cans~~ **Soy sauce barrels**	4	-	UW-REN		

3.3 Budget plan

3.3.1 *Labor budget*

Labor by activity (expendature)	Team	Volunteers	Total
Site preparation			
Mound construction	~~5~~ **2**	~~5~~ **2**	~~10~~ **4**
Garbage removal	~~2~~ **0.25**		~~2~~ **0.25**

Border demarcation	~~1~~ **0.75**		~~1~~ **0.75**
Mulching (pre-planting)	~~12~~	~~12~~	~~24~~
Subtotal site preparation	~~20~~ **2.75**	~~17~~ **2**	~~37~~ **5**
Invasive Plant Removal			
Himalayan blackberry	~~30~~ **17**	~~114~~ **82**	~~144~~ **99**
English holly	~~2~~ **3**		~~2~~ **3**
herb-Robert	~~4~~ **0.5**	**1**	~~4~~ **0.5**
Subtotal Invasive Plant Removal	~~36~~ **20**	~~114~~ **83**	~~150~~ **103**
Plant Acquisition			
Planning	~~6~~ **9**		~~6~~ **9**
Nurseries	~~18~~ **1.5**		~~18~~ **1.5**
Salvage	~~30~~ **5**		~~30~~ **5**
Live Stake Collection	~~20~~		~~20~~
Subtotal Plant Acquisition	~~74~~ **12.5**		~~74~~ **12.5**
Planting			
Polygon 1	~~50~~ **28.5**	~~200~~ **146**	~~250~~ **174.5**
Polygon 2	~~22~~ **44**	~~40~~ **41.5**	~~62~~ **85.5**
Mulching	~~6~~ **3.5**	~~40~~ **50**	~~46~~ **53.5**
Subtotal Planting	~~78~~ **76**	~~280~~ **237.5**	~~312~~ **313.5**
Total	~~208~~ **113.5**	~~411~~ **322.5**	~~619~~ **431.75**

Labour by source (revenue)		**Total Hours**
Team		198
Volunteers		
Friends of North Creek Forest		1300
UWB/CCC sustainabilty organization		400
Eastside native plant society		300
Total volunteers		2000
Total labor revenue		2198

3.3.2 *Financial budget*

Expenditures:

Plants:	Cost:
Conifers:	~~$ 92~~ **$0**
Deciduous trees:	~~$ 100~~ **$67.89**
Shrubs:	~~$ 190~~ **$222.30**
Understory	~~$260~~ **$87.60**
Subtotal plants:	~~$ 592~~ **$377.79**
Mulch:	$0
Subtotal Mulch:	$0
Art project:	**$102.80**
Project total:	~~$642~~ **$480.59**

Revenue by fund source:

Course fee allotment:	$ 525
Donations:	
By Community Partner	~~$200-300~~ **$102.80**
By Center for Urban Horticulture (UW)	**$231**
By Sustainability Organization	**$490.55**
By Pipers Creek	**$290**
By Team members:	**$200**
Total Donations:	~~$200-300~~ **$1314.35**
Project total:	~~$725-825~~ **$1839.35**

Plant total costs are based off the King conservation district bare root sale and Weyerhauser seedling sale program at the Rochester Greenhouse. For any that did not apply, a best guess was made based from the prices from the King conservation district bare root sale. Many of the shrubs will preferably be live staked if possible (no cost). We added $50 to conifer prices in anticipation of container stock cost.

3.4 Habitat structures plan

Table 4. General materials for habitat structures plan.

2-1a, 1-2b	Coarse woody debris	15 y^3	~~Local arborists and contractors~~ **On-site windthrow**	Shovel (6)	UW-REN
	~~Rocks~~	~~5~~	~~Local landscapers~~ **Discovered large rocks on–site, team decided not to**	Auger	UWB/CCC

			import more rocks		

Both polygons contain a diversity of habitat features such as a significant amount of large woody debris, the concrete garage foundation that doubles as a rock pile-esque structure, a variety of naturally occurring depressions and mounds, and a fallen Douglas fir in polygon 2 (Figure 4). Because of the natural variations on the slope, no large topographical changes will need to be created. Temperature, light, soil moisture, travel corridors, roosting opportunities, and refuge chances are found in polygon 2, and polygon 1 has great potential to mimic these forest structures with installment of specific habitat structures (Goal 2).

The planted vegetation will create habitat features themselves, and influence the micro-conditions such as temperature and moisture levels among different areas (Objective 1-3, Task 1-1b) building the fundamental ecosystem functions to kick-start the growth and success of the next forest successional stage (Wright 2010).

In addition to the active restoration activities that will impact the habitat features of the site, we will install habitat structures, especially in polygon 1, where there are fewer naturally occurring features. We will transport in coarse woody debris from local arborists and use the debris to create brush piles around polygon 1 and 2, at an approximate density of 15 meters apart (Task 2.1). These individual and piles of coarse woody debris provide structural diversity and unique niches that will trap moisture and sediment and create habitat for a diversity of organisms. The ecosystem functions of erosion control, soil formation, nutrient cycling, refuges, raw materials, and food production (Constanza et al.1997) will reverse the historical forest simplification and promote higher biodiversity of both plant and animal species, restoring the forest to its full production potential (Wright 2010). The restored natural cycles will support the growth of our plantings and ensuing successional development of the North Creek Forest.

3.5 Education plan

The UW-REN student team will publicize the restoration efforts in the North Creek Forest. We plan to utilize media and technology approaches to provide outreach for the project and the ongoing conservation effort (Objective 3-1) using professors, members of the Friends of North Creek Forest, team members, and volunteers. This North Creek Forest story will help people to care about the meaning and impact of not only this project, but of conservation projects that affect the greater Puget Sound area and the world. The student and community interactivity of the North Creek Forest story will continue the recognition, awareness, and sense of responsibility for public resources, and attract community land stewards to perpetuate the project's success and scope.

In addition to drawing attention to the existing North Creek Forest project and website through local press, using a social media outlet such as Facebook will reach a larger audience and spread the conservation message on a broader and faster scale. A Facebook network can be used to increase communication and compassion for the project and its greater implications on other aspects of environmentalism. This network could be used to more easily connect with community groups that can volunteer and help care for the forest. Groups such as the Cascadia & UWB

Sustainability Organization, ASUWB/CCC, Friends of North Creek Forest, and others can increase communication potential and help recruit volunteers for work parties and events.

These community members will engage with each other, the UW-REN team members, and the forest through their stewardship activities. Through this engagement, each learn from and teach every other person involved in the North Creek Forest restoration. This educational network will exponentially increase the ability of active individuals to know and help spread the benefits of environmental restoration. Public education, experiential sharing, and historical context will increase the likelihood that the project will succeed. During the project activities and volunteer events, participants will learn how and why to identify and remove invasive species. They will learn which plant species should be included in the restoration and why, and how the forest systems and functions change and respond to invasion, disturbance, and anthropogenic influences. Participating members can help the UW-REN group record and analyze the amount and health of vegetation in the restoration area, and foster a deep understanding of the importance of biodiversity. They can explore the interactions between different flora, fauna, habitats, and abiotic features in the North Creek Forest and understand how ecosystems function and sustain life, as we know it.

UW-REN team members will always be available for questions posed by interested parties, and will direct participation within the site to achieve the most benefit for restoration and least harm (Goal 2). We will be pursuing our own labor, volunteer network, and Community Partner contacts to mechanically remove blackberry canes and roots from polygon 1, and parts of polygon 2, and while performing this task, the physical activity will cause both beneficial and negative effects to the basic hydrologic, vegetative, and soil structure of both polygons. We will direct any activity on the site to cause the minimal amount of damage, and maximum amount of positive changes to the site structures. We don't want our human involvements in the forest to cause more harm than good, because we are attempting to restore the positive features of healthy forest succession and increase biodiversity (Louks, et al. 1970). The volunteer activities need to be closely monitored in order to accomplish the restoration goals for the site, and prevent negative effects that jeopardize the success of the restoration. We intend to direct the human traffic through the site to specifically create trail areas of depression and basins of compacted soil to collect rainfall into standing water, and prevent "social trails" that can cause drainage problems and damage the site restoration (Marion 1998).

The North Creek Forest will thrive under carefully monitored human activity and restoration efforts, and with the continuation of educational outreach programs and UW-REN involvement, the Bothell and wider community needs can co-exist and support the needs of the forest environment.

3.6 Art plan

Our goal is to capture the interactions between humans and nature in a project that is educational, inviting, and inspiring. We intend to use native species of moss such as Brachythecium moss (*Brachythecium asperrimum*), lanky moss (*Rhytidiadelphus loreus*), and broom moss (*Dicranum scoparium*) as the main natural material, and a door to represent human involvement, which welcomes visitors to the site. The potential location to place the door will be by the red alder in the north east corner of polygon 1 on the access path. In an attempt to obtain more information about mosses, we will contact a moss specialist, Jackie Brookner. (http://www.jackiebrookner.net/)

What is interesting is that human beings tend to think of nature as a world separate from themselves, all of their activities, and products. In truth, humans are a product of nature and without the condition provided by the natural world, there would not be human existence. When looking at an anthill, is an anthill part of nature? When looking at a beaver dam, is it a structure separate from nature?

Are the activities of humans a part of nature? Humanity only separates human inventions from nature because of the human perspective of perceiving things. If everything human belongs to the natural world then everything created by society is an addition to nature's design. The door opens visitor's minds in new and innovative ways. It also represents a gateway to the site where we humbly support the process of restoration, which characterizes an interactive and interdependent relationship. The moss represents nature that has been taken for granted.

To think back to the origin, nature is vital and efficient; it is in a continuous state of change, preserving favorable traits, and evolving to new adaptations. So how do humans fit into this picture? From a neutral perspective, the human species is not damaging nature, but part of nature. From a human perspective, human activities alter the conditions that sustain life on the planet. The law of nature and the source that sustains life has been ignored. This art project provides opportunities to visitors to learn that humanity is part of nature and the natural environment is vital to this society, hence human beings need to be aware of the importance of sustaining the natural world.

Table 5. Plant material for art plan

Species	Qty	Form
Brachythecium asperrimum	~~5~~	~~clumps/~~salvage
Rhytidiadelphus loreus	~~5~~	~~clumps/~~salvage
Dicranum scoparium	~~5~~	~~clumps/~~salvage
Unknown moss		**salvage**

AD15: Rodney Pond generously offered a large amount of live moss that was salvaged from the Union Bay Natural Area. Additional moss was collected near Jim Freese's house. Moss was not collected from the restoration site as preliminarily planned, because it would potentially damage the vegetative community. The process involved transferring the collected moss on to the door which gradually rooted on.

Table 6. General material for art plan

Materials	Source
Door	Salvage
~~bricks~~	~~salvage~~
~~Metal hooks~~	~~Hardware store~~
~~Rope~~	~~Salvage or hardware store~~
Steel frame	**$70**
Aluminum frame	**$30**
Hinges	**Salvage**
Glass plate	**Salvage**
Steel post	**Salvage**
Wooden board	**Salvage**

AD16: The following describes the additional materials used final art installation, as well as signage not in the original plan:

Steel door frame

The steel door frame was welded and built by Mark Bogdan, a friend of Bill. The dimension of the steel frame is 103" (length) x 36 ½" (wide). Bill suggested to dig about 24" the ground when placing the steel frame to reinforce its stability, and the length of the steel frame was designed longer than the length of the door to accommodate the underground portion.

Door with moss

Before the process, Teppei Sato and Bill removed the existing paint off the door to protect the moss from potentially hazardous compounds. The moss has been transferred on to the door. The moss from the Union Bay Natural Area and Jim Freese's property has been maintained under shade cover and been frequently watered since it was transferred on to the door and has since rooted.

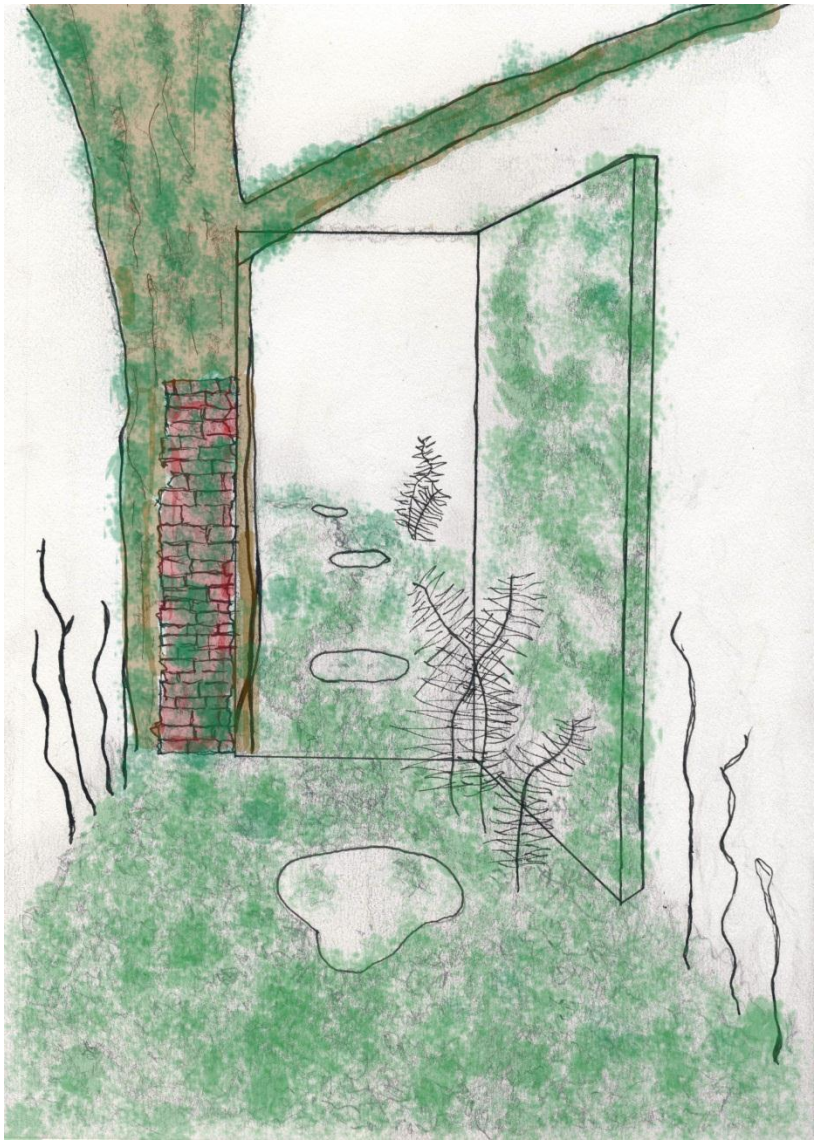
Signage

The materials that Bill and Teppei Sato chose were a glass plate (19.69" x 27.83"), a wooden board (22"x 30"), an aluminum frame (22" x 30"), and a steel post (105" length). The signage can be seen at children's eye level, because a primary goal of the poster design was hope that children visitors to the restoration site and enjoy their time and learn about the project. The dimension of the signage is 22" (length) x 30" (wide). Since the signage needs to be securely installed into the ground, the total length of the steel post will be 50-60", with approximately 24" underground.

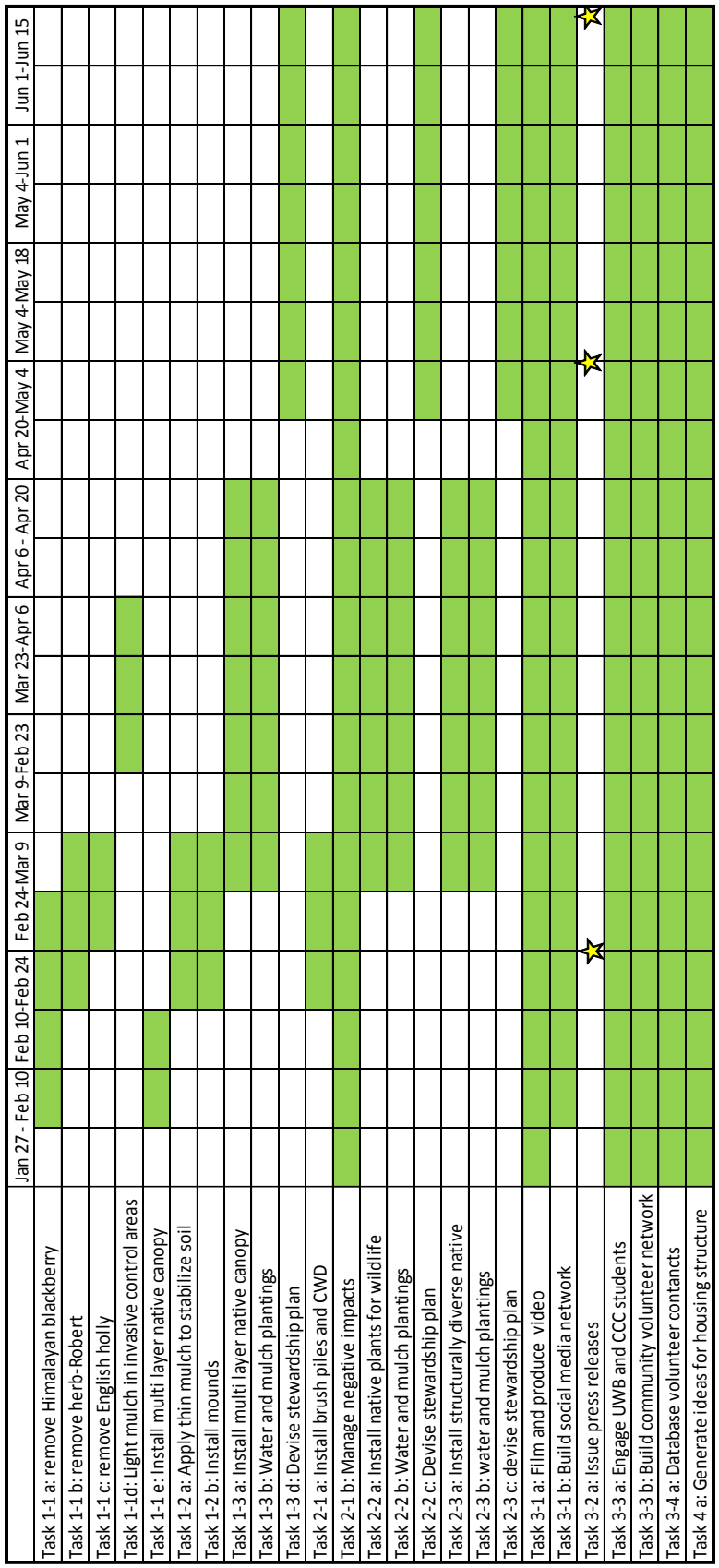
Construction Plan

Construction of the steel frame and signage is scheduled on the 26th of May during a large volunteer event. Since our team will use the door at the Symposium, construction of the door will be implemented after the event.

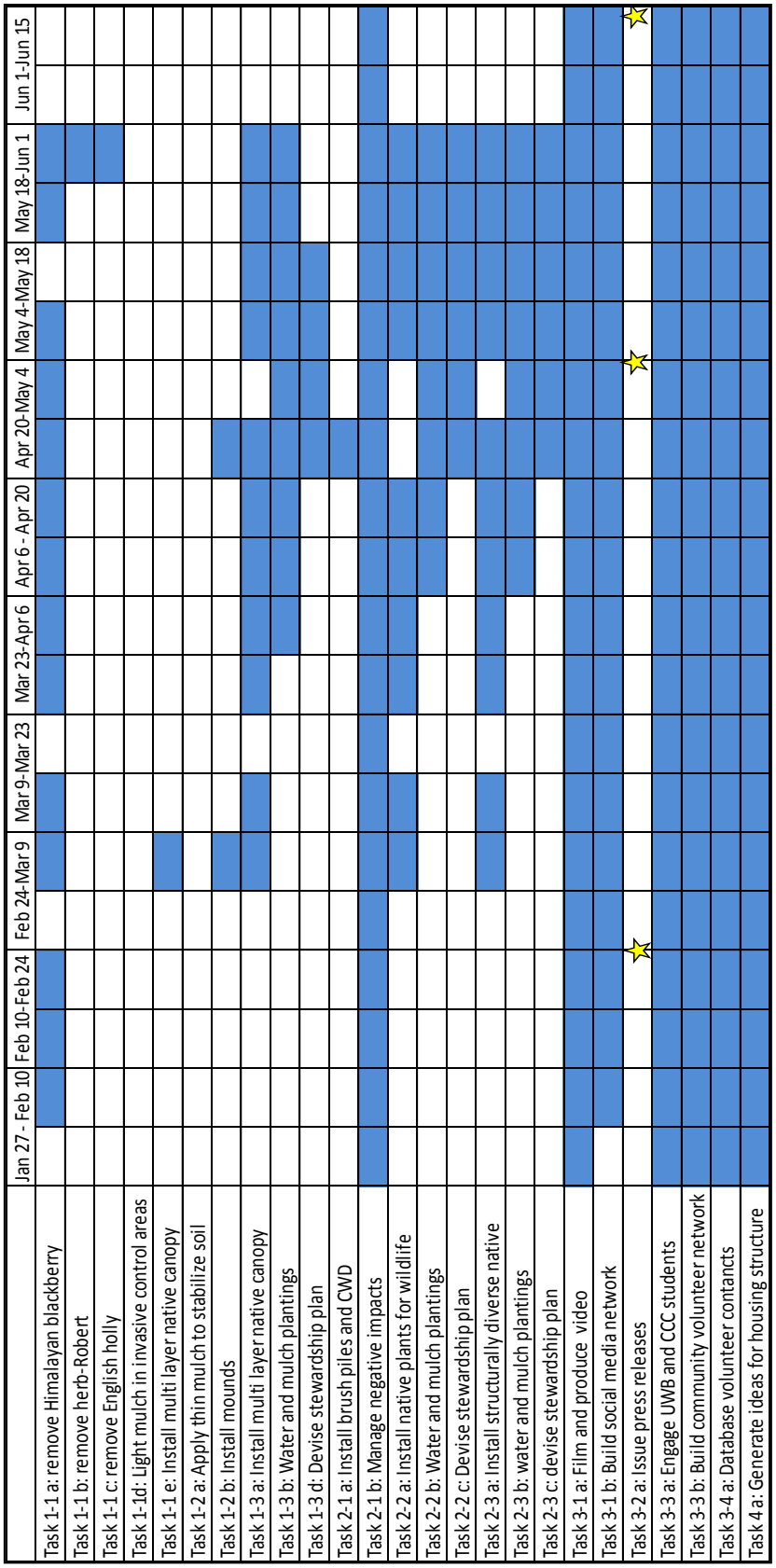
Sketch:



4. Work timeline (planned)



Work timeline (actual)



5. Design for the Future

5.1 *Stewardship expectations and development plan*

The CP is currently in the process of turning the property our project site is on over to the city of Bothell. Upon completion of our project the CP will be responsible for the stewardship of the project site until the city takes over. The types of stewardship activities we believe the CP should support includes mitigation against re-invasion of non-native species and introductions of new invasive species, maintaining and replacing plant material, and making sure the site is properly irrigated.

We also encourage our CP to continue to work with the UW-REN program and allow future students to maintain and continue restoration and conservation on and adjacent to our site. The CP has commitments of over 1000 hours of volunteer labor, and we will share our volunteer contacts we make during the course of the project to strengthen the pool of volunteer resources available to the CP for maintenance activities. We also encourage our CP to continue stewardship activities via volunteer work parties and events. At these events we encourage our CP to invite local horticulturists and gardeners / restoration experts to speak to volunteers about how their activities are helping the conservation and restoration of NCF.

The ideas we provide the CP for educational content of future work parties and interpretative materials will aid in providing a rich experience for the community in the future, and help to maintain ties between our project and surrounding schools which are looking for environmental education opportunities.

5.2 *Project design and stewardship*

The design of various aspects of our project fit within our stewardship expectations for the long term success of this project. We have chosen native plants specifically suited for the forest and have taken measures to insure that they flourish. We have devised a plan for watering the plants that we have installed and will inform our CP how to properly dispense water during the summer. We have also made suggestions for an irrigation system to be built and recently have discovered an outdoor faucet on our site. We are contacting our CP to see if it can be turned on. This will help drive the succession of plant species, which is vital to our long term vision.

AD17: The outdoor faucet could not be turned on, and the team used the hose system installed by the CP to water the installed vegetation.

Using community volunteers, providing educational opportunities to students and community, and installing art for the enjoyment of the community are also parts of our design for the future. This will empower our vision by creating a positive relationship with the community and connecting the community with the CP which is an important aspect to the long-term stewardship of this project.

Also, using digital media will build awareness for the effort to conserve the North Creek Forest by bringing awareness to what we've done as UW-REN students and to aid the CP in purchasing and conserving more of the forest, obviously important to the long term stewardship of our site and sites adjacent to ours.

Lastly, we will be creating a long term maintenance plan for our community partner so that they will have a tool to guide them in regards to proper restoration and conservation efforts.

Lessons Learned

Labor plan

Implementation of restoration took 70% of planned time (see labor budget, section 3.3.1 of as-built report). Ratios of team to volunteer effort were roughly as planned; one exception is planting in polygon 2, which took more team than volunteer effort. The majority of the effort in polygon 2 planting hours from the team came from supplemental watering, a task we included in the planting category. Manually watering installed plants was challenging, as it required flexibility to respond to the weather. We learned that it is a good idea to have arrangements for weekly volunteer work parties as weather heats up if manual watering is the only option. Ideally, an irrigation system is in the budget, and as we move on to projects not constrained by the academic schedule, plants are installed in the fall to give time for optimal root development before hot weather sets in. The effort spent watering reinforces the value of these two approaches.

Originally, the team planned to make time before volunteer events to stage plant material on the project site. For some work parties, the team was unable to do that, and the extra time managing volunteers in the placement of plant material was substantial. This experience demonstrated the value of staging materials beforehand.

Budget plan

We spent less on plants than we originally planned. We knew going into the project that the CP would not be able to lend a substantial amount of support because they were devoting their funds to purchasing 35 acres of the North Creek Forest for conservation. We found that we were able to get free plant material fairly easily and that offering advertising to one nursery was a good way to get donations – which speaks to the importance of having signage, a webpage, or other platform were recognition/advertising can be posted. We were unable to make the time to collect live stake material to bring down costs even further. This is due in part to the timing of the academic year: we were finalizing our planting plan during the last weeks of the season when staking species was ideal, and we as a team were unable to make time to collect live stake material before dormancy ended. The challenges inherent in doing restoration under the constraints of the academic year were made clear to us by capstone instructors at the outset; facing those challenges instilled in us the value of following the recommended schedule of implementing projects in the fall and winter.

The team also learned a lot about where the best prices on plant material and what time of year sales are happening. Our experience rushing to finalize our planting plan to take advantage of cheap King Conservation District prices again re-enforced the value of following the recommended schedule and not the academic schedule.

Planting plan

Not including mosses used in the art installation, we obtained 81% of the species outlined in the planting plan (Table 2). Attempting to locate sources for all of the species was informative in what species are generally easily propagated and available in nurseries and what species are less easy or very difficult to propagate, and were salvaging is the best bet for obtaining them. Pacific dogwood is an example of a hard species to obtain, as it is often sold as a hybrid which is not consistent with native biodiversity conservation goals. In contrast, Douglas-fir was very easy to obtain in large quantities at no cost. Our experience with the variability in the availability of plant material will inform our strategies for future restoration projects.

Some on the team learned firsthand that installed plant material will deal with shock by dropping their leaves, and appear to be dead for a while before sending out new leaves. This experience illustrated why it is important not to spend time removing installed plant material.

When the team conducted a site assessment in the fall, we tested soils by digging soil pits at a recommended density that theoretically would capture a representative sample of the soils across each polygon. However, as we cleared Himalayan blackberry, we found that soils were generally less well drained in polygon 1 than our sampling areas. Some minor changes in the planting plan were made to accommodate; for example we lowered oceanspray and tall Oregon-grape numbers and increased the numbers of species with a wider tolerance range of soil wetness, i.e. thimbleberry. Luckily most of the species we selected for polygon 1 had a wide enough tolerance of soil water content to match the conditions of the polygon; in another environment were plants species are more specialized, we may have had a serious issue on our hands as we had already purchased plant material when we discovered the soils were not as well drained as we had previously thought. While time constraints limited the depth of the soil analysis we could conduct, this experience demonstrated to us the potential issues with sampling size when conducting a site assessment.

Appendix 1: Literature Cited in As-Built Report

Anderson CM. 1997. Native Plant Alliance Manual of Native Plant Communities for Urban Areas of the Pacific Northwest. Seattle (WA): Cascade Biomes, Inc.

Carey AB, Harrington CA. 2001. Small mammals in young forests: implications for management for sustainability. Forest Ecology and Management [Internet]. 154: 289-309.

Chalker-Scott L. 2009. Sustainable Landscapes and Gardens: good science – practical application. GFG Publishing.

Chappell CB. 2006. Upland plant associations of the Puget Trough ecoregion, Washington. Natural Heritage Rep. 2006-01. Olympia (WA): Washington Department of Natural Resources, Natural Heritage Program. Available from http://www1.dnr.wa.gov/nhp/refdesk/communities/index.html.

Clewell & Aronson, A. and Aronson, J. 2007. Ecological Restoration. Washington (DC): Island Press.

Costanza R, D'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, and ven den Belt M. 1997. The value of the world's ecosystem services and natural capital. Nature [Internet] 387: 253-260.

Franklin JF, Dyrness CT. 1988. Natural Vegetation of Oregon and Washington (Revised ed). Corvallis (OR): Oregon State University Press.

Gold W. 2011. Restoration and ecological principles. University of Washington, Bothell BES 462 October 14 class lecture

Gold W. 2012 January 18. Personal communication.

Groom M, Meffe GK, Carroll CR. Chapter 7: Habitat Fragmentation. Principles of Conservation Biology. 3rd ed. Sunderland (MA): Sinauer Associates, Inc.

[GSP] Green Seattle Partnership. n.d. Forest Steward Field Guide [Internet]. [Cited 2012 January 22]; Available from http://greenseattle.org/forest-steward-resources-1/forest-steward-field-guide

King County. 2007. Weed Alert: Herb Robert (*Geranium robertianum*) [Internet]. (WA): King County Noxious Weed Control Program. Available from: http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/Herb_Robert_Factsheet.pdf

King County. 2008. Weed Alert: English holly (*Ilex aquifolium*) [Internet]. (WA): King County Noxious Weed Control Program. Available from: http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/English-Holly-Fact-Sheet.pdf

Kruckeberg, AR. 1991. The Natural History of Puget Sound Country. Seattle (WA): University of Washington Press.

Leigh M. 1999. Grow Your Own Native Landscape: A Guide to Identifying, Propagating, and Landscaping with Western Washington Native Plants. WSU Cooperative Extension Publication MISC0273.

Leopold A. 1966. A sand county almanac. Oxford University Press, New York, New York, U.S.A.

Loucks OL. 1970. Evolution of diversity, efficiency, and community stability. American Zoologist 10:17-25.

Marion, Jeffrey L. 1998. Recreation ecology research findings: Implications for wilderness and park managers. In: Proceedings of the National Outdoor Ethics Conference, April 18-21, 1996, St. Louis, MO. Gaithersburg, MD: Izaak Walton League of America. pp. 188-196. .

Molles MC (Jr). 2008. Chapter 22: Geographic Ecology. Ecology: Concepts and Applications. New York (NY): McGraw Hill.

Norse, E. 1990. Ancient Forests of the Pacific Northwest. Washington, D.C.: Island Press.

Pojar J, Mackinnon A. 1994. Revised Plants of the Pacific Northwest Coast. Auburn (WA): Lone Pine.

Shaw S. 2011. Invasive Plants: Identification and Management. University of Washington, Bothell BES 463 November 18 guest lecture.

[SNP] Sound Native Plants. 2001. Environmental Conditions Favorable for Establishment of Outplanted/Transplanted Plants. Olympia (WA): Sound Native Plants.

Stinson C, Fisher G, Johnson B. 1998. Native Plants for Wildlife. Seattle: King County Wildlife Program.

Stokes D. 2012 January 23. Personal communication.

Sutherland D. 2005. Definition and Inventory of Old Growth Forests on DNR-Managed State Lands [Internet]. [cited 2011 December 5]; Olympia (WA): Washington Department of Natural Resources. Available from http://www.dnr.wa.gov/Publications/lm_ess_westside_oldgrowth_rpt.pdf

Wright, Richard. 2010. Environmental Science: toward a sustainable future. 11th edition. Pearson Education inc. Upper Saddle River, New Jersey.

Appendix 2: Abbreviations used in Figure 4

ACCI:	*Acer circinatum*	vine maple
MANE*:*	*Mahonia nervosa*	dwarf Oregongrape
OECE:	*Oemleria cerasiformis*	Indian plum
POMU:	*Polystichum munitum*	sword fern
RUAR:	*Rubus armeniacus*	Himalayan blackberry
RUSP:	*Rubus spectabilis var. spectabilis*	salmonberry
TOME:	*Tolmiea menziesii*	piggy-back plant