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Assessing competition between invasive and native plant species and investigating life history of Jugulans californica at Ascot Hills Park

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ABSTRACT
With California losing many of its indigenous populations to an influx of invasive plants, ecological efforts to restore native species to highly impacted areas — particularly in urban settings — have never been more relevant. This project will encompass a series of biodiversity experiments to be performed at Ascot Hills Park, an urban park in Los Angeles, CA. The first of these is designed to assess competition between invasive grasses *Avena spp.* and *Bromus spp.* — which have previously been found to make up over 65% of vegetation in the park — versus California native *Aristida purpurea* (perennial grass) and *Asclepias fascicularis* (narrowleaf milkweed). This investigation will take place over the course of a year, with factors such as biomass, relative invasive and native grass percentage, and soil composition measured to determine how the grasses are competing with one another and which environmental factors play the greatest role in influencing differences in growth. The second project focuses on California native *Juglans californica* (black walnut) germination and life history, as there may be a correlation between cold stratification of the seed and higher rates of survivorship among adult individuals. The overarching goal of both projects is to determine the best methods for restoration of native plant species to Ascot Hills Park, with an additional aspiration of raising ecological awareness within the immediate community surrounding the park to promote community activism in further conservation efforts.

Introduction

California has an incredibly rich plant biodiversity, with one-third of its species native to the state and found nowhere else in the world (Barbour et al. 1993). However, the native foundational species which shape the diverse landscape have been severally impacted by urbanization and the introduction of invasive species. Ecologically, invasive species are defined by their ability to rapidly spread in space and inflict negative consequences upon the native organisms previously present in the area they enter, often reducing the natives' ability to grow or eliminating their presence completely (Alpert 2000). With the loss of these native species, there is a high risk of losing a significant part of California's natural heritage, biodiversity, and beauty.

This proposed project will work with faculty supervisor Dr. Willette's ongoing efforts to restore the native biodiversity of Ascot Hills Park, dubbed "the next great urban park of Los Angeles." Ascot Hills Park is a 93-acre urban park located in the El Sereno and Hillside Village neighborhoods of East Los Angeles (Wolch et al. 2005). Previous research conducted by myself and my colleague Sarah Shapiro found that invasive plants make up 94.45% of the park, with 66.22% consisting of two types of invasive grasses, *Avena spp.* and *Bromus spp.*

Due to this high percentage of invasives found within the park, this project seeks to understand why and how these species have overtaken the area. These data will be valuable in informing current conservation efforts at Ascot Hills Park. Currently, much conservation work at Ascot Hills is focused on reintroducing native trees back into the area. However, with recent climate models predicting a shift in environmental conditions that will favor grasslands over the current woodland habitat, and because our preliminary data showed invasive grasses to be most prevalent at Ascot Hills Park, it is also valuable to focus on invasive grass species as well.

Much of this project will be centered on competition experiments between invasive *Avena spp.* and *Bromus spp.* versus California native *Aristida purpurea* and *Asclepias fascicularis*. *Aristida purpurea*, commonly known as purple three awn, is a group of seven subspecies (varieties) of perennial, native California grasses with narrow panicles commonly found throughout the western United States (Allred 1984). *Asclepias fascicularis*, also known as narrowleaf milkeweed or Mexican whorled milkweed, is a flowering, perennial forb with decussate leaves indigenous to the western United States and Baja California (Woodson 1954). Measurements and data will be taken over the course of a year to examine how these plants grow and compete in relation to one another and to determine which resources the invasive grasses are exploiting for their own benefit.

In addition, this project will also investigate the ideal conditions for survivorship of *Juglans californica*, California native black walnut. *J. californica* is a foundational species and a hardwood tree endemic to Southern California. It is listed as 'vulnerable' on the IUCN Red list, meaning it has a high risk of becoming endangered unless action is taken to protect its habitat

and ability to reproduce. Despite its ecological role and limited geographic range, the early life-history of *J. californica* is poorly studied. For example, seed germination guidance recommends a 3-month cold stratification treatment at 5°C; however, such a temperature is atypical in Southern California, especially for multiple weeks. This project will include a stratification experiment with seeds stored at five different temperatures prior to planting; data on seed width, weight, and germination will be collected to aid in the understanding of this species' early life history.

Overall, these projects are designed to explore the broad research questions driving all plant ecology research within the park: How can we decrease the amount of invasive species within the area, and how can observation and monitoring of both the interactions between these species and early life history patterns be used in conservation efforts to restore the native plant populations of Ascot Hills Park?

Background

In the summer of 2016, I participated in the SURP program under the mentorship of Dr. Willette in which I collected baseline data as to which plant species were most prevalent throughout Ascot Hills Park. After 11 days of data collection and analysis of over 1,000 data points, my colleague and I found that 94.45% of the park consisted of invasive plant species, with 66.22% of total plant cover consisting of two types of invasive grasses: *Avena spp.* and *Bromus spp.* Due to this incredibly high percentage of exotic grasses present within Ascot Hills, I decided to assess the invasibility of these two grass species found within the park in relation to native plants typically found within the area.

A previous study assessing which vegetation types best reduced the establishment of invasive foundational red brome (*Bromus rubens*) and Mediterranean (*Schismus spp.*) grasses within the Mojave Desert found that compared to both early and late successional shrub species, a foundational forb best resisted invasion from the exotic grasses, reducing invasive vegetation biomass by 97% in no-nitrogen-added communities and by 88% in nitrogen-added communities (Abella 2012). As *Asclepias fascicularis* is a type of forb, it is a prime candidate for use within these competition experiments, as there is a high likelihood that this species will exhibit the same resistance against invasive grasses as found in the cited study. While *Aristida purpurea*, a three awn or needle grass, does not bear much resemblance to forb plants, it fits the qualifications for a sturdy, native California grass suited for a Mediterranean environment that is easy to grow and manipulate during experimentation (Allred 1984). Furthermore, the presence of *Asclepias fascicularis* within the experimental plot will most likely enhance the competitive abilities of *Aristida purpurea*, as the milkweed will likely reduce the invasibility of *Avena spp.* and *Bromus spp.* enough so that the native grass will exhibit increased growth.

While the main focus of this investigation relates to the analyzation of competition, differing growth rates, and survivability between native and invasive species, it is important to remember that not all differences in growth can be attributed to the interactions between the exotic and native species; abiotic and environmental factors play a major role as well. One study found that in analyzing over 110 different invasive versus native plant comparisons, in 79 studies, the invading species were not statistically more likely to have higher growth rates, fertility, or competitive ability (Daehler 2003). Instead, the difference in growth could be attributed to environmental conditions (Daehler 2003).

Because so little is known about the early life history of *J. californica*, my faculty mentor and I decided to investigate further and learn more about what environmental factors would affect the germination and growth of this foundational species. Unfortunately, ongoing changes in the climate may threaten the survivorship of this already vulnerable tree. Warmer seasonal temperatures, due to climate change, have been show to negatively impact key life-history stages in multiple plant species, including foundational species, like *J. californica*, that provide habitat and food for a wide range of associated flora and fauna. Furthermore, there is also an invasive species of eastern black walnut, *Juglans nigra*, which resides within Ascot Hills. By studying the native species, we may gain insight into how we can diminish the presence of this invasive.

Methods

This proposed project will follow a series of methods that should enable me to conduct my proposed experiments in a timely manner at the field site. The methods are as follows:

1. Develop an experimentation scheme to assess competition between *Avena spp.* and *Bromus spp.* versus *Aristida purpurea* and *Asclepias fascicularis*. Specifically, I will gather baseline data on differences in biomass, soil composition, relative amounts of invasive versus native grass, and other environmental measurements applicable to the project. Using a randomized block design, I will then prepare the site by clearing existing vegetation from 0.25 x 0.25 m^2 test plots.

2. Perform competition experimentation at Ascot Hills Park in a block design with three replicates per treatment that will be examined at 3-month intervals for a total of 12 months. In each block, 12 greenhouse raised seedlings of *Avena spp.*, *Bromus spp.*, *Aristida purpurea* and *Asclepias fascicularis* will be planted in a replacement series design and monitored for interactions with one another. Every 3 months, one set of replicates will be harvested to obtain the total biomass of each species; this will provide a temporal perspective of the interaction between the plants over the study period. Additional abiotic measurements, such as soil analysis, will also be taken at this stage. All plots will be photographed individually each month to provide visual documentation of the interactions. In addition, the same experiment will be performed in a controlled greenhouse environment at LMU using either

soil from Ascot Hills or propagation mix to simulate how the plots would grow under ideal conditions. This parallel experiment will be used to control for potential environmental confounding factors, such as the region's ongoing drought.

3. Stratification of *J. californica* seeds will contain multiple sample groups. Seeds will be exposed to temperatures of either 5°C, 22°C, 23°C, 30°C, or ambient temperatures within the park. Every two weeks, 20 seeds will be removed for transplantation into germination trays at the LMU greenhouse; all remaining seeds will remain at their experimental temperatures. Walnut seeds will exposed to their respective temperatures for either 2, 4, 6, 8, 10, or 12 weeks depending on when they are removed from planting. When removed, data will be collected on seed weight, width, and presence or absence of germination.

4. Data collected over the year-long period will be collected into spreadsheets and statistically analyzed using Excel, SPSS, and Primer5 software. For the competition experiment, I will be examining the different growth patterns and biomass of invasive and native species as well as quantitative measurements related to soil composition. For the walnut experiment, I will be examining the weights and widths of the different treatment groups and running correlation tests between temperature and seed germinations.

5. Under the mentorship of Dr. Willette, I will prepare a scientific manuscript based on the project's findings and targeted for a peer-reviewed journal. I will perform a rigorous review of current literature on the project topic, exchange multiple drafts with revisions with Dr. Willette, and aim to present this work in the annual LMU undergraduate symposium in 2018 and submit the manuscript for publication thereafter.

Expected Results

At the conclusion of this project, I will prepare a scientific paper and poster presentation to summarize my results, with the hope to present at the 2017 Undergraduate Research Symposium as well as other conventions. While it is incredibly hard to determine exactly how *Avena spp.*, *Bromus spp.*, *Aristida purpurea* and *Asclepias fascicularis* will grow and compete in relation to one another, I expect that competition plots with a lower proportion of invasive grasses and higher soil nutrient concentrations will allow native *Aristida purpurea* and especially native *Asclepias fascicularis* to outcompete the invasive species and become the predominant plants. In the plots with higher proportions of *Asclepias fascicularis*, I predict that invasive grass prevalence will decrease — based upon previous studies designating forb plants as best for halting the invasibility of foreign grasses — while native grass growth will increase. Additionally, based upon the dynamics I observed at Ascot Hills this summer, I expect *Bromus spp.* to outcompete *Avena spp.* solely on the prospect that I remember seeing more *Bromus spp.* growing in the field site while collecting preliminary data.

While I am still unsure exactly which other factors besides plant type I plan on manipulating within these competition plots, I hope to observe patterns between competition and both abiotic and environmental factors in effort to determine whether or not these play a role in influencing the growth of any of the three plants. Particularly, I hope to find a pattern between environmental factors and either the invasiveness of *Bromus spp.* and *Avena spp.* or the natives' ability to outcompete the invasives that pose a detrimental threat.

Because I am conducting competition experiments both at the field site and in a controlled environment on campus, I suspect that both *Aristida purpurea* and *Asclepias fascicularis* will show higher growth rates and an increased ability to outcompete their invasive counterparts under idealized conditions within the greenhouse. Because the organisms within the greenhouse setting will be more closely monitored, I will not have to worry about contamination by other organisms not involved in the competition experiments, nor will I have to account for drastic weather patterns that may disrupt the investigation.

For the walnut experiment, I expect to see a positive correlation between length of time exposed to colder temperatures and presence of germination. As of now, I am unsure if this same trend will apply to seed weight or width, as these variables are more likely dependent on the environment in which the seed was initially produced.

Conclusion

The overarching goal of this research project is to aid in the restoration of California native plant species to Ascot Hills Park, in attempt to preserve the rich biodiversity of the area and to promote ecological awareness and stability within what could become one of the greatest, most frequented urban parks in Southern California. While this project specifically focuses on foundational species life history and competition experiments between native and invasive plants, it is important to place these investigations in context with the larger goal of promoting and preserving biodiversity within urbanized areas by encouraging ecological awareness.

With about 80% of Americans living in are near urbanized areas, working to develop an ecologically-informed public will foster an atmosphere of enormous economic and political change related to environmental conservation and restoration policies (McKinney 2002). Exposing the public surrounding Ascot Hills Park to environmental issues and taking active steps to correct them is undoubtedly the best way to raise awareness not only for the larger cause of environmental preservation, but also our smaller scale aspiration to restore the area to its original splendor of native California species present throughout the entire park.

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