SER-UW native plant nursery: Forging the missing link between plant materials and student restoration projects

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List of Acronyms

CEP: Community, Environment, and Planning

CSF: Campus Sustainability Fund

CUH: Center for Urban Horticulture

DRC: Douglas Research Conservatory

ENVIRO: Program of the Environment (course label)

ESRM: Environmental Science and Resource Management (course label)

LARCH: Landscape Architecture (course label

MEH: Master of Environmental Horticulture

REN: Restoration Ecology Network

SEFS: School of Environmental and Forest Sciences

SER-UW: Society for Ecological Restoration UW Student Chapter

UBNA: Union Bay Natural Area

UW: University of Washington

UWBG: University of Washington Botanic Gardens

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1 Abstract

Environmental horticulture is the production of plants in a manner that produces genetically appropriate plant materials for ecological restoration projects. It is an often overlooked component of the restoration process because plants are supplied by a few large nurseries for a single region. Furthermore, the academic programs that teach environmental horticulture are few. At the University of Washington (UW) there are only two courses, both in the spring quarter that teach plant propagation and production. The Society for Ecological Restoration- UW Student Chapter (SER-UW) spent the 2015-2016 academic year expanding the infrastructure and programming capacity of its student run native plant nursery in order to fill in this educational need. During the expansion process, the nursery engaged over 50 students per quarter from seven different UW courses and increased volunteer hours by approximately 520%. Student volunteers helped propagate 2,000 plants, which will then be sold to students for restoration projects and individual research projects. The expansion necessitated the construction of a new production space. Collaboration with the UW Construction Management department allowed us to build a hoop house exclusively for the SER-UW nursery. Partnerships with UW Botanic Gardens and UW Grounds were established to promote the use of native plants in the UW campus landscape. We found that the nursery naturally integrated with many parts of campus and facilitated the efforts of many groups using native plants. Future partnerships will strengthen the nursery's role within the UW community. We have determined that the full potential of the nursery cannot be realized without the support of the UW to a fund a full-time nursery manager and a graduate research assistant position to facilitate continuity, volunteer recruitment, and the refinement of plant production practices. With this built and social infrastructure in place the SER-UW nursery is well positioned to teach students the hard skills of native plant production as well as promote discussion and research on maintaining genetic diversity within restoration nursery stock.

2 The Role of Horticulture in Restoration Ecology

The installation of plants is a major component of most restoration ecology projects. In order to satisfy the needs of restoration projects, native plant nurseries need highly trained horticultural staff that can produce not just the volume of plant material required but also in an ethical manner that protects existing material source regions and produces genetically appropriate materials. Many native plant species are challenging to produce with cryptic stratification and scarification requirements that require scientific studies to develop the best propagation protocols. Although many skills such as seeding and potting are best learned on the job, for which many nurseries are suited to teaching their employees, the ethical and research skills that are essential to sustainable horticulture are often overlooked. These components of native plant production are best taught in an academic setting focused on education and research.

The difference between a restoration nursery and conventional nursery is essentially the focus placed on preserving genetic diversity. A restoration nursery focuses on maintaining genetic diversity all the way from seed collection and seed cleaning to limiting the number of generations grown in production (Basey et al., 2015). Conventional nurseries on the other hand are aiming to efficiently produce identical plants that have a specific desirable trait, often working with cultivars that are all clones of each other. The majority of horticulture education programs teach students conventional nursery skills and not environmental horticulture skills.

Genetic discussions within restoration nurseries are not limited to diversity but also debates about provenance and the maximum distance, or transfer limit, that plant materials should travel to reach a restoration site. Matching source and installation site provenances is important because source-related genetic variation can be considerable for adapted traits such as cold hardiness and phenology (Johnson et al., 2004). Conventional nurseries often do just the opposite and import plants from great distances and can actually be the vector for the introduction of invasive species (Reichard and White, 2001).

Since its inception in the 1980s, restoration ecology has blossomed into a $10.6 billion annual industry and involves thousands of volunteers per year (BenDor et al., 2014). Despite this growth, the horticulture departments of many high schools, community colleges and universities are being cut. This loss in educational opportunities is a severe hindrance to the ecological restoration mission. It can even be seen on the local scale at the University of Washington (UW) which has a robust restoration ecology program for undergraduates and graduates but only has two plant propagation courses, both offered in the spring quarter, and no professors devoted completely to horticulture instruction and research.

Upon starting my degree as a Master of Environmental Horticulture (MEH) at the UW, I was interested in both restoration ecology and environmental horticulture, and I noticed this gap in horticulture curriculum. I also began volunteering with the UW student chapter of the Society for Ecological Restoration (SER-UW), by coordinating plant salvages with King County, volunteering at the native plant nursery, and working at the two on-campus restoration sites managed by SER-UW, Kincaid Ravine and Whitman Walk. While working with the nursery, fellow MEH student, Kelly Broadlick and I realized that the student run nursery had the potential to augment the horticulture curriculum by expanding the growing capacity and service-learning opportunities of the SER-UW native plant nursery. To do this the nursery now runs weekly work parties throughout the entire academic year, completing plant production tasks that supply plants for courses and other campus projects. The activities complement and supplement existing UW courses.

3 Overview of the SER-UW Nursery

3.1 The SER-UW Native Plant Nursery

The Native Plant Nursery of SER-UW is a student run nursery that supplies plants to on campus restoration projects Kincaid Ravine and Whitman Walk, and UW classes. The nursery also promotes the use of native plants in landscaping by providing plants to the University of Washington Botanic Gardens (UWBG), UW Grounds, and the public. Each week the two graduate student nursery managers organize a work party to accomplish plant production tasks and teach UW students basic horticulture skills necessary for restoration nurseries.

3.2 The mission

The mission of the SER-UW Native Plant Nursery is 1) to be the UW campus educational hub for experiential learning of horticulture and 2) to be the link between native plant materials for campus and student restoration projects.

Long term goals of the nursery are to secure funding for a full-time nursery manager and a Research Assistant position for a graduate student; establish propagation protocols to become efficient at producing plants for restoration projects; create an educational hub similar to the UW Farm that incorporates as many students as possible each quarter.

3.3 The history, role within SER-UW

In 2013, the SER-UW Native Plant Nursery began as the storage site for plants intended to be planted at Whitman Walk and Kincaid Ravine, the two SER-UW on campus restoration sites, but which students didn't have enough time to plant during the wet season. Originally plants were stored in burlap sacks, but when a family of ducks was discovered in one of the bags, the students decided that a more permanent solution was needed. Plants were potted up and maintained for the following planting season.

Over the winter of 2014-2015, SER-UW attended five plant salvages where students salvaged at least 200 plants each time. The nursery managers decided to start a few species from seeds to teach students about seed propagation. Additionally, ESRM 412: Native Plant Production class donated several hundred plants at the end of the spring quarter. The nursery was suddenly amassing plants at a rate much greater than could be used at Kincaid Ravine and Whitman Walk each year and of species that were not appropriate at these two sites. The solution was to start selling the plants to different UW projects. In spring 2015, the nursery held its first public plant sale and sold to two UW courses, Restoration Ecology Network (REN) Capstone and Restoration of North American Ecosystems.

Besides not having homes for the plants, the SER-UW nursery was running out of room at the Center for Urban Horticulture (CUH) to store them. The plants extended on approximately 600 sq. ft. of uncovered tarp space, on top of and under a bench in a shared hoop house and were spreading out to floor space under other benches. In addition to not having enough space for the large inventory of plants, it was taking more time to maintain all of these plants. To solve these issues, Kelly Broadlick and I wrote and received a Campus Sustainability Fund (CSF) grant for $54,000 to fund two nursery manager positions for three quarters, build a hoop house, and purchase more plant production materials.

For the 2015-2016 school year, this grant also allowed the nursery to expand its mission to purpose grow plants for student restoration projects, partnering with the REN capstone course, North American Restoration and Nicolette Neumann's MEH project. To further its educational mission, the nursery took on two undergraduate interns per quarter, and involved over 50 volunteer students per quarter. Winter 2016, the nursery team coordinated with the Construction Management department to build the hoop house with student volunteers.

3.4 The missing link

There are many groups on campus that work with plants that until recently did not have a connection with each other. Through the work at Kincaid Ravine and Whitman Walk, the SER-UW nursery was inspired to grow more plants for restoration and campus landscaping projects. Additionally, the nursery was able to connect the people installing plants with students interested in growing plants. I consider the responsibility of the SER-UW nursery to "forge the missing link" between all the interested parties. A couple of exciting examples from this past year was the work the nursery managers did with UW Grounds, the Arboretum, and the Native Plant Production and Restoration of North American Restoration courses. The UW Grounds purchased plants from the nursery and donated plant materials for cuttings and live stakes. The Arboretum requested Lupines to be grown that they could not obtain in the required quantities elsewhere. And finally, the SER-UW nursery cares for the plants from the Native Plant Production class over the summer and fall so that they are healthy and ready to be planted the following winter by the Restoration in North American Ecosystems class. In each of these examples the nursery provided coordination for the partner group to obtain native plants that they would either have

not been able to afford or would not have considered. These connections are just the tip of the iceberg and the nursery is looking forward to nurturing these new connections and making even more new ones with different departments and student groups.

4 Volunteer Management

4.1 Volunteer Data

The majority of the plant production work is done by volunteers at weekly work parties. Attendance rates vary by dates from only the nursery managers and interns to 22 volunteers with the average number of volunteers per event being 10 (Figure 1).

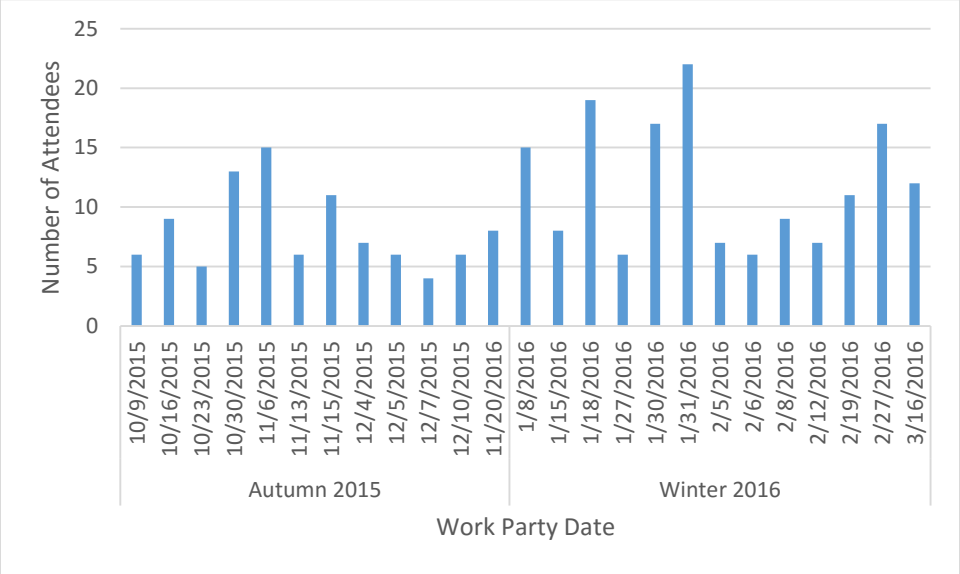

Figure 1: The number of volunteers at nursery work parties for Autumn 2015 and Winter 2016 quarters.

By the end of the 2016 winter quarter, 87 different individuals had racked up 902 volunteer hours at 24 work parties at the SER-UW nursery. This is in comparison to the 230 volunteer hours contributed by volunteers for the whole 2014-2015 academic year. The nursery was on track to increase volunteer hours by 520% between last year and this year (230 volunteer hours for 2014-2015, and approximately 1200 volunteer hours projected for 2015-2016). The majority of volunteers (55 or 63%) were single time volunteers (Figure 2). This is due to the fact that many of our volunteers come to fulfill requirements for their classes. It is helpful to get these volunteers but shows that the nursery needs to work on recruiting more consistent returning volunteers in order to get more high quality help. Returning volunteers require less training, can be trusted for more challenging tasks, and also increase the community feeling of the nursery.

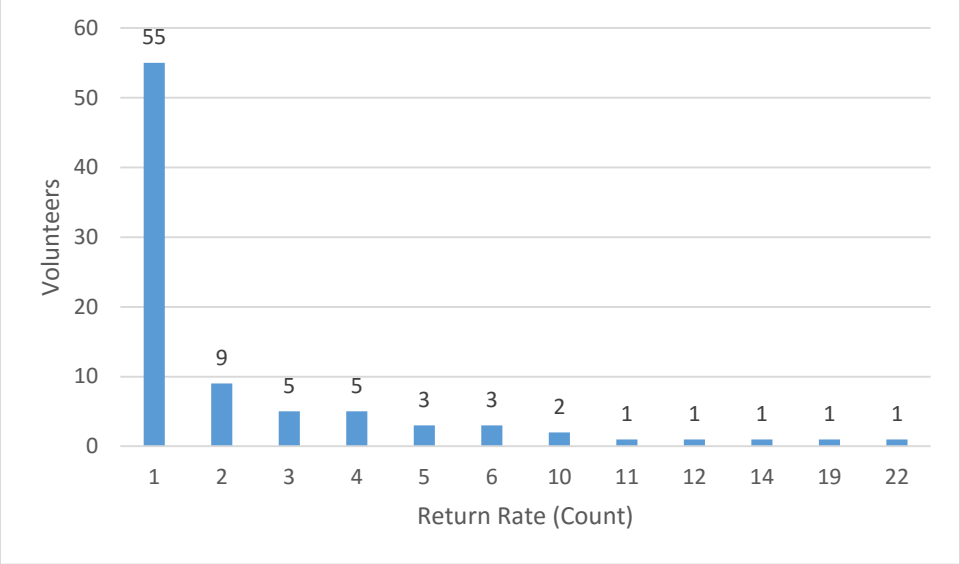

Figure 2: Return rate of nursery volunteers.

From discussions with the UW Farm manager, Sarah Guerkink, the SER-UW nursery has many more single time volunteers than the Farm which hosts anywhere from 30 to 60 Carlson Leadership & Public Service Center volunteers who are required to come 20 to 40 hours throughout the quarter. Many of these students are taking a course titled ENVIR 240: The Urban Farm.

2016-2017 Volunteer Number Targets

The average number of volunteers at work parties not related to infrastructure building is 8.9 volunteers with the average number of volunteer hours for those events being 27 hours per work party. The work parties related to hoop house building skew the volunteer rates to the right. If the nursery has the same average number of volunteers for 2016-2017 as 2015-2016 for non-infrastructure related work parties, then the nursery will have approximately 810 volunteer hours. If the nursery is able to increase its average volunteers per work party to 10 per work party, then the nursery will have an expected 900 volunteer hours for 2016-2017. This seems like a good goal to continue the momentum of the volunteer building capacity of the nursery in the absence of large infrastructure upgrades.

4.2 Understanding motivations

It is a serious endeavor to get volunteers to this many work parties per quarter, working for over 3 hours on average, and in such quantities. Not every work party had 10 participants or how many we would have liked for the tasks we were trying to accomplish. In order to understand what drew in participants it is important to understand their motivations.

Understanding the volunteers' motivations can help more successfully recruit volunteers which can be measured by an increase in the number of volunteers and how long they volunteer, combined with a reduction in the time and effort spent attracting them to an event. Just as importantly a greater understanding of personal motivation of volunteers can help the nursery managers design work parties that fulfill the volunteers' motivations (Moskell et al., 2010).

Clary and Snyder (1999) found when interviewing people active in a wide variety of volunteer activities and non-volunteers that there was a positive correlation between intentions to volunteer in the future when someone had previously volunteered versus someone who hadn't volunteered in the past. They suggested that once someone has had a positive volunteer experience, they develop a civic ethic that encourages them to volunteer in the future. They did not find this same positive effect on people who were required to volunteer, and in fact they were slightly less likely to volunteer in the future. McDougle et al. (2011) also found that students with previous volunteer experience significantly increased the chance that they would then volunteer for an environmental organization.

Interviews with environmental volunteers in the Seattle-Tacoma metro area, found that the top motivations of volunteers are "social-psychological" themes and not environmental (Asah et al., 2014). (The volunteers in this study are assumed to have similar motivations to the SER-UW nursery volunteers, as the nursery is also works on restoration ecology in the Seattle area. The demographics of the study group are different since SER-UW volunteers are principally UW students and not a mixture of the Seattle community.) The top three mentioned themes discussed by the environmental volunteers in descending order were positive emotions, community, and socializing. "Help the environment" was the twelfth most cited reason (Figure 3). Furthermore, McDougle et al. (2011), found that young-adult volunteers interested in developing social connections were more likely to spend more time volunteering than other youth trying to gain greater understanding. This corresponds with the relatively low ranking of "Career" in the sub-themes listed by Asah et al. (2014), as shown in Figure 3.

1. Positive emotions
2. Community
3. Socializing
4. Meaningful action
5. Values
6. Learning
7. Altruism
8. Dependence on volunteers
9. Career
10. Satisfaction
11. Health
12. Help environment
13. Sharing knowledge and using skills
14. Ego defense and enhancement
15. Social Identity
16. Get outside
17. Protect the environment
18. Preventative-protective
19. Recreation and Leisure
20. User
21. Legacy for future generations
22. Time rather than money
23. Convenience

Figure 3: Motivation "sub-themes" expressed by Seattle-Tacoma metro area environmental volunteers. Listed in descending order of frequency of expression (Asah et al., 2014).

Applying research concepts to the SER-UW nursery

Since Asah et al. (2014) found social-psychological themes expressed over 20 times as often as the environmental themes, it seems very important to take this into consideration when promoting and executing work parties. Advertisements for work parties should emphasize how fun the event is going to be and as an opportunity to catch up with friends. The work parties themselves should not just be productive but fun for participants. Ways to make work parties more fun are to include games that are often implemented in other environmental education settings. Other ways to make work parties more social are to take time to get to know the volunteers by having icebreakers and introductions at the beginning in order to take time to get to know each other. Closing thoughts such as a "One-word whip" at the end of a work party are effective ways to check in and see how things went for everyone. Finally, another way that the nursery is trying to make things feel more communal includes working around a large potting bench custom designed for the nursery and to play music whenever possible.

To address learnings from Clary and Snyder 1999 and McDougle et al. 2011 on the function of previous volunteer experience influencing future experience, I recommend making more partnerships with other on campus groups. Possible partners are fraternities and sororities, the UW Farm, UW Hillel, Earth Club, ASUW Student Food Cooperative, Husky Real Food Challenge, EcoReps, GIVE at the UW, Xi Sigma Pi (Forestry Honors Society), Society of American Foresters, and the International Forestry Students' Association. These partnerships could help the nursery tap into a network of people who have already identified that they enjoy volunteering as recommended by Clary and Snyder 1999. This could help reduce the effort to recruit and retain volunteers.

Finally, the observation from Clary and Snyder (1999) that required volunteerism may have a negative effect on future volunteering is of particular interest to the SER-UW nursery because so many volunteers come to the nursery from required volunteer components of classes. We have seen many times that students will come for their required number of times but never return to the nursery. This further drives home the need to partner with other organizations that may not necessarily be environmentally driven but more socially driven.

Volunteer Recognition

Asah et al. (2014) found that volunteers often cited "Dependence on volunteers" as a motivation to volunteer. Statements of this kind show that the volunteers understand that the work would not happen without them. This is definitely true at the nursery and as an education focused group we don't want the work to happen without them. To show our appreciation for our volunteers we always have snacks at work parties and we also developed a frequent volunteer reward system. Participants have the opportunity to fill out a "Plant Friend" punch-card and upon their third work party they receive a small sedum as a form of thank you (Figure 4). The nursery should start to track how many frequent volunteer cards are completed.

Figure 4: Frequent volunteer punch card and *Sedum spathulium* as a gift to frequent volunteers

4.3 Work Party Activities

A major objective of the 2015-2016 nursery expansion was to have regular weekly work parties at a consistent time in order to increase volunteer opportunities. In the past work parties at the nursery were sporadically scheduled and activities were not planned in advance. This meant that many production activities were neglected.

Common plant production activities preformed at work parties this year were pot washing, weeding, potting salvage plants, seed sowing, transplanting, and up potting seedlings. Less common activities were salvaging plants, and organizing the production area. The nursery also led a few restoration work parties at various sites around the Center for Urban Horticulture and Union Bay Natural Area where volunteers removed invasive plants and planted nursery plants. These restoration ecology work parties counted towards rent. (For more information on the rent agreement see Chapter 7.6 Memorandum of Understanding.)

Pot Washing

The SER-UW nursery reuses donated pots and containers in order to reduce environmental and economic costs of buying new materials and wasting materials. Used pots must be scrubbed to remove all the dirt and then soaked for 15 minutes in a bleach solution. Pots need to be sanitized to ensure that pests and diseases lingering in the soil are not transferred to the new plants.

The best post washing method was to use a 5-gallon bucket filled with warm water to soak the pots and cones in it. Then over the 5-gallon container you scrub the pots. Scrubbing the pots in 5-gallon buckets allows many volunteers to work at once spread out over the tables of the headhouse and greatly reduces the amount of dirt that goes down the drains. The 5-gallon buckets can then be emptied on the lawn. Once a large quantity of scrubbed pots accumulates, they are fully submerged in the sink in the head house in a solution of 2 cups concentrated bleach for a full large sink basin. Ideally the pots should be allowed to dry before stacking them and putting them into storage.

Weeding

Weeding pots is one of the simplest, most time consuming, but most necessary activities at the nursery. Weeding encourages the native plants to thrive, prevents the spread of weeds to restoration sites, and is necessary before selling plants. A seemingly limitless number of volunteers can be involved on a single

day. All weeds are composted in the bay behind the headhouse. If a large of amount of soil is removed for a pot, it is top-dressed with fine bark mulch to fully cover the roots of the plant.

Up potting seedlings

This year we started plants from seed in 10-inch Ray Leach Conetainers. This size conetainer is an ideal space saver for species with moderate to low germination rates. It is also easy to up pot seedlings from a conetainer into a one-gallon container because the two container types are approximately the same depth. Seedlings are ready to be up potted once their roots have reached the bottom opening of the conetainer, the soil within the cone is securely held in place by roots, and there is sufficient above-ground biomass. To remove the seedling safely from the conetainer it is necessary to loosen the soil. This can be done by rolling the cone on the counter and squishing it. Once it is loose, you can lightly pull the stem of the plant and slip out the soil and roots. The seedling can then be placed in the middle of a one-gallon container filled with soil medium making sure to keep the root collar at the same height as in the cone and preventing air pockets from forming in the 1-gallon pot. Tamping down the soil is helpful to condense the medium without fully compacting it.

Transplanting

Transplanting occurs when two or more germinants have emerged within the same cone and need to be separated into different cones in order to properly develop into mature plants. Transplanting can be a nerve-wracking experience for new volunteers because the seedlings are so delicate. The most important thing when transplanting seedlings is to keep the root system intact. To do this you can use a narrow spatula to slip down into the soil between the germinants, and then use tweezers to gently pull at the base of the plant. The spatula can then be used to guide the root of the plant into the soil of an empty or new cone.

Seed sowing, cuttings, plant salvages, seed stratification and scarification

Seed sowing, cuttings, plant salvages and seed pretreatments such as seed stratification and scarification are all activities that commonly happen at weekly work parties. They are discussed in full detail in Chapter 6 Plant Propagation.

Invasive plant removal

The most common invasive plant that the nursery removed in the Union Bay Natural Area is Himalayan Blackberry, *Rubus armeniacus*. Leather gloves are best for working with blackberry because the thorns do not pass through the leather. Long sleeves and long pants are recommended. To properly remove blackberry, the root ball must be totally removed. It is helpful to use loppers or hand pruners to cut the canes back to approximately one foot from the ground. Then you can use a long-handled shovel to dig out the root ball. If the patch of blackberry is especially thick or tall it is helpful to have a hard rake to pull out the canes. Removed plants can be placed on a tarp which once full can be folded in half and then you can compress the plants by stomping on them. All plants should then be brought to the compost. Once an area has been cleared of blackberry it should either be mulched with wood chips or planted or seeded with native plants and then mulched.

The nursery is also charged with maintaining the prairie rain garden on the west side of Merrill Hall. This rain garden was planted with a high diversity of grasses and forbs native to the South Sound Prairies.

Weeding this area to remove the invasive plants is more challenging because it requires stronger plant identification skills than in other locations. Fortunately, the Maintenance Guide is very thorough and helpful. It is attached as Appendix 12.1.

Native plant installation

Proper installation of plants requires digging holes to the proper size and depth. It is also important to make sure that the plants are installed so that their root collar is at the same depth as it was in the pot. Plants that are root bound from being in a pot for too long should have their soil loosened so that the roots can grow in a natural pattern. After a plant has been placed in its hole it should be back filled with the original medium, making sure there are no air pockets that could dry out the roots. Finally, to suppress weeds, minimize erosion, and maintain soil moisture, a layer of wood chips should be laid out over the root area of the plants.

4.4 How to prepare and run work parties

Running successful work parties requires a certain amount of planning. The first step is to advertise work parties. We do this by posting short explanations of our work parties to Facebook, the SER-UW Listserv, Hortgrads Listserv, ESRM 100 teaching assistants, and the different classes we are partnering with each quarter. The activities of the work party are driven by what different production tasks need to happen to get the plants started or keep them healthy.

Once the task has been selected you need to consider what steps need to occur before volunteers show up. Most work parties only require that the tools and materials are gathered immediately beforehand. Plant salvages that partner with the King County Natural Resources Department's Salvage Program need a pickup truck and small sedan to be reserved from UW Fleet Services in advance. Seed sowing requires that seeds be soaked in water overnight before they are sown. Having everything gathered before the work starts helps you give better demonstrations and supervision. Table 1 outlines the tools and materials necessary for each work party type.

Table 1: Tools and materials required to run different plant production work parties.

Activity	Tools and Materials Needed
Plant Salvages	Shovels, wheelbarrow, gloves, burlap sacks, hand pruners
Pot Washing	Dirty pots, scrub brushes, 5-gallon buckets, bleach
Seed Sowing	Conetainers, racks, seeds, soil medium, metal spatulas, weigh boats
Weeding	Leather gloves, kneeling pads, wheelbarrows, dirty pots for weeds
Up Potting	Clean pots, soil medium, fertilizer, plant tags, grease pencils
Potting	Clean pots, soil medium, fertilizer, hand pruners, plant tags, grease pencils
Transplanting	Conetainers, soil medium, metal spatulas, plant tags, grease pencils, tweezers
Striking Cuttings	Conetainers, soil medium, fertilizer, hand pruners, plant tags, grease pencils
Invasive plant removal	Loppers, hand pruners, shovels, carts, tarps, gloves, mulch, pitchfork, 5-gallon buckets, hard rake
Plant Installation	Shovels, mulch, 5-gallon buckets, gloves, hand pruners
Seed scarification and stratification	Seeds, water bubbler, acid, netting, plant tags, grease pencils, coco coir, Rubbermaid bin

Extra prep work includes researching species specific information for seed scarification, stratification, and sowing densities. We also had to research fertilizer rates and proper cutting techniques. All of these details are summarized in Chapter 6: Plant Propagation.

The start of each work party should begin with an icebreaker, and an explanation of the task. Describing the task should include passing around the sign-in sheet, a demonstration, an explanation of the importance of the task, and a discussion of the safety issues related to the task and equipment. It is also important to realize that not all volunteers will show up at the beginning. For all volunteers that drop in later, they also need a quick demonstration and safety talk, etc.

At the end of a work party it is nice to have volunteers come back together to do a wrap activity like a one-word whip, where everyone stands in a circle and quickly goes around the circle summing up their experience in one word. It is also beneficial to have volunteers help with the clean-up process. Finally, having volunteers sign out when they leave allows you to have an accurate record of how many volunteer hours were spent on a certain activity.

4.5 Work Party Data

From the daily plant work log (more details on the daily work log in 7.4 Record Keeping) I have calculated the average rate for different nursery activities. Each average rate is rounded to the nearest whole number. These averages can help future nursery managers estimate how much they can get done

at a work party or one on one with an intern or individually Table 2. These data were collected from time spent by the nursery managers and interns together or alone, as well as with working with volunteers at work parties. They do not include every time an activity was performed because sometimes entries into the daily plant work log were incomplete and either missing the time an activity took or how many pots were washed or cells sown with seeds. Completely missing from our records is how quickly pots can be weeded, plants salvaged, and pots fertilized.

Table 2: Average rate per hour of different nursery activities.

	Total of person hours	Total of Quantities	Number of Times the Activity was Performed	Average Rate (quantity/person/hour)
Seed sowing	35.5	865 cells (number of seeds per cell depends on species)	6	24
Potting	74	689 plants	6	9
Up potting	14.55	141 plants	4	10
Pot washing	35	1273 pots or cones	4	36
Transplanting	1.25	23 seedlings	2	18
Cuttings	2	196 cuttings	1	98

Some activities are inherently time consuming. For example, potting up plants after salvages can be very time consuming for new volunteers. There are special requirements such as root or leaf pruning that they must learn. Also potting up salvage plants requires people to label each pot and the time to do so is incorporated within the 9 plants/person hour estimate. This rate is probably much lower than the average potting rate of a commercial nursery that has experienced staff and is not focused on education.

Cuttings and pot washing on the other hand are much easier for volunteers to learn. We were able to strike 98 cuttings per hour which included teaching completely inexperienced people how to properly fill the cones, what polarity is, and how to make good cuts.

Some activities have to be repeated often. Seed sowing has to occur periodically from the fall through winter because each species has a different stratification length requirement. Pot washing must occur fairly often because we use a large volume of pots and cones, each of which must be sanitized before being used. It also useful to recognize that some activities most precede others, i.e. give yourself time to wash pots before you try to pot up plants or sow seeds. Another recommendation since is that it is challenging to predict how many volunteers will show up and the rate that they will complete an activity, is to always have back up activities.

5 Integration with UW Courses

5.1 Current course collaborations

The SER-UW nursery's programming naturally integrates with the restoration courses offered by UW's School of Environmental and Forest Sciences (SEFS). The nursery partners almost entirely with Environmental Science and Resource Management (ESRM) courses. Opportunities for students include volunteering and purchasing plants for restoration projects. Currently the nursery partners with at least

three courses per quarter: Introduction to Environmental Science (ESRM 100), the Carlson Center & Public Service Center volunteers, and Interns each quarter, Introduction to Restoration Ecology in the Autumn, Restoration Ecology capstone in the winter and spring quarters, Restoration of North American Ecosystems in the winter, and Native Plant Production in the spring (Figure 5). The courses provide a consistent source of volunteers which helps accomplish many propagation and restoration tasks at weekly work parties while providing an experiential-learning experience for many students. The different courses provide different levels of exposure to the nursery from single volunteer requirements for ESRM 100 to weekly work requirements for the Carlson Center volunteers and almost daily work for ESRM 399 interns.

Each Quarter		
ESRM 100: Introduction to Environmental Science Carlson Center Service Learning Courses- Various ESRM 399: Field and Teaching Internships		
Autumn Quarter	**Winter Quarter**	**Spring Quarter**
ESRM 362: Introduction to Restoration Ecology	ESRM 473: Restoration in North American Ecosystems ESRM 463 Restoration Ecology Capstone: Proposal and Plan	ESRM 412: Native Plant Production ESRM 464 Restoration Ecology Capstone: Field Site Restoration

Figure 5: Courses that SER-UW Native Plant Nursery collaborates with broken down by academic quarter.

5.2 ESRM 100: Introduction to Environmental Science

ESRM 100: Introduction to Environmental Science is an introductory course and is targeted at non-ESRM majors. The focus is the importance of the environment in society with emphasis on environmental degradation, distribution and uses of resources, and ethics of conservation and recycling. Students are required to attend one three-hour volunteer event and have the option of doing a second one for extra credit. Each quarter approximately 20 to 30 ESRM 100 students volunteer at the nursery. Adapting work parties by providing good background information on SER-UW and very explicit task directions has made work parties with a majority of ESRM 100 students very successful. Still some volunteer activities that require more background knowledge or safety training, such as construction projects or plant sales are not appropriate for ESRM 100 students

http://www.pce.uw.edu/courses/environmental-science-intro.html

5.3 Carlson Leadership & Public Service Center

The Carlson Leadership & Public Service Center partners UW courses with different community organizations to provide service-learning opportunities. The Carlson Center tries to match classes with the most related curriculum to the work of the community partner. The service-learning component of this class requires students to volunteer 20-40 hours throughout the quarter and ideally at a consistent rate per week. At the beginning of the quarter, volunteers are given an orientation and then are expected to show up to as many weekly work parties as possible. At the end of the quarter the volunteers receive a short evaluation on their performance. The nursery was able to post how many positions were available each quarter. In the winter quarter only two positions were offered because we did not know how much extra time was required to work with these students. In the spring, five positions were posted but only three were filled.

Recommendations

Since volunteers are required for their classes to come consistently throughout the quarter and for a minimum of 20 hours per quarter, Carlson Center volunteers are ideal volunteers for the nursery. There is minimal effort to recruit volunteers and they are required to return each week so they become fairly skilled volunteers. In the future, I recommend that the nursery offer more positions each quarter, as many as 10 to increase the volunteers at each work party.

Many students volunteering through ESRM 100 and the Carlson Center are often underclassmen with little previous experience working in nurseries or restoration ecology, they would benefit from a mini lesson at the beginning of each work party. This could be a 10- to 15-minute lesson on native plant production, pertinent to the day's activity that would improve the education quality for students at the work parties. Example class topics are outlined in Table 3.

Table 3: Possible weekly work party class topics and associated activities (Credit: Mary-Margaret Greene).

Class Topic	Associated Volunteer Activity(ies)
Pathogens and pests: How they function in a nursery setting	Pot washing
Growth needs of plants: water, sun, food, and space	Up-potting
Seed anatomy: Parts of a seed and how it grows	Seed sowing
Seed zones and plant provenances	Collecting cuttings, salvaging plants
Plant maintenance: What goes into caring for a large number of plants	Weeding, watering

5.4 ESRM 399: Field and Teaching Internship

Each quarter this year, the nursery managers worked with two undergraduate interns. Interns were required to apply by submitting their resume and a short explanation of why they were interested in the position, their previous relevant experiences, and what they wanted to learn while working with the nursery. Applications were reviewed and then the top applicants were interviewed. This was excellent experience for the nursery managers to practice the hiring process and interns to practice interview skills.

In exchange for helping out with the nursery for 9 hours a week the interns received 3 credits for the ESRM 399: Field and Teaching Internships. One intern in the Autumn Quarter received 5 credits for CEP 446: Internship which is the College of the Built Environment's equivalent of ESRM 399. In order to receive credit for ESRM 399 or CEP 446, the interns and nursery managers had to create learning objectives and agree upon a final project. Each of the interns has had similar learning objectives related to Plant Production and Volunteer Management. As shown below:

Plant production

1) Plant identification- Become familiar with 15-20 new species: the look, common name and botanical name.
2) Irrigation- Practice proper hand watering skills, i.e. Using the different nozzles for the different plant stages, recording watering in notes.

3) Plant salvages- Use proper digging techniques to remove plants from salvage site, transportation techniques, and potting skills
4) Learn about common propagation techniques, like starting plants from seed and cuttings.
5) Understand the basics of plant physiology as they relate to growing plants in a nursery environment.

Volunteers and work parties

1) Learn how to plan, organize, and execute a successful work party. By the end of the quarter be able to facilitate a work party with a partner.
2) Learn how to communicate effectively with groups of volunteers, sharing relevant background information and proper technique on a level that is appropriate for your audience. Learn techniques to keep your volunteers safe and engaged.

Each intern then had another section that was developed specifically for their individual interests and role. The following are the communications intern's objectives from winter quarter:

1) Advertise weekly work parties through Facebook posts, and email list servers in order to increase volunteer attendance.
2) Visit two courses, capstone and North American restoration, to educate students about volunteer and plant purchasing opportunities.
3) Create a mid-quarter newsletter.
4) Build up a stockpile of photos and short videos for promotional materials.
5) Create a punch card system for frequent volunteers.
6) Find free advertisement opportunities, and update the intern survival guide with a new section.
7) Plan and gather footage for an introductory video to briefly explain the nursery and its mission.

The construction project intern had a single objective to:

1) Learn how to design and build a functional structure, from start to finish. This includes identifying the functions it will serve, researching design options, construction methods, and materials, sourcing those materials, and finally building and finishing the structure in a safe and timely manner.

Intern Final Projects

The final project of the autumn 2015 communications intern, Jamie Costantino, was to create an intern survival guide. This has now been given to all interns who started in the winter and spring quarters. It is the responsibility of each exiting intern to help review the document and make sure it is up to date for the next crop of interns. The most recent version of the survival guide is attached as Appendix 12.2 Nursery Internship Survival Guide.

The final project of the of the autumn 2015 construction project intern, Wyatt Hoffman, was the design of a potting bench. It had been the intention of Wyatt and Kelly to build the potting bench during the quarter but the uncertainty of where to place the potting bench without a hoop house meant they did not build it. The draft of the potting bench is attached as Appendix 12.3

The final deliverable for the two winter quarter interns was the outline of a video to be posted on the SER-UW website and Facebook page. The video plan includes an overview of the SER-UW nursery, interviews with different volunteers, customers, and other relevant people. Some of the footage has

already been collected. The footage and outline will be passed on to a professional videographer and produced in fall 2016. The outline of the video is attached as Appendix 12.4.

Lessons learned

At the end of each quarter, the nursery managers conducted an exit interview with the interns to understand what went successfully and what needed more work. Interns also received an evaluation based on up their performance. The form is based off of the CPE 446 internship evaluation form. From the exit interviews, we realized that some of the learning objectives were not realistic. For example, the first interns were expected to become familiar with all species but this was considered impossible because there are over 70 different species in stock and the interns do not get to work with each one. This learning objective was then rewritten for the interns to learn 15-20 species which is much more attainable. The second major adjustment was to lessen the requirement of having interns run a work party on their own at the end of quarter but instead with a partner.

Recommendations

The quarterly internships have been overall a great success as a learning opportunity for the interns themselves and as management experience for the nursery managers. The final projects of the interns have also been extremely helpful for accomplishing the major goals of the nursery. In the future, the managers should continue to adapt the focus of the internships to the changing needs of the nursery. For example, the nursery will be focusing more next year on finding a permanent funding source for a full-time manager. To help with this major task an intern could focus on researching appropriate grants and helping draft them. Another intern could act as a lobbyist for the nursery and help seek out and make connections with different departments to find departmental funding sources. I also think that having a dedicated Communications Intern is a must for the nursery so that volunteer recruitment continues to grow and plant sales are well advertised. It would be ideal for this student to have both communications and graphic design skills. Finally, the nursery should continue to work on recruiting interns from different departments such as Landscape Architecture, Biology, Communications, Political Science, Business, Environmental Education, and Graphic Design to complement the horticulture and ecology skills of the nursery managers.

5.5 ESRM 462 + 463: Restoration ecology network-capstone course (REN Capstone)

The Restoration Ecology Network Capstone course is a year-long course in which students restore a small site in the Seattle metro area. Ten teams, 5 to 8 students per team, work to prepare and implement a restoration ecology project for a community partner. The course spans all three UW campuses, Tacoma, Seattle, and Bothell with most groups based out of Seattle. http://depts.washington.edu/uwren/index.htm

During winter quarter the student groups put together planting plans and purchase plants for their restoration projects. There are ten groups and each group has at least $500 to spend on plants. The SER-UW nursery has some species that could fit the needs of these groups. At the beginning of the winter quarter we presented to the students to introduce our plants and services to the course. We explained our mission and the purchasing process.

We did not have the capacity to fulfill all the requests for all the groups, but we did not expect to be able to do that. Plant orders were fulfilled on a first-come, first-served basis. We collaborated closely with the course's teaching assistant, Kat Cerny-Chipman who completes the purchases for the groups.

Lessons Learned

Only five of the ten capstone groups purchased plants from the SER-UW Nursery. Collectively the groups only purchased 128 plants of the 2000 plants available in stock. This was both significantly fewer groups and fewer plants purchased than we were expecting. Likely reasons for low sales were that many of the groups that partner with Seattle City Parks receive free plants as part of their partner agreement. Other groups have plant materials budget for their projects which their site partner manages and purchases plants from other nurseries because they are very likely unaware of the new SER-UW nursery, and the nursery does not have the quantities that they require. The most significant reason that the groups did not purchase plants from SER-UW is that the most economical option was to buy bare root plants from the King Conservation District bare root plant sale. The bare root plants were $0.90 to $1.60 versus the SER-UW trees and shrubs in 1-gallon pots which cost anywhere from $2.50-$4.00 at our Restoration pricing.

Recommendations

In the future, I recommend that the nursery focus its propagation plans more narrowly on the species list of just the UW campus groups from Kincaid Ravine and Yesler Swamp. Yesler Swamp's species' list is more definitive than many groups because it is set by the mitigation plan to offset the boardwalk installation. The Kincaid Ravine group works closely with a SER-UW officer that manages the entire ravine which makes collaboration much easier. Secondly, as will be discussed in more detail in Chapter 8.1 Pricing Scheme, I recommend that the nursery lower its prices for student groups to more closely match the prices for bare root plants.

5.6 ESRM 362/SEFS 530: Introduction to Restoration Ecology

The Introduction to Restoration Ecology course is offered for both undergraduates and graduate students each Autumn Quarter. It provides an overview to ecological restoration of damaged ecosystems.

http://courses.washington.edu/esrm362/index_files/syllabus.htm

For extra credit, students can volunteer with the nursery during normal weekly work parties. During the first few weeks of classes we went in and gave a brief presentation about SER-UW and the nursery and encouraged people to join our mailing list or find us on Facebook. Only a few students from this class volunteered with the nursery because the class time and work party time conflicted.

Recommendations

In the future, it would be ideal if the work party was not held at the same time as the class. The lecture schedule for this course is full of case studies and guest lectures. It seems appropriate for the nursery managers to come in and make more than just a pitch to volunteer at the nursery but to also do a guest lecture on the importance of horticulture in restoration with specific emphasis on how restoration nurseries can maintain genetic diversity and the concept of provenance.

5.7 ESRM 473: Restoration in North American Ecosystems

Restoration in North American Ecosystems is a whirlwind tour of the ecosystems and climates of North America along with the strategies for their restoration. Prof. Kern Ewing teaches this course each winter quarter.

http://depts.washington.edu/ehuf473/

The lab portion of the class has groups of students working on small restoration plots in the Union Bay Natural Area (UBNA) with the intent of creating sites similar to the prairies of the lower Puget Sound. The teaching assistant, Regina Wandler, coordinated the purchasing of 340 prairie plants of 12 different species from the SER-UW nursery. The majority of these plants were originally donated by the Native Plant Production class in the spring of 2015 and then cared for by the nursery until winter 2016. This is an example of one of the missing links that the nursery provides to the restoration courses on campus.

Each group is limited to a budget of $150 which greatly restricts how many plants the students can buy. To stretch the budget further, Prof. Kern Ewing grows plugs of *Deschampsia cespitosa* and *Festuca idahoensis* and the teaching assistant purchases many species as seeds.

This winter quarter the teaching assistants for Restoration in North American Ecosystems and Native Plant Production collaborated to align the future species list from the two courses. This coordination means that next year a greater portion of the plants used by NA Restoration will be supplied by ESRM 412 and fewer plants grown by ESRM 412 will be composted.

The two teaching assistant also identified species that the SER-UW nursery could provide as cheap container plants that previously have been purchased as seed. Kelly Broadlick coordinated the donation of bulbs of *Camassia quamash*, *C. leichtlinii*, *Dichelostemma congestum* (previously *Brodiaea congesta*), and *Lilium columbianum*. A portion of each of these bulb species will be potted up in order to be planted by next year's ESRM 473 class. The other portion will be planted in the raised beds in order for the nursery to provide a continued and economical supply of these desirable species for future years.

5.8 ESRM 412: Native Plant Production

The focus of the Native Plant Production course is to teach students how to apply propagation techniques to growing plants for restoration projects. It also requires students to problem solve the unique challenges of working with native plants in the artificial conditions of a native plant nursery to generate plants resilient to the natural conditions of restoration sites.

https://courses.washington.edu/esrm412/

The nursery is integrated with this spring course in a variety of ways. The first way is that students can work with the nursery as part of their mandatory 10 hours of volunteers for the quarter. Second, they help put together the irrigation system. This involves organizing the plants by shade and water requirements, determining the timing and length of irrigation, and setting up the components of the irrigation system. Third, as part of the vegetative propagation lab the students start plants from cuttings, and pot up the bulb species previously discussed.

Fourth, the class does a study to compare growth and germination rates in different container types, grows a bunch of prairie species, and then donates them to the nursery. The nursery cares for them until the next winter when Restoration in North American Ecosystems purchases and installs them in UBNA. Fifth, the class provided a few seeds for the nursery that had been placed in stratification over

the summer. The nursery tried sowing *Sambucus racemosa* and *Lomatium utriculatum* seeds, but had limited success with each species.

Recommendations

The SER-UW nursery managers should continue to collaborate with the teachers and teaching assistants of ESRM 412 and ESRM 473 to align the species lists. The nursery can hold over the plants produced by ESRM 412 each spring but also can supplement the species needed by ESRM 473 but growing additional plants of each species and also starting some fast growing species in the fall so that they are not pot bound by the next winter. Monitoring of the plots in UBNA has shown that potted plants have a higher survival rate than plants sown as seeds (Personal Observation). Thus, the ESRM 473 groups will be more successful if the nursery can help supply more affordable plants to their project.

Students from ESRM 412 can also assist the nursery with propagation protocol development by reviewing the species specific development records and synthesizing the recorded information. Finally, the students as part of their practical experience could perform stratification or scarification experiments to help honing the propagation protocols. Performing plant production experiments is already an option for students instead of volunteering, but not many students choose this option. Perhaps if the experiment option was supported by the nursery managers then more students would choose it.

5.9 Potential future course partnerships

So far, the SER-UW nursery has only directly collaborated with ESRM courses. (The courses associated with the Carlson Center are not ESRM courses.) One ESRM courses that the nursery has not collaborated with but is a very natural fit is ESRM 411: Plant Propagation. Options for collaborations include coming in during the lab period of ESRM 411 and teaching students about seed sowing, sowing rates, thinning, and striking cuttings. These could spark important discussions about the propagation skills students might be expected to know for restoration jobs. Efforts should be made so that activities that the nursery does with ESRM 411 do not overlap significantly with ESRM 412 partnerships since many students take both courses.

Nursery managers in future years should work on establishing new relationships with departments outside of SEFS, such as Program of the Environment, Landscape Architecture and Biology. In the future a course modeled off the ENVIR 240: The Urban Farm could be developed for the nursery. The Urban Farm is focused on food production, human health, and planetary sustainability. Along with the lectures the course is connected with the Carlson Center, and students do a service learning portion with the UW Farm. The course is offered 4 quarters a year and is an option for Environmental Studies majors as a “Biological Systems Requirement” as part of the degree’s foundation requirements. This course is analogous to ESRM 412 except that ESRM 412 is only offered in the spring quarter. Developing ESRM 412 into a similar 4 quarter course with required service learning components that integrates with the Program of the Environment would help incorporate many more students into the nursery.

A possible Landscape Architecture class that the nursery could work with is LARCH 303: Ecological Systems Studio which emphasizes the innovative use of ecological processes and patterns in design development to improve a designed landscape’s performance. The nursery could do a guest lecture to teach students about the importance of sustainable horticulture practices to produce the plants they need in their design projects. LARCH 475: Community Design/Build Studio which actually installs plants

in a project in Seattle each year may be an appropriate course to partner with as an additional buyer of SER-UW nursery plants. This course is taught by Prof. Daniel Winterbottom each winter and spring quarter. Prof. Ken Yocom might be another ally for the nursery as a lecturer and researcher who is trained in ecology and landscape architecture.

Further investigation and networking is necessary to identify exact courses in the biology department to partner with, because it is not immediately obvious from the course descriptions. Ben Wiggins, the Faculty Coordinator of Biology Instruction, would be a helpful person to help navigate the Biology curriculum.

6 Plant Propagation

6.1 Genetic Diversity Considerations

As discussed in Chapter 2: The Role of Horticulture in Restoration Ecology, a restoration nursery has a responsibility to source, track and maintain genetic integrity within its stock. At the coarsest level, genetic diversity should be considered by obtaining plant materials from a complimentary source area. These regions are often referred to as transfer zones, seed zones or provenance (Bischoff et al., 2006; Levy-Boyd and Haard, 2014; Ying and Yanchuk, 2006). They are geographic areas within which plant material can be moved with little risk of being poorly adapted to their installation conditions. Fourth Corner Nurseries tracks their seeds by the Level III Ecoregions defined for North America by the Environmental Protection Agency (Figure 6). Other options for delineating a transfer zone are to collect only within a single watershed or a set distance from a restoration site.

Once a transfer zone has been determined then there is the question of selecting plants from a single source or from multiple, mixed sources. Using a single source of materials runs the risk of basically promoting fragmentation by not promoting gene flow. This can then lead to population isolation and eventually inbreeding. Mixed sources have more genetic diversity and therefore have the increased likelihood that at least some of the plant materials will be successful at a given site. Mixed sources also have the opposite problem of a single source in that you can end up promoting outbreeding depression and eventually losing unique genetic qualities of an individual population (Kaye, 2001). Each of these options has its advantages and disadvantages, and restoration practitioners must keep them in mind when determining their plant material sources.

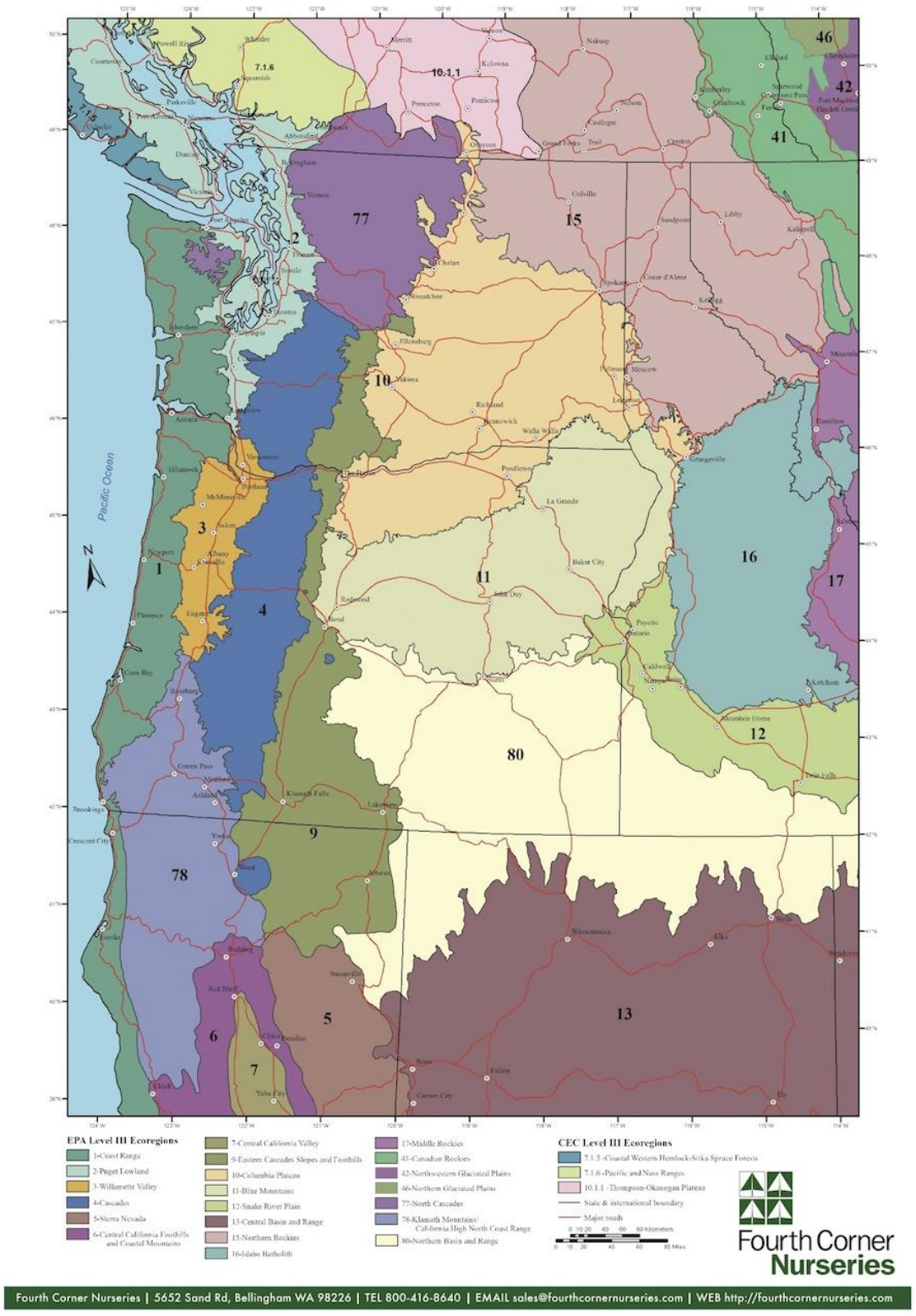

Figure 6: Environmental Protection Agency's Level III Ecoregions for the Pacific Northwest (Levy-Boyd and Haard, 2013).

After choosing a collection site, nurseries must then follow strict collection rules to maintain the genetic viability of the source population. Collection rules are dependent on the breeding system of a plant, i.e. self-compatible or self-incompatible, whether the plant reproduces vegetatively or sexually only, and the longevity of the plant among other considerations. Dumroese et al. (2009) recommend collecting seeds from at least 30 individuals, but state that collecting from 50 to 100 individuals is preferable. Collectors should also limit the percent of seeds of the total available seeds. Basey et al. (2015) recommends collecting from sites with large populations. It is beneficial to collect at multiple times while the seeds mature to capture the genetic diversity of the early and later producers.

The opportunity to maintain genetic diversity persists throughout the whole plant production process within the nursery. Basey et al. (2015) outline all the steps and related rules to maintain diversity when producing plants within a nursery (Figure 7). It is important to understand the effects of producing plants in an artificial setting such as a nursery on the genetic diversity of a crop. Just as in an agricultural setting, there is the chance to exert selection pressure on your plants to select for ones that grow successfully in a nursery setting. This should be avoided since success in the nursery setting does not necessarily correlate to success in a restoration site. The best ways to promote genetic diversity are to collect genetically diverse materials, and increase the survival rates because the higher your survival rates are, then lower the selection pressure.

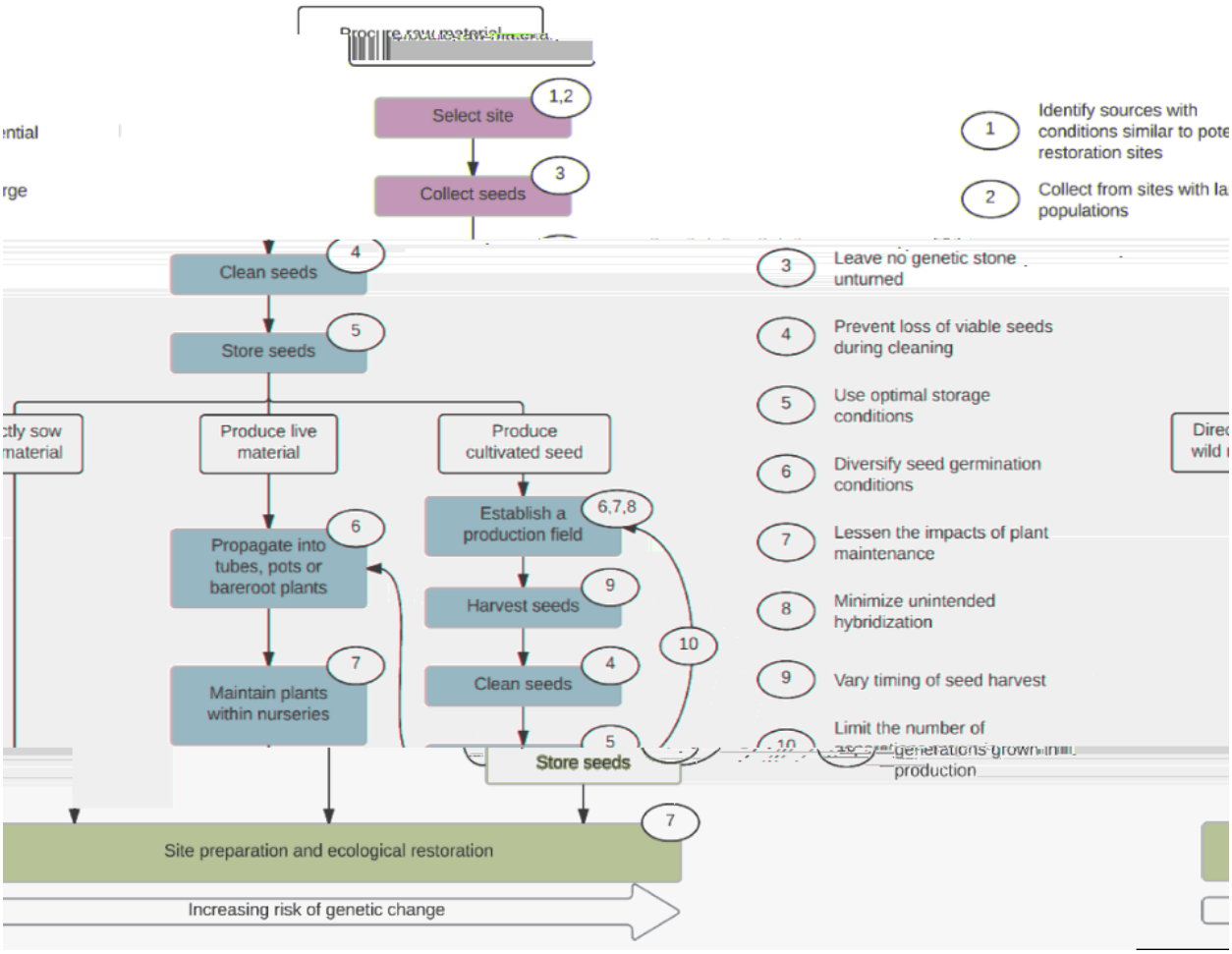

Figure 7: Steps in native plant material production and 10 associated rules to collect and maintain genetic diversity (Basey et al. 2015).

These concepts are covered in ESRM 412, but the SER-UW nursery has a responsibility to continue the discussion throughout the year. The nursery not only has a responsibility to create and follow guidelines concerning these issues but also to teach students so they can put them into practice. Educating future restoration professionals on this topic has the potential to greatly increase the quality of many future restoration projects by helping people develop specific guidelines on provenance, material sourcing, and internal nursery practices.

6.2 Propagation techniques

Plant propagation is the creation of new plants from either sexual or asexual techniques. Propagation methods used by the nursery for 2015-2016 were seed sowing, salvaging plants, and striking cuttings. Propagation techniques were determined for each species depending on individual biological characteristics and the horticulture industry standard growing method (Table 6). Many species of plants in the nursery were not propagated by the nursery and arrived as bare root plants. This was done to supplement the existing inventory because the nursery had not previously attempted to grow them.

6.3 Soil Media

The nursery tested out three different soil media this past year. Seeds were sown in either coco coir, the byproduct of husking coconuts for their fruit, or Sunshine Mix #4 from SunGro. All plants that were up potted, or potted as salvage plants or bare root plants were grown in fine bark mulch from Pacific Topsoil.

Coco Coir

Coco coir is being marketed as a sustainable alternative to peat moss which is harvested from peat bogs. The bogs provide valuable wildlife habitat that does not regenerate quickly but slowly over thousands of years as layers of sphagnum grow on top of the previous growth. Coco coir has high porosity which is ideal for seedlings trying to develop root systems. It also has antimicrobial properties which prevent many fungus and bacterial infections that tiny seedlings are susceptible to. The nursery purchased the coco coir as ten-pound-dry bricks that had to be rehydrated before working with. We placed the brick in a wheelbarrow with water and scraped the outside with a weeding fork. It helped to keep flipping the brick over to the side that just soaked in the water.

http://www.coirtrade.com/whyusecoir.html

Sunshine Mix #4

Sunshine Advanced Growing Mix #4 from Sungro was used mostly out of convenience because it is readily available as extra from other projects occurring at the Center for Urban Horticulture. The ingredients are Canadian sphagnum peat moss, coarse perlite, dolomitic limestone, a “long-lasting wetting agent”, and Resilience™, which is their trade name for mixes enhanced with silicon. It is a much denser growing medium than coco coir and contains sphagnum moss which the nursery was trying to avoid. We did some comparison testing with a few species to casually observe differences in germination and seedling survival between the coco coir and sunshine mix #4 to determine if coco coir was a viable option. Sunshine mix # 4 comes in 3.8 cu ft. bales.

http://www.sungro.com/files/catalogues/SG_Pro_Catalog_12_20_15_website.pdf

Fine Bark Mix

Bridget McNassar, our technical advisor from the native plant nursery of Oxbow Organic Farm and Education Center, recommended that we use fine bark mulch from Pacific Topsoil for our larger plants as she does at her nursery. The fine bark mulch comes from fir and hemlock bark. It is ground to 1” minus particle sizes. The fine bark mulch is similar to the highly organic soil of most Puget Sound Lowland forests. It is also easier to adjust your fertilizer rates when working with a medium that has negligible amounts of nitrogen, phosphorus, and potassium. Another benefit of working with fine bark mulch is that is relatively cheap and can be delivered by the yard.

http://pacifictopsoils.com/products_all.htm#Bark

6.4 Seeds

Most species were grown from seed in order to increase the genetic variability of the finished plants. Seeds were donated by Bridget McNassar. Her seeds were either collected on the farm property in Snoqualmie Valley or purchased from Inside Passage, based out of Port Townsend, WA or Silva Seed in Roy, WA (Table 4). For each species, Bridget let us know the approximate seeds per gram and a

suggested stratification and scarification treatment and sowing rate. The sowing rate is based off of the expected or observed germination rate from Bridget's experience. For example, if the germination rate was 30% then she recommended seeding 3 seeds per cell.

Table 4: Seeds sown in 2015-2016, their sources, weight, and recommended treatments from Bridget McNassar.

Species	Target Quantity	From Oxbow (g)	Source/Year	Approx. Seeds/gram	Suggested pre-treatment, sowing rate
Acer circinatum	50	30	Oxbow, 2015	10	Fall sow, 1-2/cell
Acer macrophyllum	25	X	Interlaken Park, Seattle WA and Issaquah, 2016	6	Fall sow, 4/cell
Carex obnupta	200	0.5	Inside Passage, 2014	2500	Fall sow, 4/cell
Cornus sericea	50	8.6	Oxbow, 2014	37	Fall sow, 1-2/cell
Lonicera involucrata	50	1.5	Oxbow, 2014	500	Fall sow, 3/cell
Oemlaria cerasiformis	25	15	Inside Passage, 2015	8	Fall sow or 100 days of cold stratification, 2-3/cell
Physocarpus capitatus	50	1.5	Oxbow, 2014	1050	Fall sow, 3/cell
Picea sitchensis	100	X	X		
Rosa nutkana	50	7	Oxbow, 2014	100	115 days warm and 115 days cold stratification, 4/cell
Rosa parviflorus	50	1.5	Oxbow, 2015	950	Fall sow, 5/cell
Rubus spectabilis	50	2.7	Oxbow, 2015	275	Acid scarification, 60 days warm and 90 days cold stratification, 4/cell
Symphoricarpos albus	50	2.4	Oxbow, 2014	150	45 days warm, 60 days cold, 45 days warm, 60 days cold stratification
Thuja plicata	100	1.5	Silva Seed, 2014	450	30 days cold stratification, 3/cell
Tsuga heterophylla	50	1.4	Silva Seed, 2014	300	45 days cold stratification, 4/cell
Pseudotsuga menziesii	50	4	Silva Seed, 2014	75	30 days cold stratification, 3/cell

Scarification

Scarification is any method of disrupting an impermeable seed coat so that water and oxygen can enter seeds with physical dormancy (Dumroese et al., 2009). Scarification was only necessary for *Rubus spectabilis* seeds. Dumroese et al. (2009) note that despite the fact that *R. spectabilis* has a thick seed coat, the seeds are easily damaged by sulphuric acid and instead recommends using citric acid. A diluted solution of lemon juice was used to soak the seeds for 48 hours. In the future citric acid power dissolved in water is recommended because the lemon juice left lots of pulp on the seeds which was time consuming to remove.

Stratification

Stratification is the use of specific moisture and temperature conditions to "break" a seed's natural physiological dormancy (Dumroese et al., 2009). Most of the species the nursery propagated from seed required at least some time in cold stratification. The two options for cold stratification were to either place the seeds in a container of coco coir in the walk-in fridge or to sow the seeds in cones and place them outside in the hoop house which is referred to as fall sowing. Fall sowing allows the seeds to stratify in nearly natural temperatures and reduces the processing steps by skipping placing them in the refrigerator. Fall sowing has the added benefit of splitting up the timing of seed sowing between the fall and spring and reduces the amount that has to be done in the spring. The incubators in the Tissue Culture Lab or Merrill Hall are also available for stratifying seeds. These incubators can set to temperatures equivalent to the average daytime and night time temperatures of winter, summer and spring/fall.

Some species (*Rosa nutkana, Symphoricarpos albus,* and *Rubus spectabilis*) required alternating between warm stratification and cold stratification. We created warm stratification conditions by placing seeds in a pot of coco coir, in the greenhouse where average daily temperatures throughout the year are in the 70s. We were careful to keep the seeds moist. For each species we followed Bridget McNassar's recommendations for stratification length and also propagation protocols from ESRM 412 and the Native Plant Network's Propagation Protocol database.

How to sow seeds

Germination rates increase for most species after the seeds are soaked for 24 hours or at least overnight in well aerated water before being sown or stratified. This allows seeds to adequately imbibe water which is the first step of germination. For each species we used a mason jar filled with water, poured the seeds in, and then placed a small electric aquarium filter in the water. The filter was left on overnight until the seeds were ready to be sown or placed into stratification. To separate the seeds from the water we poured the mixture over a fine screen.

All seeds were started with coco coir or Sunshine mix #4 in 10-inch ray leach conetainers. These conetainers were then organized in a rack that holds 98 cones. This pot size is commonly used by nurseries for starting shrubs and trees that will eventually be up potted to 1-gallon or greater. The advantage of using these conetainers or cones is that they use relatively little soil medium which is good when you are unsure of your germination rates and if you will actually fill all of your cones with germinants. Second, they are very easy to sort within the rack so you can easily move out the unfilled

cones and avoid wasting space. The cones can also be spaced out to half density to all extra air flow between plants and reduce the chances of fungal infections.

To properly fill the cones, all large lumps in the soil were broken down and large pieces of bark or other materials were removed. Periodically while filling the cones the whole rack was tamped down to remove air pockets. Once every cone was filled to approximately 1 centimeter from the top, they were all moved to another rack. This is a form of pest management to avoid having soil built up between cones which can act as a refuge for pathogens.

Finally, the seeds were sown using the recommended sowing rate from Bridget McNassar or from other propagation protocols (Table 4). The rule of thumb for planting depth of seeds is to place them in the soil a distance from the surface equal to the length of the seed. Useful tools for seeding are weigh boats to hold seeds and thin metal spatulas. Once all seeds have been sown the rack should be watered with a misting nozzle head. This attachment prevents the seeds from being blasted out of the cones.

Seedling Care

The seeds were misted every other day or as often as needed so that they did not dry out. The coco coir and sunshine mix #4 dried out at different rates. Once the germinants progressed from dicotyledons and monocotyledons to true leaves then the cones were watered with the “shower” setting of the hose. This is the transition from the establishment phase to rapid growth phase (Dumroese et al., 2009). The length of the establishment, rapid growth and hardening phase is different for each species. For a sample outline of the observed and expected length for each phase for a few example species see Figure 10.

Once in the rapid growth phase the seedlings had higher nutrition needs that were not supplied by the coco coir or fully by the sunshine mix #4. While still in the cones, the seedlings were “fertigated”, fertilized at the same time as irrigated, with a liquid fertilizer. We chose Neptune’s Harvest Fish Fertilizer 2-4-1 and applied it once a week using a watering can to dispense the mixture. We used an application rate of 1 teaspoon dissolved in 1-gallon of water.

The seedlings remained in the cones until their roots reached the hole at the bottom, their roots held the soil together, and they established a substantial amount of above ground biomass. Once they reached this condition they were up potted into 1-gallon pots with fine bark mulch and were top dressed with 5- to 6- month slow release Osmocote. This was part of our trials to work with different fertilizer types to figure out the best way to integrate organic fertilizers into our propagation protocols.

The final phase of plant development at the nursery is the hardening phase which is when growth slows and energy is diverted from shoot growth to root growth (Dumroese et al., 2009). Hardening occurs in the fall to prepare the plants for the cooler winter temperatures and to prepare the plants for planting out. Strategies for inducing the hardening phase are to reduce fertilizer rates, induce moderate moisture stress, and decrease temperatures (Dumroese et al., 2009). To achieve this, we used Osmocote which only last 5-6 months and will taper off when the temperatures are dropping in the fall.

6.5 Plant Salvage

Each winter the King County Natural Resource Department collaborates with developers to sponsor the Plant Salvage Program. The County locates potential salvage sites, recruits volunteers to remove plants prior to construction, and then transplants the salvaged plants at salmon habitat restoration sites. The

first half of the day is spent digging up plants for the county and then volunteers can spend the second half of the day digging for themselves. These events are the original source of plants for SER-UW restoration projects.

http://www.kingcounty.gov/services/environment/stewardship/volunteer/plant-salvage-program.aspx

For the 2015-2016 salvage season, there were two salvage sites, one in Snoqualmie and one in Issaquah. Each site is a remnant secondary-growth, low-elevation Puget Sound forest patch. Ironically, the current conditions of these forests are very similar to the target conditions of many restoration projects in the Puget Sound region. They have closed canopies of *Tsuga heterophylla, Thuja plicata*, and *Pseudotsuga menziesii*. Common understory species include *Rubus spectabilis, Berberis nervosa, Gaultheria shallon, Sambucus racemosa, and Polystichum munitum*. Spring ephemerals include *Trillium ovatum, Achlys triphylla, Tolmiea menziesii, and Tellima grandiflora* (Personal Observation).

Figure 8: Issaquah, Washington Salvage site.

Salvaging plants is fairly simple but there are a few tricks to keep in mind while out digging plants that help increase the survival rates. The first rule is to choose small ones that are likely to fit into 1-gallon pots. Digging up smaller plants is less labor intensive and the plants are more likely to survive because they have lost a smaller proportion of their root system than if you tried to dig up larger plants. At the same time, it is important to try to dig up as much of each plant's root system as possible. This can be tricky for some species such as *Gaultheria shallon* and *Berberis nervosa* which have root systems that stretch out horizontally.

Timing is also an important consideration for salvaging plants. This is usually not too big of an issue because the King County Plant Salvages are only held in the rainy months. Still, it is important not to dig up plants that have already started to leaf out, i.e. *Oemleria cerasiformis* can start leafing out as early as the beginning of February and can no longer successfully root if it is expending energy putting out leaves. Timing also influences one's ability to locate spring ephemerals which you cannot locate until they emerge in late March.

Once a plant was dug up we placed it in a burlap sack with as many other plants as would fit and a small amount of native soil was also put in the bag. The native soil was incorporated with the fine bark mulch when we potted up the plants. We wanted to include the native soil with the potting soil because it can inoculate the potting soil with beneficial bacteria and fungi. Using native soil also have the potential to introduce pests and diseases and the nursery may need to consider washing the roots instead.

While transporting and before they are potted up, it was essential to keep the burlap sacks, plants, and soil moist. This was usually not a probably because November through March is usually quite rainy in the Seattle area. Yet, if there was a warm, dry spell between the time that the plants were removed from the ground and potted it was important to hose down the sacks with water.

Potting Salvage Plants

To pot up the salvage plants, we used fine bark mulch. The plants salvaged in December 2015 did not receive any fertilizer treatment until spring 2016 when they were top dressed with 5- to 6- month slow release Osmocote. The plants salvaged in February were mixed with either 240 g of Walt's Organic Garden Blend Fertilizer per 15-gallons of fine bark mulch or 180g Walt's Rainy Pacific Northwest Organic Fertilizer per 15-gallons of fine bark mulch. These fertilizer rates were based off of the manufacturer's recommendation and then scaled to 15-gallons of fine bark mulch which is equivalent to 3 5-gallon buckets, an easy measuring device for the nursery that fills a standard wheelbarrow to three-quarters full. Most plants were potted in 1-gallon pots but some were too large and were potted in 2-3 gallon pots. Occasionally the roots were pruned to fit the plant into a pot. All plants were well watered.

Through careful observation of survival rates of plants from salvages of the 2014-2015 season we developed a few species specific potting techniques. For *Berberis nervosa* and *Gaultheria shallon* we often had to do some major root pruning to fit the plants in the pots. To compensate for the lost roots, we then removed about half the leaves to reduce transpiration. We also scored the major roots to induce callusing and promote root growth. We dipped the scored roots of *G. shallon* into RootBoost™ Rooting Hormone of which the active ingredient is Indole-3-butyric Acid. These techniques were tried to increase the survival rates of the species which in the past have been rather low. We have also noticed that even *B. nervosa* plants that successfully transplant will first experience severe transplant shock and have their leaves turn brown and defoliate before growing a new set of leaves.

6.6 Vegetation Propagation Techniques

This past year, the SER-UW nursery tried several vegetative propagation techniques for the first time in the nursery's history: striking cuttings and bulb divisions.

Cuttings

The only species we started from cuttings were *Physocarpus capitatus* and *Vaccinium parvifolium*. *V. parvifolium* is a slow growing species that takes many years to reach the 1-gallon size. We collected *V. parvifolium* cuttings from mature individuals at the February plant salvage in Issaquah, WA. The material was kept cool and moist in the walk-in refrigerator of the Douglas Research Conservatory head house until we were able to process it. Material was cut to approximately 1 foot in length. Using hand pruners, the distal end of the cutting was cut with a straight edge and the proximal end was cut with an angled cut. The proximal end of the cuttings was lightly scored with hand pruners and was then dipped in RootBoost™ rooting hormone. The cuttings were placed in 10-inch Ray Leach conetainers that had been filled with Sunshine Mix #4. The cuttings were pushed into the soil deep enough to cover at least two

bud nodes so that these meristematic sites could produce roots. The racks of cuttings were then placed in the mist bench in Zone 1 of the Douglas Research Conservatory.

Even though we had originally planned to start *P. capitatus* from seeds, we decided to do *P. capitatus* cuttings as well after determining the extremely large demand for that species coupled with how easily *P. capitatus* roots from cuttings. We were also compelled to start some *P. capitatus* from cuttings because we made a new partnership with UW Campus Facilities gardeners, Tom Erler and Janelle Patterson. They offered us material from the rain garden heavily planted with *P. capitatus* by the Husky Union Building (the HUB), that they were just going to compost. We followed the same procedure as *V. parvifolium* for the *P. capitatus* except we did not use the rooting hormone. The larger diameter material donated by Tom and Janelle was used by the Friends of Yesler Swamp group as live stakes.

Bulbs

In April of 2016, the SER-UW nursery received *Camassia quamash*, *C. leichtlinii*, *Dichelostemma congestum*, and *Lilium columbianum* bulbs from Fourth Corner Nurseries. In collaboration with ESRM 412 students, the nursery rehabilitated the raised beds by removing the top six inches of soil which were infested with weed seeds and weeds, and then replacing the removed soil with Sunshine Mix # 4 mixed with slow release fertilizer and sand.

Fall 2016, the nursery will be able to dig up the bulbs and divide them. Individual protocols for each species will need to be developed in order to encourage production of new offsets. For example, *C. quamash* does not produce offset bulbs unless stimulated by wounding (Lamber, 2001). The bulbs in each bed will have to be replaced every 3-5 years so that the restoration sites receiving these bulbs do not become genetically limited.

6.7 Plant Development Record

For each species started by seeds or a vegetative propagation technique we have created a Plant Development Record. The Plant Development Record form is adapted from *Nursery Manual for Native Plants: A Guide for Tribal Nurseries* (Dumroese et al., 2009). It is a record of all the important information about each crop, such as seed source and germination rates and the timing of the different plant development phases. It includes any details that will help us replicate successful growing techniques and troubleshoot unsuccessful methods. Eventually, the individual species development records will be used to create propagation protocols tailored to the facilities and capabilities of the SER-UW native plant nursery. The plant development records should be synthesized after a few years, and for species that are successful a propagation protocol should be written up. The Development records can be used as an extra resource for ESRM 412 students who are required to research and write three propagation protocols. The protocols can then be submitted to the Propagation Protocol Database sponsored by the Native Plant Network (http://npn.rngr.net/npn/). The Plant Development Record form can be viewed as Appendix 12.5.

6.8 Propagation Environment

A propagation environment is an area that is modified to encourage the growth of nursery stock by manipulating temperature, light and relative humidity (Dumroese et al., 2009). For a native plant nursery such as the SER-UW nursery, multiple different propagation environments are necessary to fulfill the needs a wide variety of plants with different requirements. Furthermore, the different stages of growth of a species may require different growing environments.

Greenhouse

Seedlings in the establishment phase are especially vulnerable and require the most environmental manipulation. The SER-UW nursery has half a bench in zone 3 of the Douglas Research Conservatory Greenhouse which provides consistent levels of light and regulates daily and nightly temperatures. We used this environment to start species that we wanted to provide to Nicolette Neumann for her pollinator patch at the UW Farm which had relatively short establishment and rapid growth phases. We started seeds of *Penstemon cardwellii, P. serrulatus, Lupinus polyphyllus, L. latifolius*, and *Symphyotrichum subspicatum* in October to be ready for planting in March. We took advantage of the warm growing conditions to grow these plants out of season. Unfortunately, we did not have much success with these plants, but fortunately in an adjustment of her species' list, Nicolette did not end up needing to use these species in her final planting plan.

Mist Bench

The mist bench in zone 1 of the Douglas Research Conservatory has the ideal environmental conditions for cuttings which prefer high humidity, warmed temperatures, and low light. The roof of the mist bench is covered with white germination cloth which prohibits a large portion of the light. The sides are enclosed with clear plastic to maintain the high humidity and warmer temperatures within the tunnel of the mist bench. There are small emitters that run along the middle of the bench that spray a small amount of water for 10 seconds once every hour. Cuttings remained in the mist bench until they were well rooted and then were up potted and transferred to the outside growing space.

Hoop House

The hoop house environment can be controlled to change with the season and the plants' needs. In the winter it is covered with a 6-millimeter thick white poly covering. This is to slightly insulate the air and keep the temperatures very slightly warmer than ambient temperatures. The poly also prevents that plants from being damaged by snow or wind. It is an ideal environment for fall sowing seeds since they will experience near-natural winter temperatures and the moisture can be controlled since the roof is impermeable. For the summer, a timed irrigation system of micro emitter is set up since there is virtually no rainfall all summer.

In the fall and spring when day time temperatures are high but night time temperatures are low the sidewalls can be rolled up during the day and the doors opened to increase circulation and lower air temperatures. The sidewalls can then be rolled down and doors closed for the evenings.

In the summer the poly covering is replaced with a 60% shade cloth (Figure 9). The shade cloth allows for much greater air circulation than the poly covering but also protects the plants from the strong summer sunlight. This is ideal for many of the species the SER-UW nursery grows which are adapted to the low light conditions of the forest floor.

Figure 9: The newly finished hoop house with the 60% shade cloth on the roof.

Tarp Area

The species that the nursery grows that are native to the South Sound prairies do not need to be protected from the sun the same way the forest species do. These shade intolerant species are placed on a tarp. They are open to the elements throughout the whole year. A timed irrigation system is also set up for these plants.

Organization by shade tolerance levels and hydrological requirements

For the summer of 2015 there were three zones of plants on the tarp space that were equipped with a timed irrigation system. Zones 1 and 2 were under a basic shade structure that only had shade cloth on the roof but not the sides, and zone 3 had no shading. To determine which zone each species went into, the shade tolerance and water requirements were researched. From the qualitative descriptions of full sun, mostly sunny, partial, mostly shady, and full shade we created a numerical "sun value" of 1 to 5 with full sun being a 1 and full shade being a 5. The scale for "water values" was 1 to 3 with dry being a 1, moist is 2, and wet equals 3. If a plant fell across a range of sun or hydrological requirements, then the values were averaged. For 2015 there was only equipment for three zones and we tried to put an equal amount of plants in each zone. By trying to have an equal number of plants per zone some plants did not receive the proper care. Zone 1 had plants that required shade and wet conditions. Zone 2 was shade and moist. Zone 3 was sun and dry to moist conditions.

Recommendations

This same rating system can be used in the future but the resulting categories can be further refined. I recommend having two general zones of inside the hoop house for shade tolerant species with an average rating of 2.5 to 5 for their sun value, and species with a sun value of 1 to 2 would be outside the hoop house on the tarp (Table 5). I chose a low threshold for putting the plants inside the hoop house because the plants in pots respond to light differently than plants out in the wild and often are more sensitive to the sun.

Both the outside and inside plants would be broken down by their "water values" into dry (1), moist (1.5 to 2), and wet (2.5). A sample of the species for each zone is shown in Table 5. Zones could be further broken down by pot size by grouping 4" and ½ gallon pots together, 1-gallon pots on their own, and 2-3 gallon and 5-gallon pots together. The hoop house should be set up with a timer to coordinate the

duration and frequency for at least 8 zones. Also the zones should be laid out without trying to put an equal number of plants in each zone and instead put emphasis on the correct shade and hydrological conditions for each plant. Only after the plants have been arranged by zone should the micro-tubing and emitters be installed. Space should also be set aside for plants that will be up potted and take up more space eventually. Lines can be laid out with shut-off valves so that although space is reserved within in a zone for the plants, water is not being wasted by spraying areas not occupied by plants yet.

Table 5: Recommended shade and irrigation zones demonstrated with two example species each.

	Sun Requirements						Hydrology					
Sample species	**Full Sun**	**Mostly Sunny**	**Partial**	**Mostly Shady**	**Full Shade**	**Sun value**	**Dry**	**Moist**	**Wet**	**Water value**	**Inside/Outside (outside, sun value 1-2, inside 2.5-5)**	**Dry (0-1), Moist (1.5-2) Moist-Wet (2.5-3)**
Koeleria macrantha	x					1	x			1	Outside	Dry
Anaphalis margaritacea	x	x				1.5	x			1	Outside	Dry
Elymus glaucus	x	x				1.5	x	x		1.5	Outside	Moist
Amelanchier alnifolia	x	x	x			2	x	x		1.5	Outside	Moist
Populus trichocarpa	x					1		x	x	2.5	Outside	Wet
Mimulus guttatus	x	x	x			2			x	3	Outside	Wet
Rosa gymnocarpa		x	x			2.5	x	x		1.5	Inside	Moist
Blechnum spicant				x	x	4.5		x		2	Inside	Moist
Geum macrophyllum		x	x			2.5		x	x	2.5	Inside	Wet
Acer circinatum			x	x		3.5			x	3	Inside	Wet

7 Plant Production and Greenhouse management

The vision and purpose of a plant nursery drive the management and plant production decisions. The vision of the SER-UW Native Plant Nursery is to be the UW campus educational hub for experiential learning of horticulture and to be the link between native plant materials for campus and student restoration projects. This is a distinctly different objective than a for-profit nursery. It puts education as the primary objective and defines the scope of clients to UW projects. This means the work is mostly done by volunteers and required stock is determined by the UW projects that the nursery partners with. Close discussions with partners help establish the desired species and stock type.

7.1 Propagation and Plant Production Plan

We envisioned our primary customer to be the REN-Capstone course because they need approximately 4,000 plants each year mostly of Puget Lowland Forest species. These species are typically not ready for out-planting for at least one year from being started from seed. Therefore, the available stock for each year is always dependent on the prior year's work. Maintaining plants over multiple years is one of the most compelling reasons for having a full-time nursery manager, but also is the essential component to planning out the year's work. The second planning constraint is that space is extremely limited at CUH so there is only room to grow plants that are definitely going to be sold to courses.

To satisfy these constraints it is necessary to coordinate with the different groups early on. In the spring of 2015 we obtained the planting plans of REN-Capstone to determine the most frequently requested plants by most of the groups. We then filtered by the stock type (i.e. 1-gallon, 4", bare root, or live stakes) and the standard propagation method (i.e. seed, salvage, or cutting) to determine which species and the quantities to grow. We also compared wish lists from Kincaid Ravine, Whitman Walk, Nicolette Neumann's pollinator hedgerow, ESRM 473, and the Washington Park Arboretum (Table 6). Table 6 does not include species that the capstone groups only salvaged or planted as live stakes. For each species we estimated eventual "crop size," as large (l), medium (m), or small (s), which is the above pot size of the plant which effects the spacing of plants both horizontally and if they would fit beneath a table.

We started the majority of the plants from seed, see Table 4 for species and target quantities. Additionally, we got a donation of bare root plants from Fourth Corner Nurseries to supplement our inventory until we got caught up with the multi-year cycle of producing plants from seed.

Table 6: Propagation planning done in spring 2015 for plant purchases in 2016-2017. Sorted by highest quantity needed.

			Propagation Material Source				User, Quantity				
Species	Crop Size	Stock Type	Seed	Salvage	Cutting	Bare Root	Capstone	Kincaid	Plant Sale	Nicolette	Total
Polystichum munitum	l	1-gallon		x			201	25	20		246
Carex obnupta	s	plug	x				194	x			194
Physocarpus capitatus	m	1-gallon	x		x	x	121	x	20	20	161
Cornus sericea	s	1-gallon	x		x	x	113	20	5	20	158
Rubus spectablis	m	1-gallon	x				91	26	2		119
Oemleria cerasiformis	s	1-gallon	x			x	116				116
Gaultheria shallon	m/l	1-gallon		x			50	15	20	15	100
Thuja plicata	m	1-gallon	x				63	35			98
Rosa nutkana	s	1-gallon	x			x	66		5	20	91
Berberis nervosa		1-gallon		x			40	20	20		80
Tsuga heterophylla	m	1-gallon	x	x			50	23			73
Lonicera involucrata	m	1-gallon	x			x	62	x	10		72
Picea sitchensis	m	1-gallon	x				55	11			66
Ribes sanguineum	s	1-gallon	x				24	?	15	20	59
Athyrium filix-femina		1-gallon		x		x	55				55
Rosa gymnocarpa		1-gallon				X					50
Symphoricarpos albus	m	1-gallon	x		x	x	49				49
Alnus rubra	s	1-gallon	x				45				45
Dicentra formosa		1-gallon		x			25		20		45
Tolmiea menziesii	s	4"	x	x			44		x		44
Tellima grandiflora	s	4"	x	x			40		x		40
Acer circinatum	s	1-gallon	x			x	28	10	x		38
Sambucus racemosa		1-gallon	x	x			30	x	5		35
Blechnum spicant		1-gallon		x			15		20		35
Vaccinium parvifolium		1-gallon		x	x		20		10		30
Acer macrophyllum	s	1-gallon	x				25				25

			Propagation Material Source				User, Quantity				
Species	**Crop Size**	**Stock Type**	**Seed**	**Salvage**	**Cutting**	**Bare Root**	**Capstone**	**Kincaid**	**Plant Sale**	**Nicolette**	**Total**
Pseudotsuga menziesii		1-gallon	x				24				24
Vaccinium ovatum		1-gallon			x		21		x		21
Rubus parviflorus		1-gallon	x				10		10		20
Amelanchier alnifolia		1-gallon								20	20
Holodiscus discolor		1-gallon	x				10	6			16
Solidago Canadensis		1-gallon								15	15
Rhamnus purshiana		1-gallon				x					15

We decided to salvage *Berberis nervosa* and *Gaultheria shallon* because they are difficult to grow from seed but readily available at salvage sites around King County (Table 7). Starting *P. munitum* and *Blechnum spicant* from seed is not an option since ferns do not produce seeds and instead reproduce through spores. We decided that working with spores was too technically challenging, and not worth the effort since *P. munitum* and *Blechnum spicant* are readily available at salvage sites through King County. *A. rubra* was salvaged because it is very common at salvage sites and easily transplants. There were a few species *Pseudotsuga menziesii*, *Fragaria vesca*, and *Rubus spectabilis* that were opportunistically salvaged and are listed as "Bonus Plants" in Table 7. Our target numbers were based on our estimates of needs of Capstone and two public plant sales. We also calculated in a Margin of Error to account for mortality from transplanting. This Margin of Error was based off our observations from previous salvages. With better record keeping it will be possible to have a more accurate margin of error.

Table 7: Target numbers for the King County Plant Salvages that the nursery attended in 2015-2016.

	Target Numbers			
Species	Capstone	Plant Sale	Margin of Error	Overall
Berberis nervosa	60	20	60	140
Gaultheria shallon	65	20	20	105
Polystichum munitum	225	20	15	260
Alnus rubra	45	0	3	48
*Vaccinium parvifolium**	20	10	20	50
Blechnum spicant	15	20	5	40
BONUS PLANTS				
Pseudotsuga menziesii				
Fragaria vesca				
Rubus spectabilis				
			Total	**643**

7.2 Crop Planning Schedule

Producing many different species all with different pretreatment requirements and establishment lengths can get very confusing. For example, it is important to move seeds from warm to cold stratification at the right time to keep a crop everything on schedule. It is equally important to salvage and collect cuttings at the appropriate time for a certain species. One method to keep on top of all this information is to create a crop planning schedule for all the species and propagation techniques you intend to use. By adding the target quantities and container size at each growth phase to the crop production schedule you could then better predict the exact space available in the nursery at any one time.

We did not do this for the 2015-2016 growing season and it was very confusing trying to keep track of all the different species. Figure 10 is an example of a crop planning schedule for a few species that the SER-UW nursery propagated this past year based off of propagation protocols from the Native Plant Network and also notes from the Plant Development Record. When viewing Figure 10, note that crops were started much later than is recommended. The crop schedule is color coded to show the different phases of propagation for the different propagation techniques. When using a crop production schedule such as this it is helpful to keep in mind that it is just a prediction and that many factors can determine when the different phases actually occurs.

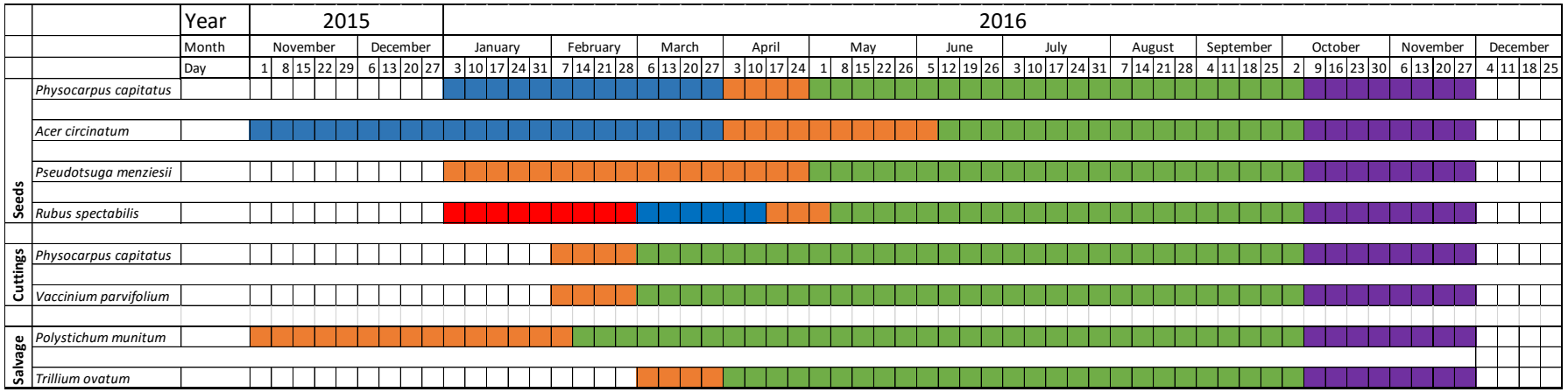

Figure 10: Crop planning schedule. Blue= cold stratification, red warm= stratification, orange= establishment phase, green= rapid growth, and purple= hardening.

7.3 The infrastructure of the nursery

This year the overall objective for the SER-UW nursery was to establish the infrastructure for the nursery to provide quality care for a larger number of plants. This meant building a hoop house, a potting bench, and plant production tables. We also purchased a storage shed to house materials and tools in the hoop house to improve the work layout.

Hoop house

We selected a hoop house kit from Oregon Valley Growers in Aurora, Oregon. The footprint is 30 ft. by 48 ft. It is 10ft wider than the pre-existing hoop houses at CUH but the same length. The frame has a gothic arch, which is meant to shed snow better than a standard hooped structure. The peak of the roof is 15 ft. tall. The side walls do not start curving into the roof until 6 ft. off the ground so it is possible to stand at full height for most people right next to the sidewall, increasing the workable space in comparison to the old hoop houses. In the winter the structure is covered with 6 millimeter poly and in the summer it is covered with a 60% shade cloth. The sidewalls roll up for ventilation. The house has double 4 by 8ft doors on each end, which are part of a prefabricated end wall kit with polycarbonate siding.

Building process

After receiving the CSF grant in June 2015 we learned that we had to obtain a quote from UW Facility Services and have them build the hoop house. We did not know this when we put together our budget. We consulted with Facility Services over the summer and by the beginning of October had a quote from them. It was $71,000 for all materials and labor. This included an additional amount of work than we had not originally considered which was getting an electrical line sent out to the hoop house which required trenching. We had budgeted $25,000 for all materials and labor which from consulting with contractors while writing the grant was the market rate for this style hoop house. Since we could not afford to pay UW Facility Services to build the hoop house and we could not work with another contractor unless UW Facility Services turned down the job, we were stuck for many months with no options. In December, we got permission from UW Facility Services to build it with volunteers. We asked Bill Bender, the Department Chair of UW Construction Management, with students in the Construction Management honors society Lambda Sigma Chi, to help us build the hoop house. He graciously agreed to help us out and his students got some practical experience in exchange for helping us build the hoop house.

The first step was to layout the footers of the foundation. We then augured holes, 16 inches in diameter by 24 inches deep, for each of the four corners and for each of the arches of the roof. There was also a hole augured for each side of the double doors. The holes were filled with concrete and the sleeves for the arches were set. Fortunately, the Construction Management students had a surveying level on a tripod with a stadia rod, and determined that the north side of the hoop house was 18 inches higher than the south side. If they had not used this piece of equipment, fitting together the whole house in a level and correct manner would have been impossible. Since the ground was so sloped we had 24 yards of gravel, 12 yards of crushed ¼ minus and 12 yards ¼ washed gravel delivered and dumped on the ground. We spread it out with hard rakes.

A baseboard was installed on each side wall to keep the gravel in and for attaching the sidewalls and roofing materials. A hip board was also installed for the top of the sidewalls to be attached to and the poly in the winter.

The next step was to put the arches together and place them into the sleeves. There are 10 arches, 5 ft. on center, except for at one end where two arches are closer. The arches are held together with support rods installed across the width of the house. Tracks for the “wiggle wire” to hold the poly or shade cloth in place were installed on the base board, hip board, and along the arches of the end walls.

The end walls with the frames for the doors were installed next. The polycarbonate siding had to be cut to the shape of the roof because they came in large rectangular pieces not precut for the shape of the roof. The doors also had to be cut out. Finally, the shade cloth was installed and kept in place with the wiggle wire.

The house is not completely finished. The sidewalls were not built yet and must be built before the fall. We did not have the correct material to make the sidewalls. We also did not have the correct poly for the roof. We received clear plastic instead of white which will let in too much solar radiation and increase the temperature of the house too much.

Recommendations

The flooring of the hoop house should follow the standards of the Americans with Disabilities Act. To do so the nursery should collaborate with UW Facility Services to create a floor that is compact enough for all persons to access the interior of the hoop house. Possible options include adding additional ¼ minus crushed rocks and compacting it with rollers, or pouring a concrete floor. The surrounding area in the yard of the Center for Urban Horticulture also needs to be upgraded so that it is ADA accessible as well.

Production tables

The production tables are 4 ft. by 12 ft. The base frames were donated by the UW Botany Greenhouse. They were originally 16 ft. long and then were trimmed to 12 ft. long to actually fit two along the width of the SER-UW hoop house. They are 3 ft. tall, with wide gauge steel wire on the top. The tops are stationary. We chose 4 ft. wide tables so that almost anyone can reach the middle of the table. Underneath each table, black mats were placed that will allow water to drain out from the lower level of pots and lift them a few inches off the ground.

Space

We put 13 12ft. by 4 ft. plant production tables inside the hoop house. The 12 ft. long tables will fit approximately 154 1-gallon pots, the primary stock type we are producing, and be able to hold a total of 1,848 1-gallon pots on top of the 12 tables. There will also be space for 1,232 1-gallon pots on the tarp space outside the hoop house (8 rows of 4x12 ft., 154 plants per row, and 1,232 1-gallon pots). In total we will have space for approximately 3,100 1-gallon pots. A possible way to increase the capacity of the hoop house is to place pots under the tables and thus have room for 4,900 plants. This estimate has been simplified and does not take into account all the different pot sizes we work with, most importantly the cones to start seeds.

There are several considerations for placing plants underneath the tables. It would be very space efficient, increase the revenue of the nursery, and help meet the demands of more projects. Space

becomes especially dear when there are certain species that remain in the nursery for more than a year to develop. At the same time, there are pest and pathogen issues related to having pots underneath other plants. Since the plants would be only slightly raised from the ground there would be reduced air flow under the plants. The lower layer of plants would also receive all the water from the upper plants and the dripping water could be a vector for disease transfer. These issues must be balanced in order to optimize space and mitigate pest issues.

Potting bench

Over autumn quarter 2015, Kelly Broadlick and the construction projects intern, Wyatt Hoffman, designed a potting bench. The potting table was designed to be versatile and accommodating for both large and small groups of people. It is comprised of two 5 by 5.5 ft. tables that are attachable at the legs and underneath the table surface to create one 5.5 ft. by 10 ft. table (Figure 11). This allows the table to be taken apart and one or both pieces to be moved outside for work, while also allowing large groups to work around a larger table for things such as potting salvage plants or up-potting. The potting bench was built by Ed McKinley, a carpenter with UW Facility Services. In the future, the table top may be painted with a mural and then finished with a layer of epoxy to protect it from water damage.

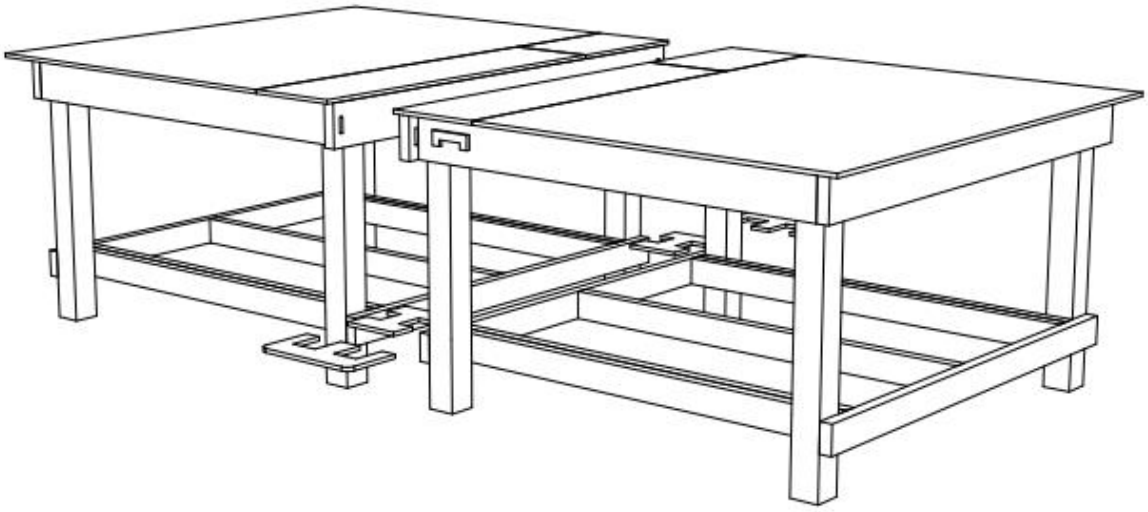

Figure 11: AutoCAD draft by Ed McKinley of the potting bench.

Storage

An 8 ft. by 3ft. and 5 ½ ft. tall storage shed was placed in the northwest corner of the hoop house. It holds plant production tools and materials such as potting media, pruners, fertilizer, and pots. It is important for efficient work flow to have these items right in the hoop house. A rack to hold dirty and clean pots will be built and placed against the outside of the west end wall.

7.4 Record Keeping

Record keeping and keen observation are essential to keeping track of what is happening in the nursery and reviewing what is working and what is not. Record keeping should include plant production records such as a daily watering sheet, daily plant work log, and the plant development record, but also should

include plant sales, volunteer hours, manager hours, and photos and videos. Photos and videos are useful for outreach material such as Facebook posts, emails, and presentations.

The daily watering record, daily plant work and plant development records are kept in a binder which is stored in the cabinet in the head house. Eventually there will be a second one kept in the hoop house for plant work and watering done out there.

As with any data collection the advantages and disadvantages of paper versus electronic data collection must be weighed. Using paper means spending extra time entering data later, but you also have a hard copy that can referred to if data gets corrupted. Entering data electronically theoretically saves data entry time. Electronic data entry also would require the nursery to purchase a tablet. For now, all nursery record keeping is done on paper and then select information is transferred to digital format.

Daily Watering Record

Each of the species in the greenhouse are checked at least three times per week to see if they need water. If they are watered, this is recorded in the daily watering record. We also use this log to keep track of weekly fertigation. In the future the watering sheet could be more detailed and broken down by potting medium and record an estimate of the amount of water being applied to each plant. This could be used in studies on the efficiency of irrigation.

Daily Plant Work Log

The daily plant work log is intended to be an accurate representation of what the daily tasks and issues are within the nursery. Each task related to plants and plant health is recorded on the day the work happens by the person performing the work. This will help future managers understand the level of work required, keep the inventory up to date, and bring to light any trends that are difficult to see on an individual day.

This record keeping document is especially important for inventory tracking. The inventory is managed by one individual so that there are not conflicting versions of the inventory. Recording what plants have been composted or added to the nursery in the daily plant work log is an efficient way for the information to be collated and then the one manager uses the logs to update the inventory numbers.

In the daily plant work log the activity/activities preformed, the time it took (in person hours, i.e. number of people multiplied by time), the species and the number of plants or other items worked with.

Common activities that should be recorded are:

- Seed sowing
- Seed pretreatment
- Pest management
- Up-potting
- Fertilization
- Potting
- Cuttings
- Setting aside plants
- Irrigation maintenance
- Composting dead plants
- Weeding

Time spent watering was not recorded in this sheet, but perhaps would should be in the future. Additionally, any questions or concerns are recorded.

Volunteer Hours

Volunteer hours are tracked on an individual basis and by participants per work party. The hours worked by each volunteer are based off the sign-in sheets at each work party and entered into a Google spreadsheet. This information is useful for understanding recruitment trends, and for grant applications. Attendance lists are necessary for getting reimbursed for snacks by SEFS.

Manager and Intern Hours

To record the time the nursery managers and interns spent on all things nursery related we used a time tracker program called Toggl. It is a simple tool that allows you to use a timer while you are actively working on something or manually add activities later. We recorded time in six different project headings: Administrative Tasks, Communications, Construction, Plant Sales, Propagation Tasks, and Work Party.

7.5 Inventory Management

Keeping the inventory list up to date is critical for letting people know what stock is available and also for determining trends in mortality or production success. Inventory tracking is also one of the biggest challenges for plant nurseries of all types. The number of variables associated with each plant are enormous and much greater than the amount associated with most pre-packaged inventory management programs.

I developed an inventory tracker in Excel to keep all the information about each species accurate. Important information for each plant was the species, source, pot size, if it is in a sellable condition, and the price. The inventory tracker also manages the plant sale invoices and holds customer data. The species, pot size, purchase category, and price are all linked using VLookup functions. The current inventory numbers are automatically updated using a Sum Function within a Pivot Table. The first sheet of the inventory tracker gives detailed instructions on how to use the tracker.

One of the major issues with this inventory tracking system was keeping track of plants as they transitioned from establishing to being sellable. It also does not track the seed source, or propagation type along the whole time the plants are in the nursery.

Recommendations

From talking with other native plant nurseries in the area it seems that a more sophisticated system than Excel is necessary to track all the pertinent information related to plant production and sales. A system that can account for the flow of plants from one development stage to the next while understanding that they are the same individuals is tricky. From talking with Dylan Levy-Boyd from Fourth Corner Nurseries and Bridget McNassar from Oxbow it seems like the best applications for inventory management are Microsoft Access and FileMaker. Both of these programs are database management systems that can be used as desktop databases and also as apps on a smart phone or a tablet. Microsoft Access is a software supported by UW IT and is available to UW students and staff as a free download. Users need the most up to date version of Microsoft Office, Office 365, in order to use the cloud supported Apps. FileMaker seems to have a more adaptable interface but costs money for

customer support and added services. It is probably cost prohibitive to use FileMaker. The inventory tracker could work as an electronic version of the information we are gathering with the Species Specific Development Record.

An important form of identification for the inventory tracker to work better in the future would be to create a unique "Lot Identification Code" for each species that references its year, source, and propagation method. This way species produced by multiple methods in the same year can be tracked separately. Additional information that the UWBG needs for its collection records should be integrated as well.

At the same time as improving the internal inventory tracking, the nursery needs to do a better job about publically displaying the available inventory. Either a PDF or Google spreadsheet of the current inventory should be posted to the SER-UW webpage to make it easier to share the current inventory numbers with interested groups.

7.6 Memorandum of Understanding

To secure space for the hoop house and other growing areas at the Center for Urban Horticulture, the SER-UW Nursery has signed a Memorandum of Understanding (MOU) with UWBG. The MOU is available as Appendix 12.6.

For the 2015-2016 school year, the space usage rate is $15 per 24 sq. ft., as specified by UWBG Facility Services. For the 1,440 sq. ft. of space utilized by the SER-UW hoop house in the DRC yard, SER-UW will owe UWBG $900 per month. This amount will primarily be paid in the form of volunteer hours at a rate of $26.72 per hour, based on the United Way's estimate of the average value of a volunteer hour in Washington State for 2014. (Source: https://www.uwkc.org/volunteering/volunteers-rock-our-world/) Therefore, $900 per month is equivalent to 34 volunteer hours per month. Rent can also be paid as in-kind donation of plants at a retail value rate.

Volunteer hours

Volunteer hours are accrued by working on UWBG approved projects. Some projects from the 2015-2016 school year were pulling blackberry around the Amphibian Corridor in UBNA and weeding the prairie rain garden by the west side of Merrill Hall. These projects help UWBG maintain UBNA and are also relevant projects for students interested in restoration ecology.

In-kind Donations: Plants

Trading plants for rent is a mutually beneficial arrangement between the nursery and the UWBG. Plants were installed at the Amphibian Corridor as a form of rent payment. Also, Ray Larson, the Curator of Living Collections for UWBG, purchased plants from the nursery for installation at the Washington Park Arboretum and CUH. He also has requested that the nursery grow 100-200 *Lupinus Lepidus and L. latifolius* for the Arboretum. He requested that the nursery grow the native lupine species because he could not find the quantity of lupines as container plants from commercial nurseries but there was an abundance of seeds available. This is another example of the SER-UW nursery providing a needed service on campus while teaching students to grow plants.

7.7 Partnerships other than student groups

In addition to working with UW courses and the UWBG, the SER-UW native plant nursery also collaborated with UW Grounds and the UW Construction Management Department. UW Grounds

purchased and provided plant materials and the UW Construction Management Department helped build the hoop house.

UW Grounds

Collaborating with the UW campus gardeners is a chance for the SER-UW nursery to increase the use of native plants in the UW campus landscape. This year approximately 30 plants were purchased by the UW campus gardeners, Tom Erler and Janelle Patterson. In addition to buying plants they also donated *Physocarpus capitatus* material pruned from the rain garden near the Husky Union Building (the HUB). If the SER-UW nursery had not used this material it would have all ended up in the compost. Instead, the SER-UW nursery used this material to teach students how to take cuttings, an important skill for restoration nurseries. The other portion of the *P. capitatus* materials was used by the Friends of Yesler Swamp group as live stakes. SER-UW collaborates with the campus gardeners for Ivy pulls on Earth Day.

Recommendations

In the future, the UW campus gardeners could collect more material from *P. capitatus* and *Symphoricarpos albus* to be used as cuttings. Other species could be considered but with caution to choosing species that are likely to be planted as cultivars such as *Ribes sanguineum*. The nursery should also work with the UW Seattle and UW Bothell campus gardeners to work on “contract growing” plants from seed for future projects. UW Bothell has a completely organic landscape and the native plants grown by the SER-UW nursery fit in well there. The future managers should coordinate with the UW Bothell Gardener Lead, Tyson Kemper, about growing plants for UW Bothell, and also plan a fieldtrip to visit the Bothell campus. Tyson is also a great resource for the nursery to learn about using compost teach as an Integrated Pest Management strategy to reduce the need to spray pesticides and fungicides and get the most out of organic fertilizer applications.

UW Construction Management

During winter quarter, the SER-UW nursery partnered with Lambda Sigma Chi, the UW Construction Management honors society. Bill Bender, the department chair of UW Construction Management, searches for a community service project for his students each quarter. The projects are usually much smaller than building the SER-UW hoop house but Bill and his students made an amazing commitment and contribution to finish out the project. The Construction Management students were essential in interpreting the instructions, installing a level foundation, and advising the delivery of 24 yards of gravel before the completion of the structure. They also came equipped with their personal tools, anything from power drills and levels to a cement mixer. The students’ and Bill’s building experience was invaluable for building the hoop house in an efficient and safe manner (Figure 12).

Figure 12: Toby Bloom, UW Construction Management student, determining the height of each corner to set a level foundation for the hoop house.

8 Business Model

8.1 Pricing Scheme

Current

As a small educational nursery, the SER-UW nursery works with many different groups with different levels of funding. Our primary foci are SER-UW projects, Capstone groups, and any other on-campus or UW affiliated projects. Furthermore, the nursery is not supplying to outside restoration groups at this time like EarthCorps, unless they are working on a UW or SER-UW on campus project. The nursery also does a fall and a spring public plant sale as a fundraiser and to move species that are not ideal for restoration projects.

To better serve all these groups we have come up with a pricing structure that is based on three different levels: retail, restoration and in-kind donations. Retail and Restoration rates are paid in cash. Groups that pay retail prices are the public plant sale and UW Grounds. Students groups such as Capstone and Restoration of North American Ecosystems pay Restoration rates. In-kind donations for SER-UW sites are tracked at restoration prices and UWBG rent projects are tracked at retail prices.

We researched the average prices of local nurseries growing the same species and used their prices as our base prices for each pot size. We then assigned each species a relative value, High, Base or Low, depending upon if the species is desirable or difficult to grow. Finally, based off of Seven Oaks Nurseries pricing scheme of wholesale versus retail pricing, we doubled the retail price in comparison to restoration price which was our equivalent to wholesale pricing (Table 8).

Table 8: 2015-2016 pricing based off of pot size, relative value, retail price or restoration price.

Pot Size	Relative Value	2015-2016 Retail Price	2015-2016 Restoration Price
4"	Low	$3.00	$1.50
1/2 Gallon	Low	$4.00	$2.00
1-gallon	Low	$5.00	$2.50
2-3 Gallon	Low	$10.00	$5.00
5+ Gallon	Low	$24.00	$12.00
4"	Base	$4.00	$2.00
1/2 Gallon	Base	$5.00	$2.50
1-gallon	Base	$6.00	$3.00
2-3 Gallon	Base	$12.00	$6.00
5+ Gallon	Base	$26.00	$13.00
4"	High	$5.00	$2.50
1/2 Gallon	High	$7.00	$3.50
1-gallon	High	$8.00	$4.00
2-3 Gallon	High	$16.00	$8.00
5+ Gallon	High	$30.00	$15.00

Lessons learned

When we were planning the species and quantities to grow and create a pricing structure we were working from the planting plans of the 2014-2015 REN-Capstone groups. The planting plans included the species, quantities, and stock type that they intended to plant (Table 9.) Table 9 only includes the planting plans from six of the ten groups because we did not receive complete planting plans from all the groups. We assumed that if 6 groups planted 2,756 plants then 10 groups would have planted approximately 4,410 plants. We didn't have the As-Built reports when we were putting together our Propagation Plan in the spring of 2015 and trying to figure our bare root order.

Table 9: Plants from 2014-2015 REN-Capstone planting plans by stock type.

Stock Type	Quantity
Bare root	1015
Bare root or plug	396
Bare root or potted	37
Bare root or salvage	12
Live stake	618
Live stake or potted	24
Plug	295
Potted	326
Salvage	24
Salvage or seeds	6
Unknown	3
Total	**2756**

We knew that only a small portion of the plants, 326 of 2,756 were purchased as potted plants and that the majority of the plants were purchased as bare root. What we didn't completely understand was that the difference in pricing between bare root plants and potted plants was significant enough that even if we had the species the students needed priced at the industry average for the pot size, we would not sell the plants. This meant that even though many Capstone groups needed species we had such as *Lonicera involucrata* or *Thuja plicata*, they did not purchase them from us. Another reason they did not purchase plants from us was that we couldn't fill all their needs even for a single species sometimes because our inventory was not filled out enough. This makes sense since the propagation work we did in 2014-2015 originally had no objective and so the plants that were ready, despite supplementing with bare root plants from Fourth Corner Nurseries, did not meet the needs of Capstone.

Recommendations

For the 2016-2017 school year the SER-UW inventory should be able to better meet the needs of some REN-Capstone groups. From strategically salvaging, seeding, cutting, and potting bare roots we will have much greater quantities in the species most commonly used by the capstone groups. Also by potting the bulb species for Restoration in North American Ecosystems, we will better be able to fulfill their needs. To actually get the class groups to buy the plants though, I believe we need to lower the Restoration Prices so that they better match the prices they are paying for bare root plants of the same species. It should be noted that the nursery has a responsibility to not undercut market prices, and these suggested low prices for potted plants are only for groups within the University.

I recommend keeping the majority of the Retail prices the same, but also adding in a new category to Relative Value called "Special". Special plants such as *Trillium ovatum* or *Achlys triphylla* are highly desirable but are rarely sold by nurseries because the difficulty to propagate them. We have them in stock from salvaging them. Special plants would mostly be reserved for public plant sales. By disconnecting the Retail and Restoration prices we are able to supplement the extreme discount of the Restoration Prices with the higher Retail prices. The new prices I propose are outlined in Table 10. I also

added a new pot size, plug, since some species such as *Carex obnupta* or other graminoids will most likely be sold in that container type.

Table 10: 2016-2017 pricing scheme based on pot size, relative value and alignment with bare root pricing.

Pot Size	Relative Value	2016-2017 Restoration Price	2016-2017 Retail Price
Plug	Low	$0.50	$1.00
4"	Low	$0.50	$3.00
1/2 Gallon	Low	$0.75	$4.00
1-gallon	Low	$0.90	$5.00
2-3 Gallon	Low	$1.25	$10.00
5+ Gallon	Low	$3.00	$24.00
Plug	Base	$0.50	$1.00
4"	Base	$0.50	$4.00
1/2 Gallon	Base	$0.75	$5.00
1-gallon	Base	$1.25	$6.00
2-3 Gallon	Base	$1.50	$12.00
5+ Gallon	Base	$5.00	$26.00
Plug	High	$1.00	$2.00
4"	High	$1.00	$5.00
1/2 Gallon	High	$1.00	$7.00
1-gallon	High	$1.75	$8.00
2-3 Gallon	High	$2.00	$16.00
5+ Gallon	High	$6.00	$30.00
1-gallon	Special	N/A	$12-25

Also in the future, the nursery would benefit from collaborating with UW Foster Business school students to create a comprehensive business plan for the nursery in order to maximize profits for the nursery. The plan should cover all labor and material costs, plant sales along with courses offered to the general public through UWBG's adult education program.

8.2 Annual budget

2015-2016 Income

As discussed in 7.1 Propagation and Plant Production Plan, the income of the nursery is constrained by the decisions made in the past year and space. For example, the available stock for this past fall and this spring was determined by haphazard salvage, seed sowing, and donations done in 2014-15 before the new vision of the nursery was imagined. The inventory contains more plants of 2-3 gallon and 5-gallon size than was ideal, because those sizes are too large and expensive for most restoration projects. It also had some plant species that are not often included in restoration projects, i.e. *Tolmiea menziesii* or *Aruncus dioicus*. That being said, if we sold everything that was sellable this spring, we would had made $6,530. This is assuming that most plants will be sold at whole sale price, and 150, the same number that was sold at fall 2015 public plant sale, will be sold at retail price. There are 1,789 available plants with an average retail price of $6.73 and average wholesale price of $3.37.

But the nursery did not sell all of its sellable plants which would have been astonishing. Instead, from November 1st, 2015 to April 24th, 2016 the SER-UW nursery sold 771 plants and distributed 391 plants as "In-kind donation payments" to UWBG and Kincaid Ravine (Table 11). For rent, the SER-UW contributed 209 plants at a retail value of $2,238.50 to UWBG. SER-UW donated 182 plants at the restoration price to Kincaid Ravine at a value of $895.50.

Table 11: Quantity of plants purchased and value of plants by group and purchase category from September 2015- April 2016.

Group	Purchase Category	Quantity of Plants Purchased	Value of Plants
Kincaid Ravine (SER-UW)	In-kind donation- Restoration	182	$895.50
UWBG Rent	In-kind donation- Retail	209	$1,343.00
	In-kind donation Total	**391**	**$2,238.50**
REN-Capstone	Restoration	133	$377.50
ESRM 473	Restoration	337	$612.00
Nicolette's Pollinator Hedgerow	Restoration	106	$160.00
	Restoration Total	**576**	**$1,149**
UW Grounds	Retail	39	$139.00
Fall Public Plant Sale	Retail	151	$1,091.00
Centennial Woods	Retail	5	$25.00
	Retail Total	**195**	**$1,255.00**
	Retail + Restoration Total	**771**	**$2,404.50**
	Overall Total	**1,162**	**$4,643.00**

The SER-UW Nursery was most successful at selling plants to the Restoration of North American Ecosystems class, and sold out of almost all plants appropriate for the prairie restoration projects. The Fall Public Plant Sale was also very successful and raised approximately half of the money earned by the nursery. This suggests that in the future the SER-UW nursery should focus on supplying more plants to Restoration of North American Ecosystems by tightening the connection the two courses (ESRM 473 and ESRM 412) and the nursery.

There were approximately 1,000 plants in a sellable state still in the nursery after the 2015-2016 winter restoration planting season. Many of these were plants that were ideal for the REN-capstone groups but they did not purchase from us but instead from the King Conservation District bare root sale. Having 1,000 plants leftover at the end of the planting season is not ideal since we do not expect to sell more than 200 plants at the spring plant sale. In order to avoid this situation in the future I propose lowering the wholesale price (Table 10) so that Capstone and ESRM 473 would preferentially purchase plants from the SER-UW nursery and it would be better meet its goals of providing plants for UW restoration projects.

2016-2017 Income

Using the new pricing scheme, if we sold everything that we are preparing for next year, and we reach our propagation target goals, we would make $4,562. To reach this value, I assumed that most plants will be sold at the restoration price, and 300, which is equal to twice as many plants sold at the fall 2015 plant sale will be sold at the retail price. There will be 2,434 available plants, and the average retail price will be $7.16 and average Restoration price will be $1.55. This number is probably an overestimate because it does not take into account plants donated in exchange for “rent” which is not a monetary transaction. It is also a huge assumption that as a new nursery we will fulfill all our propagation targets.

Annual Costs

After the initial establishment of the nursery infrastructure, the annual costs of the nursery are primarily the salaries of the nursery managers and then a much smaller amount for plant production materials.

Materials costs

The estimated annual recurring costs for the SER-UW nursery are approximately $2,070 (Table 12). This estimate includes the soil media, fertilizers, and replacement materials for the hoop house roof. The estimate takes into account the expected lifespan of each item, as labelled as the repurchase rate. Covering the annual material costs of plant production and maintaining the hoop house are within the realm of possibilities for the nursery to cover with revenue from plant sales.

Table 12: Annual materials cost based off of the average Repurchase Rate in years.

Repurchase Rate	Item Description	Quantity	Unit Price	Extended Price + 9.5% Tax
1 year	Compressed Coconut coir brick / 10 lb	4	$ 19.49	$ 85.37
1 year	Bottle Wash Brush	5	$ 2.23	$ 12.21
1 year	Rootboost Rooting Hormone / 20z	1	$ 6.78	$ 7.42
1 year	Citric acid / 1lb	1	$ 9.29	$ 10.17
1 year	Ziploc Freezer Quart Bags	1	$ 4.49	$ 4.92
1 year	Plant Stake Labels, Yellow Box of 1000	2	$ 28.95	$ 31.70
1 year	Clorox concentrated germicidal bleach	2	$ 23.49	$ 51.44
1 year	Fine bark mulch by the cubic yard	6	$ 43.25	$ 284.15
1 year	Fertilizer	2	$ 12.25	$ 45.00
1 year	Office supplies	1	$ 50.00	$ 110.00
1 year	Snacks for events	30	$ 12.00	$ 600.00
1 year	Printing	1	$ 50.00	$ 50.00
1 year	Seeds	15	$ 10.00	$ 164.25
1 year	Grease pencils	1	$ 11.40	$ 12.48
1 year	Gloves	20	$ 3.98	$ 87.16
2.5 years	Metal spatulas	5	$ 1.90	$ 10.40
2.5 years	Mesh cloth	1	$ 8.69	$ 9.52
6 years	Conetainer pots, case of 1100	1	$ 88.00	$ 96.36
6 years	Paint to repaint table (1 gal)	1	$ 34.95	$ 38.27
6 years	Poly for roof	1	$ 481.50	$ 527.24
6 years	Shade cloth	1	$ 336.00	$ 367.92
	Total			**$2,069.25**

Wages

The cost of the nursery manager's labor can vary considerably based upon the position category. For the 2015-2016 academic school year the two nursery manager positions were funded as hourly employees for 15 hours per week and only 5 hours for one manager over the summer. The hourly rate was based upon the UW pay scale for a green house manager (Table 13). The cost per person includes a 17% Fringe Benefit Rate. The two positions cost $24,622.77. These positions were covered by a Campus Sustainability Fund grant.

Table 13: Cost of two hourly manager positions for 2015-2016.

	# of Positions	Hours per week	Weeks per year	Hourly Wage	Cost per Person	Total Cost
Academic Year	2	15	36	$18.38	$11,612.48	$23,224.97
Summer Quarter 2015	1	5	13	$18.38	$1,397.80	$1,397.80
					Total	**$24,622.77**

8.3 2015-2016 CSF Funding

For the 2015-2016 academic year, the SER-UW Nursery was funded through a UW Campus Sustainability Fund (CSF) grant of $54,400. The UW CSF is a student administered granting organization who funds student led initiatives to "create a sustainable campus and foster an environmentally conscious university culture by funding student-led projects that lessen the university's environmental impact". The CSF has also funded the SER-UW initiatives at Whitman Walk and Kincaid Ravine. Each year the CSF has a $400,000 budget allocated by the Student Activities Fee which each student pays in addition to tuition.

https://csf.uw.edu/about-us/our-mission

The nursery expansion grant covered the cost of the two hourly positions as outlined in Table 13. The requested amount was approximately $20,000 greater than the granted amount in order to fund a second year of manager positions and give the nursery more time to find a more sustainable permanent funding source. The grant also covered the expenses of the infrastructure and materials upgrades for the nursery (Table 14). Without the grant, almost none of the accomplishments of the past year could have happened.

Table 14: Budget for materials and the hoop house for the 2015-2016 SER-UW Nursery expansion funded by UW Campus Sustainability Fund.

MATERIALS		
Item	**Description**	**Price***
Overhead Irrigation	Automated and on a timer. Allows us to check in on plants only occasionally during the summer. Reduces time spent hand watering throughout the year and increases water efficiency.	$290.00
Hand watering	Hoses and hose attachments for careful hand watering of seedlings and to supplement irrigation system.	$270.00
Volunteer Morale	Boombox from goodwill to increase productivity and morale at weekly work parties.	$20.00
Plant production	Tools for handling seeds, seed storage, and working with seedlings.	$140.00
Office Supplies	For record keeping and communicating schedules	$110.00
Printing	Will be used to print record keeping forms, propagation protocols, promotional materials, and signage for the nursery.	$220.00
Storage	Storage unit for tools, containers, and office supplies.	$160.00
Low Tables	Materials for twelve custom plant production tables made from used wire racks and cedar lumber. Elevating plants reduces their exposure to water borne pathogens and promotes healthy root growth through air pruning.	$1,700.00
Work Tables	Materials for two custom made work tables for potting plants. One large table ideal for standing and working, and one that is wheel-chair accessible. The second table will double as a small bookkeeping desk.	$250.00
Soil	Six yards of fine bark, our potting media for large seedlings and salvaged plants (price includes delivery fee). Also, six cubic feet of seedling media for seed germination.	$460.00
Containers	Containers for starting plants from seeds or cuttings. Expected to last 5-7 years.	$250.00
Pot-washing Station	Materials for custom designed, mobile pot-washing station for washing and sanitizing used pots.	$80.00
Tools	Two sets of pruners for root pruning to fit salvaged and bare root plants into pots.	$50.00
	Materials Total	**$4,000.00**
LABOR		
		$24,622.77

HOOP HOUSE- Sunrise Gothic 30 from Steuber Distributing Company		
Item	**Description**	**Price***
Dimensions	30x48ft, 1,440 sqft footprint. Sidewall height 6ft.	-
Framing	Bent steel arches for roof, endwall frames made from cedar.	$ 6,500.00
Covering	Double poly covering, inflator fan.	$ 2,900.00
Shade Cloth	To provide shade at 60% in the summer. Put on directly over double poly roof.	$ 450.00
Roll-up Sidewalls	Manually operated to ventilate on warm days.	$ 1,400.00
Installation	$6.50 per sq ft.done by Tom Moran of Greenhouse Repairs and Installation.	$ 9,500.00
Power/Water	Estimate for facilities to install power pole.	$5,053.00
	Hoop house Total	**$ 25,803.00**
FULL PROJECT TOTAL		**$54,425.77**

The expansion project installed all the initial infrastructure for the nursery and included many one-time purchases or at least large items that will not be replaced for quite some time. The hoop house frame is estimated to last at least 30 years and the potting bench and plant production tables with proper maintenance will last for a very long time as well.

As could be predicted, the purchases made for the nursery expansion did not exactly follow the initial budget. Most notable deviations were the cost of the hoop house construction was much lower because it was just materials and no outside labor costs because it was built by student volunteers, saving approximately $10,000. On the other hand, the potting bench, listed as the work table, cost over $1,000 for the materials and for the UW Facilities carpenters to build it, and not $250. Also the production tables most likely will cost $4,000 because we did not use our original design plans.

The time it took to negotiate the bureaucratic system of UW to build the hoop house and also the time it takes to build items such as the tables was grossly underestimated. Fortunately, with the savings of building the hoop house with volunteers, we were able to purchase necessary infrastructure items and establish all the necessary infrastructure.

8.4 The Value of Permanently Funding the SER-UW Native Plant Nursery

In the future, different salary and funding options should be explored. It is not realistic to keep having the nursery managed by two graduate students who are only compensated hourly. There is too much work for two people to only be paid for 30 hours a week total. Also, other positions requiring the same level of experience and responsibility compensate graduate students as Research Assistants who receive a stipend, tuition waivers, and benefits. Funding a full-time salaried Nursery manager position similar to the UW Farm manager and one Research Assistant would provide the best programing continuity while still maintaining student involvement in the management. It would cost $103,229.16 to fund these two positions based on the rates for 2016-2017 (Table 15). Rates for a manager position increase based on

merit raises, market adjustment increases (if any), and the varying cost of benefits. In the future, another option to explore would be to partially fund work-study positions for interns.

Table 15: Costs to fund a full-time, permanent nursery manager and one Research Assistant for the 2016-2017 academic year.

Position Title	Salary	Benefits on Salary	Tuition	Total Cost
Nursery Manager	$43,875	$19,225 (30.5%)	N/A	$63,000.00
Research Assistant	$21,821.58	$3,281.58 (17.7%)	$15,126.00	$40,229.16
				$103,229.16

It is unclear where funding for a full-time manager or Research Assistants would come from but somehow the educational value of the SER-UW nursery must be recognized as the primary benefit of the nursery and something worth funding to reap the benefits of the initial infrastructure investments. This is tricky because many granting institutions, including the Campus Sustainability Fund prefer to fund "actionable" items that can be completed in a year or two. This favors projects like the nursery expansion project to build a hoop house and increase growing capacity but excludes projects that just need routine funding to maintain programming.

In comparison, the UW Farm manager's position is only partially funded by the sales of farm products and the majority of its funding is provided by several different UW departments including the College of the Environment, Housing and Food Services, and UWBG. The SER-UW Nursery also has cross-disciplinary benefits and could perhaps be funded through several Departments such as SEFS, UWBG, College of Built Environments, UW Grounds, and UW Biology.

I believe that the SER-UW Native Plant Nursery can only reach its full potential if it has funding for a full-time nursery manager and a graduate Research Assistant. The SER-UW Nursery needs a full-time manager to create long-term structure that ensures continuity to the program, which might otherwise lose momentum with student turnover. He or she would provide technical expertise to the project by creating the propagation plan each year which may include working with species that take multiple years to produce. Propagation protocol development is also a slow process that takes multiple production years to establish the best protocol. Both propagation plans and propagation protocols are beyond the timeline a two year Masters student.

The Manager would also be in charge of volunteer recruitment. With a full-time manager position the nursery could continue to offer intern positions and work with the same courses it already collaborates with now but could also support more Carlson Center volunteers. The UW Farm manager hosts 30-50 Carlson Center volunteer each quarter which is only possible with the coordination of a full-time manager. The SER-UW Nursery could also collaborate with this many Carlson Center volunteers if it was supported by a full-time manager.

The role of the Graduate Student Research Assistant would be not only to assist the Nursery Manager with running the plant nursery, but also to take on a complimentary master's research project to develop new propagation protocols or increase the plant production or environmental education capacity of the nursery.

These positions together would extend SER-UW's capacity to provide quality plants for the long-term maintenance of UW natural area projects such as the Whitman Walk, Kincaid Ravine, Union Bay Natural Area, and Yesler Swamp. They could also partner with UWBG's adult education program to create programming to educate the public on the benefits of landscaping with native plants, native plant production methods, and sustainable nursery management practices.

9 Summary of Recommendations

Section Number and Title	Page Number	Recommendations
4.1 Volunteer Data	4	• Continue to have 10 work parties for each quarter. Increase average volunteer numbers for non-infrastructure work parties to 10 volunteers per work party for a total of 900 volunteer hours for the year.
4.2 Understanding motivations	6	• Co-host work parties with other student groups such as Earth Club and Xi Sigma Pi. • Include games and icebreakers in work parties. • Keep track of number completed frequent volunteer cards.
5.3 Carlson Leadership & Public Service Center	7	• Start work parties with 10- to 15-minute mini-lessons.
5.4 ESRM 399: Field and Teaching Internship	8	• Recruit interns from different departments than just SEFS. • Align intern projects with the major goals of the nursery.
5.5 ESRM 462 + 463: Restoration ecology network-capstone course (REN Capstone)	10	• Focus propagation plans more narrowly on the species list from Kincaid Ravine and Yesler Swamp.
5.6 ESRM 362/SEFS 530: Introduction to Restoration Ecology	11	• Schedule guest lecture to discuss the role of nurseries in maintaining genetic diversity in restoration projects.
5.8 ESRM 412: Native Plant Production	12	• Collaborate with teachers and TAs of ESRM 473 and ESRM 412 to align the plant species propagated and installed. • Supplement species grown by ESRM 412 by growing fast growing species in the fall. • Students can review species specific development records and help write up propagation protocols. • Students can perform stratification and scarification experiments.
5.9 Potential future course partnerships	13	• Collaborate with ESRM 411 on lab activities about seed sowing and cuttings. • Develop a Program of the Environment course with similar curriculum to ESRM 412, service learning components with Carlson Center, and offered 4 quarters a year. • Schedule guest lecture with LARCH 303. • Encourage LARCH 475 to purchase plants from the nursery. • Connect with Ben Wiggins, the Faculty Coordinator of Biology Instruction, to determine biology courses to partner with.

Section Number and Title	Page Number	Recommendations
6.8 Propagation Environment	25	• Divide irrigation zones into outside and inside the hoop house based on “sun values” and dry, moist, and wet based on “water values”. • Layout micro-tubing after zones have been organized. • Do not try to put an equal number of plants in each zone.
7.3 The infrastructure of the nursery	34	• Make the floor of the hoop house ADA accessible.
7.5 Inventory Management	38	• Use a database management system such as Microsoft Access of FileMaker. • Track plants using a “Lot Identification Code”. • Track information that UWBG needs for its Collection Records.
7.7 Partnerships other than student	39	• Collect more cutting materials from campus, just be careful they are not from cultivars. • Contract grow for UW Seattle and UW Bothell campuses. • Collaborate with Tyson Kemper about compost tea as a pest management strategy. • Plan a fieldtrip to UW Bothell to learn about their organic gardening practices.
8.1 Pricing Scheme	41	• Align restoration prices with bare root prices. • Increase prices of “Special” plants that are not available at other native plant nurseries. • Collaborate with UW Foster Business School students to develop a business plan.
8.4 The Value of Permanently Funding the SER-UW Native Plant Nursery	50	• Secure funding from several UW departments to fund a full-time nursery manager and a Graduate Research Assistant.

10 Conclusion

This past year has been an amazing phase of growth and transformation for the SER-UW Native Plant Nursery. My fellow nursery managers and I installed the infrastructure to produce approximately 3,000 plants for student restoration projects each year. We also developed the programming to support quarterly internships and a robust volunteer program that fills in the gaps of environmental horticulture education on campus.

In the future, the nursery has the potential to teach a new generation of restoration ecologists, landscape architects, and curious students from many other majors about the importance of maintaining genetic diversity within nursery stock in order to create landscape resilience in disturbed ecosystems. At the same time the nursery is collaborating with many campus groups that are affecting environmental change now. The full potential of the nursery cannot be realized without the full support of UW to fund a full-time nursery manager position and research assistant position. The successes of this past year act as proof that the nursery can fulfill an important role on campus to connect the groups producing plant materials with the people installing them.

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12 Appendix

12.1 Prairie Rain Garden Maintenance Plan

Malcolm Howard (mfhoward@uw.edu) Prairie
Rain Garden Installation Project Draft
maintenance plan for UW-SER March 2015

Summary:
The Prairie Rain Garden installation project was started over the summer of 2014, and planted Fall 2014 –Winter 2015 at the UW Center for Urban Horticulture.
Objectives of the project are 1) managing surface runoff to prevent water ponding on the trail and 2) converting an underutilized/weedy site into a structurally/biologically diverse native prairie plant community.

Tools required: All required tools can be found in the UBNA tool cage.

- shovel (for mulch/planting)
- wheel barrow (for transporting mulch/water jug)
- watering can
- water jug
- rake (for spreading mulch along grass border)
- bucket (for mulching around plants)
- weeding tool (optional)
- mulch fork (optional; for shoveling mulch from pile)

Resources required:

- Arborist wood chip mulch. Source: Available for free from UWBG pile located behind headhouse, or UW Grounds Department pile located behind UW farm)
- Plants (if available). Source: UWBG, SERANursery, Kern Ewing, Bakker lab

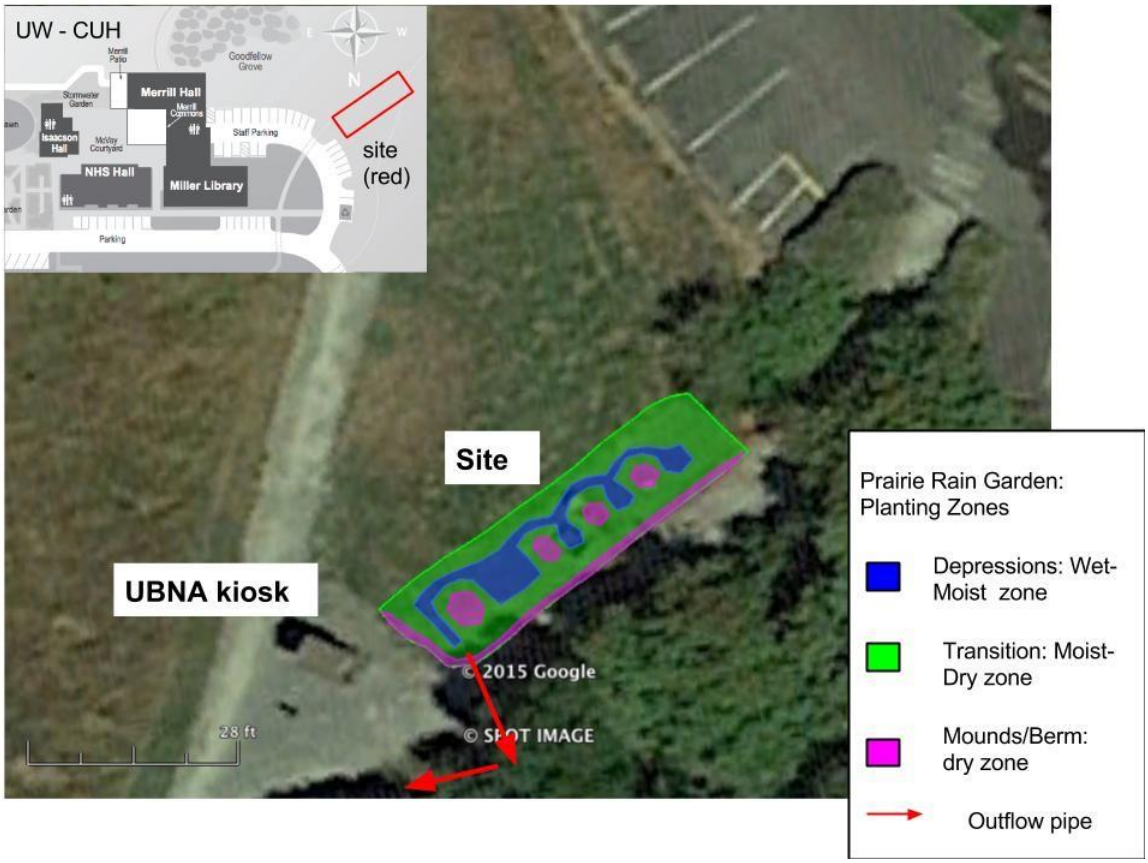
Estimated maintenance hours: 4 man (/woman) hours per academic quarter (e.g. would take 1 person 4 hours **,** or 4 people 1 hour per quarter).

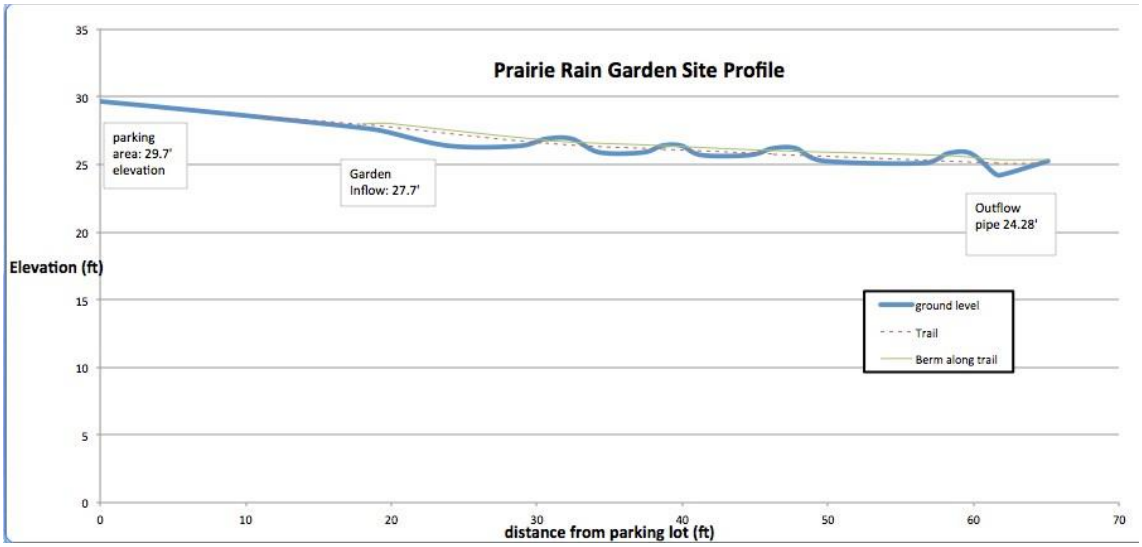
Summer 2015
Task 1: Weed in between plants
Why: Reduce competition from weeds
Task 2: Water all plants (Once in July and August if possible)
Why: Allow seedlings to become established during first dry season

Fall/Winter/Spring 2015/2016B and beyond
Task 1: Weed in between plants (once/quarter)

Task 2: Add mulch to border, berm and mounds (twice/year)
Why: Reduce weeds, increase soil moisture retention, reduce erosion Task 3: Clear debris/sediment from outflow pipes (twice/year)
Why: Keep pipe from becoming clogged
Task 4: Replace dead plants, if resources available (once/year, water first summer of plant establishment)
Why: Increase native plant cover

UWBG Prairie Rain Garden Installation Project: Plant list			
Species	**common name**	**moisture requirements**	**Total live plants on site**
Achillea millefolium	common yarrow	mesic-dry	68
Allium cernuum	nodding onion	mesic-dry	2
Anaphalis margaritacea	pearly everlasting	mesic-dry	21
Armenia maritima	sea-thrift	dry	2
Campanula rotundifolia	harebell	mesic-dry	4
Carex inops	long-stolon sedge	mesic	59
Carex obnupta	slough sedge	wet-mesic	6
Clarkia amoena	farewell to spring	mesic-dry	4
Danthonia californica	California oat grass	mesic-dry	18
Danthonia spicata	poverty grass	mesic-dry	3
Deschampsia cespitosa	tufted hairgrass	mesic	184
Dodecatheon hendersonii	shooting star	mesic-dry	2
Elymus glaucus	blue wild rye	mesic-dry	58
Erigeron speciosus	showy fleabane	mesic-dry	32
Eriophyllum lanatum	Oregon sunshine	dry	22
Festuca roemeri	Roemer's fescue/ Idaho fescue	dry	155
Fragaria vesca	wild strawberry	mesic-dry	16
Fragaria virginiana	Virginia strawberry	mesic-dry	3
Glyceria elata	tall mannagrass	wet-mesic	24
Hieracium scouleri	Scouler's hawkweed	mesic-dry	4
Lupinus lepidus	prairie lupine	dry	40
Potentilla gracilis	slender cinquefoil	mesic	20
Ranunculus occidentalis	western buttercup	mesic	6
Sidalcea malviflora ssp. virgata	dwarf checkermallow	mesic-dry	2
Sisyrinchium idahoense	Idaho blue-eyed grass	mesic	21
Symphyotrichum hallii	Hall's aster	mesic-dry	2
Symphyotrichum subspicatum var. subspicatum	Douglas aster	mesic-dry	1
Viola adunca	hookedspur violet	mesic-dry	4


UW - CUH
Merrill Hall
Merrill Commons
Isaacson Hall
McKay Courtyard
NHS Hall
Miller Library
Staff Parking
Goodfellow Grove
Parking
site (red)
Site
UBNA kiosk
© 2015 Google
© SPOT IMAGE
28 ft
Prairie Rain Garden: Planting Zones
Depressions: Wet-Moist zone
Transition: Moist-Dry zone
Mounds/Berm: dry zone
Outflow pipe


Prairie Rain Garden Site Profile
parking area: 29.7' elevation
Garden Inflow: 27.7'
Outflow pipe 24.28'
ground level
Trail
Berm along trail
Elevation (ft)
distance from parking lot (ft)
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70

12.2 Nursery Internship Survival Guide

SER-UW NATIVE PLANT NURSERY

Intern Survival Guide

By Jamie Costantino, Communications Intern Autumn 2015

Edited by Anna Carragee, Nursery Manager 2015-2016 and Ceci Henderson Communications Intern Winter 2016

Introduction

Welcome to SER-UW's Native Plant Nursery family and team! Your internship is a great opportunity for personal learning and growth as an individual and working as a team member. We hope you have a great experience with SER-UW, and to help you get started, we have made a bit of a guidebook or "survival-guide" to help you along the way!

Chapter I: Learning Objectives

Your learning objectives will be created collaboratively between you and your manager within the first week of classes. Focus areas include plant production, communications and volunteer management. It is your responsibility to get the ESRM 399 form signed by the SER-UW Faculty Adviser, Prof. Jon Bakker and submitted by the UW's add/drop deadline to your ESRM adviser for credits.

Chapter II: First Step Tasks

Here are the things we need to do during the first week to get you set up.

- Get keys for access to the Douglas Research Conservatory and gated areas around CUH. For the first weekly check-in, you need to bring a $45 deposit, either a check or cash, to Carrie Cone.
- Send us a photo of yourself so we can make a post on the Facebook page, or send out a brief email, to announce and introduce you and your fellow intern as part of the Native Plant Nursery Team for the quarter!
- Send your team members a photo of your visual schedule so meeting times can be planned most effectively to accommodate everyone's schedules. If you have any other recurring commitments, please share those as well.
- Share all necessary contact information with your team members.
- Look through the google drive folders and documents shared with you to start familiarizing yourself with the vast amount of documents, spreadsheets, and photos!
- Familiarize yourself with the location of the nursery and modes and times of transportation to get there!
    - There are several bus routes to the CUH from main campus, which take 10-15 minutes.
    - Most ways of walking to CUH from main campus take about 30 minutes.

Chapter III: Expected Tasks

Weekly Checkins

Weekly check-ins are meetings that the whole team shares to review work done over the previous week, discuss any important news, and map out a work plan for the week.

- Weekly check-ins are usually scheduled for a consistent time, once a week (Feel free to ask Anna, Kelly, or Courtney about this)!
- The Agenda for the week that will be discussed in meeting should be available on the Google Drive the night before. Be sure to read up! This is incredibly useful.

Weekly Work Parties

Weekly Work Parties are a really fun part of this internship! All who can attend (you, as an intern will likely attend all of them), come together to work on a wide variety of tasks that the nursery needs to focus on. This is a wonderful way to bond with members of SER-UW, and individuals excited about working with native plants!

- Weekly Work Parties are also usually scheduled at a consistent time each week.
- Various weekly objectives will be highlighted including rent tasks, weeding and planting in the nursery or surrounding project sites, pot washing, etc.
- You will hopefully be leading work parties on your own at some point, so keep eyes and ears open, and ask questions!

Hours

The amount of credits you hope to receive for participating in this internship program correlates to the amount of work hours you must put in throughout the quarter.

- Keep track of your hours! (3 credits=about 9 hours a week) Specifically, keep track of the activities that you do and how long they take you. If you attend weekly meetings and work parties you're already halfway there. Your log of hours will be given to Prof. Jon Bakker at the end of the quarter and also the nursery manager will review it as a way to plan for the next intern.
    - We highly recommend you use the site Toggl to track your hours. This is an easy way to record what you did, when you did it, all in one place.
- Exactly nine hours do not need to be completed each week. The correct sum total of hours across the quarter is sufficient! Therefore, if you have some busy weeks with coursework or other responsibilities you can take it easier that week and make it up another week when those other responsibilities are lesser.
- If you're finding yourself without much work at any point in the quarter, **do not hesitate to ask for anything/fill in with your own ideas!**
- If you're finding yourself with too much work at any given time, then let Anna, Kelly, or Courtney know. They will help you find a better balance for your work load.

Write ups/Oral Presentations

You will be asked to write up reports throughout the quarter tracking work, hours, and learning growth. Extra reports include:

- Intern Profile Archive at the end of the quarter.
- Final write up or have an in person discussion at the end of the quarter about your time at the nursery.
- Contribute to this “Survival Guide!"

Plant production tasks

- Weekly watering times may be scheduled for seeds and seedlings in the nursery and greenhouse. We will try to set up a schedule that works well for everyone!

Chapter IV: Specifically Communications Intern

Work Party Posts/Emails

You have the special job of announcing and sharing information about the nursery’s weekly work parties via our Facebook page, email listservs, and the SER-UW Google Calendar.

- Use the publishing tools to schedule Facebook posts in advance. This means you can add as many posts as you want in advance and are less likely to forget to post something.
- For weekly work parties, have post up on Facebook by Tuesday evening at 7pm but actually scheduled to post around 7pm Wednesday night.
    - If you notice these times are not getting good “reach” then try out different times for posting.
    - Earlier works better than later. DO NOT POST ANY LATER THAN WEDNESDAY AFTERNOON FOR A FRIDAY WORK PARTY.
    - The timing will need to be adapted for events not on Fridays.
- Important information to include: what task will be focused on at the work party, if all materials will be provided, what attire is most appropriate for the weather, that snacks will be included, any additional fun information, and a **map** to help people find the party! Maps can be found in the SER-UW Shared Google Drive Folder →Nursery→Nursery Photos→Maps.
- It may be helpful to make an event page on Facebook for bigger events.
- Get event info sent over email! See email protocol below.
- Finally, make sure the event is on the SER-UW Google Calendar, which is displayed on the SER-UW webpage. Additionally, make sure the event description is included.

EMAIL PROTOCOL

- When advertising Nursery events, make sure the announcements get sent over email to reach a broad audience! Corrine Hoffman is the SER-UW Communications Officer for the 2015-2016 year. She compiles all announcements from the different SER projects and sends out periodic emails with the information for upcoming events. To get nursery event info included…

    - Email Corrine ASAP at **corrine1@uw.edu** to check if she has an email going out in the time period needed for the nursery event. If so, send her all the necessary details (preferably as a short blurb she can just paste into her main email) and she will send it to the listervs below.
        - If Corrine is not sending out an email in the desired time period, draft an email in the sernursery@gmail.com account (username and password in Chapter VI: Logins) and send to listservs below.
- Listservs to send nursery info from the sernursery@gmail.com account (username and password in Chapter VI: Logins):
    - Send email out to community_ser@uw.edu and hortgrads@uw.edu.
    - Email David Campbell at davidc23@uw.edu to reach cfrgrads@uw.edu and Lisa Nordlund at nord@uw.edu to reach cfrunder@uw.edu.
        - Important: you MUST email David Campbell and Lisa Nordlund to ask approval for them to send the desired nursery info on to their student lists- you cannot email the lists yourself (email won't go through).
        - The advisors are busy and they may need a couple days to get around to sending your email. Email them ASAP!

Chapter V: Specifically Construction Intern

In addition to your plant production and volunteer management learning objectives, much of your work this quarter will focus on construction projects. You and Kelly will sit down at the beginning of the quarter and come up with a work plan for upcoming projects.

Things to do during week 1

- Get keys
- Safety training
- Find times when we can meet up weekly to work
- Develop work plan for the quarter

What to expect this quarter

We will work both together and independently. Getting in all of your hours will probably require you coming in on your own time to work on projects. Let Kelly know if you aren't sure what to work on, or are having trouble getting in all of your hours.

Tasks will change throughout the quarter. We will be doing both building and planning/prep for upcoming building projects. Keeping ourselves on task will require us looking ahead and anticipating upcoming needs.

You are encouraged to take initiative- if you see something that needs to be done, go for it! Just keep Kelly in the loop so that we aren't duplicating our efforts.

You have the opportunity to gain project management experience with this internship. If you want this experience, say so early on. We can work together to find a project that you can be the lead on.

You will get more out of this internship if you document your efforts. We can talk about what this might look like, but I would like it if you produced something at the end of the quarter.

Chapter VI: Plant Profiles

Plant profiles are posted once every week on our Facebook page. The goal of these plant profiles is to highlight one of the species present in our nursery each week in a creative way. This is a great opportunity to inform our community, while learning more about the species you may be working with, in a fun way! You and the other intern will take turns writing the plant profiles each week.

- Profiles should include one or two short paragraphs about the plant plus a photo to highlight the beautiful qualities of the plant.
- We found that profiles get the most exposure when submitted early on Sunday afternoons, around 2pm.
- Be sure to look through the SER-UW drive to access the species lists and the previous ones on the Facebook page in order not to repeat a species that has been done already.
- Merrill Library has a ton of great resources, and you can always ask Anna, Kelly, or Courtney for more knowledge!
- Kelly has a large array of great pictures squirreled away on her computer, so be sure to ask her if you're in need of one!
- If you pull a photo from an online source make sure to give credit to the photographer.
- Sometimes it can be very effective to focus on a species that is especially relevant to a project SER is working on. You can always ask which species may be a great feature for this specific week!

Chapter VII: Logins and other access codes

We have accounts for Gmail, Wufoo, Mailchimp, Smore, and Facebook! Here are some log in codes and useful steps!

(This section has been abbreviated so as to not publically post all SER-UW passwords.)

12.3 Potting Bench Design Document

Designed by Kelly Broadlick and Wyatt Hoffman

Overview

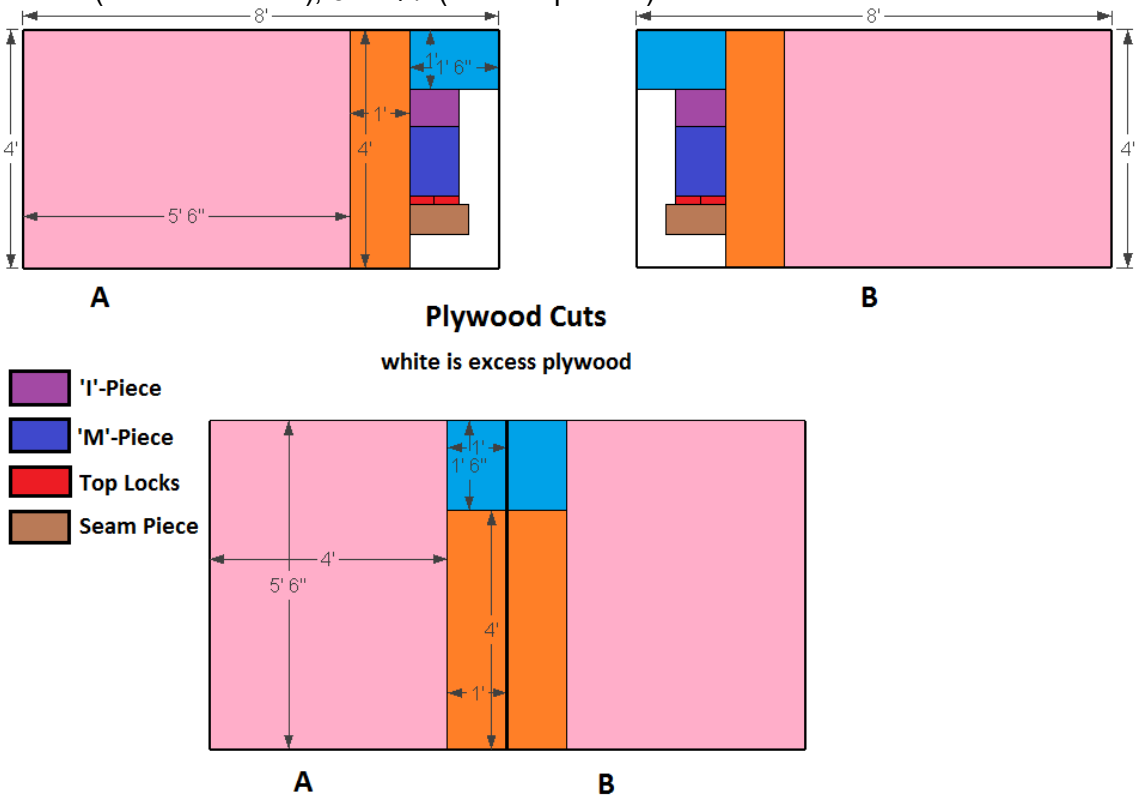
This potting table is designed to be versatile and accommodating for both large and small groups of people. It is comprised of two (2) five by five and a half foot (5'x5.5') tables that are attachable at the legs and underneath the table surface to create one five and a half by ten foot (5.5'x10') table. This allows the table to be taken apart and one or both pieces to be moved outside for work, while also allowing large groups to work around a larger table for things such as potting salvage plants or up-potting.

Components

*Important Note: Numbers listed below are the *total of pieces required for both halves of the table*. If just building one at first halve all numbers.

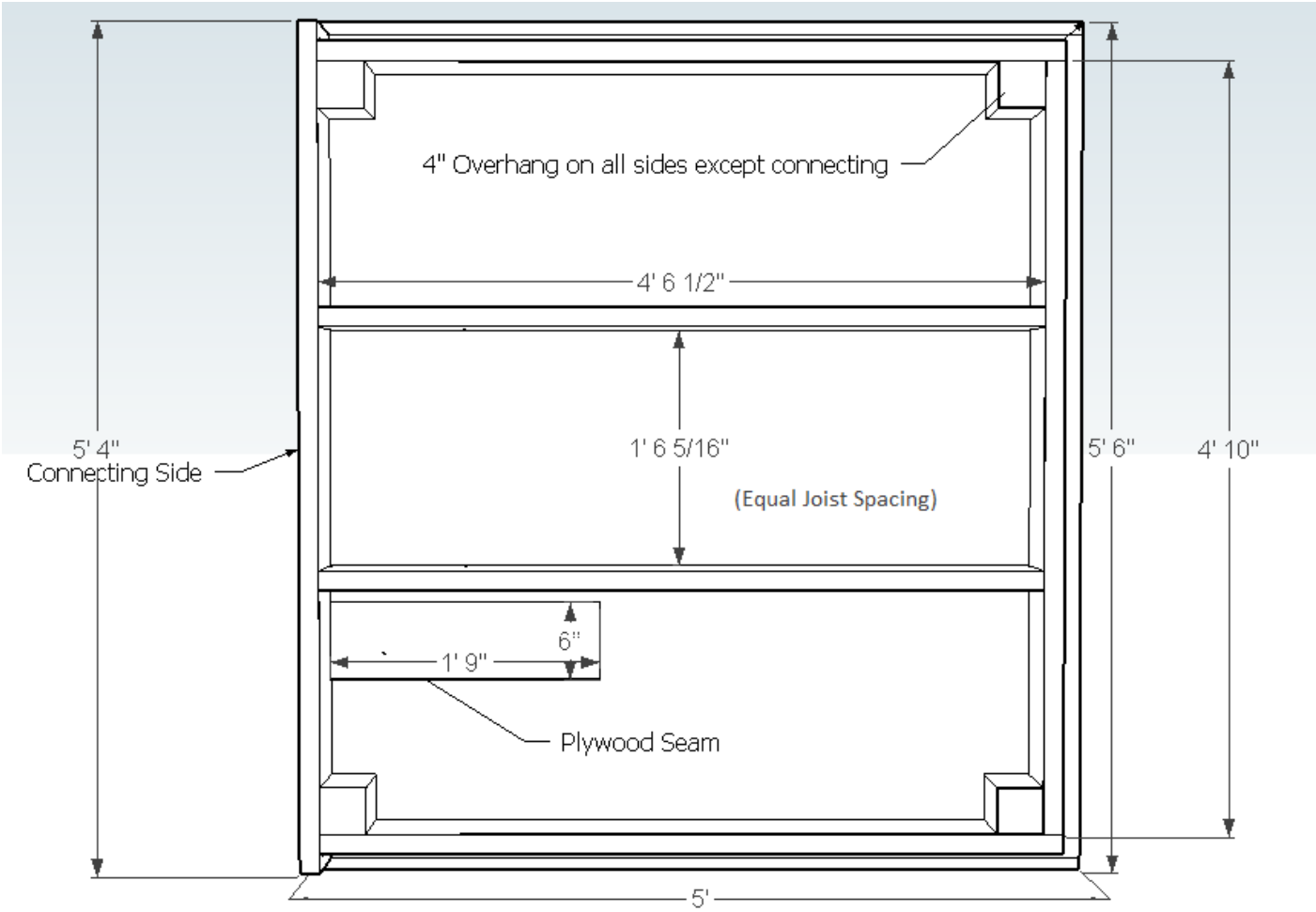
Surface

- 2 pieces of ½" 4'x8' MDO Plywood - Cut as pictured below
- Excess plywood will be used for Locking Pieces (7.5"x10" (x2 for 'M' Pieces) ,10"x14" (x2 for 'I'-Pieces), 5"x1 ¾" (x2 for top locks)



Top Supports

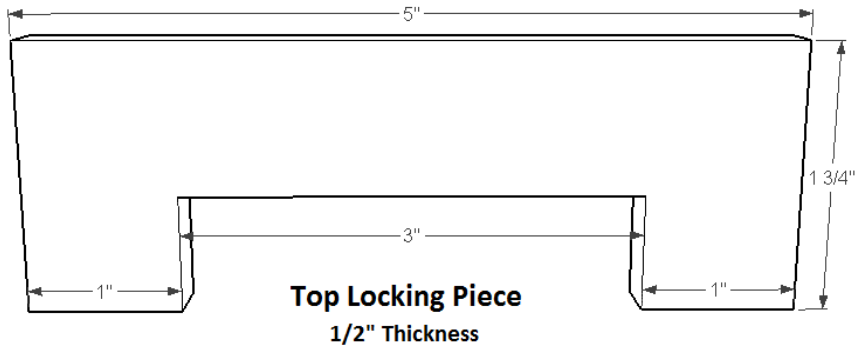
- 2”x6” pieces of wood, leaving a 4” surface overhang (from outside of 2”x6”s) on each side except the connecting side (0” overhang on connecting side).
    - Eight (8) pieces at 54 ½” long
    - Two (2) pieces at 58” long
    - Two (2) pieces at 64” long
- Supported by joists
    - Two (2) on <u>each</u> table segment running toward connecting side, at a spacing of ~18⅓” from each other/top supports
- Plywood Seam Reinforcement
    - Located under seam between the two smaller MDO cuts, intended to strengthen them. a 6”x12” piece will cover 3” on either side of the cut and the full length of the seam.
- Screwed into Legs



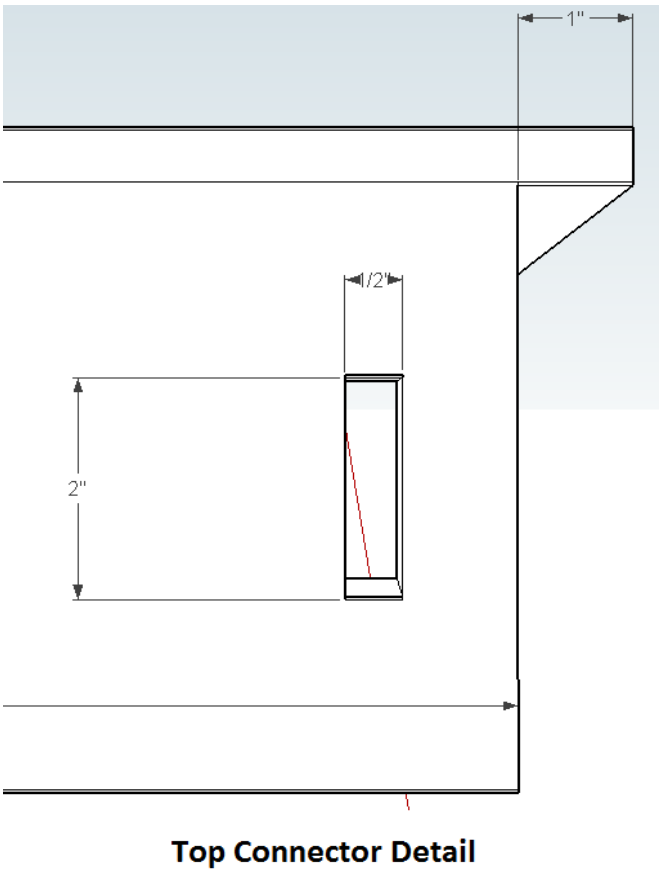
Underside of Table Surface (Joists and Reinforcing Seam)

Top Connector and Locking Piece

- Connecting side 2”x6” runs along plywood surface edge, leaving a 1” overhang at either of its ends. This leaves 2” to be used for a top locking piece (Pictured below)
    - This locking Piece will only need to be ~½” thick
    - If left at ½” could potentially shorten connecting side 2”x6”

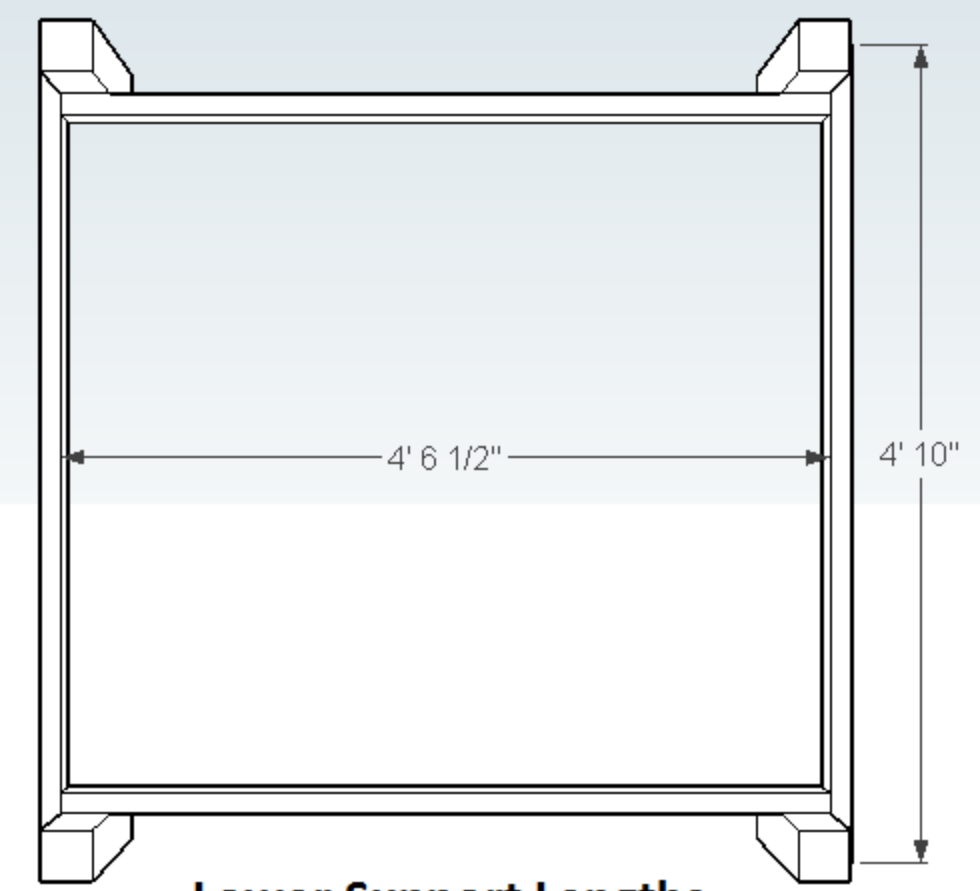


The Locking Piece will slide into the connector slot (a hole cut into the extra 2” on the connecting side 2”x6”)



Bottom Supports

- 2”x4” pieces, at a height of 6” (33” table height) or 9” (36” table height)
  - Four (4) pieces at 58” long
  - Four (4) pieces at 56 ½” long
- Screwed into Legs
- One table will potentially be used for storage, so a section of plywood may be laid on top of these supports



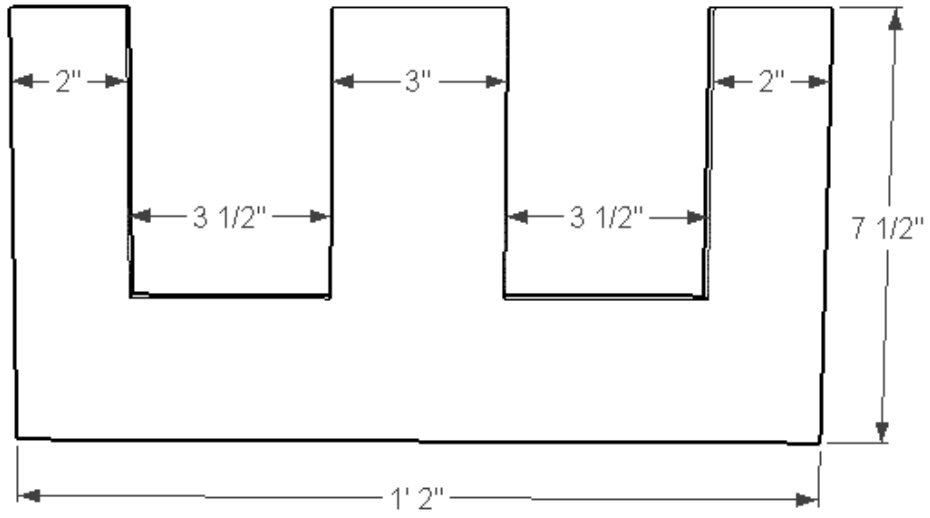
Lower Support Lengths

(2"x4"s at 6" (33" surface) or 9" (36" surface)

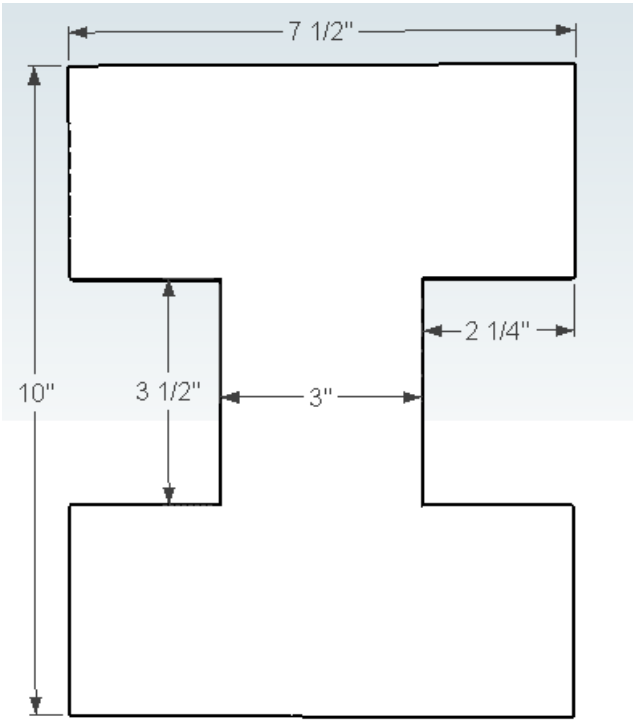
Legs

- Eight (8) pieces of 4”x4” at 32½” (33” table height) or 35½” (36” table height)
- Placed inside top 2”x6” supports, outside bottom 2”x4” supports

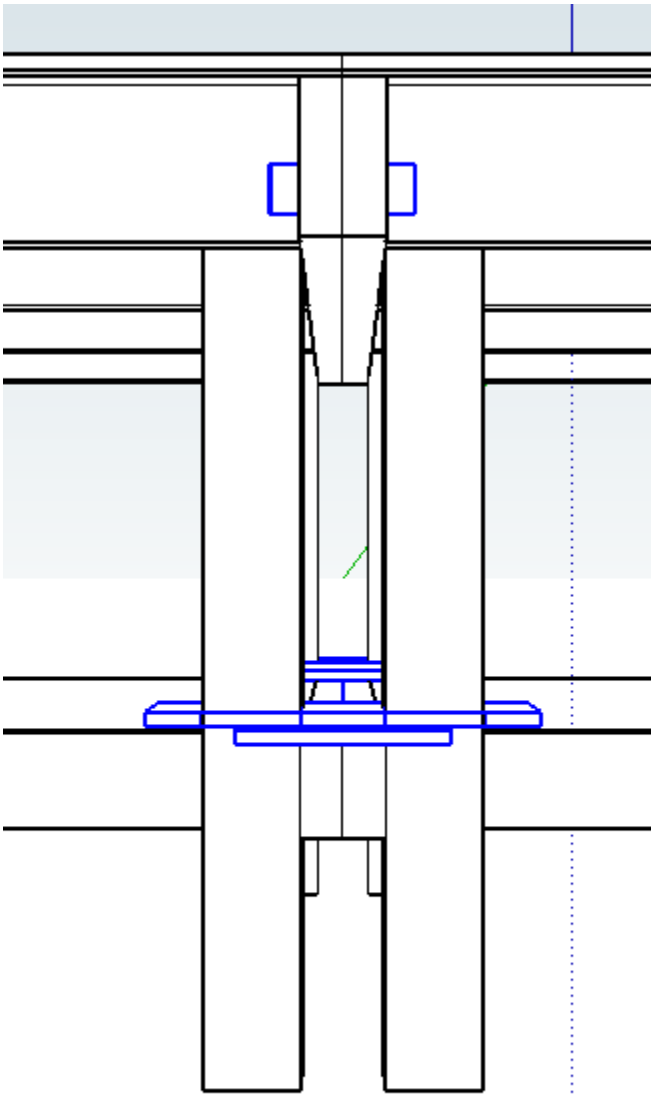
Other Documentation Images



Bottom Locking Piece



Bottom Locking Piece



Tables Locked Together

12.4 Introduction to the SER-UW Nursery Video Outline

By Ceci Henderson and Jesse Barr

Video Planning Draft

Vision: Introduce potential donors, partners, and volunteers to the mission, activity, and goals of SER nursery.
Length: 2-3 minutes
Video style: Promotional: Narration, interviews, and ambient sounds/music over footage, still shots, and time lapses. Clear message, emphasis on strong opening and closing phrases. OR one narrative voice?
Focus to keep in mind: What does the nursery do? What makes us interesting and unique? Why should people care?

1) Intro- what is the SER Nursery?
    a) (Shots of Hoop House, DRC, greenhouse, general CUH)
    b) "SERUW is a chapter of the Society for Ecological Restoration International (SER), a non-profit organization infused with the energy of members around the world who are actively engaged in ecologically-sensitive repair and management of ecosystems through an unusually broad array of experience, knowledge, and cultural perspectives."
    c) "SER Mission: "To promote ecological restoration as a means of sustaining the diversity of life on Earth and reestablishing an ecologically healthy relationship between nature and culture."
    d) The Society for Ecological Restoration University of Washington Chapter (SERUW) was founded in 2008 "Our mission is to bring together students at the University of Washington with a common interest in the science and practice of ecological restoration, and a common goal to restore and sustain the biodiversity of our beautiful campus." goals (elevator speech)
2) People- who we are
    a) Student-run organization with grad student managers, undergrad interns
        i) Over _300?___ volunteers per year
        ii) Involves undergrads from all majors and class standings- we've had everything from business to art majors volunteer with the nursery
        iii) Mix of grads and undergrads fosters a dynamic and enthusiastic environment
    b) Nursery Managers: Anna, Kelly, Courtney, Mary-Margaret
        i) (Interview/recording of managers)
        ii) Handle all aspects of running the nursery, from planning planting schedules to handling sales, from washing pots to running work parties
    c) Faculty Advisor
        i) (John Bakker interview/recording)
3) Current work- what do we do?
    a) Provide plants for restoration projects
        i) Shots of plants, restoration sites
        ii) Interview of satisfied customer/s?
    b) Plant salvages
        i) Shots of potting
        ii) Any salvage site pictures/video?
    c) Restoration work parties
        i) Blackberry removal before and after shots
    d) Hoop house build

   i) Allows us to increase production, have bigger restoration impact
   ii) (Think about framing it in sense of where we've been and where we're going- story of the nursery)
   iii) Gives us a home and an identity- sense of space
4) Future work
   a) Growing positive influence
      i) New collaborators (UW Grounds crew)
      ii) Involves interns, volunteers
         (1) Interview w/ volunteer?
5) End- invitation to get involved
   a) Volunteer- check out calendar, FB, get added to mailing list
      i) Show links
   b) Apply to be an intern or manager
   c) Partner with us
      i) Always looking for new ways to branch out and get involved on/off campus
   d) Donate!
      i) Where do find donate info, where the money would go (1-2 sentences of explanation)
   e) Ending statement: The nursery is spreading sustainable ecological restoration across the University of Washington community and growing fast- join us in maintaining the health and biodiversity of our beautiful campus!
      i) End shot of group of volunteers looking excited

People to interview:

(Not all people/groups mentioned here necessarily need to be interviewed)

1. Managers: Anna, Kelly, Courtney, Mary-Margaret
2. Faculty: Jon Bakker, Kern Ewing
3. Involved volunteers: Claire, Tori, Kelsey, Joel, Jim, (make him say I bleed for restoration) Huang-Li, Dan
4. Project partners/customers: Regina, Nicolette, Kat
5. Arboretum curator: Ray
6. UW Grounds: Tom
7. Others?

Interview questions to ask:

(Very few will make it into final product, but we'll need to ask a lot of get good options to use)

1) Managers (Anna, Kelly, Courtney, Mary-Margaret)
   a) Name?
   b) What is your area of study?
   c) How did you become involved with the nursery?
   d) How do you think the nursery benefits UW/the community/the environment?
   e) What do you think is the best part about the nursery?
   f) What are your hopes for the nursery in the future?

g) What has been your favorite activity with the nursery and why?
h) Why do you think providing native plants is important in this area?
i) What impacts/changes have you seen on the UW/local community since becoming involved with the nursery?

2) Faculty (Jon Bakker, others?):

a) Name?
b) What do you teach/what is your area of research?
c) How are you involved with the nursery?
d) How does the nursery benefit UW/the community/the environment?
e) What do you think is the best part about the nursery?
f) What are your hopes for the nursery in the future?
g) What impresses you about the nursery (activities or managers)?
h) Why is the work the nursery does important?

3) Volunteers:

a) Name?
b) What is your major/area of study?
c) Why do you volunteer with the nursery? What do you like about volunteering with us?
d) What activities were you particularly excited to do with the nursery?
e) Why do you think it's important to grow native plants in this area? What benefits do you see?

4) 'Customers'

a) Name?
b) What group do you purchase plants for? How are you involved with the nursery?
c) Why do you purchase plants from the nursery? What are the benefits of purchasing from us?
d) Does purchasing plants from the nursery affect the students? How do they benefit?
e) Do you plan on continuing to purchase plants from nursery in the future? Why?
f) What impresses you about the nursery? What do you like about it?

5) Nursery partners (Tom-UW Grounds, Ray-Arboretum curator, etc.)

a) Name?
b) Organization/position?
c) How are you/is your organization involved with the nursery?
d) How does purchasing plants from the nursery benefit your organization/how does the nursery benefit your organization?
e) What do you like about the nursery? What impresses you?
f) What kind of involvement with the nursery do you hope for in the future?

12.5 Plant Development Record

Adapted from

Plant Development Record Species: _____

[redacted]

ıle Collection Date collected: _____

ɔn site: _____

ɟf collection window (early, late): _____

of collection: _____

vhat worked well, problems, challenges): _____

ıle Processing Date of processing: _____

: _____

ight: _____ Estimate of Purity: _____

Location: _____

Conditions: _____

vhat worked well, problems, challenges): _____

ɪment

ɪment method | Duration | Date began | Date ended

_____ | _____ | _____ - _____

_____ | _____ | _____ - _____

_____ | _____ | _____ - _____

_____ | _____ | _____ - _____

hment Date sown, if different from above: _____

tion Environment: _____

rate/method (seeds/container):_____

er type: _____Media used: _____

n type and frequency: _____

ɜtion notes (date began and ended, % germination): _____

_____

tion (type, rate, and frequency, if any): _____

ɜablishment phase completed: _____ Total (days): _____

e at end of establishment phase: _____

ransplanting or thinning, problems, challenges): _____

_____

_____

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Plant siz

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Plant Development Record Species: _____

Active Growth- Early Date active growth phase began: _____

Plant size at start of active growth phase: _____

Propagation Environment: _____

Irrigation type and frequency: _____

Fertilization type, rate, and frequency: _____

Horticultural treatments (spacing, cultivation practices, etc.): _____

Notes (development, vigor and health, problems, challenges): _____

_____

_____

_____

_____

_____

_____

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e hardening phase began: _____

_____

_____

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_____

es, etc.): _____

_____

_____ Total (days): _____

_____

_____

_____

_____

_____

, things to try next year, etc.): _____

_____

_____

_____

_____

_____

_____

____ Time occupying nursery space: _____

_____

_____

Hardening Dat

Propagation Environment: _____

Irrigation type and frequency: _____

_____

Fertilization type, rate, and frequency: _____

Horticultural treatments (spacing, cultivation practic

Plant size at end of hardening phase: _____

Date hardening phase completed: _____

Storage Conditions: _____

Notes (vigor and health, problems, challenges): ____

_____

_____

Other Notes (performance of crop after outplanting

_____

_____

_____

_____

_____

_____

Summary- Total time to ready date: _____

12.6 Memorandum of Understanding between SER-UW and UWBG

University of Washington Botanical Gardens and the

Society for Ecological Restoration UW Student Chapter

14 April 2016

Introduction

This Memorandum of Understanding (MOU) is entered into by the University of Washir
Botanic Gardens (UWBG) and the Society for Ecological Restoration University of Was
Student Chapter (SER-UW), a Registered Student Organization whose mission, as a stuc
chapter of the international organization, is "to promote ecological restoration as a mean
sustaining the diversity of life on Earth and reestablishing an ecologically healthy relatio
between nature and culture". It is the intention to operate a student run native plant nurse
Center for Urban Horticulture (CUH) to support the propagation and maintenance of pla
native to the Puget Lowland Region, to be used in student restoration projects and on-ca
plantings. The second component of our mission is to provide hands-on horticulture lear
experiences to the UW community.

To ensure the successful implementation and management of this nursery, this agreemen
define the roles of all parties involved. It is the desire of all involved, that the two organi
work towards a collaborative relationship, using combined knowledge and resources, an
provide educational opportunities for the greater community. This project is an opportu
all involved to form a collaborative partnership will lead to greater benefits for the UWB
UW, and the wider horticultural community.

Space Requirements

SER-UW has various space requirements which UWBG will help facilitate. The major s
requirement is an area for a hoop house in the DRC yard. Details concerning the hoop h
other space requirements are described below.

Hoop house

The to be constructed hoop house will be 30 ft wide by 48 ft long and constructed south
existing hoop houses within the yard of the Douglas Research Conservatory at CUH. It v
a total footprint of 1,440 sq ft. The house will lie outside the required 200 ft buffer from
shoreline of Lake Washington in order to comply with the Washington Shoreline Manag
Act.

Tarp Space

SER-UW will also occupy 576 sq ft of outdoor tarp space as an additional growing area
space is shared with ESRM 412: Native Plant Production, which uses it as lab space, an
exempt from lease payments as it is part of a UW class. See Appendix I for a map.

Memorandum of Understanding

Between the

University of Washington Botanical Gardens and the

Soil Storage
SER-UW requires space for storage of 4 to 8 cubic yards of soil per year to be stored in east of the head house. Soil deliveries will be coordinated with the UWBG Manager of Horticulture in terms of timing of delivery and location within the storage bins.

Pot, Tool and Materials Storage
In order to reduce pest issues within the hoop house, SER-UW requires dry storage spa pots, tools and other plant production materials. An assigned cabinet in the head house approved bin space under the benches in the head house, and allocated space in the fiel will accommodate these storage needs.

Greenhouse Bench Space
As a student organization, is allowed free bench space of Zone 3 of the Douglas Resea Conservatory. Upon consent of Prof. Soo-Hyung Kim, the faculty in charge of bench a SER-UW will have guaranteed use of one half bench space for the full duration of the and SER-UW partnership. If more space is required, SER-UW will follow the Bench S request procedure managed by the Greenhouse Assistant.

Sawdust Beds and Wet Beds Available
The sawdust beds and wet beds in the DRC yard are available upon prior request to UW Manager of Horticulture to SER-UW for short term storage of plants.

Lease Payment
For the 2015-2016 school year, the space usage rate is $15 per 24 sq ft, as specified by Facility Services. For the 1,440 sq ft of space utilized by the SER-UW hoophouse in th yard, SER-UW will owe UWBG $900 per month. This amount will primarily be paid i of volunteer hours at a rate of $26.72 per hour, based on the United Way's estimate of average value of a volunteer hour in Washington State for 2014. (Source: https://www.uwkc.org/volunteering/volunteers-rock-our-world/) Therefore, $900 per m equivalent to 34 volunteer hours per month.

Volunteer events will be coordinated by SER-UW. Tasks will be recommended by the Manager of Horticulture and will focus on improving the grounds of the UWBG; CUH Washington Park Arboretum. Task examples may include invasive plant removal from Bay Natural Area and maintenance of the prairie rain garden. Extra hours can be banke future months. Volunteer hours will be recorded by SER-UW with volunteer signed ch sheets and submitted to the UWBG Manager of Horticulture.

As another form of lease payment, SER-UW will provide plants from our nursery stock UWBG, when requested by the UWBG Curator of Living Collections, at market value. of these plants will be deducted from the monthly space usage rate, and therefore will occasionally reduce the number of volunteer hours required to comply with lease paym SER-UW will provide an invoice to UWBG.

At monthly meetings, SER-UW will provide monthly reports of volunteer sign-in sheets, volunteer hours, and plant invoices to the UWBG Horticulture Manager so that all parties know the progress SER-UW is making with space usage payments.

Policy

It shall be the policy that the area used for the hoop house and outdoor space will be used for educational activities and plant propagation. Use of the space will continue until this agreement is amended or terminated by agreement of both parties. At any time, any party involved can request a review of the MOU, whereby all parties will reconvene and review the document.

In the event of UWBG and SER-UW partnership dissolution, for whatever reason, SER-UW will turn over the hoop house to UWBG in a mutually acceptable condition and plants will be removed in order for other UWBG approved occupants to take over the space.

User Procedure Requirements

Routine maintenance of the hoop house structure and plants are the sole responsibility of the SER-UW. UWBG will provide emergency assistance in hoop house maintenance and holiday watering. Arrangements for watering can be made with the UWBG greenhouse assistant.

Monthly Meetings

Monthly meetings between the UWBG Associate Director, Manager of Horticulture and SER-UW Nursery Managers will occur in order to facilitate check-ins about upcoming events and troubleshoot any issues.

Integrated Pest Management

Maintenance of the area immediately surrounding the hoop house and tarp space will be provided by the UWBG IPM specialist. SER-UW will follow all recommendations from the IPM specialist on pest control within the SER-UW hoop house. All pesticide spraying will be posted in advance to comply with all state pesticide laws.

Utility Requirements

As part of the monthly lease the University of Washington will provide water and electricity to the SER-UW hoop house. Water will be used to run the irrigation system set up by the ESRM 412 class in the outside tarp space and also the irrigation system inside of the hoop house. An extension cord run from the nearest outlet will supply our modest power needs prior to setting up a designated power hook-up. UWBG is not financially responsible for the initial setup of a designated electrical line to the hoop house.

Access

It is understood that the SER-UW has access to the DRC yard at any time. Time at the site may be spent participating in educational activities, tours, social gatherings, meetings, or work parties. For any events, the SER-UW will coordinate with the UWBG Events calendar. At this time, the intention of the SER-UW is to manage the nursery activities on an ongoing basis with one to two nursery managers and two undergraduate interns with key access to the DRC yard and greenhouse space. Additionally, the nursery managers will coordinate weekly work parties to

g time and day of the week will be chosen
incorporate the UW community. A regular work par to schedule.
each quarter, and will be placed on the UWBG even

Public Plant Sales
n plant sales per school year. Sales will not
It is the intent of SER-UW to hold two to three publ ill be approved by UWBG in advance.
be held within the DRC yard. The date and location equest to UWBG Manager of Horticulture
UWBG will provide labor and golf carts upon prior tation. Anticipated months of plant sales are
to help move plants from the yard to the approved lo be advertised through the UWBG website,
November, February, and April. All plant sales will Garden Tour calendar.
newsletters, and the Miller Library's Plant Sales and

Construction Projects
the nursery will be conducted in the DRC
Small construction projects to facilitate the setup of ally additional volunteers. Tool usage will
yard by SER Nursery Managers, interns, and occasi policy (Appendix 2). The area surrounding
be governed by the policies outlined in the volunteer building space. Temporary storage of
the field houses has been designated as an appropria houses. Access to power will be
tools and materials will take place in and near the fi and minimize the impacts of building
provided. SER-UW will maintain a tidy work space
projects while they are in progress.

Financial Procedures

any way. The SER-UW is a self-sustaining
UWBG is not responsible for funding this project in partnership with UWBG seek grants for
organization. The SER-UW will independently or i
plant production materials and labor.

ement of the project, the SER-UW, in
To ensure proper accountability and financial manag nvironment and Forest Sciences, will be
conjunction with Wendy Star of the UW School of F ding activities for this project.
responsible for all necessary bookkeeping and accou

Updates to the Memo of Understanding

be amended in any way, the UWBG and
In the case that this Memo of Understanding needs t may be revised or amended at any time by
the SER-UW will negotiate changes. This agreement ll be reviewed annually, each June,
mutual agreement of all parties. The partnership sh nursery managers for the coming school
beginning in 2016. At this time the SER-UW studen rticulture and Associate Director. The lease
year will be introduced to the UWBG Manager of H cial Program, will also be reviewed.
payment rate which is subject to change by UWBG

Signatures

Sarah Reichard
Director
UW Botanic Gardens

Sarah Reichard — 4/20/16
Signature *Date*

Anna Carragee
Nursery Manager
Society for Ecological Restoration- UW

Anna Carragee — 4/14/16
Signature *Date*

Kelly Broadlick
Nursery Manager
Society for Ecological Restoration- UW

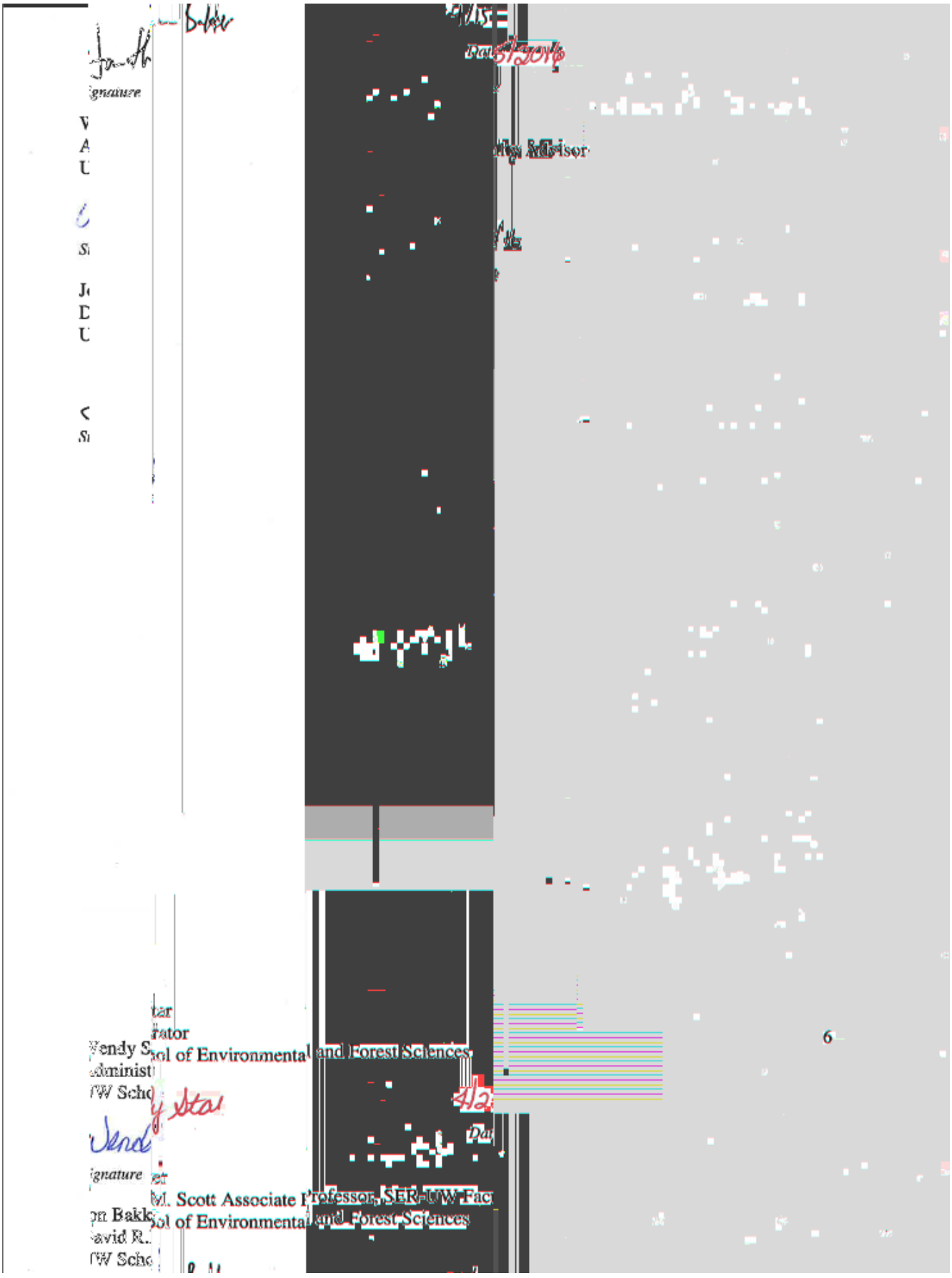
4-14-16
Signature *Date*

Fred C. Hoyt
Associate Director
UW Botanic Gardens

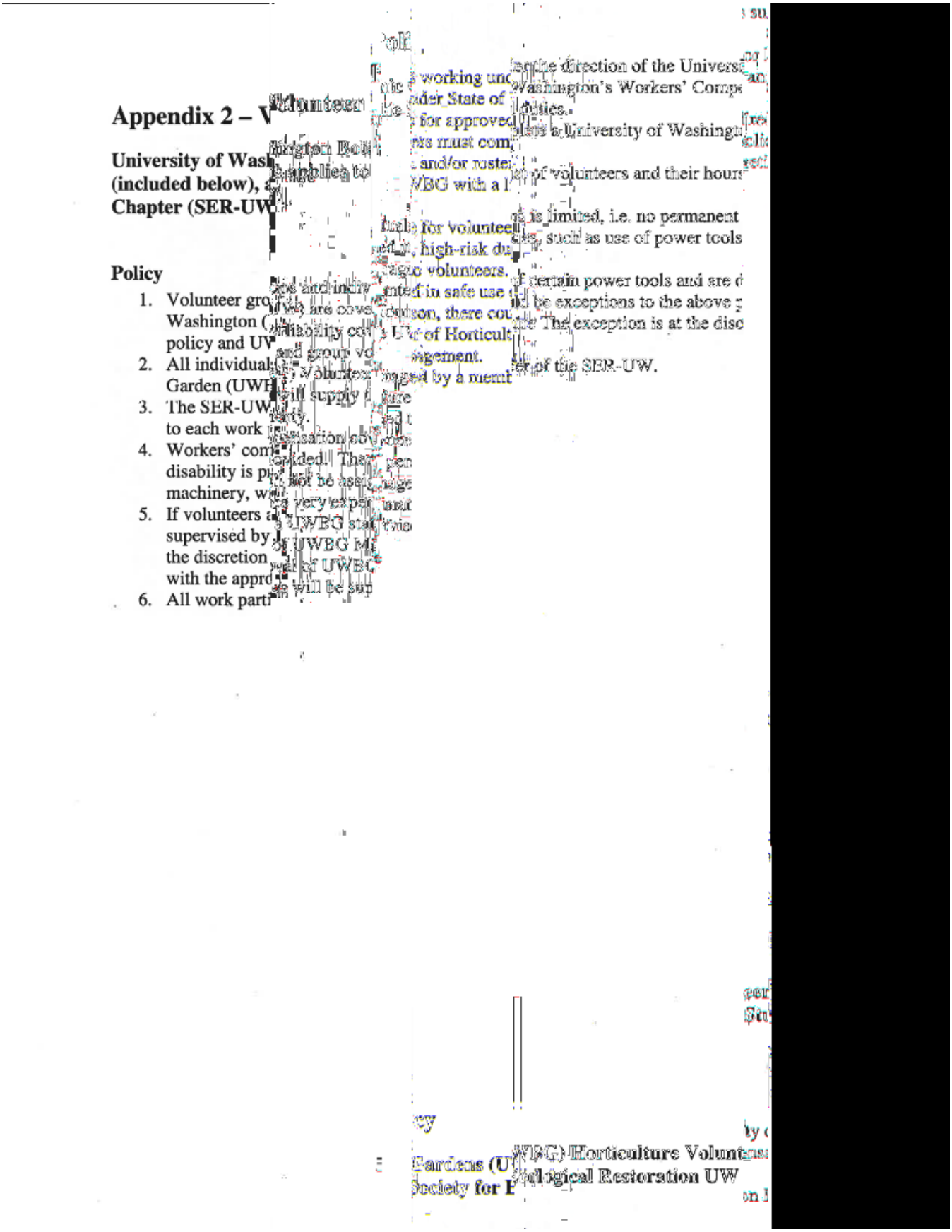
Fred C Hoyt — 4/14/16
Signature *Date*

David Zuckeman
Manager of Horticulture
UW Botanic Gardens

4/14/16
Signature *Date*



Appendix 1 – DRC Map



Appendix 2 – V

University of Wash
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Chapter (SER-UW

Policy

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