
# Chicago Botanic Garden

Research Experiences for Undergraduates

*Plant Biology & Conservation: From Genes to Ecosystems*

Poster Symposium

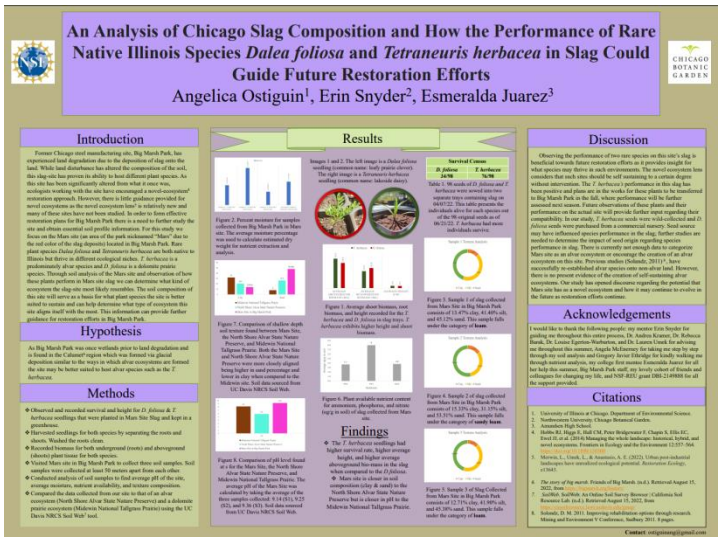
August 19, 2022

CHICAGO BOTANIC GARDEN

1) **Angelica Ostiguin** is majoring in Earth and Environmental Science with a minor in Earth and Environmental Science at the University of Illinois at Chicago and is expecting to graduate in 2024.

Title: An Analysis of Chicago Slag Composition and How the Performance of Rare Native Illinois Species *Dalea foliosa* and *Tetraneuris herbacea* in Slag Could Guide Future Restoration Efforts

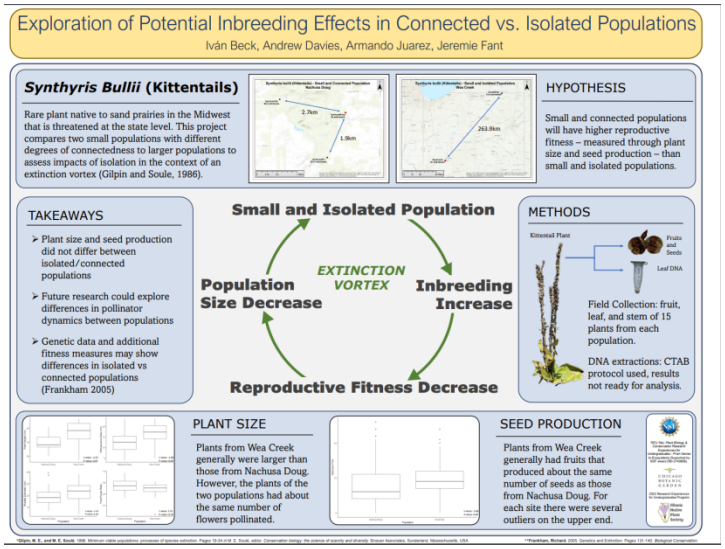
Abstract: The novel ecosystem lens is relatively new in the world of conservation, and it considers how sites differing from their historical natural origin can be used in restoration. Our study focuses on the Mars slag site located in Big Marsh Park. *Dalea foliosa* is a dolomite prairie species and *Tetraneuris herbacea* is an alvar species. We observed the performance of these rare plants in our site's slag and collected 3 soil samples. From these samples we analyzed the soil composition and determined what plant species our site may be suited to host. We also compared our site's soil data to that of the North Shore Alvar State Nature Preserve and the Midewin National Tallgrass Prairie. We found that *T. herbacea* seedlings performed better on Mars site slag than the *foliosa*. Additionally, we found that the Mars site is closer in soil composition to the North Shore alvar site. There is not enough evidence to categorize our site as an alvar ecosystem, but our study opens up discourse regarding the potential that the Mars site has as a novel ecosystem and how it may continue to evolve in the future as restoration efforts continue.




2) **Iván Beck** is studying Organismal Biology and Ecology with a minor in Education at Colorado College and is expecting to graduate in 2024.

Title: Exploration of Potential Inbreeding Effects in Connected vs. Isolated Populations

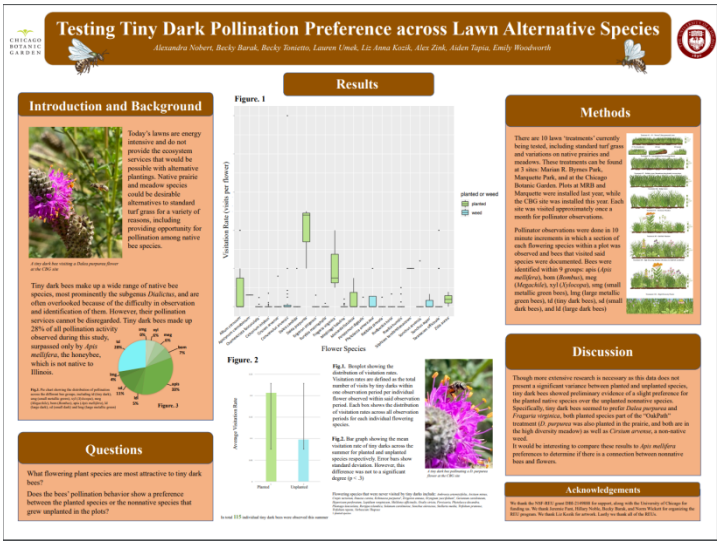
Abstract: Small populations are vulnerable to the effects of an extinction vortex: within shrinking populations, individuals have fewer potential mating partners, leading to greater inbreeding and therefore lower genetic diversity and reproductive fitness of future generations. *Synthiris bullii*, commonly known as Kittentails, are a plant species endemic to sand prairies in the Midwest region which are threatened in the state of Illinois. To test for potential inbreeding in Kittentail populations, 1000+ individuals from 12 populations of various sizes were sampled and data was collected concerning the seed production, seed viability, and genetic makeup of said individuals. For this project, two small Kittentail populations with differing degrees of connectivity to larger populations were compared based on the metrics previously described to assess isolation effects upon smaller populations. We hypothesized that the more isolated small population would have lesser genetic diversity and would produce fewer seeds than the more connected small population. Although no genetic results are ready yet, seed count data suggests no statistically significant difference in seed production between the individuals of the two small populations. Future research will examine seed production across all small and large populations of kittentails that were examined, as well as genetic diversity of differently sized populations.



3) **Alexandra Nobert** is majoring in Environmental Science and History at the University of Chicago and is expected to graduate in 2024.

Title: Testing Tiny Dark Pollination Preference across Lawn Alternative Species

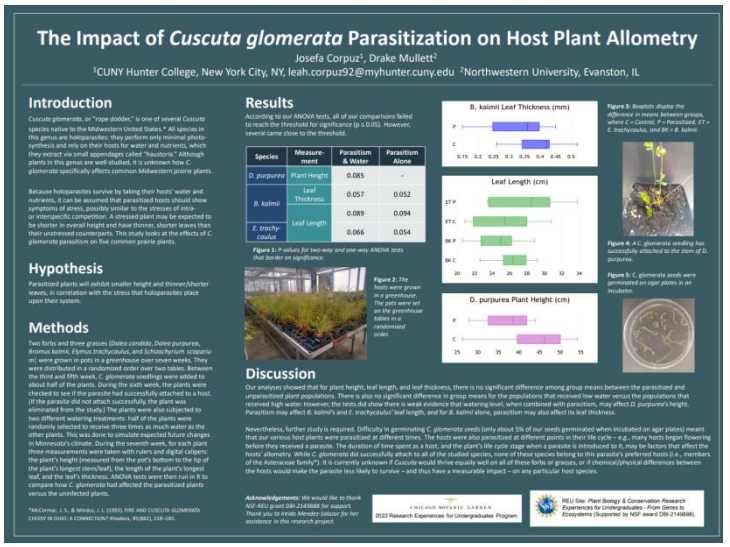
Abstract: Today's lawns do not provide the ecosystem services that would be possible with alternative plantings. Native prairie and meadow species could be desirable alternatives to standard turf grass for a variety of reasons, including providing opportunity for pollination among native bee species. Tiny dark bees make up a wide range of native bee species and provide substantial pollination services. Thus, it is important to understand their pollination preferences when constructing ecologically beneficial lawns. In this study, 10 lawn 'treatments' were tested at different sites, including standard turf grass and variations on native prairies and meadows. Each site was visited approximately once a month for pollinator observations. Pollinator observations were done in 10 minute increments in which a section of each flowering species within a plot was observed for bee visitation. Bees were identified within 9 groups, including tiny dark bees. Though more extensive research is necessary, tiny dark bees displayed a preference for planted native species over invasive weeds. Specifically, tiny dark bees prefered *Dalea purpurea* and *Fragaria virginica*, both planted species in the "OakPath" treatment, as well as *Cirsium arvense*, a non-native weed. Further analysis could include a comparison of these results to *Apis mellifera* to determine if non-native bee preferences will differ from native ones.




4) **Josefa Corpuz** is majoring in Biology at CUNY Hunter College and is expecting to graduate in 2024.

Title: The impact of *Cuscuta glomerata* Parasitization on Host Plant Allometry

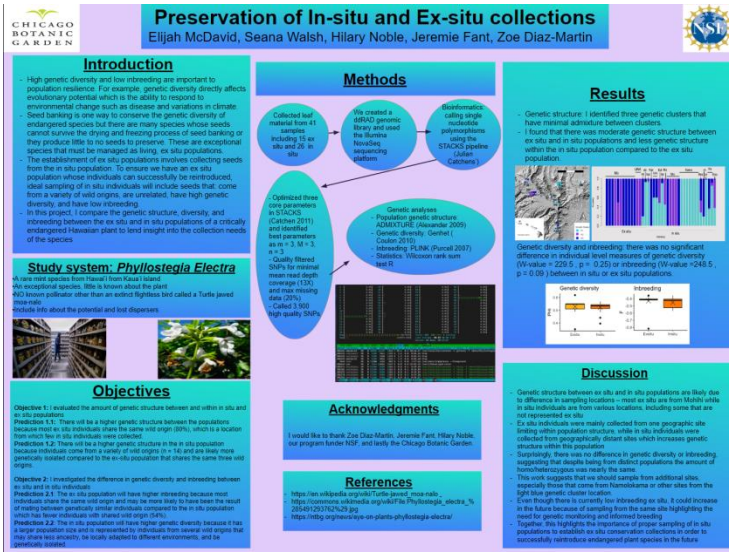
Abstract: *Cuscuta glomerata*, or "rope dodder," is one of several *Cuscuta* species native to the Midwestern United States. All species in this genus are holoparasites: they perform minimal photosynthesis and rely on their hosts for water and nutrients, which they extract via small appendages called "haustoria." Although plants in this genus are well-studied, it is unknown how *Cuscuta glomerata* specifically affects common prairie plants in the Midwest. In this study, five different prairie plants (two forbs and three grasses) were grown in a greenhouse. Half were infected with rope dodder, while half were left as controls. In addition, roughly half of the plants were subjected to high watering conditions to simulate expected future changes in Minnesota's climate. After seven weeks of growth, the plants were measured for overall height, leaf length, and leaf thickness in order to see how parasitism affected the hosts' external anatomy. Statistical analyses showed that there was no significant difference in these measurements between the parasitized and control plants, but further study is needed.



5) **Elijah McDavid** is majoring in Animal Science with a minor in Theater at Middlebury College and expected to graduate in 2025.

Title: Preservation of In-situ and Ex-situ Collections

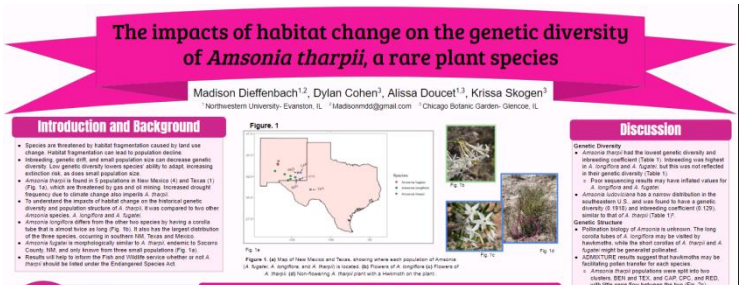
Abstract: Most botanists working in botanic gardens work with collections the gardens have in situ (collections in the wild) and ex situ (collections sampled and planted from in situ collections in gardens). Studying ex situ and in situ genetic data is increasingly more critical due to their impact on research using collections managed by a garden. Proper sampling of in situ and breeding of ex situ populations allows scientists to reintroduce plant species in hopes that they will not die of genetic complications. Research shows that most ex situ collections suffer from inbreeding and low genetic diversity due to a lack of genetic information when breeding the species. We analyzed in situ and ex situ populations of *Phyllostegia electra*, a mint plant from Hawaii, to determine the genetic structure, genetic diversity, and inbreeding, to test this idea. This was performed on software mimicking PMx software. We found little admixture within our genetic structures, no significant difference in our inbreeding and genetic diversity, and surprisingly found little inbreeding and average genetic diversity. This suggests that we need to do better on sampling to have a representation of all the genetic clusters.




6) **Madison Dieffenbach** is majoring in Environment Science with a minor in Art Theory and Practice at Northwestern University and is expected to graduate in 2024.

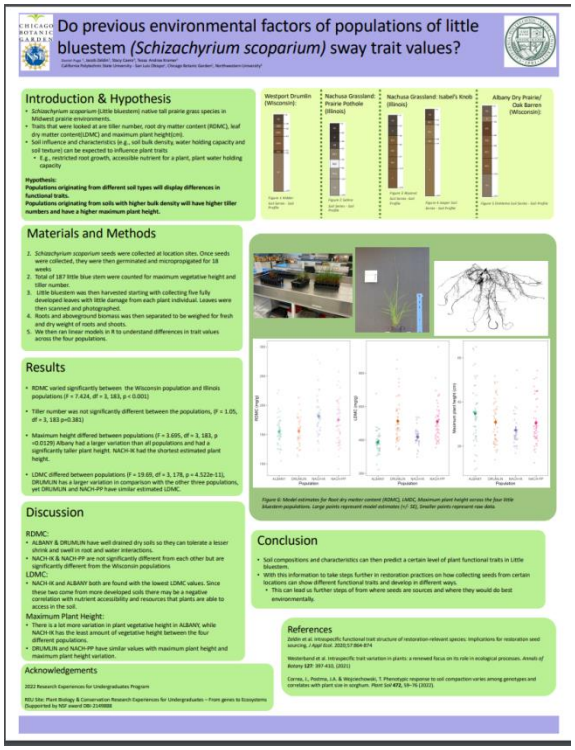
Title: The impacts of habitat change on the genetic diversity of *Amsonia tharpii*, a rare plant species

Abstract: Many species are faced with habitat fragmentation, inbreeding,and small population size that decrease genetic diversity. Low genetic diversity may impact a species' ability to adapt, increasing extinction risk. *Amsonia tharpii* is distributed across five populations in the southwest US, which are threatened by pipeline expansion, oil and gas mining, and increased drought. To understand the impacts of habitat change on the genetic diversity and population structure of *A. tharpii,* we compared it to two *Amsonia* species, *A. longiflora* and *A. fugatei*. We estimated genetic diversity through analysis of inbreeding statistics and population structure. *Amsonia tharpii* had the lowest genetic diversity and inbreeding coefficients compared to *A. longiflora* and *A. fugatei*. *Amsonia tharpii* populations likely belong in two genetic clusters: BEN & TEX and CAP, CPC, & RED, with little gene flow between them. This refutes our hypothesis that closely located populations would be more related, since BEN is closer to CPC than TEX. We hypothesize that *Amsonia tharpii* is self-incompatible from the inbreeding coefficient. Additionally, *A. tharpii* did not have strong population structure, especially when compared to *A. fugate*i and *A. longiflora*, which show high gene flow. We want to resequence *A. longiflora* and *A. fugatei* for comparison and conduct reproductive studies to determine *Amsonia* self-compatibility in future studies.



7) **Daniel Puga** is majoring in Environmental Earth and Soil Science from California Polytechnic State University-San Luis Obispo and is expected to graduate in 2024.

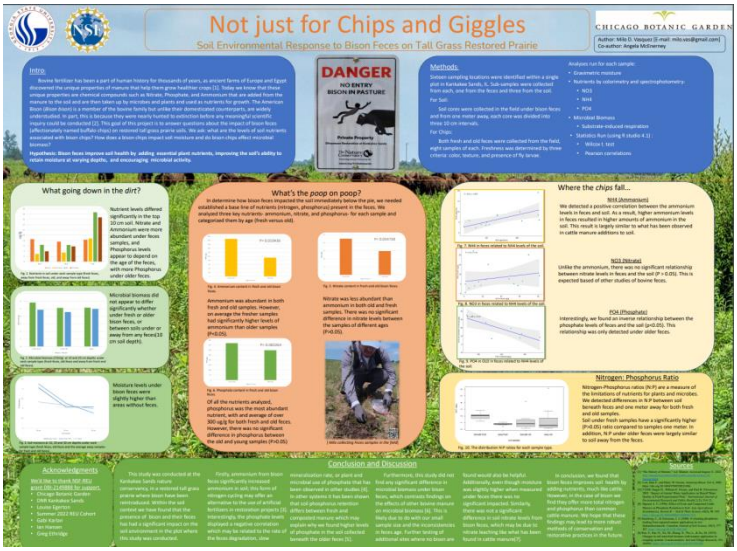
Title: Do previous environmental factors of populations of little bluestem (*Schizachyrium scoparium*) sway trait values?




Abstract: *Schizachyrium scoparium* (Little bluestem) is a tall prairie grass species native to the Midwest prairie environments. In this summer internship I looked at different functional trait that can have been affected by soil conditions. In this poster I worked to see if there was a correlation with the relationship of the plant species and the soil, to see if high bulk density affected root dry matter content, tiller number, leaf dry matter content and maximum plant height. With an addition to other soil forming processes. I focused on looking at the different populations to see if Little bluestem populations originating from soils with high bulk density will show a difference in different functional traits. I also looked at to see if Little bluestem originating from soils with high bulk density will show a certain number of tillers. With this information, it can further help with restoration practices by knowing if placing a plant somewhere if it will do well in the new environment or have a certain developing functional trait that was caused from the seeds originating location.

8) **Milo Vasquez** is majoring in Environmental Studies at Georgia State University and expected to graduate in 2023.

Title: Not Just for Chips and Giggles: Soil Environmental Response to Bison Feces on Tall Grass Restored Prairie

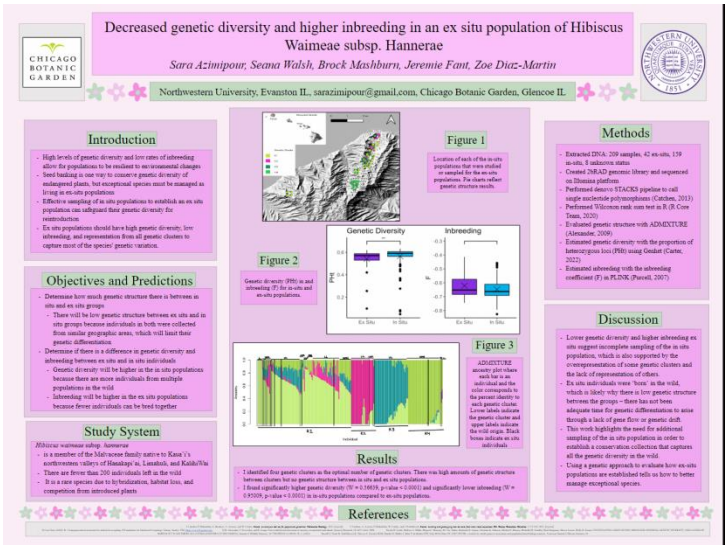



Abstract: Bison (*Bison bison)* is a member of the bovine family, such as cows, but unlike their domesticated counterparts, are widely understudied, presumably because they were nearly hunted to extinction before any meaningful scientific inquiry could be conducted. This project aims to answer questions about the impact of bison feces on tallgrass prairie soil properties. Samples collected from a plot in Kankakee Sands, IL, consisted of sampling the bison feces directly, soil cores from under the bison feces, and another from one meter away to act as a control. Each soil core was divided into three 10 cm intervals. Feces freshness is determined by three criteria, color, texture, and presence of fly larvae. All sub-samples are analyzed for moisture percentage, nutrients using spectrophotometry, and induced respiration for soil microbe biomass. The results of this study are intended to improve conservation efforts and methods for prairie restoration that involve bison reintroductions in North America.

9) **Sara Azimipour** is majoring in Biology and Gender Studies with a minor in Legal Studies at Northwestern University and is expected to graduate in 2025.

Title: Decreased genetic diversity and higher inbreeding in an ex situ population of *Hibiscus waimeae subsp. hannerae*

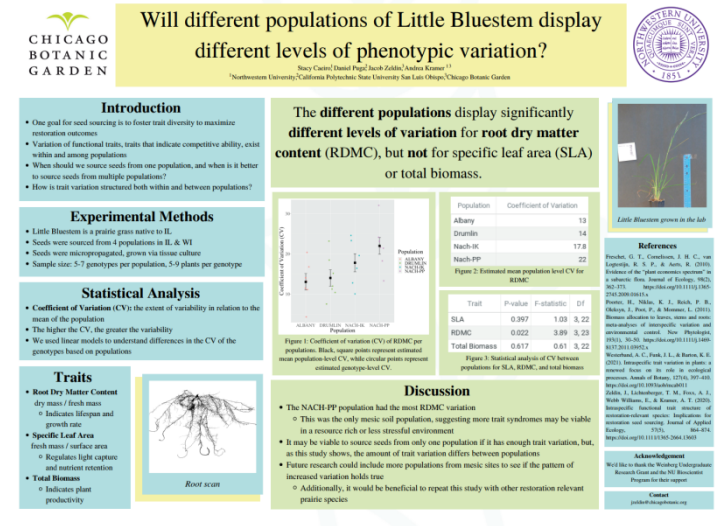
Abstract: For exceptional species resistant to seed banking, effective sampling of in-situ populations to establish an ex-situ population can safeguard their genetic diversity and aid in conservation efforts. Our objectives with this project were to determine how much genetic structure is there between in situ and ex-situ individuals and determine if there is a difference in genetic diversity and inbreeding between ex-situ and in situ individuals. This was tackled with Hibiscus Waimeae subs. Hannerea is a rare species native to Kauai's northwestern valleys of Hanakapi'ai, Limahuli, and KalihiWai. Samples were collected from both ex-situ and in-situ populations, and bioinformatics and genomic data were looked at. We found that there was no genetic structure between in-situ and ex-situ populations. We also found significantly higher genetic diversity and significantly lower inbreeding in in-situ populations compared to ex-situ populations. Lower genetic diversity and higher inbreeding ex situ suggest incomplete sampling of the in situ population, which is also supported by the overrepresentation of some genetic clusters and the lack of representation of others. Using this genetic approach to evaluate how ex-situ populations are established importantly tells us how to manage exceptional species better by making sure sampling is extensive and comprehensive.




10) **Stacy Caeiro** is majoring in Data Science and Global Health at Northwestern University and is expected to graduate in 2025.

Title: Will different populations of Little bluestem display different levels of phenotypic variation?

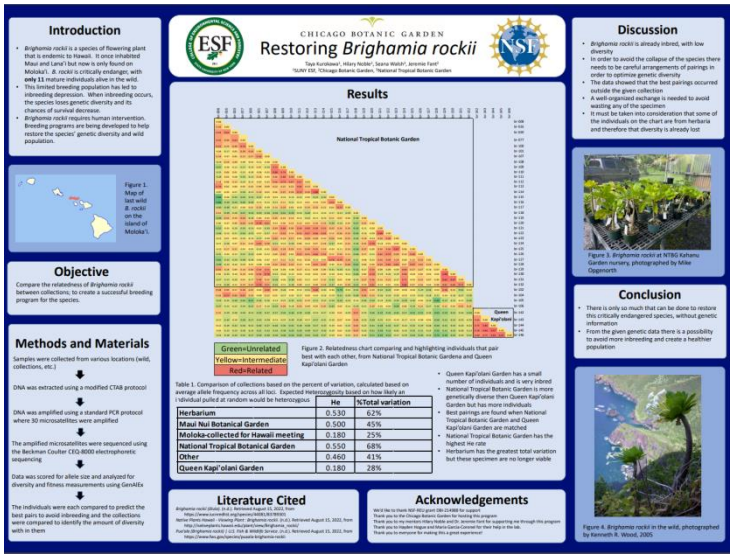
Abstract: One goal for seed sourcing is to foster trait diversity to maximize restoration outcomes. Trait variation exists both within and among populations. However, there is no official guidance on when to source seeds from one population or multiple populations. Thus, we studied if different populations of Little Bluestem, a prairie grass native to Illinois, would display different levels of phenotypic variation. Seeds were sourced from four populations. Then, they were micropropagated, grown via tissue culture. The sample size was 187 plants. Root dry matter content, specific leaf area, and total biomass were measured. Afterwards, the coefficient of variation, the amount of variation in relation to the mean, was calculated at the genotype and population level. The different populations displayed significantly different levels of variation for root dry matter content, but not for specific leaf area or total biomass. The mesic, or moist, soil population had the most variation. Thus, more types of traits may survive in a resource rich environment. So, it may be viable to source seeds from one population if it has enough trait variation, but, as this study shows, the amount of trait variation differs between populations. Future research could include more mesic soil populations.



11) **Taya Kurokawa** is majoring in Biotechnology at SUNY College of Environmental Science and Forestry and is expected to graduate in 2025

Title: Restoring *Brighamia rockii*

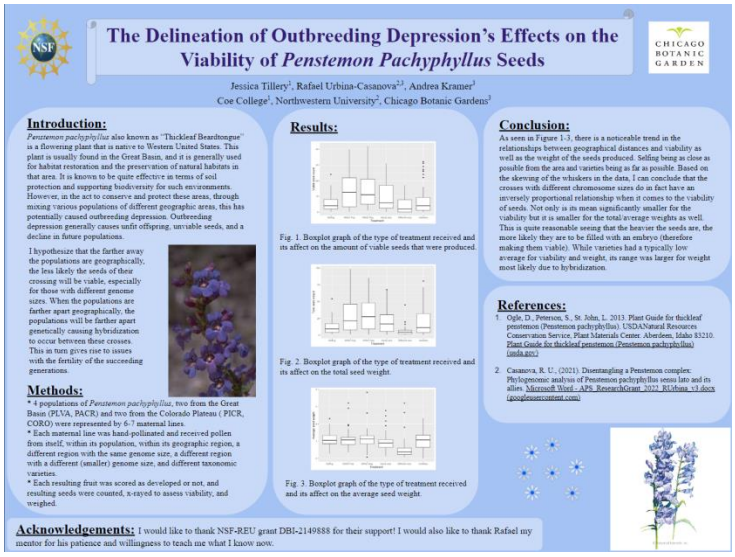
Abstract: *Brighamia rockii* is a species of flowering plant that is endemic to Hawaii. There are only 11 mature individuals alive in the wild. The species will not be able to recover on its own and requires human intervention. Breeding programs are being worked on but only some much can be done to avoid inbreeding depression without the help of genetics. In this project genetic data was recovered from numerous individuals in various collections. This data was then analyzed to compare the relatedness between collections; to create a successful breeding program for the species. The data showed that the best pairings occurred outside the given collection. Although it must be taken into consideration that some of the individuals on the chart are from herbaria and therefore that diversity is already lost. But there is a possibility to avoid more inbreeding and create a healthier population if a well-organized exchange with careful pairing arrangements, is established.




12) **Jessica Tillery** is majoring in Environmental Science and Chemistry at Coe College and is expected to graduate in 2023.

Title: The Delineation of Outbreeding Depression's Effects on the Viability of *Penstemon Pachyphyllus* Seeds

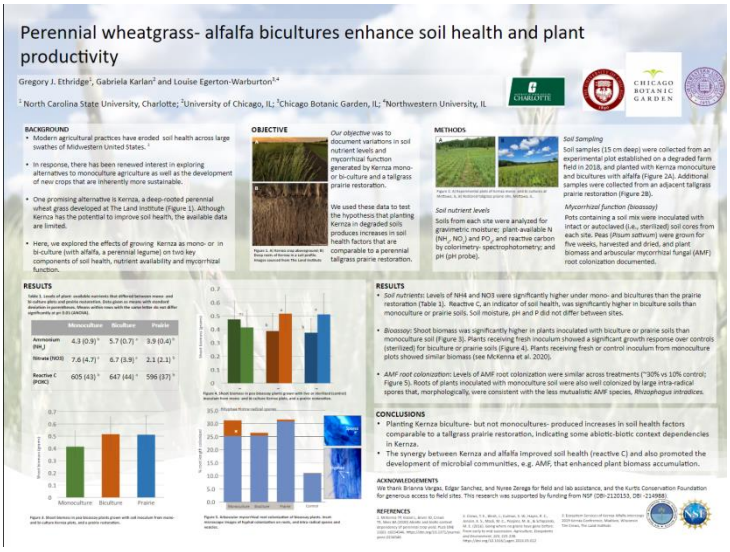
Abstract: P Outbreeding depression which can be attributable to hybridization, is becoming an increasingly threatening problem for *Penstemon pachyphyllus* as the species may be poorly delineated and paraphyletic. In the attempt to preserve this flowering plant, the mixing of populations from different geographical areas that seem morphologically similar to Penstemon when they are in fact genetically different may exacerbate this problem. Based on previous research, we identified 2 regions with different genome size, which might be a sign of cryptic speciation and be driving the effects of outbreeding. We designed a crossing experiment to assess the effects of outbreeding considering geographic distance, geographic barriers and genome size differences. We measured fruit and seed set, seed viability and seed weight to test for outbreeding depression on reproductive fitness. We found that both genome size differences and geographic isolation play a role in outbreeding depression, with genome size difference being the most relevant factor. This improves our understanding of how to safely conserve Penstemon pachyphyllus while minimizing the threat of unviable seeds and/or unfit offspring.



13) **Gregory Ethridge** is majoring in Biology at the University of North Carolina at Charlotte and is expected to graduate in 2023. **Gabi Karlan** is majoring in Environmental Studies with minors in Biology and Quantitative Social Analysis at the University of Chicago and is expected to graduate in 2025.

Title: Perennial wheatgrass-alfalfa bicultures enhance soil health and plant productivity

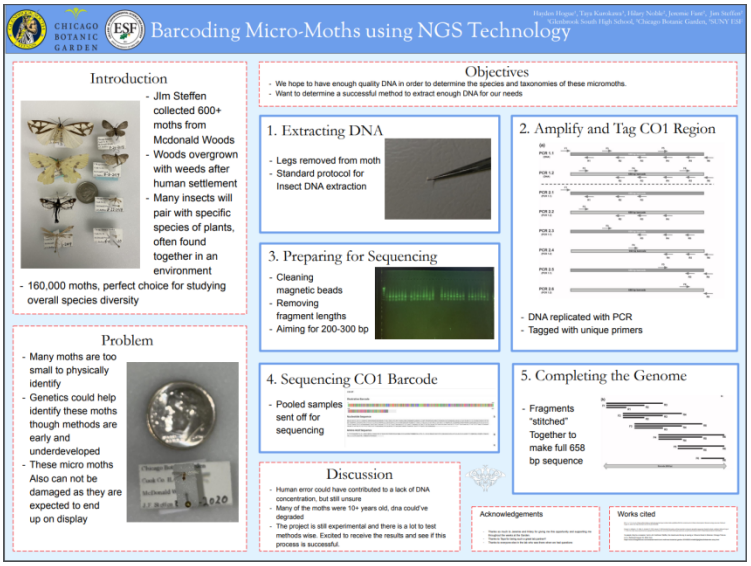
Abstract: Modern agricultural practices have contributed heavily to the erosion of top soil and degradation of soil health. Kernza (*Thinopyrum intermedium),* a wheat grass in development at The Land Institute has garnered excitement due to its perennial nature and deep roots thought to support a more robust microbial biome. When planted alongside Alfalfa in a biculture, the thought is that one mitigates the need to fertilize as heavily as well. This study sought to characterize the soil health benefits of growing Kernza in monoculture, biculture alongside alfalfa, and a restored prairie serving as a control. Samples were taken from plots at Mettawa, IL and were analyzed for nutrient concentration as well as used as an inoculum to grow the pea plants that would be our model species for this study. Nutrient assays showed higher levels of reactive carbon and ammonium in our biculture soil. Harvested pea plants showed statistically significant differences in biomass compared to sterilized samples in prairie and and biculture plots, implying that the




14) **Hayden Hogue** is a studying at Glenbrook South High School

Title: Barcoding Micro-Moths using NGS Technology

Abstract: Moths often pair with specific plant species and serve as markers that reflect the overall diversity of species within an ecosystem. Jim Steffen, a Chicago Botanic Garden ecologist for 30+ years, believes moths could be the key to the restoration of the McDonald Woods. He collected over 600 moths to identify, and as many were too difficult for even him to physically identify, being so small and similar; we are turning to genetics to help solve this problem. The methods we use are experimental as the decade-old specimens were exposed to a pesticide that denatured their DNA. By amplifying the fragments of DNA and barcoding them we should be able to stitch together one complete strand of DNA of around 658 bp. So far we have successfully gotten 48 samples ready to be sent off for sequencing and are optimistic about the future.



**PROGRAM INFORMATION**:
The Chicago Botanic Garden has hosted a Research Experiences for Undergraduates (REU) Site, supported in-part by NSF, since 2003. This year 18 students participated in our ten-week summer undergraduate research experience, which is one of only a few programs in the country that offers undergraduate students an opportunity to explore a diverse array of scientific fields related to plant biology and conservation. Students are mentored by faculty and graduate students from the joint Chicago Botanic Garden–Northwestern University Graduate Program in Plant Biology and Conservation and other graduate programs as well as staff from the Garden. Their research projects are based at the Daniel F. and Ada L. Rice Plant Conservation Science Center, and they receive training in all aspects of the research process, from hypothesis formulation through experimental design, data collection, analysis, and ultimately presentation of results through this public research symposium. REU interns also serve as research mentors for high school students participating in the Garden's College First program, and participate in field trips, workshops, and professional development activities. Additionally, students and their mentors often pursue opportunities to present at national scientific meetings or publish findings in peer-reviewed journals following completion of the program.

**REU Coordinators**: Jeremie Fant, Becky Barak, Hilary Noble, and Norm Wickett

**BIG THANKS TO:**

**Mentors:** This science training program would not be possible without your dedication. We appreciate all the time and effort you have put into these students and hope that it has been as rewarding for you as it was for the students.

**College First:** Your partnership allowed for a richer growth of our students through mentorship and science communication.

**Institutional Partners:** The Morton Arboretum and UIC CIM$^2$AS Program for fostering a network of institutions that seek to train the next generation of scientists. Thank you in particular to the Biology department of UIC for hosting the lunch and poster symposium.

**Funders:** This summer program was supported in part by NSF-REU DBI-2149888 (Wickett, Fant) and the Charles and Margery Barancik Foundation.