[Effects of woody encroachment of *B. pilularis* on the Jasper Ridge ecosystem]

[Jasper Ridge is a biological preserve owned by the research institution Stanford University. Originally, Jasper Ridge was comprised of pristine grasslands but recent periods of heavy Spring rainfall have contributed to the woody encroachment of *B. pilularis*. This study aims to examine three phenomenons, 1) the effects of *B. pilularis* encroachment on herbaceous plant density & abundance, 2) the effects of *B. pilularis* encroachment on insect pollinator abundance and diversity, 3) the effects of woody encroachment on herbivory abundance – this is examined as a DRIVER not as an impact. We examined the hypothesis that woody encroachment would cause phenomenons – use spell check! 1 and 2 to decrease whereas we hypothesize that herbivory may increase or decrease creating negative or positive feedback loops that facilitate or inhibit further woody encroachment. We studied 11 plots at Jasper Ridge – all under varying levels of pre-existing Baccharis ground cover – and collected and analyzed insects, used the pindrop method to determine vegetation density, calculated the volume of *B. pilularis* seedlings, and analyzed herbivory levels. No findings were consistent with our hypotheses, however no confident conclusions could be drawn because data was skewed.]

Introduction

Jasper Ridge is a biological preserve located in Portola Valley, California. It is owned by Stanford University and used as a research facility. Originally, Jasper Ridge was a grassland but in the early 1970's *B. pilularis* began to spread rapidly contributing to woody encroachment at Jasper Ridge. (Williams et al. 1987)

Woody encroachment of *B. pilularis* has significant effects on the surrounding ecosystem of Jasper Ridge. Before woody encroachment, Jasper Ridge originally had a variety of grasslands. Serpentine grasslands consist of mostly native plants, like bunch grass and wildflowers that have evolved a tolerance to the high magnesium and low calcium ratio. Serpentine soil eroded from the Earth's mantle and consists of relatively high concentrations of magnesium, nickel, mercury, chromium and relatively low concentrations of calcium, nitrogen and phosphorus nutrients. Native plants have developed a tolerance for the toxic minerals whereas exotic species cannot differentiate between magnesium and calcium and end up absorbing a toxic amount of magnesium causing them have stunted growth and eventually die. Organisms native to California and who are reliant on serpentine soil are decreasing as serpentine becomes more sparse and scattered due to woody encroachment.

Annual grasslands, in contrast, have herbaceous plants species that are non-native grasses like oatgrass and velvetgrass. The plants are perennial or annual with some slow growing perennial bunch grasses in California, but mostly fast growing European annual grasses that have crowded out many native plants.

Thus, because their soil has low nutrients and heavy toxic metals, and because exotic plants absorb high levels of magnesium which stunts their growth and inhibits their survival, serpentine grasslands are not as susceptible to invasion by non-native plants as non-

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Comment [DP2]: You must use the full genus name the first time you introduce a plant or any other organism

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Comment [DP4]: This is backwards, whether herbivory is driving or imhibiting woody encroachment

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Comment [DP5]: Need to mention that the plots were under various degrees of pre-existing Baccharis cover class.

Comment [DP7]: Your study doesn't really have much to do with the serpentine grasslands, so this is a little too broad to be put in your introduction.

Comment [DP6]: Actually, the whole extent of JR was not a grassland before the 1970s. You might mean pristine grasslands existed at JR prior to the 1970s serpentine grasslands whose soil is nutrient rich and able to support exotic plants. However, serpentine grassplands have become sparse and scattered due to woody encroachment and annual grasslands remain in its place. As annual grasslands are more susceptible to exotic invasion, facilitating woody encroachment.

It was hypothesized that the spread of *B. piluaris* was due to grazing or fires but no significant grazing or fire activity has occurred since the 1960s and woody encroachment still occurs today. Instead, previous research has found that the peak invasion of *B. piluaris* occurred in two periods of high rainfall which allowed *B. pilularis* invasion to occur rapidly due to X???.

Woody encroachment can have many impacts on the surrounding ecosystem due to canopy effects that contribute to light reduction and decreased moisture. This puts grass plants at a major disadvantage and facilitates further woody encroachment. As the plant life changes, so does the ecosystem. Woody encroachment thus effects not only vegetation but also levels of herbivory and insect pollinator diversity and abundance.

Our study aims to find to what extent woody encroachment affects pollinator diversity and abundance, the success of herbaceous species, and native herbivory rates. To determine the role of native herbivory in driving woody encroachment, this study has two major hypotheses. 1) Native herbivory rates will decrease in regions of high *B. pilularis* cover, decreasing the number of predators on *B. pilularis* and facilitating *B. pilularis* invasion. Under this hypothesis, we expected that there would be a lesser difference in herbivory between the control and enclosed plots used in this study as woody encroachment increases. 2) Native herbivory rates will increase in regions of high *B. pilularis* cover contributing to a greater difference between control and enclosed plots.

We also hypothesized that herbaceous species abundance and pollinator diversity and abundance would decrease as canopy level increases.

Methods

We evaluated # plots at the Jasper Ridge Biological Preserve, # plots under cover class A, X plots under cover class B, X plots under cover class C. Two yellow insect pan trap bowls (A and B) were placed in each plot 8 hours before data collection. Insects were identified to the level of biological Order by microscopy. Move the insect stuff up here.

Vegetation was measured using the pin drop method and data regarding density and abundance of woody or herbaceous vegetation were recorded. 6 data points were sampled. Data was categorized into 5 categories: 0-10cm, 10-20cm, 20-30cm, 30-40cm, over 40cm.

We measured herbivory on 8 seedlings. Herbivory (spelling) levels were measured based on a 0 to 4 scale. Zero (don't start sentences with numbers) being no herbivory, 1 being <_5% herbivory, 2 being >_5% herbivory but 50% remaining leaf area, 3 being less than 50% of leaf area remains, and 4 being 100% leaf herbivory. There was also an n/a option for which the plant was dead due to causes other than herbivory.

Vertical height, greatest width and depth were measured for 8 *b. pilularis* seedlings. Volume was calculated from these measurements using Microsoft Excel 2008. Seedlings were separated into two groups. Exclosure and control. The exclosure group was enclosed in

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Comment [DP9]: It's okay to say "we"

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Comment [DP11]: Were – data! This would probably read better as we rated vegetation according to 5 categories. Or something that like…..

Comment [DP10]: Good!

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an area where larger herbivory could not access it and control group had no enclosure.

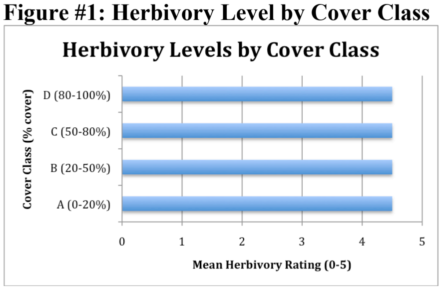
Insects were analyzed after suspension in 70% ethanol by a dissecting microscope. We determined insect types based on an insect key. Insects were classified into the biological orders Coleoptera, Hemiptera, Hymenoptera, Diptera, Thysanoptera, or Lepidoptera.

Cover class was determined based on aerial photography. We assigned plots to 4 cover class categories. A had 0-20% cover, B had 20-50% cover, C had 50-80% cover and D had 80-100% cover. Move this up to the section where I indicated.

Results

Herbivory did not increase or decrease based upon *B. pilularis* cover. The average herbivory level in each cover class (A to D) was 4.5. This indicates that herbivory is not correlated with canopy cover. (Figure 1)

Figure #1: Herbivory Level by Cover Class

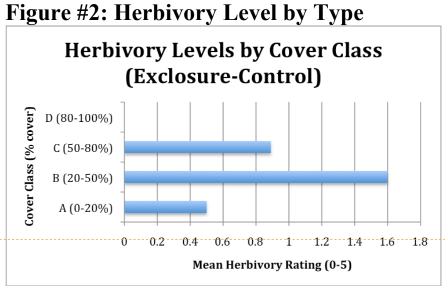


This figure is a graph of the average herbivory level sorted by canopy class/percent cover. Each class had an average herbivory rating of 4.5 This indicates that canopy cover is not correlated with herbivory rates. This should be a paired bar graph – showing exclosure and control separately. If done that way, you don't need Figure 2.

The difference in average herbivory by cover class is displayed in Figure 2. The decrease is not gradual based upon cover class.

Remember that you should only be stating your results and any trends in your data; no analysis of your data should be in the results section. More of your results will go here.

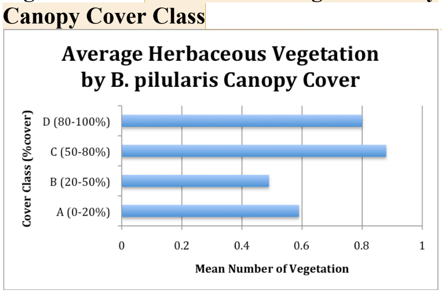
Figure #2: Herbivory Level by Type



The above graph shows the difference in herbivory level between the exclosure and control group. The average control rating was subtracted from the average exclosure rating for each class. This graph displays no typical pattern of increase or decrease in herbivory between control and exclosure plots as the density of B. pilularis *increases or decreases.*

The average number of live or dead herbaceous vegetation in Jasper Ridge is 0.32 plants. The standard deviation is 1.09 and the standard error is 0.04. (Figure 3).

Figure #3: Herbaceous Vegetation by Canopy Cover Class



Comment [DP13]: herbivores

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Comment [DP16]: oops

Comment [DP14]: Except as noted, you did a great job on presenting the results section.

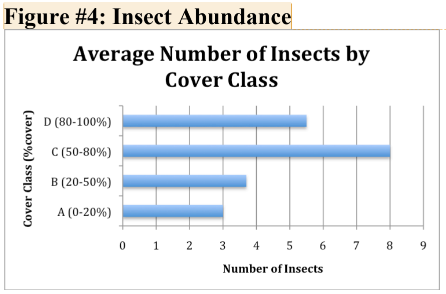
Comment [DP15]: Hmm, I think something went wrong with your analysis. No one else saw an average of 4.5 across all the cover classes.

Comment [DP17]: So what was the purpose of measuring the different height categories? This should have been reported here….Also, you should have reported the dead and live vegetation separately.

This is a graph of vegetation based on canopy cover class. Both live and dead herbaceous plants are included. Class A had 0.59 herbaceous plants, class B had 0.49, class C had 0.88, class D had 0.8.

When split into cover class, the average number of insects was found to be 5.05. Cover class A had an average of 3 insects, B an average of 3.7, C an average of 8 and D and average of 5.5. The standard deviation was 2.23 and the standard error was 1.12. (Figure 4).

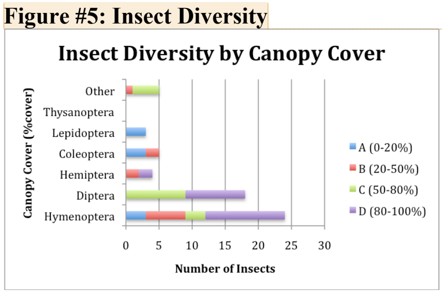
Figure #4: Insect Abundance



This graph shows the average number of insects found in each canopy type.

The average number of insects found in all plots was 2.11 with a standard deviation of 3.24 and a standard error of 0.611. Cover class D had the largest number of Hypmenoptera and Diptera which were also the most commonly found species. Cover class A had mostly Lepidoptera and Coleoptera.

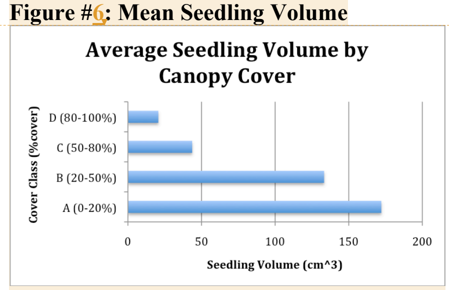
Figure #5: Insect Diversity



The graph shows the insect diversity within each canopy cover. Each canopy class is separated by a color. The key is located to the right of the graph. The most commonly found insects were hymenoptera and diptera regardless of cover class. No thysanoptera were found.

The average seedling volume decreased as canopy cover increased. The average overall seedling volume was 119.97 cm^3. The standard deviation was 277.50 and the standard error was 28.32.

Figure #6: Mean Seedling Volume



This graph show the average seedling volume based on percent canopy cover. A had an average volume of 172.12 cm^3. B had an average of 133.25. C had an average of 43.63 and D had an average of 20.64.

Discussion

This study tested the effects of woody encroachment on herbaceous plant life (life - too vague), insect pollinator diversity and abundance, and level of herbivory based upon different levels of canopy cover. We hypothesized that herbivory levels would either increase or decrease with increased presence of *B. piularis.* It was found that the average level of herbivory was the same in each canopy class. This would indicate that no correlation between herbivory and canopy class exists.

Comment [DP18]: Most students reported higher numbers here. Something is definitely off in your calculations.

Comment [DP19]: Why doesn't the number of insects on this graph match up with the number of insects on Figure 5??????? You only need a graph like the one shown in Figure 5, but please check your analysis since many students produced different results.

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Comment [DP20]: So, how come these numbers are higher than the ones preorted in the Figure 4?

Also, this is a little backwards. See the graph I've put in at the bottom of your report for comparison.

Comment [DP22]: I think your data analysis was flawed. See comment above in results.

In addition, we hypothesized that there would be a significant difference in herbivory between control and exclosure plots as the density of *B. piluaris* increased or decreased. No pattern was found indicating a greater increase or decrease in difference.

We hypothesized that herbaceous species would decrease as canopy levels increased. Instead, herbaceous species abundance was found to be greatest in higher canopy levels.

Finally, we hypothesized that insect pollinator abundance and diversity would decrease with increased canopy cover. It was found that insect pollinators were actually most abundant and diverse in plots with greater canopy cover.

The data in this study is most likely skewed and significant conclusions should not be drawn from this study. There are several possibilities for incorrect data. Bio44Y students are new to this type of data collection and may have collected data incorrectly. Several of the seedling plots had dead seedlings so data for these was not obtained. Finally, it is possible that statistical analyses were calculated incorrectly and that graphs were made incorrectly contributing to the unlikely results.

Things to do in re-write
1. Introduction – shouldn't introduce Serpentine grasslands since your study doesn't have anything to do with them.
2. results – re-analyze and include error bars. All your data analysis seems to be off.
3. Figure 1 – paired bar graph
4. Figure 3 – Number of touches per height category of live and dead herbaceous vegetation.
5. Figure 4 – Number of touches per height category of live and dead woody vegetation.
6. Get rid of your existing Figure 2 and 4.
7. Figure 5 – redo so that cover class is on the X axis. The distribution of types should be in the legend.
8. Figure 6 – your seedling volumes are off.

Obviously, if your results are different, you will need to change your discussion section too.

Comment [DP23]: Why might we have failed to detect a difference?

Comment [DP24]: In the discussion, you should report the finding, and then follow with a sentence or two about what the finding means.

Comment [DP25]: What could it mean?

Comment [DP26]: Poor quality?

Comment [DP27]: The correct way to report this would be to say that there may have been inter-individual differences in sampling methods that, in conjunction with small sample sizes, drowned out effects.

Comment [DP28]: Indeed.
All your graphs are missing error bars. This is an important feature to present since it gives us a way to assess significance.

References

1. K. Williams, R.J. Hobbs, S.P. Hamburg. (1987) "Invasion of an annual grass land in Northern California by *Baccharis pilularis* ssp. Consanguinea." Department of Biological Sciences, Stanford University.

2. Bio 44Y Lab Manual. (Spring 2010-2011) "Core Experimental Laboratory"
3. Diana Proctor. Bio 44Y ecology lectures.