2017 Native Revegetation and Restoration at Goose Creek

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RIPARIAN RESTORATION

Environmental Leadership Program

Conducted by the University of Oregon 2017 Environmental Leadership Program

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Figure 1: Rows of native trees and shrubs.

1.0 About the Project

1.1 Introduction

The Environmental Leadership Program (ELP) Riparian Restoration Project began in 2014 to give students experience in monitoring and data collection while benefiting the owners of Whitewater Ranch, the beneficiaries of the McKenzie River, and the local environment. Since the start of this program, University of Oregon students have been working to improve the health and environmental quality of Goose Creek through native, riparian plant revegetation. Our team continued the restoration of riparian buffer zones along Goose Creek on Whitewater Ranch, an organic blueberry and Christmas tree farm. The owners of Whitewater Ranch wanted to improve their stream's water quality to benefit themselves and the community. For an organic farmer to meet regulation standards, it is essential that they include ecosystem health in their agricultural priorities. Our partnership has assisted Whitewater Ranch to gain certifications through USDA Organic, Salmon Safe, Oregon Tilth, Whole Foods Market Responsibly Grown, and Good Agricultural Practices (GAP). Through the process of removing invasive species and replanting native species along the riparian zone, we improved the environmental health of the area. After planting, we monitored the plants' growth and vigor through transect and photopoint monitoring, the health of the stream through temperature and macroinvertebrate monitoring, and pollinator abundance through transect monitoring within the surrounding blueberry fields. These protocols allowed us to analyze the effectiveness of the on-going restoration.

1.2 History of Study Site

The study site for our restoration project is located along Goose Creek, flowing through Whitewater Ranch in Leaburg, Oregon (Figure 2). It is 25 miles east of Eugene along the McKenzie River, near Leaburg Hatchery. The land is owned by farmers and entrepreneurs Jim and Jane Russell and is managed by Lorin and Mary Alice Zastoupil. The property is 1,800 acres and is bordered by the McKenzie River. Their land management practices promote sustainability as well as creating a balance between the farm and the ecosystem in which it is located (Russell 2017).

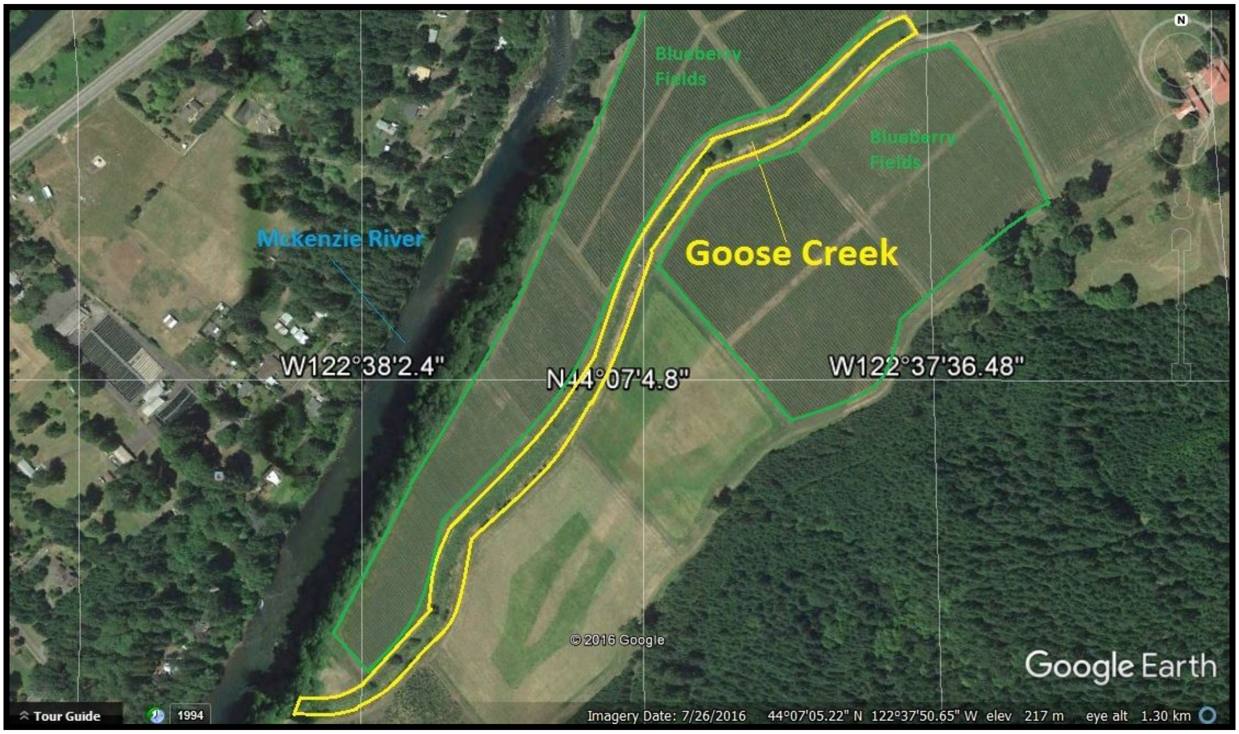

Figure 2: Aerial photo of our study site, Goose Creek, which divides the blueberry fields of Whitewater Ranch.

The creek was channelized in 1936, using a temporary wooden dam in order to direct excess water around the buildings on the property and into the McKenzie river flood channel. In the 1950s, the property was used for logging and cattle grazing. This had negative impacts on the stream quality and the surrounding environment. Logging and grazing disturbed natural habitat and created slope instability and soil degradation, causing sediment to accumulate in the stream. Grazing also removed the riparian vegetative buffer around the stream, increasing stream temperatures and decreasing biodiversity (Tasker and Bradstock 2006). In 1984, the Haack family bought the property and began farming Christmas trees. Jane and her husband Jim Russell inherited the property from Jane's family. Since then, they have continued the Christmas tree farm, begun sustainably harvesting timber, and started a successful organic blueberry farm (Robins et al. 2014). In 2014, Jim and Jane partnered with the University of Oregon Environmental Leadership Program for the purpose of improving their property through the restoration of Goose Creek.

The creek was surrounded by large populations of reed canarygrass, Himalayan blackberry, horsetail, stinging nettle, and rapeseed. In previous years, the ELP Riparian Restoration teams have planted a mixture of native trees and shrubs along Goose Creek in order to improve water conditions, increase biodiversity, and invite pollinators to the area. The restoration design was based on the moisture tolerance and requirements of each species (J. Weber, personal communication 2017). For example, species such as Pacific Ninebark

(*Physocarpus capitatus*) that need swampy, wet conditions were planted closer to the creek, while species such as Oregon Ash (*Fraxinus latifolia*) that require drier conditions, were planted further away from the creek. The taller species such as Oregon Ash and the Red Alder (*Alnus rubra*) were planted exclusively on the southeast side so they would not shade the blueberry fields once they mature. Additionally, species that usually grow in thickets were planted next to each other to increase pollinator attraction based on their behavior. Finally, all of the plant species were planted in rows approximately one meter apart to allow for easy maintenance. Phase I of our project is located near the culvert of Goose Creek, where our team and past teams planted native species and maintained invasive species. Phase II of our project is located further downstream on Goose Creek, where our team and past teams monitored the revegetation work done by the McKenzie Watershed Council.

Figure 3: New leaves of a red alder (*Alnus rubra*).

1.3 Overview

In the first year of this project, the 2014 team created the restoration plan for Goose Creek. The team's main goal was to create a foundation through which future teams could build off of in order to restore the area. They focused on removing invasive species and creating a riparian buffer zone by planting native species. The 2014 team also collected data on a variety of features of Goose Creek in order to create a specific and robust restoration plan (Robins et al. 2014). The 2015 team planted additional native plants for monitoring and observed stream temperature and macroinvertebrate diversity. They also conducted a baseline pollinator survey from which future teams could use for comparison, and expanded the photopoint monitoring (Ortiz et al. 2015). The 2016 team continued to monitor the plantings to track the progress of the project while also monitoring stream quality through temperature and macroinvertebrate diversity. They continued the pollinator surveys and further expanded the vegetation and photopoint monitoring (Nichols et al. 2016). This year we built upon the work of previous ELP teams' revegetation, riparian plant, and water quality monitoring. We also continued the pollinator surveys and photopoint monitoring, and created two new protocols to expand our monitoring.

After continuing the work of the past teams, we used their data along with our own to analyze the progress of our project. The Phase II monitoring, previously referred to as The Freshwater Trust's (TFT) Revegetation Protocol, helped us establish the amount of native and invasive species that are currently present at Goose Creek. The stream temperature monitoring provides status data for the stream which will allow future teams to gauge the effectiveness of shade provided by the plantings. The pollinator surveys were used to determine if our plantings are attracting more pollinators to the area, which will benefit the organic blueberries. The photopoint monitoring provides a visual method of tracking the growth of our plantings and the decline of invasive species. Phase I monitoring, previously referred to as Riparian Planting Monitoring Protocol, collected data on our plantings, determining the growth, survival, and vigor of each individual plant. The macroinvertebrate survey data can be used as a bioindicator of water quality and the health of Goose Creek. This year we also created three new protocols to standardize our methods for future teams to use: a protocol for macroinvertebrate surveys, a protocol for observing turtles, and a protocol for fencing effectiveness. Along with creating new protocols, we also changed the names of two methods for clarity. Adjusting protocols is an integral part of using adaptive management techniques. Adaptive management itself is a vital part of all successful land management plans.

2.0 Stewardship Summary

In the winter of 2017, the Riparian Restoration team along with other ELP students planted 10 species of native trees and shrubs, in the form of hardwood cuttings and container stock, along Phase I of Goose Creek (Appendix A). Another important part of land stewardship is the removal of invasive species - thus, we have been removing Himalayan blackberry and Reed canary grass from the restoration area. Additional protective weed mats were installed to help the plantings reach free-to-grow status while repressing undesirable species. Free-to-grow status entails plantings have reached a level of establishment that surpasses the surrounding grasses and vegetation, freeing them from the possibility of suffocation.

During the spring of 2017, ELP students continued maintenance of the site by mowing grasses in between rows of plantings, weed whacking grasses in hard to reach areas, uprooting blackberry, increasing locations of secured weed mats, and caging hardwood cuttings to protect from browsing elk. The introduction and maintenance of resilient native plantings that are adapted to the local ecosystem will aid the surrounding environment through biological functions of improved soil composition, water quality, and pollination rates.

3.0 Monitoring Summary

Incorporating ecological monitoring methods in restoration projects provide a vital scientific role in revealing short and long-term change, thus aiding management to more effectively reach the project goal. Monitoring aids in identifying problems which prompts solutions and adaptive practices to better suit objectives in mind. Evaluating success through data collection provide clues to what is working, and possibly to what is not working. This information can instruct future management on decision making and contribute to the success of the restoration strategy as a whole.

3.1 Stream Temperature Monitoring and Results

3.1.1 Goals and Methods:

Figure 4: Performing stream temperature monitoring.

Stream temperature monitoring is important to detect whether plantings are growing effectively to shade Goose Creek and reducing water temperature. The colder water will allow more oxygen to dissolve in the stream and higher oxygen levels will contribute to riparian biodiversity since cold water fish require high oxygen levels in water. Following already established methods for evaluating water temperature allows us to confirm whether or not we have successfully reduced stream temperatures at Goose Creek.

Our team took two stream temperature surveys using the water temperature survey protocol created by the 2015 Riparian Restoration team. We did the surveys once in April and once in May. Trout Creek was used as a reference site in order to compare how stream temperature changes without human disturbance. We took five different thermometer measurements at areas that had been designated by the previous year's ELP team (Appendix F). Our data will be part of references for future teams to compare with their data and generate stream temperature change trends for Goose Creek.

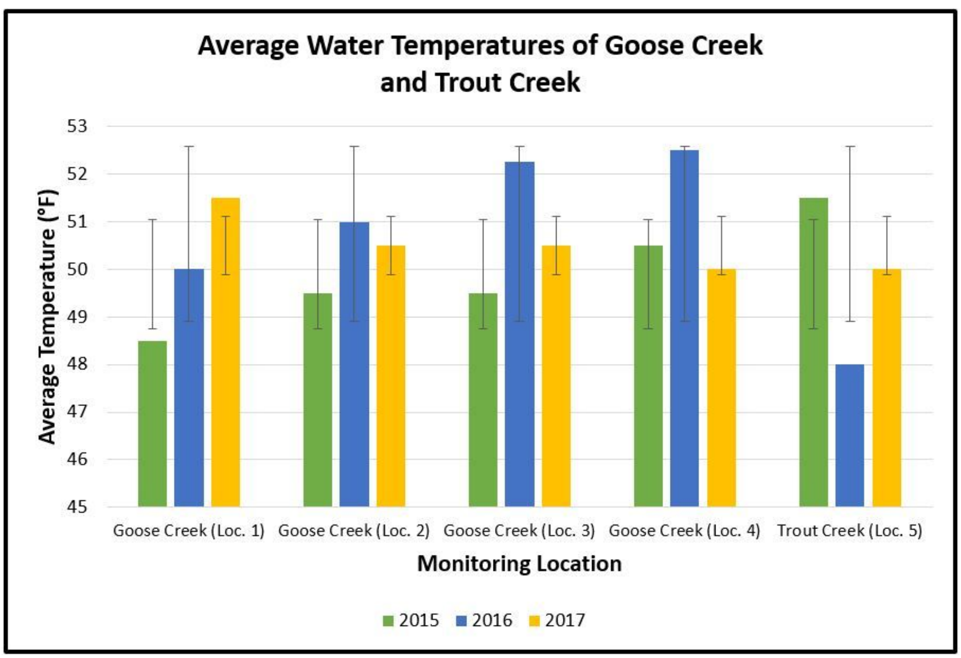

Figure 5: Average water temperature of Goose Creek (Locations 1 - 4) and Trout Creek (Location 5) between 2015 and 2017.

3.1.2 Results and Discussion:

In 2017, water temperatures varied between 48-52 °F. When comparing our data with data from previous years, it is difficult to make any definitive extrapolations due to variable weather and observer bias. This includes inconsistencies with measuring depth, how long the thermometer was held in the water, and measuring distance off the bank. After calculating average temperatures for this years data, we observed that the mean temperature has increased from 2015 to 2017 for the first location (Figure 5). For all other locations the temperature trends has varied thus far. The fluctuation between surveys of the past three years may be due to the variable weather conditions while sampling; while the 2015 and 2016 spring season were relatively dry and warm, 2017 was cold and wet. Trout Creek was recorded at a lower average temperature over the last three years. This could be in part due to the shading from the already existing riparian buffer along Trout Creek.

3.2 Photopoint Monitoring

3.2.1 Goals and Methods:

We used photopoint monitoring as a qualitative method to create a visual representation of the plant growth in Goose Creek and allow us to make comparisons with previous years' data more effectively. These photo points can evaluate the results of the project as well as easily convey this information to our community partners, funders, and members of the public. We took photos at locations designated by previous ELP teams using UTM locations (Appendices H and I). We added five new photo point locations in Phase II, labeled as Locations 14-18, and eliminated three locations last utilized in 2015, resulting in a total of 15 locations being photographed. The locations eliminated were Locations 3, 7, and 9, as they captured area that was already covered by other photopoints.

Figure 6: Photopoint monitoring from 2015 to 2017 (Location 1).

3.2.2 Results and Discussion:

This year's photopoint data shows some differences since last year's due to our team's management effort. When compared to last year's photopoints, the previous year's plantings show a robust growth trend (Locations 1 and 2). There were also some trees removed from the riparian zones (Locations 4 and 12). In general, the vegetation planted by previous teams show a positive growth, but invasive plants also experienced a re-growth and occupied areas quickly after mowing. Water levels of the creek also fluctuated. These changes may be largely attributed to variability in rainfall and human activity.

3.3 Phase II Monitoring Protocol

3.3.1 Goals and Methods:

Phase II of the project is focused on the restoration of a 1.4 acre stretch along the south bank of Goose Creek by the McKenzie Watershed Council. The monitoring of Phase II was done by following guidelines set by ELP Riparian Revegetation Monitoring Protocol to complement the data we collected from photopoint monitoring. Using these guidelines, our team collected data along the same 12 transects monitored by the 2016 Riparian Restoration team (Appendices B and C). The transects were six meter-long straight lines set up perpendicular to Goose Creek and roughly 75 meters apart from each other. Variance in the 75 meters was allowed to accommodate issues with bank stability or the shape of the creek. We used each transect as a sampling unit along which we collected data within one 6x6 meter plot and then two 1x1 meter subplots. The subplots were placed at the one meter and four meter marks along the transect using a quadrat frame (Figure 7). Within the sub-plots we collected data on the percent cover of native and non-native (both invasive and non-invasive) plant species. The ratio of native to invasive species can help future teams in determining what parts of Phase II require more maintenance and management relative to what areas are already well maintained.

Figure 7: Phase II subplot monitoring.

Each transect was used as the centerline for a 6x6 meter plot. Within each plot we counted the number of native shrubs and trees. We measured the diameter at breast height (DBH) of any trees present and did a stem count for shrubs and vines.

3.3.2 Results and Discussion:

The main difference in our Phase II monitoring data to that of 2016 team's data is the presence of more native trees and shrubs across Transects 1-6 (Figure 8). This is due in part that Transects 1-6 were treated; invasives were sprayed/removed in last fall, and trees/shrubs were planted this last winter. This was apparent in both the plot and subplot data. The average percent cover of ground substrate (bare dirt or mulch) increased due to the removal of invasive plants and other unwanted vegetation. Transects 7-12 did not show any change in native trees or shrubs present due to enhancement along this part of the creek not beginning until next year.

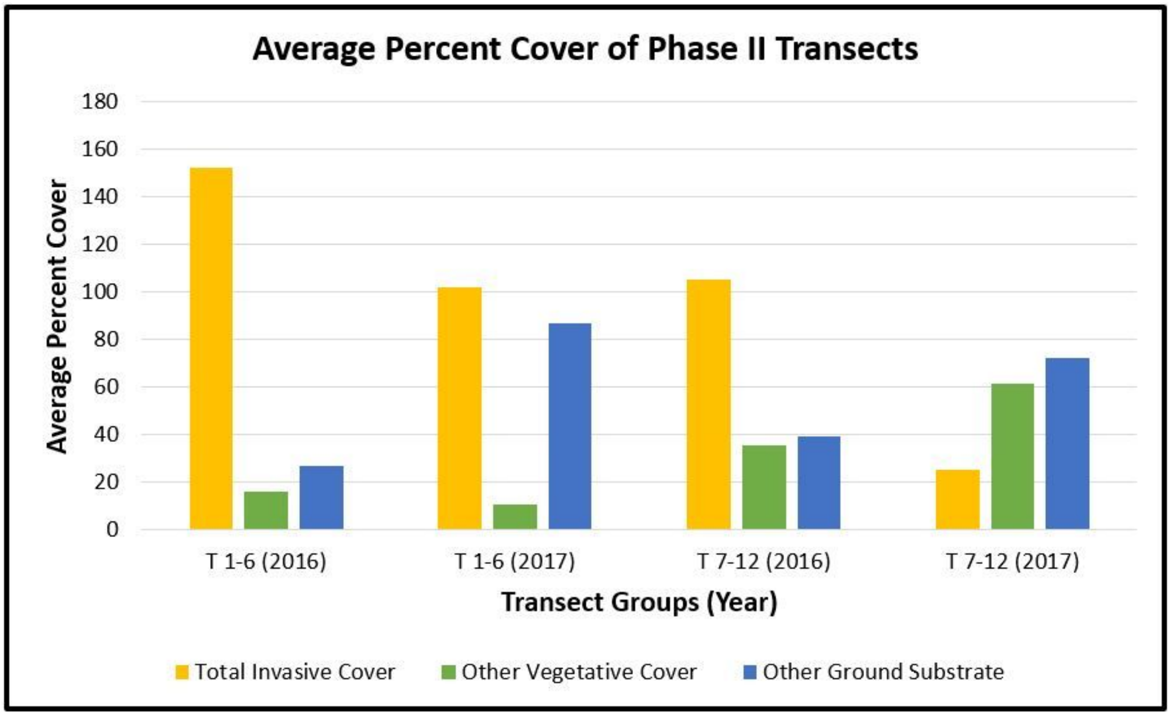

Figure 8: Average percent cover comparison between transects before and after restoration in Phase II began.

3.4 Phase I Monitoring and Results

3.4.1 Goals and Methods:

We recorded and analyzed data concerning the survival, growth, and vigor of tree and shrub species planted from previous ELP teams in 2015 and 2016, as well as those we planted in the winter of 2017. This information can be of use to future management in order to identify particular species and locations that are successful. Our team utilized the 2015 ELP Riparian Planting Monitoring Protocols to identify the advancement of certain species and particular planting techniques. We revisited four previously-established circular plots placed along Goose Creek, two plots on both the North and South banks (Appendix J). These plots were chosen to best represent the diversity of our plant species as well as site conditions, including wet and dry environments.

New trees and shrubs in the circular plots were added to the maps individual plants were given a unique numbered identification tag. Data collected included plant survival, hydrologic zone, height and stem class (for shrubs), damage, and competition. Shrub vigor was approximated through categorizing maturity levels by number of stems: sprout (1 stem), young (2-10 stems), and mature (> 10). Tree vigor was measured by live crown height (the distance between the highest and lowest live branches).

Species success per hydrologic zone was also analyzed in determining site conditions best suited for each tree and shrub. Zones represent distinct interfaces between the land to the stream. Listed from farthest from stream to closest these hydrologic zones include upland, transition, bank, overbank, and toe.

3.4.2 Results and Discussion:

We observed three tree mortalities in total. One was located in Plot 1, a Willow (*Salix spp.*), the other two mortalities were 2017 hardwood cuttings; a Red-osier Dogwood (*Cornus sericea*) and Willow (*Salix spp.*), found in Plot 3. We also observed an unknown identification of plant mortality, a Common Snowberry (*Symphoricarpos albus*) in Plot 3. Average height of species declined from 2016 to 2017 in approximately two thirds of the tree and shrub species. The species that had the greatest decrease in height from 2016 to 2017 were Clustered Wild Rose (*Rosa pisocarpa*), Snowberry (*Symphoricarpos albus*), and Red-flowering Currant (*Ribes sanguineum*). In contrast, Willow (*Salix spp.),* Red-osier Dogwood (*Cornus sericea*), and Oregon Ash (*Fraxinus latifolia*) showed positive growth from 2016 to 2017.

Findings on species vigor per hydrologic zones (Figure 11) show Oregon Ash to increase in growth within the transitional and upland zones but decreased within the bank. Pacific Ninebark (*Physocarpus capitatus*) thrived more within the transitional zone similarly but decreased in growth inside the bank and overbank zones. Douglas spiraea (*Spiraea douglasii*) recorded higher growth within the transition and upland hydrologic zones but fell in the overbank area.

Rates of growth from 2015 to 2016 ranged somewhat in species growth per hydrologic zone contrasting the 2016 to 2017 data. Higher proportions of growth was observed in species during the 2015 to 2016 project year (Figure 10). Possible reasoning behind the limits in growth during the 2016 to 2017 project year could include higher water levels that affected plants in the toe zone early in the spring season and overbank plantings that may have been affected by the 2016 summer drought. Willow (*Salix spp.),* a flood tolerant species that grows with their roots in the water, implies this correlation due to its growth compared to other species (Figure 10) while having access to greater summer water. Willows also grow quickly therefore can possibly withstand browsing from animals on site. Nootka Rose (*Rosa nutkana*) and Oregon grape (*Berberis aquifolium*) are more drought tolerant, therefore heavy rainfall may limit growth. Major limitations we found include browsing by elk and deer on site that hindered growth, coupled with intense competition of invasives such as reed canarygrass and Himalayan blackberry.

Figure 9: Phase I monitoring.

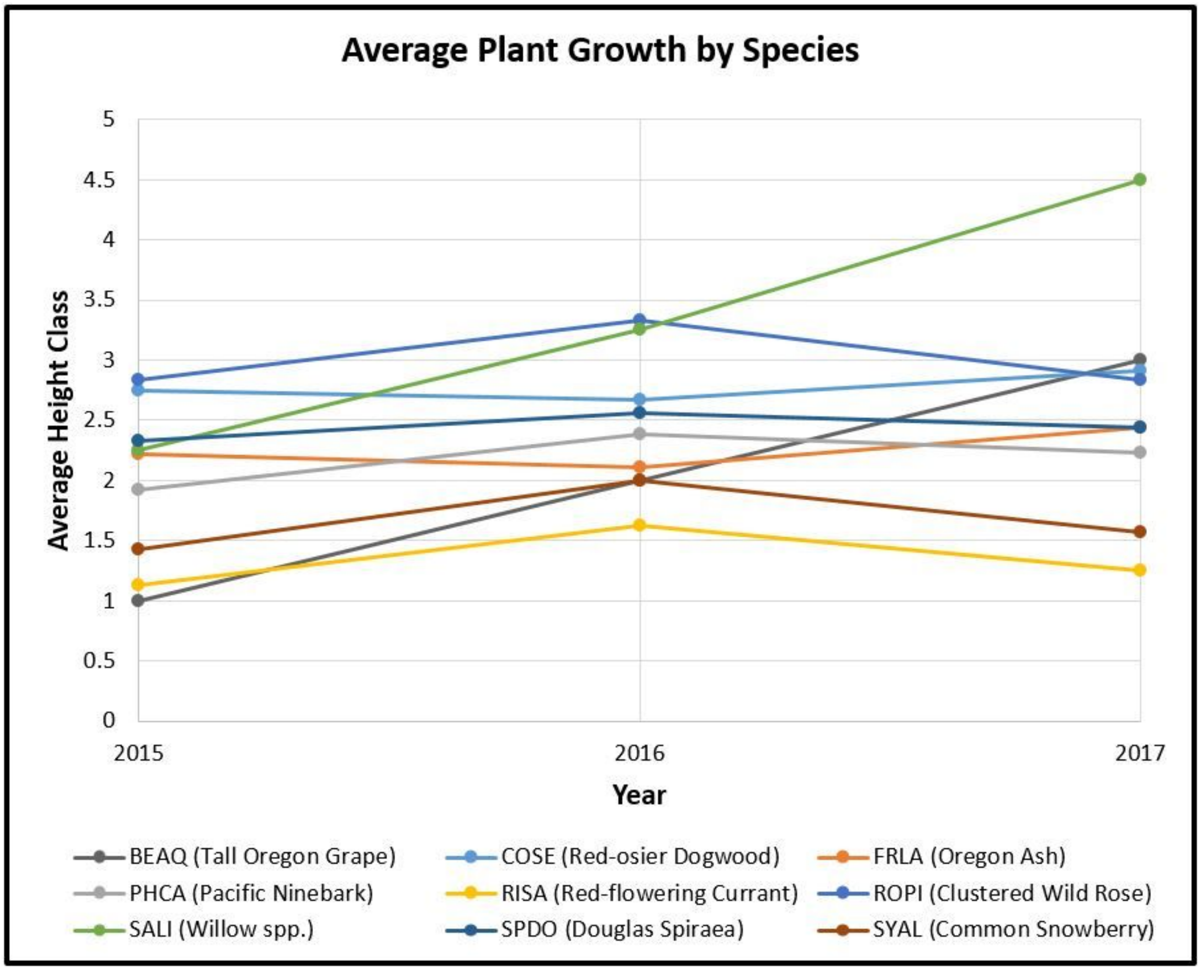

Figure 10: Average height class by species for three-year-old plants growing within monitored plots from 2015 to 2017.

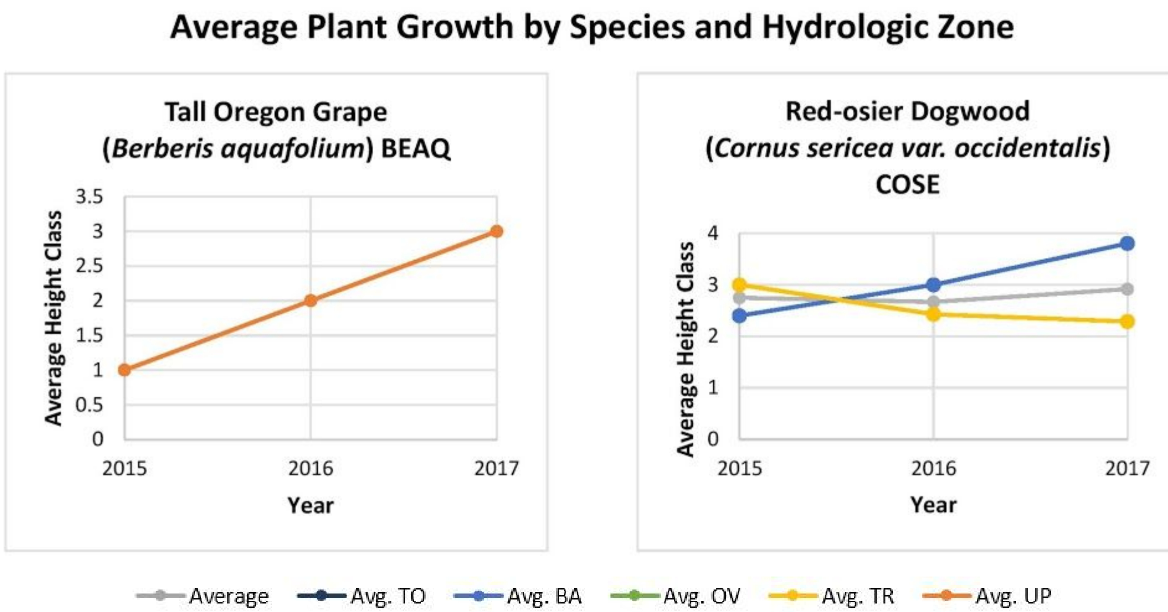

Figure 11: Average height class by species per hydrologic zone from 2015 to 2017 (Hydrologic zones: Toe = TO; Bank = BA; Overbank = OV; Transition = TR; Upland = UP).

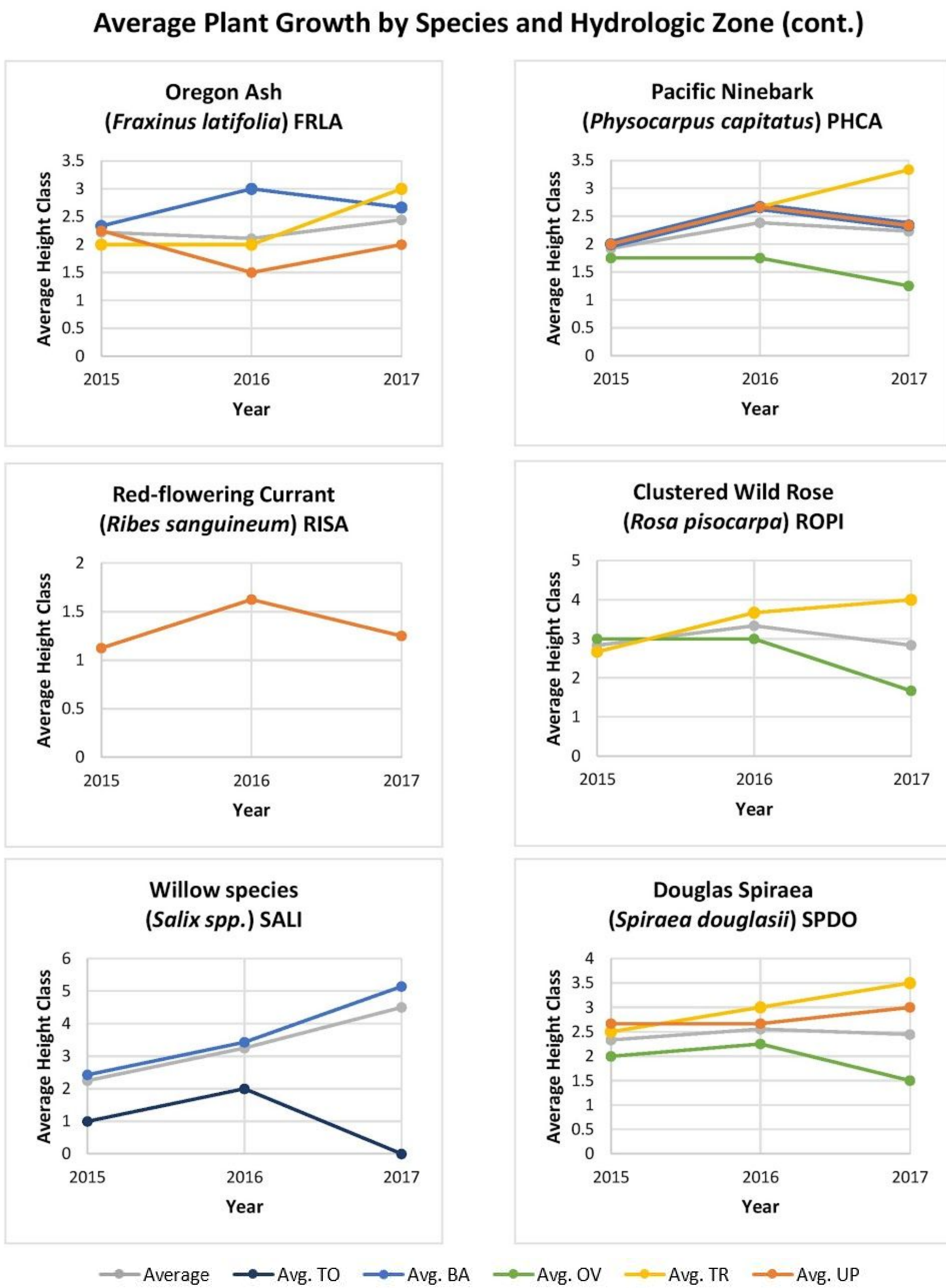

Figure 11 continued: Average height class by species per hydrologic zone from 2015 to 2017 (Hydrologic zones: Toe = TO; Bank = BA; Overbank = OV; Transition = TR; Upland = UP).

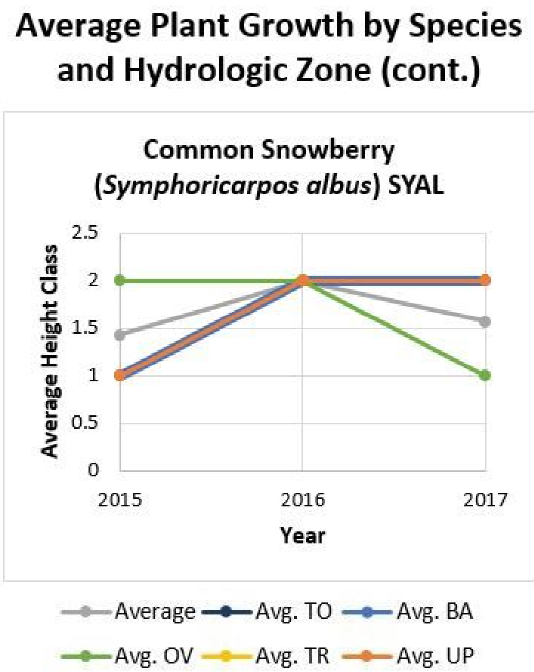

Figure 11 continued: Average height class by species per hydrologic zone from 2015 to 2017 (Hydrologic zones: Toe = TO; Bank = BA; Overbank = OV; Transition = TR; Upland = UP).

<u>3.5 Aquatic Macroinvertebrate Survey:</u>

3.5.1 Goals and Methods:

Certain aquatic macroinvertebrate animal species can be very useful bioindicators in determining the water quality and health of the ecosystem in which they are found. Our team evaluated the health of Goose Creek by surveying specific macroinvertebrate organisms living within the stream at four locations: two at our reference site, Trout Creek, one near the culvert of Goose Creek, and one within Phase II.

Two team members waded through the streams of these areas and captured specimens with a D-net. Collection of organisms was done by placing the D-net flat across the bottom of the creek, collecting material within the bed of the creek in a 1 ft^2 area directly in front of the net. We sampled from downstream working our way upstream at each location in order to channel disturbances we caused away from our sample area. Each captured organism was then separated into ice trays and identified to order using a dichotomous key.

We used the McKenzie Watershed Council Macroinvertebrate Index for assessment based on a point scale where each specimen was classified into one of three possible classes. Class 1 is ‘Sensitive,’ Class 2 is ‘Somewhat Tolerant,’ and Class 3 is ‘Tolerant.’ Class 1 organisms scored three points each, Class 2 scored two points each, and Class 3 scored one point each. Total points were based off each species identified (i.e: each species only scored one time). Water quality at each location was determined from the total points scored.

Figure 12: Macroinvertebrate monitoring.

3.5.2 Results and Discussion:

Comparing our results of the macroinvertebrate survey to 2016 findings, we discovered some discrepancies among survey locations. The 2016 team surveyed three locations, two of which were the same; Trout Creek and the culvert at Goose Creek. The third location at Goose Creek, among the unrestored area, was taken at the bridge in 2016. Our 2017 collections of the unrestored area were taking further down Goose Creek just beyond the culvert on the North bank. The first location at Trout Creek near the bridge and the second location of Trout Creek, about 100 feet upstream from the first location, were evaluated as a low index with a rating of 5, considered poor with regards to water quality. The unrestored area of Goose Creek had a higher index with a rating of 10 while the highest index was evaluated at the culvert at Goose Creek, the location of our restorative work with a rating of 13. Findings from the previous year include Trout Creek with a rating of 8, the unrestored area of Goose Creek at the bridge at 7, and the Phase I culvert at 6.

Considering abundance and species type that may be indicative of different water qualities, our team deduced the disparity of scoring of Trout Creek compared to the two locations at Goose Creek to be due to a variety of factors. Though Trout Creek scored relatively low, the species found were known to be indicative of higher water quality ratings, or more pollution tolerant (Appendix E). For example, four mayfly larvae were found at the first location of Trout Creek, an organism that could represent higher water quality due to its sensitivities to pollution. The second location collected six mayfly larvae. Trout Creek also has faster flowing water, which may account for the lack of diversity observed. Goose Creek at the culvert may have received a higher rating for the variety of organisms found, including; lung snails, aquatic worms, midge larvae, mayfly larvae, and more. We have fallen under the impression that the culverts at Goose Creek may not be the best sampling locations because of sampling error. The

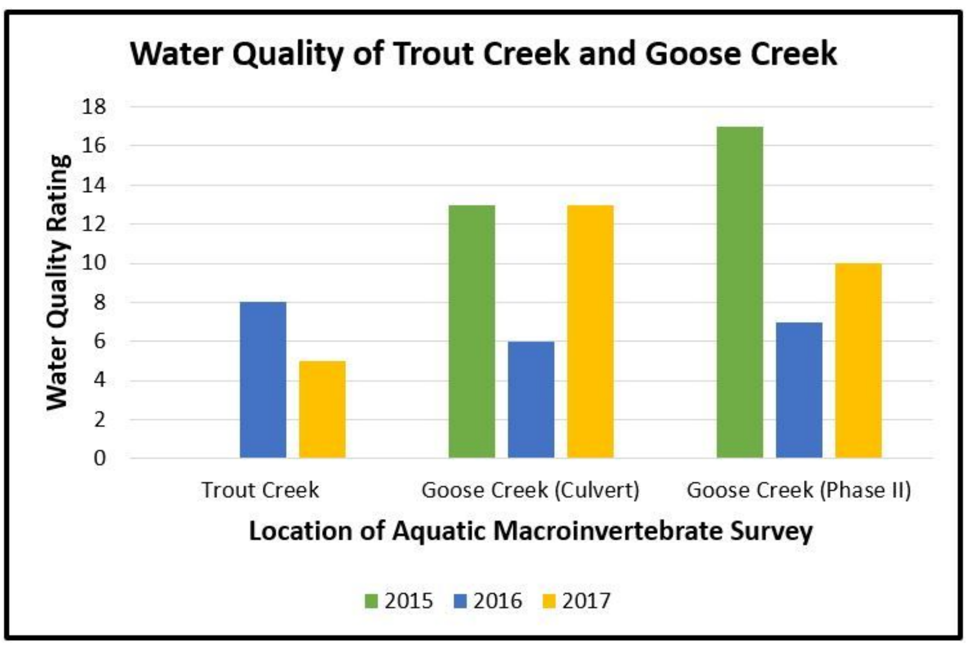

Figure 13: Comparison of water quality rating by location based on macroinvertebrate data.

culverts are not necessarily representative of the rest of Goose Creek and this may be why the culverts scored higher than the other locations (the Phase II location was a culvert).

Because Goose Creek's restoration work is designed to mimic the ecological functions of Trout Creek, the macroinvertebrate survey suggests a greater diversity and abundance of organisms in Goose Creek, hinting at higher water quality within Goose Creek. It is difficult to imply a positive correlation between our restoration work and water quality directly due to a multitude of biological processes that could have affected the findings. Sampling error may be cause for small sampling size coupled with the shading of the Trout Creek sampling locations.

3.6 Pollinator Survey

3.6.1 Goals and Methods:

One of the long-term goals established by this restoration project is to use our riparian plantings to attract native pollinators to Whitewater Ranch so that the owners of the ranch can increase the overall yield as well as the health of the blueberry fields that lie adjacent to our project site. Previous ELP teams have conducted baseline surveys to establish the number of pollinators prior to our team's efforts to revegetate the streambank. Our team conducted two surveys in May 2017 following guidelines established by the ELP Native Pollinators Protocol (Ullmann et al. 2010, as modified by P. Boulay). For each survey, we followed the same four 60-meter long transects established by previous Riparian Restoration teams (Appendix D). These transects were selected using a restricted random sampling procedure by the 2015 ELP team, with each beginning at least one bush inwards from any edge, and all at least eight meters apart from one another. This was done in an effort to reduce the chance of error that could be introduced by double-counting pollinators. Before undergoing the survey, we recorded the weather conditions, temperature, wind speed, phenology, as well as the start and end times of the pollinator survey. To minimize the influence of weather on pollinator activity, we conducted surveys when it was bright enough out to see shadows, and wind speed was be below 10 MPH.

Figure 14: Pollinator monitoring.

Walking along the transects at a pace of three meters per minute for a total of 20 minutes, we observed the blueberry rows and recorded the number of pollinators visiting the flowers of blueberry plants. Teams of two were utilized so that one person could observe pollinators while the other documented the description of pollinators, total numbers observed, as well as the confidence level of observation. The data that was collected from these surveys was then used in comparison with previous teams' data to discern what kind of pollinators are visiting Whitewater Ranch and how effective the planted pollinator hedgerow is at attracting native pollinators to the other flowering plants at Whitewater Ranch.

3.6.2 Results and Discussion:

We found fewer pollinators in 2017 than we did in 2016. This can most likely be attributed to the fact that the weather was very unfavorable to pollinators this year, heavy rains and high wind speeds may have limited pollinator activity. Both 2015 and 2016 ELP teams reported finding a higher percentage of bumblebee's than all other pollinators, we found the opposite this year. 2016's team reported finding an average of 9 bumblebees when combining all transects, while there was only one bumblebee seen across all transects in 2017.

The honeybee appears to be the most frequent visitor to the blueberry fields this year, with an average of five bees observed per visit. This can likely be attributed to the fact that new honeybee hives were installed or replaced in locations all across the ranch to offset the dwindling populations of wild hives. Despite the low amount of pollinators observed, the blueberry bushes had many blueberries forming, indicating adequate pollination. We only visit the ranch once per week so it is possible pollinators were more active on days we were not able to survey. The weather conditions this year impeded us from monitoring the blueberries during optimal bloom time which impacted our data. Future ELP teams may want to adjust the protocol to allow monitoring at different points in the month to account for these type of situations.

3.7 Turtle Monitoring Summary

The 2017 Riparian Restoration team had the exciting opportunity to develop a new protocol and collect baseline data for turtle populations at Goose Creek. We established two observation locations, based upon recommendations from Jim Russell: a known turtle basking log and the pool it creates downstream (Appendix G). Observations were made by sitting quietly and visually scanning the areas for turtles and other wildlife.

We collected data on two different days and made no observations of any turtles basking on the log or in the pool downstream. However, turtles have been seen at Goose Creek before and are known to nest on the property. At the pool location, we observed a lamprey swimming in the creek, as well as Rough-skinned Newts and schools of small fish (potentially full-grown minnows).

3.8 Fencing Monitoring Summary

Our team developed a new monitoring protocol in order to compare the growth of fenced and unfenced hardwood cuttings. Team members selected five plantings (Tags 1-5) from the fenced side (North side) and five planting (Tags 6-10) from the unfenced side (South side). We measured height from the ground to the highest leaf. The baseline data (Figure 15) can be used by future teams to determine if the fencing is protecting the plantings from elk.

Baseline Fencing Effectiveness Data			
Fenced		**Unfenced**	
Tag #	**Height (cm)**	**Tag #**	**Height (cm)**
1	58	6	38
2	95	7	46
3	55	8	51
4	80	9	51
5	62	10	37
Average Height:	**70**	**Average Height:**	**45**

Figure 15: Baseline data for fencing effectiveness monitoring.

4.0 Conclusion/Recommendations

4.1 Conclusion

The 2017 ELP Riparian Restoration team has gained invaluable experience and knowledge from this project while aiding in the restorative actions of Whitewater Ranch. By providing a thorough analysis of the restoration we hope to aid future teams in immersing themselves in this project to perpetuate the important work being done.

4.2 Recommendations

4.2.1 General:

Our team developed some general recommendations for future teams to consider. This year, we noticed that the Spirea have begun to form clusters on the South Bank near the mouth of the culvert. Spirea are rhizomatous - they grow by spreading below-ground stems called rhizomes, and new shoots form at the end of these rhizomes (P. Boulay, personal communication 2017). The weed mats surrounding their newly formed clusters are preventing the new rhizome shoots from growing into healthy new stems, and we recommend these weed mats be removed once the plant has reached a level of growth where it won't be encroached upon by invasives. The same can be said for other species that are rhizomatous as well; future teams must ensure if the weed mats are removed that invasives do not overtake the plots. Fencing seems to have been an effective method for preventing damage due to elk. The whole study site could get fenced so all plantings are protected. However, this would make maintenance harder around the edges, so future teams must consider the benefits and drawbacks. The alders appear to be unhappy because they are too close to the bank and their roots are staying too wet. Future teams should avoid planting alder close to the banks and instead plant them in higher rows.

Adding weed mats between gaps is another option to reduce the maintenance needed by the weed whacker and scalpers, but future teams will eventually need to remove all of the mats as the plantings reach free-to-grow status. The benefits and drawbacks will need to be considered before deciding to implement this suggestion. There are currently hardwood cuttings in the ground that are dead, and we recommend leaving these for the elk to chew and rub against. This could prevent them from doing so on living stakes. Additionally, the large ash should be caged in order to protect them from the elk. The cages will need to be large enough to allow for side branching.

A few problems we encountered while completing the monitoring could have been avoided had we heard the following suggestions. When our data sheets were not printed on Rite in the Rain paper and it did rain, it was extremely difficult and time consuming to record the data. All data sheets should be printed in Rite in the Rain unless the team is sure that it will be sunny all day in the field. We also put any blank copies of data sheets in our binder that can be used by future teams rather than printing out new ones. That being said, all of our monitoring took longer than expected, especially the first time a team attempted any given protocol. This should be kept in mind when field days are planned. Usually, we took an hour longer than expected. Part of this was due to protocols being misunderstood. We recommend that before data is collected, the entire team reviews the protocol, resolves any confusions, and establishes norms for recording information such as damage, comments, and any other reporting that could vary due to observer bias.

4.2.2 Phase II Monitoring:

For our team this was the most confusing protocol, we recommend that future teams ensure they understand how to collect the data before starting. Descriptions of the area should be given special attention and should be updated as needed. Using two data collectors will help keep the data consistent and allow them to communicate easily and effectively.

4.2.3 Pollinator Monitoring:

For this protocol, there were a couple of things that could have made collecting data easier. Make sure the measuring tapes are clean; one got dirt in it which made it very difficult to unroll and roll up. Also be sure to place them so that the meters side is face up. This makes it easy to keep track of your pacing. The pacing outlined in the protocol was not easily applied to the field, one must ensure they know how many steps per minute they were taking. For us, this was about one step every 10 seconds, or one meter every 20 seconds. The protocol also calls for recording any other pollinators that visit the flowers. Most groups saw ladybugs, but there is no consensus for if these are considered pollinators. A consensus should be established and added to the protocol. This year, we had a very late, cold, and wet winter which disrupted our monitoring. Future teams should consider the weather and phenology of the year and adjust monitoring days accordingly. Our team also decided that four transects is not representative of the entire field. Future teams should consider monitoring additional transects.

4.2.4 Aquatic Macroinvertebrate Monitoring:

This year we created an official protocol for the macroinvertebrate survey. Future teams should be sure to adhere to our protocol and make adjustments as necessary to stay consistent throughout the project. We did not establish permanent locations for these surveys, but highly recommend that a future team use some, if not all, the past locations used by previous teams.

4.2.5 Phase I Monitoring:

For this protocol, we ran out of tags and wire and had to go back later to tag the rest of the new plantings. Ensuring that all materials are accounted for before starting the protocol is essential. Teams should also make sure there are no duplicate numbers in a single plot, as this caused confusion in data entry. We further recommend checking each tagged plant to make sure the tags are properly placed and not limiting the growth of the plant. Be sure to keep the classification for the hydrologic zones consistent. We ended up going back through our data and matching it to the classification used by the two teams before us. In addition, some of the plots have more plants to monitor than others. Rather than dividing into equal groups, try to assign an appropriate number of people based on the number of plants in the plot.

Our team built upon Phase I data collection through analyzing tree and shrub growth per plot area. Appendix J includes a color-coded directory to plant height classes; marked red for decrease in growth, yellow for consistent growth, and green for increase in growth. These maps provide a biogeographical distribution of plants that may aid in determining specific species that are doing well or poor in certain locations and hydrologic zones. We recommend future teams to investigate these maps and possibly build upon conclusions to aid in revegetation, promoting free-to-grow status within plots. Upon quick inspection we found some interesting results. Plot 4 had no increase in growth within the whole plot while more than half decreased in growth. Furthermore, Plot 3 consisted of more than half of the planted species showing an increase in growth while only one plant decreased. We believe determining reasons behind these factors, such as animal foraging within Plot 4, can be very beneficial to future management and the project as a whole.

4.2.6 Stream Temperature Monitoring:

The UTM for location 3 was incorrect and sent us to an area that did not match the location description. This had also been an issue for past teams. We took data based on both the incorrect UTM and location description, as had past teams. We recommend that the incorrect UTM data be discarded and for future teams to stop recording data at that location. We found the correct UTM and updated the data sheet accordingly. Our team also had difficulties holding the thermometers, with one thermometer being lost in Trout Creek. We attempted to find a better way to secure the thermometer for data collection. We taped the thermometer to the wire of a flag, however the flag would also slip off. Future teams will need to devise a better way to safely record temperature using the thermometer to avoid what happened this year. We also recommend taking the temperature at Trout Creek first to limit the amount of time spent walking back and forth between the two creeks. Future teams could expand this monitoring protocol to include more locations on Goose Creek to get a more complete picture of the stream's temperature.

4.2.7 Turtle Monitoring:

This year we created the protocol for turtle monitoring and collected baseline data. Of the two locations that will be monitored, one of them is difficult to see because of the tall reed canary grass surrounding the area. Finding a nondisruptive way to remove the grass one to two weeks before the monitoring occurs will limit disturbances to the turtles, and foster accurate data collection.

5.0 Acknowledgements

The ELP Riparian Restoration Team would like to acknowledge and give a big thanks to the owners of Whitewater Ranch, Jim and Jane Russell, as well as the managers of the ranch, Lorin and Mary Zastoupil. We would also like to thank the McKenzie Watershed Council for their help and support with this project; the ELP co-director at the University of Oregon, Peg Boulay; Avni Pravin for her dedication, support, and guidance to the team and her hard work in organizing and helping manage the project; and everyone involved in making the Environmental Leadership Program at the University of Oregon possible. In addition, we would like to give a special thanks to our private donor, the University of Oregon's Environmental Studies Program, for making this opportunity possible.

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7.0 Appendices

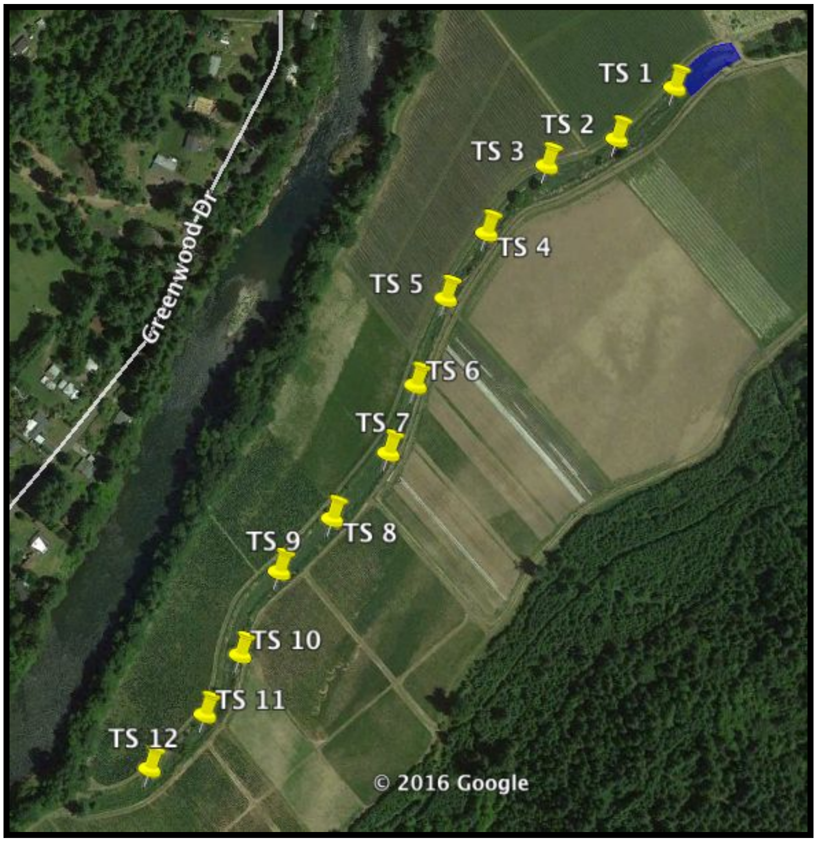
Appendix A. Plant Species List

Common Name	Scientific Name	Species Code
Vine-maple	*Acer circinatum*	ACCI
Tall Oregon grape	*Berberis aquifolium*	BEAQ
Red-osier Dogwood	*Cornus sericea var. occidentalis*	COSE
Pacific Ninebark	*Physocarpus capitatus*	PHCA
Red-flowering currant	*Ribes sanguineum*	RISA
Clustered Wild Rose	*Rosa pisocarpa*	ROPI
Willow species	*Salix spp.*	SALI
Douglas spiraea	*Spiraea douglasii*	SPDO
Common Snowberry	*Symphoricarpos albus*	SYAL
Oregon Ash	*Fraxinus latifolia*	FRLA
Western Crabapple	*Malus fusca*	MAFU
Red Alder	*Alnus rubra*	ALRU
Oceanspray	*Holodiscus discolor*	HODI
Nootka Rose	*Rosa nutkana*	RONUN
Twinberry	*Lonicera involucrata*	LOINI

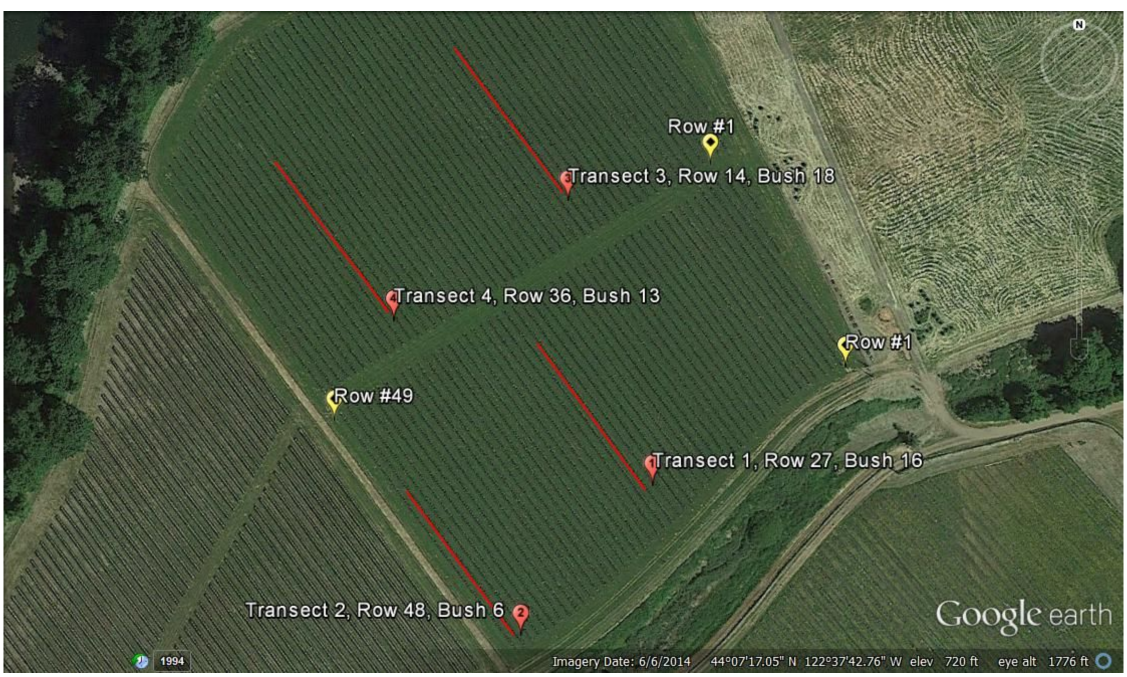
Appendix B. Phase II Transect UTMs

Transect #	Easting	Northing
1	529779	4885353
2	529725	4885305
3	529660	4885280
4	529604	4885217
5	529566	4885156
6	529538	4885075
7	529513	4885012
8	529461	4884951
9	529412	4884902
10	529376	4884825
11	529344	4884770
12	529293	4884720

Appendix C. Map of Phase II Transects



Appendix D. Map of Pollinator Transects



Appendix E. Aquatic Macroinvertebrates Observed

Species	Individuals Counted	Pollution Tolerance	Goose Creek	Trout Creek
Mayfly Larva	10	Sensitive (x3)	X	X
Fish	2	Sensitive (x3)	X	--
Whirligig Beetle	1	Sensitive (x3)	X	--
Stonefly Nymph	1	Sensitive (x3)	X	--
Water Penny Larva	1	Sensitive (x3)	X	--
Fingernail Clam	1	Somewhat Tolerant (x2)	--	X
Dragonfly Larva	1	Somewhat Tolerant (x2)	--	X
Damselfly Nymph	1	Somewhat Tolerant (x2)	X	--
Aquatic Worm	1	Tolerant (x1)	X	--
Midge Larva	2	Tolerant (x1)	X	--
Lung Snail	16	Tolerant (x1)	X	--

Appendix F. Stream Temperature Location UTMs

Site #	Site Location
GC1	0530054 / 4885455
GC2	0529784 / 4885366
GC3	0529224 / 4884716
GC4	0529838 / 4885406
GC5	0531043 / 4885943

Appendix G. Turtle Monitoring UTMs

	Easting	Northing
Basking Log UTM:	0529786	4885379
Pool UTM:	0529581	4884850

Appendix H. Photopoint Monitoring

Location 1 (2016)

Location 1 (2017)

Location 2 (2016)


Location 2 (2017)

Location 4 (2016)

Location 4 (2017)

Location 5 (2016)

Location 5 (2017)

Location 6 (2016)

Location 6 (2017)

Location 8 (2015)

Location 8 (2017)

Location 10 (2016)

Location 10 (2017)

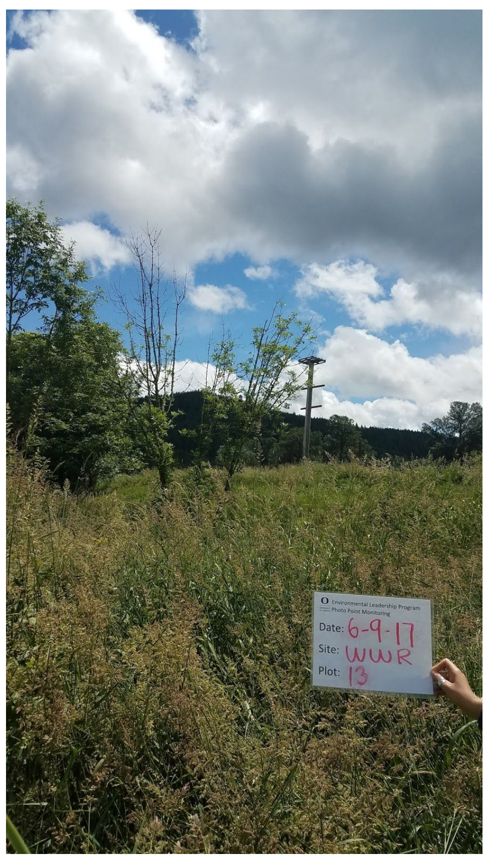
Location 11 (2016)

Location 11 (2017)

Location 12 (2016)

Location 12 (2017)

Location 13 (2016)



Location 13 (2017)

Location 14 (2017)

Location 15 (2017)

Location 16 (2017)

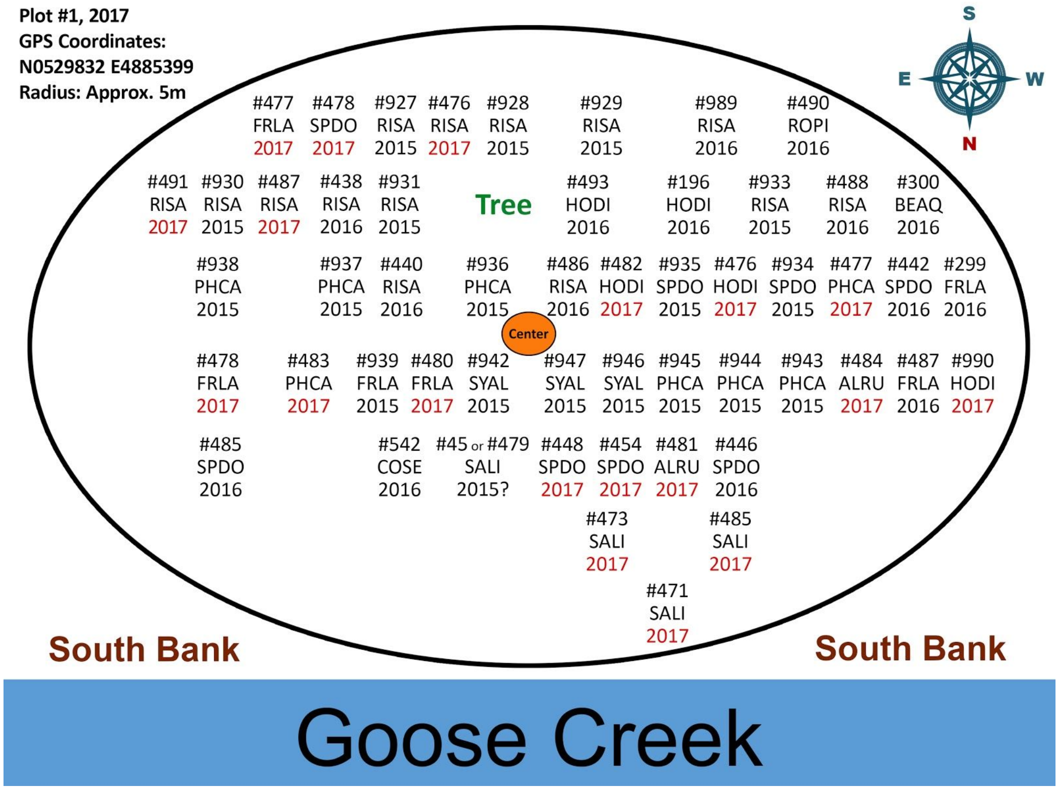
Location 17 (2017)

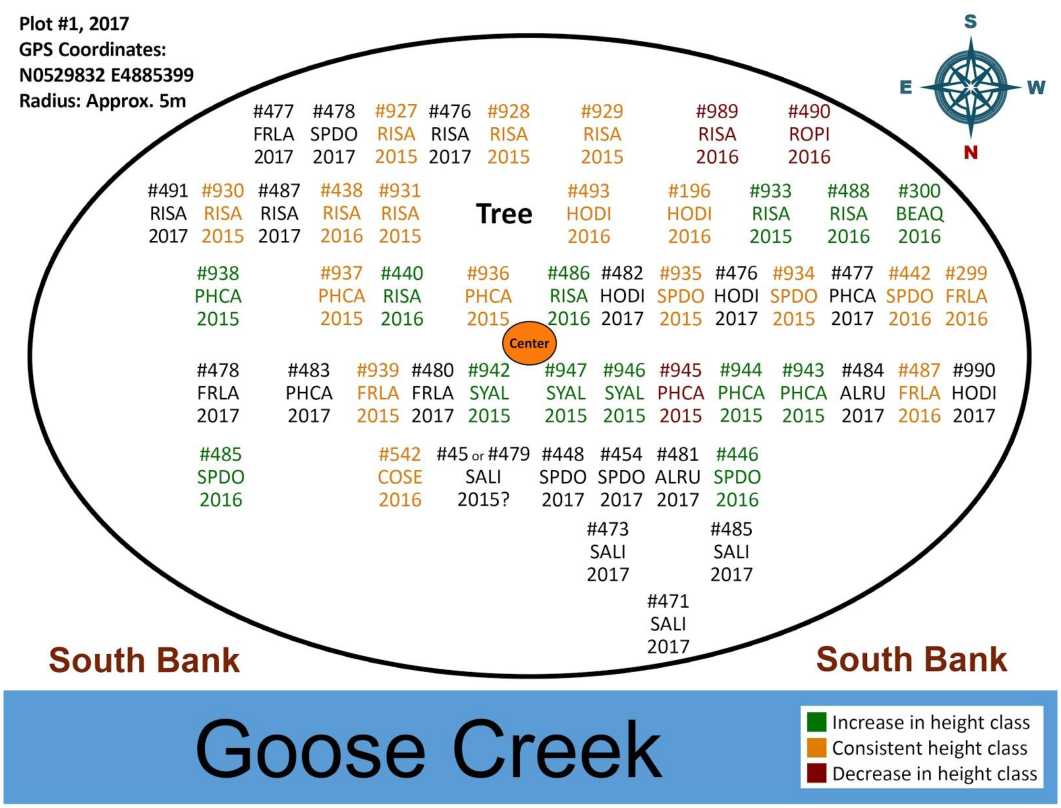
Location 18 (2017)

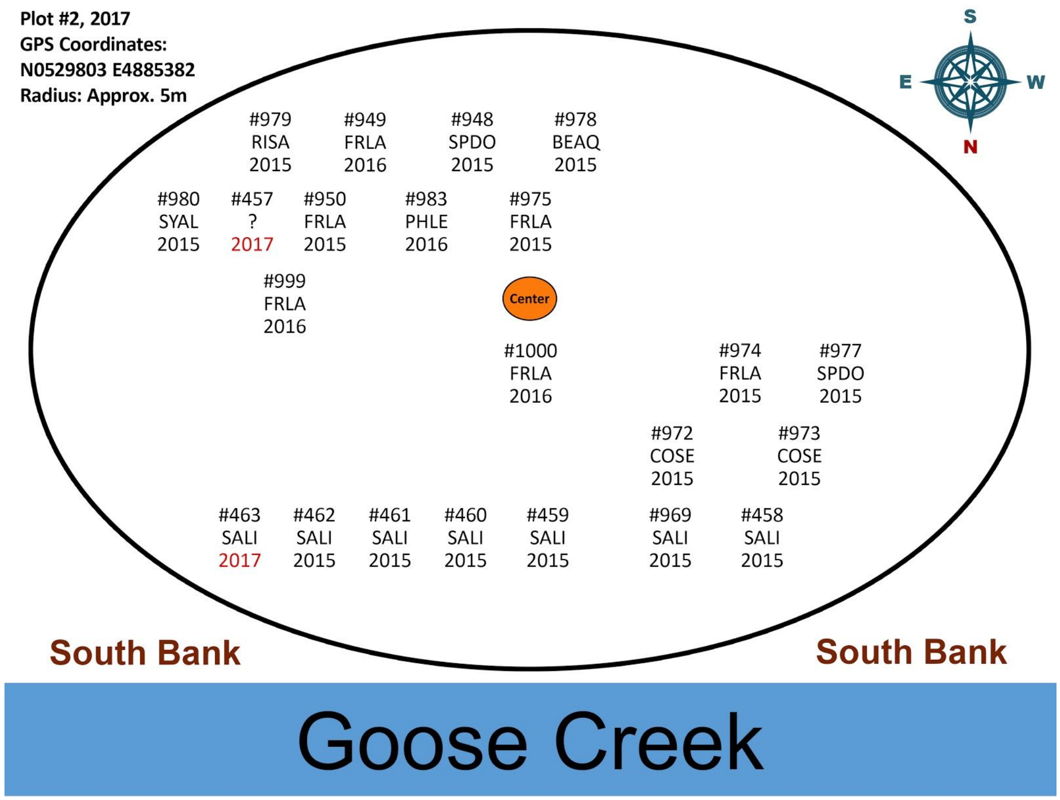
Appendix I. Photopoint Location UTMs

Loc#	Site Loc
#1	529.781 E 4885.373 N
#2	529.781 E 4885.373 N
#4	529.789 E /4885.355N
#5	529.822 E/4885.405 N
#6	529.801 E/ 4885.386 N
#8	529.839 E/4885.406 N
#10	529.740 E/ 4885.326 N
#11	529.563 E/ 4885.162 N
#12	529.631 E/ 4885.268 NE
#13	529.681 E/ 4885.297 N
#14	529.542 E/4885.070 N
#15	529.469 E/4884.956 N
#16	529.397 E/4884.887 N
#17	529.322 E/4884.737 N
#18	529.741 E/4885.335 N

Appendix J. Phase I Monitoring Plots



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E
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#948 SPDO 2015
#978 BEAQ 2015
#980 SYAL 2015
#457 ? 2017
#950 FRLA 2015
#983 PHLE 2016
#975 FRLA 2015
#999 FRLA 2016
Center
#1000 FRLA 2016
#974 FRLA 2015
#977 SPDO 2015
#972 COSE 2015
#973 COSE 2015
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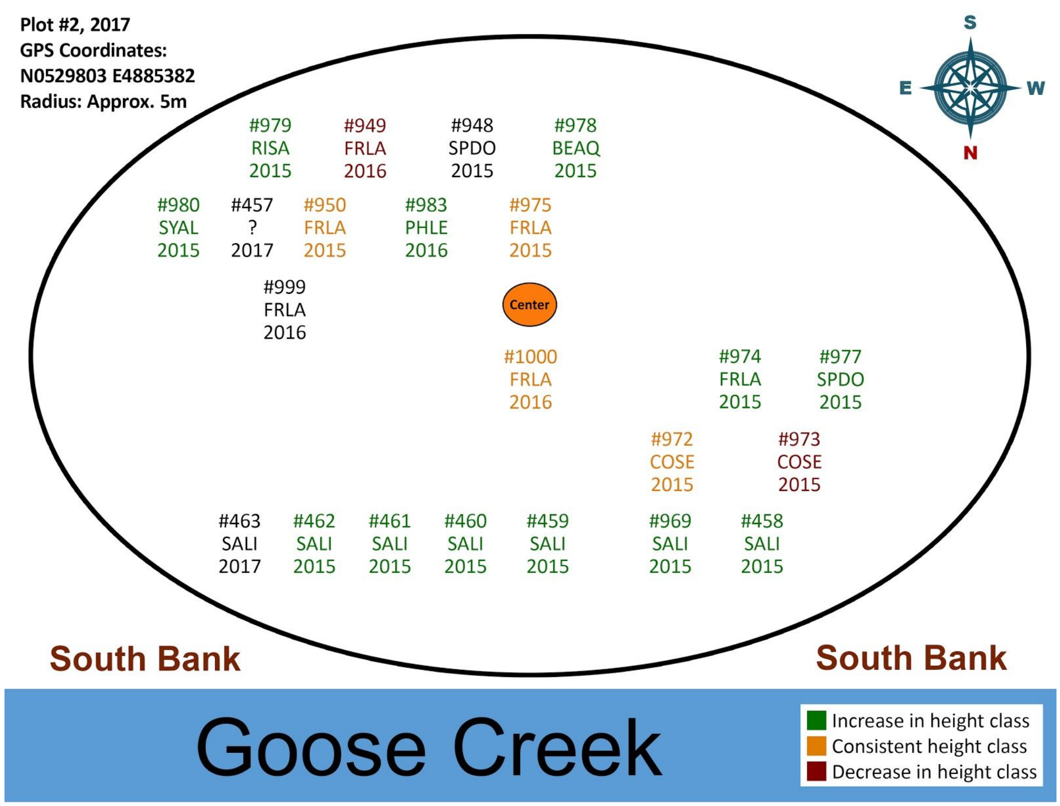
South Bank
South Bank
Goose Creek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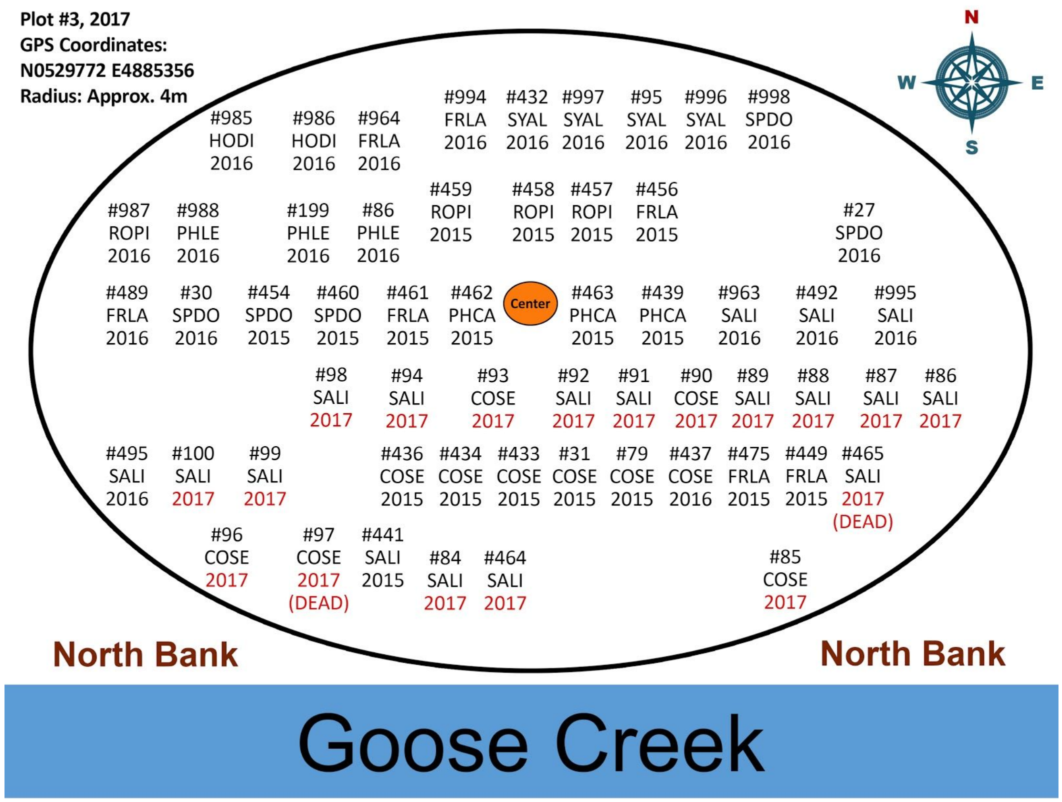
#948 SPDO 2015
#978 BEAQ 2015
#980 SYAL 2015
#457 ? 2017
#950 FRLA 2015
#983 PHLE 2016
#975 FRLA 2015
#999 FRLA 2016
Center
#1000 FRLA 2016
#974 FRLA 2015
#977 SPDO 2015
#972 COSE 2015
#973 COSE 2015
#463 SALI 2017
#462 SALI 2015
#461 SALI 2015
#460 SALI 2015
#459 SALI 2015
#969 SALI 2015
#458 SALI 2015
South Bank
South Bank
Goose Creek
Increase in height class
Consistent height class
Decrease in height class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#998 SPDO 2016
#987 ROPI 2016
#988 PHLE 2016
#199 PHLE 2016
#86 PHLE 2016
#459 ROPI 2015
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#457 ROPI 2015
#456 FRLA 2015
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#30 SPDO 2016
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Center
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#963 SALI 2016
#492 SALI 2016
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#434 COSE 2015
#433 COSE 2015
#31 COSE 2015
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#475 FRLA 2015
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#465 SALI 2017 (DEAD)
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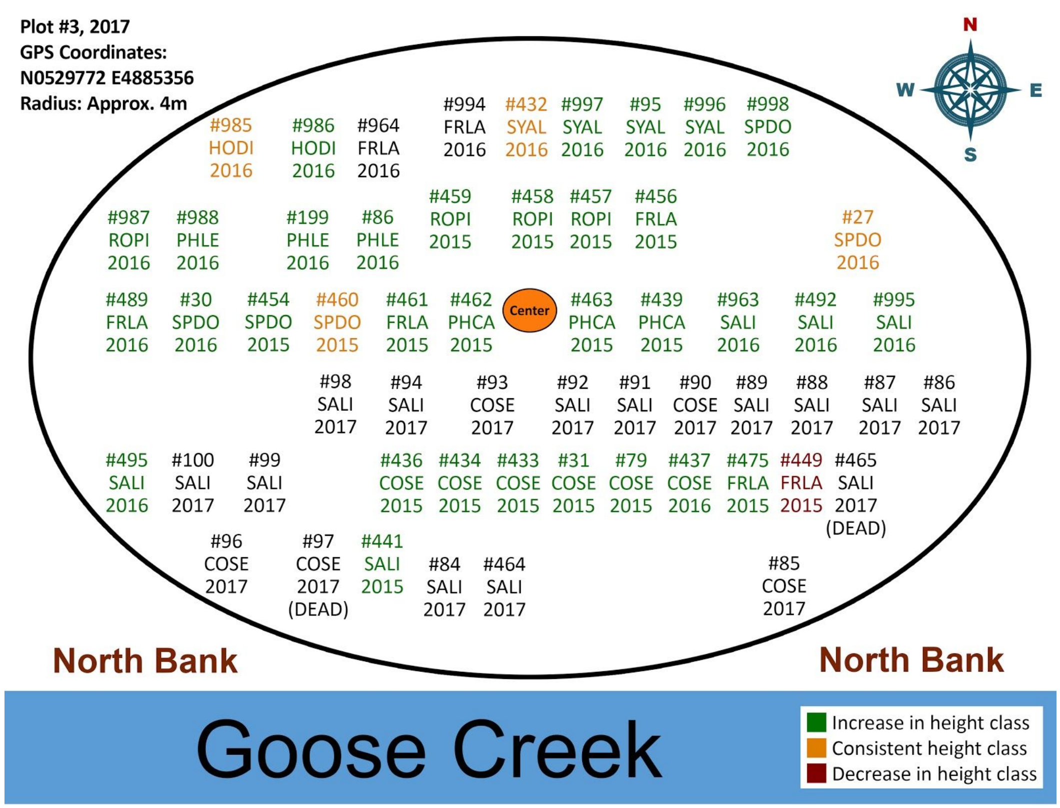
#464 SALI 2017
#85 COSE 2017
North Bank
North Bank
Goose Creek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#97 COSE 2017 (DEAD)
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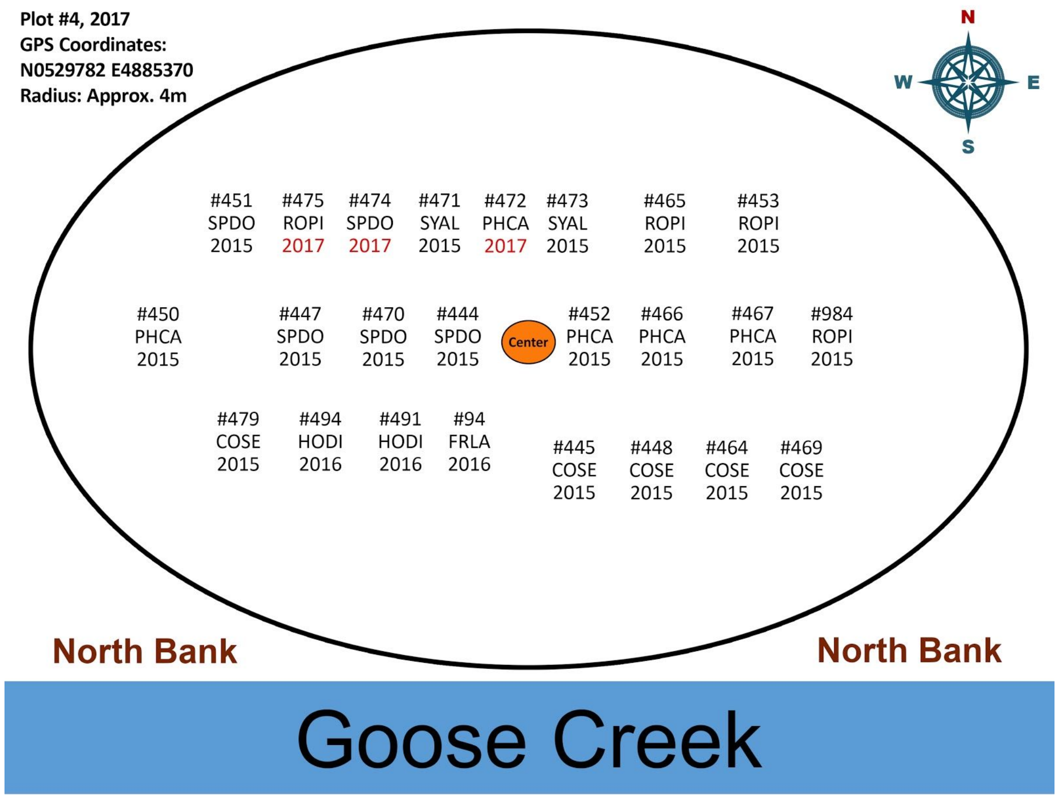
#85 COSE 2017
North Bank
North Bank
Goose Creek
Increase in height class
Consistent height class
Decrease in height class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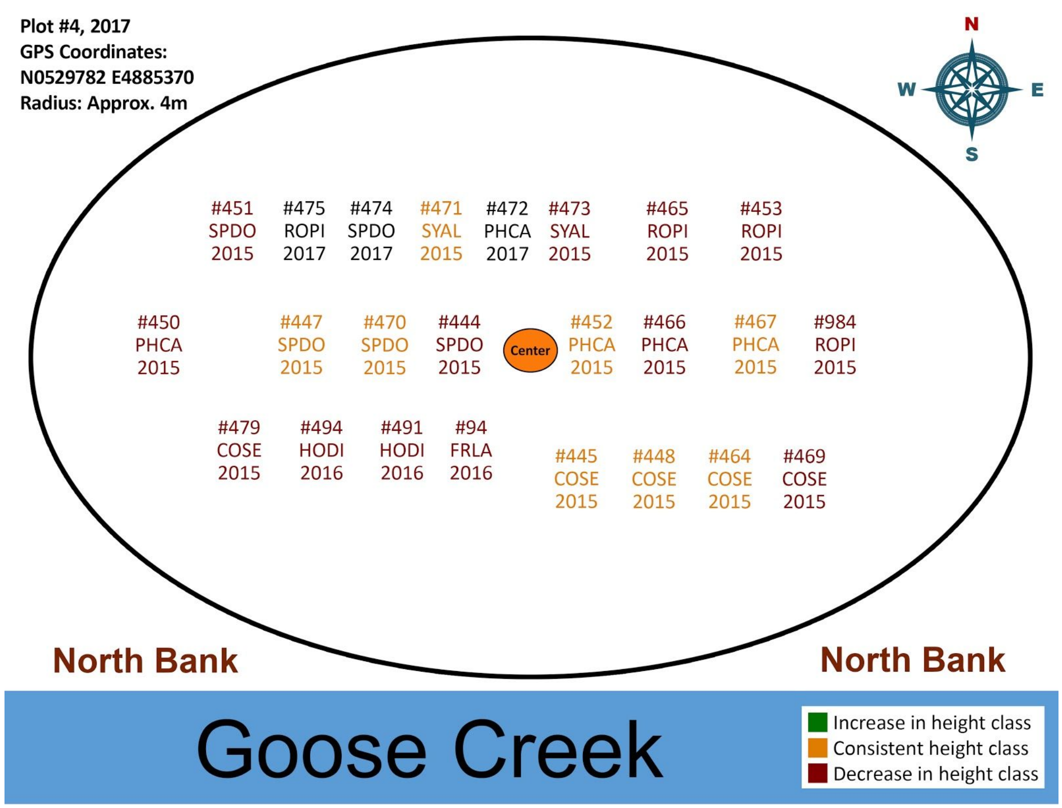
North Bank
North Bank
Goose Creek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#491 HODI 2016
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North Bank
North Bank
Goose Creek
Increase in height class
Consistent height class
Decrease in height class