Native Plant Habitat Restoration on Humboldt State University Campus

ENVS 411: Sustainable Campus
Spring Semester 2012

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Table of Contents

1) Problem statement and background.....3
2) Goals and Objectives.....6
3) Alternatives.....6
    - Grazing.....6
    - Hand Removal.....7
    - Prescribed Fire.....7
    - Herbicide.....7
4) Methods.....8
5) Implementation Strategies/Timeline.....9
6) Results.....11
7) Monitoring.....14
    - Success Criteria.....15
    - Long-term Monitoring.....15
    - Project Evaluation.....16
    - Adaptive Management.....16
8) Literature Cited.....17
9) Appendix I: Photo Points.....19
10) Appendix 2: Brainstorming Ideas.....23

Problem Statement

On the Humboldt State University campus there are many areas that are inhabited by various invasive species. Several non-native plant species are covering and degrading potential native species habitat on campus, creating difficulties in areas for natives to inhabit them.

Background

Invasive Plant Community

Invasive plants can have substantial negative impacts on native flora and fauna as well as on the soil regime. Invasive species can displace native species, hybridize with native species, alter biological communities, and alter ecosystem processes. Many Invasive species form monocultures that can out-compete native species which causes a reduction in food and potential habitat for native wildlife (Aschehoug and Callaway 2000). Also if left unchecked invasive species have the potential to spread from the site they inhabit and continue to grow into other areas. This is why ecological restoration often involves removal of invasive species. Human-caused landscape alterations can affect the distribution and quality of environmental resources in ecosystems in a way that pre-adapted, non-native plants can colonize and complete with native plants (D'Antonio and Meyerson 2002). Observed on the site were many signs of disturbances including clustering of rocks and gravel, broken cement chunks, plastic sheets, netted coverings, and tarp ingrained into the sloping area of the site indicating a large amount of disturbance, providing viable habitat for the present invasive species. It can also be seen that the area has patterns in the layout of the invasive species. English Ivy is seen dominating on the bottom of the slope as well as near the Redwood trees, Blackberry clusters around the top of the slope, and Crocosmia in areas of open canopy and where it is sunny.

-English Ivy:

English Ivy (*Hedera helix*) is an invasive ground cover plant that colonizes disturbed areas, and is able to quickly establish itself as a monoculture (Biggerstaff and Beck 2007). In Oregon English Ivy is considered to be a noxious weed. English Ivy can thrive with minimal amounts of sunlight and can reproduce vegetatively as well as through seeds. Ivy segments as short as one inch can root and form a new plant, which can make removal especially challenging (*Hedera helix*, USFS, 2011). English ivy dominates the ground level of the system and quickly invades

the soil and replaces the native ferns, reducing biodiversity, altering underground systems, and changing overall ecosystem functions (www.cal-ipc.org). It grows on trees and shrubs adding weight to the canopy structure that ultimately increases storm damage (Westbrooks 1998).

-Himalayan Blackberry:

Invasive Blackberry species dominate areas that would otherwise be occupies by higher quality wildlife habitat such as native plant communities (Caplan and Yeakly 2006). Himalayan Blackberry (*Rubus armeniacus)* was introduced to America from Europe in the late 1800s as a cultivated crop and its spread was very difficult to contain. It is commonly found in disturbed areas on a variety of soil types and light conditions. Capable of growing up to six meters in a year, blackberry quickly overtakes native low growing vegetation through shading and accumulation of dead leaves and stems (Hoshovsky 2000). The rapid formation of dense thickets bearing large, sharp prickles makes blackberry a major barrier to the movement of animals and trail maintenance.

-English Holly:

English Holly (*Ilex aquifolium*) is an invasive species that hails originally from the British Islands and flourished throughout central Europe before the period of glaciation (English Holly Identification, King County 2012). Holly gradually adapted to the warmer climate conditions present after glaciation and began to spread. It was brought to America as an ornamental and then began to disperse and invade. English Holly is from the Family Aquifoliaceae, and is identifies by its sturdy dark green leaves with five sharp spines on each leaf. It is a dioecious evergreen tree that grows 15-50 feet tall. The flowers are white, inconspicuous and smell sweetly. Holly can also be identified easily from the brighter red drupe fruit hanging in clusters from female trees. Holly can be persistent in forests as it is shade tolerant and can grow in drained soils. If it grows tall enough, it can create rough growing for the understory as it creates heavy shade under its dense foliage. English holly has the ability to encroach into native forest habitat and reproduce successfully in undisturbed native communities due to its tolerance. Holly is pollinated by bees and its seeds area dispersed through birds (primarily blackbirds). It can take a variety of methods to effectively remove it including hand removal herbicides, and trimming (Nawrocki 2010). The most effective way to remove holly is to dig up and remove thoroughly so no roots remain. Herbicide is not usually recommended due to the wax coating of the holly leaves, as the chemicals would most likely run off.

-Montbretia:

Montbretia (*Crocosmia x crocosmiiflora*) is a non-native dioecious perennial herb that grows from basal underground corms. It is prominent around the Pacific Northwest as an invasive species, and has subsequently invaded areas such as Australia and New Zealand (Cal-IPC 2012). It can distribute itself through above ground stolons, and can be a problem when not thoroughly removed, as the corms left behind became unattached, can still survive and thrive. This hybrid species is member to the Iridaceae Family, which can be represented through growth from bulbs, having a basal rosette of leaves, and being a monocot with a prominent mid-vein. Montbretia has vibrant orange corollas from a raceme inflorescence, which espouse the dehiscent capsule through wind. In California, this specific *Crocosmia* is used ornately in gardens and is popular among uninformed homeowners due to its beautiful vibrancy and low maintenance (Factsheet 2006). Montbretia grows in many conditions, and prefers to colonize disturbed areas. It can easily out-compete native species vying for the same areas, as it grows in dense patches and hoards sunlight and water. The recommended use to manage Montbretia is to manually remove every piece of the plant so as to not leave behind any detached stolons, or corms, as it is very resilient and can re-grow from the little pieces left behind. Mowing will subdue it but it will re-grow after a short period of time.

Native Plant Community

Redwood (*Sequoia sempervirens*), also called coast redwood and California redwood, is native to the central and Northern California coast, a region of moderate to heavy winter rain and summer for which is vital to this tree species. It is a conifer, which can reproduce both asexually and sexually. Redwood seeds, generally, are ready to germinate soon after they fall to the ground. The germination rate of redwood seeds is usually low, however, in its early stages redwood grows rapidly in height (Rogers 2000). These trees are highly valued by HSU because of the potential for research as well the aesthetic value.

Other native species that may inhabit this area include Sword ferns (*Polystichum munitum*), Clover (*Trifolium*), Lady Fern (*Athyrium filix-femina*), and many others. Many of these plants area understory plants and can survive in areas that receive a minimum amount of sunlight. The

rooting systems of these plants also act as a hold and prevent drastic soil erosion and sediment runoff.

Goals

- Create habitat for native vegetation
- Increase cover and abundance of native plant species in the project site
- Improve ecological resilience of the site by increasing the diversity of native species
- Improve the aesthetic quality of the project site
- Long-term maintenance

Objectives

- Decrease the abundance of non-native and invasive plant species by 100% at the site
- Eradicate all non-native and invasive plant species by April, 2012
- Complete native plant installation by May 1, 2012
- Achieve 90% native cover on the project site within three years
- Implement three year monitoring strategy to ensure invasives do not come back

Alternatives

1. Grazing (Goats):

The site is already visited by deer and other herbivores (as seen through the droppings on site). Thus we know that some of the plants on site attract, and are palatable for grazing (ruminant/ungulate) species. Bringing in goats to the site would be an effective way to eliminate the invasive English Ivy and Crocosmia. They would be maintained by being tied up to a central tree and allowed to roam the distance of the site. Or they could possibly be fenced in with a temporary fence to allow for constant grazing of the site, removing the invasive species at a high rate. A study was done on the effects of goat grazing on English Ivy previously in the Willamette Valley in Oregon. The findings there showed that the sample plots that had been browsed by goats had a large decline in the presence of Ivy, and that re-treatment resulted in suppression of growth of the English Ivy and a succession back towards native flora, including ferns (Borman et al. 2010).

This alternative would be time effective, but not entirely cost/clean-up effective. A cost would have to be paid to either buy or rent the goats, and also to buy the fencing. If the goats are left on the site (which is only 120 ft by 40 ft), there may be large amounts of excrement that may need to be removed. There would need to be constant supervision of the goats to make sure they were not escaping and causing turmoil elsewhere, as this site is on campus with a large diversity of other species. There may be an issue with soil compaction of the goats, as they would be constantly stomping around with heavy bodies putting pressure on soil with small hooves, and the goats may also cause erosional problems with slope failure, as there is a small steep slope on the site. We would have to remove the native ferns on the site while the goats were present, as they do eat ferns when other plant abundance has dwindled (Bullock, 1985).

3. Hand Removal and Replanting Natives

This alternative would be cost effective as well as achievable in a relatively short amount of time. The feasibility of replanting native ferns would allow for a more diverse environment after treating the infected area. This will help suppress the invasive species from re-establishing post treatment. By replanting native species we would be increasing the ability for natives to grow and thrive to give them a head start to outcompete the invasives that are trying to re-establish themselves (ICPRB).

5. Prescribed Fires

The use of fire can be an effective tool to help reduce and eliminate unwanted, outcompeting non-native species. Repetition of prescribed fires could be an effective tool if used correctly and efficiently. Prescribed fires are most appropriate on sites that are mostly comprised of monocultures of invasive plants, such as grasslands (Lisa 2003). Other reasons we will not choose this alternative is because the site is not suitable for prescribed burning because of the close proximity of trees, a house, a daycare facility, and even possibly the new Schatz Energy Center.

6. Herbicide

Herbicide is an effective method for controlling invasive plants in many areas. An issue concerning the use of chemical control has to do with issues raised by the public. In 2007, Californians for Alternatives to Toxics sued the Humboldt County Agricultural Commissioner and California Department of Parks and Recreation when herbicides were used on an invasive plant species near the Eel River (Beyond Pesticides 2007).

If this alternative was chosen, a systemic herbicide would be used. System herbicides are absorbed through plant tissues and then into the roots, effectively killing the plant in a matter of days. Systemic herbicides such as triclopyr and glyphosate are effective in removing invasive plant species (Westbrook 1998). These work by stopping amino acid synthesis in any plant it touches so great care would need to be taken in order to not accidentally apply herbicide to native plants in close proximity. In cases of English Ivy with large woody stems, the stems should be girdled and herbicide applied directly to the open cut (English Ivy 2012).
Herbicide has been decided to not be a feasible alternative due to reception by the public, and the fact that HSU has a general policy not to use herbicides. The site is on campus and the public will likely see the process of invasive plant removal. The reaction to herbicide use would not likely be a positive one. This method also has the potential to harm native plants on site.

Methods

Initial Data Collection

The area between the Natural Resources and Forestry building is the reference site, as it has been restored previously by removing invasive plant species present and replanting native species. For this project, the area between the Schatz Energy Center and the house next to the parking lot (across the road from CCAT) will receive a similar treatment. Before removing anything from the site, we first took a survey of all the species that were present and estimated a ground cover percentage with a one square meter quadrat along two line transects across the site. The invasives consisted of mostly English Ivy, and Himalayan Blackberry and Crocosmia, but the site also included the following species: English Holly, Pampas grass, Clover, Dock, Wild Mustard, CA Blackberry, "Arrow" Ivy, Wild Strawberry, Dandelion, Plantago (ssp), Ceanothus, Cedar, Evergreen Huckleberry, Sword Fern, Lady Fern, Firs, and Redwoods.

Removal process

The removal of the above mentioned invasive species would be done by hand over a span of one month. Tools such as shovels, trowels, Pulaskis, and rakes will be used to remove the plants. The process will begin in the western portion of the site and removal will continue to the end of the plot until complete removal (depending on time constraints). English Ivy, as one of the more

dominant invasive species, will be removed with as much of the below ground rhizomes as possible to eradicate it from the site. Crocosmia will be removed from the site with trowels to remove the bulbs to prevent resprouts. Larger and more difficult plants such as Himalayan blackberry will be removed with shovels and rakes. Removed plants and other debris will be placed in a pile nearby the site and is to be taken by Doug Kokesh and Plant Operations to be composted or mulched.

Replanting

Following up removal of invasive species on the site, planting native species will take place to stabilize the soil along with other methods to prevent erosion. Once the invasive species are removed from the site native plants such as *Polystichum* (ferns) will be planted to inhabit the area. Other methods to stabilize the soil and minimize erosion will be to place wood-chips and eucalyptus mulch on the site to minimize the amount of erosion, along with rounded straw barriers to catch sediment runoff.

Monitoring and Follow up

After the site has been replanted the site will be monitored for the progress of plant growth including the native and invasive species. The natives will be monitored for plant growth and will be assessed for how successful their growth and habitation of the site is, which will determine the success of the project. The invasive species will be monitored as well, to see if removal was successful and determine if additional removal will be needed. We used the area between the Forestry building and Natural Resources building as a reference condition to assess effectiveness, as that area has been restored by a previous ENVS 411 class and is nearby to this site.

Implementation Strategies

1. Initial contact with Doug Kokesh, the manager of Grounds and Landscape Services at Humboldt State University, with: Roger, Pat, Jacob, Brett, and Robert. (1/31/12)

2. Meet with Doug Kokesh to visit site and establish common goals and objectives, with: Roger, Pat, Jacob, Brett, and Robert. (2/7/12)

3. Site visit and survey: Measuring the area of the site behind Schatz energy center (120 feet by 40 feet). Develop a list of species present at the site, native and non-native, and identify problem species, with: Roger, Pat, Jacob, Brett, and Robert. (3/8/12)

4. Establish photo reference points and take pre-restoration photos of the site for future project evaluation, with: Roger. (3/12/12)

5. Complete line transect across the length of the site estimating percent cover. The 1 square meter quadrat was placed every 3 meters and percent was estimated for each species looking down from above, as well as bare ground and leaf litter, out of 100% possible. 24 plots were sampled, 12 above the slope and 12 below, with: Roger and Jacob. (3/12/12)

6. Begin removing target species from site, with: Roger, Pat, Jacob, Brett, and Robert. (3/12/12)

7. Visit with Freshwater Farms Nursery for plant recommendations and possible donations, with: Jacob, Pat, and Robert. (4/14/12)

8. Finish invasive removal. Take pictures post-removal, for reference, with: Roger, Pat, Jacob, Brett, and Robert. (4/27/12)

9. Replant native species: Ferns, Evergreen Huckleberry, Redwood Sorrel, etc.; and stabilize exposed soil using wood chips and mulch, with: Roger, Pat, Jacob, Brett, and Robert. (4/27/12)

10. Complete line transects post-removal using the same method and same path as was used in step 5, with: Roger. (4/30/12)

11. Create graphs and figures of effectiveness of removal methods comparing pre to post removal, with: Roger. (4/30/12)

12. Create a powerpoint showing the results of the project, with: Roger, Brett, Pat, Jacob, Robert (5/1/12)

Results

The initial survey of the site resulted in 20 tree, shrub, vine, and grass species present. Tree: Redwood, Cedar (ssp), Fir (ssp). Shrub: Evergreen Huckleberry, Himalayan Blackberry, California Blackberry, Lilac, Sword Fern, Lady Fern, English Holly. Vine: English Ivy, "Arrow" Ivy. Grass: Clover, Wild Mustard, Dandelion, Pampas Grass, Crocosmia, Dock, Plantago (ssp). Not all species were represented in the quadrat sampling during the percent cover estimates however, as there may have been very little of them or they had been crowded out.

Near the beginning of the project, percent cover estimates were taken evaluating the abundance of the invasive and native species present at the site. The invasive species that had the highest abundance and thus the largest dispersal potential and threat were the English Ivy and Crocosmia, with an average percent cover of 28% for Ivy, and 36% for Crocosmia (Figure 1).

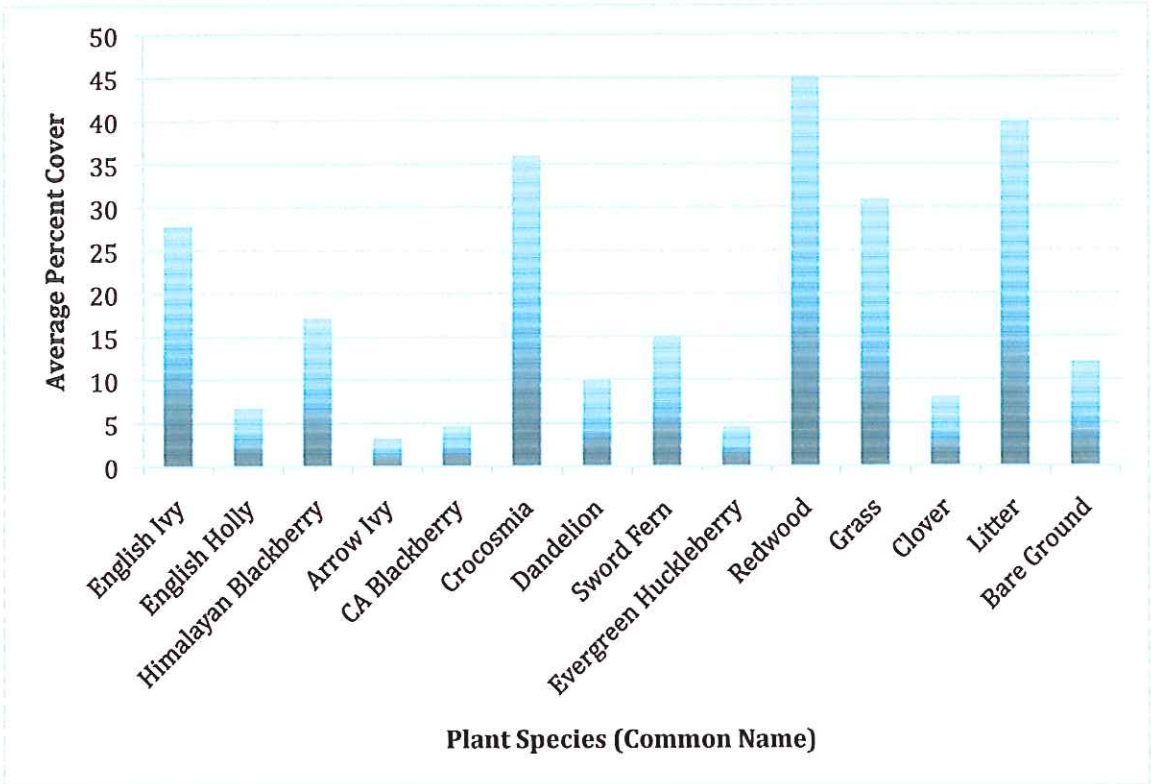

Figure 1: Average percent cover of plants (and litter/bare ground) pre-removal, assessing averages over the plots they were found in.

Along with calculating percent cover, we also analyzed the frequency, or evenness, of these species pre-removal. Himalayan blackberry was the most frequent species found along the 24 plots sampled, as it was found in 16 plots. Crocosmia and English Ivy were also very abundant, showing up in 13 plots for Crocosmia, and 14 plots for English Ivy (Figure 2).

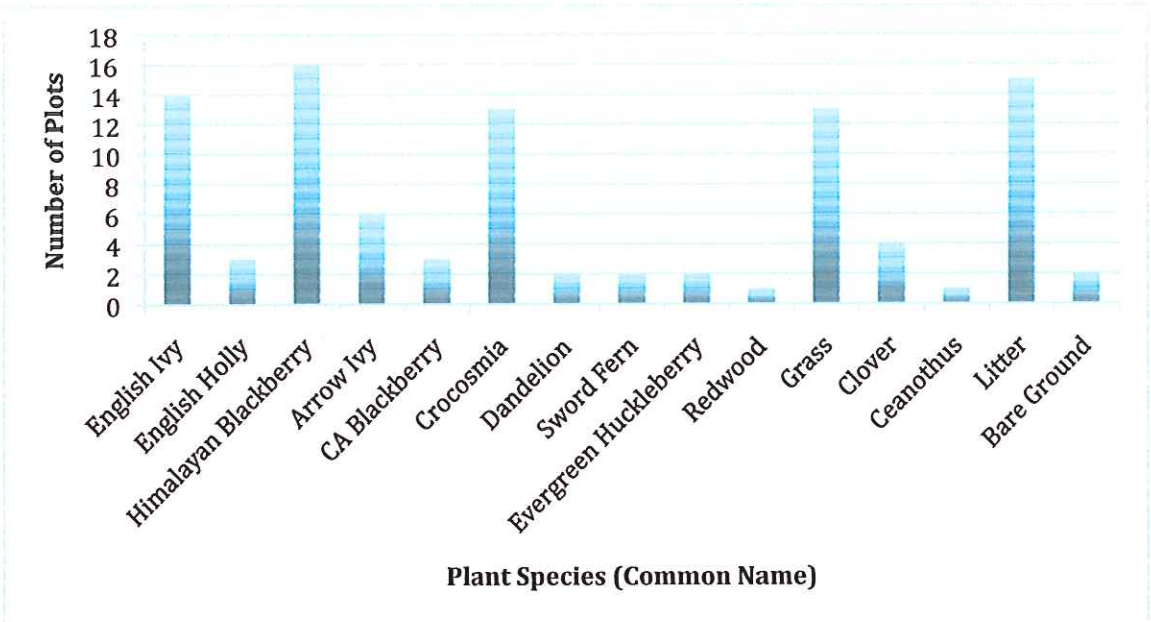

Figure 2: Species Evenness pre-removal, showing in how many plots each of the plants were found, out of 24 plots sampled.

After the invasive species were removed, and more natives were planted in the areas where the Ivy and the Blackberry was removed, another estimate of percent cover was taken, in order to assess how effective the removal process was. Post-removal, in the quadrats sampled, grass, lady fern, and litter (as mulch had recently been laid down) had the highest percent covers in the average of the plots they were found in (ie. lady fern had 60%, but was in one plot). Also English Ivy, Himalayan Blackberry, and English Holly were not found in any plots sampled (Figure 3).

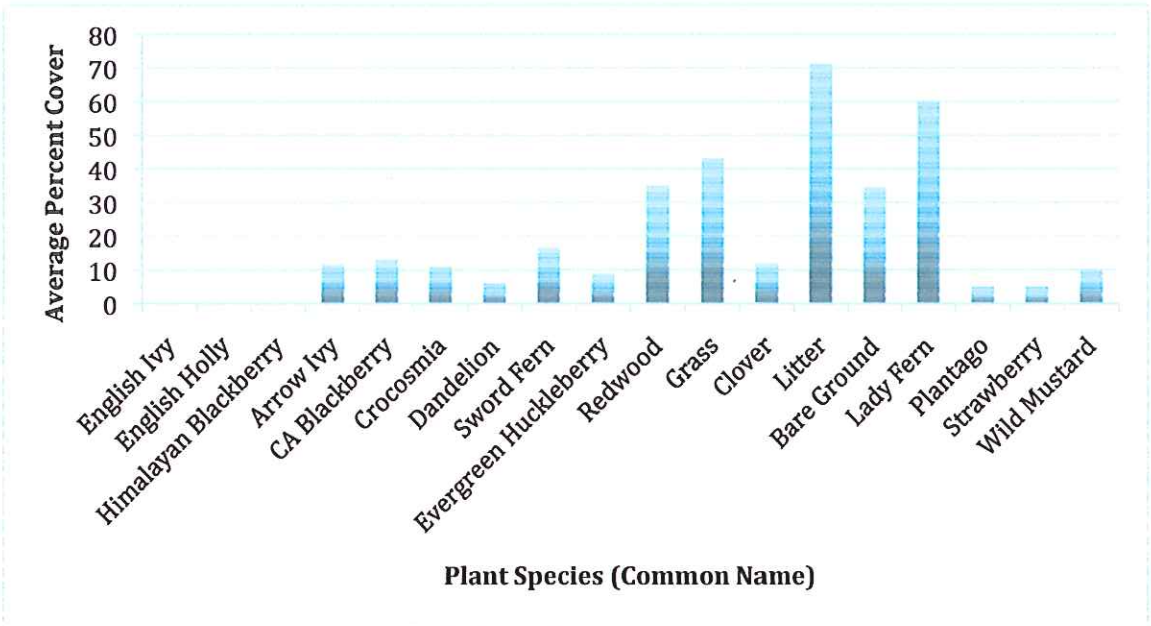

Figure 3: Average percent covers of plants (and litter/bare ground) post-removal.

Also, similarly to pre-removal, post-removal frequency/evenness estimates were taken to analyze how many times each species was present along the transect gradient. Grass, Litter, and Bare Ground were the most common ground cover variables post-removal and post-planting. New species were found in these plots samples also, including: Lady Fern, Plantago (ssp), Wild Strawberry, and Wild Mustard (Figure 4). These plants were present pre-removal, just not represented in any plots sampled.

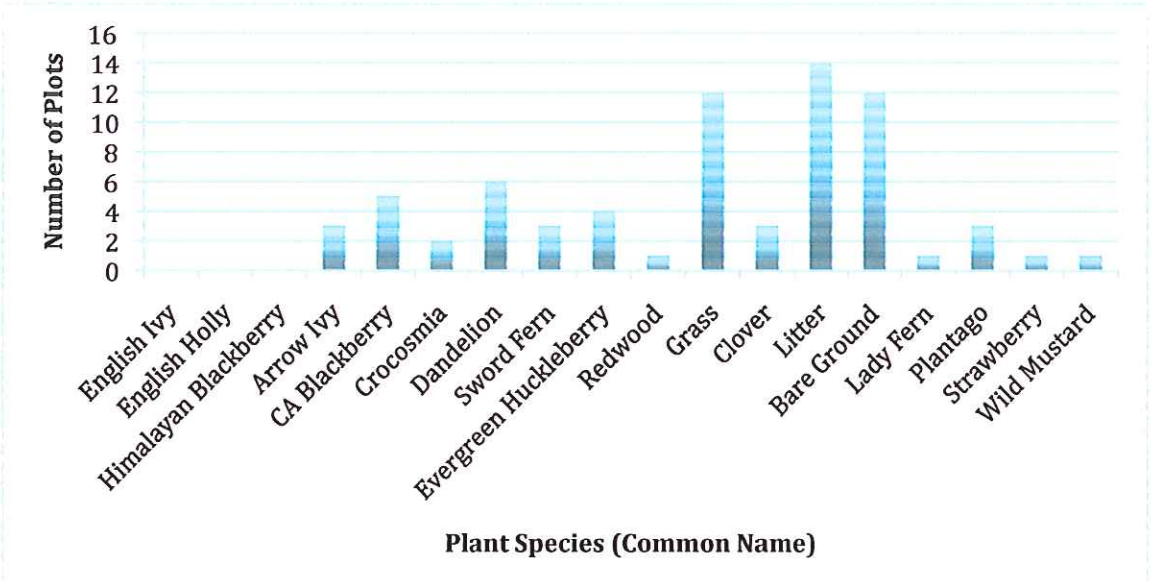

Figure 4: Species Evenness post-removal, showing how many plots the species (or litter/bare ground) was found in, out of 24 total plots sampled.

Comparing the data pre-removal to post-removal, and with following the same basic path of line transects, we were able to put the data side by side to allow for analysis and an effectiveness assessment. Most of the main invasive target species (Himalayan Blackberry, English Holly, English Ivy) were not found in the second round (post-removal) of quadrat sampling, and native species (CA Blackberry, Sword Fern, Lady Fern) showed an increase in percent cover from pre-removal to post-removal (Figure 5). Also new species are represented now, as also indicated in Figure 3, and Figure 4.

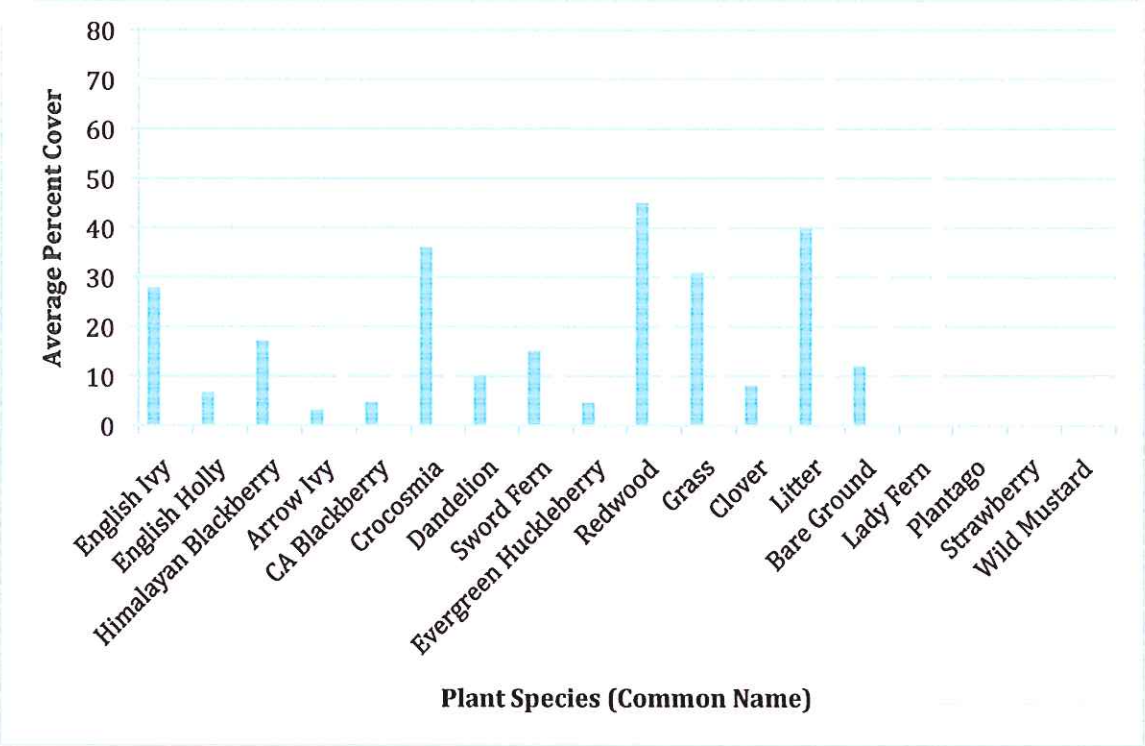

Figure 5: Side by side analysis of average species percent covers pre-removal (Blue), and post-removal (Red), "Litter" is high due to the site recently being mulched.

Monitoring

Why Monitor?

Long-term monitoring will take place before and during the invasion as well as before, during and after any control attempts that can provide valuable ecological information. In particular, it is important to understand how changes in the abundance of species influence ecosystem properties and processes that, in turn, will help guide management decisions. Monitoring design and data collection should be sophisticated enough to allow statistically sound

data analysis. It would be interesting to investigate whether we have certain threshold levels of abundance where any further increase of invasive plants would result in unacceptable levels of the soil erosion, nutrients, and even the symbiotic microorganisms in the soil. Will the soil be stable enough to support the native species when the invasives are all taken out? Will the invasives just take back over? Monitoring is needed to provide information on how well our project worked and what we could do in the future to 'adapt' to the best possible concept.

Success Criteria

-At the end of the projected monitoring plan, about 3 years from now, the project site will:

1) Have native vegetation established→ ferns, grasses, and sorrel
2) To remove Crocosmia, Himalayan Blackberry, and English Ivy by 85%
3) Having no erosion problems
4) Having less than 5% of all invasive species come back the next year

-After the end of the 3 year monitoring period, our group will finalize a decision to see if we have met our goals and objectives. If our group feels like we accomplished our goals, then we will get a more professional opinion from Doug Kokesh. If additional measures need to be taken, then additional efforts will be continued to fully complete our project goals and objectives.

Long-Term Site Monitoring

The effectiveness of restoration near the Schatz Energy Building will be monitored through vegetation cover percentage that was previously established in late January. We estimated ground cover percentages of each species that was present at the site (both native and non-native). In addition to vegetative cover percentiles, we also took photo points at the worksite to visually document invasive removal and any other subsequent changes during our project. These photo points can be used in the future to document continued change in vegetation cover. Both the photo points and the vegetative cover percentiles will be marked on a restoration map. We also recommend that changes in weather and the erosion problem should also be considered in our long-term monitoring program.

Project Evaluation

After working on this semester long restoration project, our group felt like we accomplished a major portion of the project, just in regards to the actual removal of invasives and replanting natives. Even though we are finished with the actual removal of invasives and planting of native ferns, grasses, and sorrel, there is still much to be done in terms of post-monitoring, post-adaptive management, and how to keep the invasives from ultimately infesting the area again. All in all, our group worked together efficiently and effectively. Sometimes it was hard to get the group all together at the same time because of time conflicts and having five members, but even then, we all pulled together are fair share of work on and off the project site.

Adaptive Management

Adaptive management will begin at the start of this project until the end of the 3-year monitoring plan. Implementing this monitoring plan is crucial for this project to be fully completed someday. Working in a non-controlled experiment/ environment, there is always a need for backup strategies to help us deal with the unexpected. As the project is implemented, pre and post monitoring will take place. After the 3 year monitoring period, our group and plant operations manager, Doug Kokesh, will decide whether or not more actions should be taken to fully complete this restoration project.

Threshold Point	Adaptive Management Strategy
-If Native vegetation survivorship <50%	- Increase (biodiversity) by planting more natives and removing invasives
-Bank destabilization and soil erosion	-Use sand bags and jute netting to decrease disturbance and soil erosion
- If there >40% of Crocosmia, English Ivy, and Himalayan Blackberry	-Continued removal effort, as well as ask advice from plant ops manager, Kokesh, to try and keep invasives away

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Appendix 1: Photo Points

Pt 1, Before:

After:

Pt 2, Before:

After:

Pt 3, Before:

After:

Appendix 2.

Alternatives brainstorm:

- Grazing
- Plastic covering
- Complete hand removal
- Partial hand removal
- Prescribed burning
- Herbicide
- Heavy machinery
- Hire a crew
- Gather volunteers from Natural Resources Club or CCAT
- Introduce natural fauna to remove it (gophers, etc)
- Direct abundant seeding to try and outcompete invasives
- Paving over the site
- Flooding & attempt drowning the plants
- Explosions/dynamite
- Turn site into a community garden
- Allow invasives to continue to grow until they kill each other
- Construct apparatus to block out sunlight
- Use as a dump site and bury the invasives
- Plant plants which produce allelopathic conditions
- Introduce slugs/snails in large quantities

Time Log for Roger Stephens

DAYS	DESCRIPTION	HOURS
Jan 26, 2012	Brainstorm	1.5
Jan 31, 2012	Brainstorm	1.5
Feb 2, 2012	Brainstorm	2
Feb 7, 2012	Meet with Doug	1.5
Feb 14, 2012	Research	2
Feb 19, 2012	Background Writing	3.5
Feb 23, 2012	Research	2
Feb 27, 2012	Goals/Objectives	1
Mar 12, 2012	Initial Data Collection/Begin	4
Mar 13, 2012	Site Removal	2
Mar 16, 2012	Site Removal	2
Mar 20, 2012	Alternatives	2
Mar 23, 2012	Site Removal	2
Mar 27, 2012	Implementation	2
Mar 29, 2012	Planning	1.5
Mar 30, 2012	Site Work	2.5
Apr 1, 2012	Site Work	2
Apr 5, 2012	Planning	1.5
Apr 6, 2012	Site Work	2
Apr 7, 2012	Site Work	2
Apr 10, 2012	Monitoring	2
Apr 13, 2012	Site Work	2
Apr 17, 2012	Group Discussion	2
Apr 20, 2012	Site Work/Meet with Doug	3
Apr 26, 2012	Report Revision	2
Apr 27, 2012	Site Work/Replanting	2
Apr 30, 2012	Excel Figures/% Cover	4
May 1, 2012	Report Revision/Addition	4
May 2, 2012	Powerpoint Slides/Report	6
May 2, 2012	Log of Hours	1
May 3, 2012	Presentation/Practice	1
		69.5 hours total

Appendix

Sources:

Websites
http://abe-research.illinois.edu/pubs/factsheets/SumpPumps.pdf

http://www.buypumpswholesale.com/page/tdhcalculator_w/help

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http://www.appropedia.org/CCAT_yurt_rainwater_catchment

http://www.appropedia.org/M_Street_Eureka_rainwater_catchment

http://www.appropedia.org/Original:Rainwater_management

http://www.appropedia.org/Original:Rainwater_harvesting

"Chlorination of Drinking Water." *Drinking Water Testing Environmental Testing Lab Water Research Center*. Web. 29 Nov. 2011. <http://www.water-research.net/watertreatment/chlorination.htm>.

http://eartheasy.com/blog/2009/03/tips-for-installing-a-rainwater-collection-system/

http://www.greenandmore.com/ra-wp-gardn-gro.html

http://www.instructables.com/id/Elevated-Dual-Barrel-Rainwater-Collection-System/

http://www.mendeley.com/research/water-quality-rooftop-rainwater-harvesting-systems-review/
Journal of Water Supply Research and Technology AQUA (2006)
Volume: 55, Issue: 4, Publisher: IWA Publishing, London, SW1H 0QS, United Kingdom, Pages: 257-268
DOI: 10.2166/aqua.2006.008 Available from Journal of Water Supply Research and Technology AQUA

"Urban Runoff." *The Charles Edward Via, Jr. Department of Civil and Environmental Engineering*. Web. 28 Nov. 2011. <http://www.cee.vt.edu/ewr/environmental/teach/gwprimer/group18/urbanr.htm>.

Time Log for Jacob Faucher

Date	Event	Hours
Jan 26th	Brainstorming	1.5
Jan 31st	Initial Contact with Doug	1.5
Feb 2nd	group work	2
Feb 7th	Survery with Kokesh	1
Feb 9th	group work	1
Feb 14th	research	2
Feb 16th	group work	1
Feb 19th	Background writing/ research	2.5
Feb 21st	group work	1
Feb 23th	research and writing	2
Feb 27th	Goals and Objectives	2
Feb 28th	Goals and Objectives	1.5
March 6th	Met with group before site removal	2
march 8th	group work	2
March 12th	Site Removal	1.5
march 20th	worked on alternatives	3
march 22nd	group work	2
march 26th	implementation strategies	1.5
march 27th	implementation	2
march 30th	site removal	2.5
april 2nd	group work	1.5
April 4th	Removal	1.5
April 5th	start on post-monitoring	2
April 7th	monitoring	2
April 9th	monitoring	1.5
April 10th	group work	1.5
April 13th	site removal	2
April 15th	site removal and met with Rick from Freshwater Farms	3.5
April 19th	site removal and monitoring	2
April 21th	Site removal and planting of natives	3
April 24th	work on final project-Problem Statement	2
May 2nd	work on final project-Problem Statement and Background	4
May 2nd	finishing touches on ppt presentation	2
		64

Time Log for Brett Agler

Date	Event	Hours
Jan 26th	Brainstorming	1.5
Jan 31st	Initial Contact with Doug	1
Feb 2nd	group work	2
Feb 7th	Survey with Kokesh	1
Feb 9th	group work	2
Feb 14th	research	2
Feb 19th	Background writing/ research	3
Feb 21st	group work	1
Feb 23th	research and writing	2
Feb 27th	Goals and Objectives	2
Feb 28th	Goals and Objectives	1.5
March 6t	Met with group before site removal	2
march 8th	group work	2
March 12th	Site Removal	1.5
march 13th	site removal	2
march 20th	worked on alternatives	3
march 22nd	group work	2
march 26th	implementation strategies	1.5
march 27th	implementation	2
march 30th	site removal	2.5
april 2nd	group work	1.5
April 4th	Removal	1.5
April 7th	worked on paper	2
April 9th	paper	1.5
April 10th	group work	1.5
April 13th	site removal	2
April 15th	site removal and met with Rick from Freshwater Farms	3.5
April 19th	site removal and monitoring	2
April 21th	Site removal and planting of natives	3
April 25 - 26	my sections of the paper	4.5
May 2nd	Powerpoint	4
May 2nd	finishing touches on ppt presentation	2
	TOTAL:	66.5

Time log for Robert Camacho

Date	Event	Hours
Jan 26th	Brainstorming	1.5
Jan 31st	Initial Contact with Doug	1.5
Feb 6h	Research for project background	3
Feb 7th	Survey with Kokesh	1
Feb 9th	group work	1
Feb 16th	group work	1
Feb 21st	group work	1
Feb 27th	Goals and Objectives	2
Feb 28th	Goals and Objectives	1.5
March 6th	Met with group before site removal	2
march 8th	group work	2
March 12th	Site Removal	1.5
march 13th	site removal	1
march 17th	site removal	1
march 20th	worked on alternatives	0.5
march 22nd	group work	2
march 26th	implementation strategies	1.5
march 27th	implementation	2
march 30th	site removal	2.5
march 31st	site removal	1
april 2nd	group work	1.5
April 4th	Removal	1.5
April 6th	Correspondence and outreach	1
April 8th	Met with Doug for consulting and to get tools	1
April 10th	group work	1.5
April 13th	site removal	2
April 15th	site removal and met with Rick from Freshwater Farms	3.5
April 19th	site removal and monitoring	2
April 21th	Site removal and planting of natives	3
May 2nd	research for presentation	1
May 2nd	finishing touches on ppt presentation	2
	TOTAL	50.5