GoNatives! Research Internship

Miles Hyland
Western Washington University

Follow this and additional works at: https://cedar.wwu.edu/cenv_internship

Part of the Environmental Sciences Commons

Recommended Citation
Hyland, Miles, "GoNatives! Research Internship" (2022). College of the Environment Internship Reports. 86.
https://cedar.wwu.edu/cenv_internship/86

This Article is brought to you for free and open access by the College of the Environment at Western CEDAR. It has been accepted for inclusion in College of the Environment Internship Reports by an authorized administrator of Western CEDAR. For more information, please contact westerncedar@wwu.edu.
Internship Title: GoNatives! Research Internship

Student Name: Miles Hyland

Internship Dates: June 2022 through December 2022

I grant to Western Washington University the non-exclusive royalty-free right to archive, reproduce, distribute, and display this Internship Report document in any and all forms, including electronic format, via any digital library mechanisms maintained by WWU.

I represent and warrant this is original work, and does not infringe or violate any rights of others. I warrant that I have obtained written permissions from the owner of any third party copyrighted material included in this document.

I acknowledge that I retain ownership rights to the copyright of this work, including but not limited to the right to use all or part of this work in future works, such as articles or books. Library users are granted permission for individual, research and non-commercial reproduction of this work for educational purposes only. Any further digital posting of this document requires specific permission from the author.

Any copying or publication of this document for commercial purposes, or for financial gain, is not allowed without my written permission.

STUDENT SIGNATURE Miles Hyland

DATE: 12/5/2022
Contents

Introduction 1

Duties and Responsibilities 1

Results and Discussion 5

Assessment 9

Literature Cited 4

Appendix I: Greenhouse Study Photos 10

Appendix II: Seed Collection Information 12

Appendix III: Vanilla Leaf Germination 13

Appendix IV: Twinflower Germination 14

Appendix V: Modified Hoagland Recipe 16

Appendix VI: WA Park Collection Sites 17

Appendix VII: June Seedling Tray Photo 19

Appendix IIX: Hour Log 20
Introduction

This project focused on the relationship between soil biota, such as mycorrhizal fungi, bacteria, and other microorganisms, and the success of native plants grown in landscaped settings. In particular, we hoped to obtain data which might describe the mycorrhizal associations formed by target species, as well as their growth response to the introduction of native soil biota. This work will improve our understanding of how to grow certain plants, such as sea thrift (*A. maritima*), that have proven difficult to maintain in native plant gardens and nurseries. My roles within this project were wide ranging, and included responsibilities such as the maintenance of *A. maritima* in the greenhouse, the collection of seed and soil samples from the field, the assessment of roots to quantify the degree to which mycorrhizal fungi had colonized plants, and analysis and synthesis of the information and data collected.

Duties and Responsibilities

**Greenhouse Work**

One of my primary responsibilities in this project was overseeing the growth and maintenance of sea thrift plants in the Western Washington University (WWU) Biology greenhouse. The goal of this greenhouse study was to quantify the biomass response of sea thrift to native soil biota. I was involved with several key tasks in this study. First, I started with seedling trays containing 16 germinated sea thrift plants that had been sown some weeks prior. After tending to these plants for several weeks, we repotted them and inoculated half with unsterilized native soil (which included biota), and the other group with sterilized native soil (which did not include biota).
In addition, my work in the greenhouse also included managing the plants’ moisture levels by controlling the frequency and duration of the greenhouse misters, mixing and applying a 60mL (5mL/plant) round of a modified Hoagland’s solution as fertilizer (Appendix VI), rotating the plants’ position in order to control potential microclimatic differences (light, warmth, etc.), and making five data collections to assess each plant’s growth and general condition. The two primary quantitative measurements taken during these data collections were the length of the longest leaf (cm) and the number of leaves present on each plant.

After approximately four months of growth, the sea thrift plants were harvested and processed. This began by removing each plant from its pot, with the goal being to keep as much of the belowground growth intact as possible. Next, we separated the roots and shoots of each plant, and gently washed the roots to remove remaining soil. The shoots were placed in small paper bags and dried at 60°C for approximately 72 hours before being weighed. With the roots, rather than obtain mass data, we followed a modified clearing and staining method, and created root slides. This modified method was based on the method described in Phillips & Hayman (1970), and started with placing roots in 5% KOH for 24 hours, then 3% HCl for 24 hours, and finally staining them with Trypan Blue for approximately 18.5 hours (Phillips & Hayman, 1970). These roots will be examined in the microscopy lab at a later date to determine the degree of arbuscular mycorrhizal fungi (AMF) colonization.

**Analysis of Greenhouse Data**

Once we had collected the final shoot masses (g), lengths of the longest leaf (cm), and number of leaves of each plant, we performed 2-sample t-tests to identify any differences between the control and experimental groups. This involved logging the data, exporting it to
RStudio, and then testing it to make sure it met assumptions of normality and homoscedasticity. These assumptions were tested for using the Shapiro-Wilk Test, and the standard deviations of each group.

**Wild Plants and Seeds**

In addition to the collection of native soil biota for our greenhouse experiment, we also collected wild roots and seeds from sea thrift and two other species: vanilla leaf (*Achlys triphylla*) and twinflower (*Linnaea borealis*). The first step to collecting the species was to locate them in their native habitat. I did this by using the iNaturalist app, which allows users to log the locations of plant and animal species. Once I had located native populations of these species, I then contacted the land managers overseeing those areas to gain permission to collect samples.

For sea thrift, we collected seeds and roots at the same time, which involved plucking the ripe seed heads off the flower and digging gently around the base of the plants to collect the smaller, more delicate roots without disturbing the plant. For vanilla leaf, we followed the same procedures for roots, but the scarcity of ripe seeds at the time of root collection forced us to wait until later in the season before collecting seeds. Similarly, twinflower seeds were unripe when we first located them in the field. As a result of scheduling and availability issues, we had to wait until September before returning to collect them, at which point all the low elevation seeds had been shed. So, we found two higher elevation sites in the North Cascades, and most of the twinflower seeds were mature at that time (Appendix II).

These collections were performed with two primary goals in mind. First, with the roots of these species, we hoped to better understand if they form mycorrhizae in their native habitat. As
with the sea thrift roots from the greenhouse, we did this by clearing and staining the roots, creating slides, and then analyzing them in the microscopy lab. However, rather than spending only 24 hours in 5% KOH like our lab grown roots, the wild root samples required approximately 120 hours to fully clear. This process was closely monitored to assess the condition of each sample, and to make sure the root tissue remained intact. For the microscopic analysis portion of this process, we looked for three main structures: hyphae, vesicles, and arbuscules.

The wild seeds were collected for future greenhouse studies. Since there are no commercial sources of vanilla leaf and twinflower, we will need to propagate our own plants for any future projects. Towards that long term goal, these first seed collections will be used in germination studies to compare various pre-treatment methods so we can maximize germination rates in future greenhouse studies. To prepare for these experiments, my responsibility was to gather information regarding stratification requirements, as well as to begin the minimum 60 day stratification process for each species. The twinflower seeds are extremely small, and sit within a resinous casing, which meant the first step of this process was to separate seed from case. This involved rubbing these seeds against a metal screen, recovering each seed, and placing them on a moistened paper towel. After this process was complete, the two paper towels and the 151 total seeds were placed in unsealed ziploc bags and stored in the laboratory refrigerator. For vanilla leaf, we first separated the parasitized and non parasitized seeds, and then placed 200 of each onto moistened paper towels, which then went into unsealed plastic bags and into the fridge. The stratification of both seeds began on 12/5/2022 and should continue for at least 60 days.
Finally, one important task performed throughout the course of this internship was the maintenance of a lab notebook to document my work. This includes general procedures, data collection tables, locations and times of seed and soil collections, and other information about the project. Ideally, this notebook will serve as a document going forward which will allow the project to continue uninterrupted after my work is complete.

Results and Discussion

The part of this project that was conducted in the greenhouse has several outcomes in need of discussion. First, the plants grown in sterilized soil had a mean shoot mass of 0.0588g and a standard deviation of 0.0174g, while those grown in inoculated soil had a mean shoot mass of 0.0404g and a standard deviation of 0.0079g (Figure 1). However, after conducting a 2 sample t-test with an alpha level of 0.05, we found only moderate evidence to suggest that there is a difference in the true mean shoot mass of sea thrift plants grown in a sterilized growing medium compared to those grown in a medium inoculated with native soil biota ($t_{(210)} = 2.3576$, $p = 0.0506$). Our failure to detect stronger evidence is likely due in part to small sample size, as well as the relatively high standard deviation for our sterilized, control group (Figure 2). Finally, we found no evidence that the two groups differed in maximum leaf length ($t_{(210)} = 1.65$, $p = 0.1301$), or in the number of leaves on each plant ($t_{(210)} = 0.822$, $p = 0.4379$).

One reason the shoot mass of our control group may have been greater than the experimental group is that the nutrients released during soil sterilization enhanced the growth of our control plants, and outweighed any potential benefits from the presences of native soil biota (Bunn, 2022). This is an especially strong possibility considering the elevated importance of mycorrhizal relationships for plants in stressful growing conditions, a factor which was not
examined in this project (Evelin et al., 2009; Miransari, 2010). Lastly, one point of concern is that although the modified clearing and staining method we used did provide adequate clearing in most cases, a number of root segments may have benefitted from more time in the 5% KOH solution. In these cases, certain AMF structures may have been obscured by the darkly stained cortical tissue.

Finally, our analysis of the field collected roots provided further insight into the mycorrhizal relationships formed by these plants (Table 1). For vanilla leaf, we found that root segments generally ranged from moderate to high AMF colonization, while colonization in our twinflower roots was found to be slightly lower. It’s important to note, however, that the twinflower roots were much more difficult to work with, and many of the segments either did not stain well or else had highly deteriorated cortical tissue. These two facts added significantly to the difficulty of making positive identifications of AMF structures. Lastly, our field collected sea thrift roots had similar issues, albeit to a lesser extent, and in general were observed to have a moderate amount of AMF colonization.
Figure 1: Mean shoot mass (with 95% confidence intervals) for sea thrift plants grown under different soil biota conditions in the WWU Greenhouse.

Figure 2: Mass distributions of sea thrift plants grown in the WWU greenhouse.
Figure 3: Mean number of leaves for each group of *A. maritima* plants grown in the WWU greenhouse.

Figure 4: Mean maximum leaf height for each group of *A. maritima* plants grown in the WWU greenhouse.
Table 1: Summary table of AMF structural features identified in wild root samples of *A. triphylla*, *L. borealis*, and *A. maritima*.

<table>
<thead>
<tr>
<th>Sample</th>
<th>% of Root Segments with Hyphae</th>
<th>% of Root Segments with Vesicles</th>
<th>% of Root Segments with Arbuscules</th>
<th>Level of AMF Colonization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanilla Leaf 1</td>
<td>100%</td>
<td>100%</td>
<td>83.3%</td>
<td>High</td>
</tr>
<tr>
<td>Vanilla Leaf 2</td>
<td>100%</td>
<td>58.3%</td>
<td>100%</td>
<td>High</td>
</tr>
<tr>
<td>Vanilla Leaf 4</td>
<td>100%</td>
<td>58.3%</td>
<td>25%</td>
<td>Medium</td>
</tr>
<tr>
<td>Twinflower 3</td>
<td>83.3%</td>
<td>41.6%</td>
<td>16.6%</td>
<td>Low-Medium</td>
</tr>
<tr>
<td>Twinflower 5</td>
<td>100%</td>
<td>75%</td>
<td>100%</td>
<td>High</td>
</tr>
<tr>
<td>Twinflower 6</td>
<td>91.7%</td>
<td>83.3%</td>
<td>58.3%</td>
<td>Medium-High</td>
</tr>
<tr>
<td>Sea Thrift 1</td>
<td>100%</td>
<td>91.7%</td>
<td>25%</td>
<td>Medium</td>
</tr>
<tr>
<td>Sea Thrift 2</td>
<td>100%</td>
<td>91.7%</td>
<td>41.7%</td>
<td>Medium</td>
</tr>
<tr>
<td>Sea Thrift 3</td>
<td>89.5%</td>
<td>89.5%</td>
<td>26.3%</td>
<td>Medium</td>
</tr>
</tbody>
</table>

**Assessment**

Although we discovered valuable information regarding growth trajectory of *A. maritima*, we were not able to quantify the effect these relationships may have for plants grown in nurseries. This may in part be due to the small sample sizes we were working with, and in part due to the release of nutrients in our control group after soil sterilization. Despite this, we have a) gained insight into the growth trajectory of sea thrift, b) discovered that all the plants included in this project do form AMF associations, and c) compiled information regarding the seed collection and propagation methods for each species of interest.
In most ways, this experience met my learning objectives outlined at the beginning of the internship. For example, the time I was able to spend in the field collecting samples and identifying plants gave me further insight into the ecology of these species, the communities of vegetation they form, and in turn the ecology of western Washington in general. I also got plenty of experience working in a laboratory setting, and learned how to perform tasks like creating slides, stratifying seeds, mixing fertilizers, etc.. This hands on experience is definitely something that will be useful going forward, both for the skills I learned as well as for the information it gives me regarding the type of career and educational opportunities I may decide to pursue going forward.

LITERATURE CITED

Bunn, R., WWU, pers. comm. 2022


Appendix I: Greenhouse Study Photos

Harvested sea thrift roots and shoots after approximately 4 months of growth.
Appendix II: Seed Collection Information

2022 Seed Collections

Vanilla Leaf

- 7/11
  - Mature and immature seeds collected from the Sehome Hill Arboretum (48.7291382, -122.4839078)
  - Other sites which likely have similar timing for mature seeds
    - 48.7309174, -122.4803398
    - 48.7293234, -122.4835278

Twinflower

- 7/11
  - Seeds in Sehome Hill Arboretum (48.730178, -122.4808417) were still immature at this time, but multiple patches of twinflower were flowering, which means the seeds would probably be mature in mid August.
  - Other sites in the arboretum which likely have similar timing for mature seeds
    - 48.7311177, -122.4801494
    - 48.7314755, -122.4802520

- 9/16
  - Newhalem Visitors center in North Cascades National Park (48.66677685982805, -121.26684194603229)
    - Patches of twinflower bordering the pathways that surround the visitors center. Many of the seeds had been shed, but there were still a few mature seeds on most individual plants.
    - There was also abundant twinflower on the River Loop Trail, which begins at the visitors center and makes its way down to the Skagit River.
    - Ideal time for collection would likely mid-late August, depending on the timing and intensity of summer’s onset.

- 9/23
  - Thunder Knob Trail, which begins at Colonial Creek Campground (48.69119248938048, -121.09967989648007)
    - Abundant twinflower all along the side of the trail, with a greater proportion of these plants in seed as you move up it.

Sea Thrift

- 7/1
  - Mature seeds collected from Cattle Point Interpretive Area on San Juan Island (48.4541423, -122.9617709)

- 7/13
  - Mature seeds collected from two sites in Washington Park, Anacortes
    - 48.4990099, -122.7010166
    - 48.4914162, -122.6929568
Appendix III: Vanilla Leaf Germination Protocols

Method 1

Pre-treatment: Soak seed in water for 24 hours before sowing.

Growth Medium: Finely milled peat moss (compost or leaf mould also work) with a small amount of sand for drainage.

Sowing: A. triphylla does best when surface sown. Gently press the seed into the surface of the growth medium and then cover with a thin layer of sand.

Further Instructions: For the first 2-4 weeks after sowing, keep the growth environment warm (18-22C) and mist frequently to maintain adequate soil moisture. Following this warm period, reduce temperatures to below freezing (around 0C, although range from -5C to 4C has been given) for the next 4-6 weeks. Seeds will germinate at cool temperatures (5-12C). Do not expose to hot sun or strong direct light.

Source:
https://twiningvinegarden.com/shop/perennial-seed/flowering-perennial-seed/achlys-triphylla-vanilla-leaf-seed/

https://www.jelitto.com/Seed/Perennials/ACHLYS+triphylla+Portion+s.html

Method 2:

Pre-treatment: cold, moist stratification period for appx 60 days before sowing.

Growth Medium: Finely milled peat moss (compost or leaf mould also work) with a small amount of sand for drainage.

Sowing: Surface sow outdoors in late fall or early winter.

Source: https://klamathsiskiyouseeds.com/product/achlys-triphylla-vanillaleaf/
Appendix IV: Twinflower Germination Protocols

Info From https://depts.washington.edu/propplnt/Plants/L_borea.htm

Seed propagation recommended against.

- Germination rate appx 1 in 30
- Seeds do not persist in seed banks
- Vegetative propagation generally more successful.

If propagating from Seed, use the following techniques

- Air dry the seeds and plant in the fall using a sandy, acidic soil.
- If planting in the spring, cold stratify for appx 60 days prior to sowing.


Seed Processing

- Hand rub capsules against a screen

Pre Planting Treatment

- At least 60 day cold, moist stratification,
  - Otherwise, plant in late fall for an outdoor stratification period of appx 5 months.
- Irrigate thoroughly before winter stratification

Sowing Method

- Twinflower seeds have been identified as having a light requirement, which means they should be surface sown.

Container type

- 160ml conetainers (plug). One seed per Container.

Growth Medium

- 6:1:1 milled sphagnum peat, perlite, and vermiculite with Osmocote controlled release fertilizer (13N:13P2O5:13K2O; 8 to 9 month release rate at 21°C) and Micromax fertilizer (12%S, 0.1%B, 0.5%Cu, 12%Fe, 2.5%Mn, 0.05%Mo, 1%Zn) at the rate of 1 gram of Osmocote and 0.20 gram of Micromax per 172 ml container.

Establishment Phase
- Germination occurs in late spring, following several days with temperatures at or above appx 22C, and continues for about 4 weeks. This source notes a germination rate of 50%
### Appendix V: Modified Hoagland Recipe

<table>
<thead>
<tr>
<th>Stock</th>
<th>FW</th>
<th>Stock (M)</th>
<th>mL of Stock per Liter for Full Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca(NO$_3$)$_2$</td>
<td>164.09</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>KNO$_3$</td>
<td>101.1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>MgSO$_4$</td>
<td>120.37</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>KH$_2$PO$_4$</td>
<td>136.09</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fe(III) EDTA Micronutrient Solution (see below)</td>
<td>367.05</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stock</th>
<th>FW</th>
<th>g/L for Stock</th>
<th>Stock (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H$_3$BO$_3$</td>
<td>61.83</td>
<td>2.86</td>
<td>0.0463</td>
</tr>
<tr>
<td>MnCl$_2$·4H$_2$O</td>
<td>197.91</td>
<td>1.81</td>
<td>0.0091</td>
</tr>
<tr>
<td>ZnCl$_2$</td>
<td>136.315</td>
<td>0.11</td>
<td>0.0008</td>
</tr>
<tr>
<td>CuCl$_2$·2H$_2$O</td>
<td>134.45</td>
<td>0.05</td>
<td>0.0004</td>
</tr>
<tr>
<td>NaMoO$_4$·2H$_2$O</td>
<td>241.95</td>
<td>0.025</td>
<td>0.0001</td>
</tr>
</tbody>
</table>
Appendix VI: WA Park Collection Sites
Appendix VII: June Seedling Tray Photo
## Appendix IIX: Hour Log

<table>
<thead>
<tr>
<th>Date</th>
<th>Hours</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5</td>
<td>weekly checkin/project intro</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 watering sea thrift</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 internship contract/mentorship plan</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>weekly checkin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 project research (looking through existing onedrive documents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Seed collection site research/outreach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 sea thrift seed collection on San Juan Island</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 watering sea thrift</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>seed collection in Sehome Hill Arboretum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Sea thrift seed/soil collection in WA Park</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 watering sea thrift</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>seed/root collection in Sehome Hill Arboretum</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>weekly checkin</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>notebook</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>notebook</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>root clearing/staining</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>root clearing/staining</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Nursery outreach/germination research</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>weekly checkin</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>root clearing/staining</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>watering sea thrift</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>notebook</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>root clearing/staining</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>root clearing/staining</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>weekly checkin</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>germination research</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>lab stuff (??)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>repotting sea thrift</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>watering sea thrift</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>transferring hours into excel</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>Preparing/applying fertilizer, and preparing root slides</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Preparing root slides</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>Preparing root slides and collecting qualitative data on sea thrift</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Germination Research</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Watering Armeria</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>sea thrift quantitative data</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>seed collection</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>vanilla leaf seed sorting and lab time</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>seed collection</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>greenhouse/sea thrift maintainence</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>sea thrift data collection</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>vanilla leaf seed sorting, emails, lab time, etc</td>
</tr>
<tr>
<td>Date</td>
<td>Activity Description</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>9/22</td>
<td>Twinflower Processing and Germination Research</td>
<td></td>
</tr>
<tr>
<td>9/22</td>
<td>Sea thrift data collection, seed collection info compiled to onedrive</td>
<td></td>
</tr>
<tr>
<td>9/23</td>
<td>Twinflower Seed Collection</td>
<td></td>
</tr>
<tr>
<td>9/26</td>
<td>2.5 Microscopy</td>
<td></td>
</tr>
<tr>
<td>9/28</td>
<td>2 Microscopy</td>
<td></td>
</tr>
<tr>
<td>10/6</td>
<td>0.5 Twinflower vegetative germination</td>
<td></td>
</tr>
<tr>
<td>10/10</td>
<td>2 microscopy</td>
<td></td>
</tr>
<tr>
<td>10/10</td>
<td>0.5 Sea thrift data collection</td>
<td></td>
</tr>
<tr>
<td>10/11</td>
<td>2 Microscopy</td>
<td></td>
</tr>
<tr>
<td>10/14</td>
<td>3.5 Sea Thrift Harvest and root/shoot analysis preparation (clip boxes, drying stuff, etc.)</td>
<td></td>
</tr>
<tr>
<td>10/17</td>
<td>0.75 Sea Thrift Shoot Mass data collection and root clearing</td>
<td></td>
</tr>
<tr>
<td>10/18</td>
<td>0.75 Root clearing and staining</td>
<td></td>
</tr>
<tr>
<td>10/21</td>
<td>0.5 Shoot mass data confirmation</td>
<td></td>
</tr>
<tr>
<td>10/24</td>
<td>2 Shoot mass data analysis and graphing</td>
<td></td>
</tr>
<tr>
<td>10/26</td>
<td>2 Root slide creation</td>
<td></td>
</tr>
<tr>
<td>10/28</td>
<td>2 Root slide creation</td>
<td></td>
</tr>
<tr>
<td>10/31</td>
<td>Project organization/planning/lab notebook catch up</td>
<td></td>
</tr>
<tr>
<td>11/1</td>
<td>1.75 root analysis</td>
<td></td>
</tr>
<tr>
<td>11/2</td>
<td>1.25 root analysis</td>
<td></td>
</tr>
<tr>
<td>11/16</td>
<td>2 root analysis</td>
<td></td>
</tr>
<tr>
<td>11/18</td>
<td>2 root analysis</td>
<td></td>
</tr>
<tr>
<td>11/27</td>
<td>0.5 Report Outlining</td>
<td></td>
</tr>
<tr>
<td>11/28</td>
<td>2 root analysis</td>
<td></td>
</tr>
<tr>
<td>11/29</td>
<td>1.5 root analysis</td>
<td></td>
</tr>
<tr>
<td>11/29</td>
<td>2 Report Drafting</td>
<td></td>
</tr>
<tr>
<td>11/30</td>
<td>1.5 root analysis</td>
<td></td>
</tr>
<tr>
<td>11/30</td>
<td>1 Report Drafting</td>
<td></td>
</tr>
<tr>
<td>12/3</td>
<td>Data Crunching/Making figures</td>
<td></td>
</tr>
<tr>
<td>12/4</td>
<td>3 Report Drafting</td>
<td></td>
</tr>
<tr>
<td>12/5</td>
<td>2.5 Report Drafting</td>
<td></td>
</tr>
<tr>
<td>12/5</td>
<td>Seed Stratification Setup</td>
<td></td>
</tr>
<tr>
<td>12/6</td>
<td>2.5 Report Editing and Formatting</td>
<td></td>
</tr>
<tr>
<td>12/7</td>
<td>0.5 Lab clean up</td>
<td></td>
</tr>
<tr>
<td>12/7</td>
<td>1 Formatting</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL:** 123.5