TOOLS FOR A NEW DECADE of Managing Northern California Plant Communities

THE ELEVENTH SYMPOSIUM
PRESENTED BY

NORTHERN CALIFORNIA BOTANISTS

– virtual –

10-12 January 2022

Tools for a New Decade of Managing Northern California Plant Communities

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Cover photo courtesy of Russell Huddleston. This photo is a blue oak (*Quercus douglasii*) woodland with California goldfields (*Lasthenia californica*) in northern Tehama County, taken on April 9, 2021. Traditional ecological knowledge regarding the management and use of oak woodlands along with population biology and ecological restoration are being used to develop new methods and approaches for preserving and maintaining California's blue oak woodlands.

WELCOME!

Northern California Botanists

welcomes you
to our eleventh symposium

MISSION STATEMENT: Northern California Botanists is an organization with the purpose of increasing knowledge and communication among agency, consulting, academic, and other botanists about botanical issues concerning science, conservation, education, and professional development. Our primary objectives are to establish a communication forum via occasional meetings, a scholarship fund for students working on botanical problems in northern California, a job forum, and symposia that focus on the botany of northern California.

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Evaluation of 2022 Northern California Botanists Symposium

We'd love to hear your thoughts about our eleventh NCB Symposium – we actively use ideas from these evaluations for planning future events!

Please fill out the online survey at Google Forms:

https://forms.gle/qYyf6BFNnyUBEEyB6

copy and paste into your browser if necessary

ADDENDUM

Addition to page 2:
Fourth talk added to
Session 2: Traditional Ecological Knowledge and Ethnobotany

8A. TEK for Climate Change Adaptation.
Ali Meders-Knight – *Chico Traditional Ecological Stewardship Program*

Addition to page 12:
Added to Abstracts

8A. **MEDERS-KNIGHT, A.**
Chico Traditional Ecological Stewardship Program, Chico, CA. https://tekchico.org/
tekstewardship@gmail.com

TEK for Climate Change Adaptation.

– no abstract available –

Correction to page 3:
Session Chair name corrected
Session 4: Great Basin Restoration Approaches

Session Chair: ***Allison Nunes*** *- Humboldt State University*

Addition to page 6:
Additional talk added to
Session 8: Lightning Talks

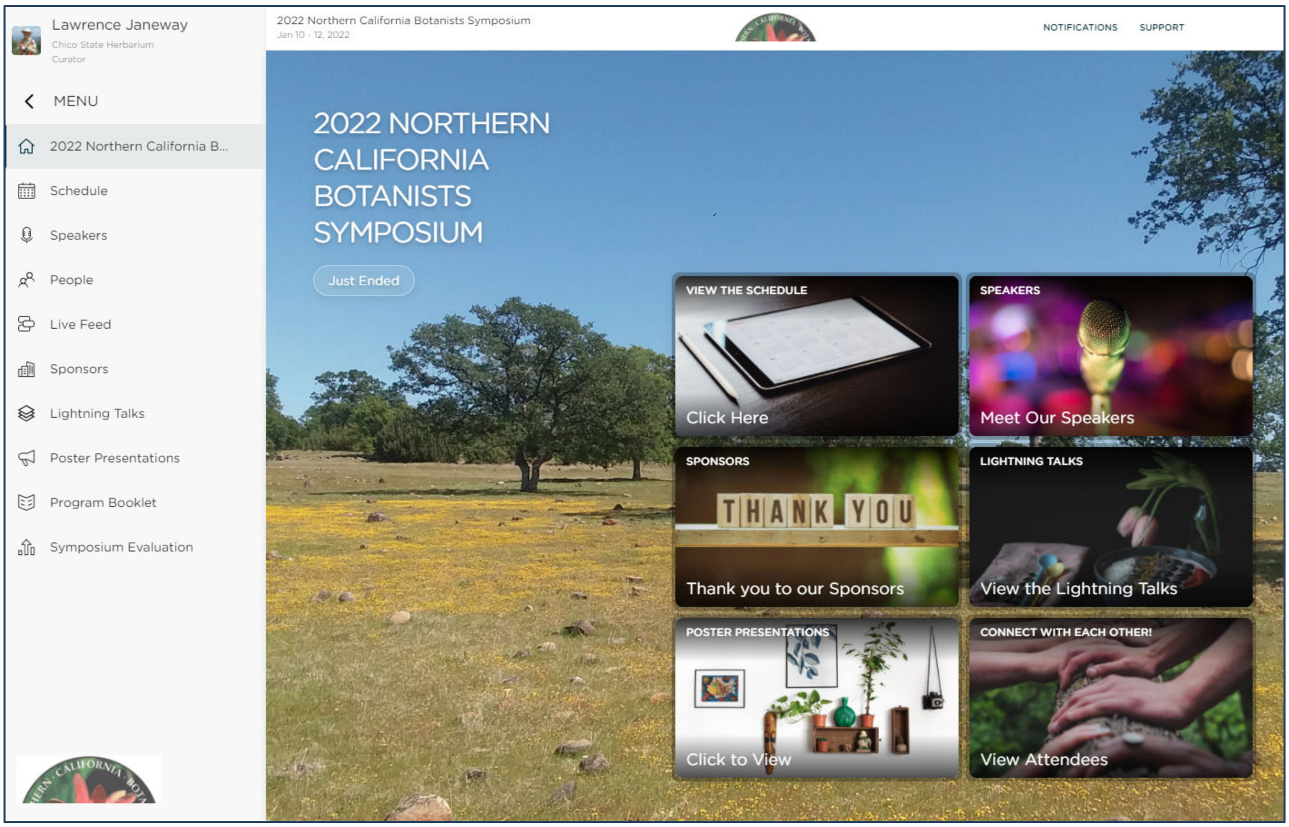
39A. The California Certified Botanist.
David Magney *- California Native Plant Society*

Addition to page 21:
Added to Abstracts

39A. DAVID MAGNEY
California Native Plant Society – dmagney@cnps.org

The California Certified Botanist.

ADDENDUM


Lawrence Janeway
Chico State Herbarium
Curator
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PROGRAM OF PRESENTATIONS BY INVITED SPEAKERS

– A Virtual Symposium –

All Talks are Pre-recorded – Live portions are noted below

(Abstracts of talks start on page 9; index to authors on page 30)

MONDAY, 10 JANUARY 2022

Opening Remarks and Welcome

8:45 a.m.

1. Opening Remarks – Live.
   Linnea Hanson *- President, Northern California Botanists*

Session 1: The Power of Pollinators: Habitat, Conservation, and Plant Interactions

9:00 – 10:05 a.m.

Session Chair: ***Russell Huddleston*** *- Environmental Protection Agency, Region 9*

2. Creating High Quality Habitat Dominated by Native Herbaceous Vegetation in the Built Environment.
   Pat Reynolds *- River Partners*
3. Monitoring Butterfly Populations in the Sierra-Cascade Foothills as Part of a Conservation Initiative.
   Don Miller *- California State University, Chico*
4. Floral Signals and Pollen Placement: Revisiting the Natural History of a Beloved Sierra Nevada Wildflower System.
   Devon Picklum *- University of Nevada, Reno*
5. Pollination Extends to Frugivory in the Pallid Bat, *Antrozous pallidus*.
   Jaclyn Alperti *- NatureServe*

10:05 – 10:25 a.m.

Session 1 - Live Q&A

Session 2: Traditional Ecological Knowledge and Ethnobotany

10:30 a.m. – 11:35 p.m.

Session Chair: ***Kerry Byrne*** *- Humboldt State University*

6. "Yes, It Often Doesn't Have a Happy Ending:" California Indian Oral Traditions and Environmental Science.
Sherrie Smith-Ferri *- Grace Hudson Museum*

7. Yurok Tribe Food Sovereignty: Combining Traditional Food Systems, Gardens, and Orchards to Decolonize Diets.
Taylor Thompson *- Yurok Tribe Environmental Program*

8. Indigenous and Indigenous-Informed Burning for Habitat Enhancement and Stewardship.
Don Hankins *- California State University, Chico*

11:35 – 11:55 a.m.

Session 2 - Live Q&A

12:00 – 1:00 p.m. **LUNCH**

12:30 – 1:00 p.m. **Heritage Growers Breakout Session**

Keynote Address

1:00 – 1:50 p.m.

Introduction of the Keynote Speaker.
Kerry Byrne *- Humboldt State University*

9. Tribal Cultural Relationships with Plants – From Mountains to the Sea.
Frank Lake *- U.S. Forest Service, Pacific Southwest Research Station*

1:50 – 2:10 p.m.

Keynote Address - Live Q&A

Session 3: Poster Session

(Abstracts of posters start on page 23; index to authors on page 30)

2:15 – 3:30 p.m. Poster Session – On-line

Session Chair: ***Barbara Castro*** *- California Department of Water Resources, retired*

Poster presenters will be available to answer questions during the session period.

Session 4: Great Basin Restoration Approaches

3:35 – 4:40 p.m.

Session Chair: ***Kerry Byrne*** *- Humboldt State University*

10. Restoration Plant Material Development in the Great Basin Region of the United States: A History and Comparison of Research Approaches.
Francis Kilkenny *- U.S. Forest Service, Rocky Mountain Research Station*

11. Conservation Implications of the Discovery of New Locations of a Threatened Species using Iterative Ensemble Niche Modeling.
Israel Borokini *- University of California, Berkeley, Department of Integrative Biology*

12. Interagency Seed Collection Efforts in the Great Basin Ecoregion.
Jess Kindred *- Great Basin Plant Conservation and Restoration Program*

13. Community Approach to High Desert Restoration: A History of Co-Occurrence Does Not Predict Response to Invasion.
Alison C. Agneray *- University of Nevada, Reno*

4:40 – 5:00 p.m.

Session 4 - Live Q&A

Day One - Closing Remarks

5:00 – 5:10 p.m.

Day One Closing Remarks – Live.
Jane Van Susteren *- Vice-President of Northern California Botanists*

TUESDAY, 11 JANUARY 2022

Second Day Opening Remarks

9:00 a.m.

Second Day Opening Remarks – Live.
Jane Van Susteren - *Vice-President of Northern California Botanists*

Session 5: New Discoveries

9:10 – 10:15 a.m.

Session Chair: ***Jane Van Susteren*** - *California Department of Forestry*

14. Lineage and Species Discovery in the Remarkably Diverse Tribe Eriogoneae – *Eriogonum* and Relatives.
J. Travis Columbus - *California Botanic Garden*

15. *Lomatium macrocarpum s.l.*, a Plant with a Wide Range and Many Names.
Kevin Mason - *Carex Working Group*

16. New Concepts for What is *Erythranthe guttata* and What is Not.
Steve Schoenig - *California Department of Fish and Wildlife, retired*

17. Steps toward Understanding Western Bellflowers.
Nancy Morin - *Flora of North America*

10:15 – 10:35 a.m.

Session 5 - Live Q&A

Session 6: Riparian Vegetation Restoration from Theory to Practice

10:40 – 11:45 a.m.

Session Chair: ***Rob Thoms*** - *Stillwater Sciences*

18. River Restoration 2.0: A Broader Palette of Options and the Return of the Floodplain.
Pete Downs - *University of Portsmouth and University of California, Santa Barbara*

19. Water Stress in Riparian Woodlands from Groundwater Decline and Climate Change – Ecosystem Indicators at Multiple Scales.
John Stella - *SUNY*

20. Case Studies of In-stream Restoration and Riparian Revegetation in the Salmon River Watershed.
Deja Malone-Persha - *Salmon River Restoration Council*

21. Does Hydrologic Restoration of Mountain Meadows Result in a Net Increase in Carbon Storage?
__Amy Merrill__ - American Rivers

11:45 a.m. – 12:05 p.m.

Session 6 - Live Q&A

12:05 – 1:00 p.m. **LUNCH**

Session 7: eDNA

1:00 – 2:05 p.m.

Session Chair: __Rachel Meyer__ - University of California, Santa Cruz

22. CALeDNA Teams Search for Patterns in Plant, Microbe, and Animal DNA Presence in Vernal Pools, Oases, Rivers, Mountains, and Coasts.
__Rachel Meyer__ - University of California, Santa Cruz
__Jason Sexton__ - University of California, Merced

23. Fungal Metabarcoding to Illuminate Plant-Fungal Networks in Complex Plant Communities.
__Gregory Gilbert__ - University of California, Santa Cruz

24. Coastal Dune Restoration Efforts Complicated by Changes in Soil Biota and Chemistry Associated with Establishment by Non-Native Invader.
__Lorraine Parsons__ - Point Reyes National Seashore, National Park Service

25. Zeta Diversity Patterns in Metabarcoded Lotic Algal Communities as a Tool for Bioassessment.
__Ariel Levi Simons__ - University of California, Los Angeles

2:05 – 2:25 p.m.

Session 7 - Live Q&A

Session 8: Lightning Talks

2:30 – 3:15 p.m.

Session Chair: __Kristen Kaczynski__ - California State University, Chico

Lightning Talk presenters will be available to answer questions during the session period.

26. New county record collections in the Northern and Central Sierras.
__Shane Hanofee__ - Kleinfelder

27. Is *Phytophthora ramorum* a threat to California chaparral?
__Wolfgang Schweigkofler__ - Dominican University of California

28. Slowed obligate seeder recovery post-fire in dozer lines.
Hannah Weinberger *- Ascent Environmental*

29. Invasive spongeplant found in Feather River.
Robin Carter *- California Department of Water Resources*

30. Creating Habitat: A State-wide experiment for the Western Monarch (*Danaus plexippus*).
Kim Armstrong *- River Partners*

31. A Botanist's Perspective Working on Burned Area Emergency Response (BAER) Teams in Northern California.
Lusetta Sims *- Shasta Trinity National Forest*

32. The Importance and Establishment of Research Natural Areas Within the National Forest System.
Lauren Quon *- Cleveland National Forest*

33. CNPS Local Floras project.
David Magney *- California Native Plant Society*

34. Long-term recovery of restored Sacramento River floodplains.
Brook Constantz *- University of California, Santa Cruz*

35. Learn to Love those Latin Names: A straightforward new book on how to use scientific names.
Ann Willyard *- Hendrix College, retired*

36. Post-fire monitoring of vegetation in Santa Cruz and Santa Clara counties: opportunities for collaboration and next steps in 2022.
Kelsey Guest *- California Native Plant Society*

37. Management and ecological surveys indicate long-term grassland restoration success but potential for biotic homogenization.
Justin Luong *- University of California, Santa Cruz*

38. Whiskeytown PG&E Plant Survey 2021: Highlights, Discoveries and Questions.
Chris McCarron *- Great Basin Institute*

39. Digitizing California's National Forest Herbaria.
Jenn Yost *- Cal Poly, San Luis Obispo*

Session 9: Now the Good News

3:20 – 4:25 p.m.

Session Chair: ***Israel Borokini*** *- University of California, Berkeley*

40. Preventing Extinction of San Mateo Thornmint.
Christal Niederer *- Creekside Science*

41. California Native Plant Society Unveils Fully-Rebuilt and Updated Rare Plant Inventory.
Aaron Sims *- California Native Plant Society*

42. *Angelica lucida* Mitigation: Comparison of Transplanting and Seeding Restoration Methods, Humboldt Bay, California.
    Victoria Bryant *- Stillwater Sciences*

43. Recovery Program for Large-flowered Fiddleneck (*Amsinckia grandiflora*): Recent Successes after 30 years of Experimentation.
    Holly Forbes *- University of California Botanical Garden, Berkeley*

4:25 – 4:45 p.m.

Session 9 - Live Q&A

Closing Remarks

4:50 – 5:00 p.m.

Closing Remarks – Live.
Linnea Hanson *- President, Northern California Botanists*

POST-SYMPOSIUM WORKSHOPS

WEDNESDAY, 12 JANUARY 2022

Workshop 1: Features of the Consortium of California's CCH2 Data Portal.

Time: 9:00 a.m. – 12:00 p.m.
Location: Zoom link provided after registration
Instructor: **Katie Pearson**, Project manager, California Phenology Network

The CCH2 data portal (cch2.org) hosts data for over 4.1 million herbarium specimens, 1.4 million of which have now been imaged. CCH2 is a powerful tool for botanists, students, and researchers to create and track specimens and manage species checklists. Herbaria across the state use CCH2 to manage their collections' data, but we need help! In this workshop, we will demonstrate how to use basic and advanced functions in CCH2 to discover and map specimen data and manage species checklists. We will also discuss how YOU can get involved with curating the data of plants you've collected or those near you through georeferencing, data entry, and quality-checking.

Workshop 2: Tracking Plant Population Change using Calflora.

Time: 1:00 – 4:00 p.m.
Location: Zoom link provided after registration
Instructor: **Cynthia Powell**, Executive Director of Calflora

We will cover using Calflora at home and in the field in terms of tracking population change over time. These changes may include changes in plant phenology over time, how development is affecting a population, and plant distribution or range changes due to e.g. climate change. We will also learn how to re-discover historic observations in the field, rare plants in Calflora, specimens in Calflora, and which native plants to use in restoration work / gardens based on ecoregion and climate tolerances.

ABSTRACTS OF TALKS

Abstracts are in chronological order; index to authors is on page 30.
See also the List of Common Acronyms on page 29.

1. **HANSON, L.**
2837 Mariposa Avenue, Chico, CA 95973. linneachanson@gmail.com

Welcome to our Eleventh Northern California Botanists Symposium.

I'd like to welcome all of you to our eleventh symposium, *Tools for a New Decade of Managing Northern California Plant Communities*. This will be our first online symposium. We hope you will enjoy the program that we have organized for you this year with great speakers and posters. Our keynote speaker, Frank Lake, will address *Indigenous Knowledge and Ethno-Botany: Tribal Understandings and Connections of Plants and Their Environment*. We will have the poster session on Monday afternoon after the keynote to provide ample time to view the many varied posters that have been submitted. We plan to have lightning talks Tuesday afternoon. We again hope to provide botanists with a forum to listen to talks on a variety of subjects. We have encouraged students to attend so please be sure to take time to interact with them and for them to meet you. Northern California Botanists is a cooperative association of Federal, State, Academic, Consulting and other botanists in the Northern California region, with the purpose of increasing knowledge and communication about botanical issues concerning science, conservation, education and professional development. Have a great online symposium.

2. **REYNOLDS, P.H.**
River Partners, 928 2nd St #200, Sacramento, CA 95814. preynolds@riverpartners.org

Creating High Quality Habitat Dominated by Native Herbaceous Vegetation in the Built Environment.

Establishment of native herbaceous vegetation in urban landscapes has the potential to significantly increase habitat values and ecological function compared to traditional landscaping. Habitat garden designs that include native species that naturally occur in the region and incorporation of habitat features such boulders, coarse woody debris, duff layers, bare soil and water features can provide important habitat for beneficial insects including pollinators and other wildlife species while improving water infiltration and retention and reducing irrigation needs while sequestering carbon. Pat Reynolds' talk will include real world examples of how these important components of a habitat garden can be designed, constructed, and maintained to create resilient, high value landscapes dominated by native herbaceous vegetation.

3. **MILLER, D.G.**
Department of Biological Sciences, and Center for Water and the Environment, California State University, Chico; 400 West First Street, Chico, CA 95929-0515. dgmiller@csuchico.edu

Monitoring butterfly populations in the Sierra-Cascade foothills as part of a conservation initiative.

Beginning in 2008, I have organized an annual population census of butterflies found on the eastern edge of the Sacramento Valley, in the foothills of the Sierra-Cascade ranges. This "butterfly count," sponsored by the North American Butterfly Association (NABA), has been part of a broader effort to survey and monitor butterfly populations across the continent. The so-called Fourth of July butterfly count is loosely modeled after the Audubon Society's annual Christmas bird count, and provides the general public opportunities to help assess the well-being of these iconic and important insect pollinators. Like the Christmas bird count, our annual Big Chico Creek Ecological Reserve (BCCER) butterfly count spans a 15-mile diameter count circle; it is centered at the Reserve's headquarters and straddles several canyons and ridges, including the Butte Creek Ecological Preserve. Results are entered into the NABA database, along with thousands of data points from hundreds of other annual butterfly counts. Recently, data from the NABA counts, a long-term data set collected by Art Shapiro at UC Davis, as well as data from the social media platform iNaturalist, were published to reveal long-term declines in butterfly populations across western

North America. Although not all butterfly species are suffering declines, I will interpret these patterns, as well as potential drivers causing the declines, by highlighting trends in selected butterfly species observed in ongoing BCCER butterfly counts.

4. **PICKLUM, D.A.**
University of Nevada, Reno; Department of Biology Mail Stop 314, 1664 N. Virginia Street, Reno, NV 89512. dpicklum@unr.edu

Floral Signals and Pollen Placement: Revisiting the Natural History of a Beloved Sierra Nevada Wildflower System.

Within flowering communities, pollinators often visit several different plant species concurrently as they forage for floral rewards. These plant species may interact indirectly via their shared pollinators, and can experience impaired pollination services due to heterospecific pollen transfer. Alternatively, plants can benefit when pollination is enhanced due to larger pollinator populations. In natural settings, indirect interactions can be context dependent, and may be influenced by floral traits (e.g. morphology, reward type, or floral displays). Here, we revisit the pollination of two flowering species first observed by natural historians in the 1950's and 60's to disentangle the role that floral traits play in shaping indirect interactions. *Dodecatheon alpinum* (alt. *Primula tetrandra*, Alpine shooting star) and *Pedicularis groenlandica* (Elephant head lousewort) share similar color, a pollen reward, specific behavioral requirements (buzz pollination), habitat preference, and are both predominately visited by *Bombus* (bumblebee) species. With this work, we describe bee foraging behavior and pollen deposition, showing that bees move between these species where they co-occur. Pollen placement data and stigma samples show that these species partition pollen on bees' bodies imperfectly, leading to occasional heterospecific pollen transfer. We then measure floral color using reflectance measurements and visual models, which indicate these two plant species overlap in color to a bumble bee's eyes and vary within their populations. Together these data connect floral traits, bee preference, and plant reproductive ecology, adding to previous natural history work, and setting the groundwork to further understand the evolution of floral traits.

5. **ALPERTI, J.[1], KELT, D.A.[2], HEADY, P.A.[3], and FRICK, W.F.[4]**
[1]Department of Wildlife, Fish and Conservation Biology, University of California, Davis, 1 Shields Avenue, Davis, CA 95616. jraliperti@ucdavis.edu.
[2]Bat Conservation Research and Services, Aptos, CA 95001. pheady3@batresearch.org.
[3]Department of Wildlife, Fish and Conservation Biology, University of California, Davis, 1 Shields Avenue, Davis, CA 95616. dakelt@ucdavis.edu.
[4]Bat Conservation International, 500 N Capital of Tex Hwy, Bldg. 1, Suite 175, Austin, TX 78746. wfrick@batcon.org.

Pollination Extends to Frugivory in the Pallid Bat, *Antrozous pallidus*.

Seasonal reliance on plant-based resources is very uncommon in temperate insectivorous bats. The pallid bat (*Antrozous pallidus*) is an exception and in the Sonoran Desert switches from an arthropod-based diet to one that includes cactus nectar during spring when columnar cacti bloom. Such cactophily is a common strategy among nectar-feeding phyllostomid bats, including migratory *Leptonycteris* species that consume nectar and fruit from columnar cacti. Spring nectarivory by *A. pallidus* begs the question of whether they also consume cactus fruit during the summer, despite lacking morphological and physiological adaptations for frugivory. We recorded foraging behavior of bats at 134 fruits of the cardón cactus (*Pachycereus pringlei*) in Baja California Sur, Mexico, and used stable isotope analysis to quantify incorporation of fruit into the summer diet of *A. pallidus*. We found that *A. pallidus* visited cardón fruits just as frequently as the lesser long-nosed bat, *Leptonycteris yerbabuenae* (51.0% and 49.0% of total observed visits, respectively), and removed the same amount of fruit. Carbon isotopes in wing tissue and exhaled breath of *A. pallidus* were consistent with frugivory, although variability in the proportion of cactus-derived $\delta^{13}C$ in *A. pallidus* was higher in summer than in spring. Our results confirm that nectarivory in *A. pallidus* extends to frugivory, highlighting remarkable dietary plasticity in a temperate bat. Moreover, these data suggest that *A. pallidus* may be an important mutualist to columnar cacti in parts of the Sonoran Desert.

6. **SMITH-FERRI, S.**
Dry Creek Rancheria Band of Pomo Indians, 2918 Mill Creek Rd., Ukiah, CA 95482.
sherries@drycreekrancheria.org

"Yes, It Often Doesn't Have a Happy Ending:" California Indian Oral Traditions and Environmental Science.

California Indian oral traditions (often called "myths" or "legends") are typically seen as unscientific at best, if not outright naïve and childlike. In fact, there is a great deal of important environmental science to be learned from these narratives. Wood Rat, Waterdog, Flint Boy, Old Man Coyote, Peppernut Girl and others can teach us much. For example, current research on the relationships between mycorrhizal fungi and plants show Native beliefs centered around "talking trees" as less bizarre or fanciful, and more prescient, than botanists were willing to credit, at least until recently.

7. **THOMPSON, T.[1] and MCCOVEY, L.[2]**
[1]Food Sovereignty Division, Yurok Tribe Environmental Program, P.O. Box 1027, Klamath, CA 95548.
tthompson@yuroktribe.nsn.us
[2]Yurok Tribe Environmental Program, P.O. Box 1027, Klamath, CA 95548.
lomccovey@yuroktribe.nsn.us

Yurok Tribe Food Sovereignty: Combining Traditional Food Systems, Gardens, and Orchards to Decolonize Diets.

The concept of food sovereignty is not new to Yurok people, who have resided in villages along the North Coast of what is called California since time immemorial. Prior to the arrival of European American settlers, the Yurok people thrived off a sovereign food system consisting of salmon, acorns, seafoods, berries, and other traditional foods that are still found throughout the region. The effects of colonization and attempted genocide still impact the Yurok community today. Along with many other indigenous peoples, the Yurok Tribe is at the forefront of combatting the effects of global climate change, the disastrous effects of hydroelectric dams, the banning of prescribed and cultural burns, and other environmental harms that are a threat to traditional food systems. Our presentation will discuss the current and planned projects of the Yurok Tribe Environmental Program (YTEP) Food Sovereignty Division to meet the caloric, nutritional, and cultural food needs of Yurok Tribal living on and near the Yurok Indian Reservation (YIR) and combat the negative impacts of colonization and the ongoing harms of genocide. Some of these efforts include restoring cultural and prescribed burns to tanoak groves, harvesting and processing traditional foods to distribute to elders and those who cannot access them, and the creation of Yurok Food Villages throughout the reservation. The carbon-neutral and zero-waste Food Villages will include traditional food and medicine cultivation, vegetable gardens, orchards, food preservation equipment and materials in a commercial, educational space, and facilities to host farmers markets.

8. **HANKINS, D.L.**
California State University, Chico, 400 West First Street, Chico, CA 95929-0425.
dhankins@csuchico.edu

Indigenous and Indigenous-Informed Burning for Habitat Enhancement and Stewardship.

Since time immemorial, Indigenous peoples within the California Floristic Province have utilized fire to sustain ecoculturally rich landscapes. The balance of Indigenous fire and wildfires created fire dependent ecosystems and cultures. Specific stewardship practices emerged from the complex reciprocal relationships between fire, landscapes, and people. Indigenous fire as a process coevolved in fire prone landscapes to enhance ecocultural diversity and functionality. While this process has been disrupted by factors including policy, disease, and genocidal acts it is imperative to revitalize Indigenous fire practices at a landscape scale to reduce vulnerability across social-environmental systems. Life with fire requires knowledge and skill to read the land and its needs to apply fire when and where appropriate. It is not enough to simply reapply fire to the landscape; its success is contingent on application of knowledge and practice to achieve desired outcomes. It also requires the support of the broader society and policy reform. In light of an increase in devastating fires and their aftermath stemming from factors including climate change, we are all vulnerable to the results. Support and action from a broader culture of fire that is Indigenous-led poses a time-tested solution to life with fire to sustain the richness and resilience of our ecosystems and society.

9. **LAKE, F.K.**
USDA Forest Service, Pacific Southwest Research Station, Arcata Lab, 1700 Bayview Dr., Arcata, CA 95521. frank.lake@usda.gov

Tribal Cultural Relationships with Plants – From Mountains to the Sea.
Northern California Tribal cultures have adapted to climate and environmental processes over millennia. Since time in memorial, tribes have learned to use a variety of ecosystems, habitats, and plants as culturally valued resources. Plants have and continue to be used for foods, materials, medicines, spiritual and ceremonial practices as well as a cultural identity among tribes. Many non-tribal entities do not fully understand and acknowledge the relationships of tribes with plants. This presentation will share the various ways tribes have stewarded, fostered, and enhanced plants as favored resources that promote diversity, resistance, and predictability of habitat conditions. Such information is applicable to landscape and associated habitat restoration strategies, conservation of rare and threatened plants species, and for climate adaptation. Examples will be provided of various projects and opportunities to work with tribal traditional ecological knowledge and tribes in the management of plants across northern California.

10. **KILKENNY, F.F.**
USDA Forest Service, Rocky Mountain Research Station; Boise Aquatic Sciences Lab, 322 E Front Street, Boise, ID 83702. francis.f.kilkenny@usda.gov

Restoration Plant Material Development in the Great Basin Region of the United States: A History and Comparison of Research Approaches.
The Great Basin region of the United States has a long history of large-scale revegetation and restoration seedings that require seed amounts well in excess of what would be available through direct wildland collections. To meet this seed need, several federal research programs have arisen that develop plant materials suited to agronomic production and large-scale use. A few of these programs have existed for over a century. For much of this time only a handful of approaches to plant material development were implemented, focused primarily on selecting for sources and traits that supported ungulate forage value and, to a lesser degree, seed production. Even though other potential approaches were available from the beginning of these programs, decisions made at high levels in the federal government affected the structure and scope of these research programs and, ultimately, which land management goals were supported. Recently, additional development approaches have been established that broaden the range of options for seed producers and restoration practitioners. This talk will focus on the history of plant material development in the Great Basin and compare across approaches within the context of past and current land management research goals.

11. **BOROKINI, T.I.[1,2], NUSSEAR, K.[3], DILTS, T.E.[4], and WEISBERG, P.J.[5]**
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Conservation Implications of the Discovery of New Locations of a Threatened Species Using Iterative Ensemble Niche Modeling.
An iterative and ensemble modeling approach was used to fit ecological niche models to better understand the ecological drivers of *Ivesia webberi* distribution. Geographical projections were generated from

weighted average ensembles of six niche modeling algorithms (Boosted Regression Trees, Random Forests, Maximum Entropy, Artificial Neural Networks, Generalized Additive Models and Generalized Linear Models), and were used to guide field validation surveys. Alternating niche modeling and field surveys were conducted for five years (2015-2020) generating additional absence points and novel occurrences. Niche differences between the original and novel environmental conditions were estimated using tests of niche overlap, similarity, expansion, and stability, based on principal component analysis. Differences between the geographic projections of the first- and fifth-year iterative niche models were also compared. Model-guided field surveys resulted in the discovery of nine new locations of *I. webberi*, including two accidental discoveries, increasing the number of known locations to 32, and expanding the northern reach of the known species range by 65 km. The new locations resulted in a 7% niche expansion; however, niche similarity (p=0.10) was not significantly different. Furthermore, there was 44% overlap between the original and new locations. *I. webberi* niche is associated with perennial herbaceous cover, Topographic Position Index, and climatic variables. These results demonstrate the effectiveness of iterative niche modeling and model-guided field surveys, which resulted in the discovery of new locations of a rare and threatened species, expanded the known species range, and improved model performance. This can support effective conservation management for threatened species.

12. **KINDRED, J.C.[1], EDWARDS, F.[2], KULPA, S.M.[3], NETZ, D.[4], and WILHELM, R.[5]**
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Interagency Seed Collection Efforts in the Great Basin Ecoregion.

Wildland seed collections are the starting point for native seed research, development, and restoration. We discuss native seed collection efforts of the Great Basin Plant Conservation and Restoration Program (GBPCRP) and its partners since the implementation of the National Native Seed Strategy in 2015. Through interagency collaboration implementing the Seeds of Success Program, we collected seeds and their associated data from hundreds of native plant populations across the Great Basin ecoregion. Since 2017, more than 200 lbs. of wildland collected seed have gone to growers for increase from these coordinated efforts. Approximately 70,000 lbs. of locally adapted native seed will be available as soon as 2022 for application on restoration projects across this ecoregion from these increase efforts. Here, we discuss our successes and lessons learned from coordinated seed collection efforts to meet the growing need for native plant materials in the Great Basin.

13. **AGNERAY, A.C.[1,2], FORISTER, M.L.[1,3], PARCHMAN, T.L.[1,4], and LEGER, E.A.[1,5]**
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Community Approach to High Desert Restoration: A History of Co-Occurrence Does Not Predict Response to Invasion.

Restoration mixes are often comprised of haphazard collections of species sourced from disparate locations, resulting in communities differing in environment of origin and lacking a history of tion. We asked if restoration effectiveness differed between communities founded with species sharing a history of co-occurrence (sympatric) or associations of the same species from different locations (allopatric). Using 6 shrub, grass, and forb taxa, we compared establishment, productivity, reproduction, phenology, and resistance to invaders for sympatric and allopatric communities. Each community type was planted into outdoor mesocosms and measured over three growing seasons, and invaded with *Bromus tec-*

torum in their final season. There were no consistent differences between allopatric or sympatric communities. Instead, individual collections of taxa responded differently to these treatments: many had no response to neighbor type, though it was beneficial for some taxa from some collections to be planted with allopatric neighbors, while others benefited from sympatric neighbors. For instance, the largest *Elymus* spp. in our study benefited from allopatry, growing 50% larger in the random mixtures on average than in the single-origin mesocosms. *Bromus tectorum* biomass was most affected by the size of *Elymus* spp. and *Poa secunda*: larger native grasses had the most suppressive effect. Our results demonstrate community composition does affect plant performance, but planting sympatric communities is not sufficient to ensure high ecosystem services.

14. COLUMBUS, J.T.[1], MILLS, C.[2], MATZKE, C[3], FRAGA, N.S.[4], and PEARMAN, P.B.[5]

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Lineage and Species Discovery in the Remarkably Diverse Tribe Eriogoneae – *Eriogonum* and Relatives.

Polygonaceae tribe Eriogoneae currently comprises 18 genera, 340 species, and 548 minimum-rank taxa, of which 17,173 (51%), and 282 (51%) are present in California. *Eriogonum* (252 total species, 118 in California) and *Chorizanthe* (63 total species, 35 in California) are the largest genera; in contrast, the 16 remaining genera each comprise only 1–3 species. The tribe is morphologically quite variable, is widely distributed throughout California, and occupies a broad range of elevations and habitats. With overarching goals of improving the classification and our understanding of diversification, we are testing monophyly of taxa and examining relationships within and among taxa using sequences from double-digest restriction site-associated DNA (ddRADseq). Analysis of these data along with morphology, geodistribution, and ecology are revealing previously unknown lineages and species. We report findings from four studies with emphasis on taxa occurring in northern California. Specifically, the widespread *Eriogonum spergulinum* as currently delimited represents two species and is sister to a clade comprising seven of the tribe's small genera. The southern Sierra Nevada endemic *E. polypodum* likewise represents two species and is sister to a clade of the montane dioecious *E. diclinum*, *E. incanum*, and *E. marifolium*. The widespread western North American *E. umbellatum* also represents at least two independent lineages in northern California, related in part to distribution on serpentine soils. We believe our approach, which involves finer-scale sampling and sequences from thousands of loci, will continue to uncover buckwheat lineages and species, and will greatly improve our knowledge of the patterns and processes of evolution.

15. MASON, K.

Carex Working Group

Lomatium macrocarpum s.l., a Plant with a Wide Range and Many Names.

Lomatium macrocarpum sensu lato is a variable taxon with an extensive range in western North America. There is a large degree of petal color variation in this species complex that seems to coincide with differences in habitat. Species with varying petal color are allopatric from each other, and warrant taxonomic splitting. At least 4 species are described here. One of these, an endemic to the Willamette Valley of Oregon, is critically rare, with only two known populations remaining in the entire Willamette Valley.

16. SCHOENIG, S.
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New Concepts for What is *Erythranthe guttata* and What is Not.

California botanists are becoming more comfortable with the new family for monkeyflowers (Phrymaceae) and the "new" genera (*Diplacus, Erythranthe, Mimetanthe*) but there may be low awareness that the subgenus Simiolus that includes the diversity of the old name *Mimulus guttatus* has grown from 5 species (in TJM2) to 20 named and recognized species in California currently. Identification of these species is tricky, although half are restricted to very localized regions. The "common yellow monkey" has gone from one of the easiest identifications to one that I think most botanists are ignoring because of unfamiliarity and the trickiness of the characters used in identification. I will encourage people to become more familiar with this group and provide some advice on using the new names especially in professionally prepared reports and lists. My talk will emphasize species found in the northern portion of California.

17. MORIN, N.R.
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Steps Toward Understanding Western Bellflowers.

California is home to 18 species of Campanuloideae, a subfamily of Campanulaceae, the bellflower family, with 1050 species worldwide, of which 400—500 are in *Campanula.* Recent comprehensive molecular phylogenies (by other authors) of Campanuloideae split *Campanula* into two major clades, *Campanula* and *Rapunculus,* with North American *Campanula* mostly basal in *Rapunculus*, intermixed with *Githopsis, Campanulastrum, Triodanis, Heterocodon*, and non-North American *Peracarpa* and *Legousia.* The goal of the project reported here was to have a taxonomic structure that reflected both these phylogenetic conclusions and the morphology and ecology of these taxa. North American species traditionally in *Campanula* include morphologically distinct, narrow endemics: xerophytic annuals now in *Ravenella* (California: *R. angustiflora, R. griffinii, R. sharsmithiae, R. exigua*) and *Poolea* (Texas); wetland annual *Protocodon* (Florida), and wetland perennials *Palustricodon* (nc and ne North America), *Eastwoodiella* (California: *E. californica*), and *Rotanthella* (Florida). *Smithiastrum* contains what were formerly *Asyneuma prenanthoides* and *Campanula wilkinsiana*. The remaining California campanuloid species are in an unrelated subclade of *Rapunculus*, all Eurasian campanulas. *Campanula shetleri* (restricted to Castle Crags) and *C. scabrella* (Mt Eddy, Lassen, Warner Mountains; Rocky Mountains), are high elevation tufted plants; *C. scouleri* is a woodland plant (California and Oregon); *Campanula parryi,* a Rocky Mountain species, and *C. lasiocarpa*, far northwest, are also in this group. *Campanula rotundifolia* is in an even more distant clade and is a highly diverse, circumboreal species. Campanuloideae in California most likely had at least five origins. Recognizing new genera is a first step toward reflecting their phylogenetic and morphological diversity.

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River Restoration 2.0: A Broader Palette of Options and the Return of the Floodplain.

River restoration in its contemporary form began in *ca*.1990 and has the implicit goal of improving the integrity of freshwater ecosystems. Initially, approaches were based on morphological 'carbon copy' from historical or geographical analogs but best-practice veered rapidly towards limiting factors-based rehabilitation and process-based renaturalization. Both approaches tended to have an in-channel focus, perhaps because river restoration became tied to flood risk management leading to floodplains being 'out of bounds', but certainly it was reinforced by channel-based metrics of success. Sustained environmental gains in many projects may have been marginal at best. However, the last decade has seen a reinvigoration of restoration principles based around broader principles of nature-based solutions, biomic restoration, nature-culture hybrids and, ultimately, re-wilding. Each approach demands the re-integration of channel-floodplain complexes. Nature-based solutions, including for 'natural' flood management, demand a watershed hydrological assessment and, ideally, an appreciation of sediment sources and delivery pathways. Biomic restoration is most charismatically entwined with 'Stage 0' restoration of incised channels and explicitly demands the hydrogeomorphic reconnection of channels and floodplains that may have been functionally disconnected for decades or more. In long-settled areas, nature-culture hybrid approaches to restoration embrace the notion that there is no 'natural' equilibrium condition and requires a valley-wide focus to recreate culturally created fluvial environments. This evolution in the palette of restoration options is highly demanding of multidisciplinary baseline analyses but offers the potential for significant and sustained environmental gain, a goal that is more urgent still in the context of the global freshwater biodiversity crisis.

19. STELLA, J.C.[1], WILLIAMS, J.[2,3], KIBLER, C.[4], ROHDE, M.M.[2], PELLETIER, L.[2], SINGER, M.[5,6], ROBERTS, D.[4,6], LAMBERT, A.[3,7], and CAYLOR, K.[4,6,8]
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Water Stress in Riparian Woodlands from Groundwater Decline and Climate Change – Ecosystem Indicators at Multiple Scales.

Though riparian woodlands are thought to be buffered against water stress by their landscape position and favorable hydrology, climate change and groundwater extraction increasingly threaten their long-term sustainability, particularly in drylands globally. Here we synthesize findings on the water stress response of riparian woodlands during and after the exceptional California (USA) drought of 2012–2019 from concurrent studies at different spatial and temporal scales. We coupled tree-ring studies from riparian stands along the Santa Clara River in Southern California with a basin-scale remote sensing investigation and a state-wide satellite imagery analysis to compare the timing and severity among indicators, and as well as ecosystem resilience. Tree-ring analyses revealed strong reductions in radial growth and carbon isotope discrimination as well as enrichment in $\delta^{18}O$ during the driest years, indicating severe drought stress which was determined more by the rate of groundwater decline than by climate drivers. This pattern was reinforced at the landscape scale, where we observed decreased canopy greenness and increased dead biomass progressing downstream as a "brown wave" from 2012 to 2016. Immediately after the drought, individual trees showed strong recovery of canopy-integrated leaf gas exchange, as indicated by tree-ring $\Delta^{13}C$ and $\delta^{18}O$, as well as radial growth, except at sites subjected to the greatest water stress. Overall there were consistent relationships between groundwater depth, healthy vegetation cover, and tree growth and function, indicating that woodland health deteriorated in a predictable fashion as the water table declined at different sites and different times. The statewide analysis of Sentinel satellite imagery reinforced these results, showing woodland stress responses to deeper groundwater across all riparian ecotypes, as evidenced by concurrent declines in NDVI. Furthermore, we found greater seasonal coupling of canopy greenness to groundwater for vegetation along streams with natural flow regimes in comparison with anthropogenically altered streams, particularly in the most water-limited regions. Together these studies pave the way for developing complementary climate and groundwater sensitivity indicators to help manage vulnerable riparian woodlands experiencing global change.

20. MALONE-PERSHA, D.
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Case Studies of In-stream Restoration and Riparian Revegetation in the Salmon River Watershed.

In an effort to restore habitat for Threatened salmonid species at a landscape scale, the Salmon River Restoration Council has undertaken a series of in-stream restoration projects throughout the riparian corridor of the California Salmon River. This presentation will provide an overview of revegetation methods within three in-stream restoration projects, two of which are in the post-construction monitoring phase and one of which is planned for implementation in 2023. These projects aim to address the legacy impacts of mining and logging that have resulted in channel simplification and degraded habitat. Two of these projects restore floodplain connectivity on the North Fork and the third provides fish passage on a tributary to the South Fork. In addition to restoring aquatic habitat, these projects have incorporated terrestrial habitat restoration through active revegetation and noxious weed management. All three projects feature revegetation plans driven by the following objectives: restore functional riparian habitat that will provide structural complexity, diversity, shade, and stream inputs of woody debris and organic matter, as well as reduce the abundance and distribution of non-native invasive plant species in project areas. We have used a variety of revegetation techniques including pre-construction vegetation classification and mapping, the construction of brush baffles and innovative augmented planting areas, diverse riparian plantings and the application of both hydroseeding and direct seeding of locally sourced materials by hand. Project methods, outcomes, and lessons learned will be discussed.

21. MERRILL, A.G.
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Does Hydrologic Restoration of Mountain Meadows Result in a Net Increase in Carbon Storage?

Soils are the earth's largest carbon reservoir, and wetlands hold higher concentrations of soil carbon compared to other ecosystems. Wet and mesic meadows, created in topographic lows and along headwater streams in mountainous terrain, are pockets of high soil carbon storage. In the Sierra Nevada mountains of California, such meadows comprise <2% of the area, yet are estimated to hold 12% to 31% of the region's soil organic carbon. With over 60% of these meadows suffering hydrologic degradation in the past 200 years, we are draining rather than filling these rich carbon stores. Can restoration reverse the process and store more carbon? We measured changes in belowground carbon storage in seven meadows before and after hydrologic restoration, compared to six nearby control meadows and to two healthy meadows. Two years following restoration, several meadows showed a large increase in soil storage compared to controls, some showed little change, and several show net losses in response to restoration. A simple field measure - frequency of sedge and grass species - was sufficient to explain most of the variability in belowground carbon response compared to controls. Changes in net carbon sequestration in all 15 meadows over the years were tightly correlated to both pre-restoration vegetation cover and to changes in precipitation, underscoring the importance of vegetation cover and type and the tight relationship between belowground carbon allocation and interannual variability in precipitation. We propose using these findings as a basis for developing a protocol for meadow restoration in the voluntary carbon market.

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CALeDNA Teams Search for Patterns in Plant, Microbe, and Animal DNA Presence in Vernal Pools, Oases, Rivers, Mountains and Coasts.

The CALeDNA program is a multi-institutional research network that collaborates on environmental DNA (eDNA) projects and includes citizen and community scientists in these projects. Now five years in, we have amassed tens of thousands of environmental samples and have sequenced DNA from over 2000 of these samples using multilocus metabarcoding to target plants, algae, fungi, bacteria, animals and other groups. Here, Meyer and Sexton present CALeDNA case studies they've been involved with (among many California investigators we will introduce in our presentation) that examine geospatial and temporal patterns of biodiversity variation. We focus specifically on how eDNA is being used to learn about ecological processes such as wildfire or streamflow, and used to describe the complexity of microhabitats such as vernal pools, oases, and lagoons. Change in community composition (beta diversity) under disturbances or ecological gradients has been the most useful for these projects to measure. Assessing beta diversity through time measures the resilience of systems when eDNA-derived communities return to a stable, familiar state. Another strength of eDNA that we highlight is species co-occurrence networks, which hint at how many invasive plants and ecological keystone plants interact with other species that turn up in CALeDNA surveys. As California eDNA continues to develop as a common tool, it is especially important to integrate disparate surveys to better investigate the scale and patchiness of plant DNA signals in the environment, because plant DNA distributes differently from that of other kingdoms.

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Fungal Metabarcoding to Illuminate Plant-Fungal Networks in Complex Plant Communities.

All plants are colonized by a diverse assemblage of endophytic fungal symbionts, including disease-causing parasites, benign commensals, and beneficial mutualists. Such fungi vary in their specificity to host plant species, but most are polyphagous, able to colonize a number of the plant species they encounter. Despite their ubiquity, we know little about the diversity, composition, spatial distribution, and structure of plant mycobiomes in complex plant communities. We used PacBio fungal metabarcode (ITS) sequencing to characterize the foliar fungal communities associated with plant leaves in three habitats on the UC Santa Cruz campus: mixed-evergreen coastal forest, a grassland, and an organic farm. We identified 1747 fungal taxa from 598 plant species. In addition to the expected abundance of filamentous Ascomycetes, we found an unexpectedly rich community of Basidiomycete yeasts, rusts, and smuts. Of roughly 500 fungal taxa found at least five times, about a third were found across all three habitats, and a quarter were restricted to a single habitat. A small number of fungal taxa were broad host generalists associated with many plant species, but most were found on limited subsets of several host species. Subsets of plant hosts tended to share multiple fungal taxa, and analytical tools from network theory reveal a clear modular structure in the plant-fungal networks.

24. PARSONS, L.S.[1], YANG, B.[2], BECKER B.H.[3], FUQUA, S.R.[4], SPAETH, M.K.[5], and BARBERÁN, A.[2]

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Coastal Dune Restoration Efforts Complicated by Changes in Soil Biota and Chemistry Associated with Establishment by Non-Native Invader.

Point Reyes National Seashore (PRNS) contains some of the highest quality remaining coastal dune habitat in the U.S. This habitat, however, has been seriously threatened by encroachment of European beachgrass (*Ammophila arenaria*) and iceplant (*Carpobrotus edulis*) since being planted in the early 1900s. As of the late 1990s, these species accounted for 60% of PRNS's 2,200 acres of coastal habitats. Concerned about impacts on dunes and listed plants and wildlife, PRNS has over the last 20 years removed 271 acres of beachgrass and iceplant from 525 acres of former native dune habitat. Restoration efforts have met with mixed success, with herbicide-treated backdunes being largely dominated by persistent standing dead beachgrass and thick litter ("thatch") for eight+ years post-treatment. As cover of primary and secondary invaders (e.g., European searocket, *Cakile maritima*) remains low due to vigilant retreatment, other factors appear to be constraining native dune habitat reestablishment following restoration. Recent studies at PRNS conducted in collaboration with University of Arizona (U of A) suggest that invasion by beachgrass changes both soil microbial communities and chemistry and that some of the changes do not dissipate following restoration, particularly in herbicide-treated backdunes. In particular, fungi and bacteria associated with litter decomposition appear affected by both beachgrass invasion and restoration. PRNS is partnering with U of A on an adaptive restoration experiment to determine whether use of whole soil inoculum from intact native dune habitats can jumpstart development of healthier microbial/decomposer communities in restored backdunes that can accelerate beachgrass decomposition and improve restoration success.

25. SIMONS, A.L.[1], THEROUX, S.[2], MAZOR, R.[3], STEELE, J.[4], and OSBORNE, M.[5]
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Zeta Diversity Patterns in Metabarcoded Lotic Algal Assemblages as a Tool for Bioassessment.

Assessments of the ecological health of algal assemblages in streams typically focus on measures of their local diversity and classify individuals by morphotaxonomy. Such assemblages are often connected through various ecological processes, such as dispersal, and may be more accurately assessed as components of regional, rather than local, scale assemblages. With recent declines in the costs of sequencing and computation, it has also become increasingly feasible to use metabarcoding to more accurately classify algal species and perform regional scale bioassessments. Recently, zeta diversity has been explored as a novel method of constructing regional bioassessments for groups of streams. Here, we model the use of zeta diversity to model the health of streams on regional basis. From 96 stream samples in California, we used various orders of zeta diversity to construct models of biotic integrity for multiple assemblages of diatoms, as well as hybrid assemblages of diatoms in combination with soft-bodied algae, using taxonomy data generated with both DNA sequencing as well as traditional morphotaxonomic approaches. We found the performance of our zeta diversity-based models of biotic integrity were more accurate for algal assemblages classified using metabarcoding compared to traditional morphotaxonomic methods. Importantly, we also found that these algal assemblages are more likely to be assembled under a process of niche differentiation rather than stochastically. Taken together, these results suggest the potential for stream bioassessments to be made using zeta diversity patterns of algal assemblages classified using metabarcoding.

26. SHANE HANOFEE
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New county record collections in the Northern and Central Sierras.

27. **WOLFGANG SCHWEIGKOFLER**
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Is *Phytophthora ramorum* a threat to California chaparral?

28. **HANNAH WEINBERGER**
Ascent Environmental – hannah.weinberger@ascentenvironmental.com

Slowed obligate seeder recovery post-fire in dozer lines.

29. **ROBIN CARTER**
California Department of Water Resources – robin.carter@water.ca.gov

Invasive spongeplant found in Feather River.

30. **KIM ARMSTRONG**
River Partners – karmstrong@riverpartners.org

Creating Habitat: A State-wide experiment for the Western Monarch (*Danaus plexippus*).

31. **LUSETTA SIMS**
Shasta Trinity National Forest – lusetta.sims@usda.gov

A Botanist's Perspective Working on Burned Area Emergency Response (BAER) Teams in Northern California.

32. **LAUREN QUON**
Cleveland National Forest – lauren.quon@usda.gov

The Importance and Establishment of Research Natural Areas Within the National Forest System.

33. **DAVID MAGNEY**
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CNPS Local Floras project.

34. **BROOK CONSTANTZ**
University of California, Santa Cruz – brook.constantz@gmail.com

Long-term recovery of restored Sacramento River floodplains.

35. **ANN WILLYARD**
Hendrix College (retired) – willyard@hendrix.edu

Learn to Love those Latin Names: A straightforward new book on how to use scientific names.

36. **KELSEY GUEST**
California Native Plant Society – kguest@cnps.org

Post-fire monitoring of vegetation in Santa Cruz and Santa Clara counties: opportunities for collaboration and next steps in 2022.

37. JUSTIN LUONG
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Management and ecological surveys indicate long-term grassland restoration success but potential for biotic homogenization.

38. CHRIS MCCARRON
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Whiskeytown PG&E Plant Survey 2021: Highlights, Discoveries & Questions.

39. JENN YOST
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Digitizing California's National Forest Herbaria.

40. NIEDERER, C.
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Preventing Extinction of San Mateo Thornmint.

In 2008, there was one extant occurrence of San Mateo thornmint (*Acanthomintha duttonii*). The state- and federally endangered mint was struggling to persist, with only 249 individuals occupying 34 m^2, down from ~53,000 in 1994. Initial efforts focused on propagation/seed increases and grass control at the original site. We identified a successful restoration treatment of post-germination scraping and seeding in unoccupied areas. By 2010 we had 3450 individuals occupying 102 m^2. But over the next few years, numbers at the original site began declining again. We began searching for alternate seed introduction sites within the historic range, testing soil composition and moisture, and seeking similar plant communities on similar serpentine grassland vertisols. In 2016, we began seeding additional sites. By May 2020, we were pleased to report ~43,000 plants occupying 540 m^2 at six occurrences, the highest number since this project began. Numbers declined to ~30,000 in May 2021, likely due to extreme drought. The Creekside Science Conservation Nursery has produced 47,000 to 180,000 seeds annually for more than six years. Seeds were originally carefully installed in individually marked plots at a rate of 500 seeds/m^2, with a minimum of 10,000 seeds/site/year. Now that we have documented success with our methods, we are scaling up by more haphazardly seeding larger macroplots, which are sampled rather than censused. Most of the new sites are outperforming the original site, leading us to believe that focusing scarce resources on the original site would have been a poor decision.

41. SIMS, A.E.
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California Native Plant Society Unveils Fully-Rebuilt and Updated Rare Plant Inventory.

In June 2021, the California Native Plant Society (CNPS) launched its fully-rebuilt and updated *Rare Plant Inventory* database and website. The *Inventory* is a widely-used resource guiding rare plant education, protection, conservation planning, and land acquisition and management in California. CNPS published the first *Inventory of Rare and Endangered Plants of California* in 1974 to provide current and accurate information on the distribution, ecology, and conservation status of California's rare and endangered plants. In the years since, the *Inventory* has moved from a physical set of index cards to an online database where more than 2,400 plants in California are now documented and ranked as rare in the state. The update integrates data maintenance performed within the same web-based program, meaning that updates and changes are made live for immediate use in searches to help inform conservation priorities. Visitors to the refreshed site will find over 60 additions and changes to California Rare Plant Ranks in addition to hundreds of data updates since the database rebuild began. For the first time, the site includes an "Other Status" section with additional status information and details on seeds that have been banked as part of the California Plant Rescue initiative, and a Status Review page where all past status review documents can be sorted and downloaded. The new site was developed with support from the state

of California, Center for Plant Conservation, and the California Plant Rescue initiative, and can be reached at www.cnps.org/rare-plants/cnps-inventory-of-rare-plants.

42. BRYANT, V.[1] and TERAOKA, E.[1,2]
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Angelica lucida Mitigation: Comparison of Transplanting and Seeding Restoration Methods, Humboldt Bay, California.

A population of *Angelica lucida* (California Rare Plant Rank 4.2) was identified within an area that was going to be impacted by construction of a wetland mitigation area. Following discussions with appropriate permitting agencies, all *A. lucida* plants with the potential to be impacted were transplanted into a nearby relocation area. Additionally, mature seeds were harvested from a nearby population of *A. lucida* and spread throughout the relocation area. The relocation area was monitored for two years following transplanting. Of the 40 transplanted individuals, only five were found to be alive after two years. However, 86 recruits from seed were observed in the transplant area at the end of the two-year monitoring period. Monitoring results suggest transplanting *A. lucida* has limited effectiveness as a restoration method but show seeding to be a promising strategy. Though the *Angelica* genus is described as perennial, our data suggest that *A. lucida* may have a biennial life cycle, further supporting seeding as a more effective restoration method than transplanting.

43. SCHWEIZER, J.[1] and FORBES, H.[2]
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Recovery Program for Large-flowered Fiddleneck (*Amsinckia grandiflora*): Recent Successes after 30 years of Experimentation.

Large-flowered fiddleneck (*Amsinckia grandiflora*, Boraginaceae) is an annual wildflower of California grasslands. It has been a subject of intense study for its heterostyly, population declines in the face of invasive grasses, and responses to environmental manipulation going back at least to the 1960s. Since 2012, support from the Bureau of Reclamation and the USFWS Recovery Implementation Team helped our partners make advances in site selection and site manipulation. An initial selection of ten sites was narrowed down to four through outplanting experimentation. Outplanting of seedlings was more successful than direct seed sowing in producing flowering plants that went on to produce seed in situ. Five years (2014 - 2021) of outplanting seedlings proved most effective in creating populations of over 3,000 individuals beginning by 2018. Monitoring data in April 2020 showed 6500 plants at both the single extant natural population and in a nearby introduction site. This far exceeded our goal of having over 3,000 plants in created populations.

ABSTRACTS FOR POSTERS

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See also the List of Common Acronyms on page 29.

1. **EWALD, J.**[+] **and IVEY, C.**
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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, hybridization in nature has only been reported once in the literature. Previous research characterized fourteen potential barriers to reproduction, but did not find complete isolation. Thus, either unmeasured barriers exist or hybridization occurs more frequently than reported. I conducted whole-genome sequencing on individuals of *M. guttatus* and *M. glaucescens* found in natural populations. I then analyzed the sequence data to determine if genetic introgression is occurring between the two species. Lastly, I collected data on bract shape and trichome density in greenhouse-grown parents, hybrids, and backcrosses 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.

2. **FINCH, B.**
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Ecology and Distribution of *Lewisia leeana*, Quill-leaf Lewisia, in Eastern Fresno County.

The purpose of this study is to determine the ecology and map the distribution of the disjunctive population of *Lewisia leeana* in eastern Fresno County. Mapping was carried out during 113 hiking days in 2013-2021 which included photographing, establishing location with GPS, and posting to iNaturalist. The ongoing baseline study focuses on expanding the five areas where 15 observations of *L. leeana* were made from 1900 through 2006. I have posted a total 692 observations of *L. leeana* to iNaturalist. *L. leeana* is almost always found in soil of granitic origin on north facing slopes at elevations greater than 2600m, and it shows no consistent associations with any other organisms. An additional 3,276 other plants and fungi (181 species) were identified during the study and posted to iNaturalist. Continued study of the distribution of *L. leeana* may help monitor effects of climate change. I recommend follow-up monitoring of key locations every five years.

3. **FREDERICK, R.**[+] **and LEGER, E.**
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The Maternal Effects of Production Environment on *Elymus elymoides* in Ecological Restoration.

Genetic fitness is a crucial element of success in ecological restoration. In the Great Basin, extensive restoration efforts have been prompted by widespread high-intensity wildfires, invasion by introduced species, and the effects of climate change. However, restoration needs often outpace what can be collected in the wild, so seeds for many native plant species must be produced in agronomic fields. It is important to understand how these field conditions affect the genetic fitness of such seeds. In my project, I ask how the competitive ability of bottlebrush squirreltail (*Elymus elymoides*), a common restoration grass, is affected by its maternal growing environment. I will do this by growing two populations under maternal environments representing a range of conditions, from high resource with high intraspecific densities to low resource, high interspecific density conditions. I will test competitive traits in their progeny in a controlled greenhouse experiment, and compare seed traits in both generations. I expect to find lowered competitive ability and stress tolerance in individuals experiencing less stressful maternal environments, and decreased seed mass and germinability in individuals with more stressful maternal environments. By quantifying these effects in restoration populations, we can provide direct recommendations to restoration growers to improve seed characteristics by optimizing maternal environmental conditions.

4. **HAZELQUIST, C.[1], GUILLIAMS, C.M.[1], HASENSTAB-LEHMAN, K.E.[1], KENNY, R.[+2], and BOES, W.[3]**
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Using High-Throughput DNA Sequence Data to Infer the Phylogeny of *Lewisia* (Montiaceae) and Evaluate a Potentially New Species from the Sierra Nevada Foothills.

The genus *Lewisia* comprises between 25 and 30 taxa of perennial herbs in the family Montiaceae. This variable, western North American genus has been the subject of considerable taxonomic and morphological study. Earlier Sanger sequencing based phylogenetic studies revealed geographically and morphologically cohesive groupings, but with relatively low statistical support. In 2017 Wendy Boes noted a population of morphologically and ecologically distinctive lewisias in the northern Sierra Nevada Foothills similar to the widespread, high elevation species *L. nevadensis* (A. Gray) B.L. Rob. To re-examine phylogenetic relationships across the genus and investigate the potential new taxon from the Sierra Nevada Foothills, we gathered samples throughout the genus with a focus on both *L. nevadensis* and the potentially undescribed taxon. We built a genetic dataset using ddRAD library preparation and high-throughput sequencing. This large dataset was used to infer phylogenetic relationships across the genus. We also used a subset of these samples in population genomic analyses, which coupled with a focused morphometric study were used to assess the distinctiveness of the putative new taxon. Preliminary ddRAD data show strong support for the kelloggii, columbiana, and rediviva clades previously identified using Sanger sequencing. Our preliminary morphological analyses show that the putative new *Lewisia* from the Sierra Nevada Foothills is distinctive with respect to *L. nevadensis*. In phylogenetic analyses, samples of the putative new taxon form a strongly-supported monophyletic group nested within a paraphyletic *L. nevadensis*, a pattern potentially revealing an instance of peripheral isolate speciation.

5. **KANG, H.**
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Vernal Pool Flora of Roseville.

Roseville is located approximately 20 miles northeast from Sacramento and harbors diverse vernal pools which are often hidden behind suburban walls. The alluvial deposits from the Sierra Nevada provide a rich foundation for the vernal pools (Cometa-Fiddyment complex and San Joaquin soils). Unlike most of Sacramento's vernal pools, Roseville's vernal pools have been under-collected and understudied. The remnants of what is left of Roseville's vernal pools reveal the rich history of Roseville's past wildlands. These collections over the past two years summarize only a portion of Roseville's vernal pool flora and more discoveries will be made. Some county records I collected include common vernal pool species such as *Montia fontana* and other uncommon species like *Spergularia macrotheca* var. *longistyla* (CRPR 1B.2). Select families from this collection will be digitized and available to view online due to funding from the California Phenology Project. Herbarium specimens hold valuable datasets and DNA that prove to be especially useful in our changing climate. Floras and herbarium specimens improve our understanding of the biodiversity in California and climate change.

6. LAMPE, L.A. and IVEY, C.T.
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Investigating Climate-Related Phenological Shifts and Implications for Plant-Pollinator Interactions in Two Northern California Habitats.

Phenology, or the timing of life history events, is often cued by climate. In many species across the globe, phenology has shifted in recent decades in response to climate change, but many interactions between species are dependent on alignment of their respective phenologies. Plant flowering, for example, must occur during pollinator flight periods for pollination to be successful. Alpine habitats may be especially sensitive to climate change; therefore, climate-related phenological changes in communities may be unique in alpine areas. Using selected Northern California plant and bee taxa deemed in relationship through extensive literature review and field observation, I compare the dates of historical plant and pollinator collections with contemporary collections to evaluate whether phenological shifts have occurred in these taxa. Differences in the magnitude or direction of changes in phenology between plant-pollinator partners suggest that misalignment of services may be a concern. In addition, I compare collections from alpine and low-elevation habitats to evaluate whether shifts in phenology or potential misalignments vary between these habitats. Further understanding of the potential for phenological misalignment, especially in communities at risk of habitat loss, will aid in predicting future impacts on species interactions and, by extension, biodiversity.

7. MACKEY, H.E., Jr.
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150-Year Trends and Potential Implications in Selected Perennials in the Foothills and Mountains of Northern California.

Nine perennials were examined from the Consortium of California Herbaria online data base (CCH2) for historical changes in phenology. Only records with an identifiable collection date and elevation were included. Years ranged from 1863 to 2019, Day of the Year from 68 to 267, and elevations from 46 to 3997 meters. Sample sizes varied considerably. For example, with *Dicentra pauciflora* 63 dates were used, whereas with *Eriogonum umbellatum* var. *nevadense* 322 dates were used. Data were divided into pre- and post-1970, because northern California has had a 1-degree C increase in temperature and a 1-month earlier shift in snowmelt and waterway runoff since 1970. *Dicentra uniflora*, *Dicentra pauciflora*, and *Claytonia lanceolata* had a shift to earlier collection and flowering of 10-15 days. *Dicentra formosa* showed a shift to later flowering of 15 days at higher elevations. *Triteleia ixioides* ssp. *anilina* and *Fritillaria atropurpurea* showed little change. *Wyethia mollis* and *Balsamorhiza sagittata* showed earlier trends of 6-12 days. *Eriogonum umbellatum* var. *nevadense* showed an earlier trend at lower elevation with less change at higher elevation. These data provide a means to speculate on the difficulties of predicting interactions of species with climate change. For example, the range of the butterfly *Parnassius clodius* overlaps with six of the perennial plants utilized by larvae or adults. *P. clodius* uses *D. uniflora, D. pauciflora* and *D. formosa* as host plants on which larvae feed. Adult butterflies lay over-wintering eggs near *Dicentra* plants. The nocturnal larvae apparently consume *Dicentra* leaves and/or fruits during the short growth period of these plants. *W. mollis, B. sagittata* and *E. umbellatum* var. *nevadense* are nectar sources for adult *P. clodius*. It is important that the host plants for larvae be timed with availability of *Dicentra* food sources and food sources for adults be available at the appropriate time after pupation. Concurrent earlier shifts of larval and adult food sources with this butterfly could be very important. Areas where these species occur near one another might require additional consideration in management planning. In forested settings, the underground portions of *D. pauciflora* grow at the interface between the duff and the underlying soil and of *D. uniflora* only slightly deeper. Underground reproductive structures could be destroyed during forest fires. It would not be unexpected for the distribution of these *Dicentra* species to decline as fires become more common and intensify in California. Non-forested, more open areas could become candidates for protection of these species. The CCH2 database serves as a tool to monitor the complexity of changes that can occur with long-term climatic and botanical shifts in Northern California.

8. MAYER, M. and KACZYNSKI, K.M.
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Dozer Line Impacts on Local Vegetation Recovery after the Carr Fire.

As wildfires grow in extent and frequency, the scope of fire suppression activities has increased as well. During wildfires, bulldozers are used to build fire lines as they are typically able to construct them faster than hand crews and with a larger impact. These dozer lines leave large swaths of forest bare of vegetation and soil and incur a high ecological cost on the areas where they are constructed. Although dozer line construction is a common fire suppression practice, there is very little research investigating post-fire recovery of these heavily disturbed areas. This research examined the post-fire recovery within and adjacent to four dozer lines, specifically examining the potential impact from non-native species. Vegetation sampling occurred three years post-fire within and adjacent to dozer lines in m^2 plots along 20 total transects. Data was also collected on percent bare ground, litter depth and dead and downed debris. Plots within the dozer line showed little evidence of recovery. Plots within the dozer line were on average nearly 50% bare ground, and absent of vegetation and most organic material. As the distance from the dozer line increased the likelihood of finding a non-native species decreased. In addition, as the dozer line increased in width, there was an increased likelihood of finding non-native species in plots within or adjacent to the dozer line. This study demonstrates that dozer lines have the potential to alter local vegetation patterns in a post-fire environment.

9. RIVERA, I., HASENSTAB-LEHMAN, K.E., GUILLIAMS, C.M., and THOMAS, E.A.
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Santa Barbara Botanic Garden Tissue Bank: A Resource for Plant Genetics Research.

Biorepositories are critical resources for DNA-based research, providing material from which researchers can conduct biodiversity studies. These investigations range from understanding the genetic structure of rare populations on the landscape, to description of new or cryptic taxa based on improved phylogenetic inference. Tissues gathered by local researchers can be used by international colleagues in studies of trait evolution and biogeography for groups of taxonomic interest, especially when costs or permits would prohibit their own fieldwork. The Santa Barbara Botanic Garden has established a repository for plant tissue collections that will soon be connected to the Global Genome Biodiversity Network, with an emphasis on the flora of California and the California Channel Islands. Island taxa currently make up nearly 30% of the tissue bank, 1,900 of the 6,200 collections. Island endemics and rare mainland species are among the most highly represented taxa in the repository, including several species of *Dudleya, Crocanthemum greenei*, *Eriodictyon capitatum,* and *Berberis pinnata* subsp. *insularis.* Prominently featured plant families include Crassulaceae with 1,300 tissues, Asteraceae with 900 tissues, Boraginaceae with 650 tissues, and Malvaceae with 350 tissues. The tissue bank is growing with every field season as researchers contribute collections. Practices for tissue collection, recording metadata, and long-term tissue storage and curation are discussed, as well as opportunities to collaborate using this new resource. This repository will be accessible to researchers for tissue loans and will accept and curate tissue contributions.

10. THAO, S. and BLEE, K.
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Investigating the Location of Histone H3 in *Arabidopsis thaliana* Cells.

Histone H3 is a greatly modified and highly conserved nucleosomal protein that plays a role in chromatin formation and gene regulation. Previous research on histone H3 had concluded that it also binds to the mitochondria and leads to the release of cytochrome c. These studies were done through the use of immunoblotting, a process involving cell lysis that may lead to random protein binding. The Subcellular Localization Database for Arabidopsis Proteins (SUBA) software predicts the histone protein to be localized in the mitochondria. The purpose of this study is to use fluorescent microscopy to visualize histone H3 in real-time in order to determine if it binds to the mitochondria of *Arabidopsis thaliana* cells. *Arabidopsis thaliana* plants containing red fluorescently tagged histone H3 proteins will be cross-bred with plants containing yellow fluorescently tagged mitochondria. High resolution microscopy will be used to visualize the location of the fluorescently tagged histone H3. We predict that histone H3 will bind to the mitochondria of the cell. The results of this study will provide more insight into the functions and structure of histone H3.

11. THOMAS, D.
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Dirca occidentalis, a Proxy for the Diminishing Arcto-Tertiary Geoflora in California?

Dirca occidentalis, western leatherwood or dirca, is a rare plant endemic to the San Francisco Bay Area and the only member of the family Thymelaeaceae native to California. It is one of the earliest blooming native plants, flowering in late winter. For the past 10 years, the Santa Clara Valley CNPS Chapter has conducted an annual early-season field trip to various parks to view dirca in bloom. In 2020 a field trip was led to Rancho San Antonio Open Space Preserve in Los Altos to observe it, the last previous visit having been in the year 2000. It was discovered that of the 14 gps point locations recorded for dirca in 2000, only 2 remained in 2020. This disappearance of dirca had occurred unnoticed and unrecorded during this 20-year time period. The suspected causes of this die-off include climate change and the transformation of the oak woodland plant community by Sudden Oak Death disease. With rapid climate change, it appears that there is a need for more comprehensive and systematic monitoring of rare plants on the San Francisco Peninsula. A systematic monitoring program is being developed to track changes in the populations of dirca, and preliminary results are presented. This program includes periodic recording of plant locations in the Calflora and iNaturalist online databases and the tagging of a sample of plants to detect changes in abundance in the plant community. Perhaps *Dirca occidentalis* can serve as a proxy for the decline of other Tertiary-era plant relicts in California.

12. THORUP, K.[+] and BLEE, K.
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Isolation of Plant-Growth Promoting Rhizobacteria from Mixed-Conifer Forest in the Sierra Nevada, California.

Climate change enhances the occurrence of extreme weather: wildfires, drought, rising summer temperatures—all of which dramatically decrease forest growth and increase tree mortality in the mixed-conifer forests of California's Sierra Nevada. However, microbiota living in mutualistic relations with plant rhizospheres have been found to mitigate the effects of suboptimal environmental conditions. It is the goal of this research is to isolate native beneficial bacteria—plant-growth promoting rhizobacteria (PGPR)—that can alleviate heat stress in *Pinus ponderosa* and *Pseudotsuga menziesii* seedlings. Bacteria were isolated

from the rhizosphere of *P. ponderosa* juveniles located in mixed-conifer stand in Butte Meadows, California, and further characterized for PGP potential based on ability to produce key growth regulatory phytohormones including auxin, cytokinin, and gibberellic acid. Out of ten soil samples taken, sixteen colonies were isolated and qualitatively confirmed to produce indole-3-acetic acid (auxin) using Salkowski's reagent. These bacterial isolates were further analysed to quantitatively assess auxin, cytokinin, and gibberellic acid production through a variety of spectrophotometric assays. Furthermore, bioassays will be performed to determine isolates' abilities to increase tolerance in heat-stressed *Pinus ponderosa* and *Pseudotsuga menziesii* seedlings. Upon completion of this research, a PGPR could be utilized to support the growth and transplantation of conifer seedlings in the Sierra Nevada as summer temperatures continue to rise due to the effects of climate change.

LIST OF COMMON ACRONYMS

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$\Delta^{13}C$	In geochemistry and paleoclimatology, $\Delta^{13}C$ (pronounced "delta c thirteen") is an isotopic signature, a measure of the ratio of stable isotopes carbon-13 and carbon-12 (^{13}C:^{12}C), reported in parts per thousand (per mil, ‰). 12 and 13 are molecular weights of the carbon isotopes.
$\delta^{18}O$	In geochemistry and paleoclimatology, $\delta^{18}O$ or delta-O-18 is a measure of the ratio of stable isotopes oxygen-18 (^{18}O) and oxygen-16 (^{16}O). 18 and 16 are molecular weights of the oxygen isotopes.
CNPS	California Native Plant Society
CRPR	California Rare Plant Rank
ddRAD	double digest Restriction site-Associated DNA
eDNA	environmental DNA
GPS	Global Positioning System
ITS	Internal Transcribed Spacer
NCB	Northern California Botanists
TJM2	The Jepson Manual, 2^{nd} edition
USFWS	United States Fish & Wildlife Service

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