Designing and Implementing an Education Plan for the SER-UW Native Plant Nursery

Submitted in Partial Completion of the Master of Environmental Horticulture Degree

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Introduction
The University of Washington chapter of the Society for Ecological Restoration (SER-UW) is a student organization that promotes restoration through student efforts, primarily on campus at restoration sites including Kincaid Ravine and Whitman Walk. Part of SER-UW is the Native Plant Nursery (referred from here on out as the nursery), a small, student-run native plant nursery located at the Center for Urban Horticulture at the University of Washington (UW). The nursery began out of a need to grow and store plants for SER-UW’s restoration projects. In the last three years, the nursery has grown from temporarily storing native plants in burlap bags to running a small hoophouse operation of approximately 3,000 individual plants and up to a hundred different native species. The nursery’s mission has two parts: to grow healthy, genetically diverse native plants for UW student restoration projects and also to be an educational resource to students and community members who want to learn more about native plants and native plant production. In this project, I wrote curriculum to support the nursery’s educational mission by creating a simple educational framework that future managers and interns can use as the nursery continues to grow and reach out to educate students and community members about native plants and nursery management.

Background
As a completely student-run operation, the nursery provides a unique opportunity for students at UW to learn about native plant production, propagation, and nursery management in an education-focused environment. Currently, only two production horticulture classes (classes that focus on the actual growing and caring for plants) are taught at UW: ESRM 411 (Plant Propagation) and ESRM 412 (Native Plant Production), both of which are taught during spring quarter of each year. Each class is valuable and covers in-depth horticultural knowledge, but offering these two classes only once a year creates a gap between students’ desire to learn about horticulture and the opportunity they have to take a class on the topic. The nursery works to fill that gap in horticulture education at UW, providing nursery management experience to graduate students, supplying internships to undergraduate students, and teaching about nursery practices to volunteers every Friday at weekly work parties. Two graduate students from the Master’s of Environmental Horticulture program have traditionally managed the nursery, each spending about a year running the nursery before handing off management to the next graduate student. Undergraduate interns help to run the nursery, taking part in the nursery’s operations for a quarter before handing off the internship to the next quarter’s interns. The need for formalized education plans became apparent as student interest in the nursery grew, as evidenced by increasing numbers of volunteers and intern applicants. Students come to learn about how native plant production works, or to fill a volunteer requirement that includes a written report about their experience. In interviews, nursery
Intern applicants expressed an interest in learning how to run a nursery and to learn how to grow plants for restoration. Managers found themselves in charge of increasing numbers of volunteers and interns with no written plan on how to manage and teach such large groups.

In the spring of 2016, the nursery managers decided that creating an education plan to teach community members, interns, and volunteers is necessary to fulfill the nursery’s mission of increasing horticulture education opportunities for students and community members alike. Courtney Bobsin and I, with help and support from Kelly Broadlick and Anna Carragee, wrote a grant application to the Campus Sustainability Fund (CSF) to fund two RA positions that would allow us to focus on creating and implementing curriculum to achieve our education goals. In addition, the grant would fund the nursery to buy materials for education, research, and the creation of a management plan for the nursery.

The CSF grant gave us $68,000 to fulfill these goals. Courtney took on the role of strengthening our propagation and management plans. My role was to write the curriculum and teach 5 public education classes as well as help create short lessons that can be taught at the beginning of work parties to benefit our volunteers. My project eventually grew to also include a 10-week curriculum that focuses on teaching nursery practices to our interns, who help run the nursery to gain class credit. Altogether, the curriculum aims to create a simple and consistent educational framework that future managers can use to effectively teach students and community members about native plants and native plant production.
Methods: The Three Parts

Public Education Classes
The nursery currently does little outreach to the community surrounding the University of Washington. However, as the nursery grows, the need for outside investment in our mission has become more necessary.

Public education classes have the potential to bring in money and community interest by charging an attendance fee for the classes, finding community members who might be interested in financially supporting the nursery, or by simply using the classes to advertise our plant sales and increase attendance at those public sales.

As the nursery’s operations increase, the need for more funding grows. In particular, we can foresee a problem with funding managers long-term. While graduate students currently manage the nursery, there is no steady funding for these graduate students to continue management. Graduate student managers also have a high turnover rate: so far, each nursery manager has worked for a year at most, spending at least one school quarter of that year training the graduate student who will become the next manager. This is a problem for running a nursery, because plants often take a year or two to grow from seed to a marketable plant. In the long-term, the nursery needs to find funding to employ a part-time or full-time permanent employee. A non-student employee can learn how to run the nursery and provide institutional knowledge; graduate and undergraduate students can continue to help run the nursery alongside the employee. The public education classes could help us build community support, some possible revenue, and strengthen our own mission to be a hub for horticultural education.

The planning for the public education classes began in April of 2016, when class topics were discussed and chosen. In spring 2016, the nursery applied for a grant from the Campus Sustainability Fund, looking to fund the creation of the education program and the experiments and planning required to put together a nursery planning calendar.

We reached out to Jessica Farmer and the adult education team at the University of Washington Botanic Gardens (UWBG), who could provide expertise and resources for us as we put together the classes. With Jessica’s support and advice, she and I chose 5 class topics that were related to native plants and simple enough to write a short class on. The five topics are outlined in Table 1.
Table 1: Public Education Topics & Dates

<table>
<thead>
<tr>
<th>Class Topic</th>
<th>Date Taught</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edible Native Plants</td>
<td>September 19th, 2016</td>
</tr>
<tr>
<td>Pollinator Pathways: Native Plants for Pollinators</td>
<td>November 21st, 2016</td>
</tr>
<tr>
<td>Native Ephemerals &amp; Understory Plants to Grow</td>
<td>January 23rd, 2017</td>
</tr>
<tr>
<td>Native Plant ID &amp; Use in the Garden</td>
<td>April 17th, 2017</td>
</tr>
<tr>
<td>Seedlings and Watercolors</td>
<td>May 15th, 2017</td>
</tr>
</tbody>
</table>

We determined the class times both by my calendar and the UWBG calendar: we chose to do the classes on Monday evenings, when someone would be at the Center for Urban Horticulture at 8pm to lock up after the class. We decided to hold the classes on the 3rd Monday of the month, since the 1st Monday of the month was already dedicated to the evening Monday Night Lites lectures UWBG hosts every month. We also limited the number of classes to only 5, so that I felt confident I could create and prepare quality classes. We skipped teaching a class in March, as UW would be on Spring Break for the 3rd Monday of the month.

The classes were advertised through the UWBG website and several community calendars, as well as via the SER-UW Facebook account and the SER-UW e-mail newsletter in an attempt to reach more students.

Each class was from 6:30pm-8:00pm and included an activity and a PowerPoint presentation that covered the basic information. The activity was meant to reinforce information taught in the PowerPoint as well as encourage students to engage in active learning. At the end of each class, I handed out a survey (see figure 1) to participants to determine the effectiveness of the lesson and to explore possible future avenues for public classes related to native plants.

In preparation for each class, I wrote a class outline, designed an activity to go with the class topic, wrote a PowerPoint slideshow for the accompanying lecture, and designed handouts for students to take home with them at the end of the class (see appendices B-F).
Figure 1: Public Education Class Exit Survey

<table>
<thead>
<tr>
<th>Exit Survey: SER-UW NURSERY CLASS</th>
<th>Date ____________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class topic______________________</td>
<td></td>
</tr>
<tr>
<td>1. Did you learn anything new in this class? If so, what?</td>
<td></td>
</tr>
<tr>
<td>2. Are you affiliated with the University of Washington? If so, how?</td>
<td></td>
</tr>
<tr>
<td>3. What is your age?</td>
<td></td>
</tr>
<tr>
<td>4. How likely are you to recommend future classes to a friend or return to a future class yourself? Circle one.</td>
<td>1 Not at all likely   2 3 4 5 Very likely</td>
</tr>
<tr>
<td>5. What could be improved about this class? What other topics related to native plants would you attend a class about?</td>
<td></td>
</tr>
<tr>
<td>6. How did you hear about this class?</td>
<td></td>
</tr>
<tr>
<td>7. Please add any other comments on the back of this sheet.</td>
<td></td>
</tr>
</tbody>
</table>

For the class outline, I followed a template I created (see appendix A) based on my past experience as a teacher and on some guiding educational principles. I used this template for all of the lesson plans I wrote for the nursery, aiming for simplicity and consistency while also containing all of the relevant information someone would need to teach the class.

**Friday Work Party Lessons**

All of the nursery’s functions, from planting seeds to washing pots to weeding, are only possible due to volunteer efforts during the weekly work parties. Before each work party, we have always given an explanation for what we’re doing and how to do it. The educational component to those explanations have varied, sometimes teaching more information, sometimes less. I helped plan and write lesson plans to use before work parties, aiming to make the lessons consistent as well as implement sound educational principles. The lesson plans are very simple yet detailed, giving managers and interns a solid framework from which to teach, especially if they are unfamiliar with the task they’re leading.

Over the last two years, volunteer numbers have swelled each quarter. During the 2015-2016 school year, the nursery had a total of 1,102 volunteer hours. In the 2016-2017 school year, that number grew to over 1,670 volunteer hours. Many of these students who
volunteer with us are in the ESRM 100 class, Introduction to Environmental Science. This class requires students to complete three hours of environmentally-related volunteer work and write a short paper on the experience and the purpose of their work. About 34% of work party volunteers so far this school year have been ESRM 100 students (as of March 21st).

We also rely on Carlson Center volunteers. The Carlson Center at UW is part of the Center for Experiential Learning and Diversity, working to connect undergraduate students to community service learning opportunities. Students in various classes have the option to do service learning throughout the quarter, and the Carlson Center helps them find relevant volunteer opportunities; the nursery is one of those options, so we often receive students who are taking environmental science classes or introductory classes in ESRM. Carlson Center volunteers must commit to at least 20 hours of volunteer time throughout the quarter— that means they must attend at least 7 work parties to complete their assignment. This makes them particularly valuable volunteers, because they learn how the nursery operates and become expert volunteers. By mid-quarter, we are able to rely on them to lead small groups of less experienced volunteers in nursery tasks.

Work parties provide us with an opportunity to teach some basics of how native plants are grown for restoration, instructing both repeat volunteers like Carlson Center students as well as one-time volunteers like ESRM 100 students. Having an engaging lesson plan related to the day’s task can help teach them a little about plant production, and then to solidify that learning with hands-on work that puts what they just learned into action. Even if the student isn’t particularly focused on restoration or horticulture, they can learn something that interests them that they will remember past their class assignment.

Topics for the work party curricula were determined by myself and Anna Carragee, whose thesis work centered on building the nursery and all of the partnerships she and Kelly Broadlick started for the nursery (Carragee, 2016). The topics we chose are outlined in Table 2.

The work party lessons were created both by myself and by nursery interns each quarter with my feedback and editing. I had two education interns in the fall quarter and another intern in the winter quarter; they each wrote a couple lesson plans on topics that interested them and that were related to work we did at the nursery. They then taught their lesson(s) at a work party before the end of the quarter. Lesson plans are credited to their creator (see appendices G-K).
**Table 2: Work Party Lesson Topics**

<table>
<thead>
<tr>
<th>Lesson Topic</th>
<th>Corresponding Nursery Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathogens and pests: How they function in a nursery setting</td>
<td>Pot washing</td>
</tr>
<tr>
<td>Growth needs of plants: water, sun, food, and space</td>
<td>Up-potting or weeding</td>
</tr>
<tr>
<td>Seed anatomy: Parts of a seed and how it grows</td>
<td>Seed Sowing</td>
</tr>
<tr>
<td>Seed zones and plant provenances</td>
<td>Collecting cuttings, salvaging plants</td>
</tr>
<tr>
<td>Invasive Species &amp; how they outcompete natives</td>
<td>Invasive species removal, for UWBG rent*</td>
</tr>
</tbody>
</table>

*While invasive species removal isn’t a strictly “nursery” task, the nursery relies on volunteer hours spent working on restoration projects in the Union Bay Natural Area, most commonly removing English Ivy and Himalayan Blackberry. These volunteer hours count towards rent for the nursery’s space, and so we included a lesson to go along with this task.

The design of these lesson plans is purposely simple with a good deal of background details. The idea is for a new manager or intern to read the lesson plan a day ahead of the work party and feel confident that they can follow that lesson plan and have background information that they can lean on if students have questions. The simple format aims to be user-friendly, so that managers and interns can rely on a script to help them lead the work party.

**Intern curriculum**

Each quarter since Fall 2015, the nursery has taken on two to five interns to help run the nursery and to learn about Native Plant production. These interns help the managers care for plants, run experiments, lead work parties, and do all of the tasks that are part of running the nursery. The interns sign up for ESRM 399 (or their school’s equivalent), which allows students to earn class credit by working at a subject-relevant internship. With the managers, interns come up with a plan for learning goals and a quarter-long assignment that will both benefit the nursery as well as interest the intern.

While managers do develop a learning plan for each student with some outlined goals, there is currently no plan for how to reach those education goals. For example, each quarter, managers have planned to teach students a certain number of native plants each
week so they could work on their identification skills, a skill that every intern has expressed interest in. Each quarter, managers failed to be consistent in teaching plant identification. Without a plan--without a template to follow--it is easy to let the immediate demands of the nursery dictate all activities. Running the nursery is dependent on what needs to be done each week to keep it functioning, but having a quick, one hour lesson outline with extra resources can help managers effectively teach their interns without having to reinvent the wheel each year.

The nursery is constantly changing week-to-week and quarter-to-quarter on what tasks need to be done, so the intern curriculum aims to have short lessons that stand alone. These lessons can be interchanged from week to week so that the manager can see what needs to be done in the nursery, and then choose the corresponding lesson that connects with that activity.

This is not meant to be an all-inclusive curriculum that creates boundaries on the internship; this is meant to be an outline that can help guide the manager and the intern throughout a quarter, and ensure that the intern will leave the internship with a beginner’s understanding of how greenhouse management, native plant production, and plant propagation methods work. There will always be tasks and topics that will come up throughout the quarter that are not covered in this ten-week curriculum, but it aims to provide a framework in which managers and intern can work and learn while also having the flexibility to move parts of the curriculum to suit the needs of the nursery.

To determine the topics that the intern curriculum would cover, I wrote out all of the common tasks we did at the nursery and listed some topics that could be turned into short lessons. I then talked with my father, Dr. Tom Greene, who started his own backyard native plant nursery in the early 2000s and built it up over a period of years; he has also worked in conservation and restoration since then, with valuable experience and expertise in these areas. I interviewed him on December 23rd, 2016 to gain his professional feedback and ideas about the topics I’d chosen as well as any other topics he thought might be helpful to include in a ‘greenhouse management’ internship. Then, in a meeting with Dr. Jon Bakker on January 17th, I went over the finalized topics to get his input and thoughts before I started writing the curriculum. His input was particularly helpful, as his class ESRM 412, Native Plant Production, inspired some of the topics. The nursery curriculum is unique in that it directly places undergraduate students in the role of assistant nursery managers, allowing them much more hands-on time with the plants and nursery activities than any class at UW. The final topics are outlined in Table 3.

I have placed these topics in an order that best matches my experience with running the nursery, organizing them to match the nursery’s general schedule each quarter. I also tried
to make the order educationally logical by placing important skills to immediately learn early in the quarter (like how to generally care for plants by watering and fertilizing), and ending the quarter with more complex topics that require more critical thinking (like choosing the appropriate pot shape and size for a plant).

Table 3: Intern Curriculum Weekly Topics

<table>
<thead>
<tr>
<th>Suggested Order</th>
<th>Lesson Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Orientation (Tour of headhouse, hoophouse, materials, etc.)</td>
</tr>
<tr>
<td>Week 2</td>
<td>Irrigation and fertilizing</td>
</tr>
<tr>
<td>Week 3</td>
<td>Soils and media</td>
</tr>
<tr>
<td>Week 4</td>
<td>Seeds</td>
</tr>
<tr>
<td>Week 5</td>
<td>Vegetative propagation</td>
</tr>
<tr>
<td>Week 6</td>
<td>Plant diseases and pests</td>
</tr>
<tr>
<td>Week 7</td>
<td>Heating and cooling</td>
</tr>
<tr>
<td>Week 8</td>
<td>Plant sales</td>
</tr>
<tr>
<td>Week 9</td>
<td>Pot shape &amp; size</td>
</tr>
<tr>
<td>Week 10</td>
<td>Greenhouse visits: Field trip to other nurseries</td>
</tr>
</tbody>
</table>

However, although I think this is the most logical order to teach these topics, I also know that working at the nursery has a seed of unpredictability. For example, we sometimes receive donations of cuttings from UW Grounds that we can cut and strike into containers; if we were to receive a donation of cuttings during week of the quarter, it would make sense to replace the week's soil lesson with the vegetative propagation topic, because that would be a more relevant lesson to the nursery's current operations. With the fluidity of the nursery's schedule in mind, these lessons are designed to be succinct and modular, allowing managers to adapt the internship to the nursery's demands.

Again, I used the same format for the internship curriculum as I did for the other lesson plan types to create consistency between the lessons and to capitalize on the simple framework that aids inexperienced teachers to step into the role of an educator (see appendix L).
Educational Theory

The nursery curriculum incorporates experiential learning and active learning principles of educational theory. Experiential learning is the inclusion of “experience” opportunities, encouraging students to engage in an activity or practical application of knowledge in order to learn the material. Experiences can include reflection activities, problem-solving, equal interaction between students and instructors, service learning, and other ways that students can actively engage in learning (Furman, 2014). Active learning is closely related to, and sometimes interchangeable with, experiential learning, although it tends to be more broadly defined as engaging students in the process of learning, including discussions in class and group work projects (Freeman et. al 2014). Both experiential and active learning practices move away from lecture-style instruction and the unidirectional movement of information from instructor to student. Ideally, experiential and active learning methods engage students in their own learning and promote learning transfer--students’ ability to absorb class material long-term--more effectively.

The pursuit of using teaching methods “that work” is a divisive issue, with varying opinions on how to teach with good results. The effectiveness of experiential and active learning techniques is often measured qualitatively by student evaluations and their perceptions of the class or activity: Machemer and Crawford (2007) found that students valued active learning equally as well as lectures, but did not value cooperative learning (group projects with peers); Bordelon and Phillips (2006) found that students viewed service learning (often used as a component of experiential learning) positively whether or not they had done any service learning, but also did not actually want to engage in service learning opportunities the university provided.

Other studies have shown positive effects of incorporating hands-on, experiential learning as a part of education, but do not compare those effects to lecture-based classes. For example, Hilaire et. al. (2009) incorporated hoophouse construction and operation into their undergraduate course on general horticulture along with the traditional lecture part of the class. In the class lab, the students built 12 x 15ft hoophouses, including irrigation and climate-monitoring technology, and then grew radish and lettuce plants throughout the semester. By the end of the semester, the majority of students felt confident in their newly acquired skills, reporting that they understood the basics of hoophouse construction. The students also revealed gaps in knowledge through the mistakes they made in growing the crops, so that instructors were able to see areas that they might improve the class the following year. While these results support using hoophouse construction as a hands-on learning opportunity, students rated the lectures as just as beneficial as the labs, with no difference between the two; by student perception, at least, the experiential learning component of the class was equal to, not better than, the lecture-based class environment.
However, some studies have looked quantitatively into the effectiveness of the lecture-style model of teaching versus active and experiential learning methods. While lecturing is often easy for instructors to implement, information transfer varies. A study showed undergraduates taking lecture-style classes were 1.5 times more likely to fail the class than students in classes that incorporated simple active learning principles like including questions in the lectures, encouraging discussion between students during class, and calling on students to comment or answer questions (Freeman et. al. 2013). Here, active learning forced students to engage in the material rather than passively listening to an expert’s lecture, improving students’ overall performance in class.

Conrad and Hedin (1982) found in a study of multiple experiential learning programs for ages 7-19 that students not only improved their overall learning, but also improved their sense of self-esteem and social interactions with other students. The study also found a strong correlation between the combination of formal seminars with active learning and increased intellectual development of participating students.

None of these studies advocate removing lectures entirely from teaching methods. Lectures provide some necessary groundwork of information, via an expert sharing knowledge with students. Active and experiential learning combines lectures with opportunities for students to apply information from the lecture to a problem, discussion, or hands-on activity. These follow-up activities and experiences can help students take that knowledge, solidify it, and transfer it to their own understanding with practical application or critical discussion among peers.

When I wrote the curriculum for the public education classes, I created a PowerPoint-based lecture, coupling it with an activity to engage students with the material the lecture covered. In this traditional class setting, I had a room reserved for the class, a set period of time for teaching, and students’ expectations of coming away from the class with new knowledge. Traditionally, a class like the public education classes I taught would consist of just a lecture, with an open question period at the end. The education theory I outlined above led me to include an active component to my public classes alongside the traditional lecture, improving student investment and participation in the class.

On the other end of the spectrum, neither the nursery work parties nor the internship had a lecture component or formalized plan. There is no real ‘lecture’ opportunity, since there’s no classroom associated with either the work parties or the internship, but there is the opportunity to provide structured information to students. In both instances, interns and volunteers were already doing hands-on activities related to native plant propagation and production; the internship in particular is an experiential learning setting, placing interns
in the positions of nursery assistants and requiring them to learn how to run the nursery throughout the quarter. What was missing was the formal, expert knowledge to give context to the activities; the curriculum I wrote provides a plan to formally teach important horticulture topics using the activities we regularly do at the nursery. With curriculum, nursery managers can purposely use nursery tasks to teach volunteers and interns, rather than to only use them as a way of helping complete nursery tasks. According to Conrad and Hedin: “Perhaps students can make [personal] meaning of their experiences on their own, but if this meaning is to affect their broader social attitudes and intellectual skills, systematic and directed reflection must be added.” The curriculum I wrote adds that systematic and directed aspect to the activities we already do at the nursery.

In all three types of curriculum, I worked to balance the informational, lecture component with an active component, pulling the class or lesson towards a balance of formalized education and experience.
Implementation & Results

Public Education Classes
For each of the 5 public education classes, I prepared a lecture, activity, and handouts students could take home with them. I would also practice the lecture several times, timing myself and making changes as needed. Class set-up time varied depending on the materials needed, but generally took between 30 minutes to a couple hours. The UW Botanic Gardens education team helped to advertise the classes, putting them on their website and including descriptions in their newsletters and emails. I, with the help of other SER-UW officers, advertised the classes to UW students through SER-UW’s e-mail newsletters and Facebook page.

The advertising efforts--and likely the ‘free’ price tag on the classes--led to high attendance rates, with an average of about 23 people per class. For each class, UWBG provided a class monitor to help me distribute handouts, sign students in, and help throughout the evening. I also had assistance from nursery team members at two of the classes, and from my partner, Adam Le Doux, at four of the classes. They all helped to set up and clean up after the classes; the nursery team also provided support at the ends of classes when many students had questions, answering some questions while I answered others. Adam and the nursery team also took photos while I taught and provided immediate feedback at the end of the classes. At the end of every class, I passed out surveys to all of the students and requested they fill them out honestly, encouraging them to give any and all feedback as this was a pilot program that could be changed based on their answers.

The survey responses were generally positive, with most students saying they learned something new. In one case, a student in the Seedlings and Watercolors class reported that she “re-learned (probably for the first time truly understood) how the radical operates in the seed,” indicating that even when students were familiar with the material, they would sometimes come away with a reinforcement or clarification of knowledge. Students were also asked how likely, on a scale of 1-5, they would recommend or return to another class taught by the nursery; most circled 5, with an overall average of 4.6. The age demographics of the classes tended to be older, with very few UW students attending, although the average age varied from class to class. Most class attendees reported seeing advertising for the class through the UWBG website, a Google search for free classes, or email listservs that re-posted UWBG events.
Table 4: Public Education Classes, Survey Results

<table>
<thead>
<tr>
<th>Class Title</th>
<th># of Students</th>
<th>Average age</th>
<th>Average likelihood to recommend or return to a future class (out of a 1-5 scale, 5 being very likely)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edible Native Plants</td>
<td>27</td>
<td>42</td>
<td>4.7</td>
</tr>
<tr>
<td>Pollinator Pathways: Native Plants for Pollinators</td>
<td>25</td>
<td>60</td>
<td>4.3</td>
</tr>
<tr>
<td>Native Ephemerals &amp; Understory Plants to Grow</td>
<td>21</td>
<td>56</td>
<td>4.6</td>
</tr>
<tr>
<td>Native Plant ID &amp; Use in the Garden</td>
<td>26</td>
<td>38</td>
<td>4.6</td>
</tr>
<tr>
<td>Seedlings and Watercolors</td>
<td>14</td>
<td>44</td>
<td>4.7</td>
</tr>
</tbody>
</table>

From my perspective as the instructor, I improved over time with each class. By the 5th class, I was more confident, better able to direct students between the lectures and activities, and improved in my public speaking skills. I was also able to incorporate student feedback into my later classes. The survey asked what students thought could be improved about the classes, or if there were class topics they would like to see taught in the future. For example, many students from the first two classes asked for “more plants,” and so in the following two classes on understory natives and native plant identification I increased the number of plants I covered.

The class topics students suggested varied, some of which were even classes that I did teach as a part of this series. For example, students who attended my Native Plant ID class, Seedlings and Watercolors class, and Plants for Pollinators classes all suggested teaching a class on native edible plants. The most common requested classes were topics related to how to incorporate native plants into gardens and landscapes, topics related to native edible or medicinal plants, and native plant identification in general. A full list of all class topics suggested, with the popularity of the suggestion, is listed below in Table 5.
Table 5: Student-Suggested Class Topics

<table>
<thead>
<tr>
<th>Student-Suggested Class Topics</th>
<th># of times suggested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gardening/Landscape Design for Native Plants</td>
<td>8</td>
</tr>
<tr>
<td>Edible/Medicinal Native Plants</td>
<td>7</td>
</tr>
<tr>
<td>Native (Pacific Northwest) Plant Identification</td>
<td>6</td>
</tr>
<tr>
<td>Noxious/Invasive Plant Identification</td>
<td>2</td>
</tr>
<tr>
<td>Propagation</td>
<td>1</td>
</tr>
<tr>
<td>Benefits of Native Plants</td>
<td>1</td>
</tr>
<tr>
<td>Soil Structure and Composition</td>
<td>1</td>
</tr>
<tr>
<td>Succession (Forest succession)</td>
<td>1</td>
</tr>
<tr>
<td>Restoration planting and methods</td>
<td>1</td>
</tr>
</tbody>
</table>

Overall, the classes were successful, earning positive feedback and interest in future classes. As the nursery moves forward in its education goals, looking at the feedback from these students can help shape future class topics and structure.

**Friday Work Party Classes**

Nursery interns and myself wrote the Friday work party mini-lessons over the course of the 2016-17 school year. When the interns wrote curriculum, they would then practice teaching it before the end of the quarter, leading one or more of the work parties with the support of the rest of the nursery team. Leading the work parties allowed them to test their curriculum and make changes, as well as gave them practice leading the work parties.

Unlike the public education classes, we did not survey students at the end of the work parties to gauge their response to the mini-lessons. Organized surveys are less feasible at the work parties, as students come and go at different times, and the tasks we do at the nursery often keep the nursery team and volunteers busy right up to the last minute. However, while we did not survey the volunteers, the addition of the work party curriculum made a clear difference for the interns and managers. The curriculum provides a script and a plan to work from, and helps interns and managers organize and run work parties with more confidence and consistency.
Work parties have grown in size in the last year, requiring managers and interns to manage large, unwieldy groups of volunteers every Friday. During the 2015-2016 school year, an average of 11 people showed up to each work party, with a total of 1,102 volunteer hours. During the 2016-2017 school year, an average of 19 people showed up to each work party, with a total of more than 1,670 volunteer hours. That’s a 58% increase in work party size and over a 66% increase in total volunteer hours for the year. The larger the work party, the more challenging it is to effectively teach and direct volunteers; with the curriculum, the nursery is better prepared to handle large numbers of volunteers at events.

The curriculum we wrote helped interns take a leadership role in leading the work parties, providing a written plan for them to work from. In the past, interns struggled to lead work parties because they were leading volunteers based on their memories of how the managers had led previous work parties; the curriculum not only provides education for the students, but also a script for interns and managers to work from. As a manager, I could tell that while my interns were still nervous leading their first work party, they were better able to do so when they had a curriculum plan to work from. They did not refer to me for help as much, and were able to get volunteers started on the task of the day without support from managers.

The work party curriculum provides a plan that managers and interns can read ahead of time, practice, and refer to when they lead work parties. This will be particularly helpful as new managers and interns step into the nursery team roles, because it provides support for them as they learn how to lead and direct work parties. The curriculum is available to future managers and interns both as a hard copy in a binder they can take with them to the work parties, as well as on the Google Drive that the nursery team has access to.

Having the curriculum as a hard copy allows managers and interns to take it with them to work parties and refer to it as they lead volunteers; they can take notes and make changes on the Google Drive, perhaps even write new mini-lessons, and continually update the curriculum as the needs of the nursery change over time. With the mini-lessons, the nursery can provide some educational background to volunteers while also providing support to managers and interns learning to lead the work parties.

**Intern Curriculum**

The next nursery manager will implement the intern curriculum in the fall quarter of 2017. While it hasn’t been used yet, I worked as a nursery manager for three quarters (spring and fall 2016, winter 2017) and advised the new managers for 1 quarter (spring 2017). I used my experience as a manager to write curriculum that helps to support managers and interns, covering topics and skills that students need to run the nursery.
I based the intern lessons on the same educational theories that the other curriculum are based on—hands-on activities combined with formal education to achieve learning transfer. Some of the weekly lessons also include outside sources for managers to either assign to interns or to offer to them as resources, in case an intern is particularly interested in a topic.

One of the most difficult challenges the nursery faces is turnover rate—student managers and interns change from year to year, quarter to quarter. This intern curriculum is part of the solution to that problem—it provides a continuum of knowledge for the next manager to draw from, add to, and pass on to the following manager. Learning to manage interns requires time and experience, and this curriculum will act as a guide for managers to use as they hire and teach new interns each quarter.

The curriculum exists in two places: as a hardcopy in a binder for managers to refer to while at the nursery and saved on the shared Google Drive that SER-UW has put together. It is not meant to be a static document; the binder has blank sheets of paper between each lesson plan for managers to take notes and add ideas to use the next time they teach the lesson. These notes and ideas can also include tips for how to best implement the lesson plan. As managers put the lesson plans into practice, they will likely discover the best ways to set up materials, or they will find new sources for interns to refer to. The online version on Google Drive will allow managers to make direct edits to the curriculum, to correct mistakes or to adjust curriculum to something they find more useful.

With the intern curriculum, managers can build on one another’s experience and practice, providing support for them and providing better, more consistent education for interns.
**Additional Thoughts**

The curricula are not meant to be the end of the expansion of the nursery’s education efforts. As time passes, the nursery will change and grow; the education plan at the nursery must be prepared to change and grow as well. Moving forward, future nursery team members can take simple steps towards making the nursery a better educational resource for students and community members.

There are many ways the curricula could be built upon, and even new projects that could make the nursery a more accessible, educational organization. For example:

- More topics for the intern curricula, such as writing more lesson plans on other nursery topics. The more topics and lesson plans there are, the more future managers can mold the internship to the quarter’s nursery tasks. Topics could include: other forms of vegetative propagation like crown and rhizome division; different types of irrigation systems, from drip irrigation to sub-irrigation to overhead irrigation; a specific lesson on plant identification for the species we carry at the nursery; determining plant prices, wholesale and retail; a lesson focused on teaching interns how to teach and lead work parties, giving them some guidelines on how to manage large groups of people; an in-depth lesson on fertilization and using an EC meter (electrical conductivity meter) to measure salt build-up; and many others, as topics become relevant to the nursery.

- Signage throughout the nursery and plant-holding areas to describe different parts of the nursery. The signage could describe how to program the irrigation system or explain how and why we chose that irrigation system; signage to explain how we organize plants throughout the nursery (based on watering needs, sunlight needs, etc.); signage to mark the seedling table and information about starting plants from seed; or even signage that explains the covering over the hoophouse and why we change it out seasonally. These signs could help highlight and teach about parts of the nursery that volunteers never even think to ask about, and managers never think to explain or emphasize to their interns.

- Physical paper handouts for the work party lessons that outline the main points of the lesson and nursery activity of the day. With a handout, volunteers can leave with a ‘take-home’ sheet that helps them to remember and understand what they learned and did at the nursery.

- Including a pre-class survey to the public education classes as well as handing out a post-class survey. Having a pre-class survey to compare to the post-class survey could help to even better determine the strengths and weaknesses of the class, as well as provide a tool to ‘test’ students before and after to see what they learn during the class.
• Adding surveys to work parties could be particularly helpful to determine the effectiveness of the short lessons. As I mentioned in the Implementation & Results section, it is harder to survey students at work parties than students at public education classes; however, we could require volunteers to fill out a survey in order to get credit for their volunteer work. Since many students come to the nursery to volunteer for a class assignment, they often need the nursery manager to send a confirmation e-mail to their instructor or TA, verifying each student’s attendance. We could require students to fill out a survey form, in person or online, in order to receive a confirmation e-mail to their instructor.

This is only a sample of the many ways the nursery’s education program could be improved; future interns could even take on and build some of these ideas for their quarter-long projects. The curricula I’ve written is meant to get these kinds of projects started, so that as the nursery grows, our capacity to educate and foster curiosity about native plants and native plant production grows as well.
Conclusions & Next Steps
The public classes were overall successful, with positive feedback and interest in future classes on native plants. The classes were not only well-received by students, but also forged a stronger relationship between the nursery and the UWBG education team, who provided support and resources to help the classes succeed while we provided a wider variety of classes for them to offer to the public. The classes are also unique in that SER-UW is the only university branch of the Society of Ecological Restoration providing classes for the public. SER does have classes provided by regional chapters, but those classes are primarily for people in the restoration industry, and are only open to members of SER. Our classes, being open to the public, are an opportunity for us to reach out to anyone with an interest in native plants and restoration. However, moving forward, there are some important challenges to keep in mind if these classes are to be taught again by future nursery team members.

Preparing and practicing for the public education classes took considerable time and effort. In the future, the nursery will only have a single graduate student manager, rather than the two we have always had in the past. With the reduction in staff, it will likely not be feasible for the manager to teach all of the 5 classes I wrote. Also, the plan of using these classes as possible income for the nursery has at least one major challenge: in conversations with Jessica Farmer, I learned that when UWBG classes have a fee, student registration drops. While the nursery classes all had excellent attendance, this may be because they were free classes on popular topics, and adding a fee may reduce attendance. Finally, many students requested that the classes last a little longer to give them more time to do the activity, particularly the art class and the native plant identification class, where students spent time at the end of the class painting or exploring the native plant examples.

With these challenges in mind, a good option for the public classes is for future nursery managers to choose one or two of the five classes I wrote, and increase the time of the class to 2 hours instead of an hour and a half. They could choose the topics they are most comfortable with, perhaps, or the most popular topics, and teach one or both strategically before public plant sales. Based on the survey responses, the most popular topics would be native edible plants or native plant identification. These topics would be particularly good to teach before hosting a plant sale, as they focus on plant species that the nursery usually has in stock.

This strategy would reduce the amount of work for the manager, since he or she would need to only prepare for one or two classes instead of all five. It would also allow the managers to choose the topic they are most comfortable with, and therefore most comfortable with teaching. Finally, teaching the classes right before the plant sale would
allow the manager to use the classes as a way to further spread awareness of the nursery’s public plant sales. The public classes can still be held for free with a suggested donation in partnership with UWBG, but hopefully students who come to the classes would then be more likely to go to the nursery’s public sale and buy plants. At the plant sales, the nursery team should then include a survey for customers to fill out, asking them how they heard about the plant sale so that managers could see if public class attendees also came to the plant sales.

The nursery holds two public plant sales per year, one in the spring and one in the fall, to clear out our plant stock after we have sold plants to student restoration projects. This would mean that the manager would only need to teach a public class twice during the year and could, if he or she preferred, teach the same class both times. This would continue the nursery’s public outreach efforts as well as limit the amount of time a manager would need to put towards this branch of running the nursery. Moving forward, the public classes will provide an opportunity to work with UWBG, provide native plant education to the broader public, and possibly increase attendance and sales at the nursery’s public plant sales.

The Friday work party lessons and intern curriculum will be simpler to implement, and more useful on an everyday basis. Both provide support and continuity in the quality of education the nursery provides to its volunteers and interns, and both provide a framework for managers and interns to work from. The work party curriculum has already shown that interns are more independent and confident at leading work parties when they had a pre-written plan to follow.

The intern curriculum will provide a blueprint for new managers of how and what to teach interns during the quarter. As the curriculum is put into use, managers should create opportunities for interns to give feedback; the final assignment for the interns in my curriculum is to write a paper that prompts interns to discuss what they’ve learned over the course of the quarter and what they think could be improved about the internship in the future. Interns should also have the opportunity to fill out a survey—after their end-of-the-quarter discussion with the manager—that encourages them to write about what they felt were the strengths and weaknesses of the nursery. Another potential opportunity is to have the interns present their projects and nursery experiences to the rest of the SER-UW student group; each quarter, the interns take on a quarter-long project to complete for the nursery, and in the past their projects have really only been acknowledged by the nursery managers and Dr. Jon Bakker, the nursery’s advisor. SER-UW has a meeting at the beginning of every quarter, but could also have a quarterly wrap-up meeting. At these wrap-up meetings, interns could prepare and present a short talk of their work at the nursery. This would give interns the opportunity to practice presentation skills, present their work to the whole of SER-UW, and could help document the ways in which SER-UW
and the nursery in particular are helping students to learn more about native plants, native plant production, and restoration.

No one is a good public speaker or a good teacher the first time they try. Good leadership and good teaching rely on practice and experience, and while these three curricula cannot provide experience, they can provide a plan of how to build that experience. The curricula I wrote use the educational theory that connecting formal education with meaningful activities helps students learn more effectively, with higher learning transfer and often with more enjoyment in the act of learning. Nursery managers and interns are now better equipped to effectively teach about native plants and native plant production, so that we can better fulfill our mission of becoming an educational resource for students and community members alike.
References


Appendix A: Lesson Plan Template

Title

Essential Question(s):
1.

Teacher's Goals:
1.

Materials (May Vary):
1.

<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Assessment Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to...</td>
<td>Students will have...</td>
</tr>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
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</table>

Lesson Plan:
1.
Appendix B: Public Education Curriculum, Native Edible Plants
Native edible plants lesson plan and related documents

Eat Native: Identifying Edible Native Plants
Taught Monday, September 19th, 2016, 6:30-8:00PM

Essential Question(s)
1. What are some common native plants to use both for landscaping/home gardening as well as foraging?
2. Why is it important to include native edibles in landscaping?
3. What do these plants need to grow successfully?

Teacher’s goals
1. To introduce adult students to several native, edible plant species that can be used not only for foraging purposes, but also for landscaping and to increase urban plant diversity.
2. Teach the necessity of following legal gathering practices
3. Introduce some of the ways these native plants can be eaten.

Materials (May Vary):
1. Pre-planned walk around CUH (or location of class) with examples of some of the plants along the walk
2. Cuttings or pots of all the plants being taught that night, preferably including leaf, edible part, and stem/bark of each example
   a. *Pseudotsuga menziesii*
   b. *Corylus cornuta*
   c. *Vaccinium ovatum*
   d. *Rosa nutkana*
   e. *Mahonia nervosa*
   f. *Rubus spectabilis*
   g. *Rubus parviflorus*
   h. *Gaultheria shallon*
3. PowerPoint Lecture & projector/computer to show it with
4. Copies for all the handouts (enough for each attendee)
   a. Plant ID guide
   b. Douglas fir tip syrup recipe card
   c. Class exit survey
   d. Native Plant Themed food *(optional)*
      i. Trailing blackberry jam, or huckleberry jelly (+ something to put the jam on--bread)
      ii. Rose hip and Douglas fir tip syrup with club soda
<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Assessment Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to...</td>
<td></td>
</tr>
<tr>
<td>1.) Reliably identify some of Puget</td>
<td>1.) Garden exercise: students will use their knowledge</td>
</tr>
<tr>
<td>Sound’s native, edible plant species</td>
<td>from the class to create a small plant arrangement</td>
</tr>
<tr>
<td>2.) Understand why using native</td>
<td>that includes species we learned.</td>
</tr>
<tr>
<td>species is beneficial to the urban</td>
<td>2.) Post-class survey will question</td>
</tr>
<tr>
<td>ecosystem</td>
<td>students if they feel like the class helped them</td>
</tr>
<tr>
<td></td>
<td>grow in their knowledge of Puget Sound native edible</td>
</tr>
<tr>
<td></td>
<td>species</td>
</tr>
</tbody>
</table>

**Schedule Overview and Approximate Times**

6:30PM-6:45PM  Names, Introductions, and Overview of SER-UW Nursery; include overview of how the rest of the night’s class will go.

6:45PM-7:25PM  Walk! Pre-planned walk to look at examples of edibles worked into the landscape at UBNA. (Note that sunset is at approximately 7:10PM, so be timely, or we’ll run out of daylight!) The walk is meant to get students actively engaged in learning before having them sit through a PowerPoint. Practice the walk before taking students.

7:25-7:40PM  Present PowerPoint going over the native species you have chosen to highlight. Include examples of how to use them in landscaping as well as examples of foods people make from them. Include ~3 minutes for questions after PP before moving on to next activity.

7:40PM-7:55PM  Create own garden exercise: Leave end-slide of PP up with an overview of the species we covered. Offer paper, pencils, and colored pencils for students to use and create, in pairs or solo, an example arrangement they could envision themselves planting that includes one or more of the edible plants we learned in the class.

7:55-8:00PM  Closing: Plug for next class in November, plant sale, and the volunteer night in October. Food available for post-class snacking with a native-plants theme, and ask for people to fill out class survey before they leave.
References for this Lesson:


Plant Identification

Every plant has unique characteristics that can help you learn how to identify them. Look for flowers, leaves, fruits, and unique features like the bark of trees.

Branching Patterns

Pay attention to the pattern of branching. Some plants have opposite branching, while others have more complex patterns.

Leaves: Shapes and Margins

Different types of leaves can help identify plants. Observe the shape and margin of leaves to make distinctions.

Overview

Want to learn more?

- Read and study with edible plant parts.
- Why should we eat and plant native plants?

Identifying Edible Native Plants

Eat Native

By: Karen Noguchi

SEER UV Native Plant Nursery
Shrubs

Leaves:
- glossy
- small
- opposite

Flowers:
- blue
- small
- many

Habitat:
- moist soil
- well-drained soil
- prefers partial shade

Trees

Leaves:
- deciduous
- evergreen

Flowers:
- small
- blue

Habitat:
- well-drained soil
- prefers full sun
- prefers part shade

Why eat and plant native species?

- Native species can do better in their native habitat
- Can be used in landscaping and urban ecosystems
- Can be used in culinary and medicinal applications
- Can contribute to biodiversity and ecosystem health
- Can produce food, fuel, and other resources

Picture Credits

Any Questions?
and the Number is: 34
www.wilsonnursery.com

Want to learn more?

Do not harvest with your hands or a rod.
Drought-tolerant plants do not have a root.
Never harvest more than 25% of the plant.

There are some important differences to seedlings.

Here's an example demonstration:

Growing your own

Shrubs
Native Edible Plant Identification

Douglas Fir
*Pseudotsuga menziesii*
- Tall evergreen tree with needle-like leaves
- Bears cones with distinctive, 3-lobed scales (mouse-butts)
- Buds are reddish and cigar-shaped
- Has edible new-growth that is available in the spring
- Prefers well-drained soils and lots of sunlight and space to grow

Beaked Hazelnut
*Corylus Cornuta*
- Small, deciduous tree with flexible stems
- Big, almost circular leaves with doubly serrate edges
- Leaves are velvety with small hairs
- Nuts are edible—ripe in the fall
- Prefers partial sun and well-drained soils

Huckleberry
*Vaccinium ovatum*
See also *V. parvifolium, V. membranaceum*
- Shrub that grows anywhere between 2ft and 10ft tall
- Has dark, shiny green leaves that are lance-shaped and serrated
- Flowers are pale-pink and urn-shaped
- Edible berries are dark blue to black (*V. parvifolium* are bright red)
- Prefers partial shade, moist but well-drained soil, and a slightly acidic soil
Nootka Rose
*Rosa nutkana*
- Serrate, oval leaves
- Big pink flowers that bloom in midsummer
- Straight thorns on branches
- Edible rose-hips that ripen in late summer and early fall

Oregon Grape, tall and short
*Mahonia nervosa, Mahonia aquifolium/
Berberis nervosa, Berberis aquifolium*
- Leaves are prickly, stiff, and opposite
- Bright yellow flowers bloom in spring
- Edible, dusty blue berries ripen in late spring and throughout the summer
- Short reaches between 2-3ft tall, while Tall can grow up to 10ft tall
- Short Oregon Grape: shady, dry soils
- Tall Oregon Grape: sunny dry soils

Salmonberry
*Rubus spectabilis*
- Spreading shrub with weak thorns
- Compound leaves have three leaflets with butterfly shape
- Leaf undersides covered in white hairs
- Pink flowers bloom in early spring
- Edible berries ripen in late spring/early summer
- Prefers mostly shade and moist soils
Thimbleberry  
*Rubus parviflorus*
- 3-8ft tall shrub with large, maple-shaped, velvety leaves
- Big, 5-petaled white flowers bloom in spring and early summer
- Fruit is bright red and raspberry-like, ripening in early to mid-summer
- Prefers moist soil and little sunshine

Salal  
*Gaultheria shallon*
- Dense evergreen shrub around 4ft tall
- Leathery, medium-sized leaves are glossy and bright green; shaped like a lemon
- Urn-shaped pink flowers bloom in spring and early summer
- Edible berries ripen in mid-to late summer
- Prefers full sun to mostly sunny conditions with moist soil

Other Resources:
Books:
- Pacific Northwest Foraging, by Douglas Deur
- Edible Wild Plants: A North American Field Guide to Over 200 Natural Foods, By Thomas Elias and Peter Dykeman
- Gardening for Sustainability, by John J. Albers

Websites:
- USDA plants database: http://plants.usda.gov/
- Pacific Northwest plants database, Washington State University: http://pnwplants.wsu.edu/

Nursery e-mail: ser nursery@gmail.com
Douglas Fir Tip Syrup

Recipe by Hank Shaw: http://honest-food.net/

This syrup should be kept in the fridge, where it should last about 4 months.
Makes 1 pint.

Prep Time: 5 minutes
Cook Time: 5 minutes, plus several hours of passive steeping time
Ingredients:
  2 cups water
  2 cups sugar
  2 cups fir or spruce tips, chopped
  1-2 tablespoons lemon juice (optional)

Instructions:

Bring the sugar and water to a boil in a lidded pot, stirring to make sure all the sugar is absorbed.
When it hits a boil, turn off the heat. Stir in the fir tips, cover the pot and leave to cool. The longer you steep the syrup, the stronger spruce flavor you’ll get. I let it steep overnight.
Strain the syrup through cheesecloth, add lemon juice (if using) to taste and bottle.
Appendix C: Public Education Curriculum, Pollinator Pathways

Pollinator Pathways: Native plants to grow to benefit native pollinators
Taught Monday, November 21st, 2016, 6:30-8:00PM

Essential Question(s)
1. What are some native plants that are good for native pollinators that can be incorporated into home landscapes/gardens?
2. What considerations should one take into account when designing a pollinator-focused garden?

Teacher’s goals
1. To introduce adult students to several native plant species that can be incorporated into their gardens to support native pollinators.
2. To emphasize the different aspects of creating a “pollinator patch” that can support pollinators year-round.
3. To show the need for pollinator forage in the face of habitat loss for many native pollinators.

Materials (May Vary):
1. Cuttings or pots of all the plants being taught that night, preferably including leaf, flower, and stem/bark of each example
   a. Ribes sanguineum
   b. Solidago canadensis
   c. Arctostaphylos uva-ursi
   d. Acer circinatum
   e. Symphoricarpos albus
2. PowerPoint Lecture & projector/computer to show it with
3. Extra pencils & paper for students
4. Copies for all the handouts (enough for each attendee)
   a. Pollinators Handout
   b. PDF printout of PowerPoint lecture
   c. Class exit survey
   d. Game rules sheet (1 copy, for instructor)
5. Game supplies:
   a. Cloth for head-bands (to mark who are the “flowers”)
   b. Foam football
<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Assessment Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to...</td>
<td></td>
</tr>
<tr>
<td>1.) Understand how the survival of native plants and native pollinators are related</td>
<td>1.) De-brief after the game will allow instructor to ask questions about how native pollinators and native plants are connected, and why that connection is ever-more important in an urbanized area</td>
</tr>
<tr>
<td>2.) Recognize some native plants that are good for native pollinators and understand how and where to grow them</td>
<td>2.) Post-class survey will question students if they feel like the class helped them grow in their knowledge of Puget Sound native edible species</td>
</tr>
</tbody>
</table>

**Schedule Overview and Approximate Times**

<table>
<thead>
<tr>
<th>Time (PM)</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:30-6:45</td>
<td>Names, Introductions, and Overview of SER-UW Nursery; include overview of how the rest of the night’s class will go.</td>
</tr>
<tr>
<td>6:45-7:30</td>
<td>Game! Introduce the topic with the pollinator game. Explain the game, then follow the rule sheet to play the game. Judge the feeling in the room to determine how many rounds of the game to play. Allow time for transition to and from classroom to get to a space where you can get in a big circle and toss the football around.</td>
</tr>
<tr>
<td>7:30-7:55</td>
<td>PowerPoint lecture going over the native species chosen for the class. Allow time for questions at the end.</td>
</tr>
<tr>
<td>7:55-8:00</td>
<td>Closing: Plug for next class in January, and ask for people to fill out class survey before they leave.</td>
</tr>
</tbody>
</table>

**References for this Lesson:**


[http://pollinator.org/PDFs/Guides/PacificLowlandrx9FINAL.pdf](http://pollinator.org/PDFs/Guides/PacificLowlandrx9FINAL.pdf)


Xerces Society for Invertebrate Conservation. Pollinator-Friendly Plant Lists.

Pollinator Game Rules
Game should take 20-30 minutes

1. Everyone stand in a circle
2. The ball is the 'bee’ that will be tossed around the circle; the bee has to be tossed and cannot be passed to the person right next to you.
3. Ask for 5-10 volunteers to be ‘flowers’—they get the headbands. The bee has to visit a flower every other toss in order to maintain enough food energy to continue to live.
4. Practice round: Toss the ball across the circle for 1 minute, visiting a flower every other toss. If you can do it for 1 minute, the bee survives and lays eggs for the next year!
5. Round 2: But bees can’t just bounce around flower to flower without obstacles. Ask for a volunteer to be a predator; the predator will stand in the middle of the circle and try to knock the bee out of the air. See if you can get the bee to survive for 1 minute.
6. Round 3: But then bees also face more challenges, like urbanization. Add another person in the middle of the circle who represents “urbanization” as an obstacle; decrease the flowers by 1, because urbanization also means there are fewer flowers. Can you survive 1 minute?
7. Round 4: Add one (or two) more person (people) as an obstacle, this time representing pesticides and herbicides that we use for agriculture. Decrease the flowers by 1 because agriculture means only one crop grown for large areas of land, decreasing a diversity of flowers. Can you survive 1 minute (30 seconds if it’s been challenging so far)?
8. Round 5, final round: We’ve come to mid-fall of the year, and many flowers are done, decreasing the food available to insects. Take away all but one flower, but leave the “obstacle” people in the middle of the circle. Can the bee survive for 30 seconds?
9. Wrap up Game: Discuss the implications of how quickly the bee died the more obstacles the game set up.
Pollinator Pathways

The goal is to create a connected web of resources for pollinators. Cities are not traditionally designed to do that. Pollinators face many challenges.

Want to learn more?
5 Native Plant Species for Pollinators
Creating a Pollinator-Friendly Patch
Pollinator Background Information
Defining Pollinator Pathways

And Some Native Plants to Use

Overiew
Designing a native pollinator patch

- Pick something you like, local
- Pick plants that will work with your pollinator and provide nectar
- Look for flowers that are easy to grow and easy to maintain
- Choose plants that attract butterflies and bees
- Provide shelter for pollinators

Challenges to Pollinator Facilitation

- Competition for non-native plants
- Disease
- Climate change
- Pesticides
- Urbanization: habitat loss

Pollinators: Background Information

- Bees need a wide range of nectar and pollen types
- Bees and other insects often only live a single season, from spring to fall
- Life cycle: needs both pollen and nectar to lay eggs and live a long time
- Shelter: Every pollinator has different shelter requirements

Pollinators: Background Information

- Hummingbirds--only four species for Washington
- Hummingbirds: Calliope, Calliope Hummingbird, Calliope Hummingbird, Calliope Hummingbird
- Sandia Hummingbird, Calliope Hummingbird
- Arizona Hummingbird, Calliope Hummingbird
- Black-chinned Hummingbird, Archilochus
Native Plants for Pollinators

Pacific Northwest

Pollinator Handout: Brochure, Side A
Pollinator Handout: Brochure, Side B

**Arctostaphylos uva-ursi**
- **Growth requirements:** Grows best in full sun or mostly sunny conditions with dry soil; grows as a low, creeping shrub. 
- **Size:** Less than a foot tall. 
- **Blooms:** March-April.
- **Attracts:** Bees, some butterflies.

**Acer circinatum**
- **Growth requirements:** Grows best in shade or partial shade with moist soil; grows as an open-branching small tree. 
- **Size:** 10-26 ft tall. 
- **Blooms:** March-June.
- **Attracts:** Bees.

**Symphoricarpos albus**
- **Growth requirements:** Medium-height shrub best in partial sun with moist to dry soil. 
- **Size:** 3-6 ft tall. 
- **Blooms:** May-August.
- **Attracts:** Bees, hummingbirds.
Appendix D: Public Education Curriculum, Understory Native Plants

Understory Native Plants
Taught Monday, January 23rd, 2017, 6:30-8:00PM

Essential Question(s)
1. What are some common understory native plants to plant in shady backyards?
2. Why is it important to include native plants in landscaping?
3. What do these plants need to grow successfully?

Teacher’s goals
1. To introduce adult students to several native, understory plant species that can be grown in our yards to increase urban plant diversity and to replace common non-native plants that are grown in shady places.
2. Teach the necessity of following legal gathering practices, especially for hard-to-find bulbs of rarer species.
3. Teach how to grow and care for these native species and what growing conditions work best for each.

Materials (May Vary):
1. Physical examples of plants with a root ball (ferns good for this), rhizomes (maianthemum or bleeding heart), bulbs , and seeds. Use what the nursery has at hand, just to show students examples of each.
2. 3 healthy understory plants to raffle off at the end of the evening
3. PowerPoint Lecture & projector/computer to show it with
4. Copies for all the handouts (enough for each attendee)
   a. Printout of the PowerPoint
   b. Pencils
   c. “Honorable Mentions” handout with other understory species not covered in the PowerPoint lecture
   d. Class exit survey

<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Assessment Evidence</th>
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</thead>
<tbody>
<tr>
<td>Students will be able to...</td>
<td>1.) Hands-on examination of different root/bulb types will allow students to explore understory plant types &amp; how they grow and can be propagated</td>
</tr>
<tr>
<td>1.) Name and know how to care for some of the Puget Sound’s native understory plant species</td>
<td>2.) Post-class survey will question students if they feel like the class helped them grow in their knowledge of Puget Sound native edible species</td>
</tr>
<tr>
<td>2.) Understand why using native species is beneficial to the urban ecosystem</td>
<td></td>
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</tbody>
</table>


Schedule Overview and Approximate Times:

6:30PM - 6:40PM  Names, Introductions, and Overview of SER-UW Nursery; include overview of how the rest of the night’s class will go.

6:40PM-7:00PM  Introduction to native understory plants; let students look at maianthemum and bleeding heart roots/rhizomes, 1 pot per table. Have seeds, underground rhizomes, root balls, and bulbs to look at (Lillium colombianum, maianthemum rhizomes, dicentra formosa rhizomes, fern root balls, seeds from seed cooler). Demonstrate how to carefully pop the plants out of their pots so students can look at different root/rhizome/bulb structures. Have students observe other group’s examples, too.

7:00PM-7:40PM  PowerPoint lecture going over the native species chosen for the class. Allow time for questions at the end.

7:40PM - 7:50PM  Have students talk in groups about what native understory plants they grow, if any; list out all the native understory plants they currently grow in their gardens, one list per table. What from the lecture do they want to start trying to add?

7:50PM-8:00PM  Plant raffle tickets, wrap-up, and fill out surveys.

References for this Lesson:


<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer circinatum</td>
<td>Vine Maple</td>
</tr>
<tr>
<td>Adiantum aleuticum</td>
<td>Maidenhair Fern</td>
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<tr>
<td>Aruncus dioicus</td>
<td>Goatsbeard</td>
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<tr>
<td>Asarum caudatum</td>
<td>Wild Ginger</td>
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<tr>
<td>Athyrium filix-femina</td>
<td>Lady Fern</td>
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<tr>
<td>Berberis Nervosa</td>
<td>Low or Dull Oregon Grape</td>
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<tr>
<td>Blechnum spicant</td>
<td>Deer Fern</td>
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<tr>
<td>Boykinia occidentalis</td>
<td>Slender Boykinia</td>
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<tr>
<td>Brodiaea congesta</td>
<td>Harvest Lily</td>
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<tr>
<td>Carex obnupta</td>
<td>Slough sedge</td>
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<tr>
<td>Corylus cornuta</td>
<td>Beaked Hazelnut</td>
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<tr>
<td>Dicentra Formosa</td>
<td>Bleeding Heart</td>
</tr>
<tr>
<td>Dryopteris expansa</td>
<td>Wood fern</td>
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<tr>
<td>Fragaria chiloensis</td>
<td>Coastal Strawberry</td>
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<tr>
<td>Lilium columbianum</td>
<td>Tiger Lily</td>
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<tr>
<td>Maianthemum stellatum</td>
<td>Starflowered False Solomon’s Seal</td>
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<tr>
<td>Oemlaria cerasiformis</td>
<td>Indian plum</td>
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<tr>
<td>Penstemon fruticosus</td>
<td>Bush penstemon</td>
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<tr>
<td>Polystichum munitum</td>
<td>Sword Fern</td>
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<tr>
<td>Potentilla gracilis</td>
<td>Slender cinquefoil</td>
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<tr>
<td>Pteridium aquilinum</td>
<td>Bracken Fern</td>
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<tr>
<td>Rubus parviflorus</td>
<td>Thimbleberry</td>
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<tr>
<td>Rubus spectabilis</td>
<td>Salmonberry</td>
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<tr>
<td>Rubus ursinus</td>
<td>Trailing Blackberry</td>
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<tr>
<td>Tellima grandiflora</td>
<td>Fringe cup</td>
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<tr>
<td>Tiarella trifoliate</td>
<td>Foamflower</td>
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<tr>
<td>Tolmiea menziesii</td>
<td>Piggy-back Plant</td>
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<tr>
<td>Trientalis latifolia</td>
<td>Broad-leaved Starflower</td>
</tr>
<tr>
<td>Vaccinium ovatum</td>
<td>Evergreen Huckleberry</td>
</tr>
<tr>
<td>Viola glabella</td>
<td>Stream Violet</td>
</tr>
</tbody>
</table>
Propagation of Native Plants

- Cuttings should be 2-4 inches long
- Make sure the rhizomes are several inches long and both root cuttings and rhizomes
- Root cuttings or rhizome divisions should be taken when the plant is dormant
- Divide spring-blooming plants in the fall and fall-blooming plants in the spring
- Exuberant, bulky growth will begin with these big enough to divide

Division:

- Some plants need more root than others
- Spring is the best time to divide
- Native seed sometimes need stratification or scarification
- Sow seed, when easier to find seeds than live plants or some species

Sun-Loving Plants vs. Shade-Loving Plants

- Determine the needs of your garden, you can greatly
- Plant you want to include in a smaller, stickier leaves
- Sun-loving plants tend to have
- Combine more dot骊ophyllum than with more succulent leaves
- Have broader, thinner leaves
- Shade-loving plants tend to

Native Plants

- Research Resources
- Sources for Plants
- Some Understory Species
- Propagation of Native Plants
- Understory Plants vs. Sun-Loving Plants

Overview
False Solomon’s Seal
Trillium ovatum
- Perennial, herbaceous
- Bright red berries after flowering
- Propagate by seed & division
- Height: 4-6 feet
- Prefers moist, well-drained soil

Western Trillium
Trillium ovatum
- Slow-growing, prefers moist but well-drained, nutrient-rich soil
- Height: 4-6 inches
- Prefers partial shade

White Fawn Lily
Erythronium oregonum
- Perennial, herbaceous
- Bright white flowers
- Propagate by seed or division
- Height: 2-3 inches

Broad-leaved Shooting Star
Dodecatheon hendersonii
- Perennial, herbaceous
- Bright purple flowers
- Propagate by seed or division
- Height: 1-2 feet
Resources

(some) Sources for these plants:

1. Plant These Perennials, spectacular on windy slopes and bluffs
2. These Perennials, spectacular on windy slopes and bluffs

False Lily of the Valley

Wood Sorrel
Appendix E: Public Education Curriculum, Native Plant Identification

Native Plant Identification 101
Taught Monday, April 17th, 2017, 6:30-8:00PM

Essential Question(s)
1. What traits do plants have that we can use to differentiate and identify them?
2. What are some common native plants to use both for landscaping/home gardening?
3. Why is it important to include native plants in landscaping?
4. What do these plants need to grow successfully?

Teacher’s goals
1. To introduce adult students to several native plant species that can be used for landscaping and to increase urban plant diversity.
2. Introduce how to recognize plant species using 3 or more identifiable features.

Materials (May Vary):
1. Cuttings or pots of all the plants being taught that night, preferably including leaf and stem/bark of each example, or the most identifying feature. Have an example for when teaching in the classroom, and have one to set out in the headhouse for the quiz/game after the class.
   a. Pseudotsuga menziesii
   b. Thuja plicata
   c. Vaccinium ovatum
   d. Vaccinium parvifolium
   e. Mahonia nervosa
   f. Mahonia aquifolium
   g. Ribes sanguineum
   h. Rubus spectabilis
   i. Rubus parviflorus
   j. Gaultheria shallon
   k. Arctostaphylos uva-ursi
   l. Oemleria cerasiformis
   m. Symphoricarpos albus
   n. Sambucus racemosa
   o. Acer circinatum
   p. Lonicera involucrata
2. Identification game/quiz set-up after the slideshow in the headhouse
3. PowerPoint Lecture & projector/computer to show it with
4. Copies for all the handouts (enough for each attendee)
   a. PowerPoint printout
   b. Quiz paper
   c. Quiz answer sheet (for instructor and copies for students after quiz)
   d. Class exit survey
<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Assessment Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to...</td>
<td>1.) Quiz: in pairs, students will be able to correctly identify the species they just learned</td>
</tr>
<tr>
<td>1.) Reliably identify some of Washington’s native plant species</td>
<td>2.) Post-class survey will question students if they feel like the class helped them grow in their knowledge</td>
</tr>
<tr>
<td>2.) Know what features to use to identify plants</td>
<td></td>
</tr>
</tbody>
</table>

**Schedule Overview and Approximate Times**

6:30PM-6:40PM  
Introductions and Overview of SER-UW Nursery; include overview of how the rest of the night’s class will go.

6:40PM-7:30PM  
PowerPoint show with cuttings or potted plants from the nursery for real examples as we go over each species. Ask for questions to be held to the end.

7:30-7:35PM  
Split class into two groups: people who feel comfortable with a lot of the information we went over (maybe they have previous experience with the plants we learned), and people who feel as though a lot of the species are new to them. Have them line up in two lines, then pair them up with someone from the other group.

7:35PM-7:50PM  
Quiz: In the headhouse, you should have the 16 plants laid out on tables, nicely spaced, and numbered. Students have 15 minutes to go around and identify all 16 of them as best they can, in their pairs. They get an answer sheet at the end, when they’re done.

7:50-8:00PM  
Closing: Plug for next class in May, and Spring plant sale. Ask for people to fill out class survey before they leave.

**References for this Lesson:**

Plants Database, United States Department of Agriculture. Natural Resources Conservation Center. [https://plants.usda.gov/](https://plants.usda.gov/).

Some Plant Identification Terms

- Simple Leaves: Leaves that are single and entire.
- Compound Leaves: Leaves that are divided into smaller leaflets.
- Alternate: Leaves that are arranged in a single file on the stem.
- Opposite: Leaves that are arranged in two rows on the stem.
- Palmate or Pinnate: Leaves with a central axis from which leaflets radiate.
- Sessile: Leaves that are directly attached to the stem without a petiole.
- Stipulate: Leaves with small leaf-like structures at the base.

Overview

- Quiz
- Resources to follow up on
- 16 plant species native to Washington state

Native Plant Identification 101

16 of Washington State’s Common Native Plants

Native Plant Nursery
**Acer circinatum**  
*Vine Maple*

- Prefers shady spots
- Thrives in well-drained soil
- Leaves emerge early, but decline in summer to reveal
- Green, oval-shaped leaves
- Flowers small, greenish
- Male flowers yellowish-green
- Female flowers red

**Thuja plicata**  
*Western Red Cedar*

- Conditions with nutrient-rich soil
- Grows best in shady areas
- Prefers red-brown, moist
- Needs open space
- Leaves are shed like any other cone, grey-white
- Lengths 30 ft (more than 150 ft)
- Large, evergreen conifer tree

**Pseudotsuga menziesii**  
*Douglas Fir*

- Thrives in well-drained soil
- Grows conditions with moist but
- Does not tolerate in overly wet
- Cones have drooping tips
- Bark is grey-brown
- Leaves are needle-like, dark green
- Male flowers yellowish-green
- Female flowers red
- Lengths vary from 200-300 ft

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**Other helpful things to keep in mind**

- What are other species this plant could be? What are ways I can tell two?
- Where is the plant growing?
Tall Oregon grape--Berberis aquifolium

- Thrives in low nutrient soils.
- Well-drained soil can survive
- Partial shade conditions and
- nursery-grown plants thrive in
- full sun, too.
- Prefers sunny slopes that drain
- quickly. Seedlings are self-sown.
- Leaves are opposite and palmate.
- Flowers yellow and bloom in April.
- Spreads through underground
- rhizomes.
- Small shrub with holly-like leaves.

Small Oregon grape--Berberis nervosa

- Prefers sandy areas with moist
- soil. Tolerates drier conditions.
- Flowers yellow and bloom in April.
- Spreads through underground
- rhizomes.
- Small shrub with holly-like leaves.

Red huckleberry--Vaccinium parvifolium

- Prefers moist, sunny conditions
- that thrive in shady to
- medium-shade conditions.
- Flowers white and bloom in May.
- Leaves are opposite and palmate.
- Flowers bloom in late spring.
- Leaves are oval, and yet
- evergreen
- Berries can get as large as
- 1.4 inches.
- Young leaves are red and
- shiny.

Evergreen huckleberry--

- Prefers moist soil and
- well-drained soil that is
- dark in the fall.
- Blooms in late spring.
- Flowers are pink and
- matted with hairy, red
- bristles.
- Leaves are small, oval, and
- evergreen.
-Bushy shrubs can get up to 7
- feet tall.
**Snowberry—Symphoricarpos albus**

- Open-branched, thin-leaved shrubs, to 10 ft. tall (more common - 4 ft tall)
- White, tubular flowers in clusters
- Pink or white berries
- Prefers full sun to partial shade
- Attracts hummingbirds, butterflies
- Hummingbird-friendly

**Kinnikinnick—Arctostaphylos uva-ursi**

- Low, spreading shrub, to 1 ft. tall
- Small, evergreen, elliptical leaves
- White to pink flowers in spring
- Berries in summer
- Grows in well-drained soils
- Attracts birds

**Red Elderberry—Sambucus racemosa**

- Small, shrubby tree, to 20 ft. tall
- White to light purple flowers
- Dark purple or black berries
- Grows best in full sun to partial shade
- Attracts hummingbirds, butterflies

**Indian Plum—Oemleria cerasiformis**

- Small, shrubby tree, to 20 ft. tall
- White flowers in spring
- Red berries in summer
- Grows best in full sun to partial shade
- Attracts birds

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*Image credits:*
- Snowberry—Symphoricarpos albus: [Image credit](source)
- Kinnikinnick—Arctostaphylos uva-ursi: [Image credit](source)
- Red Elderberry—Sambucus racemosa: [Image credit](source)
- Indian Plum—Oemleria cerasiformis: [Image credit](source)
Resources

Thomas Elias and Peter Dykeman

Edible Wild Plants: A North American Field Guide to Over 200 Natural Foods, by
Douglas Der

Plants of the Pacific Northwest, by Mark Turek

Wildflowers of the Pacific Northwest, by Mark Turek

Trees and Shrubs of the Pacific Northwest, by Mark Turek

Elizabeth C. Miller Library: http://digitalcollections.audible너다

USDA Plants Database: http://plants.usda.gov


Lonicera involucrata


Good for hummingbirds

Grows in partial shade and mostly sunny

Flowers

with petals of moisturer

Leaves

delicious-looking

Plants

blooming now in parts

Tall, open branches, thin stems, red-tipped leaves
<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Identification Clues</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>2.</td>
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<td>16.</td>
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</tbody>
</table>
Quiz Answer Key!

1. Red Huckleberry  
   *Vaccinium Parvifolium*

2. Salmonberry  
   *Rubus spectabilis*

3. Douglas Fir  
   *Pseudotsuga menziesii*

4. Low or Dull Oregon Grape  
   *Mahonia nervosa* or *Berberis nervosa*

5. Salal  
   *Gaultheria shallon*

6. Vine Maple  
   *Acer circinatum*

7. Western Red Cedar  
   *Thuja plicata*

8. Red Flowering Currant  
   *Ribes sanguineum*

9. Evergreen Huckleberry  
   *Vaccinium ovatum*

10. Tall Oregon Grape  
    *Mahonia aquifolium*, or *Berberis aquifolium*

11. Red Elderberry  
    *Sambucus racemosa*

12. Kinnikinnick  
    *Arctostaphylos uva-ursi*

13. Twinberry  
    *Lonicera involucrata*

14. Indian Plum  
    *Oemleria cerasiformis*

15. Thimbleberry  
    *Rubus parviflorus*

16. Snowberry  
    *Symphoricarpos albus*

*Don’t forget to fill out a survey before you go! Thank-you!*
Appendix F: Public Education Curriculum, Seeds and Art

Seeds, Seedlings, and Art
Taught Monday, May 15th, 2017, 6:30-8:00PM

Essential Question(s)
1. How do seeds develop?
2. What makes native plant seeds different from more common agricultural and ornamental plant seeds?
3. What do seeds need to germinate successfully?

Teacher’s goals
1. To introduce adult students to seed anatomy, development, and how native seeds differ from the agricultural seeds most people are more familiar with.
2. To give students a chance to interact closely with seeds and seedlings, using art as a medium for observation.

Materials (May Vary):
1. 20-25 seedlings in cone-tainers! Whatever species are available in the nursery.
2. Examples of seeds: 3 or 4 native species, chosen for variety of shape & size
3. Watercolor sets (class limited to 20 students; encourage students to share)
4. 20 Plastic paint palettes
5. Plastic pipettes
6. Plastic cups for water
7. Hot-press watercolor paper
8. 20 watercolor paintbrushes
9. Pencils, Ticonderoga #2
10. Books on plant art and seeds checked out from Miller Library
   a. Call #s:
      i. How to Draw and Paint Wildflowers, by Keith West: QK98.24.W48 1993
11. PowerPoint Lecture & projector/computer to show it with
12. Copies for all the handouts (enough for each attendee)
   a. PowerPoint printout
   b. Class exit survey
   c. Definitions sheet
<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Assessment Evidence</th>
</tr>
</thead>
</table>
| Students will be able to...  
1.) Identify the parts of a seed  
2.) Understand the stages of development of a seed to a germinant  
3.) Understand the basic steps to making a watercolor painting | 1.) Students will participate in painting seedlings at the end of class  
2.) Post-class survey will question students if they feel like the class helped them grow in their knowledge |

**Schedule Overview and Approximate Times**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:30PM-6:40PM</td>
<td>Introductions and Overview of SER-UW Nursery; include overview of how the rest of the night's class will go.</td>
</tr>
<tr>
<td>6:40PM-7:20PM</td>
<td>Give presentation on seeds and seed development. Include examples to hold up in class, like examples of native seeds, spores on a fern leaf, etc. Whatever is available to use as props. At the end of the presentation, give a quick demonstration of different types of watercolor washes.</td>
</tr>
<tr>
<td>7:20-7:30PM</td>
<td>Pass out paper &amp; pencils, then encourage people to draw outlines of their drawings with light pencil lines. While students are drawing, prepare palettes with paint &amp; fill cups with water.</td>
</tr>
<tr>
<td>7:30-7:50PM</td>
<td>Encourage students to move on to watercolor washes. Have them come and pick up a watercolor palette, paintbrush, and cup of water.</td>
</tr>
<tr>
<td>7:50-8:00PM</td>
<td>Closing: Plug for UWBG art classes! Fill out surveys, clean up.</td>
</tr>
</tbody>
</table>

**References for this Lesson:**


Seed & Seedling Definitions

1. **Angiosperm**—Flowering plant that produces seeds
2. **Gymnosperm**—Non-flowering plant that produces seeds (seeds develop without fruit), for example conifers. Usually seeds are fertilized through wind pollination.
3. **Dicotyledon/dicot**—Plant with two ‘seed-leaves’ or cotyledons
4. **Monocotyledon/monocot**—Plant with one ‘seed-leaf’ or cotyledon
5. **Stamen**—Male part of the flower, where pollen is produced; consists of anthers and filaments.
6. **Anther**—Tip of the male part of a flower, where pollen is produced and released
7. **Filament**—Stalk that anther is attached to, part of the stamen
8. **Carpel**—Female part of the flower, develops into the fruit; contains seeds. Made of the stigma, style, and ovary.
9. **Stigma**—Sticky tip to the carpel, where pollen lands and is captured
10. **Style**—Narrow tube in the carpel, transports pollen grains/sperm down to the ovary
11. **Ovary**—Protective case around seeds, part of the carpel. Develops into the fruit.
12. **Ovule**—Unfertilized female eggs, will develop into seeds when fertilized
13. **Pollen**—Fine powder, grains containing male gametes that will fertilize female ovules
14. **Seed**—A plant’s unit of reproduction, formed after the combination of a male gamete from pollen and a female ovule. Is typically made of an embryo, nutritious tissue, and seed coat.
15. **Embryo**—“Baby plant” inside the seed, containing the epicotyl, hypocotyl, and radical that will form the plant when it breaks from the seed coat.
16. **Nutritious tissue**—Tissue inside the seed that will provide food (carbohydrates, fats, or proteins) for the newly sprouted seedling until it can photosynthesize. Can be formed from several different types of tissue, including a tissue called endosperm (the most common).
17. **Seed coat**—Protective layer outside seed that helps keep embryo and nutritive tissue safe; also forms barrier to germination until broken.
18. **Epicotyl**—Part of the seed embryo, forming the growing tip of the plant with the plant’s first true leaves when the seed sprouts (placed “above” the cotyledons)
19. **Hypocotyl**—Part of the seed embryo, forming the connective tissue between the cotyledons and the radical (placed “below” the cotyledons)

20. **Cotyledon**—“Seed-leaves,” or embryonic leaves that contain nutritious tissue and can also sometimes photosynthesize when seed has sprouted. See Monocot and dicot definitions.

21. **Radical**—Part of the seed embryo; the first root. Usually sprouts first, before other parts of the embryo, to provide water and nutrition from the soil to the rest of the plant

22. **Dormancy**—A state in which a seed cannot sprout, even when placed in the right conditions. Dormancy is when the seed coat is still intact, and no moisture can get into the embryo to start the embryo’s growth.

23. **Scarification**—Physically breaking the seed coat and dormancy, either with heat, chemically, or mechanically (or a combination)

24. **Stratification**—Simulating natural weather conditions to break seed dormancy. For example, simulating winter conditions in the Pacific Northwest can mean placing seeds in a cold, moist environment for 90 days or so to emulate Seattle winters.
Seed-Bearing Plants

Background

Watercolor (a very brief overview)
Sprouting Seeds
Seed Dormancy
Native Seeds vs. Agricultural/ Horticultural Seeds
Parts of a Seed
Some background to plant reproduction

By Mary-Margaret Greene
SER-UW Nursery

Seeds, Seedlings, & Art

Native Plant Nursery
SER-UW
To Produce Seeds, You Need Pollination

Background: Seed-bearing Plants

Gymnosperms: "Naked Seeds"
Seeds are NOT enclosed in the carpel, but are often protected in a cone or "scales."

Angiosperms: "Encased Seeds"
Seeds are enclosed and protected in the "carpels," or the developed female part of the flower.

Parts of a Seed

Embryo, nutritious tissue, seed coat

Angiosperms: Further breakdown

Dicotyledons

Embryo (Baby Plant) - Baby plant, with it's "tunch" in a box

Monocotyledons

Seed coat (shell) - Protective cover over seed. Can be formed by various parts of the seed or fruit (e.g., nut)
Some plants need a combination of stratification and scarification—depends on the species.
- Seeds often need cold, moist stratification
- Weak-willed or short-lived plant
  - Seedlings below the soil to sprout
- Stratification takes time (the seed experiences variations of winter or summer
  - Varying moisture & temperature levels to break dormancy

**Stratification**

- Physical damage like weathering
- Chemicals like desiccation
- Heat in the seed-adapted ecosystems

Dormancy: The seed won't germinate even if it's in optimal conditions. You have to
- Break dormancy before it will germinate.

Native Seeds vs. Agricultural/Horticultural Seeds

...Consistent in size, germination time, growth rate, foliage...
- Easy to grow
- Easy to germinate

The main difference? We've bred agricultural and horticultural seeds to be easy:

**Dormancy**
Watercolor Paper

Art

References

Seeding is harder to keep &=material Empty until
After seeds are planted, keep least
optimal temperature and light need. Water air (oxygen)

Planbing & Sprouting

Thomas D. Lands

Nature Manual for Native Plants, by Karen L. Duntrosee, Fein Launa, and
Seeds in Ice: Seedbank and the Global Seed Vault, by Cary Power
The Triumph of Seeds, by Tor Hanso
Washes—Layers of water or paint

Pencil outlines

Making a Watercolor

1. Pencil outline
2. Washes
3. Detail work

Guidance: you want when you paint:

- Include as much or as little detail as you want—It depends on how much
- Use a fairly hard-erasable pencil
- Make your outlines very light but visible

Gradations between the two: Choose your style:

Two broad types of Watercolor—Loose and Precision—accurate and

Gradations between the two: Choose your style:

Two broad types of Watercolor—Loose and Precision—accurate and

Interested in more art direction?

Take a class. UVBC offers several art classes to learn Bobrinal Illustration.

Details

- Begin build layers of paint on top of one another to achieve depth
- Use very fine brush strokes
- Use more concentrated paint less watered down
Appendix G: Work Party Curriculum, Pot-washing

**Pests and Pathogens**

By: Emily O'Hare  
To be used for pot cleaning work parties  

**Essential Question(s):**  
1. Why do we sanitize our pots before reusing them?  
2. How do we sanitize our pots?  

**Teacher’s Goals:**  
1. Effectively teach the group the importance of washing and sanitizing pots  
2. Help people identify some different, common pests and pathogens, and how to treat them  

**Materials (May Vary):**  
1. Water  
2. Scrubbers  
3. Dirty Cone-tainers and Pots  
4. Wheelbarrows and/or Buckets  
5. Gloves  
6. Bleach  
7. Example of plant with pathogen or pest to show volunteers  

<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Assessment Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to...</td>
<td>Students will have...</td>
</tr>
<tr>
<td>1. Learn how to sanitize pots</td>
<td>1. Learned and used the process of washing and sanitizing pots</td>
</tr>
<tr>
<td>2. Recognize some different, common pests and pathogens</td>
<td>2. Been able to identify different pests and pathogens developing in the nursery, and identify the problems which they may cause</td>
</tr>
<tr>
<td>3. Understand why we wash and sanitize pots</td>
<td>3. Been able to identify different ways to treat common pests and pathogens</td>
</tr>
</tbody>
</table>

**15 Minute Mini Lesson:**

1. 1 minute: Introduce the nursery and the part it plays in SER-UW as well as how most of the plants are sold to student restoration projects in and around campus.  

2. 30 Seconds - Ask the group if they have heard of any pests or pathogens, or if they have had any experience treating them  

3. 2 Minutes - Go over what makes a pest or pathogen bad.
a. Pests can create various problems for plants!
   i. Ask: “Can anyone name some of the damages pests can cause to plants?” The most common answer will most likely be eating them, however pests can cause other types of damage as well. Pests can attract other insects, depending on what you want to happen in your nursery, this could be a good or bad thing. They can certainly eat the plant, which creates some stress on the plant trying to grow and thrive. With some pests, their fecal matter can also damage the plants. Pests can be found anywhere, in soil, on pots, and on plants.

b. Pathogens! A pathogen makes plants sick. It is identified as a bacterium, virus, or other microorganism that can cause disease. They can be found on plants, pots, and in soils.

c. What makes a plant susceptible to pathogens and pests? Air, Plants, Plant Debris, Water, and Infested Soil! Pathogens and pests can spread from all of these things. Air can carry spores of things like powdery mildew, which is very common in nurseries. Water can carry pathogens and pests a like, plant debris can become a moist home to pests and pathogens, and soil can come infested, or become infested and also serve as a home to pests and pathogens.

4. 30 Seconds - Pause and ask if anyone has any questions

5. 1 Minute - Have this prepared beforehand! Show the group an example pot with a pest or pathogen in it, point it out, and pass the pot around so that everyone can see what you are pointing too, elaborating on whatever that may be while it is being passed around

6. 30 Seconds - Pause and ask if anyone has any questions

7. 3 Minutes - Send the group around in partners to the hoophouse on a mission to find a pot with a pest/pathogen! With their partners, have them find a plant with a pest/pathogen and take some notes, a photo, or just remember what they see, on what seems to be wrong with the plant.

8. 2 Minutes - Once everyone has returned, depending on how many people you have, ask anyone if they want to share what pest or pathogen they found! Hopefully someone will pipe up, if not, feel free to “plant” an intern or volunteer who comes to work parties frequently and who knows to have an example ready to get some discussion going.

9. 1 Minute - Explain what we do to prevent pests and pathogens from spreading from pot to pot...we wash them! Making sure to include why it is so important that we wash out all of the dirt before bleaching the pots - because soil can carry pathogens to, pests and pathogens can cling to the sides of the pots and cone-tainers. Also, we wash pots and containers with scrubbers and warm water in buckets and
wheelbarrows first to avoid putting soil down the lab drain in the Headhouse.

10. 1 Minute--Have volunteers gather dirty pots from the dirty pot rack and carry them back to the DRC Headhouse.

11. 1 Minute - Back in the Douglas Research Observatory Head House - Have a group fill up buckets and wheelbarrows with water, and put all the dirty pots in one place. Once they have all filled up, gather around one pot/wheel barrow to do a demonstration.

12. 1 Minute - Ask an intern or frequent volunteer to demonstrate how to wash a pot or cone-tainer, making sure you highlight how thoroughly they are removing the dirt, and then placing the washed ones in a separate bucket. Explain that after that bucket of washed cone-tainers and pots is full, another person will take them to soak into the bleach solution

13. 1 Minute - Walk the group back outside to show them where the compost is, and explain why we dump the dirty water there instead of right outside - the soil will eventually build up on the pavement in front of the doors, and that’s no fun.

14. Have most everyone you can wash pots - either in a wheelbarrow or bucket. We have found that using wheelbarrows about half full of water to wash and buckets to hold the already washed is the best way to go about this.

15. Delegate one or two frequent volunteers, or interns help with the bleaching process, or you can do it, it’s up to you.

**How to Make Bleach Solution:**

1. **When handling bleach solution, wear rubber gloves!**
2. Fill the large or small sink up halfway with warm water
3. Pour in bleach; 5 dashes for large sink, 2.5 dashes for small sink
4. Continue to fill the sink up, making sure not to fill it to the top. Leave room for pots and cone-tainers so the water-bleach solution doesn’t overspill
5. Smell Check! Does the water smell like a chlorine pool? If so, you have the correct amount of bleach. Too strong? That’s probably okay. Not strong enough? Put another dash in and mix the water around.
6. Place all pots and cone-tainers into the water at the same time. Once they have all been submerged, start a timer for 10 minutes; that’s how long they need to stay in the bleach solution for.
7. Once the ten minutes is up, take them out and stack them on empty counter spaces to dry before putting them back into stacks to take out to the hoop house.
8. Repeat this process; the bleach solution may be reused for the entire time you are washing pots.
9. When finished, drain water and bleach down drain, making sure not to let any dirt go down the drain
10. Clean out excess dirt from sink, and rinse sink with warm water
Resources:

- Harmful Bugs:

- Sources of Diseases:

- Plant Disease Handbook: The Pacific Northwest:
  [https://pnwhandbooks.org/plantdisease](https://pnwhandbooks.org/plantdisease)
Appendix H: Work Party Curriculum, Up-potting or weeding

What a Plant Needs

By Mary-Margaret Greene
To be used for up-potting, weeding, or fertilizing work parties

Essential Question(s):
1. What do plants need in order to grow quickly and efficiently in a nursery setting?
2. What are some of the challenges nurseries face in providing plants with the resources they need to grow and be healthy?

Teacher’s Goals:
1. To connect plant needs to the day’s task: to show how plant needs are met in a nursery setting, and what tasks are required in order to maintain plants and their needs.

Materials (May Vary):
1. Example of root-bound plant, if available. (Up-potting lesson)
2. Example of plant with a lot of weeds in the pot, if available, or a variety of pots with various common weeds in them along with target plant (Weeding lesson)
3. Example of plant with nutrient deficiency, if available (Fertilizer lesson)
4. Clean pots (Up-potting lesson)
5. Dirty pots (for weeds)
6. Plants ready to up-pot (Up-potting lesson)
7. Soil/media mix (Up-potting and weeding lessons)
8. Plant tags & grease pencils (Up-potting lesson)
9. Pre-marked measuring spoons or cups for the right amount of fertilizer (Fertilizer lesson)
10. Example pot sizes (½ gallon, 1 gallon, 2-3 gallon, 5 gallon) (Fertilizer lesson)

<table>
<thead>
<tr>
<th>Program Objectives</th>
<th>Assessment Evidence</th>
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</thead>
<tbody>
<tr>
<td>Students will be able to...</td>
<td>Students will have...</td>
</tr>
<tr>
<td>1. Know all the things plants need to grow successfully</td>
<td>1. Completed some activity related to plant health, like up-potting, weeding, or fertilizing</td>
</tr>
<tr>
<td>2. Recognize some of the challenges nurseries face in growing healthy plants</td>
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15 Minute Mini Lesson:

1. 1 minute: Introduce the nursery and the part it plays in SER-UW as well as how most of the plants are sold to student restoration projects in and around campus.

2. 5 minutes: Ask volunteers what a plant needs in order to survive. Encourage answers--students can be very hesitant to participate and say something, so maybe
have a member of the nursery team in the circle ready to start everyone by answering and saying “sunlight.” Once one person participates, other students are more likely to participate.

a. Things a plant always needs: Sunlight, water, nutrients/food, soil/growing media, space to grow
b. Other things might include symbiotic plants, beneficial bacteria or fungus (mycorrhizae), moderate pH; you don’t need to mention these things specifically, but if students come up with these ideas, they’re not wrong--it’s just that these needs don’t apply to ALL plants.
c. It is likely that student volunteers will be able to come up with sunlight, water, nutrients, and soil, but they will likely forget “space to grow.” If they do, lead into the next step with saying, “There’s one more thing plants need--space to grow!”

3. No matter the activity you’re leading (up-potting, weeding, or fertilizing), you can talk about plants needing space:

If you are UPPOTTING:

4. 2 minutes: Explain that today we’re going to up-pot some plants. Ask students what they think up-potting means (someone should be able to figure out it means we’re taking plants in small pots and putting them into larger pots, but have member of nursery team answer question if no one else will). Ask why we would do that in the nursery--why not install the smaller plants into restoration sites, right from plug-size?

a. Answer: Some species, we do just that! But the smaller the plant/root mass of the plant, the less likely it is to get established in the site. To increase rate of success, we like to install bigger plants--1 gallon and up--to have a higher success rate. This means it can take a year or so to grow a plant from seed all the way up to installation size.

5. 2 minutes: Explain that these plants we’re up-potting today have filled their small containers with roots; if we leave them in this pot size, they’ll get root-bound and struggle to grow, maybe die. Ask students what they think “root-bound” means.

a. After a student or two answers/guesses, show them a root-bound plant as an example, if available. Show how the roots gather and twist at the base of the pot, because the plant is cramming all its roots downward in an effort to find more soil--but it’s blocked by the plastic of the pot. If we let a plant do this, it can be extremely difficult to out-plant it (the roots become very tough to tear apart and loosen for planting), and it may even die. Roots get stuck in a pattern when they grow--if you stick a root-bound plant in the ground without breaking up the roots, then the roots will stay basically in the exact same shape as the pot, because they’re used to growing that way. The plant will struggle to live, and will eventually die (particularly if there is a drought or some other stress on the plant).
6. 5+ minutes: In order to give these plants room to grow more and be ready to be used for restoration, we’re putting them in a bigger pot size. Demonstrate how to up-pot a plant by:
   a. Removing it gently from its smaller pot size, breaking up the roots, and carefully shaking the roots loose of the old soil
   b. In the bigger pot, put a little soil in the bottom of the pot
   c. Hold the plant in one hand in the big pot, centering it and making sure all the roots are pointing down (if roots aren’t pointing down when planted, they may not grow correctly later). If the roots are too long for the pot size you’ve chosen, you have two options: choose a bigger pot, or trim the roots with disinfected (99% alcohol solution) clippers. Some species respond well to root trimmings; some do not. Make sure you look up the species’ preferences before the work party.
   d. With your free hand, add soil all around the plant in the pot, making sure to evenly distribute the soil on all sides of the plant. After a while, you’ll put enough soil around the plant that you no longer have to support it with your hand.
   e. Gently tap the whole pot against a table, allowing the soil to settle. It’s better to let this tapping motion take care of tamping down the soil rather than pressing the soil with your hands; it is easy to compact the soil too much when you use your hands. Whatever part of the plant was underground before, make sure it’s underground now; similarly, whatever part of the plant was aboveground, make sure it’s still aboveground after you finish potting up the plant.
   f. After tapping the pot on a table, your plant often needs a little more soil after settling down; add soil as needed, leaving an inch or so of space between the surface of the soil and the rim of the pot. This is to leave space for water to sit and slowly drain down into the soil; it also leaves space for us to add a top dressing of fertilizer later.
   g. Once your plant is happily potted, add a plant tag with the appropriate scientific name or 4-letter code; include the day’s date on the other side so that managers will know when the plant was potted and they can estimate how long before they can sell it.
   h. Water in your plant! Watering in the plant helps increase the root-to-soil contact, which the roots need to grow well (the soil provides support, moisture, and nutrients). You don’t need to water each plant in individually— for efficiency’s sake, you can have students up-pot 20 or so and then water them all together.

If you are WEEDING:

4. 1 minute: Start this part after step 3 from above. Plants not only need space to grow, they need uncompetitive space. That is, we have certain plants we want to grow in the nursery, and in order to grow them well and quickly for restoration purposes, we have to keep them weeded so that the weeds don’t crowd out our
target species.

5. 2 minutes: Make a note here of what counts as a “weed.” A weed, in this context, is just a plant we’re not trying to grow on purpose. Many weeds can be native plants— an example is horsetail (Equisetum arvense or Equisetum telmateia), which is native to Washington, but is often considered a weed by gardeners and landscape designers because it’s such a pain to get rid of in wetter areas of land. Ask students whether or not they can think of any examples themselves.

6. 2 minutes: Show volunteers example pot[s] with weeds in them along with the target plant. Ask students how much they think those weeds are affecting the growth of the target plant. 10% reduction in growth? 20%? Let students throw out a few numbers. As long as they answer between 0% and 100%, they’re actually all right. It depends on the species of the target plant and the species of the weed. But, generally speaking, weeds decrease the growth and vigor of our target plants. Weeds also can provide extra habitat for insect pests, or they can weaken the target plant so that the target plant is more susceptible to insects and diseases.

7. 2 minutes: Today, we’ll be weeding our plants to give them more space to grow, and to increase their aesthetic appeal (this is especially important before plant sales--no one wants to buy a plant full of weeds).

8. 2 minutes: Using the examples you have, show students what common weeds look like and ask: What makes weeds particularly successful?
   a. Answers: Weeds are successful because they: reproduce quickly, either through large quantities of seeds or vegetatively by spreading through underground rhizomes, runners, etc.; they also often grow very quickly (and reproduce quickly); don’t require specific growing conditions, and are good at adapting anywhere.
   b. Students might come up with other answers--that’s fine! Encourage them to think about it. The key is that weeds grow fast, reproduce fast, and generally do better faster than many of the plants we’re actively trying to grow.

9. 2 minutes: Show students how to pull weeds out of the pot, pulling up the roots along with the aboveground growth. Sometimes using a lab spatula is helpful; sometimes, with big weeds, dumping the whole plant out of its pot so you can tease out the roots of the weed is helpful. Be careful with the target plant, but be brutal with the weeds! Students may ask if moss is a weed--yes, it’s a weed in this case. Moss isn’t a particularly bad weed, but we’re still going to remove it.

10. 1 minute: Use empty dirty pots to collect weeds and waste material; all of it will get composted. Often, removing weeds will remove a good deal of soil, too; do your best to keep the soil in the pot, but also have some extra soil on hand to refill the pot back to normal after the weeds have been removed. Get to weeding!
If you are FERTILIZING:

Note: This is a task best for more skilled volunteers-- regular volunteers, interns, or upper-level students (ESRM 412 in particular). Also, you don’t need a ton of people doing this--just 5-10. If you have extra volunteers, you can put them on weeding and include the weeding lesson in your introduction. It’ll be longer, but it’ll keep everybody busy!

4. 5 minutes: Start this part after step 3 from above, but instead of emphasizing space to grow, emphasize how plants need nutrients to grow. Ask students how, in a natural setting, nutrients form in the soil for plants to take up.
   a. Answers may include: natural compost from dying plant/animal material, broken down inorganic materials naturally occurring in the soil, nitrogen-fixing bacteria in the soil, beneficial microbes in the soil making nutrients available, manure from animals, etc. Encourage as many of these answers from volunteers as possible.
   b. In a nursery setting, we don’t have the natural cycle of nutrient production in all of our pots. So, how do we get nutrients into our soil? Answer: We add a small amount of compost to our soil that contributes a little nutrients, but for the most part we use a mix of organic and inorganic fertilizers (Fish & Poop, Maxicrop Liquid Kelp, and Osmocote). Osmocote is what you’re probably using that day--it’s not organic, but it’s really effective. It’s slow-release, which means we only have to apply fertilizer 2-3 times a year and it’ll slowly break down and feed the plants the whole time.

5. We have to be careful when applying fertilizer, because it is A.) expensive and B.) powerful stuff. Plants like food, but not too much food. Over-fertilizing can harm the plant just as much as under-fertilizing (also, again, it’s expensive--we can’t afford to waste fertilizer).

6. Pass out 5-10 pre-marked measuring spoons or containers. Clear plastic cups with a sharpie line on them work very well--you’ll need to do the calculations for how much Osmocote per 1 gallon container before the work party: application rates are on the bag and can also be found online if you search for “osmocote application rates” with the particular type of osmocote you’re using.

7. You’ll probably need to teach volunteers what a 1 gallon pot looks like vs. ½ gallon, 2-3 gallon, and 5 gallon pots (many times, people think the 1 gallon pots look like ½ gallons). Show them the difference in size and also have a reference table with all the sizes next to each other so that students can refer to that for reminders. You’ll need different amounts of fertilizer per container size, so either plan to only be fertilizing one pot size or assign different students with different pot sizes and appropriately marked measuring cups.

8. Get to fertilizing! Check on students and encourage them to take out weeds at the same time--you don’t want to fertilize weeds instead of your target plants!
Appendix I: Work Party Curriculum, Seed Sowing or Cleaning

Seed Anatomy and Development

By Mary-Margaret Greene
To be used for cleaning seeds, or sowing seeds work parties

Essential Question(s):
1. What are the components to a seed?
2. What steps are required to grow native plants from seed?

Teacher's Goals:
1. To introduce students to the basic anatomy of a seed.
2. To show students the steps the nursery takes to grow plants from seed.

Materials (May Vary):
1. 3 or 4 large-ish seeds cut in half for students to see (non-native is fine--just need to be large so students can see components to seed). Examples: Avocado, corn, horse chestnut, apple.
2. Seed diagram, attached (corn seed, bean seed)
3. Magnifying glasses (3-4)
4. Seed cleaning supplies, like sieves, bike tubes, etc. Can be borrowed from ESRM 412 supplies as long as they are cleaned and placed back where they belong in Jon Bakker’s lab. (Seed Cleaning)
5. Envelopes (Seed Cleaning)
6. Cone-tainers full of Sunshine #3 or other germinant media (Sowing Seeds)
7. Labels (Sowing Seeds)
8. Grease markers (Sowing Seeds)
9. Water (Sowing Seeds)
10. Small trays to hold prepped seeds (Sowing Seeds)
11. Tweezers & Lab Spatulas (Sowing Seeds)

<table>
<thead>
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<tbody>
<tr>
<td>Students will be able to...</td>
<td>Students will have...</td>
</tr>
<tr>
<td>1. Know basic seed anatomy</td>
<td>1. Participated in the short lesson by answering questions</td>
</tr>
<tr>
<td>2. Understand what stratification and scarification are</td>
<td>2. Planted, cleaned, or otherwise prepared native seeds as part of the process of growing plants from seed at the nursery</td>
</tr>
<tr>
<td>3. Understand what part of the seed-planting process they are participating in, and what other general steps are required to grow native plants from seed</td>
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</tr>
</tbody>
</table>
15 Minute Mini Lesson:

1. 1 minute: Introduce the nursery and the part it plays in SER-UW as well as how most of the plants are sold to student restoration projects in and around campus.

2. 1 minute: Explain that we'll be working with seeds today. The nursery grows at least a third of all its plants from seed, and it takes about 1-2 years to grow a plant from a seed to a 1-gallon sized plant that we can sell. Ask students if they've ever grown a plant from seed, and accept a couple responses from your volunteers (it's ok if “no” is the answer for everyone!).

3. 2 minutes: On a table next to you, have several large-ish seed examples, pre-cut in half, on display. If possible, have a few magnifying glasses as well if students are interested in looking closer at the seeds. Invite students to come closer to look at the seeds, or pass them around, while you move on to step 4.

4. 5 minutes: Using the diagram (attached), explain the 3 general components to a seed: The embryo, endosperm (or food storage), and the seed coat. A good metaphor to describe these parts of a seed is that the embryo is a baby plant, the endosperm is its lunch, and the seed coat is a protective box around the baby and lunch (this is from Thor Hanson’s book *The Triumph of Seeds*).
   
   a. The embryo, or the baby plant, has all of the components to start growing the plant; the first root, the first stem, and the first leaves are all crammed inside the embryo.
   
   b. The endosperm, or the lunch, is the food supply the seed contains to kickstart plant growth before the plant can photosynthesize and produce its own food. The endosperm is made of carbohydrates, fats, or proteins (or a combination of them). When we eat seeds in our own diets, it's the endosperm we're getting nutrients from--ask volunteers, "What seeds can you think of that we eat regularly in our own diet?"
      i. Some good examples: Wheat (grains in general), corn, peanuts, peas, beans, sunflower seeds, pecans, walnuts…
      ii. We eat all of those seeds for their 'lunch,' or the nutritious food source those seeds contain. Agricultural seeds like that have been bred over a long time to even increase the amount of “lunch” per seed.
   
   c. Finally, the seed coat is the "box," or the protective coat around the embryo and endosperm. This protective layer is meant to shield the embryo and endosperm from outside threats like predators, disease, fungi, and bad growing conditions. Ask students if they can think of some examples of protective seed coats?
      i. Some good examples: nut cases (although this is technically part of the “fruit,” many biologists include these structures as seed coats since that is the role they have evolved to fulfill), pumpkin seeds
5. 1 minute: Explain that seeds come in many variations, from size and shape to even the components that makes them up. Today, we’re working with native plant seeds, which are different from agricultural seeds in that humans have not spent generations breeding native plants to be uniform. Native plant seeds, therefore, have a lot more variation inside the species.

If you are CLEANING SEEDS:

6. 1 minute: Explain that today, we’re “cleaning” native seeds. Seeds usually develop inside fruit or other structures, to protect them from predators or sometimes (in the case of many fruits) to help with dispersal. Ask students, how might fruit structures help with seed dispersal?
   a. Some fruits are edible, so that animals eat them and disperse seeds through their feces (like Salmonberry or Thimbleberry fruits)
   b. Some fruits are evolved to have components that help the seed travel via the air or water, like cotton or dandelions.

7. 1 minute: In order to grow seeds in the nursery, we have to clean off the fruit or other protective structures around the seeds to plant them. Because native seeds are variable, and they’re not really commercially grown (only restoration workers tend to grow native plants in large numbers, and they’re still not growing them on very large scales), there’s not a very consistent or ‘official’ way to clean them. So, volunteers will have to use creativity and teamwork to clean seeds of fruit.

8. 3 minutes: Demonstrate cleaning a seed for students, using a method you like. Fleshy fruits should be crushed or broken up to reveal seeds, and then seeds should be cleaned. Dry fruits should be broken open and the seeds removed. The method of cleaning will change depending on fruit type and seed qualities. Make sure to show students what the seed looks like of each species they’ll be cleaning, so they can recognize it to clean and preserve it. Tell students, even though you used this method of cleaning, this is not the only way. Encourage them to try out different methods with the cleaning tools, but also make sure to say that they should be careful not to damage the actual seeds.

9. 1 minute: Show students envelopes. Explain that when students have sufficiently cleaned seeds, they should put the seeds in the envelopes organized by species.

10. 1 minute: Put students in groups of 2 or 3 to work together, then let them get started!

11. As students clean, you and the nursery team should move among volunteer groups to make sure they are doing a good job, not damaging the seeds, and not wasting seeds by inefficient cleaning.
If you are SOWING SEEDS:
Do steps 1-5, then jump to here and continue.

12. 1 minute: Explain that today, you will be sowing, or planting, seeds. These seeds have been prepared for sowing by a combination of cleaning them, scarifying them, and stratifying them, depending on the species. Scarifying is when the seed coat must be physically broken to allow moisture into the seed and the embryo to start growth; stratifying is when the seed must experience specific moisture and temperature conditions before it can sprout. We do both of those things at the nursery to prepare seeds for sowing.

13. 5 minutes: Demonstrate sowing seeds in a single cone-tainer.
   a. Explain that the cone-tainers are full of a media that is designed for germinating seeds.
   b. Using a lab spatula or tweezers, sow ~3 seeds in a single cone (more or less seeds can be sown based on the germination rate of the species you’re working with--check those numbers before the work party). Ask students, “Why am I putting more than one seed in this single cone-tainer?” The answer is that we can’t rely on 100% germination, and by placing multiple seeds in the cone, we’re helping to ensure that every cone will have at least one germinant. If all three sprout, we can either weed them out and let one seedling grow, OR remove the extra seedlings and place them into empty cells where no plants germinated, depending on our target number of plants.
   c. Explain that a general rule of thumb is to plant the seeds about twice as deep as they are wide, to make sure the seeds can sense light above. Some seeds are very, very tiny--in which case, they should just barely be covered by soil. Alternatively, you can use vermiculite as a thin layer over all seeds, if the material is available.
   d. Tell students to be careful and to find a method that helps them keep track of which cones they have sown with seeds--one method is to use a plant tag and move it into the cone you’re working on, so you never ‘lose your place’ as you’re planting.
   e. Emphasize that students should only plant the prescribed number of seeds per cone, and not to just take a pinch of seeds and drop them into the cone. It’s tempting to just take a small pinch of seeds, especially when they’re very tiny, but this method wastes seeds and makes it hard later if all of those seeds germinate--you can have twenty seedlings per cell, which is damaging to their development. Even though it can be a pain, be careful when sowing!
f. Make sure to label the tray of cells with the species name of the plant with a plant tag and grease marker. You only need 2 tags, one for each end-cell of planted cones.

g. Give each volunteer a small tray of seeds and a tag with the species name already written. Let them get started!

14. Double-check volunteer work, answering questions and helping them determine how deep to sow the seeds.

Resources:

- **For details on how to clean and sow seeds:**
  - Nursery Manual for Native Plants by Dumroese, Luna, and Landis: chapters 7 & 8 (pgs. 112-150); Available online at: [https://www.fs.fed.us/rm/pubs_other/wo_AgricHandbook730.pdf](https://www.fs.fed.us/rm/pubs_other/wo_AgricHandbook730.pdf)

- **For background on seed anatomy and development:**

- **Extra reading:**
  - The Triumph of Seeds, by Thor Hansen
In this case, the cotyledons (seed-leaves) were formed from the endosperm while the seed developed, so the endosperm has already been "eaten" and the endosperm now contains energy for the plant to use when it sprouts. The cotyledons now contain energy for the plant to use when it sprouts.
Appendix J: Work Party Curriculum, Collecting Seeds and Salvaging Plants

Seed Zones and Plant Provenances
By: Mary-Margaret Greene
To be used for salvage work parties or collecting cuttings/seeds

Essential Question(s):
1. Why do we try to collect seeds and salvage plants in the same transfer zone/provenance that the plants will be installed?

Teacher’s Goals:
1. To introduce volunteers to the concept of seed zones and plant provenances and why we try to collect plants and seeds in similar conditions to the ones they will be installed in.

Materials (May Vary):
1. Printed maps of seed transfer zones (attached)
2. Envelopes (for seed gathering)
3. Marker (for seed gathering)
4. Plant species target lists (for seed gathering and salvaging plants)
5. Burlap bags (for salvaging plants)
6. Shovels (for salvaging plants)

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<td>1. Understand why we gather seeds and plants in similar zones to the restoration sites we will plant them</td>
<td>1. Gathered native seed or salvaged native plants in the same zone where those plants/seeds will be installed for restoration.</td>
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<tr>
<td>2. Understand how plants are best adapted to the zones they have grown in and parent plants have grown in.</td>
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15 Minute Mini Lesson:

1. 1 minute: Introduce the nursery and the part it plays in SER-UW as well as how most of the plants are sold to student restoration projects in and around campus.
2. 5 minutes: Explain that we’ll be gathering seeds/salvaging plants today. When we gather seeds or salvage plants that will go into restoration sites in and around campus, we try to stay within the same seed transfer zone or plant provenance.
   a. Ask volunteers, do they know what a seed transfer zone is or a plant provenance? If no one answers, invite them to guess, based on what it
sounds like. Have at least a couple students give an answer, whether it’s a
guess or not.

b. A seed transfer zone or a plant provenance is the area in which a seed or
plant is adapted to thrive. These areas are generally defined by elevation,
temperature, humidity, annual rain, and other environmental conditions.
Even within a species, plant populations adapt over time to their specific
environments. A species might exist over all of the state of Washington, but
in different parts of the state, subpopulations of that species will be better-
adapted to the various microclimates in which they grow. With that in mind,
gathering seeds and salvaging plants from certain zones means that those
seeds or plants should be planted in similar zones to ensure that they thrive.

c. So, when we gather seeds or salvage plants, we try to salvage within the
same zone that most of our restoration sites are, to increase the likelihood
that the seeds and plants will thrive in the restoration site.

3. 5 minutes: Show students the seed transfer zone maps and the map of general
transfer zones in Washington (attached to this lesson—make copies before the work
party).

a. Pass the seed transfer zone maps out to them, having 2 or 3 students share
each one. Also hand out the copies of the seed transfer guidelines for
students to skim (also attached to this lesson—make copies before the work
party).

b. Have volunteers look at the maps, then swap with other groups so that they
can look at maps for different species. In their groups, encourage them to
discuss the differences between the maps and the species. The idea is to
show them how different species have different seed zones; encourage them
to look at the general seed transfer zone map and compare to the species-
specific ones.

c. Have volunteers skim the guidelines for seed transfer. What patterns do they
notice? (If they need encouragement, you can tell them to look at how
different ways zones affect plants’ adaptive qualities)

d. Ask volunteers, “Would it be really bad if we grew a plant from the wrong
transfer zone or provenance?”

i. The genes that determine the fitness of a plant are very complex, and
so it’s not necessarily a bad thing to move a plant to a microclimate
it’s not from. That plant won’t absolutely struggle to survive. For
example, we do that all the time when we’re trying to repopulate
areas with a specific species, particularly with endangered species.

ii. Ask volunteers if they can think of an example of when people do
transfer species to different zones that they’re not necessarily
perfectly suited.

1. Wolves! Or any endangered species recovery project.

2. As for plants, whenever we grow plants for ornamental
reasons, most people don’t bother to check to see if that plant
was from the same zone.

iii. But when we have the option—we try to stay in the same transfer zone
or provenance.
4. Get started salvaging plants or gathering seeds!

For Gathering Seeds:

5. Have target species and teach volunteers how to recognize those species and what the fruit/seeds look like.
6. We work to not take more than 30% of an individual plant’s fruit/seeds, and no more than 10% of a population’s overall seed in order to make sure that we don’t over-harvest and damage the next generation of plants that will grow in that site.
7. Partner volunteers so that a more experienced volunteer (like a member of the nursery team) is partnered with a less experienced volunteer. Give each team an envelope and have them write the name of the species they're gathering on it, the date, and the location of where you’re collecting from.
8. Get started gathering seed! Make yourself available to help identify plants or answer other questions.

For Salvaging Plants:

9. To salvage plants, explain to volunteers that they should try to preserve as much of the root systems as possible. Don’t worry too much about getting all the soil off—we actually want a little moist soil to keep the roots somewhat protected.
10. Show volunteers how to identify native plants that you are hoping to find and target during the salvage event.
11. Demonstrate digging up a salvage plant and storing it in the burlap bag. Explain that when the burlap bag is full, volunteers can store it in the vehicle/truck you came in and get a new burlap bag.
12. Let volunteers get started! Check on volunteers throughout the salvage to make sure they’re confident about identifying the native species you’re targeting.
General Seed Transfer Guidelines for Washington

1. These guidelines only apply when planting on sites where the species naturally occurs within the seed zones.

2. Seed mixes should include seed from a number of different random locations within the tree seed zone and elevation band. If seed mixes are comprised of collections made only at one edge of a zone or only at one limit of an elevation band, a safe transfer might be about half a band width (either geographic distance or elevation). Usually, this restriction would be more important for elevational and longitudinal transfers than for latitudinal transfers (Frank Sorensen, personal communication, March 1995).

3. Seed transfer to a higher elevation usually increases the risk of maladaptation; in other words, the potential for climatic damage. A transfer to a lower elevation will probably decrease productivity and may increase the risk associated with pest damage. If wood production is important and geographically localized collections are made, seed should probably not be transferred down to another elevation band.

4. Except for areas right along the coast, elevation does not have as great an influence as longitude for species on the west side of the Cascades. Latitude has less influence on seed transfer than longitude (Campbell and Sugano 1993, Campbell 1986, Sorensen 1983, and Campbell 1992).

5. Local populations are generally well adapted to local environments and are the safest to use until the best adapted, or better growing sources can be identified with data from long-term provenance tests (Namkoong 1969). This is particularly true for areas where large changes in the environment can occur over short distances, such as the islands in Puget Sound.

6. A seedling’s response to its planting environment is significantly influenced by its parents’ location (Campbell 1992).

7. Seed transfer zones should generally be smaller at high elevation than at low elevation (Campbell and Sorensen 1978). The size of seed transfer zones should decrease as site severity increases (Adams and Campbell 1982, Sorensen 1979). Therefore, less seed movement is possible at higher elevation Cascade sites. The steeper the genetic gradient and the harsher the planting site involved, the greater the risk of seed transfer (Adams and Campbell 1982). High elevations and harsh climates dictate that seed must be planted fairly close to its origin. However, close to the ocean at low elevation, seed movement becomes much less restrictive. The coastal climate permits most seed sources to survive, but those from harsher environments will grow much less than those from favorable environments which are better able to utilize the site potential.

8. When planting a species near its biological limits, a higher planting density is recommended and early thinning should be delayed to compensate for higher than normal mortality due to fewer seedlings being genetically adapted (Campbell 1975 and 1987). Shorter rotations would also reduce risk.
9. Risk of maladaptation is greatly increased when transferring seed across more than one environmental condition, for example, when transfer is from west to east and also from lower to higher elevation (Adams and Campbell 1982).

10. At both the geographic and elevational limits of a species distribution, natural regeneration should be strongly encouraged (Frank Sorensen, personal communication, March 1995).

11. If ownership or management would benefit by floating the zone boundaries north or south, that usually can be done. Sorensen (1994) stresses that seed zone boundaries do not represent abrupt breaks between populations that have large genetic differences. Instead, zone shapes are chosen to minimize the risk of transfer within their boundaries. The same applies for elevation (i.e. a 1000-foot band can be between 1700 and 2700 feet as well as between 2000 and 3000 feet if the former fits the species distribution or land ownership better) with the exception that the bands at higher elevation are often narrower.

12. Local conditions can also affect vigor. If wood production is important and there is a known area within a tree seed zone where growth rates are unusually slow, seed from that area should not be planted on more productive sites even if they are within the same zone and elevation. For example, throughout western Oregon there are many local areas on the east side of high ridges that receive less precipitation than the general area (i.e. they are in a rain shadow). Tree growth in these areas will be less than the growth in the surrounding area and transferring seed from these areas to those with more precipitation may result in reduced growth. This may also be true for the San Juan Islands and the islands in Puget Sound where changes in climate can be abrupt.

13. Relative humidity may be important; for example, transferring seed from a warm, dry area to a cool, moist area may increase the incidence of foliar disease (Nelsen et al. 1989).

14. Seed orchard seed is most safely used in the breeding zone of the parents or in the area where the parents have been tested (Campbell 1992).

15. The recommended number of seed parents in a seed lot ranges from 15 to 30. If there is equal representation from each seed parent, then the smaller number is suitable; if there is unequal representation, then the larger number is appropriate (Adams et al. 1992). Regardless of the number, the parents should represent a seed zone-wide mix. When specific information about the origin of the seed is maintained, single stand collections are acceptable. This gives the forester the flexibility of combining seed from multiple stands to create a seed zone-wide mix or using mathematical models to determine how far the seed from a single stand can be moved.

16. Small populations of a species separated from the main part of the range may be genetically unusual. If possible, the genetic composition of these populations should be protected by replanting them with seed collected from the isolated population. These populations can also be regenerated naturally. If these options are not practical, seed should be obtained from nearby portions of the main part of the range.

17. Seedlots should be labeled with the most specific information available on collection location and elevation. This will give foresters the most flexibility in using the seed.
Resources:

- For background on why seed transfer zones and plant provenances are important in growing native plants: http://www.nativetrees.org.uk/native-trees/why_plant_native_trees.php
Appendix K: Work Party Curriculum, Invasive Species Removal

Removing Invasive Plants - Himalayan Blackberry

By: Emily O'Hare
To be used for Blackberry Removal Work Parties

Essential Question(s):
1. Why are invasive plants more successful than native plants?
2. How can we prevent invasive plants from taking over native plants?

Teacher's Goals:
1. To introduce students to the impact that invasive plants have on the native plant population.
2. To bring forward ideas about why invasive plants spread so quickly and are so successful.

Materials (May Vary):
1. Gloves
2. Clippers
3. Shovels
4. Wheelbarrows
5. Encourage/remind volunteers to wear long pants, long sleeves, and sturdy shoes

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<td>2.) Be able to dig up invasive species and do a thorough check on the area to ensure the invasive species has been removed.</td>
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15 Minute Mini Lesson:
1. 1 minute: Introduce the nursery and the part it plays in SER-UW as well as how most of the plants are sold to student restoration projects in and around campus.

2. 1 Minute - Ask group if anyone can name a plant, native or non native, that really takes over an area of space and is hard to get rid of - if the invasive plant you are removing comes to topic, feel free to elaborate on that (see step 3)

3. 30 seconds - Bring up the invasive species you will be removing for this lesson, naming their common name and scientific name (Himalayan Blackberry, *Rubus armeniacus*)
4. 2 Minutes - Ask group if they have any suggestions as to why this plant is so successful; if really quiet, give an example try to come up with 2-4 reasons why this plant does better than native plants; you can identify them via whiteboard if available
   a. Some reasons you can come up with or students might come up with:
      i. It produces large amounts of fruits that birds eat, which are then spread in bird feces; seeds can be spread very far this way
      ii. The vines can put down roots at every node on the plant (show volunteers a node on a vine), which means small segments of the plant, if left on soil, can sprout roots and re-grow into whole plants.
      iii. It can grow in full sun as well in shady areas
      iv. It’s very fast-growing, sometimes growing several meters in a year
      v. The vines form dense, thorny bushes that make removal difficult, and also can rapidly shade out other plants

5. 1 Minute - Identify ways to get rid of invasive plants, ultimately coming to how you will be removing them today (physical removal, chemical removal, or biological removal). Go over the tools that we will be using and make sure that everyone knows how to use them.
   a. Physical removal: Going in with tools and physically removing the plant from the area. Effective, but time consuming, labor intensive, and sometimes leaves plant parts behind that resprout. Physical removal is what we always do with volunteers, as it doesn’t require them to work with chemicals.
   b. Chemical removal: Using herbicides to take out the unwanted species. Sometimes requires some physical removal, too, like cutting branches to apply an herbicidal paint. Effective, less labor intensive, but chemicals can be dangerous and require a permit to apply them. Also, as CUH is right on the edge of a swamp and other wetlands, we have to follow certain safety guidelines to keep chemicals out of the water.
   c. Biological removal: Grow competing native plants to out-compete or shade out the invasive. Doesn’t work too well with Himalayan Blackberry (since it can grow in shade to full sun, and just out competes everything anyways), but works with other invasives like reed canary grass, which has been partially shaded out of Yesler Swamp with native tree plantings.

6. 1 Minute - Ask the group if they have any ideas as to how invasive plants can be removed. Try to briefly go over each of those listed below. If no one has any suggestions, offer one of the following as an example:
   a. Hand Pulling/Hoeing : appropriate for cutting back blackberry, and for younger plants or seedlings
   b. Digging/Cutting : The removal of roots by first cutting back the blackberry, and digging down into the ground and working all of the roots out
   c. Mechanical Methods : using mechanized equipment to remove aboveground vegetation and upturn the soil, later returning to pull out resprouts from root crowns
d. Prescribed Burning: Large infested areas may be burned in order to remove the standing, mature plants. Pre-spraying of herbicides may be used to kill and desiccate the aboveground portion of the plants.

e. Prescribed Grazing: Bring in various animals to eat the blackberry. Some animals are known for digesting and destroying the seeds as they pass through the animal’s digestive tract, unlike birds, these animals are ideal. Some animals include goats and chickens.

f. General herbicide treatment: Using general herbicides

7. 2 Minutes & 30 Seconds - Go over how to remove himalayan blackberry.
   a. Step One: Introduce all of the tools that we will be using
      i. Shovel, placing it face down on the ground while not using
      ii. Leather Gloves, to wear
      iii. Clippers, how to hold them safely and how to properly use them
      iv. Hoe/Garden Fork, how to use if using, and how to use it safely, without whacking someone behind you
      v. Wheelbarrow, how we will be placing clippings and removed blackberry pieces into wheelbarrows.
      vi. Pause for questions
   b. Step Two: Clipping back the blackberry to about 3 ft tall of a stock, and removing any of the rest of the blackberry into the wheelbarrows
   c. Step Three: Begin digging around the base of the blackberry plant, being careful not to cut any of the roots that are there.
   d. Step Four: Take turns digging and pulling on the blackberry to get the plant out of the ground.
   e. Step Five: Find the main root ball of the blackberry you are removing, and pull all of that plus the roots it is stemming off, out of the ground
   f. Step Six: Once removed, shake excess dirt back into ground, being careful not to let any roots back into the ground.

8. 2 Minutes - Discuss some of the problems that people may face in removing this plant.
   a. Not being able to dig up all of the roots coming off of the root ball
      i. Ultimately, we do want to keep digging to try to get all of those roots out of the ground. If you do reach a point where you simply can not keep digging, whether they go too far down or you’ve hit a physical barrier, you can just chop off the root at the furthest point.
   b. Creating holes everywhere!
      i. Answer: try to fill holes that you make with excess dirt or grass clumps that you also dig up while trying to get the blackberry out
   c. Not sure where to start?
      i. Sometimes the blackberry clusters can look a bit intimidating! That’s okay, start with clipping them back, or looking for stubs that got missed on the open ground

9. 30 seconds - Pause and ask for any questions.
10. 3-5 Minutes - Example time! Show students over to an area where the invasive plants are growing, and pick one good, simple one to demonstrate the entire process with.
11. Let students get started!

Resources:

- **What is an Invasive Plant?**

- **Controlling Himalayan Blackberry in the PNW:**
  - [https://www.invasive.org/gist/moredocs/rubarm01.pdf](https://www.invasive.org/gist/moredocs/rubarm01.pdf)
Removing Invasive Plants - English Ivy & Irish Ivy

By Emily O’Hare
To be used for ivy removal work parties

Essential Question(s):
1. Why are invasive plants more successful than native plants?
2. How can we prevent invasive plants from taking over native plants?

Teacher’s Goals:
1. To introduce students to the impact that invasive plants have on the native plant population.
2. To bring forward ideas about why invasive plants spread so quickly and are so successful.

Materials (May Vary):
1. Gloves
2. Clippers
3. Shovels
4. Wheelbarrows
5. Encourage/remind volunteers to wear long pants, long sleeves, and sturdy shoes

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15 Minute Mini Lesson:

1. 1 minute: Introduce the nursery and the part it plays in SER-UW as well as how most of the plants are sold to student restoration projects in and around campus.

2. 1 Minute - Ask group if anyone can name a plant, native or non native, that really takes over an area of space and is hard to get rid of - if the invasive plant you are removing comes to topic, feel free to elaborate on that (see step 3)

3. 30 seconds - Bring up the invasive species you will be removing for this lesson, naming their common name and scientific name (English Ivy: Hedera helix, and Irish Ivy: Hedera hibernica)
4. 1 Minute - Ask group if they have any suggestions as to why this plant is so successful; if really quiet, give an example. (i.e. English Ivy creeps and covers, suffocates and twines itself around other trees and shrubs, putting extra weight and pressure on them, and denies them access to light; it is a fast spreading ivy) try to come up with 2-4 reasons why this plant does better than native plants; you can identify them via whiteboard if available.
   a. Some reasons you can come up with or students might come up with:
      i. It produces large amounts of fruits that birds eat, which are then spread in bird feces; seeds can be spread very far this way
      ii. The vines can put down roots at every node on the plant (show volunteers a node on a vine), which means small segments of the plant, if left on soil, can sprout roots and re-grow into whole plants.
      iii. It can grow in full sun to full shade
      iv. It can grow very rapidly
      v. It likes moist, nutrient-rich humus-y soil, just like the kind of soil we have here in the Pacific Northwest

5. 30 Seconds - Identify ways to get rid of invasive plants, ultimately coming to how you will be removing them today (physical removal, chemical removal, or biological removal).
   a. Physical removal: Going in with tools and physically removing the plant from the area. Effective, but time consuming, labor intensive, and sometimes leaves plant parts behind that resprout. Physical removal is what we always do with volunteers, as it doesn’t require them to work with chemicals.
   b. Chemical removal: Using herbicides to take out the unwanted species. Sometimes requires some physical removal, too, like cutting branches to apply an herbicidal paint. Effective, less labor intensive, but chemicals can be dangerous and require a permit to apply them. Also, as CUH is right on the edge of a swamp and other wetlands, we have to follow certain safety guidelines to keep chemicals out of the water.
   c. Biological removal: Grow competing native plants to out-compete or shade out the invasive. Doesn’t work too well with English Ivy (since it can grow in deep shade to full sun, and just grows over everything), but works with other invasives like reed canary grass, which has been partially shaded out of Yesler Swamp with native tree plantings.

6. 1 Minute - Go over the tools that we will be using and make sure that everyone knows how to use them.
   a. Clippers - How to hold them and how to place them on ground, and how to clip with them. Tools all have a dangerous side. Make sure the pointed blades at the end are always facing down when you are carrying the clippers from place to place. When putting clippers down onto ground, the cutting edge should be close to the ground, not on a slope up or propped up. The long handles are also a danger. Clippers should not be thrown or swung around in any ways. Make sure you have adequate room around you when
using tools, and make sure to look around you, keeping the sharp end pointed downwards, before moving around with the clippers. Please do not “horse around” with these extremely sharp tools.

b. Gloves - You should wear gloves when removing Ivy to protect your hands. Not only from the ivy, but also from any other surprises that could be waiting for you in the grass. The nursery will provide volunteers with gloves to use.

c. Small shovels - Shovels of any size have a sharp end. Just like with the clippers, they should never be swung around or left propped up with the sharp end up. Make sure to lay shovels flat on the ground, with the sharp end pointing into the ground, when not using shovel. Do not swing the shovels around or “horse around” with them. When moving around with a shovel, make sure the sharp end is always pointed towards the ground, not to the sky. Also, if using larger shovels, making sure to tell volunteers not to jump on them in order to push the shovel further into the ground. That can potentially break shovels, and it is important that we take good care of our tools.

7. 2 Minutes & 30 Seconds - Go over how to remove the invasive plant. For English Ivy, we start by cutting through the vine in a straight line, and creating a place for us to go in and life the ivy off the ground all at once (see GreenShortzDIY video in references). Then, we will go in and rake, and then go back and check for roots that we missed. Making sure to put the dug up plant parts into a wheelbarrow, so that we can dump them into the compost pile. Emphasize the importance of getting all the roots, and where to put the dug up plant parts once they are out of the ground.

8. 1 Minute - Discuss some of the problems that people may face in removing this plant. (i.e., not getting all of the roots up; missing a little vine that has just started to grow; not being able to get the entire thing of English Ivy off a tree). A good way to avoid these problems are by constantly doing quality checks, and making sure to get all of the roots out of one area before moving on (see tutorial in references on how to remove English Ivy from a tree).

9. 30 Seconds - Pause and ask if anyone has any questions

10. 4 Minutes - Example time! Show students over to an area where the invasive plants are growing, and pick one good one to demonstrate the entire process with.

11. Let students get started!
Resources:

• What is an Invasive Plant?

• English Ivy Removal Guide:

• Removing English Ivy from Trees:
  - http://www.fosc.org/EI-Removing.htm

• GreenShortzDIY Tutorial:
  - https://www.youtube.com/watch?v=h30C3YUhM98
Appendix L: Internship Curriculum

Week 1: Orientation

Essential Question(s)
1. What do interns need to know to get started?
2. How do we utilize the space we have at the Center for Urban Horticulture (CUH)?
3. Who all do we work alongside at CUH?

Manager’s goals
1. To introduce interns to the CUH area and where we work.
2. To give interns keys to get into the areas at CUH.
3. To fill out the ESRM 399 form (or other internship class credit form, depending on the student’s preference) and get it signed by Dr. Jon Bakker, our advisor.

Materials (May Vary):
1. CUH Key sets: We have keys that we have checked out with nursery money; interns can get a set by giving us a deposit of $20, which we hold on to for the duration of the quarter. At the end of the quarter, interns return their keys and the manager returns their deposit.
2. Key check out form: This form is kept in the envelope with the key sets. It is just to keep a record of who has the keys and when they have them.
3. Interns must bring $20 to check out a set of keys. Remind them to bring the money to the meeting in an e-mail.
4. Meeting set-up with Douglas Research Conservatory (DRC) greenhouse manager OR permission from greenhouse manager to give the tour (required to allow interns to have keys to the DRC)
5. Interns need to come to this first meeting with a FILLED OUT ESRM 399 FORM (or other form to get class credit). If Dr. Jon Bakker is available when you meet, have him sign the forms then; if not, have interns scan form and e-mail the form to him to sign.
   a. Link to ESRM 399 form:
      [http://www.sefs.washington.edu/academicPrograms/undergrad/ESRM399InternshipForm.pdf](http://www.sefs.washington.edu/academicPrograms/undergrad/ESRM399InternshipForm.pdf)

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<tr>
<td>1. Correctly water seeds, seedlings, and larger plants.</td>
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<tr>
<td>2. Be able to tell if a plant should be watered or not.</td>
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<tr>
<td>3. Correctly fertigate seedlings.</td>
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<tr>
<td>4. Understand why we use different fertilizers for different purposes.</td>
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Orientation

1. Arrange a meeting time with your interns where you meet them at the Center for Urban Horticulture. E-mail them a copy of the ESRM 399 form and ask them to fill it out before the meeting and bring it (http://www.sefs.washington.edu/academicPrograms/undergrad/ESRM399InternshipForm.pdf). Also request that your interns bring $20 to make a key deposit.

2. Take your interns on a tour of all of CUH to get them familiar with the area, where we store our supplies, and who we share the space with. If possible, reach out to the Douglas Research Conservatory’s greenhouse manager and arrange for him or her to give a tour of the DRC, reminding interns to keep the shared space clean and respect the materials and equipment.
   a. Include in the tour:
      i. The DRC, with the headhouse and the greenhouse zones. Show interns where the nursery has space inside the greenhouse, our cabinet in the headhouse, and the tool room off of the headhouse. If you have time, show interns the cooler where we keep our stratifying seeds.
      ii. The compound, with UWBG’s hoop houses and our own, as well as our outdoor holding area for plants
      iii. The shed that contains some of our supplies (we store our poly and shade cloth coverings here, for example)
      iv. The seed increase beds we take care of
      v. The tool cage attached to Merrill Hall

3. After the tour, have interns show you their filled out ESRM 399 forms and help them fill in the details if needed.

4. Go to Dr. Jon Bakker’s office to get their forms signed. If Dr. Bakker is unavailable, have interns scan their forms in the Miller Library and e-mail the forms to Dr. Bakker to sign. The forms need to be turned in ASAP to Anderson Hall, or interns will have to pay a late registration fee.

5. Have interns fill out the key form, place $20 in the envelope, and take a key set.
Week 2: Irrigation and Fertilizer

Essential Question(s)
1. Watering is an essential and constant part of plant care. What is the correct way to water plants? How do we monitor whether or not plants need to be watered? How do we use the irrigation system in combination with hand-watering?
2. How do we program the irrigation system? How do we determine the frequency and length of watering?
3. How and why do we fertilize seedlings and larger plants?

Manager’s goals
1. To introduce interns to how to water and fertilize the plants. These skills will be used throughout the quarter in constant plant care.

Materials (May Vary):
1. Examples of plant sizes, dry ones and well-watered ones for interns to compare: rack of cone-tainers, ½ gallon, 1 gallon, 2-3 gallon, 5 gallon, etc.
2. Adjustable watering head with mister setting
3. Fertilizer the nursery currently uses
4. Measuring tools for fertilizer (teaspoon, tablespoon, scale--whatever tool the fertilizer instructions asks you to use to measure the correct amount)
5. Watering can for fertigating the seedlings

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<td>8. Understand why we use different fertilizers for different purposes.</td>
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Basic Watering Skills
1. Have an 2 examples of every plant size the nursery grows, from a cone-tainer with a seedling to 5 gallon pot with a large plant in it; one example of each size should be well-watered, the other dried out (but not so you can see water-stress in the plant).

2. Ask interns to look (but not lift, yet) at the plant examples and talk about how much water they think each plant type will need.
   a. The larger the pot, obviously the more water it can hold and the longer it can take to really water through the pot. Ask interns how frequently they think plants should be watered at the nursery. After they give their answers, tell them that the nursery typically waters 3 times a week, and we aim to water...
thoroughly rather than water every day.

b. Explain that the watering frequency can depend on the weather. Ask interns, What kind of weather would mean we wouldn’t water as often? Why would we have to water more often?
   i. Answer: We water more often in the summer, when warmer temperatures mean higher rates of evaporation and the plants are actively growing and using water far more than in the winter.

3. Ideally, we don’t wait for plants to show water stress before realizing they need to be watered. Show the interns that you can pick up a pot or lift its corner to test its weight to see how well it’s watered. Invite them to lift the examples you’ve set out to let them feel the difference between a pot that needs water (should feel significantly lighter) and a pot that is well-watered. If possible, have a whole rack of cone-tainers that need water and a rack that was recently watered, so interns can feel the weight difference in a rack.

4. Show interns the irrigation system and the watering heads we use for spot irrigation. The main watering head used is the mister for the seedlings and newly planted seeds, and the shower head for everything else; ask interns why they should use the mister head on the seedlings and seeds
   a. Answer: the mister head puts out a gentler spray of water that will not blast seeds and seedlings out of their cones; the shower head has too high of water pressure to use.

5. Show interns some of the basics of how to program the irrigation system in the hoophouse and for the outside plants (Instruction manuals for these systems can be found in the Google Drive folder under SER-UW→ Nursery→ General Propagation Documents). They will likely not have to program this, but it can be useful for them to see the system we use and talk about why we have it on the settings we do. Use this time to explain that we aim to water less frequently, but thoroughly; a thorough watering means plants won’t dry out quickly. Watering too frequently can mean that plants stay too wet for too long, which can lead to pest problems and rot.

Some possible questions interns might ask, or possible avenues for conversation if you have the time to discuss:

a. Q: Is it possible to overwater the plants? How do we tell if we overwater?
   A: It is possible to overwater. Checking to see that the plants actually need water by learning to feel their weight can help us not water them when they don’t need it. Overwatering can lead to root rot as well as pests that thrive in very damp conditions.

b. Q: If we have an irrigation system, why do we need to spot-water?
   A: We have to check that the irrigation system is working. Also, during the winter, we turn the irrigation off to avoid freezing and bursting the pipes and irrigation lines, so we have to water by hand during that time. Plants do not dry out evenly on a table--the plants on the edges of the table, or the cone-
tainers on the edges of a flat, dry out faster because of higher air circulation and therefore higher water loss. So, plants on the edges of tables might need more frequent watering than plants in the center of tables and flats.

**Basic Fertilizing and Fertigating Skills**

1. Show the interns the types of fertilizer the nursery uses. Currently, the nursery uses Osmocote slow-release fertilizer on larger plants--½ gallons and up--and an organic, liquid fertilizer (Fish n’ Poop) on seedlings in 4” containers and under.

2. Have interns read the labels on each of the fertilizers, and talk about why the nursery uses two different fertilizers for different sized/aged plants. The slow-release fertilizer is good for applying ~2-3 times per year, rather than having to fertilize frequently (lowers time & labor), and the liquid fertilizer regularly feeds smaller plants that need to be grown quickly so they can be up-potted to larger pot sizes. The fertilizers also have different N-P-K balances for different stages in the plants’ growths.
   a. Ask interns what they know about N-P-K; knowledge will likely vary. Depending on their experience, explain that N-P-K is Nitrogen, Phosphorus, and Potassium, which are three major nutrients (“macronutrients”) that plants need to grow and be healthy. Plants also need “micronutrients,” or nutrients that are still necessary but are needed at a far lower concentration for healthy plant development.

3. After discussing the labels on the fertilizers, have interns work together to figure out how much slow-release Osmocote they would apply to a 1-gallon sized pot. Then have them calculate how much of the liquid Fish n’ Poop fertilizer they would need to add to our roughly 2 ½ gallon watering can. How precise do they feel they ought to be when measuring out fertilizer? (Hopefully, they already know they should be very precise, but if they don’t, explain that over-fertilizing is expensive and possibly damaging to plants).

4. Demonstrate fertigation with the liquid fertilizer on some seedlings.
   a. Ask interns why we don’t just pour a teaspoon or so of pure Fish n’ Poop on each seedling. Answer: the Fish n’ Poop is concentrated fertilizer, and would damage the plants at too-high concentrations.
Week 3: Soil

Essential Question(s)
1. How do we determine what soil mixes are best for different plants?
2. How can soil type affect a plant’s growth?

Manager’s goals
1. To introduce interns to the media types the nursery uses, why those media types were chosen, and how those media types affect plant growth. Interns with special interest in soils can perhaps do an experiment or further research on the topic with guidance from the manager.

Materials (May Vary):
1. Examples of types of media used at the Nursery: Pine bark mulch, Sunshine #s 3 and 4, compost, Cococoir, sand, etc.
2. Easy to sprout seeds (ex. Eriophyllum lanatum, Solidago canadensis, Cerastium arvense), pre-bubbled for ~24 hours
3. Water
4. Cone-tainers
5. Media for germinating seeds (Sunshine #3)

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<td>1. Interns will be required to use this knowledge to choose media types for work parties and possibly for research projects they take on.</td>
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<tr>
<td>1. Determine which media type we use at the nursery is best for several different purposes</td>
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<tr>
<td>2. Understand some common ways media can affect plant growth</td>
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Types of Media
1. Have examples of the types of media the nursery uses out for interns to see (pine bark mulch, compost, Sunshine #4, Sunshine #3, etc.). Ask interns: why might we use different soils for different purposes? If interns need prompting, ask them if they would use the same soil to plant seeds in as they would to plant larger, grown plants in. Why or why not? Note here that there is no specifically “right” answer--soil types vary widely, and we can’t always use the “best” soil for the job because the nursery can’t always afford the best materials.

2. After the above conversation, interns should understand that different soils are best for different tasks. For an example, discuss how we use Sunshine #3 and Cococoir to plant seeds, while using a mix of pine bark mulch and compost for bigger plants (we use pine bark mulch and compost in particular due to its cheap cost, ability to buy it in bulk, and its recommendation by other local plant nurseries).
3. Set up a small demonstration for them to monitor for the next few weeks. With some easy-to-sprout seeds (Eriophyllum lanatum, Solidago Canadensis, and Cerastium arvense are good species for this), have the interns (together, so this will be one group demonstration) take each soil the nursery uses and fill 5 cone-tainers per soil type. So, you should have 5 cone-tainers of cococoir, 5 cone-tainers of Sunshine #3, 5 cone-tainers of pine bark mulch, etc.

4. Plant 2-3 seeds (fine to use all one species) in each cone-tainer, making sure to tag the cones with the media type, species, and # of seeds sown per cell.

5. Have interns discuss which soil type will have the most germinants, and why.
   a. Which media do they think will have the best water retention? Seeds need to stay moist to germinate.
   b. How do they think the fine-ness of the soil will affect germination? (the pine bark mulch sometimes has large chunks that don't fit well in cone-tainers)
   c. What about nutrient levels in each soil type? Do any of the soil mixes have nutrients for sprouting plants? Does that matter for seeds germination? (No--seeds have their own food storage, and they only need fertilizing after the have sprouted)

6. Over the next couple weeks (the species mentioned above are fast sprouters, so should have sprouted within ~14 days of planting), have interns observe seedlings to see if their prediction for the 'best' soil type was correct. Note: this is a demonstration, not an experiment, but still try to exemplify best experimentation practices by labeling and monitoring carefully.

7. After two weeks, check on the seedlings as a group. Which media performed the best? Is it what the interns expected?

8. Discard empty cones that did not have germinants OR transplant extra seedlings from other cones into the empty ones, depending on the nursery’s need for those plants.
Week 4: Seeds

Essential Question(s)
1. How do native plant seeds differ from more commonly grown agricultural/horticultural plant seeds?
2. What are the methods the nursery uses to grow plants from seed?

Manager’s goals
1. To introduce interns to native seeds and how to encourage germination in native plants through scarification and stratification.

Materials (May Vary):
1. If you need a refresher on seed anatomy: http://www.cropsreview.com/parts-of-a-seed.html
2. Plant Growth Requirements spreadsheet, printed (can be found in the Google Drive here: SER-UW → Nursery → General Propagation Documents folder)
3. ~50-100 viable Eriophyllum lanatum seeds (ERLA), pre-soaked for about 24 hours with bubbler
4. Cone-tainer tray with cones
5. Sunshine #3 media
6. Tweezers & lab spatulas for planting seeds
7. Optional: Native seeds that have been scarified and need to go through stratification. If you don’t have any seeds that need to go through stratification at the time, then have examples of native seeds from several different species for interns to see and compare.

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<td>1. Interns will place ERLA seeds into stratification and, over the course of a month or so, will determine whether or not stratification is beneficial for ERLA</td>
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<td>1. Understand the basic anatomy of a seed</td>
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<td>2. Define and describe both scarification and stratification</td>
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<td>3. Understand and implement the methods the nursery uses to scarify and stratify seeds.</td>
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Seeds: Stratification and Scarification
1. Make sure interns are familiar with basic seed anatomy and review (or teach, for the first time, if interns have never learned it). Use the attached diagram to help review/teach it with them: seeds have an embryo (baby plant), food source (usually the endosperm, but the endosperm can be digested by the developing seed to produce cotyledons), and a protective layer called a seed coat.
2. Today, we’re going to focus on the seed coat and breaking something called “dormancy.” See if any of the interns are able to define dormancy (it’s ok if they can’t).
   a. Dormancy is the state a seed is in when it will not germinate, even if it’s in optimal growing conditions. This is because the seed coat is still protecting the embryo from outside influences, and the seed can’t tell it’s safe to sprout.
   b. You have to break dormancy before a seed can sprout. Different seed species have different dormancy requirements; for some species, the seeds don’t have any dormancy at all and can sprout almost immediately after being spread from the mother plant. An example is avocados, which evolved in a climate that is always warm and moist—the perfect germination conditions. They never have to wait for good conditions, because the conditions are fairly stable year-round.

3. We can break dormancy a couple of different ways—through scarification, stratification, or a combination of both.
   a. Scarification is physically breaking the seed coat to break dormancy, allowing moisture to reach the embryo and start germination.
   b. Stratification is using temperature and moisture levels to break dormancy. Some seeds need to experience a set of winter or summer conditions before they will sprout—this adaptation ensures that the seeds won’t germinate in the middle of winter and then die.
   c. Native plant seeds can have longer or more complex scarification and stratification requirements than agricultural seeds. Ask interns why they think that may be the case.
      i. Answer: Agricultural seeds have been bred for sometimes thousands of years, and we have bred a lot of their dormancy out of them to make growing them easier. Native seeds have not been put through the same artificial selection pressures, so are adapted to having a dormancy that suits their environment.

4. Scarification is something we can do at the nursery with a variety of different methods.
   a. The most common thing we do is soaking seeds in water with a bubbler. The bubbler rinses off chemicals the seed might have to keep it from germinating, cleans the seeds, provides oxygen in the water, and also simulates running water, a common way seeds are scarified in the wild. Show interns the bubbler you used to prepare the ERLA seeds.
   b. We also sometimes use hot, almost boiling, water to treat seeds like lupinus species. These plants evolved in prairie ecosystems and require fire, or high temperatures, to break their seed coat.
   c. We also sometimes use low-concentration acids, to mimic seeds passing through digestive tracts of animals.

5. Stratification is something we also do at the nursery by burying seeds in moist media and placing them in the cooler for a period of time to mimic winter conditions.
(cold, moist stratification is very common for native plants in the Pacific Northwest because those are our winter conditions).

a. We have a plastic box we call the “strat box.” The strat box has clean, moist peat moss, and we place seeds in mesh bags with a tag to identify their species and what date to take them out of stratification. Then, we place the whole box in the cooler for a period of time, checking on them intermittently to make sure they haven’t molded.

6. Scarification and stratification requirements are different for every species, and the way to figure them out is by researching what methods work best. Luckily for us, other people have done a lot of that research, and we can take their results and implement them. Show the interns the Plant Growth Requirements spreadsheet and have them look at the different species we grow and the variety of different scarification and stratification methods.

7. Today, we’re going to put seeds into stratification. Show the interns the *Eriophyllum lanatum* (ERLA) seeds. ERLA is a prairie species that we grow primarily for the prairie restoration out in the Union Bay Natural Area.

a. We’re using ERLA because it doesn’t necessarily need to be stratified—-it can sprout easily without stratification. However, some sources say that putting ERLA through 30-90 days of cold, moist stratification can increase germination, so we’re going to test it.

8. Count the ERLA seeds and divide in half.

a. Place half of the seeds into the plastic mesh square. Insert a plant tag with the species name and the date 30 days from now written on it. Close mesh with a rubber band, bury in the strat box, and place strat box into the cooler in the Douglas Research Conservatory.

b. Plant the other half of the seeds into cone-tainers with Sunshine #3 media, 2 per cell. Water in seeds.

9. Keep watering seeds. Have interns record germination rate of the seeds over the next two weeks or so.

10. After a month, take the other half of the ERLA seeds out of the cooler and plant them in cone-tainers with Sunshine #3 media. Have interns record germination rates over the following two weeks.

11. With interns, compare the germination rates. Did germination improve? Decline? Remain the same?

**If you have other seeds ready for stratification:**

12. You can also use this lesson to put other native seeds into stratification, too.

   Prepare the seeds by scarifying them and soaking with a bubbler based on their individual species needs. Then, have your interns look at the Plant Growth
Requirements chart to figure out how long the stratification should be, depending on the species. Have them write the removal date and the species code on a tag, then place the seeds and tag in a mesh square and close with a rubber band. Place seeds into the strat box and then into the cooler. On the nursery Google Calendar, have the interns make a note of when each species should be removed from the cooler.

13. It is likely that these seeds will need to be in stratification for a longer time than the interns will be at the nursery, so doing the ERLA exercise above is still beneficial.
**Week 5: Vegetative Propagation**

**Essential Question(s)**
1. What are the practices and protocols the nursery uses to vegetatively propagate plants?
2. How can we maximize efficiency and survival rate when we use vegetative propagation?

**Manager's goals**
1. Teach interns how to make cuttings using the methods the nursery favors.
2. Introduce interns to vegetative propagation.

**Materials (May Vary):**
1. Trimmings from native plants. These can often be obtained as leftovers from UW Grounds when they prune plants on campus--reach out to Grounds Crew at least a week or so ahead of time to see if they have anything available. Our current contact at UW Grounds for this is Tom Erler, terler@uw.edu.
2. Buckets of water, to hold trimmings in while working to reduce water loss in plants
3. Clippers
4. 99% Alcohol spray or bleach water (10% bleach) for sanitation
5. Cone-tainers, ½ gallon pots, or flat soil trays
6. Heating pad (available to borrow in Headhouse)
7. Extension cord
8. Soil--preferably Sunshine #3, Sunshine #4, or other fine media (*not* pinebark mulch)
9. Rooting hormone powder (Hormex)
10. Small tray/container to put rooting powder into

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| Interns will be able to... | 1. Interns will make cuttings under supervision of managers.  
2. Interns will be required to take care of cuttings through the end of the quarter and check for rooting at the end of the quarter. |
| 1. Take cuttings from larger trimmings of plants  
2. Correctly strike cuttings into soil using rooting hormone | |

**Taking Cuttings**
1. Prep work (have interns help to prep as needed):
   a. Keep the cuttings in buckets of water while working, particularly if making cuttings out of season (hardwood cuttings should normally be taken in dormant season, but that's not always possible depending on the quarter).
   b. Put a small amount of rooting hormone into the plastic tray--whatever is left in tray will be thrown away to avoid contamination with bulk of powder, so be sparing.
   c. Prep cone-tainers, half-gallons, or soil trays by filling them ~ ½ full of media
and moistening media with water
d. Place heating pad on the mist bench in Zone 1 of the greenhouse; use extension cord to plug it into the wall to start warming it up.

2. Introduce cuttings to interns as the main way the nursery does vegetative propagation. Ask them why we might use vegetative propagation when we grow most of our plants from seed.
   a. Encourage discussion. The main reasons the nursery uses vegetative propagation is to grow some plants faster than we can from seed and to take advantage of some of the leftover cuttings that UW Grounds often has. It’s also a way the nursery can simply grow more plants than we could otherwise, since the stock for the cuttings, when we get it from UW Grounds, is free.
   b. If you have time, encourage interns to think about the advantages and disadvantages of vegetative propagation vs. propagating from seed. Seeds provide more genetic diversity, but vegetative propagation tends to be faster (seeds need stratification and scarification as well as germination and growing time). More ideas on the differences can be found in the Nursery Manual for Native Plants (2008), by Dumroese, Luna, and Landis on page 154 (Link to the Manual: https://www.fs.fed.us/rm/pubs_other/wo_AgricHandbook730/wo_AgricHandbook727_177_199.pdf)

3. Show students the species you’ll be cutting. Are they hardwood (collected in winter), softwood (new growth collected in growing season), or semihardwood (cuttings taken just after the flush of growth, in late summer and early autumn)? Are they evergreen or deciduous? These questions can help you choose the best method of taking cuttings, although the following instructions can very generally work for all of them. Some species are easier to work with--some require specific cutting times and methods. Look up the species you’re working with and the recommended cutting instructions for that species.

4. Demonstrate a cutting:
   a. Explain to interns that we have to maintain the plant’s natural “polarity”--the root end of the plant has to go into the soil, while the part of the plant that grows upwards must be above the soil. In order to keep track of polarity, we at the nursery make a diagonal cut (~45° angle) with the clippers at the root-end of the plant and a flat cut at the top of the cutting.
   b. Cut a section that has ~5-6 buds on it. Make sure you make a diagonal cut at the base and a flat cut at the growing end. Optimally, your cutting will be about the width of a pencil, but this will be determined by the quality of your cutting stock. See diagram below.
c. Remove all of the leaves from your cutting. You want the plant to concentrate on growing roots, not leaves and flowers; the leaves also are an area where the plant can rapidly lose water. The plant is just pulling water up through its stem, and the leaves lose the water too rapidly for the plant to replace it without roots.

d. Gently, with a fingernail or very gently with the blade of a clipper, score the cutting at the base near the diagonal cut once or twice. This is just to remove a small amount of the bark to increase the contact of the cutting’s living tissue to the rooting hormones, to encourage more root growth. You aren’t skinning the cutting--just carefully scraping it a couple times.

e. Dip the angled end of the cutting (the “root” end) in the rooting hormone powder that you prepared in the plastic tray. Make sure to get the open area of the cuts--from the clippers and your fingernail--lightly coated with the hormone powder.

f. “Strike” the cutting, or place it in the prepared container. A cone-tainer can hold 1 cutting; a ½ gallon pot can hold ~3 or so cuttings. A flat of soil can hold varying amounts of cuttings, but be sure to give them space. Don’t shove the cutting into the soil, because that can scrape the layer of rooting hormone off; hold cutting on top of the soil you prepped, then add soil on top and around the cutting, tapping the container on the table to settle the soil in.
Three buds should go below the soil; two or three buds should be above the soil.

g. Water in cutting(s), making sure the three underground buds are covered neatly in soil. Note: if you’re doing a cone-tainer or soil flat, you can wait to water all of the cuttings in until you have filled a whole tray. If you’re just doing a ½ gallon, you can demonstrate 3 cuttings in the same pot and then water them in.

h. When ready, place the cuttings on the heating pad on the mist bench. Explain to the interns that because the cuttings don’t have any roots yet, they have to be kept in a high-humidity environment and watered frequently so they don’t dry out; the mist bench provides more frequent watering and higher humidity than we can by hand.

5. Let the interns try. Walk them through the process once, allowing for questions and feedback. One frequent mistake is scoring the cuttings too much in step “d” from above--people often want to really scrape up the bottom of the cutting, which is unnecessary. Encourage gentleness here.

6. Make cuttings until you reach target number of plants or you run out of stock material.

7. Record the number of cuttings made and tell interns that for the rest of the quarter, they must check in on the cuttings at least once a week to make sure they’re kept moist (the mist bench has been known to fail). Near the end of the quarter, we will check on the cuttings to see if they have rooted at all and record our % success.
Week 6: Plant diseases and pests

Essential Question(s)
1. What are some common pests that the nursery faces?
2. What is IPM, and how does the nursery use it to help manage pests and diseases?

Manager's goals
1. To teach interns how to examine plants for pests and diseases, as well as to check frequently for potential problems.
2. To show students how quickly a small pest/disease problem can explode into a large, unmanageable one.
3. To assign sections of the hoophouse to different members of the nursery team to monitor pests and diseases for the rest of the quarter.

Materials (May Vary):
1. Example of used sticky ‘pest card’ with plenty of insects on it to show interns
2. Sticky pest cards to post in hoophouse
3. Magnifying glasses (can be borrowed from Dr. Jon Bakker’s lab)
4. IPM Pest Guide (attached), made by past intern
5. Example of plant from hoophouse or greenhouse with some pest/disease problem, if available

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<thead>
<tr>
<th>Lesson Objectives</th>
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<tbody>
<tr>
<td>Interns will be able to...</td>
<td>1. Interns will name some methods we can implement at the nursery to catch pests and diseases early on.</td>
</tr>
<tr>
<td>1. Thoroughly examine a plant and know some key problems to look for when searching for pests and diseases.</td>
<td>2. Interns will be expected to help in frequent nursery examinations of plants as we ‘sweep’ the plants for problems.</td>
</tr>
<tr>
<td>2. Troubleshoot when they find a problem, consulting with manager to find solution to pest or disease</td>
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Pest Walkthrough
1. Explain to interns that the nursery practices IPM, or Integrated Pest Management. This means that, instead of broadcasting pesticides/fungicides on plants before we see a problem, we wait for a problem to start and try catch the problems early. As we get to know pests and diseases, we can focus on checking for problems we know are more likely, while also keeping an open mind and checking plants for abnormalities.

2. Show the students the used yellow pest card and tell them where it had been placed (ie, was it next to new seedlings? In the middle of older plants outside in the hoophouse?). Let interns look at card with the magnifying glass and try to identify them based on the quick-reference pest guide made by a past intern, Maxwell
Haenel (the species may or may not be present on the quick-reference; the idea is just to get the interns to look closely at the insects on the card). Use the card to explain that in order to practice good IPM, we have to be vigilant in looking for pests in the nursery. The cards can help us identify pests early, because the insects are attracted to the yellow card. The more dense the insects on the card, the more severe the problem.

3. Show interns the plant with the pest/disease problems. The nursery has had problems with thrips, aphids, and white powdery mildew, as well as other common problems. What is wrong with your plant example? Discuss with your interns what they might do about this particular pest problem by referencing the guide.

4. Explain that scouting in the nursery for these kinds of problems is a constant and very important task, and that from now on, they would be helping with this task. Show interns how to carefully inspect a plant, checking on the bottoms of leaves, looking closely at the soil, and looking for damage from insects on and under the leaves, on and around any flowers or fruit the plant has, and along the stems. Also let interns know that if they see a problem in the plant--like wilting, discoloration, etc.--but can’t find a source of the problem above the soil, they can check the roots by popping the plant carefully out of its pot to look for problems under the soil.

5. Now the interns (and you) will go to a table and practice scouting the plants on that table for potential problems.
   a. An option here is to pick a table that you know has a pest problem and use this as a kind of test to see if the interns are able to catch the problem. If they don’t catch it, show them how you caught the problem and let them try again on another table. This will allow you to coach them specifically on how to catch pest and disease problems early on.
   b. If you don’t have time to find a pest problem ahead of time, or you can’t find one at all, it’s fine to go to a table at random and simply walk them through the exercise of checking the plants for problems. They might catch something you didn’t!

6. To finish off the lesson, divide the hoop house into sections, with one roughly equally sized section per nursery team member. Tell the interns that this will be “their” section for the quarter--they will be responsible for checking it for pest and disease problems at least once a week. This is part of IPM and our attempt to keep on top of any problems we encounter. Show interns where to get yellow sticky cards (in the small shed inside the hoop house) to post in their section, and let them set it up with sticky cards to help them monitor. Let them know that they will be expected to do this on their own time and to keep track and report their findings every week in the nursery operations binder so that we can keep a good record of how we deal with problems.

7. Send interns to check their section (and place sticky cards) for the first time while you are there to help them if they have questions.
**Integrated Pest Management Protocols**

By: Max Haenel

This document is meant to help you identify and address different bug, fungus, and general pest issues that are common in the Puget Sound. Some of the Pests on this list we have encountered and treated previously and for those I have included our previous treatment methods and success; others we have not yet encountered but other nurseries in our area have, for those I have included treatment suggestions from outside sources.

**Powdery Mildew**

*What it is:* Powdery Mildew (PM) is a fungal disease (of which there are many species) that attacks the surface of plants, leaves and stems. It starts off as white spots that gradually grow until, in severe cases, the spots join and coat a plant's leaves making them look as if they've been dusted with flour. PM will slow plant growth, and if left unaddressed can kill plants. PM is species specific, and it's spores travel through the air.

*Treatment:* The best way to fight PM is to prevent it. It thrives in warm, moist conditions with poor circulation. It's important to keep your susceptible plants spaced well enough to allow airflow, and make sure their environment is not too wet. If your plants show signs of PM or if you are especially concerned about it we have had success with the following recipe: 1 Tsp Horticultural Oil, 1 Tsp baking soda, 1 drop dishwashing liquid, in 1 gallon of water. Mix the solution well and spray a thick coating on plant surfaces until water runs off. Apply once every 4-5 days. In our experience this solution has thinned PM within 2 applications, and kicked it completely after 4 applications. Certain species should be sprayed preventatively because they are especially prone to PM. These include: *Physocarpus capitatus, Rosa nutkana, Rosa pisocarpa, Rosa gymnocarpa, Ribes sanguineum, Acer circinatum, Rubus spectabilis, Holodiscus discolor,* and *Quercus garryana.*

**Whiteflies**

*What it is:* Whiteflies are small, winged insects named for the white wax that coats their bodies and wings (their bodies can be yellow to black in color under the wax). Whiteflies feed on plants by puncturing plant surfaces and sucking sap from them. Whiteflies can cause yellowing, drying, and loss of leaves, can cause
mold growth on leaf surfaces, and transmit viruses between plants.

*Treatment:* Their natural predators (such as lady beetles and lacewings) can effectively control their populations, but if the predators are inhibited by insecticides populations can explode. Once populations have grown, Whiteflies can be very hard to manage. Insecticidal soaps or oils, like neem oil, can be sprayed on plants to reduce populations. Sticky traps and reflective mulches have also been found useful in treating populations.

**Aphids**

*What it is:* Aphids are very small insects with soft pear-shaped bodies and long legs varying in colors of green, yellow, red, brown, and black depending upon species. Certain species can reach sexual maturity in 8 days and lay more than 10 eggs per day which means aphid populations can grow extremely rapidly. Though aphids seldom kill plants, they can slow and distort plant growth.

*Treatment:* There are many ways to treat aphids. If seen, aphids should be removed by hand, but this method is obviously not successful on large populations. Horticultural oil sprays can be sprayed on plant surfaces to kill aphids and their eggs, similarly soap solutions (such as Safer Soap) can be sprayed on plant surfaces where it will cause the aphids’ protective coating to break down, killing the aphids. Biological controls such as the Aphid Predatory Midge, Aphid Parasite, and Green Lacewing can also help reduce populations.

**Fungus Gnats**

*What it is:* With slender legs, dark bodies and long-segmented antennae Fungus Gnats look much like mosquitos. Though the adults do not cause any plant damage they do lay their eggs in moist organic materials where they hatch into larva that eat compost, fungi, and (most damaging to your plants) root hairs. Only dangerous in large numbers the larvae can cause severe damage to roots stunting plant growth or even killing plants. Signs of their damage are often mistaken for much more common root decay (caused by poor soil conditions).
**Treatment:** Populations can be monitored through the use of yellow sticky traps. If large numbers are seen a number of approaches can be used to reduce populations. One effective treatment method is the use of biological controls such as predatory nematodes or mites which feed off the Gnats reducing populations. Additionally you can reduce organic material and excess moisture which will decrease larval survival.

**Thrips**

*What it is:* Thrips are tiny black insects, of which there are a number of species, that feed by sucking the contents out of the outermost cells on leaf surfaces. They can lead to discoloration, and scarring of fruits, leaves, and flowers, and can also spread pathogens between plants.

*Treatment:* Since there are numerous species of Thrips there is no good way to deal with all of them and thus one must identify what species they're dealing with. One can do this by noting body appearance, behavior and the host plant. From there one can find predatory species or chemical controls specific to the Thrip causing damage.

**Rust Diseases**

*What it is:* Rusts are fungal diseases characterized by orange spore masses that can form on leaves, needles, and bark of infected plants causing them to defoliate, swell, become distorted or dwarfed, and even die.

*Treatment:* Clipping infected leaves and needles (and destroying clippings) can rapidly slow the spread of Rust diseases. If all affected areas can not be removed without causing damage to the plant you can also use fungicidal sprays to deal with this problem. Any leaves that fall naturally should be removed from the pot immediately to prevent further spread.
**Week 7: Heating and Cooling**

**Essential Question(s)**
1. How can we control the temperature in the hoophouse, particularly without electricity?
2. How do nurseries manage temperatures to optimize plant growth?

**Manager’s goals**
1. To teach interns about how the nursery can adjust the temperature in the hoophouse to optimize plant growth/development.
2. To introduce interns to different coverings for the hoophouse and why we use them.

**Materials (May Vary):**
1. Reading for interns:
   a. [http://www.homemadehints.com/greenhouse-covering-materials-comparison/](http://www.homemadehints.com/greenhouse-covering-materials-comparison/) This is an overview of different covering options for greenhouses/hoophouses
   b. [http://www.farmtek.com/farm/supplies/cat1a;ft_cooling_vent_heating.html](http://www.farmtek.com/farm/supplies/cat1a;ft_cooling_vent_heating.html) This is Farmtek’s website for different supplies that can be used for heating and cooling. Have interns explore this website to look at and become more familiar with the variety of materials and items.
2. Paper & pencils

<table>
<thead>
<tr>
<th>Lesson Objectives</th>
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</table>
| Interns will be able to... | 1. Interns will have to find examples of different ways we can control the environment in greenhouses and hoophouses  
2. If they are fall or spring interns, they will likely need to help in changing the covering on the hoophouse to match the season |
| 1. Understand why we change the covering on the hoophouse  
2. Understand how we use the hoophouse coverings to manipulate the inside temperature to our advantage | |

**Environmental Controls: Scavenger Hunt!**
1. Have interns read the readings mentioned in the Materials section to prepare them and make them start thinking how hoophouse and greenhouse coverings affect the environments we grow plants in.

2. Have interns go on a scavenger hunt together, looking at the different ways we manipulate the environment in the greenhouse and the outdoor hoophouses in the compound.
   a. They can explore the greenhouses that are part of the Douglas Research Conservatory and any of the hoophouses in the compound.
   b. They need to find 10 examples of people manipulating the temperature or other environmental conditions inside the greenhouses or hoophouses. Have
them try to get 10 examples, but they have to at least find 5.

c. Give them 30 minutes or so to search. They can work together as a team, but they have to go around together (no splitting up to find different ones). With a phone or camera, have them take a photo of each example so they can show you visually what they found.

3. After 30 minutes OR they find ten examples (whichever comes first), meet together in a group and have them show you their examples.
   a. Some examples may include:
      i. The cooling pads in the greenhouse
      ii. The fans in the greenhouse
      iii. The different coverings: Shade cloth, plastic, glass
      iv. The roll-up sides to the outdoor hoophouses that allow air flow below the benches
      v. The doors on the greenhouse that separate the zones and allow different temperatures for each zone
      vi. The plastic covering over the mist bench to encourage a higher humidity level
      vii. Heating pads in the mist bench or elsewhere to warm up plants
      viii. Anything else your interns are able to observe that affects the environment for growing plants!

4. Explain to the interns that out at our hoophouse, we don’t have electricity, so we have to rely mainly on the covering to provide heat or cool it off. We use plastic to insulate the hoophouse in the winter, and shade cloth to keep it cooler in the summer and allow for airflow. Depending on the season, the interns may end up helping you change out the covering (the fall interns will help put the plastic on the hoophouse, and the spring interns will help put the shade cloth on the hoophouse). We also have roll-up sides to the hoophouse to help increase airflow and control temperature that way as well (point this out especially if they didn't include it during their scavenger hunt).
Week 8: Plant Sales

Essential Question(s)
1. How do we determine if a plant is ready to be sold?

Manager’s goals
1. To teach interns how to determine the health and quality of our native plants and determine if they’re ready to be sold for restoration or retail purposes.

Materials (May Vary):
1. Examples of different plants at different stages of growth and health. Examples include:
   a. a plant with a lot of weeds in the pot
   b. a plant that has had trouble with pests or disease and is visibly distressed
   c. a severely rootbound plant, but does not show above-ground stress
   d. a healthy plant that is currently dry and needs water
   e. a plant that has recently been uppotted and has not fully filled its pot with roots (but otherwise looks very healthy)
   f. and a plant that is actually ready to be sold (i.e., it is fully established in its pot, has no pest or weed problems, is healthy, etc.)
2. A practice order to fill. Before the lesson, make up a fake plant order; include species and desired pot sizes, pretending you are a student buying plants for a restoration project. Alternatively, if you happen to have an order that needs to be filled, you can use that real order for this lesson. The order should be for at least 15 or so plants from a variety of species, just to make sure interns get enough practice.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Interns will be able to...</td>
<td>Interns will be expected to either put together at least one plant order for a student purchase OR help choose plants that are ready to sell at the plant sale (depending on quarter and timing, as plant sales are only during Spring and Fall quarters)</td>
</tr>
<tr>
<td>1. Judge when a plant is ready to sell based on if it is sufficiently rooted, disease and pest free, and otherwise healthy</td>
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When is a plant ready?
1. Have the examples of different plants for interns to review. These examples will be dependent on what the nursery has at the moment, but make sure to have as broad a range as possible and to include a healthy example that is “ready” to sell.

2. Have interns go over plants and determine together which plants they would feel comfortable selling to a customer right at that moment, with no work done on the plants.
   a. Depending on the interns’ choices, discuss why they chose the plant(s) they did.
b. Did they choose any of the plants that looked healthy, but actually aren’t ready to sell? For example, did they choose the plant that was recently up-potted and needs time to establish its roots? Did they choose the rootbound plant? Explore and discuss their choices and broaden what features they look at when determining a plant is ready to sell.

3. Explain to interns that we also price plants differently based on who we’re selling to and what time of year it is. For example, we often charge less in the fall at public plant sale for plants like Bleeding Heart (Dicentra formosa) and False Lily of the Valley (Maianthemum dilatatum) in the fall, when those plants are dormant. When they’re dormant, they look less impressive, and we sell them at a lower price; in the spring, when they are in full growth, we increase the price to match what they look like.

4. When we sell plants, we sell to students at wholesale prices (½ price) when they’re buying for restoration purposes. This is to encourage students to buy plants from us rather than other outside nurseries, but we also have to be careful to still charge enough to cover production costs. At public plant sales, we sell our plants at full retail price, determining the price of our plants by checking what other nurseries charge for the same species and size plants and also determining how much time and money it took for us to grow that plant.

5. Now that students have had a chance to see what kinds of problems we’re looking for when we’re determining what plants are ready to sell, they are going to fill your order (or the real one you happen to have!)

6. Have interns work together to fill the order, lining up the plants on a table or a designated area. After they’re done filling the order, inspect their work.
   a. Did they get the right number of plants?
   b. Did they get the right species?
   c. Are the plants they chose disease and pest free?
   d. Do the plants have healthy root systems?
   e. If interns made a mistake while filling the order, use it as an opportunity to explain what they missed and have them find a plant to replace the faulty one.
   f. If interns did a great job, then mission accomplished!

7. Let interns know that they will either be expected to fill a real order in the future or help choose plants that will be sold at a public plant sale.
**Week 9: Pot shape & size**

**Essential Question(s)**

1. How can you determine what the best pot shape and size is to grow a plant in?
2. What are the options in pot shapes and sizes, and which ones are feasible for the nursery?

**Manager’s goals**

1. To introduce interns to the variety of pot shapes and sizes available.
2. To teach interns that you can use pot shape and size to suit different plants and optimize growth and development, as well as use economic factors to help you choose pot shape and size.
3. To show interns the reasons why the nursery uses the pots types we do, and why, exploring the tradeoffs of those choices.

**Materials (May Vary):**

1. Links to readings: [http://hort.ifas.ufl.edu/woody/containers-more.shtml](http://hort.ifas.ufl.edu/woody/containers-more.shtml), [https://www.fs.fed.us/rm/pubs_other/rmrs_2010_landis_t001.pdf](https://www.fs.fed.us/rm/pubs_other/rmrs_2010_landis_t001.pdf): e-mail links to interns a few days beforehand and tell them to read it before you meet for this lesson
2. Examples of all the pot sizes/shapes you currently use at the nursery, empty pots (cone-tainers, 4” square pots, 1/2/3/5 gallon round pots, 1 gallon ridged tree pots, etc.).
3. Examples of growing plants of as many shapes and sizes as you have available, with filled-out root systems
4. Example of at least 1 rootbound plant, any size; if available, have 1 rootbound plant per intern for them to practice breaking apart and up-potting.
5. Before you teach this lesson, make sure you, the manager, know how to properly up-pot rootbound plants. Watch this video if you need to learn or a refresher: [https://www.youtube.com/watch?v=hRKumwd-49Q](https://www.youtube.com/watch?v=hRKumwd-49Q)
6. Larger pot sizes to up-pot the rootbound plants into.
7. Clippers
8. Disinfectant (10% bleach water or 99% rubbing alcohol)
9. Potting soil, media mix of preference for up-potting the rootbound plants

**Lesson Objectives**

<table>
<thead>
<tr>
<th>Interns will be able to...</th>
<th>Assessment Evidence</th>
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<tbody>
<tr>
<td>1. Recognize some of the ways pot shape and size can affect the way plants grow.</td>
<td>1. Interns will help to up-pot some rootbound plants.</td>
</tr>
<tr>
<td>2. Recognize what pot-bound plants look like and what to do when plants are pot-bound.</td>
<td>2. Interns will also be expected to help volunteers at work parties to correctly up-pot plants that may be a little rootbound.</td>
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<tr>
<td>3. Know some of the metrics we use at the nursery to determine what size/shape pot we use for a plant.</td>
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**Assessment Evidence**

| 1. Interns will help to up-pot some rootbound plants. |
| 2. Interns will also be expected to help volunteers at work parties to correctly up-pot plants that may be a little rootbound. |
Pot Shapes, Sizes, and Fixing Rootbound Plants

1. Have interns (and yourself) read these two resources BEFORE coming to the weekly work meeting:
   a. [http://hort.ifas.ufl.edu/woody/containers-more.shtml](http://hort.ifas.ufl.edu/woody/containers-more.shtml)
   b. [https://www.fs.fed.us/rm/pubs_other/rmrs_2010_landis_t001.pdf](https://www.fs.fed.us/rm/pubs_other/rmrs_2010_landis_t001.pdf)
   c. The two give a good overview about how different container types affect woody plants’ roots and growth, especially for restoration, so it gives a good basis in which to do the following lesson.

2. Show interns the different empty pot types we currently use at the nursery.
   a. Based on the reading they did last night, what do they think of each pot type?
   b. What kind of plant would they plant in each pot type?

3. Now look at the pot type examples that have plants in them.
   a. Do the interns think that the plant types are appropriately matched to the pot types? Why or why not?

4. The short, rounded 1-gallon pots we grow the majority of our stock in is not necessarily the best container stock to grow plants in, especially woody plants that are destined for restoration.
   a. Ask interns, Why would we grow plants in that container type anyways?
      i. We use those container types because we can often get free ones that are that shape and size, left over from other research projects at CUH or donated from other non-profits. They’re also cheaper if we want to buy our own.
      ii. Cost is a huge factor in how we determine what kind of pot type we use. Because we can usually get the round pots for free, we grow plants in those preferentially.
      iii. Explain to interns that we also grow plants in sizes that we are sure we can sell. For student restoration projects, students buy smaller, 1-gallon or less sized plants because it’s cheaper. For example, for a lot of our prairie species, we grow a lot of plants in the ½ gallon size to sell to the North American Restoration class, keeping the plants cheap enough for students to buy with very limited funds. We also sell 2” plugs of grass to the same class, keeping the size small for the same reason.

5. With the pots examples that have plants in them, ask the interns to work together to describe what they think the root system should look like based on the pot type.

6. After discussing each pot type and the root system they think it should have, flip the plants out of their pots. Do the roots match their expectations? Discuss why or why not. (You don’t need to know the answer--remember, these are just examples pulled from the whole nursery stock, and may not be representative! If interns are interested in seeing if there’s a pattern throughout all the pots of a pot type,
encourage them to pursue the answer to that question by sampling more individuals!)

7. Now show the interns the rootbound example you have, plus any extra you have for them to work with. If you have already done the Plant Sales lesson, they will already be familiar with what pot-bound means. This lesson focuses on how to fix that problem.

8. When a plant is rootbound, it’s best not to plant it in a restoration site because those roots are already growing incorrectly, and they won’t grow down and out naturally. In the nursery, we try to up-pot these plants before we sell them to restoration projects. You can often tell a plant is rootbound if it is soaking up and using water at a much faster rate than the other plants around it; that’s one of the reasons we do so many ‘sweeps’ in the nursery to look for issues like plants that are drying out faster than others.

9. Show interns how to pop the plant out of its pot (cutting roots with sterilized clippers if the roots have grown out of the holes in the bottom of the pot). Then, show interns how to break apart the circling roots with your hands and the sterilized clippers when needed. If the interns all have rootbound plants, too, let them work on their plants with you step-by-step.

10. With your hands and the clippers, shake the old soil off of your plant and re-shape the roots so that they point downwards, trimming where necessary. In a pot a size larger (a 1-gallon pot can usually be up-potted to a 2-3 gallon, a 2-3 gallon to a 5 gallon, etc.), place a little soil in the bottom of the pot and then place the plant in the pot. The roots should be hanging, pointing down; you will need to hold the plant in the middle of the pot with one hand as you add soil with the other.

11. Add soil all around your plant, keeping it centered in its new pot. Eventually, you will add enough soil to support the plant and you won’t have to hold it up with your hand anymore. Make sure that the soil does not cover any part of the aboveground growth, and that it covers all of the belowground growth. Grip the sides of the pot and tap the pot against a flat surface like a table or the ground to settle the soil. You may need to add more soil after tapping.

12. Water the plant in. Done! Now, your rootbound plants will grow a little more, filling these pots with a healthy root system. Aim to sell the plant before it gets rootbound again in its larger pot size.

Sources:
**Week 10: Nursery Visits Field Trip**

**Essential Question(s)**
1. How do other native plant nurseries function?
2. What goals drive nurseries to make different decisions?
3. What can we learn from other nurseries to improve our own functionalities?

**Manager’s goals**
1. To show interns the variety of approaches to native plant production in the area and broaden their perspective of nursery management.

**Materials (May Vary):**
1. U-Car (reserve through Michelle Trudeau, michtru@uw.edu)
2. Reserve visits individually with each nursery you intend to visit a month or two in advance; e-mail contacts to remind them of the visits about a week ahead of time.

<table>
<thead>
<tr>
<th>Lesson Objectives</th>
<th>Assessment Evidence</th>
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<tbody>
<tr>
<td>Interns will be able to…</td>
<td>1. Interns will be required to write a short (2-3 pg) reflection about the trip in which they will be required to think about the other nurseries they visited and think about what practices they think the SER-UW Nursery should adopt.</td>
</tr>
<tr>
<td>1. Recognize the different functions that native plant nurseries serve in the region</td>
<td></td>
</tr>
<tr>
<td>2. Compare and contrast the methods the SER-UW Nursery uses with the practices of the other nurseries they visit</td>
<td></td>
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</tbody>
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**Field trip**
1. Some options for nurseries to visit are listed below—pick two to visit. These are nurseries where we have built relationships with their employees and/or we have purchased plants from them. When you contact them, explain who you are and that you would like a 30 minute to an hour tour of their operation. In the case of some, you may consider offering to volunteer with them for a period of time for the interns and yourself to gain experience at another site, depending on your availability and their willingness to work with you.
      i. Contact: Bridget McNassar, Native Plant Nursery Manager.
      ii. E-mail: bridget@oxbow.org.
      iii. Phone: 425.788.1134 ext 4.
      i. Contacts: Terra Sittner and Dan McCain, Nursery Managers
      ii. E-mail: [http://www.stormlakegrowers.com/contact](http://www.stormlakegrowers.com/contact)
      iii. Phone: (360) 794-4842
      i. Contact: Don Norman, Nursery Manager/Owner.
      ii. E-mail: don@gonativesnursery.com
      iii. Phone: (206) 799.1749
d. King County Nursery/Cedar Hills Nursery
   i. Contact: Cindy Young, ecologist.
   ii. E-mail: cindy.young@kingcounty.gov
   iii. Phone: 206-477-4859

2. If you make contacts with other nurseries, feel free to visit those instead.

3. In preparation for the trip, have each intern write 5 questions they would like to ask the managers of the nursery you’ll be visiting. Encourage interns to think about what they’ve learned this quarter and what they feel is important to running a nursery; what stock do these nurseries carry? What is their primary goal or mission? Do they grow from seed, cutting, or buy bare-root stock to grow in pots? These are example questions, but encourage interns to branch out and think about what they could learn from these other Nurseries.

4. The field trip will likely take up the better part of a week day (these Nurseries are not necessarily open on the weekend). Coordinate with your interns, but this should be required. If needed, you can do this field trip on a Friday (when you would normally have a work party).

5. After field trip, assign the last assignment for the interns:
   a. They must write a 2-3 pg reflection about the field trip. They must answer these questions:
      i. What makes these nurseries different from our SER-UW Nursery?
      ii. If you took over managing the SER-UW Nursery tomorrow, what practices would you start or incorporate first?
      iii. Overall, what has your experience at the SER-UW Nursery been? What have you learned? What could be improved for future interns?

*Note: During spring quarter, ESRM 412 (Native Plant Production with Jon Bakker) goes on a field trip to a variety (three or so) native plant nurseries near the end of the quarter, too. The field trip they go on is on a Wednesday, from noon-7pm. If it is possible, you may consider working with Dr. Bakker and his class and taking a vehicle and traveling with them, combining the two groups. You would still need to use nursery money to rent your own U-car. Contact Dr. Bakker at jbakker@uw.edu to explore this possibility.