Northern California Botanists

BOTANICAL LEAFLETS

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PRESIDENT'S MESSAGE

We had a very successful symposium last January with 320 people in attendance! That is our largest symposium yet! Many wonderful talks and posters occurred. We even had a talk that was by live stream with the speaker in southern California. We heard the talk while we saw the PowerPoint presentation on the screen in the auditorium. Thank you all for attending and for the spectacular symposium!

With COVID-19, this has been a very different spring and summer than most of us anticipated. With sheltering in place orders by the Governor in mid-March, it certainly has changed visiting wildflowers this spring and summer! Hopefully everyone is able to do their best during this pandemic. We are planning to have our next symposium in January 2022. We are looking into having virtual options since it isn't clear whether we will be able to have an inperson symposium. We want to have options for people that don't have high speed internet so they can fully participate. We will keep you informed as we develop the symposium.

Brett Hall (since 2014) and Genevieve Walden (since 2018) have ended their time as board members. Russell Huddleston of Applied Tech Science and Kerry Byrne of the Department of Environmental Science and Management at Humboldt State University have joined the Board. Thanks for all your hard work Brett and Genevieve. And welcome Russell and Kerry.

This past spring, we received numerous fantastic applications for our student scholarships. Northern California Botanists awarded 12 scholarships at \$1,000 each this year. Two of these were awarded with money provided by the Shasta and the Sacramento Valley Chapters of the California Native Plant Society. Thank you very much to both of those chapters for providing money for scholarships! Hopefully a new batch of botanists doing vital work in Northern California will develop from those scholarships.

Take care and stay well during this pandemic.

Linnea Hanson



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Mystery Plant

This plant of slightly moist places is a robust rhizomatous herbaceous perennial with erect, pungent and resinous leafy stems over 1 meter tall. The whole colony dies to the ground each winter; stems resprout in April, producing whitish flowers May through July and small prickly fruits in late summer. Although known throughout most of lowelevation California and the central U.S., this plant is found only sporadically around the Sacramento Valley. In California, it is the only native plant in its genus, whose name implies human use of its thick, long rhizomes and roots for food, fiber and medicine



Photo by Barb Castro

2020-2021 Student Research Scholarship Awards

Northern California Botanists is pleased to announce the recipients of this years research scholarship awards. As in the past, we received many worthy applications. This year we will be awarding 12 scholarships of \$1,000 each. The Shasta and Sacramento Valley chapters of the California Native Plant Society sponsor one each of the \$1,000 Scholarships.

Chris McCarron is an Undergraduate student at the University of California, Berkeley



Brook Constantz is a PhD student at the University of California, Santa Cruz.



The title of his research is **"Population genetics of the serpentine endemic,** leather oak (*Quercus durata*)."

California's serpentine habitats present an archipelago of isolated geologic formations that constitute an ideal study system for examining the evolution and divergence of species restricted to them. The leather oak (Quercus durata var. durata), is widespread throughout California but found exclusively on serpentine soils. Chris McCarron's honors thesis research uses reduced genome DNA sequencing for 250 samples from 25 separate serpentine outcrops throughout Q. durata's range. Results will be used to answer several questions. The levels and depths of divergence among populations, spatial patterns of differentiation, genetic diversity in relation to outcrop size and proximity to other populations will all be assessed. Whether there is evidence for a single or multiple evolutionary event and the timing of isolation events throughout its range will also be determined. Comparing abiotic conditions such as rainfall and temperature to genetic dissimilarity among populations will help to gain insight into the factors driving divergence among isolated populations. Findings will have implications for oak conservation genetics and management of populations with unique genetic structure in the future. Additionally, results will inform our understanding of *Q*. *durata*'s past and provide evidence for how it became restricted to its narrow distribution over such a large range.

The title of his research is **"Spatial and Temporal Habitat Heterogeneity of Restored and Remnant Riparian Forests along the Sacramento River, California."**

Riparian restoration projects typically evaluate their success through native plant cover, survival, and biomass recovery, but rarely habitat heterogeneity. Increasing habitat heterogeneity has been a goal in restoration because of its positive impact on ecosystem function. However, more work needs to be done to identify and quantify the meaningful types of biotic and abiotic heterogeneity present in reference ecosystems to use in restoration design. Conservation groups restored 5,500 hectares of habitat along the middle reach of the Sacramento River, California, between 1989-2007. I will use this system to study woody plants' contribution to riparian habitat heterogeneity in restored and remnant forests by building off three prior forest inventories (1996, 2004, 2010) by measuring stem sizes, species, and position. I will extrapolate these inventories across the entire forest area by linking them with remotely sensed canopy roughness, canopy stratification, and ground topography. I anticipate that remnant forests have fewer and larger stems, higher canopy roughness and vertical stratification, more clustering of individuals, topographic variation, and more even biomass across species. I collected pilot data during the summer of 2020 in four forests to develop best practices for sampling. These preliminary results indicate that remnant forests have more clustering of woody plants than restored forests. Additionally, despite having the same mean basal area per tree, restored forests had more mean stems per tree in general (1.84 vs. 1.28), for Acer negundo (2.21 vs. 1.14), and a much higher percentage of the basal area from early successional species (98% vs. 68%).

2020-2021 Student Research Scholarship Awards (Cont.)

Lacey Benson is an MS student at San Jose State University.



Jake Ewald is an MS student at Chico State University



The title of her research is "A morphometric analysis of western sword fern (*Polystichum munitum*) pinnae and pinnae scales across the coast redwood forest ecological gradient."

Ferns are an integral component of biodiversity and productivity in the coast redwood understory and canopy. Given that summer fog is expected to decrease and winter precipitation patterns are predicted to change it is vital to understand the role of microclimates and adaptation strategies utilized by ferns in the coast redwood ecosystem in order to gauge how the distribution, community dynamics, and reproductive success of ferns will be affected in the coming decades. Researchers have found ferns display signs of shifting climate patterns through leaf traits such as number of fronds, size of fronds, foliar uptake capacity and leaf water retention. By studying morphological and physiological changes to ferns scientists can get a more rapid understanding of how community dynamics and slower growing species such as the coast redwood will be affected by future changes to climate. The aims of this study are (1) to compare western sword fern (Polystichum munitum or POMU) pinnae size traits (length, width, and length:width ratio) to environmental variables such as precipitation, fog frequency, and temperature; (2) to quantify pinnae scale density to compare with in situ climate data; and lastly (3) to collect, mount, and enter POMU specimens and redwood associate species into the Carl W. Sharsmith Herbarium at SJSU. To achieve these objectives, we will utilize digitized herbarium accessions as well as personal collections to measure pinnae in ImageJ as well as count scales on both pinna surfaces. Data will then be compared to latitude and in *situ* environmental variables. The results of this study will greatly inform our understanding of the landscape scale variety of morphological and physiological traits within POMU and add to previous research on POMU foliar water uptake capacity and leaf water retention abilities.

The title of his research is **"Species boundaries in two northern California monkeyflowers."**

Recently diverged taxa are thought to maintain species boundaries via the evolution of reproductive barriers. Pre-zygotic barriers such as divergent habitat, flowering phenology, and floral morphology work additively with post-zygotic barriers such as hybrid sterility or inviability to reproductively isolate species. The close relatives Mimulus guttatus and Mimulus glaucescens broadly overlap in range, have similar flower morphology, and flower at the same time. Thus, no barrier to interbreeding is apparent, and they freely interbreed in the greenhouse. However, the two species are not known to hybridize in nature. Previous research characterized seventeen potential barriers to reproduction, but did not find complete isolation. Thus, either unmeasured barriers exist or hybridization occurs in nature. I will conduct microhabitat analyses in *M. guttatus* and *M. glaucescens* habitat to evaluate the strength of microhabitat as a reproductive barrier. I have also collected leaf and bract tissue from natural populations; I will run genetic analyses on these tissue samples to test the hypothesis that introgression occurs in nature. Finally, I am currently collecting data on bract shape, glaucous coloration, and trichome density in greenhouse-grown parent species and hybrids to determine the genetic basis of taxonomically informative traits. Ultimately, elucidating the relationship between Mimulus guttatus and Mimulus glaucescens will provide insight into the process of speciation as well as the evolutionary history of this diverse genus.

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2020-2021 Student Research Scholarship Awards (Cont.)

Katherine Marlin is an MS student at Humboldt State University.



Alec Chiono is an MS student at the University of San Francisco.





The title of her research is "**Reproductive characteristics of a serotinous tree species, Knobcone pine** (*Pinus attenuata*)."

As fires in the Western U.S. become increasingly large, frequent, and severe, a serotinous conifer, knobcone pine (*Pinus attenuata*) has been and will most likely continue to expand its distribution. Serotiny, defined by maintenance of a canopy seed bank for 1+ years, is a fire adaptive strategy which protects seeds from the high heat of passing fires. In the Northern Hemisphere, serotiny exists in conifers with resin-sealed cones, such as knobcone pine. Previous literature assumes knobcone pine is fully serotinous, or in other words, all the cones remain closed until exposed to fire. However, most other serotinous species exhibit variance. We seek to determine where knobcone is not fully serotinous, and why. As climate change rapidly changes suitable conditions for tree species, it also necessary to gain a better understanding of tree migration. Knobcone pine presents a unique opportunity to study long distance seed dispersal, which is a key mechanism to facilitate tree migration. We studied this topic at the Carr Fire (2018), where knobcone had highly successful regeneration, there is little shrub cover, and species composition allows us to distinguish seedling species by sight. We will analyze our data in the next few months.

The title of his research is **"Does local variation in temperature drive different responses to climate change within one species?"**

Variation in climate across a species range is likely to have selected for divergent environmental niches. This means that populations within one species may respond differently to environmental change, and that widespread species could be vulnerable across their range. Research into how divergent niches will affect responses to climate change has focused on geographically distant populations, presumably because greater geographic distance can lead to greater environmental divergence. In Marin County however, Erythranthe guttata grows on a mosaic of habitat types with diverse thermal regimes, from mild coastal to more variable inland seeps and streams. Even at this local scale, plants at these sites experience differences in temperature extremes comparable to range-wide variation. I am studying how these populations of *E. guttata* may respond differently to climate change on a local spatial scale. First, I will use a growth chamber experiment using different temperature treatments to determine thermal performance curves for each population. I will then use these performance curves and mechanistic models to predict how habitat suitability will shift under climate change. With these methods, I can quantify the thermal niches of each population and describe the implications of any differences in their thermal niches as temperatures continue to increase. This work will contribute to our knowledge of how species may show variable responses to climate change, emphasizing the importance of conserving local populations whether the species is widespread or not. Although E. guttata is a common, widespread species and is not currently of conservation concern, at this local scale, we find diverse, unique ecotypes. If they are vulnerable to climate change, they may require different conservation efforts to preserve them.

Answer to "Mystery Plant": Glycyrrhiza lepidota Pursh (Fabaceae) - Wild licorice

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2020-2021 STUDENT RESEARCH SCHOLARSHIP AWARDS (CONT.)

Ella Abelli-Amen is an MS student at Cal Poly, San Luis Obispo.



Michael Mulroy is an MS student at Cal Poly, San Luis Obispo.





The title of her research is **"Understanding the pattern of oak mistletoe** (*Phoradendron villosum*) occurrences in California's oak savannas."

An intriguing dynamic between oak mistletoe (Phoradendron villosum) and host species (Quercus sp.) has been observed in California (Thomson and Mahall 1983): when there is a pure stand of coast live oak, the oak mistletoe can be found parasitizing it, but when valley oak and blue oak are also present, the mistletoe seems to 'prefer' growing on the other two deciduous oaks. This pattern has been quantified by ground surveys and by herbarium records, but we wanted to capture the pattern from above using remote sensing technology. Drone imagery can be used in conjunction with open source NAIP (National Agriculture Imagery Program) imagery to train a machine learning algorithm to identify each species of oak tree and unbiasedly quantify how many mistletoe are on each tree. As well as capturing the pattern in a new way, we also want to understand the mechanism: are birds dispersing the fruit to some trees more than others? Or are the fruits dispersed evenly to all three species but have higher survival and success rates on valley and blue oak? To answer these questions, we conducted a reciprocal transplant study in which we collected fruit from mistletoe growing on each of the three oak species and planted those seeds back onto each tree species. We will also collect data on bird behavior by performing an observational transect study to see which tree species mistletoe-eating birds spend more time in. This study aims to improve our understanding of parasitic plant/host relationships using both new drone technology and tried and true reciprocal transplant and bird observation methods.

The title of his research is "An investigation of lichen biotas of ultramafic and sandstone outcrops along a maritime gradient in central California."

Saxicolous lichen communities vary tremendously in response to abiotic environmental factors. While such variation is widely recognized, little research has been carried out to quantify the effects of abiotic factors on saxicolous lichen community composition. Furthermore, diversity among saxicolous lichen communities remains poorly understood, and taxa that are new to science are still regularly described, even in relatively well-studied areas such as California. Our study investigates the roles of substrate properties and maritime influence in determining species composition and distributions among these lichen communities. We are comparing lichen communities of ultramafic (e.g., serpentine) and siliceous sandstone outcrops across a largescale (\sim 65 km) coast-inland environmental gradient of decreasing maritime influence in central California. We are testing the hypotheses that 1) ultramafic and sandstone communities will be more compositionally similar in the coastal zone than the interior due to maritime influences overriding substrate effects; and 2) maritime influence factors create conditions favoring higher species diversity closer to the coast. Lichen communities on both substrates across the gradient are being measured via quadrat sampling. For each of the 18 outcrops included in this study, we plan to estimate maritime influence factors including seasonal fog cover and aerial salt deposition in GIS, and we will measure substrate elemental chemistry using x-ray fluorescence microscopy. This study will improve our understanding of how substrate properties and maritime influence interact to shape lichen community composition and will add to our limited knowledge of regional species distributions.

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2020-2021 STUDENT RESEARCH SCHOLARSHIP AWARDS (CONT.)

Reece Riley is an MS student at Fresno State University.



The title of his research is "Phylogeny of Helianthella."

This project aims to establish a phylogeny of the genus Helianthella (little sunflowers) and place it within its taxonomic subtribe in the family Asteraceae. Helianthella are all wildflowers of varying sizes, with perennial taproots and annual flowers with basal rosettes of leaves. They are distributed along the mountains of Western North America, from Southern Canada to Northern Mexico, with some highly geographically restricted species in California and Mexico. This genus has gone understudied for many decades, with its last major taxonomic treatment being a monograph in 1952. Since then it has received a few scattered additional species descriptions and seen occasional use as an outgroup in other studies, but the relationships among the 10-11 species within *Helianthella*, and the relationship of the genus to the four other genera in the subtribe Enceliinae, are unknown. The genetic and technological tools and methods available today, such as PCR and modern computers, were not yet invented when last this genus was directly studied, so applying them now could provide a wealth of new information about the spread and diversification of these species. A combination of genetic and morphological methods will be used to resolve a phylogeny of Helianthella and infer the evolutionary and biogeographical history of the genus. Preserved herbarium specimens and new field collections will be examined morphologically and sampled for genetic sequencing, and the gathered data will be run through multiple phylogeny-building programs. The resulting trees will give insights into the diversification of montane plants and their movement patterns.

Martin Purdy is an MS student at California Botanic Garden/ Claremont Graduate University



The title of his research is **"Flora of Coyote Ridge and Coyote Flat, Inyo County, California."**

California's Sierra Nevada mountain range is one of the most floristically diverse regions of its size in North America. The high Sierra Nevada, in particular, has been identified as an important source of plant species richness and endemism within the state. Anthropogenic climate warming is expected to disproportionately affect mountain ecosystems, and models have predicted serious habitat contraction and local extirpation for many alpine plant taxa. I am conducting a specimen-based inventory of vascular and non-vascular plant taxa of Coyote Ridge and Coyote Flat in order to establish baseline data for one such sensitive alpine habitat. Located in the northwest corner of Inyo County, California, the study site is ca. 50 square miles and ranges from 8,500 to 13,500 feet in elevation. This area is notable in the Sierra Nevada for having unusually diverse geology and lacking signs of recent glaciation. High floristic diversity is expected due to the high diversity of geology, topography, and habitat types contained within the study site. I am documenting plant diversity across my study site through the collection of physical specimens with associated metadata (e.g., GPS coordinates, date and time, descriptive habitat info, and photos) and georeferenced photo observations uploaded to iNaturalist. To date, I have completed 53 days of fieldwork, made 779 collections, and uploaded 347 photo observations. At the conclusion of the project, all specimens will be deposited at regional herbaria (and subsequently uploaded to the Consortium of California Herbaria) and an annotated checklist of recorded plant species will be published.

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Roisin Deak is an MS student at Cal Poly, San Luis Obispo.





The title of her research is **"Fire Influences on Meadow Vegetation Com-position."**

Altered fire frequency in California has been shown to have negative effects on forest vegetation communities. However, little research has been done to investigate the relationship between fire frequency and meadow vegetation composition. Using long-term meadow monitoring data from across California, vegetation composition will be compared from before and after wildfire events to evaluate whether fires influence community composition and promote obligate wetland species in particular. Climate data, site rating (wet, mesic, dry), topographic characteristics, and fire severity ratings for wildfire will be incorporated into the analysis. Hypothesis: Fires that kill many trees surrounding a meadow will promote the growth of obligate wetland species, this trend will be more evident under severe fires in mesic meadows. Goals: Discerning under what circumstances fire promotes the growth of obligate wetland species will enable land managers to refine decisions on control burn tactics or restoration efforts.

NORTHERN CALIFORNIA BOTANISTS IN ACTION

Leaflets features a continuing series that highlights well-known to possibly less-well-known botanists, with photographs from the present to several decades back. If you have unpublished pictures of Northern California Botanists to share, please send jpegs and relevant information to ncbotanists@gmail.com



Russell Huddleston is a consulting botanist with Applied Technology & Science in San Francisco and recently joined the board of Northern California Botanists. After an early career in theatrical lighting at the Oregon Shakespeare Festival, he decided to get a second undergraduate degree in Biology from Southern Oregon University and went on to get an M.S. in Ecology from U.C. Davis. He has conducted botanical surveys throughout California, but his particular interest is in vernal pools. He has been a volunteer docent at Jepson Prairie for over 20 years and enjoys sharing the beauty and diversity of the flora with members of the public every spring. In addition to his consulting and volunteer work he is also an adjunct faculty member at the University of California where he teaches courses in Natural History, Regulated Natural Resources and Field Survey Management.



Jennifer Whipple became fascinated with the flora of Northern California as a teenager. Raised in Scott Valley in Siskiyou County, the family ranch had an outcrop of serpentine with wildflowers not in the wildflower guides. Determined to figure out the local plants, she advanced from

the original Jepson Manual to Munz by high school. Attending Humboldt State University, she received a master's degree studying the flora of Mt. Eddy, the tallest peak in the Klamath Mountains. A summer job as a seasonal naturalist in Yellowstone National Park "morphed" into a job as a biological technician which eventually led to becoming the park's botanist for over 20 years. Now retired, she is again pursuing the local flora in Siskiyou County.



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