Project Management Tool Kit and Handbook for SER-UW Restoration Sites

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Overview

Ecological restoration is "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (Society for Ecological Restoration 2004), allowing it to "resume its historic trajectory" (Clewell and Aronson 2013). *International Standards for the Practice of Ecological Restorations* (McDonald et al. 2016) clearly articulated the key concepts to be employed when approaching a restoration project. These include the selection of an appropriate local native reference ecosystem and identifying attributes within said system, which would allow clear setting of goals and objectives of the project. All the while, one must be cognizant that restoration is often a slow progress with potential environmental changes and ongoing impacts that might require adjustments to management plans and even goals and objectives. Solid ecological and cultural knowledge base associated with the project and the early engagement of stakeholders are also essential to the long-term success of any restoration project.

Ecological restoration often involves, but is not limited to, removal of invasive plant species and planting of native vegetation. However, the mere installation of a restoration plan does not guarantee that it will bring about the desired results. Setting performance standards and monitoring the project over time are essential in determining if a project has met its goals and objectives in any point in time (Van Staveren et al. 2006; Howell et al. 2012; Rieger et al. 2014) and in facilitating any necessary changes in order for it to meet those objectives; in other words, in practicing adaptive management in ecological restoration (Howell et al. 2012; Clewell and Aronson 2013).

Society for Ecological Restoration, University of Washington Chapter (SER-UW) provides opportunities for students to design and manage multiple ecological restoration projects on campus. The *Project Management Tool Kit and Handbook for SER-UW Restoration Sites* (hereafter to be referred to as the *Handbook*) is modeled after similar guidelines established by organizations such as EarthCorps, Nature Consortium, and Green Seattle Partnership Forest Steward Program. It will provide a comprehensive resource, facilitate smooth transition of management, and ensure the sustainability and long-term success of restoration projects, which often have many first-time project managers and high turnover. It will also provide a schema,

database, and knowledge base on which to build upon as SER-UW acquires more restoration projects in the future.

From the initiation to the completion and handover of a restoration project, student project managers will find guidance in the *Handbook* to perform the following tasks.

New Projects

Project Initiation

- perform site analysis and collect site data (**Restoration Project Development and Management**)
- collect geodata and create site map (**Geodatabase**)
- establish goals and objectives for project (**Restoration Project Development and Management**)
- create restoration plan (**Restoration Project Development and Management**)
- document the progress of the project and organize the records generated (**Documentation and Data Tracking**)

Project Closeout

- meet with SER-UW officers to discuss transfer of management (**Contact List**)
- produce final as-built report or project summary report (**Succession Planning**)
- create site description datasheet (**Succession Planning**)
- update interactive web map on the SER-UW website (**Geodatabase**)
- upload all relevant documents onto the SER-UW Google Drive (**Succession Planning**)
- update the SER-UW Restoration Sites Contact List on the SER-UW Google Drive (**Contact List**)

Maintenance Project

Project Initiation

- take inventory of current site conditions (**Restoration Project Development and Management**)

- review existing restoration plan and create (adaptive) management (**Restoration Project Development and Management**)
- document the progress of the project and organize the records generated (**Documentation and Data Tracking**)
- update SER-UW Restoration Sites Contact List on the SER-UW Google Drive (**Contact List**)

Project Closeout

- meet with SER-UW officers to discuss transfer of management (**Contact List**)
- produce project summary report (**Succession Planning**)
- upload all relevant documents onto the SER-UW Google Drive (**Succession Planning**)
- update SER-UW Restoration Sites Contact List on the SER-UW Google Drive (**Contact List**)

The *Handbook* will continue to be an evolving entity. The combined efforts of SER-UW officers and student project managers to ensure that all the project closeout tasks listed above are performed will ensure that the *Handbook* remains current and relevant in the years to come.

How to Use This Tool Kit and Handbook

The *Handbook* is intended for the use by all those interested in managing and doing research on any of the SER-UW restoration sites. All the information mentioned in the *Handbook* is stored on the SER-UW Google Drive and the names of folders, sub-folders, and files will be in italic, e.g. *SER-UW* > *Restoration Sites* > *GIS Data*. SER-UW officers can grant access to students interested in utilizing the information. The *Handbook* will also be available through the SER-UW website.

SER-UW is involved with restoration sites on Main Campus, at Union Bay Natural Area (UBNA), and Yesler Swamp. These sites are in areas managed by University of Washington Grounds Maintenance (UW Grounds) and University of Washington Botanic Gardens (UWBG). The general history, description, and plan of each site as well as its restoration status at the time of writing can be found in the **Site Information** section. Contact information for staff members of the partnering departments is also listed in that section. Information about each site will be available in the SER-UW Google Drive, which will be updated regularly. The **Geodatabase** section details the GIS data available and how they are managed and organized.

The **Restoration Project Development and Management** section includes information on how to plan and manage a restoration project, guidelines on how to work with the SER-UW Native Plant Nursery in plant material procurement, information on invasive plant species plant control, and resources on plant species selection and installation.

SER-UW depends heavily on volunteers to implement restoration plans. Therefore, efficient planning and execution of volunteer work parties is paramount in the overall success of any of these projects. The **Work Party and Volunteer Event Operations** section provides a detailed guide to the logistics of planning and hosting a restoration work party.

Good record-keeping and data management are extremely important for the long-term success and sustainability of any restoration project. A schema for project records, such as restoration plans, plant lists, work logs, maintenance and monitoring plans, and records, etc. is included in the **Documentation and Data Tracking** section.

The **Succession Planning** section presents a guideline on how to prepare for the handover of a site to a new student project manager. This includes a checklist of documents that should be uploaded onto the SER-UW Google Drive.

While contact information for staff members of partnering departments is provided throughout the *Handbook*, all of these and additional information are included in the **Contact List** section. The **Other Resources** section contains a list of online resources as well as relevant courses offered by the University of Washington that may be of interest to students interested in restoration ecology and the practice of ecological restoration.

Site Information

All SER-UW restoration sites fall into one of three general categories: Main Campus, Union Bay Natural Area (UBNA), and Yesler Swamp. Sites on Main Campus are managed by UW Grounds and those in UBNA and Yesler Swamp are managed by UWBG. The sites on which SER-UW has worked in the past, is currently restoring, or those that the club has been given permission to work on if and when human resources are available are listed in Table 1 and mapped on Figure 1. These are followed by the datasheets for each of the 28 sites.

Site Number	Site Name	Managing Department	Site Category
1	Snaggle	UW Grounds	Main Campus
2	Doug-Fir	UW Grounds	Main Campus
3	Paccar Hall West	UW Grounds	Main Campus
4	Paccar Hall East	UW Grounds	Main Campus
5	Kincaid Ravine	UW Grounds	Main Campus
6	Whitman Walk	UW Grounds	Main Campus
7	Amphibian Corridor	UWBG	UBNA
8	Waterfront Corner	UWBG	UBNA
9	Pollinator Hedgerow	UWBG	UBNA
10	Prairie Rain Garden	UWBG	UBNA
11	Centennial Woods	UWBG	UBNA
12	South Puget Sound Prairie	UWBG	UBNA
13	Mitigation Unit W1A	UWBG	Yesler Swamp
14	Mitigation Unit W1B	UWBG	Yesler Swamp
15	Mitigation Unit W2	UWBG	Yesler Swamp
16	Mitigation Unit W3	UWBG	Yesler Swamp
17	Mitigation Unit W4	UWBG	Yesler Swamp
18	Mitigation Unit W5	UWBG	Yesler Swamp
19	Mitigation Unit W6A	UWBG	Yesler Swamp
20	Mitigation Unit W6B	UWBG	Yesler Swamp
21	Mitigation Unit W7	UWBG	Yesler Swamp
22	Mitigation Unit W8	UWBG	Yesler Swamp
23	Mitigation Unit W9	UWBG	Yesler Swamp
24	Mitigation Unit U1	UWBG	Yesler Swamp
25	Mitigation Unit U2	UWBG	Yesler Swamp
26	Mitigation Unit U3	UWBG	Yesler Swamp
27	2016-17 Capstone 2	UWBG	Yesler Swamp
28	Trailhead Prairie	UWBG	Yesler Swamp

Table 1 List of SER-UW restoration sites.

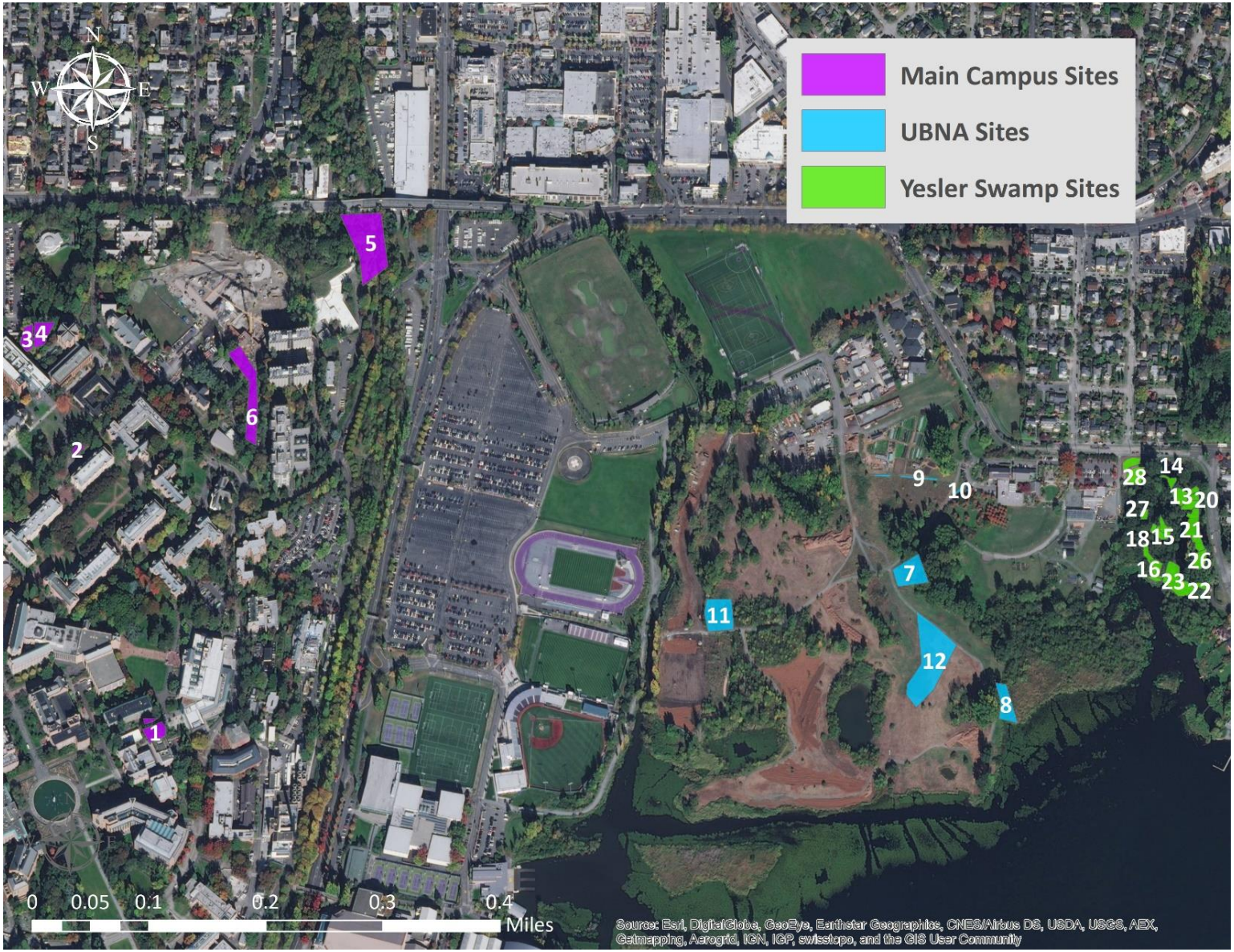


Figure 1 Map of SER-UW restoration sites.

Main Campus Sites

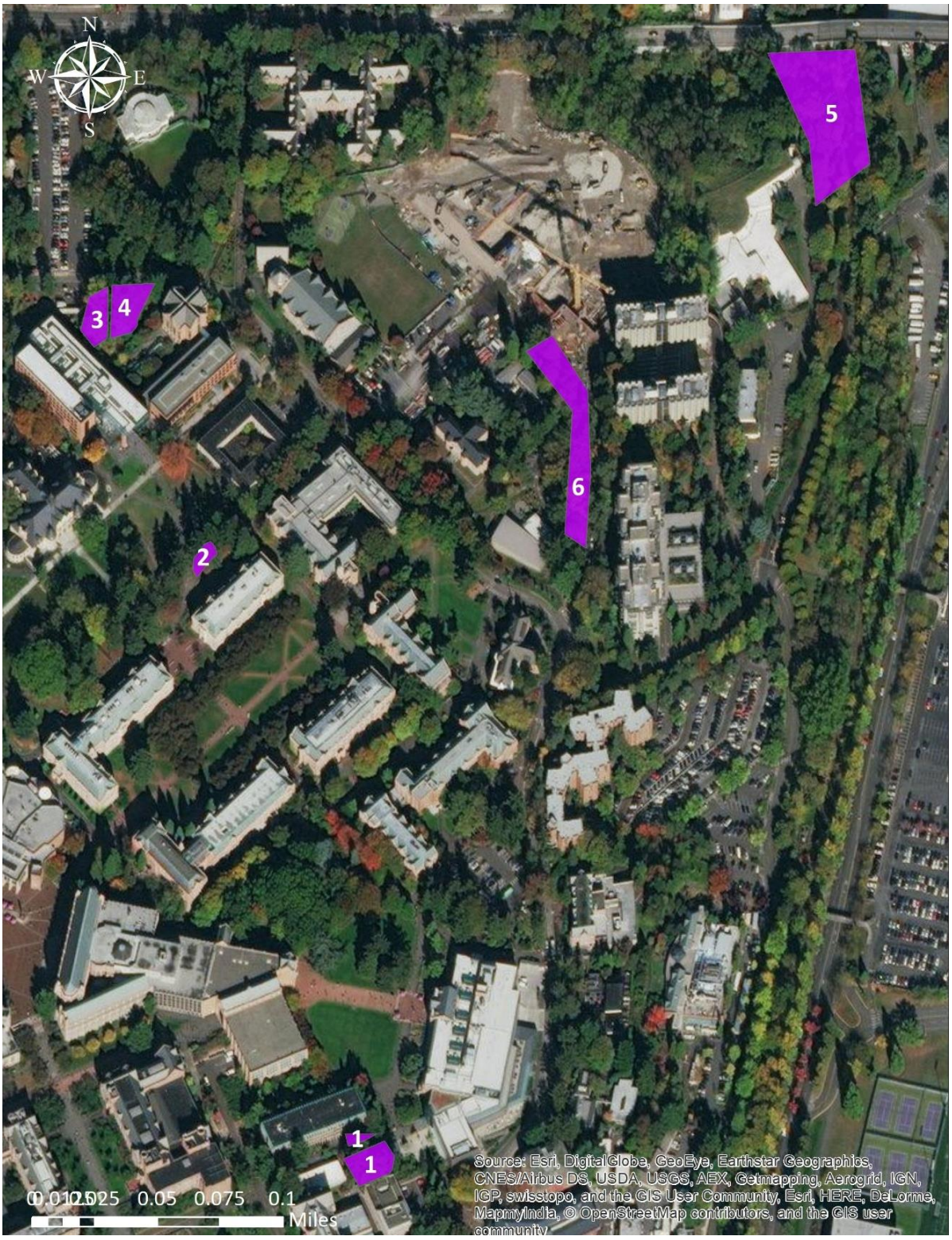
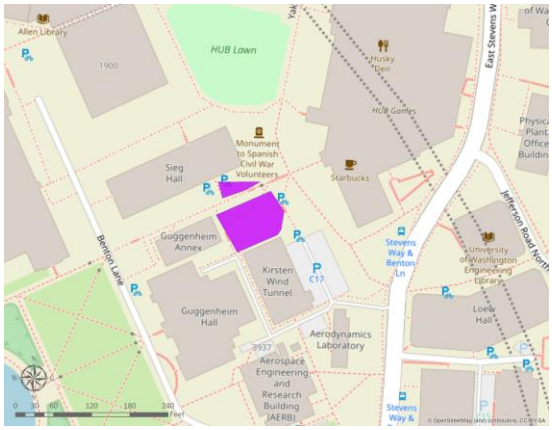


Figure 2 Map of Main Campus sites.

1 Snaggle



Department	UW Grounds
Site Category	Main Campus
Target Ecosystem	Puget Lowland Forest (Upland)
Size	7,000 sq. ft.
Contact	Tom Erler terler@uw.edu

Site Description

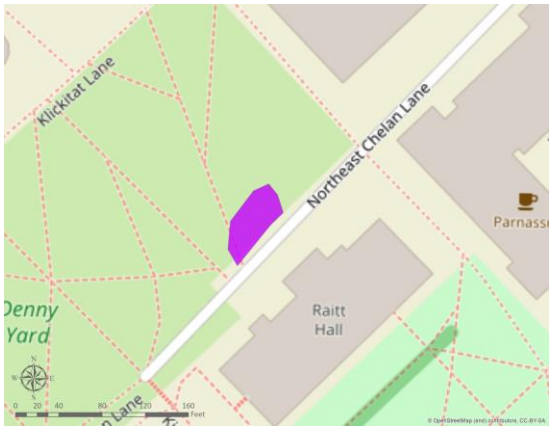
Named for the horse chestnut tree (*Aesculus hippocastanum*) snag on the site, this is a forested habitat just west of the HUB, between Sieg Hall and Guggenheim Hall. Although this site was already a great habitat for birds, the understory consisted of mostly invasive plant species such as Himalayan blackberry (*Rubus armeniacus*) and English ivy (*Hedera hibernica*). The UW Grounds crew started to remove these invasive plant species prior to SER-UW adopting this site in early 2017.

Since then, with the help of many volunteers and under the guidance of the UW Grounds crew, most of the invasive plants have been removed and a large number of native plants such as Pacific bleeding heart (*Dicentra formosa*), swordfern (*Polystichum munitum*), Pacific ninebark (*Physocarpus capitatus*), and vine maple (*Acer circinatum*) were installed.

In the spring of 2017, the horse chestnut tree on the site was treated with glyphosate and the remaining snag is a prominent habitat feature. Additional planting for the site was done in the fall of 2017 and ongoing invasive control will be needed to maintain the site.

Photos: A. Chan

2 Doug-Fir



Department	UW Grounds
Site Category	Main Campus
Target Ecosystem	Puget Lowland Forest (Upland)
Size	2,000 sq. ft.
Contact	Tom Erler terler@uw.edu

Site Description

This is a high-traffic area located in northeastern part of Denny Yard directly adjacent to the walkway. It was a mowed grassy area with a few mature Douglas-fir (*Pseudotsuga menziesii*). Without a shrub layer or diverse groundcover within the drip line of the trees, the roots of these Douglas-firs were not protected, and UW Grounds Maintenance was considering removal of the trees for safety concerns.

UW Grounds gardener and SER-UW liaison, Tom Erler, proposed planting an understory to protect the roots so as to deter the decision to take down the trees. In the spring of 2017, sheet mulching was done to eliminate the grass layer. Plant installation was done the winter of 2018. Understory plant species for this site include kinnikinnick (*Arctostaphylos uva-ursi*), Canada goldenrod (*Solidago canadensis*), oceanspray (*Holodiscus dicolor*), and thimbleberry (*Rubus parviflorus*).

Additional trees, such as western white pine (*Pinus monticola*) and Pacific madrone (*Arbutus menziesii*) were also planted.


Photo: A. Chan


Photo: A. Noble

3 Paccar Hall West

Department	UW Grounds
Site Category	Main Campus
Target Ecosystem	Puget Lowland Forest (Upland)
Size	5,100 sq. ft.
Contact	Tom Erler terler@uw.edu

Site Description

This forested site east of PACCAR Hall, between the building and Clallam Pl NE, started as a project for a graduate student from the Master of Environmental Horticulture program in 2016. This site had some established native plants as well as other horticultural species but there was also a significant layer of the invasive English ivy (*Hedera hibernica*). Multiple work parties have been held throughout 2017 to remove the ivy and install additional native plant species, including Pacific madrone (*Arbutus menziesii*), red osier dogwood (*Cornus sericea*), serviceberry (*Amelanchier alnifolia*), and oceanspray (*Holodiscus discolor*). The long-term management plan involves invasive species control, supplemental plantings, and installation of habitat features, such as bat box and owl perch.

4 Paccar Hall East

Department	UW Grounds
Site Category	Main Campus
Target Ecosystem	Puget Lowland Forest (Upland)
Size	7,100 sq. ft.
Contact	Tom Erler terler@uw.edu

Site Description

This forested site is situated next to Paccar Hall, west of Clallam Pl NE. This site already has many established native plants as well as other horticultural species. However, there is a significant layer of English ivy (*Hedera hibernica*) at this site that needs to be removed, and long-term management is required to prevent it from returning. Installation of additional native plants is recommended after ivy removal. A broken water line near this site results in the area getting quite wet in the summer, which should also be factor to consider when selecting plants for this site.

This site is available for restoration by SER-UW but had not yet been worked on at the time of writing.

Photos: A. Chan

5 Kincaid Ravine

Department	UW Grounds
Site Category	Main Campus
Target Ecosystem	Puget Lowland Forest (Upland and Wetland)
Size	1 ac.
Contact	Tom Erler terler@uw.edu

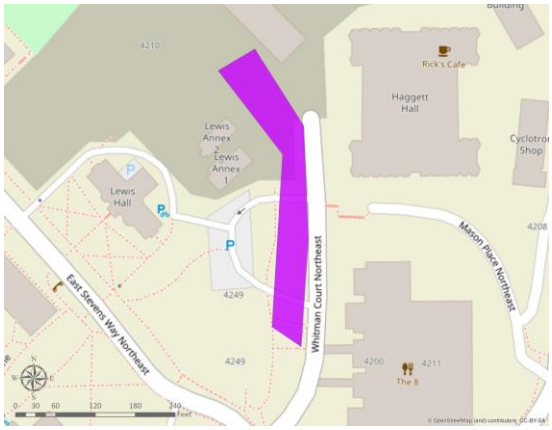
Site Description

Kincaid Ravine is a forested area located at the northeast corner of the UW campus along the Burke-Gilman Trail (Campus Sustainability Fund 2017a). The canopy of the ravine is composed mainly of deciduous trees, such as big leaf maple (*Acer macrophyllum*), black cottonwood, (*Populus trichocarpa*) and red alder (*Alnus rubra*), which are coming to the end of their natural lifespan; the understory is dominated by invasive plants species like English holly (*Ilex aquifolium*), English laurel (*Prunus laurocerasus*), Portuguese laurel (*Prunus lusitanica*), Himalayan blackberry (*Rubus armeniacus*) and English ivy (*Hedera hibernica*). SER-UW partnered with UW Grounds, UWBG, University of Washington-Restoration Ecology Network (UW-REN), and Earth Corps and started working on this site in 2013 using funding acquired through the Campus Sustainability Fund (CSF).

Native plants installed at this site, such as fringecup (*Tellima grandiflora*), swordfern (*Polystichum munitum*), salmonberry (*Rubus spectabilis*), Indian plum (*Oemleria cerasiformis*), red osier dogwood *(Cornus sericea*), and western red-cedar (*Thuja plicata*) have all established well. Long-term management involves invasive plant control. There is also potential for the restoration site to expand further westward into the ravine.

Photos: SER-UW Website

6 Whitman Walk



Department	UW Grounds
Site Category	Main Campus
Target Ecosystem	Puget Lowland Forest (Upland)
Size	0.5 ac.
Contact	Tom Erler terler@uw.edu

Site Description

This is a small forest tract located between Denny Field and McCarty Hall. SER-UW started managing this site in 2008 (Campus Sustainability Fund 2017c) when invasive species such as English ivy (*Hedera hibernica*) and Himalayan blackberry (*Rubus armeniacus*) had been the dominant understory. Over the next six years, most of the invasive species were removed and native plants, including swordfern (*Polystichum munitum*), tall Oregon grape (*Berberis aquifolium*), dull Oregon grape (*Berberis nervosa*), snowberry (*Symphoricarpos albus*), and Indian plum (*Oemleria cerasiformis*), were installed. The number of native species more than quadrupled, from 11 to 45 (Society for Ecological Restoration, University of Washington Chapter 2017).

Construction associated with the redevelopment of North Campus residence halls began in 2015. The management plan was to continue with maintenance during construction period through invasive plant removal and additional native plantings.

In the fall of 2016, a mixture of water and concrete overflowed into the restoration site, causing damage to part of the restored area. The construction company has cleaned up the site by removing most of the contaminated soil.

Due to limited access to the site as a result of ongoing construction, further restoration activity has been put on hold until access improves. The status of the site will have to be reassessed at that time, but restoration efforts would most likely involve replacing any of the damaged plants from the concrete spill and continued control of invasive plant species.


Photo: SER-UW Website

Union Bay Natural Area Sites

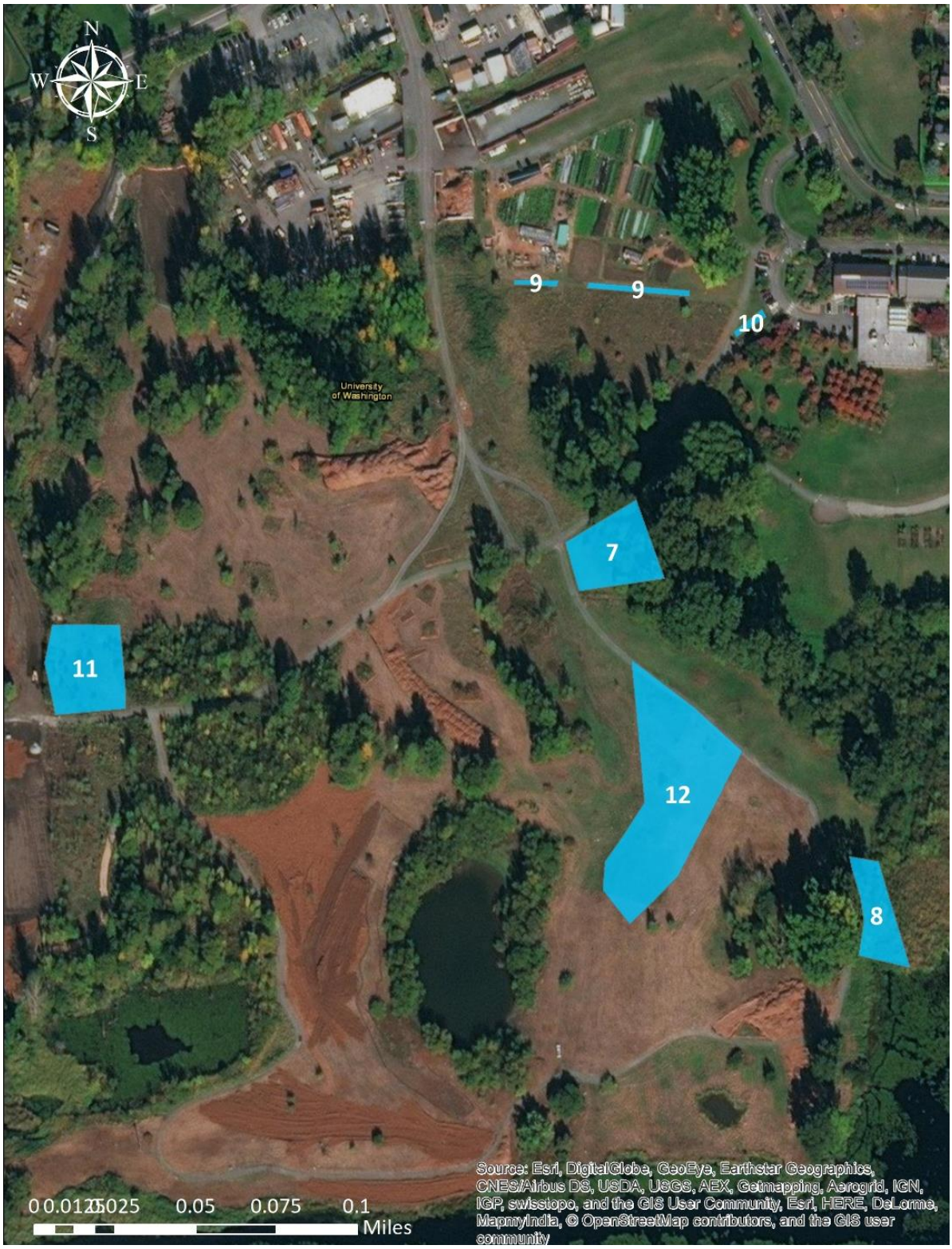


Figure 3 Map of Union Bay Natural Area sites.

7 Amphibian Corridor

Department	UWBG
Site Category	Union Bay Natural Area
Target Ecosystem	Puget Lowland Forest (Riparian) to South Puget Sound Prarie
Size	0.3 ac.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is a forested riparian habitat transitioning into an open prairie system along the trail in UBNA and encompassing an amphibian corridor restored in 2015 by a graduate student in the Master of Environmental Horticulture program (Walter 2015).

Dense vegetation along the water includes native species such as thimbleberry (*Rubus parviflorus*), Pacific ninebark (*Physocarpus capitatus*), Pacific willow (*Salix lucida ssp. lasiandra*), black cottonwood (*Populus trichocarpa*), and red alder (*Alnus rubra*). In the more open area along the amphibian corridor, species planted include red-flowering currant (*Ribes sanguineum*), salmonberry (*Rubus spectabilis*), and clustered wild rose (*Rosa pisocarpa*).

The more open area outside of the amphibian corridor was dominated by Himalayan blackberry (*Rubus armeniacus*) and various non-native grasses. Long-term management would involve removal of the invasive species and supplemental planting to establish a scrub shrub to prairie habitat.

Photos: A. Chan

8 Waterfront Corner

Department	UWBG
Site Category	Union Bay Natural Area
Target Ecosystem	Puget Lowland Forest (Riparian)
Size	9,500 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is a forested lakeshore habitat that transitions into an emergent wetland ecosystem. Restoration work has been focused on removal of invasive species such as bindweed (*Convolvulus arvensis*) and English ivy (*Hedera hibernica*) and native plant installation in the forested scrub shrub ecosystem.

Species planted at this site include thimbleberry (*Rubus parviflorus*), oceanspray (*Holodiscus discolor*), salmonberry (*Rubus spectabilis*), cascara (*Rhamnus purshiana*), and Pacific ninebark (*Physocarpus capitatus*).

Photos: A. Chan

9 Pollinator Hedgerow

Department	UWBG
Site Category	Union Bay Natural Area
Target Ecosystem	Puget Lowland Shrubland to Prairie for Pollinators
Size	2,400 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This agricultural hedgerow next to the University of Washington Farm was established by a graduate student in the Master of Environmental Horticulture program (Neumann 2016). The restoration plan was implemented in 2016 with the goal of restoring habitat for native pollinators. Plants installed include Canada goldenrod (*Solidago canadensis*), serviceberry (*Amelanchier alnifolia*), mock orange (*Philadephus lewisii*), and evergreen huckleberry (*Vaccinium ovatum*). Additional plants have been installed since, and ongoing monitoring, supplemental plantings, and invasive plant management are needed for long-term maintenance.

Photos: A. Chan

10 Prairie Rain Garden

Department	UWBG
Site Category	Union Bay Natural Area
Target Ecosystem	Puget Lowland Shrubland
Size	750 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

The Prairie Rain Garden along Wahkiakum Lane was a student project installed in 2015 (Howard 2015; Campus Sustainability Fund 2017b). The goal of the project was to help manage the runoff from the parking lot uphill from the site into UBNA. Native plant species such as snowberry (*Symphoricarpos albus*) and yarrow (*Achillea millefolium*) have established well at this site, and the focus at this site in the long run is invasive species control.

Photos: A. Chan

11 Centennial Woods

Department	UWBG
Site Category	Union Bay Natural Area
Target Ecosystem	Forested upland
Size	0.4 ac.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

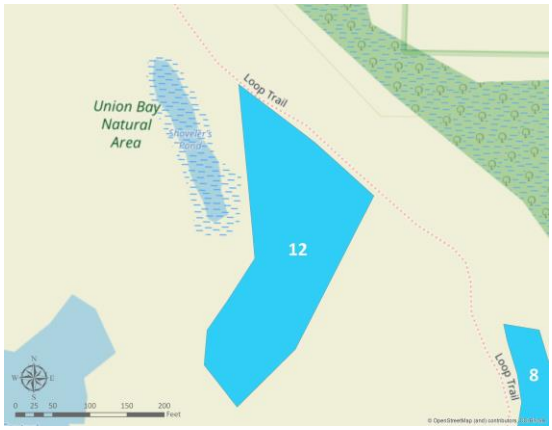
Site Description

This wooded area was restored in 2014 as part of a Master of Environmental Horticulture graduate student project (Diemer 2014). The goal was to observe the performance of tree species native to the Pacific Northwest and those from warmer climate zones in the face of changing climate. Some of the trees, such as Douglas-fir (*Pseudotsuga menziesii*), shore pine (*Pinus contorta*), and incense cedar (*Calocedrus decurrens*), have established well, but the understory is dominated by invasive species and is lacking in native shrubs or forbs.

A large-scale restoration project has been implemented around this site, including major earthwork, which has affected the topography and hydrology. Therefore, reassessment of the matrix of the site as well as the site itself is necessary when designing the restoration plan at this location.

Photos: A. Chan

12 South Puget Sound Prairie



Department	UWBG
Site Category	Union Bay Natural Area
Target Ecosystem	South Puget Sound Prairie
Size	1 ac.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This site comprises the class project sites for the ESRM 473 *Restoration in North America* classes during the winter quarters of 2013, 2014, 2015, 2016, and 2018. The goal of these projects was to restore the area to a South Puget Sound prairie ecosystem.

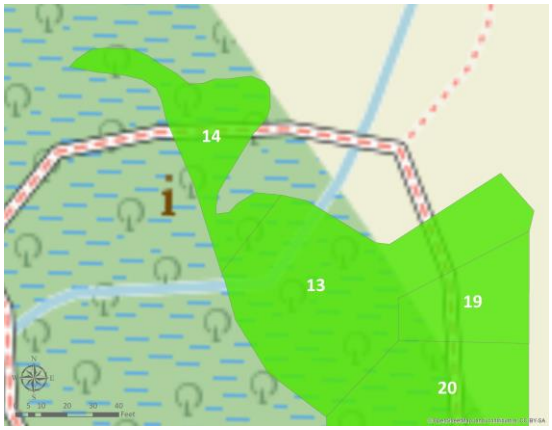
Species planted and established here include Idaho fescue (*Festuca idahoensis*), tufted hairgrass (*Deschampsia cespitosa*), and Oregon sunshine (*Eriophyllum lanatum*). Invasive species such as Himalayan blackberry (*Rubus armeniacus*) and sweet vernal grass (*Anthoxanthum odoratum*) have returned to the site since restoration was implemented. Long-term monitoring, control of invasives, and supplemental planting are recommended.

Photos: A. Chan

Yesler Swamp Sites

Figure 4 Map of Yesler Swamp sites.

13 Mitigation Unit W1A



Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forested Wetland
Size	5,100 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

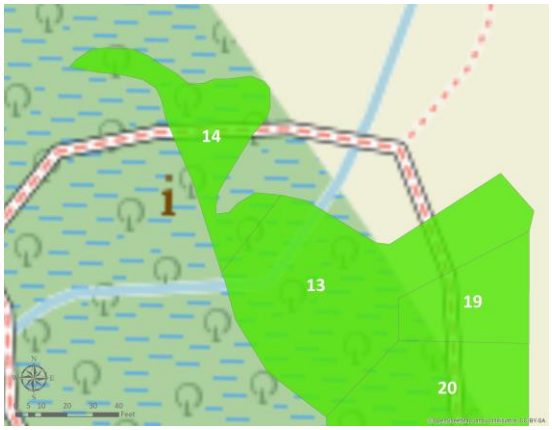
Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction of the boardwalk in Yesler Swamp (Touchstone Ecoservices 2012). This is a forested wetland, and the restoration plan was implemented in 2013 (Lockhart et al. 2013). Active maintenance and mitigation reporting is still being carried out (Denkers 2015b).

This site has high coverage of native species, including willows (*Salix spp*.), Pacific ninebark (*Physocarpus capitatus*), red osier dogwood (*Cornus sericea*), and black cottonwood (*Populus trichocarpa*). However, management of invasive species, such as English ivy (*Hedera hibernica*) and bindweed (*Convolvulus arvensis*) continues to be a challenge (Cerny-Chipman and Mallon 2016b).

Photos: Friends of Yesler Swamp

14 Mitigation Unit W1B



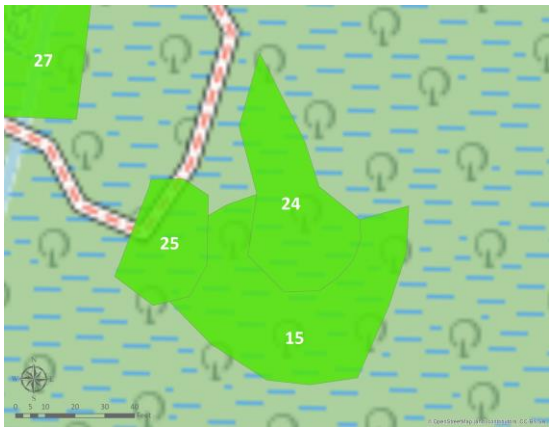
Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forested Wetland
Size	2,100 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the construction of the boardwalk through Yesler Swamp (Touchstone Ecoservices 2012). This is a forested wetland, and the restoration plan was implemented in 2016 (Cerny-Chipman and Mallon 2016a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

This site has high coverage of native species, including salmonberry (Rubus spectabilis), Pacific ninebark (*Physocarpus capitatus*), Sitka spruce (*Picea sitchensis*), and western red-cedar (*Thuja plicata*). However, management of invasive species, such as English ivy (*Hedera hibernica*), is an ongoing challenge (Long and Chan 2017b).

15 Mitigation Unit W2



Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Scrub Shrub Wetland
Size	2700 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is a scrub shrub wetland, and the restoration plan was implemented in 2015 (Denkers 2015a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

This site has high coverage of native species, including vine maple (*Acer circinatum*), red osier dogwood (*Cornus sericea*), and western red-cedar (*Thuja plicata*). However, management of invasive species, such as English ivy (*Hedera hibernica*), continues to be a challenge (Long and Chan 2017c).


Photo: Friends of Yesler Swamp

16 Mitigation Unit W3

Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forested Wetland
Size	3000 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is a forested wetland, and the restoration plan was implemented in 2015 (Denkers 2015a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

This site has high coverage of native species, including red osier dogwood (*Cornus sericea*), Sitka willow (*Salix sitchensis*), Pacific ninebark (*Physocarpus capitatus*), and western red-cedar (*Thuja plicata*). However, management of invasive species, such as reed canarygrass (*Phalaris arundinacea*), and protection of plants from beavers continue to be a challenge (Long and Chan 2017c).

A 2017-18 UW Restoration Ecology Network Capstone group has been tasked to further enhance this site.


Photo: Friends of Yesler Swamp

17 Mitigation Unit W4

Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Central Puget Lowland Freshwater Marsh
Size	1100 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is an emergent wetland, and the restoration plan was implemented in 2015 (Denkers 2015a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

This site has sparse coverage of native species, including cattail (*Typha latifolia*), common horsetail (*Equisetum arvense*), and common rush (*Juncus effusus*). Management of invasive species, such as reed canarygrass (*Phalaris arundinacea*), continues to be a challenge (Long and Chan 2017c). This site is located by a viewpoint on the boardwalk; during plant selection, plant height should be considered in order to keep the view unobstructed.

A 2017-18 UW Restoration Ecology Network Capstone group has been tasked to further enhance this site.

Photos: Friends of Yesler Swamp

18 Mitigation Unit W5

Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forested Wetland
Size	2,100 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description


Photo: Friends of Yesler Swamp

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is a forested wetland, and the restoration plan was implemented in 2015 (Denkers 2015a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

This site has high coverage of native species, including Sitka willow (*Salix sitchensis*), red-flowering currant (*Ribes sanguineum*), and black twinberry (*Lonicera involucrata*). However, management of invasive species, such as reed canarygrass (*Phalaris arundinacea*) and garden loosestrife (*Lysimachia vulgaris*), is an ongoing challenge (Long and Chan 2017c).

19 Mitigation Unit W6A

Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forested Wetland
Size	1,500 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is a forested wetland, and the restoration plan was implemented in 2013 (Lockhart et al. 2013). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

This site has high coverage of native species, including willows (*Salix spp*.), Pacific ninebark (*Physocarpus capitatus*), red osier dogwood (*Cornus sericea*), and black cottonwood (*Populus trichocarpa*). However, management of invasive species, such as English ivy (*Hedera hibernica*) and bindweed (*Convolvulus arvensis*), continues to be a challenge (Cerny-Chipman and Mallon 2016b).

Photos: Friends of Yesler Swamp

20 Mitigation Unit W6B

Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forested Wetland
Size	2,800 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is a forested wetland, and the restoration plan was implemented in 2017 (Alfaro-Wekell et al., 2017; Long and Chan 2017a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

Native species installed at this site include skunk cabbage (*Lysichiton americanum*), thimbleberry (*Rubus parviflorus*), salmonberry (*Rubus spectabilis*), and red elderberry (*Sambucus racemosa*). Native groundcover will need to planted once the newly planted shrub species shade out the invasive reed canarygrass (*Phalaris arundinacea*) at this site.

Photos: Friends of Yesler Swamp

21 Mitigation Unit W7

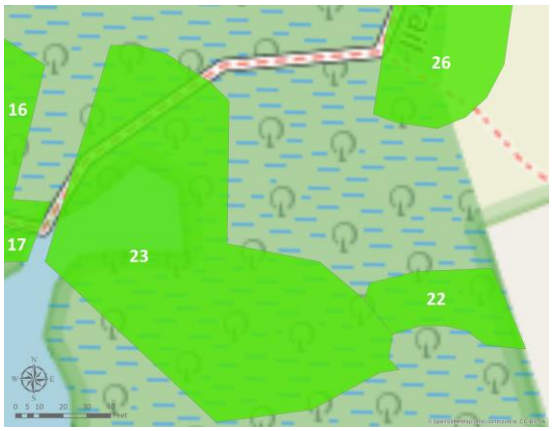
Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Scrub Shrub Wetland
Size	9300 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is a scrub shrub wetland, and the initial restoration plan was implemented in 2012 and was enhanced in 2017 (Cerny-Chipman and Mallon 2017; Long and Chan, 2017a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

Native species installed in this site include red-flowering current (*Ribes sanguineum*), red osier dogwood (*Cornus sericea*), Pacific Ninebark (*Physocarpus capitatus*), and Sitka spruce (*Picea sitchensis*). Native groundcover will need to planted once the newly planted shrub species shade out the invasive reed canarygrass (*Phalaris arundinacea*) at this site.

22 Mitigation Unit W8



Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Central Puget Lowland Freshwater Marsh
Size	1500 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

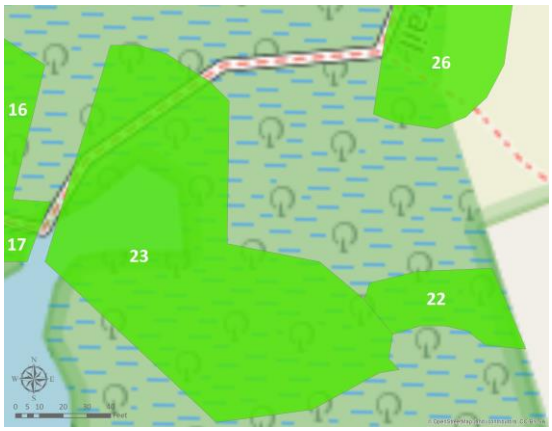
This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is an emergent wetland, and the restoration plan was implemented in 2016 (Cerny-Chipman and Mallon 2016a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

Large numbers of large-leaved avens (*Geum macrophyllum*) were planted at this site, but they appear to have poor survival. There was also a significant cover of invasive species, including English ivy (*Hedera hibernica*), English holly *(Ilex aquifolium*), and Portuguese laurel (*Prunus lusitanica*) (Long and Chan 2017b).

In the fall of 2017, much effort was put into invasive removal and planting of groundcover species like fringecup (*Tellima grandiflora*) and Pacific waterleaf (*Hydrophyllum tenuipes*).


Photo: Friends of Yesler Swamp

23 Mitigation Unit W9



Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Central Puget Lowland Freshwater Marsh
Size	11,950 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

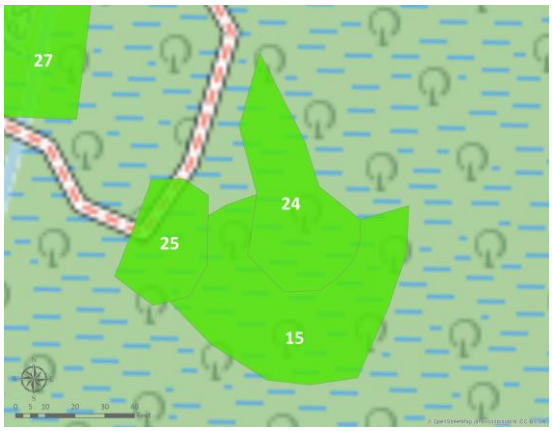
This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is an emergent wetland, and the restoration plan was implemented in 2016 (Cerny-Chipman and Mallon 2016a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015).

The hydrology at this site is in reverse to the norm in this region: human-controlled changes of water level in Lake Washington cause the site to be flooded in the summer and drained in the winter.

This unique hydrology creates challenges for plant establishment, and the native plant coverage of the site is only moderate. small fruited bulrush (*Scirpus microcarpus*) has done well here, and supplemental plantings with lakeshore sedge (*Carex lenticularis*) and tall mannagrass (*Glyceria elata*) was completed in 2017. Management of invasives, particularly reed canarygrass (*Phalaris arundinacea*), will continue to be a challenge at this site (Long and Chan 2017b).


Photo: Friends of Yesler Swamp

24 Mitigation Unit U1



Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forest (Upland)
Size	1,700 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

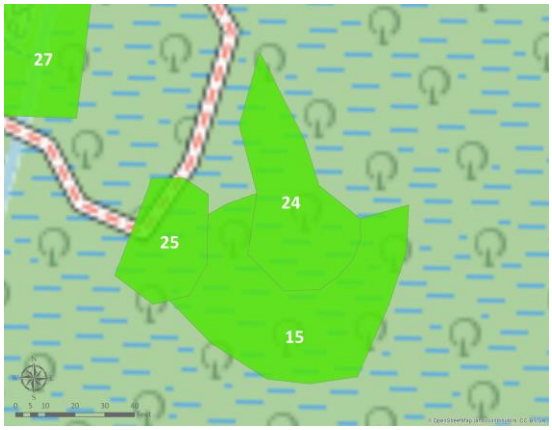
Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is an upland forested habitat, and the initial restoration plan was implemented in 2015 (Denkers 2015a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

This site has moderate to high native vegetation cover with species like common horsetail (*Equisetum arvense*), swordfern (*Polystichum munitum*), Indian plum (*Oemleria cerasiformis*), red osier dogwood (*Cornus sericea*), and western red-cedar (*Thuja plicata*). However, management of invasive species, like bindweed (*Convolvulus arvensis*) and reed canarygrass (*Phalaris arundinacea*), continues to be a challenge (Long and Chan 2017c).


Photo: Friends of Yesler Swamp

25 Mitigation Unit U2



Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Scrub Shrub (Upland)
Size	1,000 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is an upland shrub habitat, and the initial restoration plan was implemented in 2015 (Denkers 2015a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015b).

This site has moderate native vegetation cover with species like common horsetail (*Equisetum arvense*), swordfern (*Polystichum munitum*), vine maple (*Acer circinatum*), and Pacific ninebark (*Physocarpus capitatus*). The invasive species in this mitigation unit is well-controlled at this time, but close monitoring is required to maintain the condition (Long and Chan 2017c).

Photos: Friends of Yesler Swamp

26 Mitigation Unit U3

Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forest (Upland)
Size	3,900 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

This is one of the mitigation units in the compensatory mitigation plan for the negative impacts on wetlands as a result of the boardwalk construction in Yesler Swamp (Touchstone Ecoservices 2012). This is an upland forested habitat, and the restoration plan was implemented in 2016 (Cerny-Chipman and Mallon 2016a). Active maintenance and mitigation reporting is still being carried out following the guideline set in *The Wetland Mitigation Process in Yesler Swamp* (Denkers 2015).

This site has moderate to high native vegetation cover with species like common horsetail (*Equisetum arvense*), swordfern (*Polystichum munitum*), thimbleberry (*Rubus parviflorus*), Pacific ninebark (*Physocarpus capitatus*), and western red-cedar (*Thuja plicata*). However, management of invasive species, like bindweed (*Convolvulus arvensis*) and reed canarygrass (*Phalaris arundinacea*), continues to be a challenge (Long and Chan 2017b).

Photos: Friends of Yesler Swamp

27 2016-17 Capstone 2

Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	Puget Lowland Forest (Upland and Wetland)
Size	1,400 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

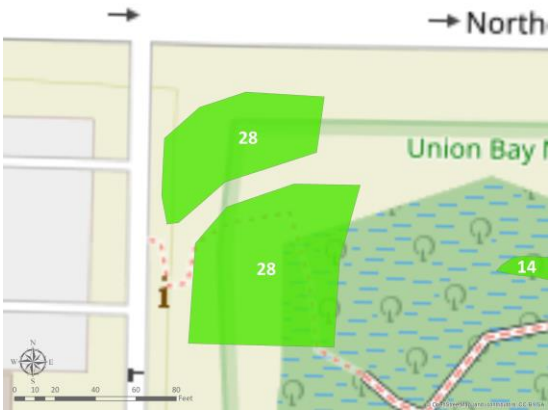
Site Description

This forested mixed upland and wetland site was restored by a group of students between October 2016 and March 2017 through the UW Restoration Ecology Network Capstone program (Wight et al. 2017).

The native plants installed have established well, and these include tall mannagrass (*Glyceria elata*), swordfern (*Polystichum munitum*), maidenhair fern (*Adiantum aleuticum*) Pacific ninebark (*Physocarpus capitatus*), and red elderberry (*Sambucus racemosa*). The biggest challenge at this project site is ongoing management and control of invasive plants, especially Italian arum *(Arum itlaicum*) and bindweed (*Convolvulus arvensis*).

Photos: A. Chan

28 Trailhead Prairie



Department	UWBG
Site Category	Yesler Swamp
Target Ecosystem	South Puget Sound Prairie
Size	5,400 sq. ft.
Contact	Jonathan Bakker jbakker@uw.edu David Zuckerman dzman@uw.edu

Site Description

Located at the Yesler Swamp trailhead, this was the project site for the ESRM 473 *Restoration in North America* class in winter 2017. The goal of this project was to restore a routinely mowed open area into a South Puget Sound prairie ecosystem. The site was prepared by the gardeners of UWBG, and plantings were done between January and March 2017.

Native prairie species such as Idaho fescue (*Festuca idahoensis*), tufted hairgrass (*Deschampsia cespitosa*), junegrass (*Koeleria macrantha*), common camas (*Camassia quamash*), Oregon sunshine (*Eriophyllum lanatum*), and yarrow (*Achillea millefolium*) were planted, and some established relatively well. Ongoing management of the site through supplemental planting and invasive plant management is needed.

Photos: A. Chan

Geodatabase

Geographic Information System (GIS) data for all the sites, in the form of Shapefiles and KMZ files, as well as an interactive web map (Figure 5), on the Google My Maps platform, are all stored in the SER-UW Google Drive (*SER-UW* > *Restoration Sites* > *GIS Data*). It was decided during the planning process of this management handbook that a web-based data management system would be the most appropriate for the GIS data for the SER-UW sites. The main reason is that all the organization's documents are already stored in the cloud to facilitate collaboration and information sharing among students. Furthermore, web-based GIS applications are user-friendly and can be easily incorporated into SER-UW's existing website.

Two web-based GIS platforms were considered: ArcGIS Online and Google Earth/My Maps. Both services are free and user-friendly, but while ArcGIS Online provides many more features and has greater GIS data analysis capability, enterprise accounts are required for easy data-sharing and collaboration. Meanwhile, Google Earth and Google My Maps are much more accessible to all UW students, and these services are also well-integrated with other online collaboration tools with which students are familiar.

While the web-based GIS platforms are user-friendly and have editing features, Esri ArcMap desktop application is a more powerful software with more functionalities. Therefore, the features and layers were created in ArcMap. The coordinates of a number of points on the restoration site boundaries were collected as waypoints with a Garmin GPS62st unit. These waypoints were used to draw polygons in ArcMap. These were then organized into various features and layers and saved as Shapefiles. They were then converted into KMZ files and imported into Google My Maps. Pop-ups with site information and photos are created for each site on the Google My Maps platform (Figure 6).

The web map is currently published on the SER-UW website. Additional information, such as location of invasive plants and monitoring photo points, may be added to this geodatabase over time. This platform allows the map to be added to an individual's Google account and accessed on Google Maps on a mobile device under the *Maps* tab in *Your Places* (Figure 7).

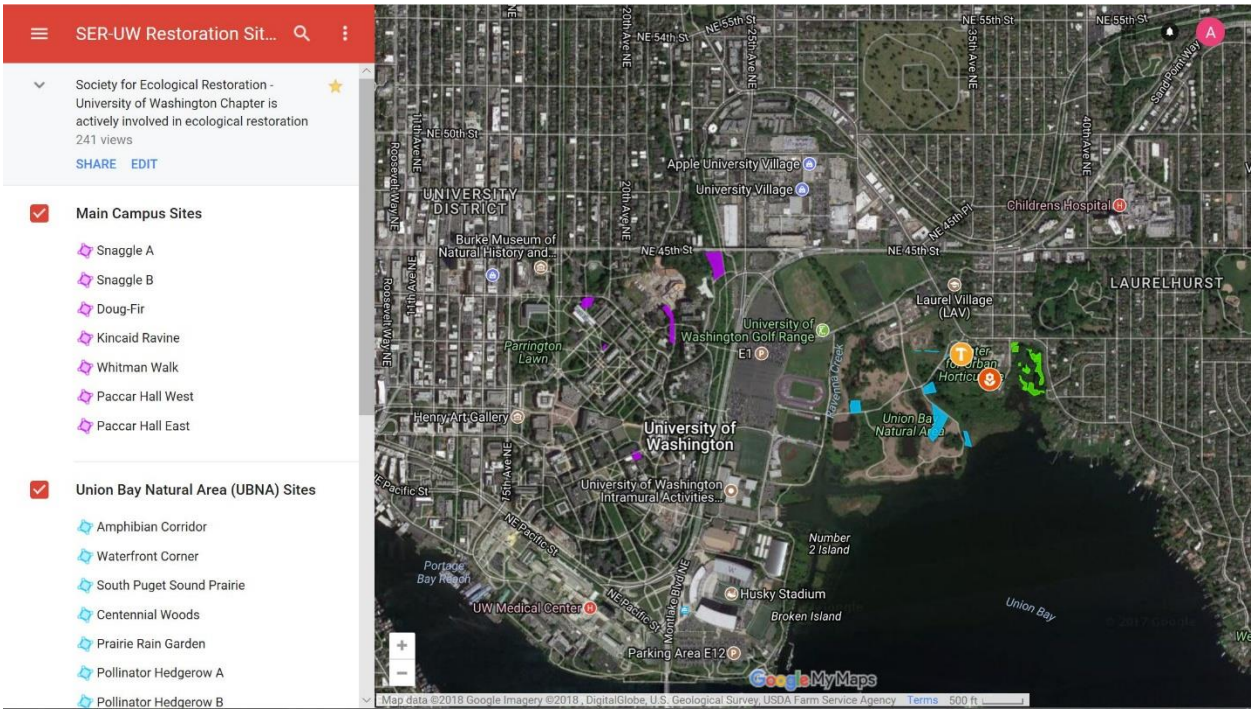


Figure 5 Interactive web map of SER-UW restoration sites.

Figure 6 Pop-up of one of the sites in the interactive web map.

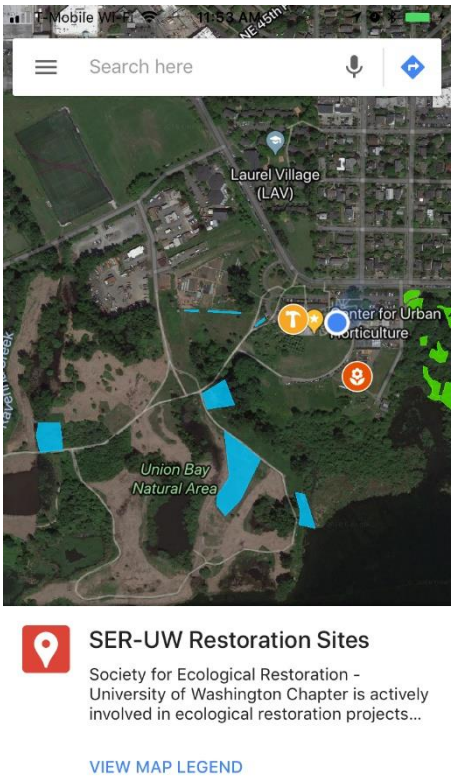


Figure 7 Screenshot of the interactive web map on a mobile device.

Restoration Project Development and Management

General Guidelines in Ecological Restoration

Many guidelines and approaches have been proposed for the planning and management of ecological restoration projects. Some of these include the *Standard Practices for Planning and Implementing Ecological Restoration Projects* (McDonald et al. 2016), *SER Guideline for Developing and Managing Ecological Restoration Projects* (Clewell et al. 2005), *Flexible Flow of Steps in Restoration Process* (Howell et al. 2012), *Five-Step Adaptive Procedure* (Tongway and Ludwig 2011), and *Four-Phase Framework* (Rieger et al. 2014). What all these guidelines and approaches have in common is the overall concept in the workflow for restoration projects: determine the current status of the project site and the target outcomes, decide and plan what needs to be done to achieve those outcomes, execute the plan, and follow up after implementation of the plan.

A number of items in these guidelines apply to projects of much larger scale and involve many more stakeholders compared to those undertaken by SER-UW. This section of the *Handbook* is an attempt to simmer down the concepts and ideas proposed in the above guidelines to something that is appropriate for the scale of restoration projects being done by SER-UW. The result is an approach that involves four sequential phases of project development and management. Appendix C is a site design and as-built report for the restoration of a section of the Yesler Swamp Trailhead Prairie and is an example of how these guidelines were used in an ecological restoration project.

Project Planning and Assessment

This phase of project development encompasses the conceptual planning and detailed assessments and inventories of the ecosystem properties of the project site (Clewell et al. 2005; Rieger et al. 2014). Conceptual planning provides the project manager with preliminary information about the site, and, in most restoration projects, the conceptual planning is done when ecological restoration may be a feasible option but before it has been determined to be the chosen option (Clewell et al. 2005). However, in the context of SER-UW restoration projects,

the sites have generally been identified by UW Grounds or UWBG as appropriate sites for students to manage and perform restoration work. Therefore, the student project manager will begin this phase already knowing the project site location, its boundaries, and the managing department. Very often, the history of the site, the reasons behind the need for ecological restoration, and the kind of ecosystem to be restored or the reference ecosystem has also been identified, but it is important for the project manager to be aware of these and take them into consideration while planning the project. In cases where a reference ecosystem has not been established, current site conditions, such as existing vegetation, soils, aspect, site use constraints, and so forth, should be taken into account when selecting a reference model. Detailed descriptions of all the ecosystem types that occur in Washington State (Washington State Department of Natural Resources 2018) can be found in the SER-UW Google Drive (*SER-UW* > *Restoration Sites* > *Restoration Resources*).

Besides setting goals to restore specific types of ecosystem or ecosystem functions, additional drivers may exist in an urban landscape, such as the UW Campus. These may include ecological goals like the establishment of a self-sustaining plant community that requires minimal maintenance and is ecologically resistant or resilient. The project may also have socioeconomic and cultural goals—for example, engagement of local residents within the university community, improvement of the general aesthetics of an area, and provision of educational and recreational opportunities.

For most situations, students will not need to be concerned with permit requirements and specifications or other legal constraints unless they are working on any of the mitigation units in Yesler Swamp; in that case, the student should work closely with the UBNA Manager and Ranger to ensure that all legal and regulatory requirements are met.

Over the years, SER-UW has established partnerships with various entities within the University (e.g., University of Washington Farm, ESRM 100 class, and Master of Environmental Horticulture program). While project managers are welcome to seek out other potential partnerships for their projects during the planning stage, they are also encouraged to fully utilize the existing partnerships.

The following are the main tasks involved in this phase of project development:

- Establish goals and objectives of the project. Goals define what the project is trying to accomplish while objectives are actions undertaken to achieve the goals.
- Perform detailed site analysis, and document the existing site conditions. This task includes, but is not limited to, documenting the ecological matrix, topography, soil condition, and hydrology; taking an inventory of the plant species and habitat features; taking photos of the site; and identifying the ongoing human impact/use. The *Green City Partnerships Monitoring Program Data Collection Methods* (Green Seattle Partnership 2013) provides details on how these baseline data can be collected (*SER-UW* > *Restoration Sites* > *Restoration Resources*).
- Identify threats to the site and plans for the removal or prevention of those threats. Examples include invasive weeds, homeless camps, and climate change.
- Identify, if any, restoration work or treatments that have been performed on the site in the past and the response to previous actions.
- Identify funding sources for the project. While most plant materials can be obtained from the SER-UW Native Plant Nursery through donations from the nursery (see **Working with the SER-UW Native Plant Nursery**), other materials and supplies may require additional funding. Other funding sources include the UW Campus Sustainability Fund, SER Northwest Chapter Student Research Grants, and Washington Native Plant Society Education Grants.

Project Design

The project design phase is when the project manager uses all the information and data collected during the previous phase to develop an implementation plan that would allow the achievement of the goals set for the project (Clewell et al. 2005; Rieger et al. 2014). Using concepts from the *Appreciate Design* model (Fridley 2017) and the *Five-Step Adaptive Procedure* (Tongway and Ludwig 2011), by establishing the functional requirements based on the project goals and identifying the constraints or limitations at the site, the project manager can establish design parameters, in other words, features or elements within the restoration project, that would meet

the functional requirements. It is imperative that the student project manager works closely with the representatives of the managing department and the SER-UW Native Plant Nursery Manager or representatives of other plant material sources, to ensure that the final project plan is appropriate and realistic for the site. Given the scale and scope of SER-UW restoration projects, earthwork and heavy construction tasks are usually not required. Therefore, a project design for one of these sites should normally include the following:

- Details about restoration tasks to be performed (e.g., invasive plant removal, soil amendments, plant installation, infrastructure installation, maintenance, monitoring, etc.)
- The timeline for said tasks. With the climate in the Pacific Northwest, plant installation is best done in the fall and in early spring to take advantage of the precipitation; this should be taken into consideration when scheduling various tasks.
- Plant species list and plant procurement plan.
- Planting plan.
- Irrigation plan (if applicable).
- Budget for the project (if applicable).
- Details on partnerships and collaborations (if applicable).
- A long-term maintenance and monitoring program with performance standards, or measurable thresholds, for evaluating whether and when the project goals and objectives have been met. An example of a monitoring program is outlined in the *Green City Partnerships Monitoring Program Data Collection Methods* (Green Seattle Partnership 2013).

Restoration Implementation

The restoration implementation phase is the one that most people think of when talking about ecological restoration. This is when the actual restoration tasks are being done, and while invasive plant removal, plant installation, and mulching are the most common tasks, this is also when plant material procurement and other site preparation tasks are done. The latter may include the following:

- marking boundaries
- installing stakes to mark monitoring locations and photo points
- placing herbivore deterrents, such as “blue tubes”, reflective tapes, and chicken wire
- installing habitat features, such as bat boxes, perches, and large woody debris
- installing signage and infrastructure

It is also imperative to engage the adaptive management process (Howell et al. 2012; Clewell and Aronson 2013) during this phase and make adjustments as needed if the installation does not go exactly according to the project plan. Changes may be needed at the time of installation, and these may lead to changes in the long-term maintenance and monitoring program. All work performed and any adjustments made should be documented, and detailed and accurate records should be kept. Photo documentation should also be done throughout the various stages of implementation. More details about record-keeping are discussed in the **Documentation and Data Tracking** section.

The bulk of the restoration work done at SER-UW sites is invasive plant removal and native plant installation. The techniques involved in these tasks are discussed in the **Invasive Plant Species Control** and **Plant Selection and Installation** sections. These tasks are generally accomplished by volunteers at work parties. The detailed logistics on how to organize and run a restoration work party are discussed in the **Work Party and Volunteer Event Operations** section.

Maintenance, Monitoring, and Adaptive Management

This is the final phase of restoration project development and is generally the phase that lasts the longest. The timeline for this phase varies depending on the individual projects, but typical maintenance and monitoring plans last about 10 years from the completion of the implementation phase (Howell et al. 2012). The purpose of this phase is to ensure that restoration efforts continue beyond the implementation phase and lead to the achievement of target trajectory of the restoration project (Rieger et al. 2014).

The following are some of the more common maintenance tasks:

- installation and/or removal of herbivore deterrents
- removal of pin flags and other flagging material
- garbage removal
- invasive plant species control
- additional/supplemental plantings
- mulching
- irrigation
- maintenance of signage and infrastructure

Restoration project monitoring involves the periodic measurement or observation of predefined indicators. The *Green City Partnerships Monitoring Program Data Collection Methods* (Green Seattle Partnership 2013), designed for urban forest ecosystems, provides a good framework after which student project managers could model their monitoring program. Modifications would be necessary to adapt it for other ecosystems, such as the prairie ecosystems in UBNA and Yesler Swamp.

The main components of monitoring tasks include the following:

- vegetation assessment (shrubs, vines, and herbaceous species)
- tree assessment
- habitat feature assessment
- photo documentation

Choosing an appropriate set of indicators during the design process will ensure that the data collected provide effective feedback for adaptive management, which is the coordination among "initial planning, monitoring, evaluation, and adjustment" (Apostol 2006). Natural communities may change and evolve over time; as such, restorations, which take multiple years to fully attain their project goals, may encounter changes that require periodic midcourse corrections (Howell et al. 2012). Based on the monitoring data, current restoration treatments or practices may need

to be refined in order for the project to meet its goals and objectives (Machmer and Steeger 2002). In some cases, even the goals, objectives, and performance standards themselves may need to be re-evaluated and updated to better reflect the need at the site. Factors that may influence the re-evaluation of site needs include new threats to the site (e.g., new invasive weed), changes to the surrounding land use, or climate change.

Monitoring results would show if restoration efforts to date (1) have successfully met the performance standards, (2) have failed to meet the performance standards, or (3) are on the right track but need improvement. With the last two results, it is important to figure out the underlying reasons; the lessons learned would form part of the knowledge base for formulating new management plans (MacDonald et al. 2016). For restoration treatments that are on the right track, project managers can generally double down on the original effort and be successful in meeting performance standards at the next monitoring. For example, a vegetation coverage standard stipulates that there should be at least 75% native species coverage, but while the site only has 60%, all the native plants have established well at the site; in this case, the manager may decide to plant more of the same species to fill in the gap. On the other hand, if a site completely failed to meet a standard, further investigation would be required. Using the same native coverage example, if a site has only 15% coverage because herbivores have been eating all the plants, the manager may decide to plant all the same species, but they would also put in deterrents such as “blue tubes” and fencing. However, if the reason for poor survival is due to a permanent change in hydrology to the site and the plants are no longer receiving the appropriate amount of water, the manager may need to reconsider not only the plant species list for the site, but also the target ecosystem for the project.

It is not uncommon for the maintenance and monitoring of restoration projects to be forgotten or poorly-resourced (Rieger et al. 2014). Due to the nature of student projects, the project manager who initiates the project usually graduates soon after the restoration implementation phase and is no longer present to oversee maintenance and monitoring, creating an additional challenge for SER-UW restoration projects. While some of the maintenance tasks at some SER-UW project sites have been performed relatively regularly by permanent staff members from UW

Grounds and UWBG as well as SER-UW volunteers, systematic monitoring and progress reporting have been lacking in all the SER-UW sites other than the Yesler Swamp mitigation units. The lack of well-defined performance standards and monitoring plans for many of the sites, and the lack of human resources to perform well-documented maintenance and monitoring plans of other sites, means that the true restoration status in reference to the original plan is unknown. Going forward, it would be beneficial to revisit some of these sites, reassess them, and make some adaptive management decisions to either reassert the effort or set new goals or performance standards.

By establishing a detailed monitoring plan with well-defined performance standards during the design stage of project development, or while making adaptive management decisions, and communicating the plan to the representatives of the managing department, the project manager will increase the chance of long-term success and sustainability of the project even if they are not available in person to oversee the monitoring tasks themselves.

Working with the SER-UW Native Plant Nursery

The SER-UW Native Plant Nursery is a student-run operation established in 2013. While the nursery donates many plants to SER-UW restoration projects, project managers are encouraged to purchase the plants from the nursery whenever funding for projects is available. The nursery is located at the Center for Urban Horticulture, just south of the Douglas Research Conservatory (Figure 9) and has housed over 1,500 species of native plants since its establishment. The nursery manager(s) will work closely with restoration project managers in project development and plant material procurement. It may take one year or more to cultivate plants that are not in stock; therefore, to ensure that the species desired for a site is available during planting season, it is important to initiate the discussion with the nursery managers early on in the project planning process. For native species that are not on either of these lists, the nursery may be able to source from other local suppliers; however, additional costs may apply to such special orders.

Figure 8 SER-UW Native Plant Nursery hoophouse. (Photo: A. Chan)

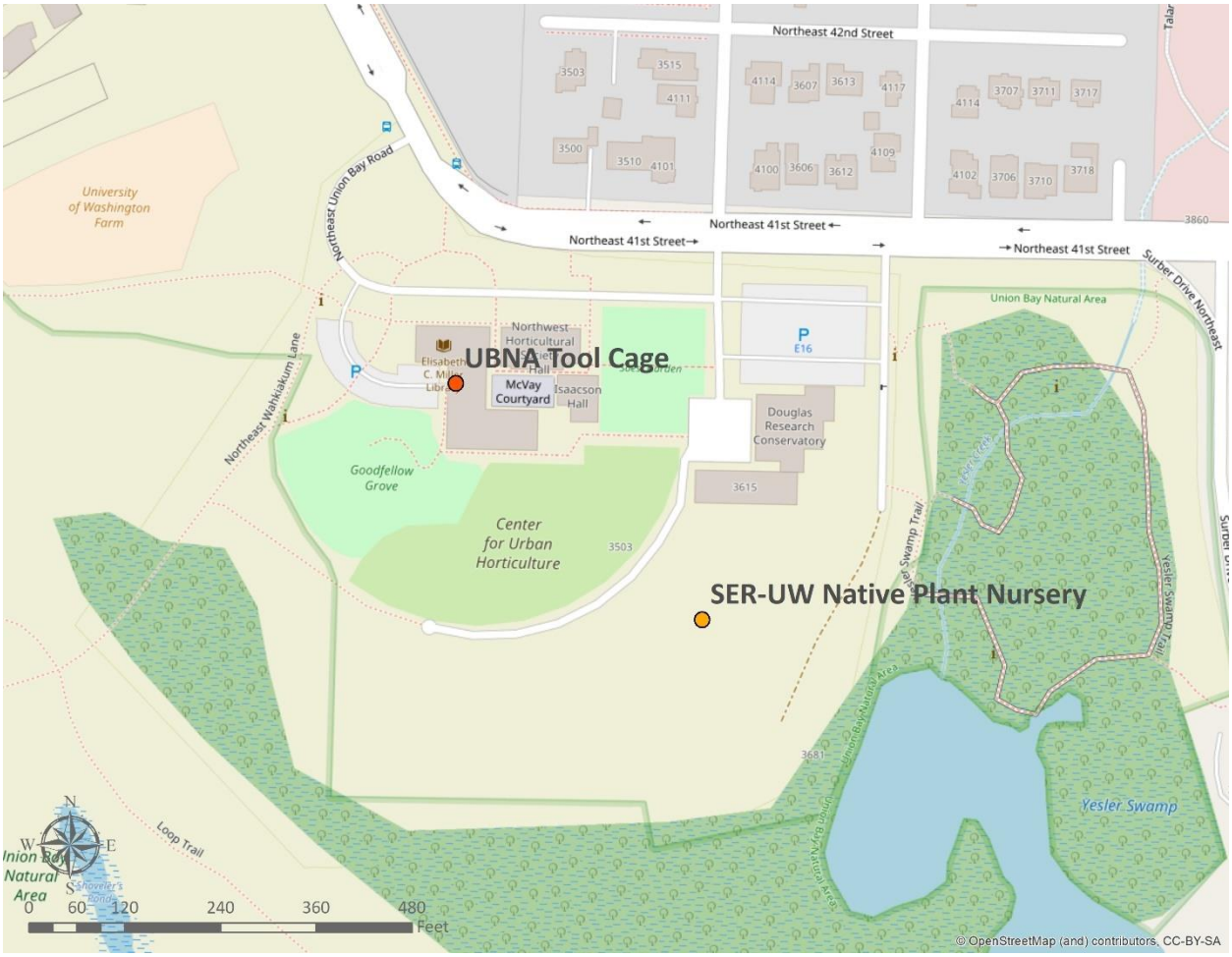


Figure 9 Map showing the locations of the SER-UW Nursery and the UBNA Tool Cage at the Center for Urban Horticulture.

Invasive Plant Species Control

Control of invasive plant species is one of the most common tasks in the management of the SER-UW restoration sites. The King County Noxious Weed and Washington State Noxious Weed Control Board (NWCB) websites are useful resources for information on species identification and management recommendations. In most cases, manual removal is the method used at SER-UW restoration sites. However, in situations where herbicide treatments or mechanical removal is required, for example in the cases of Italian arum (*Arum italicum*), sweet vernal grass (*Anthoxanthum odoratum*), and garden loosestrife (*Lysimachia vulgaris*), project managers can work with UW Grounds gardeners or UWBG Manager of Horticulture, David Zuckerman, to discuss a treatment plan.

For most small herbaceous species and some vines, hand pulling is the most appropriate method, while hand tools are used for shrub and other vine species (Green Seattle Partnership 2016). Regardless of the method, it is important to ensure that as much of the above-ground as well as the below-ground materials are removed. Waste plant materials are generally disposed of off-site: for sites at UBNA and Yesler Swamp, they are to be placed in the concrete compost bay behind the Douglas Research Conservatory; logistics should be discussed with the UW Grounds gardeners for sites on Main Campus. In rare cases, such as dead grass or turf in the UBNA prairie sites, waste plant materials may be left on-site in mounds of no more than three feet by three feet by three feet. The recommended management methods are briefly discussed below for some of the known species found on SER-UW restoration sites. More resources are also available on the SER-UW Google Drive (*SER-UW* > *Restoration Sites* > *Restoration Resources* > *Noxious Weeds Fact Sheets*).

Species-Specific Removal Methods

*English Ivy (*Hedera hibernica*)*

English ivy usually forms dense ground mats and spreads up trunks of trees (Figure 10). To remove dense ground patches, clip edges of swaths, then continue digging up the roots, clipping, and rolling up the mat into a tight bundle (Green Seattle Partnership 2016). Take care to cut around or lift the mats over existing native plants. When clearing a proposed planting area, clear the ivy at least 10 feet beyond the planting area. If the ivy has grown up a tree, the "lifesaver" or "survivor" ring method is recommended: cut vines at shoulder height and remove all ivy from that height down; then dig out the roots of the ivy in a radius that is at least five feet from the tree (Figure 11). The vines above the cut will die and decompose and there is no need to pull vines out of the tree above that point.

Figure 10 English ivy (*Hedera hibernica*) growing up tree trunks (NWCB 2018).

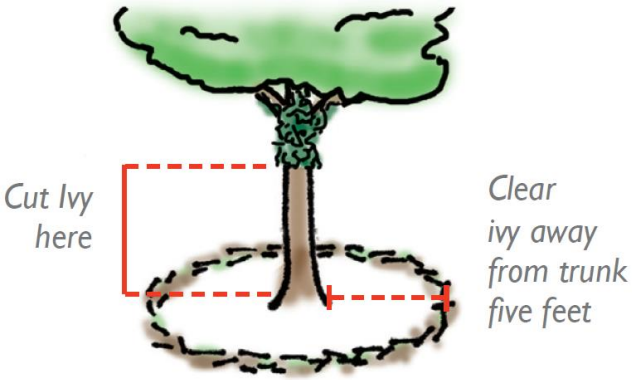


Figure 11 "Lifesaver" or "survival" ring method (Green Seattle Partnership 2016).

*Himalayan Blackberry (*Rubus armeniacus*)*

While this non-native blackberry is a widespread invasive and often out-competes native plant species, it does provide important bird habitat (Figure 12). Therefore, it is best to avoid significant blackberry removal during nesting season, in other words, mid-April to the end of July (Green Seattle Partnership 2016). If possible, it is recommended that only one-fourth of the infestation is removed each year, particularly if there is limited option for alternative habitat in the vicinity. In severely infested areas it may be necessary to repeat removal efforts two to three growing seasons prior to planting.

This species is rhizomatous, and the large clumps of root balls are usually found within the first 18 inches of soil; below the root balls, the roots can grow up to three-feet deep. The most effective way to remove Himalayan blackberry is to cut the canes one to two feet from the ground then grub, or dig out, the roots. The canes can be bent or cut into one to three-foot sections for easier transport.

Figure 12 Himalayan blackberry (*Rubus armeniacus*) (King County 2013).

*Field Bindweed or Morning Glory (*Convolvulus arvensis *)*

This is a rhizomatous vine that once established, is very difficult to eradicate; it forms dense vertical and horizontal mats that can out-compete native species (King County 2007; Figure 13). Hand pulling at least three times during the growing season (i.e., early growing season, mid-summer, and late summer) for at least three growing seasons is often needed to clear an area of field bindweed (Green Seattle Partnership 2016). However, if areas surrounding the restoration site are also infested and not managed, ongoing removal will be necessary.

Figure 13 Field bindweed (*Convolvulus arvensis*) (King County 2007).

*Italian Arum (*Arum italicum *)*

Italian arum is a poisonous, perennial, herbaceous species, originally introduced as an ornamental plant (Figure 14). It can form a dense colony once established, and so far, infestation in Washington State has been impossible to kill (NWCB 2014). From its second growing season, the tubers start to produce “daughter tubers,” which break off to form new plants. Attempts to manually remove daughter tubers could potentially facilitate spreading if they are not removed entirely, if infested soil is moved to a different site, or if plant materials are disposed of in the compost pile.

Among the SER-UW sites, it is only found scattered within Yesler Swamp. While protective clothing should be worn when managing Italian arum and one should avoid skin contact with the plant, it is recommended that student project managers do not handle this species if it is found in their project site. Chemical treatments have been used to control the spreading of Italian arum within Yesler Swamp, and the project manager should contact the UBNA Ranger or the UWBG Manager of Horticulture to coordinate treatments as needed.

Photo: Dr. Tim Miller

Photo: Denielle Cowley

Figure 14 Italian arum (*Arum italicum*) fruit (upper left), leaf (lower left), and "daughter tubers" (upper right) (NWCB 2018).

*English Laurel (*Prunus laurocerasus*), English Holly (*Ilex aquifolium*) & English Hawthorn (*Crataegus monogyna*)*

These three species were introduced to the area as ornamental or landscape plants but have escaped from landscaped areas and invaded the urban forests in King County (King County 2017; Figures 15, 16, and 17). Ranging from shrubs to large trees,these can be manually removed when they are small, and roots can be successfully dug out (Green Seattle Partnership 2016). However, do not cut larger shrubs or trees without removing the roots as the plants will send out suckers and spread, causing more problems in the future. Any plants that cannot be completely dug out need to be treated with herbicides; this requires coordination with the staff members of the managing department.

Figure 15 English laurel (*Prunus laurocerasus*) (King County 2017).

Figure 16 English hawthorn (*Crataegus monogyna*) (NWCB 2018).

Figure 17 English holly (*Ilex aquifolium*) (NWCB 2018).

*Scotch Broom (*Cytisus scoparius*)*

Scotch broom is an evergreen, multi-branched shrub that ranges from three to ten feet tall (Figure 18). It tends to spread aggressively to form monocultures (NWCB 2018). It can be removed in the spring when the soil is moist: small plants can be hand-pulled and larger plants can be dug out with shovels. Alternatively, cut plants in early summer, just as the plants begin to flower, and then cut them at least once more in late summer before they go to seed. Scotch broom seeds can remain viable in the environment for decades; therefore, in areas with significant infestation, sheet mulching and diligent monitoring are recommended after removal (Green Seattle Partnership 2016).

Figure 18 Scotch broom (*Cytisus scoparius*) (NWCB 2018).

*Reed Canarygrass (*Phalaris arundinacea*)*

Reed canarygrass is a rhizomatous, perennial, cool season grass that can reach up to six feet tall (Figure 19). It is a major threat to wetlands in this area and generally forms large, dense single-species stands which outcompete other native species. While these stands have little wildlife habitat value, they do function well to improve water quality of wetlands (NWCB 2018).

Hand-pulling or digging is only practical for reducing the density of small patches but not completely eliminating the infestation (King County 2011). Care must be taken to remove the entire root mass. If approved by the managing department, plant materials can be composted on-site but away from wet areas as long as roots and rhizomes are not in contact with the soil (Green Seattle Partnership 2016).

Where reed canarygrass infestation areas are large, the long-term control strategy should be to shade it out by installing native species over successive years, starting with sun-loving species, and then progressing to shade-tolerant ones. While shading will not completely eradiate reed canarygrass from the site, it will control its growth and allow for more structural and genetic diversity at the site (Green Seattle Partnership 2016).

Figure 19 Reed canarygrass (*Phalaris arundinacea*) (NWCB 2018).

*Yellow Flag Iris (*Iris pseudacorus*) and Garden Loosestrife (*Lysimachia vulgaris*)*

Both yellow flag iris and garden loosestrife (Figures 20 and 21)are wetland invasive species present in certain Yesler Swamp Mitigation Units (Long and Chan 2017). While manual removal, done correctly at the right time, can be effective for small infestations, UBGW staff has been treating them with herbicide as part of their UBNA management plan. Student project managers concerned with these species on their restoration sites should consult with the UBNA Ranger or UWBG Manager of Horticulture prior to taking any action.

Figure 20 Yellow flag iris (*Iris pseudacorus*) (King County 2018).

Figure 21 Garden loosestrife (*Lysimachia vulgaris*) (King County 2018).

Plant Selection and Installation

Plant species selection for a site is influenced by a multitude of factors, including, but not limited to, restoration target ecosystem, topography hydrology, soil condition, aspect, existing canopy cover, habitat requirements for wildlife, and prior/existing/anticipated human use or impact. Many resources, such as the *Green Seattle Partnership Forest Steward Field Guide* (Green Seattle Partnership 2016), the Washington Native Plant Society website (Washington Native Plant Society 2018), as well as those listed in the **Other Resources** section and the SER-UW Google Drive (*SER-UW* > *Restoration Sites* > *Restoration Resources*), are very useful when compiling the plant list for a site.

Another important element when choosing plant species for a site is to ensure that the selection would help to promote ecological resistance or resilience. An ecologically resistant community remains relatively unchanged when exposed to a disturbance; an ecologically resilient community, on the other hand, would alter easily and rapidly but then return to its original state spontaneously. One of the bigger threats to many restoration projects is climate change, and an extensive literature review done by Timpane-Padgham et al. (2017) has shown that biodiversity is one of the most important ecological attributes that would promote resilience to climate change in an ecosystem. Biodiversity may be in the form of genetic, species, or functional diversity. Therefore, some strategies when choosing plant species might include selection of plant and seed stock of local provenance, as well as those of provenance from areas where the climate is similar to our predicted future climate based on climate change models (Harris et al. 2006; Denovan *pers. comm.*); selection of species from various successional stages so that recolonization could occur after a disturbance; and selection of different functional groups or canopy strata to occupy all available niches (Denovan *pers. comm.*). The Seedlot Selection Tool is a web-based app designed for forest managers to match seedlots to planting sites based on various future climate scenarios. It is also a useful educational tool for project managers wanting to find out more about climate change projections and plant species selection.

Once the species have been selected, the next step would be to determine the quantity of plants required for the site. Sound Native Plants, a native plant nursery located in Olympia, has a Plant

Quantity Calculator (Sound Native Plants 2018) on their website that is a useful tool for calculating the number of plants needed for a site based on the desired planting density. This number is a good starting point for determining the quantity of plants required, but the ultimate quantity and stock type depend greatly on plant availability and cost as well as budget and funding available. Besides the SER-UW Native Plant Nursery, plant materials can also be acquired from a number of sources listed in the **Other Resources** section.

A number of planting patterns are often used at restoration sites. A naturalistic aesthetic can be created by randomly placing assemblages of species; in a forested or scrub shrub system, these assemblages will be composed of multiple canopy layers, and in a prairie system, one would find assemblages of forbs and graminoids. The commonly used patterns are clump-gap mosaic and forest thicket. The former is when three to five plants of a species are planted in "clumps" on their own or with several other groups of three to five plants of other species. Within the gaps between these clumps are randomly placed individuals of different species with wider spacing. Forest thicket pattern is a higher density version of clump-gap mosaic. The clumps in this situation are usually shrub and herbaceous species planted at dense spacing; the gaps are where individual trees are planted, also at dense spacing (Green Seattle Partnership 2016).

The *Green Seattle Partnership Forest Steward Field Guide*, besides being a good resource for selecting species for a site, also has a detailed section on how to install the plants. It includes information on soil and plant preparation, planting, and mulching, as well as livestaking techniques. Project managers working on the wetland sites could also refer to the guide for planting techniques unique to wetland restoration.

Work Party and Volunteer Event Operations

Event Planning and Volunteer Recruitment

While certain tasks at a small site could be done by the student manager on their own, most of the restoration tasks at all the sites would require the help of volunteers at work parties, large or small. As mentioned earlier, the bulk of the work involves invasive plant removal and native plant installation. Most of the volunteers are UW students, but sometimes, staff and faculty members as well as community members attend these events.

Scheduling of the work parties depends mostly on the timeline in the restoration plan and the human resources available. The project manager could engage the SER-UW Volunteer Coordinator and Communication Officer to plan and promote the event and recruit volunteers. There are several things to consider when planning work parties:

- the tasks to be performed
- the time in which it needs to be done
- the man-hours required to complete the tasks
- the duration of the work party
- the number of volunteers required and the maximum number of volunteers at an event

After the manager has determined the task(s) to be performed and the volume of work involved, they can then decide on the size and number of work parties they would need to complete the work. One should take into account that SER-UW work parties generally last for two to three hours, and the ideal work party leader to volunteer ratio is about 1:10. More than 10 volunteers per leader has the potential to get chaotic. If a large work party is required to do the work, the manager will need to recruit co-leader(s) for the event; these could be SER-UW officers or fellow students who have some experience at such work parties.

While the manager can plan to host their work party any day of the week and any time during the quarter, it would be beneficial to know when the SER-UW Native Plant Nursery and the UBNA Ranger might be hosting their regular events. By spreading out the various events throughout

the week, potential volunteers will be given more choices in terms of event times and there is less risk of multiple events competing for volunteers.

If the manager is considering hosting a large event, the biggest source of volunteers for SER-UW events is the ESRM 100 *Introduction to Environmental Science* class. This class is offered every quarter, and the students from this class are generally looking for restoration volunteer opportunities during the first seven weeks of the quarter. Other times during the year that a manager might consider hosting a large work party are when there are city-wide or even national calls-to-action for volunteerism or conservation-related activities, such as Green Seattle Day, Martin Luther King Day of Service, Earth Day, and Arbor Day.

For large work parties as well as those where the manager wants to set a maximum capacity, pre-registration is highly recommended. A template for an SER-UW Restoration Work Party Volunteer Registration Form is stored in the SER-UW Google Drive (*SER-UW* > *Volunteer Management* > *Restoration Vol Reg Form Template*). The number of expected participants is tracked, and a pre-populated volunteer sign-in sheet could be generated prior to the event. The volunteer coordinator could also close registration on an event that has reached its maximum capacity.

Once a work party has been confirmed, the details will be entered into the SER-UW Event Calendar and announced in the weekly SER-UW Newsletter and on other social media platforms. Other ways to promote an event and recruit volunteers would be to reach out to faculty members who teach classes about restoration ecology (see **Other Resources**) and ask for permission to make an announcement before class or email their class about volunteer opportunities.

Tool Reservation

UW Grounds Maintenance Sites

UW Grounds Maintenance will generally be able to provide all the tools needed for work done on their sites. Student project managers for these sites will be working closely with the gardeners supervising the sites and should coordinate with the gardeners to discuss tool needs. Tom Erler is the UW Gardener who acts as the liaison with SER-UW and can also provide guidance and assistance.

UWBG Sites

Tools and resources in the UBNA Tool Cage, located behind Merrill Hall at the Center for Urban Horticulture (Figure 9), are available for work parties on the UWBG Sites. The tool cage is managed by the UBNA Ranger and tool reservation is done using the UBNA Tool Reservation Calendar. This calendar can be viewed with this link; to get permission to edit the calendar and access the tool cage, please contact the UBNA Ranger or one of the SER-UW officers. More information about the UBNA tool reservation can be found on the SER-UW Google Drive (*SER-UW > UBNA Tools > Work party/Tool Use Calendar*; Appendix A).

Registered Student Organization Canopy and Table Reservation

As a Registered Student Organization (RSO), SER-UW has access to RSO equipment for on-campus events. If you require canopy and/or table reservations for your restoration work party on Main Campus, contact the SER-UW Volunteer Coordinator to make the arrangements.

Work Party Operations

General Volunteer Event Timeline

Most SER-UW restoration work parties last two to three hours. The following is a sample timeline for a three-hour event from 10:00 AM to 1:00 PM.

9:00 AM	Event lead arrives at event site to set up
10:00 AM	Welcome and volunteer orientation
11:15 AM	15-minute break (Give 10-minute heads-up at 11:05 AM)
11:30 AM	Regroup and orientation for the rest of the event
12:40 PM	Clean-up and Debrief (Give 10-minute heads-up at 12:30 PM)
1:00 PM	End event and thank volunteers

Day of Event Operations

The following are some general guidelines that would help to make the volunteer event go smoothly.

Set-up at Event Site

- Make sure to bring the list of volunteers who have pre-registered for the event, extra blank sign-in sheets, and a copy of the SER-UW Volunteer Program Waiver and Release Agreement (*SER-UW* > *Volunteer Management* > *General Work Party Sign-in Sheet Template* and *SER Volunteer Liability Waiver and Release Agreement*; Appendix B).
- Pick up canopy and table from RSO if these have been reserved (see **RSO Canopy and Table Reservation** section).
- Survey project to plan scope of work and stage plants for planting event.
- Take "before" photo of the site.
- For planting work parties, extra preparation time may be needed to stage the plants prior to the arrival of volunteers.
- Gather gloves, tools, supplies, and snacks. Keep track of the types and number of tools and supplies being used for the work party. For events at UBNA or Yesler Swamp, these could be left outside the tool cage for the volunteers to bring to the project site or laid out at the site. For Main Campus events, check with the supervising gardener.

Volunteer Check-In and Orientation

- Greet volunteers as they arrive and make sure they sign in (even if they have pre-registered).
- Advise volunteers on the location of the restrooms, particularly for UBNA and Yesler Swamp events. Sometimes, non-students or community members come to these events, so do not assume that they know their way around campus.
- Advise volunteers to bring their water bottles, snacks and extra clothing with them to the site.

- Backpacks and other belongings that are not needed at the site should be stored in a secure and clean location (e.g., in the tool cage). Alternatively, an extra tarp could be brought to the work site for them.
- Introduce yourself and SER-UW to the volunteers.
- Give a brief history of the project site and the work that is being done. This may be the first time some volunteers participate in restoration activities, so take this opportunity to share your knowledge about ecological restoration with them. Here are some talking points:
    - What are the goals of ecological restoration?
    - What constitutes a healthy ecosystem?
    - What are the impacts of invasive plants?
    - Why are native plants important?
- Go over the work plan for the day.

Safety Briefing and Demonstration

Ensuring that the volunteers are working in a safe environment and performing their tasks properly are the keys to successful restoration work parties. Therefore, it is important that the work party lead goes over the safety briefing and demonstrates the task to be performed before the volunteers start working.

- Be aware of any hazards at the site, such as long-hanging tree limbs, uneven terrain, and so forth, and point them out to volunteers. If wasps and bees are found at the site, be sure to stay away from that area, warn volunteers, and ask if anyone has any known allergies.
- Know where the first aid kit is located or bring one to the site.
- Make sure that all the volunteers are properly attired to perform the tasks. Do not hesitate to reassign a volunteer or even turn them away if their clothing or footwear does not provide them the protection they need to work safely at the site.
- Make sure that all volunteers have access to water and sunscreen.

- Never assume that volunteers know how to use the tools. Demonstrate the proper way to carry/hold and use all the tools and how to place them when they are not in use.
- Volunteers should be spread out while they work and have plenty of space between them and their neighbors. It is also important to clearly define the extent of the work area.
- While most restoration work parties take place rain or shine, if there is lightning, strong winds, poor air quality, or extreme heat, the work party should be cut short to ensure the safety of those present.
- When removing invasive plants, be sure that volunteers are clear on what the target plant species looks like to avoid pulling out non-target plants, or, worse, previously planted native species.
- During a planting event, demonstrate how to install a plant properly (see **Plant Selection and Installation** section). Ask volunteers to put the empty pots upside-down by their plants so that work party leads could go around to check their work for quality control.
- Demonstrate how to properly apply mulch around a plant: "Make a donut, not a volcano" (see **Plant Selection and Installation** section).

Guidelines and Tips for During the Event

The priority of the event lead is to manage the volunteers and not to work on the restoration site. Therefore, the more volunteers there are, the less the lead should be doing restoration work and the more they should be connecting with volunteers, offering assistance if needed, and ensuring a steady flow of quality restoration work.

- Volunteers
    - Check to see if they have questions, need any materials, feel comfortable with their tasks, and generally get to know them better.
    - Are they drinking water? Do they need an early break?
    - Do they have a clear area to work in? Are they almost done with one task and ready to start a new one?
    - Keep volunteers occupied and make sure they are having fun.

- Quality Control
    - Invasive Plant Removal
        - Ensure proper identification of the invasive species to be removed.
        - Ensure proper removal of the roots of the target invasive species.
        - Ensure proper disposal of all invasive plant materials.
    - Planting
        - Is planting being done at the correct location?
        - Are holes the right depth? Is the plant level with the ground?
        - Are plants properly planted with enough soil below, around, and above? Use the tug test to ensure proper planting.
        - Is mulch is being used? If so, make sure that it is applied properly.

Event Wrap-up

- Set aside 20 to 30 minutes to wrap up the event.
- Have volunteers gather the tools they have brought with them and/or have been using, and sweep the area they have worked in for any lost tools, personal belongings, or garbage.
- Count tools before leaving the project site.
- Have volunteers bring the tools, gloves, and supplies back to the tool cage or UW Grounds storage.
- Clean all the tools that need cleaning. Hose down the gloves and hang them on the drying lines in the tool cage.
- Thank all the volunteers for their time and share accomplishments.
- Give volunteers a chance to share their experiences or reflect on them with others.
- Remind volunteers of upcoming opportunities and ways to stay involved with SER-UW.
- Sign the forms for volunteers who are there for Service Learning. Remind others who need the hours for class credit to sign out and inform them that the SER-UW Volunteer Coordinator will contact the Teacher Assistants of their class.
- Take “after” photo of the site.

After the Event

- Make sure all the tools are clean and returned to the tool cage. Lock the tool cage and secure the key.
- Document any broken tools or supplies and report them to the UBNA Ranger or the UW Grounds gardener in charge.
- Return all the empty pots to the SER-UW Nursery or a previously agreed upon location for the nursery manager or UW gardener to pick up.
- See **Documentation and Data Tracking** for volunteer tracking and work logs.

Documentation and Data Tracking

Every SER-UW restoration site is essentially an outdoor classroom or laboratory for students to learn about ecological restoration. Every project serves as an example that could be used to guide and inform future efforts either at the same location or at similar project sites. Essentially, "every restoration sets a precedent" (Howell et al. 2012). In order to facilitate transfer of knowledge, each project needs to be documented so that any observations and lessons learned may be incorporated into management plans of the same site or project design at other similar sites. This need for thorough documentation is especially vital at SER-UW sites given that most students involved are first-time restoration project managers, and there is a high turnover of managers. All the documents related to the sites are to be stored on the SER-UW Google Drive (*SER-UW* > *Restoration Sites*); this is the most practical and convenient platform for data storage and management as it is a free service that is already being utilized by SER-UW for its operations. It is also a familiar platform for most UW students.

While every project manager may have their own style of organizing the files, it is important to bear in mind that these documents will be part of an archive that will be used in the future by others; as such, the names of the files and folders should clearly indicate the contents and include the year and month (or season) of when the document was generated.

Although this is not an exhaustive list, the following are the types of documents generated by restoration projects.

Restoration Plans

These include all the documents generated during the project planning and design stages as well as the final as-built record, for example

- proposal with details of goals and objectives of the project
- site map and other GIS data
- original and revised version(s) of the site plan and planting plan
- plant lists

- monitoring and maintenance plan
- final as-built report

Photographs

Photographs are almost a requisite part of restoration documentation. Not only do images from established photo points allow managers to track progress over time, they could also be used to show how particular implementation procedures or techniques are carried out, what plant materials looked like at time of planting, how habitat features are being utilized by wildlife, and so forth (Howell et al. 2012). These images and photographs taken during volunteer events at the sites are also very useful for outreach and publicity.

Activity Records, Work Logs, and Volunteer Tracking

These records document restoration tasks done at each site as well as the human resources involved in accomplishing these tasks. The Work Log (Appendix D) is for recording tasks accomplished at each field session or volunteer event; data from all the work logs can then be transferred to and summarized in the Activity Tracking Sheet (Appendix D), which will allow the manager to track the progress of the restoration project.

Project managers need to work closely with the SER-UW Volunteer Coordinator to keep track of all the volunteers that have participated in SER-UW activities. One reason is that many students receive class credits for volunteering at SER-UW events, and it is important to make sure that their instructors and/or teacher assistants are informed of their attendance. The SER-UW Native Plant Nursery rents its space from the UWBG, and volunteer hours spent on restoration work within UBNA counts towards the rent. Metrics such as volunteer participation may also have an impact when SER-UW applies for sponsorships or grants. Therefore, accurate volunteer tracking also has financial implications for the organization. After each volunteer event, a digital copy of the volunteer sign-in sheet is to be uploaded into the Volunteer Management folder for the academic quarter and the volunteer coordinator should be informed. The SER-UW Volunteer Management Guideline can be found on the SER-UW Google Drive (*SER-UW* > *Volunteer Management* > *SER-UW Volunteer Management Guideline*).

Monitoring and Maintenance Records

- monitoring data and reports
- adaptive management plans and treatments

Data Archives and Management Records

This is essentially the “miscellaneous” section with all other records and would include, but not be limited to

- raw, summarized, and analyzed data collected during all stages of restoration
- finances, funding, and budgetary materials
- contact list for and correspondence with partnering departments and organizations
- outreach and publicity materials

Succession Planning

As mentioned earlier in the **Restoration Project Development and Management** section, it is not uncommon for a student project manager of an SER-UW restoration site to graduate relatively soon after the implementation phase of their project. In cases where a final as-built report that contains all the details of the maintenance and monitoring protocols for the site is produced, SER-UW or the next student manager tasked to steward the site will be unable to manage and maintain the site according to the original goals and objectives if the report is not archived in the SER-UW Google Drive. Therefore, one of the final tasks a project manager needs to perform is to ensure that the final report, together with other information associated with the site and its long-term management, is uploaded to the SER-UW Google Drive for future reference. This task would not be as onerous if proper documentation and tracking discussed in the previous section has been performed thoroughly over the course of the project.

In situations where a final as-built report is not produced, for instance, if the project is not done as part of a capstone project and a report for submission is not required, or if the manager took over the maintenance of a site, it would be prudent for the student manager to produce a summary of the goals and objectives of the project, work that has been completed, adaptive management treatments performed, and recommendations for the future. While this may not be as detailed and thorough as a formal as-built report, it would at least give the SER-UW officers or the next project manager a solid starting point for managing the site.

Ideally, SER-UW should have the complete archive of all the documents associated with the restoration sites it stewards. However, as that may not always be possible, the following is the minimal list of items that should be uploaded to the SER-UW Google Drive:

- site description datasheet (*SER-UW* > *Restoration Sites* > *Restoration Resources* > *Site Description Datasheet Template*)
- site map and geodata
- plant lists and planting plans
- final as-built report or project summary report

- monitoring data if available
- activity records
- photographs and photo points

Contact List

Society for Ecological Restoration – University of Washington Chapter

Main Contact	seruw@uw.edu
Native Plant Nursery	sernursery@gmail.com
Native Plant Nursery Managers	
Derek Allen (2017-2018)	deallen4@uw.edu
Sarah Shank (2018-2019)	sashank7@uw.edu
Volunteer Coordinators	
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Scott Davis (2018-2019)	scottd89@uw.ed
Communications Officer	
Riley Plumb (2017-2018)	rileylplumb@gmail.com
Union Bay Natural Area Ranger	
Jonathan Backus (2018-2019)	jbackus@uw.edu

Student project managers for individual sites may be found in the SER-UW Restoration Sites Contact List in the SRE-UW Google Drive (*SER-UW* > *Restoration Sites* > *SER-UW Restoration Sites Contact List*).

University of Washington Faculty and Staff

Professor of Restoration Ecology and Union Bay Natural Area Manager	
Jonathan Bakker	jbakker@uw.edu
University of Washington Botanic Gardens Horticulture Manager	
David Zuckerman	dzman@uw.edu
University of Washington Grounds Maintenance Gardener and SER-UW Liaison	
Tom Erler	terler@uw.edu

Other Resources

Plant Species Selection and Planting Plans

United States Department of Agriculture

United States Department of Agriculture PLANTS Database

Washington Native Plant Society

Native Plants for Western Washington Gardens and Restoration Projects

Sound Native Plants

Species Selection Guide

Green Seattle Partnership

Green Seattle Partnership Forest Steward Field Guide

Plant Materials

Inside Passage Seeds and Native Plants Services

P.O. Box 639

Port Townsend, WA 98368

Phone: (800) 361-9657

forest@insidepassageseeds.com

Go Natives! Nursery

2112 NW 199th St.

Shoreline WA 98177

Phone: (206) 799-1749

don@gonativesnursery.com

Sound Native Plants

PO Box 7505

Olympia, WA 98507

Phone: (360) 352-4122

rebecca@soundnativeplants.com

Storm Lake Growers

18510 WA-203

Monroe, WA 98272

Phone: (360) 794-4842

terra@stormlakegrowers.com

UW Courses with Topics on Restoration Ecology

ESRM 362 *Introduction to Restoration Ecology*

ESRM 411 *Plant Propagation: Principles and Practices*

ESRM 412 *Native Plant Production*

ESRM 415 *Biology, Ecology, and Management of Plant Invasions*

ESRM 462, 463, and 464 *Restoration Ecology Capstone*

ESRM 473 *Restoration in North America*

ESRM 474 *Restoration Problem Solving: Ecological Engineering*

ESRM 479 *Restoration Design*

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Appendices

Appendix A: UBNA Tool Reservation

The following information can also be found on the SER-UW Google Drive (*SER-UW* > *Restoration Sites* > *UBNA Tools* > *Work Party/Tool Use Calendar*)

The UBNA Tool Reservation Calendar is to be updated by all users of the tools and resources from the UBNA Tool Cage. The above link will only allow you to view the calendar. To get permission to edit the calendar, please contact the UBNA Research Assistant or the Teacher Assistant of your capstone or restoration class. **Login to your UW/Google account to access the calendar.**

Please update the calendar by creating an event **at least 1 week in advance with time, location, contact name, type and quantity of tools to be used** (in the "Description" of the event).

There is a key to the tool cage stored in the Restoration Ecology Lab; it is to the right as you walk in the lab and is attached to a yellow bucket lid (please return promptly).

The loppers are stored in the Restoration Ecology Lab. The wooden cart is also stored in the lab, and it needs to be treated with care. To get it in and out of the building use the dolly that was purchased for that purpose.

In some quarters there may be a key stored on the south side of the cage in a small lock box. In winter 2018, this lockbox is installed, and the code is 1850. Please leave the key in the lockbox while you are at your work party.

Please clean the tools and gloves you use before returning to the cage. If you need instruction on using the hose or if there are any broken tools, please email the UBNA Ranger.

2018 Spring UBNA Ranger: Jon Backus, jbackus@uw.edu

Tool Cage Inventory:

*Loppers and wooden cart are in the Restoration Ecology Lab.

Item	**Quantity**
loppers*	19
Vermont wooden cart*	1
mallet, short handle	1
leaf rake	11
shovel	39
mulch spreading rake	9
post pounder	2
tarp	2
charcoal grill	1
saw	1
wheelbarrow	5
ladder	1
trowel	20
5-gallon bucket	13
cultivator	5
wire brush	2
mattock	5
fence post	18
tall weeding tool	4
weed cutter, long handle	1
tine weeder + mattock	2
hand pruners	7

6" hand saws, foldable	3
hammer	1
pliers	2
UBNA restoration work sign	1
small short shovel	1
edger (narrow blade shovel)	1
post-hole digger	1

Appendix B: Society for Ecological Restoration UW Student Guild (SER) Volunteer Program Waiver and Release Agreement

This document is stored on the SER-UW Google Drive (*SER-UW* > *Volunteer Management* > *SER Volunteer Liability and Release Agreement*).

This is a waiver and release of liability. Please read carefully before signing.

I agree to assume all risks of loss and injury that may arise out of my participation, and I agree to waive any and all claims against SER and all parties described below. I hereby release and agree to indemnify and hold harmless SER, its partners, collaborating agencies and organizations involved in this project, the participants in this project and their respective agents, representatives, officers, employees, assigns and insurers, hereinafter referred to as the "Released Parties," from any and all liability, claims, demands or actions or causes of action whatsoever, arising out of damage, loss of injury to my person or property, whether anticipated or unanticipated, while participating in any activities contemplated by this agreement, whether such damages, loss or injury result from negligence of the Released Parties, or from some other cause. This release and agreement shall be binding upon me, my heirs, successors, assigns, administrators and executors. I have read and understand the project description and the duties that will be expected of me related to the project. I realize that working on this project may involve risks and hazards, which may include, but are not limited to 1) the use of tools and other equipment, 2) working around other participants who may not be accustomed to this type of labor or the tools and equipment associated with it. I am aware that these risks and other hazards are inherent in participation in this project and hereby assume sole responsibility for all such risks and hazards.

I agree to conduct myself in a safe and courteous manner and to accept supervision from SER members. I understand that if I fail to do so my permission to participate in the project may be retracted. I hereby grant permission to SER to use my photograph on its World Wide Web site or in other SER related printed publications without further consideration. I acknowledge SER's right to crop or treat the photograph at its discretion. I also acknowledge that SER may choose not to use my photo at this time, but may do so at its own discretion at a later date. I also understand

that once my image is posted on SER's website, the image may be downloaded by any computer user. Therefore, I agree to indemnify and hold harmless SER from any claims. I hereby acknowledge that I have read, understood, and voluntarily agree to the foregoing waiver and release agreement.

Appendix C: Ecological Restoration Project Development and Management – An Example

The following is an example of how the project development and management guidelines in the *Handbook* are used in a South Puget Sound prairie restoration project. The materials presented are extracted from a group project performed by Group 2 of the ESRM 473 *North American Restoration* in Winter 2017. The members of this group are Ashley Adelman, Anne-Gigi Chan, Daniel Connolly, Erin Filley, William Hose, Hyungsang Kim, and Andrew Ryan Miller. This report showcases the project planning and assessment, project design, and the restoration implementation phases. While no monitoring report is available for this site at this time, personal communications with the UBNA Ranger revealed that invasive species management has been carried out at the site since implementation of the restoration plan.

Site Design and As-Built Report for Prairie Restoration Project: Yesler Swamp, Union Bay Natural Area

Photo: A. Chan

ESRM 473
Winter 2017
Group 2

Ashley Adelman, Anne-Gigi Chan, Daniel Connolly, Erin Filley, William Hose, Hyunsang Kim, and Andrew Ryan Miller

Introduction

Yesler Swamp is a 6-acre wetland complex east of the Center for Urban Horticulture, University of Washington, Seattle, and is part of the Union Bay Natural Area (Figure 1). The goal of this project is to restore a routinely mowed open area in the upland section of Yesler Swamp into a South Puget Sound prairie ecosystem.

Although the project site was not historically a prairie, intact South Puget Sound prairie ecosystems are rare and they are worthwhile target ecosystems for restoration. Furthermore, the topographical and climatic conditions of the site are similar to those where South Puget Sound prairies are traditionally found and will likely support a healthy prairie ecosystem.

Site History and Description

Yesler Swamp is located on the western shore of Lake Washington by Union Bay (Figure 1). In 1916, The Army Corps of Engineers completed the construction of the Ship Canal to connect Lake Washington with Lake Union which caused the water level of Lake Washington to drop by 8 to 10 feet. (Chrzastowski, 1983). This exposed land that was historically the lake bed around Union Bay and Yesler Swamp is found on the easternmost part of this exposed area. While the area around the swamp underwent significant development, the swamp itself was not suitable for development and remained relatively undisturbed. The upper or northern part of the swamp was utilized for planting “victory gardens” during WWII, but the remnants of these gardens were not evident by the 1960s (Friends of Yesler Swamp, 2013).

The land exposed by the drop in Lake Washington water level will eventually become Union Bay Natural Area (UBNA). And while dramatic changes took place in the western part of UBNA, Yesler Swamp was, once again, left relatively undisturbed since WWII. Restoration throughout UBNA started in the early 1990s and more focused and organized effort at the swamp started in the early 2000s (Friends of Yesler Swamp, 2013). Most of the restoration at Yesler Swamp has been directed at the wetland complex; meanwhile, the northwestern corner of the swamp was maintained as a mowed grassy field.

This restoration project is part of a larger project for students of the Restoration of North American Ecosystems class in the winter of 2017. The restoration site is one of 10 sites located in the northwestern corner of Yesler Swamp near the trail head. It is roughly rectangular in shape, measuring about 75 feet by 25 feet. The site is bound in the north and south by two other restoration sites and in the east and west by a gravel trail which meanders through the area. All these sites are in the upland area of forested wetlands to the east and south. To the west and north are impervious surfaces consisting of a parking lot and a road (Figures 1 and 2).

The site has a relatively even terrain with a gentle slope towards the east. It is also a very open area comprised of mostly bare ground with scant and scattered herbaceous plants. This area used to be a grassy space that was mowed on a regular basis. Most of the vegetation has been removed by the University of Washington (UW) Grounds Maintenance crew and the area was covered with wood chips. Herbicides were also applied at the site to remove invasive species. A non-native tree was located near the middle of the site; this was removed and the stump was ground down, which created a slight depression in the middle of the site. The soil in the depression is much softer and wetter than the rest of the site. After a period of significant rain, the only wet area was still in this depression and the rest of the site appeared to be quite well-drained and there was no pooling of water. Overall, the site was a relatively “clean slate” as far as restoration sites are concerned (Figures 3 and 4).

Human Disturbance and Impact

Much of the ecological restoration around the UW campus and behind University Village stems from filling in the municipal waste plant that previously occupied much of the area. For decades, this has been the primary focus of land management in the area. Restoring this landscape was taking a completely anthropogenically disturbed habitat and converting it into gradients of wetland, grassland, and prairie. For our area of Yesler Swamp in particular, there is high human and vehicle traffic surrounding the area. This leaves the habitat vulnerable to the unpredictability of the anthropogenic community. For a high-use area, it is difficult to predict what will be best

suited for a restoration project long-term. Continuous disturbance of foot traffic can be detrimental to a newly restored site.

Due to its close proximity to a parking lot and entrance to more of the area, it is beneficial to make it look aesthetically pleasing as well as be a long-term functional habitat for native plants and animals. Restoration in this area will help to prevent foot traffic through the site and encourage visitors to use the gravel path instead of a grassy shortcut, limit erosion and mud migration down the eastward slope during the rainy season, and create an aesthetically pleasing entrance to the Yesler Swamp. Restoration of this site benefits both the natural communities of plants and animals, as well as the surrounding human community that visits the area.

Goals and Objectives

Goal 1: ***Improve ecological value and function of the site by increasing biodiversity and providing pollinator habitat***

- **Objective 1-1:** Remove and suppress invasive species.

    - **Approach:** Removing and suppressing invasive species will create a functional environment for growth of new native species.

    - **Plan implementation:** Most of the non-native and invasive vegetation at this site has been removed by the UW Grounds Maintenance crew. These include herbaceous species as well as a non-native tree which was cut and then ground down. A small number of invasive herbaceous plants were present at the eastern part of the site and those were pulled just prior to planting. A 2-inch thick mulch ring of arborist chips was placed around each newly installed plant; this will suppress the growth of invasive species immediately surrounding the new plants while they establish (Figure 7).

    - **Maintenance and Monitoring:** Evaluating the site once every 6 months or annually to monitor invasive species that could be reintroduced. These need to be removed as needed. The UW Grounds Maintenance crew will be maintaining the

entire trailhead area of Yesler Swamp, so they will be able to monitor the site and take action as needed. Future work parties involving student or volunteer groups doing restoration work at Yesler Swamp could also be involved in invasive species removal.

- **Objective 1-2:** Select a diverse plant set of South Puget Sound prairie species to increase biodiversity, ecosystem function, and provide pollinator habitat.

    - **Approach:** Plant selection was based on how well species can establish and spread successfully by themselves. These plants should also complement each other, not compete, and, possibly, facilitate each other's growth. They should also flower at different times to provide food and habitat for pollinators throughout the growing season. As the reference ecosystem for this project is the South Puget Sound prairie, a list of ten native prairie species, including a mix of graminoids and forbs, were chosen for this project (Table 1) based on the findings in *The Vascular Plant Flora of the South Puget Sound Prairies, Washington, USA* (Dunwiddie, et al., 2006). All the seedlings in our plant list were ordered from the Society for Ecological Restoration, University of Washington Chapter (SER-UW) Student Nursery and the seeds were obtained from the Silver Falls Seed Company, Oregon. As we do not need to purchase other supplies for this project, our group spent our entire budget of $236 on plant materials.

    - **Plan implementation:** The final list of plants received (Table 2) was almost identical to what was requested. As a result of a shortage of junegrass (*Koeleia marantha*), we received 2 pots of Aspen fleabane (*Erigeron speciosus*) in place of one pot of junegrass. The SER-UW Student Nursery also had a surplus of 2-inch pots of tufted hairgrass (*Deschampsia cespitosa*) and Idaho fescue (*Festuca idahoensis*), so we also received additional pots of those as donation.

    - **Maintenance and Monitoring :** Evaluating the site once every 6 months or annually to monitor for plant survival. A target of 80% survival would be ideal. Additional plants of species that thrive at this site may be planted to replace those that do not do well. Other native species that are not in the plant list of this project may be considered for additional planting to maintain biodiversity while keeping plants properly distanced from each other to maximize ecosystem function. This

could potentially be a project for student or volunteer groups interested in restoration work at Yesler Swamp. The site should also be monitored for flooding and actions should be taken to mitigate any damage should that happen.

- **Objective 1-3:** Install native plants.

    - **Approach:** Plant seedlings and sow seeds.

    - **Plan implementation:** 68 seedlings were planted and 5 oz of seeds were sown at the project site (Figure 5). Instead of planting the same species right next to each other, species were plotted sparsely over the project site. Plants are spaced so that they have relatively equal amounts of surrounding areas to instigate growth and prevent competition for sunlight or water or other nutrients. By doing so, it creates a more natural environment where multiple species coexist and live together. The optimal restoration site will mirror a natural setting. Because of the wet, muddy depression in the project site, the distribution of the plants were based on their tolerance for wet soil (Table 3 and Figure 6). Mulch rings were applied around all the plants to suppress growth of invasive species and keep the soil moist while the seedlings establish themselves (Figure 7). Plant installation took three work sessions in late February and early March, each being 2-3 hours of work in groups of 2 to 5 people.

    - **Maintenance and Monitoring :** See Objective 1-2.

Goal 2: ***Increase aesthetic value of the site through restoration while preventing direct disturbance by people due to high usage and visibility of the area.***

- **Objective 2-1:** Provide visual pleasure through planting a diversity of species.

    - **Approach:** Plant diversity provides color variation throughout the growing season as a result of different flowering times. Also, sparsely planted species give the impression of a more natural setting instead of planting species aligning to each other which would give it a more manicured look

- **Plan Implementation:** See Objectives 1-2 and 1-3.

- **Maintenance and Monitoring:** See Objective 1-2.

- **Objective 2-2:** Protect newly restored area from human disturbance.

  - **Approach:** Proper placement of plants and application of mulch rings.

  - **Plan implementation:** To avoid human disturbance, plants were installed a few feet distant from adjacent paths to prevent people from unintentionally stepping on the plants while walking on the paths. Also, mulch rings were provided around newly planted species to mark where plants are installed so that even people who intentionally enter the project site may notice where the plants are and avoid stepping on them.

  - **Maintenance and Monitoring:** As this is a public green space, it is up to the users to act responsibly and not disturb the restored site. A possible solution might be using signage to notify people that this site is under restoration and requires minimum disturbance. Outreach to the local community to alert them regarding active restoration at the site could also help educate the public about how to treat such a site.

Challenges

Our restoration efforts at the Yesler Swamp Trailhead went very smoothly and we are anticipating a good outcome for the site in the future. There were a few obstacles encountered prior to our restoration work, but no great difficulties were faced when preparing the site, deciding on what species to use, and subsequently planting our selected seedlings and seeds. At the beginning of our restoration work, we noted there may be some difficulties due to the site's

general geographic location. It was located very near a road and many forms of human disturbance. The site's topography posed a bit of a challenge as well: the very muddy slope was a hard area to work with. Aside from the geographic and topographic challenges facing us in this restoration effort, there proved to be many invasive species and other non-native weeds that had to be removed prior to any plant installation. The Yesler Swamp Trailhead restoration required careful consideration of the aforementioned challenges to successfully restore the site.

The largest challenge of our Yesler Swamp restoration site was deciding where and how to plant our seedlings and seeds so they receive the least amount of negative impact from human activity. We were concerned about foot traffic on our site and decided not to plant anything too close to the trail system. Besides figuring out how to deal with human impacts at Yesler Swamp, we had to put much effort into preparing the area due to the thick, muddy soil at the site. Much preparation work involving aerating and breaking up the tough soil was done prior to implementing our seedlings and seeds at Yesler Swamp. The topography of the site was a challenge for planting our selected species, but was overcome by diligent preparatory work and planning from all involved. Some other challenges include preparing the site by removing invasives and other weeds. These species, like scotchbroom (*Cytisus scoparius*) and oatgrass (*Arrhenatherum elatius*) for example, were present in the site prior to our arrival and will need to be monitored far into the future to prevent them from re-establishing themselves. Careful maintenance in the future of our Yesler Swamp restoration site will be necessary to prevent degradation from human impacts and invasive species as well. We believe that despite the obstacles encountered, our restoration work will be a success and will restore the Yesler Swamp Trailhead to an aesthetically pleasing and ecologically beneficial area. The challenges faced in our restoration efforts at Yesler Swamp will be similar to the challenges faced by future maintenance and monitoring efforts as well. A careful balance must be held at the site to prevent re-establishment by terrible invasive species, mitigate negative human impacts, and prevent the site from overall deterioration. Our restoration efforts at Yesler Swamp gave the site a great chance at facing these obstacles and overcoming them thanks to our careful planning and preparation work.

Conclusion

The goal of this restoration project was to transform a mowed grassy field from a landscape of low ecological value into an ecosystem that is biologically diverse and would perform multiple ecological functions. This was to be achieved by restoring the site into a South Puget Sound Prairie ecosystem, which, in itself, is a rare and threatened ecosystem worthwhile of restoration.

At the start of this project, it was expected that the site would be planted with a series of plants from the Society for Ecological Restoration, UW Chapter Student Nursery. All of the requested plants were planted, though there was also added Aspen fleabane (*Erigeron speciosus*), extra tufted hairgrass (*Deschampsia cespitosa*), and extra Idaho fescue (*Festuca idahoensis*) as can be seen in Table 1 and Table 2. All of these species are native to South Puget Sound Prairies (Dunwiddie, *et al.*, 2006; Chappell and Crawford, 1997), so despite not being exactly as was expected, the planting was still a success in this regard. Overall, the project went according to plan.

The goal from this point on is to maintain the site so that it can continue to develop into a full prairie ecosystem and allow the species living within to thrive. While the location of the site will not allow the use of some maintenance strategies typically used for prairie restoration, such as controlled burnings, due to being located in a populated area, the proximity to the Center for Urban Horticulture means that the site will be managed by the UW Grounds Maintenance crew. With their aid, it should be possible to keep out species such as Himalayan Blackberry (*Rubus armeniacus*) and Scotch Broom (*Cytisus scoparius*) which are among the most prevalent invasives plaguing South Puget Sound Prairies. Ongoing restoration activities are also taking place throughout Yesler Swamp, so additional planting and invasive species control could potentially be achieved by student and volunteer groups working in this area.

Given the success of a similar project in the western part of Union Bay Natural Area with comparable physical conditions, the high-visibility of the site which would encourage community engagement, and the "built-in" monitoring and maintenance system with the UW Grounds

Maintenance crew, we are hopeful that this restoration project will be a success and that a robust South Puget Sound Prairie ecosystem will establish and thrive at this location.

Tables and Figures

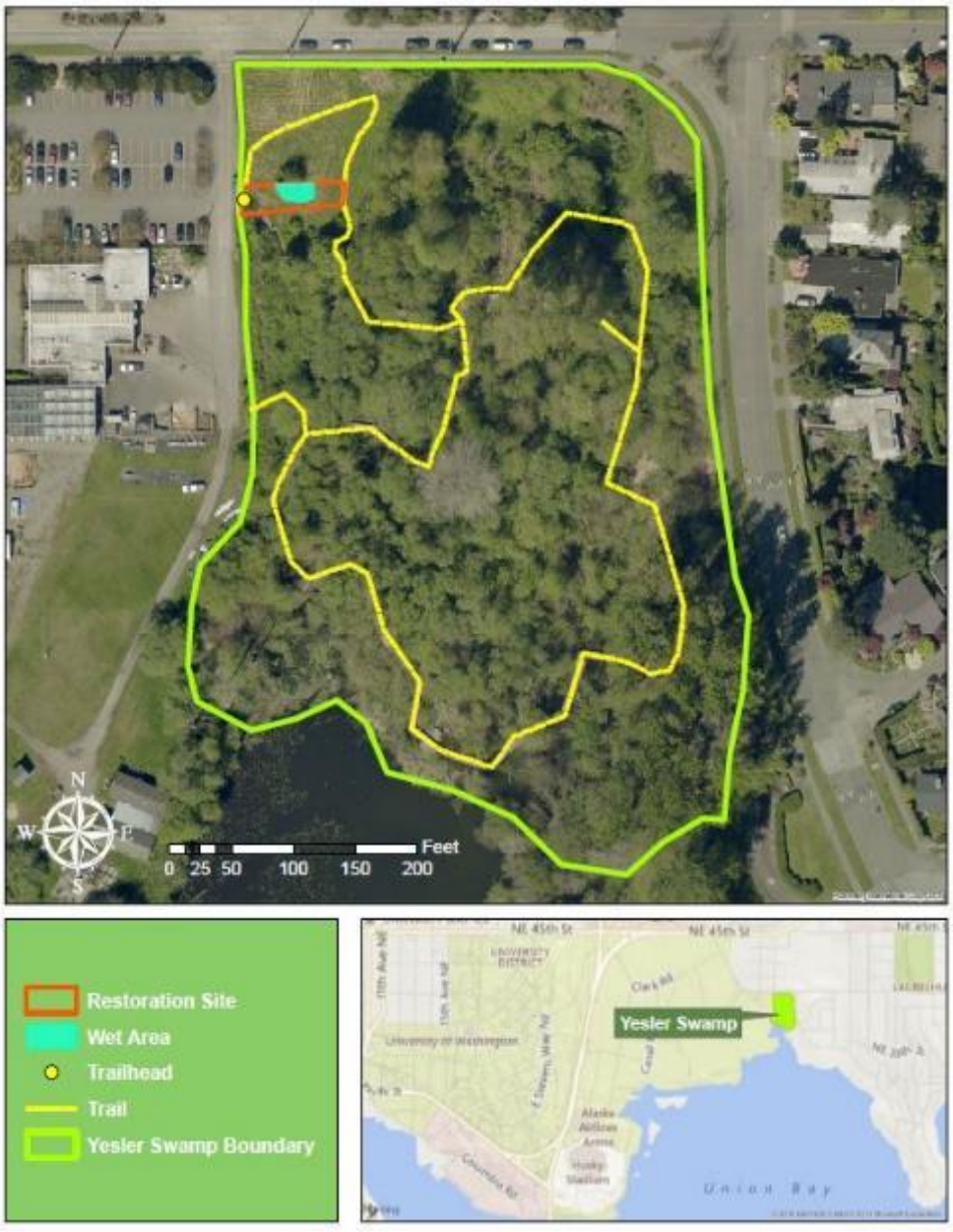

Figure 1. Map of Yesler Swamp, Union Bay Natural Area, Seattle, WA.

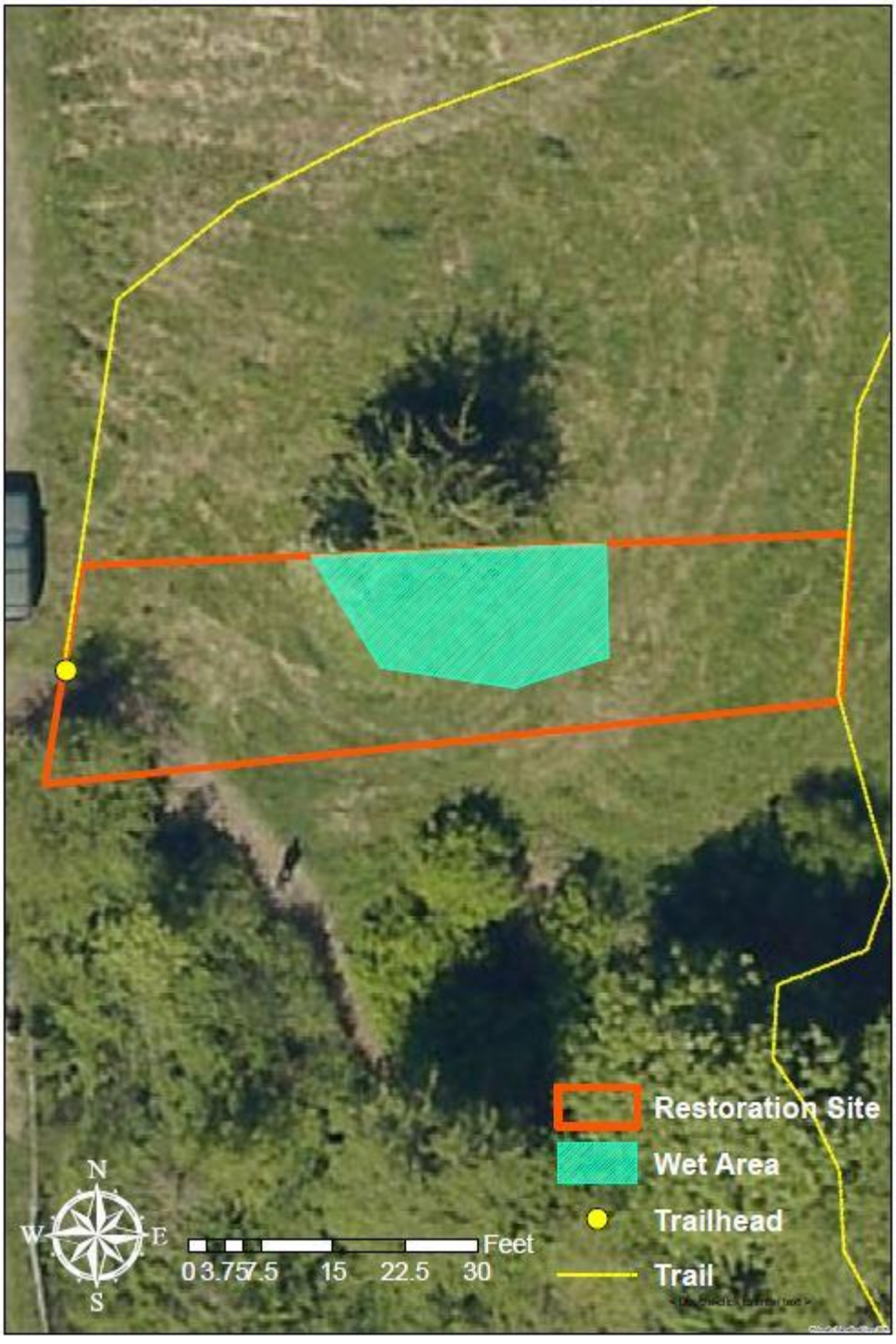

Figure 2. Map showing the layout of the restoration site.

Figure 3. Restoration site looking west/uphill before planting (Photo: A. Chan).

Figure 4. Restoration site looking east/downhill before planting (Photo: A. Chan).

Figure 5. Plants ready to be installed (Photo: A. Chan).

Figure 6. Staging of the plants prior to installation (Photo: A. Chan).

Figure 7. Mulch rings around newly installed plants.

Species	Common Name	Type	Quantity	Source
Achillea millefolium	Yarrow	Seedling	10 (1/- gal)	SER-UW*
Camassia leichtilini	Giant Camas	Seedling	10 (1-gal)	SER-UW
Camassia quamash	Common Camas	Seedling	10 (1-gal)	SER-UW
Carex inops	Long-stolon sedge	Seedling	4 (1-gal)	SER-UW
Deschampsia cespitosa	Tufted hairgrass	Seedling	5 (1-gal)	SER-UW
Elymus glaucus	Blue wild rye	Seeds	5 oz	Silver Falls Seed Co.
Eriophyllum lanatum	Oregon Sunshine	Seedling	10 (1/2 -gal)	SER-UW
Festuca idahoensis	Idahoe fescue	Seedling	5 (1-gal)	SER-UW
Koeleia marantha	Junegrass	Seedling	6 (1-gal)	SER-UW
Ranunculus occidentalis	Western buttercup	Seedling	8 (1-gal)	SER-UW

Table 1. Requested Plant List.

* Society for Ecological Restoration, University of Washington Chapter.

Species	Common Name	Type	Quantity	Source
Achillea millefolium	Yarrow	Seedling	10 (1/2-gal)	SER-UW
Camassia leichtilini	Giant Camas	Seedling	10 (1-gal)	SER-UW
Camassia quamash	Common Camas	Seedling	10 (1-gal)	SER-UW
Carex inops	Long-stolon sedge	Seedling	4 (1-gal)	SER-UW
Deschampsia cespitosa	Tufted hairgrass	Seedling	5 (1-gal)	SER-UW
Deschampsia cespitosa	Tufted hairgrass	Seedling	12 (2-in)	SER-UW
Elymus glaucus	Blue wild rye	Seeds	5 oz	Silver Falls Seed Co.
Ergeron speciosus	Aspen fleabane	Seedling	2 (1/2-gal)	SER-UW
Eriophyllum lanatum	Oregon Sunshine	Seedling	10 (1/2-gal)	SER-UW
Festuca idahoensis	Idahoe fescue	Seedling	5 (1-gal)	SER-UW
Festuca idahoensis	Idahoe fescue	Seedling	12 (2-in)	SER-UW
Koeleia marantha	Junegrass	Seedling	5 (1-gal)	SER-UW
Ranunculus occidentalis	Western buttercup	Seedling	8 (1-gal)	SER-UW

Table 2. Received Plant List.

Dry area only	Species	Common Name
	Camassia leichtilini	Giant Camas
	Deschampsia cespitosa	Tufted hairgrass
	Ergeron speciosus	Aspen fleabane
	Eriophyllum lanatum	Oregon Sunshine
	Festuca idahoensis	Idahoe fescue
	Koeleia marantha	Junegrass
Wet area only	*Carex inops*	Long-stolon sedge
Mostly in wet area	*Achillea millefolium*	Yarrow
	Camassia quamash	Common Camas
	Elymus glaucus	Blue wild rye
	Ranunculus occidentalis	Western buttercup

Table 3. Distribution of plants installed.

References

Chappell, C., and R. Crawford. Native Vegetation of the South Puget Sound Prairie Landscape. 1997. IN Dunn, P., K. Ewing, Nature Conservancy of Washington,and University of Washington, Center for Urban Horticulture. *Ecology and Conservation of the South Puget Sound Prairie Landscape*. pp. 107-124. Seattle, WA: Nature Conservancy of Washington.

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Dunwiddie, P., E. Adverson, A. Stanley, R. Gilbert, S. Pearson, D. Hays, J. Arnet, E. Delvin, D. Grosboll, and C. Marschner. 2006. The Vascular Plant Flora of the South Puget Sound Prairies,

Washington, USA. *Science Chronicles*. **17(2)**: 51-69.

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Appendix D: Sample Restoration Work Log and Activity Log

Two templates for the Restoration Work Log are available for project managers. The first one, shown below, is stored as a Google Doc that can be printed and filled out at the end of a work party. It can also be used as a template to create a more formal project record with site map and photo record of the work party. This document is stored on the SER-UW Google Drive (*SER-UW > Restoration Sites > Restoration Resources >Work Log and Activity Log Templates > SER-UW Restoration Work Log*).

The second template is a Google Form. Data collected in the work log can be summarized here, and all the information will automatically populate the corresponding or linked activity log. The Restoration Work Log template (*SER-UW > Restoration Sites > Work Log and Activity Log Templates > SER-UW Restoration Work Log Form (Template)*), and Restoration Activity Log template (*SER-UW > Restoration Sites > Restoration Resources > Work Log and Activity Log Templates > SER-UW Restoration Activity Log (Template)(Responses)*) are also stored on the SER-UW Google Drive.

SER-UW Restoration Work Log

Society for Ecological Restoration – University of Washington Chapter
Restoration Work Log

Project Site: _____ Date & Time: _____

Work Party Lead(s): _____

Total Number of Volunteers: _____ Total Person-Hours Worked: _____

Invasive Species Control

Area (sq. ft.) : _____

Species	**Phase of Development (seedling mature, flowing, seeding)**	**Estimated # of pounds**
	TOTAL	

Planting

Persons-Hours Spent Staging: _____

Number of Plants Installed:

Species	**Container Size**	**Quantity**
	TOTAL	

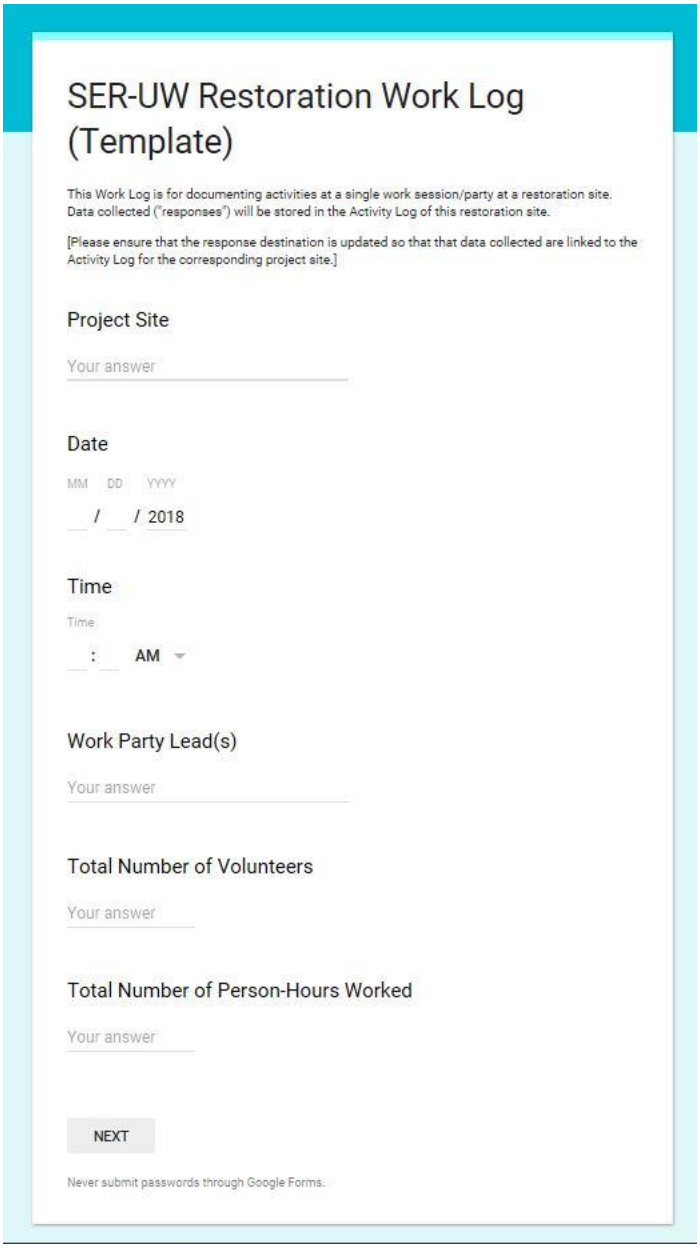
Mulching

Area (sq. ft.): _____ Depth (in.): _____

Further Site Maintenance Needed/Next Steps

Comments (e.g. wildlife observed, other tasks performed, survival rings, incidents, unusual findings, concerns, etc.)

SER-UW Restoration Work Log Template Google Form



SER-UW Restoration Work Log (Template)

This Work Log is for documenting activities at a single work session/party at a restoration site. Data collected ("responses") will be stored in the Activity Log of this restoration site.

[Please ensure that the response destination is updated so that that data collected are linked to the Activity Log for the corresponding project site.]

Project Site

Your answer

Date

MM DD YYYY

/ / 2018

Time

Time

: AM

Work Party Lead(s)

Your answer

Total Number of Volunteers

Your answer

Total Number of Person-Hours Worked

Your answer

NEXT

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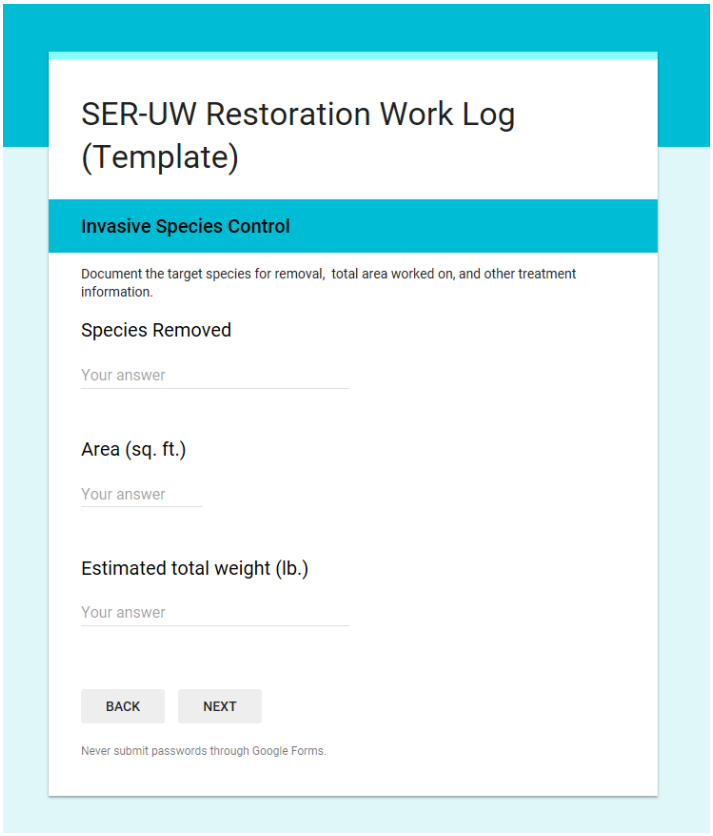


SER-UW Restoration Work Log (Template)

Invasive Species Control

Document the target species for removal, total area worked on, and other treatment information.

Species Removed

Your answer

Area (sq. ft.)

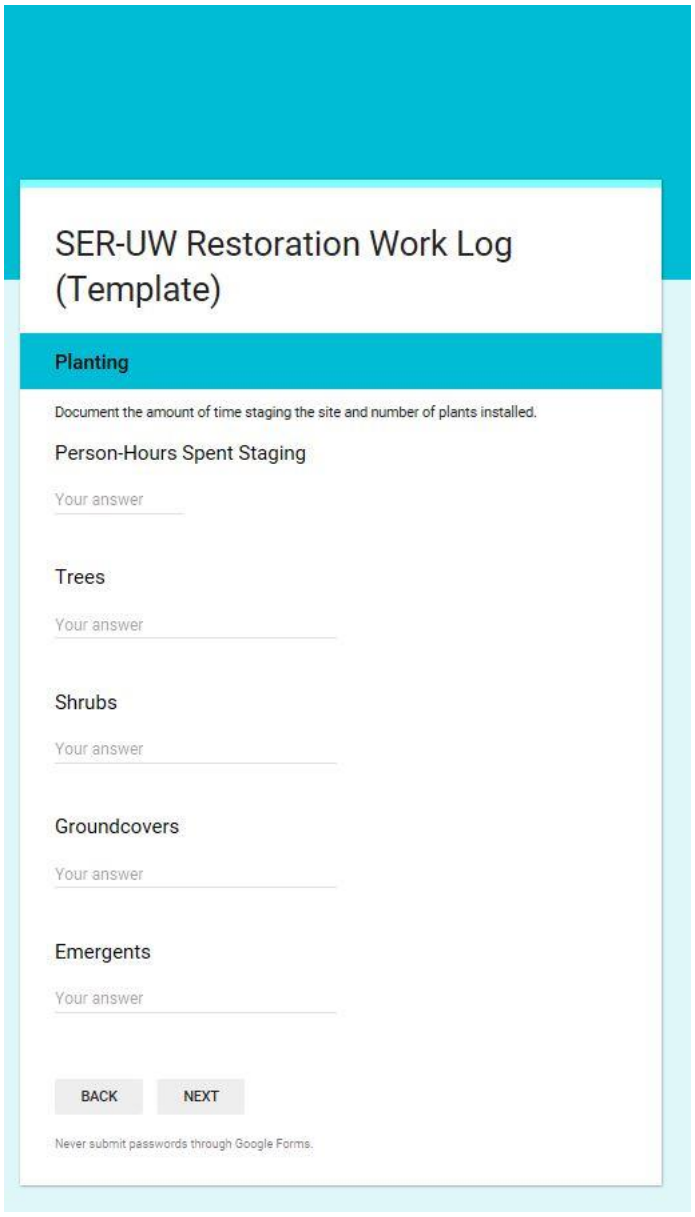
Your answer

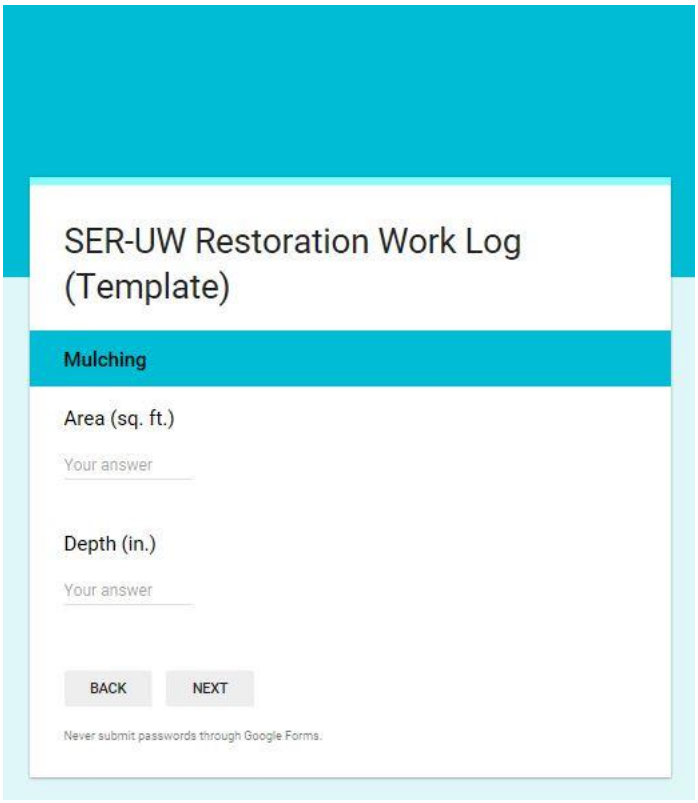
Estimated total weight (lb.)

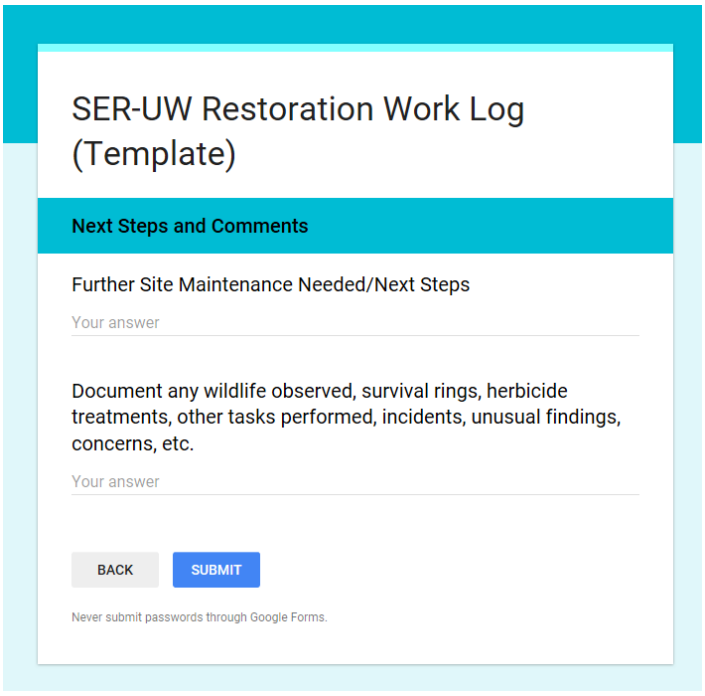
Your answer

BACK NEXT

Never submit passwords through Google Forms.


SER-UW Restoration Work Log (Template)
Planting
Document the amount of time staging the site and number of plants installed.
Person-Hours Spent Staging
Your answer
Trees
Your answer
Shrubs
Your answer
Groundcovers
Your answer
Emergents
Your answer
BACK
NEXT
Never submit passwords through Google Forms.


SER-UW Restoration Work Log (Template)
Mulching
Area (sq. ft.)
Your answer
Depth (in.)
Your answer
BACK
NEXT
Never submit passwords through Google Forms.


SER-UW Restoration Work Log (Template)
Next Steps and Comments
Further Site Maintenance Needed/Next Steps
Your answer
Document any wildlife observed, survival rings, herbicide treatments, other tasks performed, incidents, unusual findings, concerns, etc.
Your answer
BACK
SUBMIT
Never submit passwords through Google Forms.

Acknowledgements

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