PLANT ADAPTATIONS:

RESEARCH, CONSERVATION, and MANAGEMENT

THE SEVENTH SYMPOSIUM
PRESENTED BY

NORTHERN CALIFORNIA BOTANISTS
at California State University, Chico
11-13 January 2016

Plant Adaptations:
Research, Conservation, and Management

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Cover photo courtesy of Julie K. Nelson. *Ivesia gordonii,* alpine ivesia, frames the view of Echo Lake from the ridgeline to the south (8000 ft. elevation), near Middle Peak in the eastern Trinity Alps. This location is near a population of the newly described subalpine serpentine endemic, *Antennaria sawyeri*, Trinity Alps pussytoes; the photo was taken during a field trip to see the new species, led by Pete Figura, one of its coauthors. The contact zone between pinkish ultramafic ('serpentine') rocks and gray granitic rocks can be seen in the background. While the new pussytoes species is only known from a small area of the Trinity Alps, always on serpentine, alpine ivesia is widespread in the mountains of the western U.S. and grows on many different rock types. 15 July 2014.

WELCOME!

Northern California Botanists

welcomes you
to our seventh 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.

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PROGRAM OF PRESENTATIONS BY INVITED SPEAKERS
Bell Memorial Union Auditorium
(Abstracts of talks start on page 9; index to authors on page 37)

MONDAY 11 JANUARY 2016

7:30 a.m. **Check-in for registered participants, late registration, and poster set-up**

ALL DAY **Posters on display** – Bell Memorial Union second floor Mezzanine
Also Session 6, Poster Session, Tuesday at 8:30 a.m.

Opening Remarks

9:00 a.m.

1. **Linnea Hanson**, President, Northern California Botanists

9:05 a.m.

David Hassenzahl, Dean, College of Natural Sciences, California State University, Chico

Session 1: Plant Genetics 101

9:15 – 10:45 a.m.

Session Chair: Jenn Yost, Cal Poly, San Luis Obispo

2. **Andrew Thornhill**
   Spatial Phylogenetics—combining molecular phylogenetics with collection-based data to interpret evolutionary and ecological history, as well as better inform conservation decisions
3. **Justen B. Whittall**
   Genomic skimming for Wallflower chloroplast genomes and its utility for phylogenetics of very recent and rapid adaptive radiations
4. **Sharifa Crandall**
   What in the world is metagenomics? Fungal DNA barcoding in a coastal California vegetation matrix

10:45 – 11:05 a.m. **Break**

Session 2: Locally Rare and Peripheral Plant Populations

11:05 a.m. – 12:25 p.m.

Session Chair: Brett Hall, University of California, Santa Cruz

5. **Dianne Lake**
   The East Bay Locally Rare Plant Program: A 25 year retrospective and future goals—Part 1. History
6. **Heath Bartosh**
   The East Bay Locally Rare Plant Program: A 25 year retrospective and future goals—Part 2. Conservation

7. **Jason Sexton**
   Ecological and evolutionary patterns and processes at peripheral populations: A case study in Sierran monkeyflowers
8. **Andrew Doran**
   Connecting conservation and collections: The on-line resources of the University & Jepson Herbaria and the UC Botanical Garden at Berkeley

12:25 – 1:35 p.m. **Lunch**

Session 3: Managing in a Changing Climate

1:35 – 2:55 p.m.

Session Chair: Jane Van Susteren, North State Resources

9. **Josephine Guardino**
   Rangeland management considerations on the Tuscan: Living between the rocks and sky
10. **Barbara Fernandez-Going**
    California grasslands and climate change: Factors influencing resistance
11. **Eric Knapp**
    Effects of salvage logging on native and non-native understory species diversity and cover
12. **Niall McCarten**
    Response of plant species to modification in hydrological functioning in vernal pools due to predicted changes in the California climate

2:55 – 3:05 p.m. **Break**

Session 4: New Discoveries

3:05 – 4:25 p.m.

Session Chair: Julie Kierstead Nelson, Shasta Trinity National Forest, U.S. Forest Service

13. **Thomas Stoughton**
    An update concerning the tuberous Claytonia of northern California: How many unique species are we calling Claytonia lanceolata?
14. **Matt Ritter**
    California's Big Trees.

SHASTAPALOOZA—A CLUSTER OF NEW DISCOVERIES IN THE EASTERN KLAMATH RANGES OF WESTERN SHASTA COUNTY:

15. **Dana York**
    *Shasta Fawn Lily (*Erythronium shastense*): Road (or lake) to discovery*
16. **Dean W. Taylor**
    Calcareous Endemics of the California region
17. **Len Lindstrand III**
    A new species of Vaccinium (Ericaceae) from the southeastern Klamath Mountains and the Sierra Nevada, California, with two subspecies
18. **Layne Huiet**
    A California Maidenhair Fern (Adiantum) eludes discovery for over one hundred years

Session 5: Lightning Talks

4:25 – 5:00 p.m.

Session Chair: Jenn Yost, Cal Poly, San Luis Obispo

19. **Dena Grossenbacher**
    Geographic range size is predicted by plant mating system in California and beyond
20. **David L. Magney**
    The California Botanist Certification Program
21. **Amy Henderson**
    Fine-Scale vegetation sampling, classification, and mapping of 644,000 acres in Modoc and Lassen counties
22. **David Campbell**
    Fire followers of Yosemite National Park
23. **Wolfgang Schweigkofler**
    Research on invasive plant pathogens at NORS-DUC
24. **Aaron E. Sims**
    Storing seeds today for an uncertain tomorrow

* * * * *

5:15 – 6:15 p.m. **Reception** – Colusa Hall
No-host bar with complimentary hors d'oeuvres.

6:30 p.m. **Banquet** – Bell Memorial Union Auditorium
Dinner tickets required. Buffet dinner will include fish, meat, and vegetarian entrees.

Keynote Speaker

7:30 p.m. Bell Memorial Union Auditorium – EVERYONE IS WELCOME

25. **Susan Harrison**, University of California, Davis, Department of Environmental Science and Policy
    The future of plant diversity in a warmer, drier California

TUESDAY 12 JANUARY 2016

8:00 a.m. **Check-in for one-day registrants**

ALL DAY **Posters on display** – Bell Memorial Union second floor Mezzanine

Session 6: Poster Session

(Abstracts of posters start on page 23; index to authors on page 37)

8:30 – 10:00 a.m. Poster Session – Bell Memorial Union second floor Mezzanine

Session Chair: Barbara Castro, California Department of Water Resources

Poster presenters will be available to answer questions.

Raffle, Auction, and Awards

10:00 – 10:30 a.m. Raffle, Auction, and Awards – Bell Memorial Union Auditorium

Second Day Opening Remarks

10:30 – 10:40 a.m. Opening Remarks – Bell Memorial Union Auditorium

Linnea Hanson, President, Northern California Botanists

Session 7: Restoration

10:40 a.m. – 12:00 p.m.

Session Chair: Samantha Hillaire, Garcia and Associates

26. **Kyle Merriam**
    On the fens: Can excluding livestock restore degraded fen wetland ecosystems?
27. **Maria Benech**
    Rim Fire restoration: Large scale reforestation
28. **John Dittes**
    Bringing back a floodplain: Wetlands restoration at Ash Creek State Wildlife Area, Lassen and Modoc counties, California
29. **Margaret Willits**
    Mountain Ladyslipper (Cypripedium montanum) restoration before and following the Rim Fire

12:00 – 1:20 p.m. **Lunch**

Session 8: Evolution of the California Flora

1:20 – 2:40 p.m.

Session Chair: Matt Guilliams, Santa Barbara Botanic Garden

30. **Bruce Baldwin**
    Origins of vascular plant diversity in the California Floristic Province
31. **Daisie I. Huang**
    Why are there so many species of lupines? Insights from the Lupinus albifrons species complex

32. **J. Travis Columbus**
    California grasses: Diversity, geography, and ecology
33. **Bryan T. Drew**
    Age, diversity, and origin of the California mints, with special emphasis on the genus Salvia

2:40 – 3:00 p.m. **Break**

Session 9: Now the Good News

3:00 – 4:20 p.m.

Session Chair: Jenny Marr, California Department of Fish and Wildlife

34. **Michelle Coppoletta**
    One step forward and two steps back: The long journey toward conservation of a rare California endemic
35. **Marla Knight**
    Conservation of Siskiyou mariposa lily, Calochortus persistens
36. **Teresa Sholars**
    Pygmy Forest mapping and vegetation classification as the path toward effective conservation
37. **Julie Kierstead Nelson**
    Pushing the boundary—an updated Jepson Herbarium Klamath Range Geographic Subdivision better represents underlying geology and regional floras of the Klamath and Cascade Ranges

Closing Remarks

4:20 – 4:30 p.m.

Linnea Hanson, President, Northern California Botanists

4:30 – 5:30 p.m. **Tour of the Chico State Herbarium** (optional)

Meet outside of the Bell Memorial Union Auditorium to walk across campus

POST-SYMPOSIUM WORKSHOPS

WEDNESDAY 13 JANUARY 2016

Workshop 1: Surveying for Rare California Bryophytes
9:00 a.m. – 4:00 p.m. Bell Memorial Union, room and field site locations TBA

Instructor: **Ben Carter,** Sharsmith Herbarium, San Jose State University

This workshop will provide a foundational understanding of rare bryophytes in California that will aide participants in conducting rare plant surveys that include bryophytes. The first half of the day will focus on identifying the rare bryophytes (and morphologically similar species) and will be broken down by geographic regions, vegetation types, and microsite preferences. This will provide participants with general guidelines for the most important microsites to survey for sensitive bryophytes depending on the region and vegetation type being surveyed. The second half of the day will be spent at a local field site where participants will learn to recognize microsites important to bryophytes. Participants will encounter several plant communities and learn how to build on their knowledge of vascular plant ecological preferences to identify microsites that are likely to harbor rare bryophytes. No prior experience with bryophytes is necessary (although it will be useful), but participants will be expected to have a working knowledge of plant communities and dominant vascular plant species.

Workshop 2: An Expanding Threat: Exotic *Phytophthora* Species Entering Native Landscapes
9:00 a.m. – noon. Bell Memorial Union, room TBA

Instructors: **Elizabeth Bernhardt**, Principal/Plant Pathologist, Phytosphere Research
Suzanne Rooney Latham, Senior Plant Pathologist, California Department of Food and Agriculture, Plant Health and Pest Prevention Services, Plant Pest Diagnostics Lab
Ted Swiecki, Principal/Plant Pathologist, Phytosphere Research

Plant diseases caused by *Phytophthora* species have been an increasing concern worldwide as new species and hybrids are being discovered at an alarming rate. In California, recent work has shown that a variety of *Phytophthora* species are found in native plant nurseries, restoration sites, and native landscapes. The first detections of *P. tentaculata* in the US, ranked as a high priority threat by USDA, were in California native plant nurseries and restoration plantings. This workshop will present current information on the threats to California native vegetation posed by these serious plant pathogens and steps being taken to prevent introduction and limit spread of exotic *Phytophthora* species.

The workshop will cover the impacts of *Phytophthora* species in California and beyond, the life cycle and dispersal mechanisms of *Phytophthora*, pathways of *Phytophthora* spread, including local and global spread via infected nursery stock, current efforts to prevent introductions by clean nursery stock initiatives, the aftermath of introductions in restoration plantings and efforts to contain or eradicate introduced *Phytophthora* species from field sites, and will demonstrate the methods currently used to detect *Phytophthora* species.

Workshop 3: Making Herbarium-Quality Plant Specimens
9:00 a.m. – 3:00 p.m. Holt Hall, Room 129 (The Chico State Herbarium)

Instructors: **Ellen Dean**, Herbarium Curator, Center for Plant Diversity, UC Davis
Shannon Still, Director of Plant Conservation, UC Davis Arboretum and Public Garden

Identifying plants with certainty often requires the collection of a pressed plant specimen which can be examined with a microscope, compared to herbarium specimens, or sent to an expert for further study. A pressed specimen that can be donated to a herbarium is sometimes required as part of particular studies, especially those funded by state or federal agencies. A herbarium-quality pressed specimen should be collected only if the plant population has enough individuals, and the resulting pressed specimen needs a label that includes very specific information. This information can be hand-written on a data sheet or entered into a spreadsheet/database in the field. In this workshop, students will learn how to make herbarium-quality specimens using plant presses. We will also go over lichen and moss collection, which does not use presses. We will go over the types of data that are collected for label-making and how one produces specimen labels, including the use of paper data-sheets, field data entry, and Calflora labels. The early morning will be spent learning how to collect plants and what types of plant parts should be collected and what types of data need to be collected. We will also discuss the ethics of plant collecting. We will spend some time outside collecting plants for pressing and collecting data. Late morning will be spent pressing plants. After lunch, we will go over electronic data collection and label-production.

ABSTRACTS OF TALKS

Abstracts in chronological order; index to authors on page 37
See also the List of Common Acronyms on page 36

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

Welcome to our Seventh Northern California Botanists Symposium

I'd like to welcome all of you to our seventh symposium, *Plant Adaptations: Research, Conservation and Management*. We hope you will enjoy the program that we have organized for you this year with great speakers and posters. Our keynote speaker, Susan Harrison, will address *The Future of Plant Diversity in a Warmer, Drier California*. Instead of a plenary speaker we will have six lightning talks Monday afternoon before our reception. We again hope to provide botanists with a forum to listen to talks on a variety of subjects and to spend time socializing with each other. We have encouraged students to attend, so please be sure to take time to meet them and for them to meet you. We have moved the poster session to Tuesday morning to provide ample time to view the many varied posters that have been submitted. 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 symposium.

2. **THORNHILL, A.H., and MISHLER, B.D.**
University and Jepson Herbaria, University of California, Berkeley, 1001 Valley Life Sciences Building #2465, Berkeley, CA 94720-2465. andrew.thornhill@berkeley.edu, bmishler@berkeley.edu

Spatial Phylogenetics—Combining Molecular Phylogenetics with Collection-based Data to Interpret Evolutionary and Ecological History, as well as Better Inform Conservation Decisions

Biodiversity has usually been measured by examining changes in the number of species across a region to identify areas of particularly high species diversity and endemism. Beta-diversity, or turn-over on the landscape, has likewise been measured by comparing proportions of species shared among subareas. However, investigations based on species distributions alone miss the full richness of analyses that can result from taking a phylogenetic approach. Our research group is applying a novel suite of phylogenetic tools including two new metrics, Relative Phylogenetic Diversity and Relative Phylogenetic Endemism, and new methods called Categorical Analysis of Neo- And Paleo-Endemism (CANAPE), and phylogenetic range-weighted turnover (PhyloRWT). These methods are rank-free since it does not matter what taxonomic levels the terminals represent, as long as they are monophyletic and their geographic distribution can be characterized, and are thus relatively robust to lumping and splitting decisions by taxonomists. Understanding such patterns of biodiversity on the landscape is important for conservation planning, given the need to prioritize efforts in the face of rapid habitat loss and human-induced climate change. These new phylogenetic methods allow assessments of protected lands that are not limited by reliance on species distribution alone and can identify complementary areas of biodiversity that have unique evolutionary histories in need of conservation. How each of these metrics is calculated will be explained, and examples of their application will be given from Australia and California. Hotspots of Californian plant diversity and endemism are mapped, their make-up assessed, and similarities and differences among them characterized.

3. **WHITTALL, J.B.**
Department of Biology, Santa Clara University, 500 El Camino Real, Santa Clara, CA 95060. jwhittall@scu.edu

Genomic Skimming for Wallflower Chloroplast Genomes and its Utility for Phylogenetics of very Recent and Rapid Adaptive Radiations

The chloroplast genome (cp) and nuclear ribosomal region (nr) have become staples in plant evolution and systematics. Traditional PCR methods relying on one or two of these loci have produced amazing insights into the evolutionary history of California plants. However, comparing small portions of the cp and nr often do not provide sufficient variation to resolve recent and rapid evolutionary events such as adaptive radiations. Genome skimming has made it cheaper and easier to simultaneously sequence the entire cp and nr (including the internal transcribed spacers), while also producing a large portion of the mitochondrial genome (mt). By sequencing genomic DNA that is naturally enriched in cp, nr and mt DNA (relative to the remainder of the nuclear genome), we can generate robust phylogenetic datasets for all three plant genomes. We have applied genome skimming to help resolve a recent and rapid adaptive radiation in *Erysimum*, the third largest genus in the Brassicaceae, with over 220 species distributed across the Northern Hemisphere. Previously, we estimated the crown age of *Erysimum* at less than 3 million years, yet had very little resolution of the relationships within the genus. Here, we combine data from four multiplexed samples with 50bp single-end reads with another 31 multiplexed samples with 250bp paired-end reads. We used *Arabidopsis thaliana* in a reference-guided assembly for the cp, nr and mt followed by multiple sequence alignment and phylogenetic analysis. Genome skimming in *Erysimum* produced greater resolution than traditional PCR methods, allowing insights into the order and frequency of edaphic shifts driving this adaptive radiation. Although genome skimming is relatively cheap and easy, it still may not be sufficient to completely resolve the most recent and rapid adaptive radiations.

4. **CRANDALL, S.G.**
Environmental Studies Department, University of California, Santa Cruz, 1156 High Street, Santa Cruz, CA 95064. sgulamhu@ucsc.edu

What in the World is Metagenomics? Fungal DNA Barcoding in a Coastal California Vegetation Matrix

Recent advances in high-throughput DNA sequencing have revolutionized detection of fungi worldwide. Genera and species can now be identified accurately, quickly, at affordable costs, and at the scale of entire communities. Until recently, it was difficult to quantify the vast majority of fungi because of their small size (~ 2-20 μm) and cryptic spore morphologies. “First generation” biotechnologies such as Sanger sequencing are too time consuming to assess taxonomic richness at the community level and only work on a subset of culturable taxa. However, with the advent of metagenomic environmental sequencing technologies, we can start to answer questions about fungal community composition, structure, and assembly from the local to the landscape level. In this talk, we will first demystify metagenomics by defining common genetic terms and methods. Next, we will discuss how metagenomics can be used as a tool to answer questions in fungal and plant ecology. Finally, we will discuss how metagenomics was used to examine fungal spore composition and phenology (the timing of spore release) across a coastal vegetation matrix of redwood forest, mixed-evergreen forest, and maritime chaparral. Rainwater samples were collected at 12 sites once a week from January to March in 2013 and were processed for metagenomic sequencing. Results indicate that fungal communities produce spores at distinct "early" versus "later" times during the wet season across the vegetation matrix.

5. **LAKE, D.**
Unusual Plants Coordinator, CNPS, East Bay Chapter. diannelake@yahoo.com

The East Bay Locally Rare Plant Program: A 25 Year Retrospective and Future Goals—Part 1. History

The East Bay Chapter of CNPS has one of the oldest locally rare programs in the state. Started in the late 1980’s, we developed a local rarity list, after extensive research, of native plants with 5 or fewer locations

in the Alameda-Contra Costa County area. Ranks and Criteria were developed and the first publicly available report was produced in 1991. Agencies, consultants, and others soon started considering locally rare plants in their projects and decisions, and the report became an important conservation tool. Several improvements have occurred over the years, including a change from an individual location system to a region system of 40 botanical regions, resulting in more accurate field condition data. Recently, an on-line version of the database was created and will be publicly accessible in 2016. The program was also important in developing the East Bay's Botanical Priority Protection Areas, one of the Chapter's chief conservation tools, and conservation perspectives of that program will be discussed.

6. BARTOSH, H.
Rare Plant Chair, CNPS, East Bay Chapter; Principal, Nomad Ecology LLC, 822 Main Street, Martinez, CA 94553. Hbartosh@nomadecology.com

The East Bay Locally Rare Plant Program: A 25 Year Retrospective and Future Goals—Part 2. Conservation

The East Bay Chapter of CNPS has one of the oldest locally rare programs in the state. Started in the late 1980's, we developed a local rarity list, after extensive research, of native plants with 5 or fewer locations in the Alameda-Contra Costa County area. Ranks and Criteria were developed and the first publicly available report was produced in 1991. Agencies, consultants, and others soon started considering locally rare plants in their projects and decisions, and the report became an important conservation tool. Several improvements have occurred over the years, including a change from an individual location system to a region system of 40 botanical regions, resulting in more accurate field condition data. Recently, an on-line version of the database was created and will be publicly accessible in 2016. The program was also important in developing the East Bay's Botanical Priority Protection Areas, one of the Chapter's chief conservation tools, and conservation perspectives of that program will be discussed.

7. SEXTON, J.P.
School of Natural Sciences, University of California, Merced, 5200 N. Lake Rd., Merced, CA 95343. jsexton2@ucmerced.edu

Ecological and Evolutionary Patterns and Processes at Peripheral Populations: A Case Study in Sierran Monkeyflowers

There is great need for protecting and prioritizing plant populations for conservation as well as understanding the basic, underlying patterns and processes that govern plant distributions. In this vein, what differentiates peripheral populations, if anything, and what limits expansion at species range limits are important questions. Here I present findings from several studies of peripheral populations in Sierran monkeyflowers, specifically in *Mimulus laciniatus* (Phyrmaceae: cut leaf monkeyflower) and close relatives. In collaboration with many others, I have conducted common garden experiments, controlled crosses, and population genetics studies within this group. All populations examined (>20) across the species range are genetically differentiated, including peripheral populations, and possess unique alleles. Gene flow among populations is most strongly related to climate, rather than spatial distance or patterns conceived of from classic models of range limitation (i.e., swamping gene flow from central populations). There is general climate adaptation across the species range, including at peripheral areas, which often possess abundant populations. Nevertheless, peripheral populations are not necessarily locally adapted. Gene flow between peripheral populations can result in highly adaptive effects. I conclude that because of the distinct environments they inhabit, peripheral populations can be highly unique and important in ecological and management contexts, even within a modestly sized geographic range such as that of *M. laciniatus*. The examination of peripheral populations of *M. laciniatus* even resulted in the discovery of a new species: *Mimulus filicifolius*.

8. **DORAN, A.S.[1], and FORBES, H.[2]**
[1]University & Jepson Herbaria, University of California, Berkeley, 1001 Valley Life Science Building, Berkeley, CA 94720. andrewdoran@berkeley.edu
[2]University of California Botanical Garden at Berkeley, 200 Centennial Drive, Berkeley, CA 94720. hforbes@berkeley.edu

Connecting Conservation and Collections: The On-line Resources of the University & Jepson Herbaria and the UC Botanical Garden at Berkeley.

These two natural history museums, some of the oldest in California, have collections from this state dating back to David Douglas from the 1830's and some of the earliest records for living and preserved plants, algae and fungi. Early records, such as the state geological survey, have provided an invaluable insight into the historic distribution of rare plants. A commitment to collecting, recording and preserving specimens dates back to the inception of both museums and continues to this day. This talk will highlight specific examples and methods of facilitating information throughout the last two centuries to record, document and conserve plants (in a broad sense) and highlight resources for botanists, conservationists, agencies etc. to search and obtain information for use in research and conservation. Specific examples from vascular plants will include the *Eriogonum truncatum* (Mount Diablo Buckwheat), *Delphinium bakeri* (Baker's Larkspur) amongst others. This talk will also highlight the wealth of materials available to participants beyond living and preserved plant data such as literature and archives containing unpublished manuscripts, photographs, plant illustrations, correspondence, field books, all that help to piece together the bigger picture of California rare plants, past, present and future.

9. **GUARDINO, J.L.**
Dittes & Guardino Consulting, P.O. Box 6, Los Molinos, CA 96055. joguardino@sbcglobal.net

Rangeland Management Considerations on the Tuscan: Living Between the Rocks and Sky

Managing California rangelands requires a balance between natural resource conservation and economic realities of cattle-grazing operations in a variable and changing Mediterranean climate. Assessing vegetation productivity, establishing utilization standards and measuring end-of-season Residual Dry Matter (RDM) are important aspects of sustainable range management. We were retained by The Nature Conservancy (TNC) to address these considerations on their 37,870-acre Dye Creek Preserve located in the southern Cascade Range foothills of Tehama County. Our approach is applicable to approximately 100,000 acres in the region that are protected in-perpetuity by 34 Conservation Easements on private cattle-ranches, established and administered by TNC. The majority of this acreage is on the "harsh" Tuscan volcanic geologic formation; the Red Bluff and Modesto formations are represented to a lesser extent. Estimating productivity, determining RDM standards and monitoring RDM here is challenging here due to complex topography, variability of soils, vegetation, and weather over time. Global Information System data were used to assemble a "picture" of the Dye Creek Preserve to guide management efforts. Data include fenced pasture units (27), slope classes (5), soil units (38), and vegetation types (9). The Natural Resource Conservation Services (NRCS) Soil Web Survey was queried for metadata relating to soil parameters and vegetation productivity. We calculate annual vegetation production over the entire preserve to be 7,240 tons, 12,465 tons, and 17,157 tons in low, average and high rainfall years, respectively. Information from our analysis was provided to a certified Range Scientist to aid in development of a formal monitoring plan for a changing climate.

10. **FERNANDEZ-GOING, B.M.**
NCB 2010-2011 Research Scholarship awardee
Department of Ecology, Evolution, and Marine Biology, University of California, Santa Barbara, CA 93106. bar.fern34@gmail.com

California Grasslands and Climate Change: Factors Influencing Resistance

Climatic variation, perhaps the most important force structuring the world's ecological communities, now receives growing attention from ecologists because of the incontrovertible evidence for directional climate change, including increases in variability. Large differences are expected among communities in the

magnitude, rate, and direction of their responses to climate change, based on factors such as microclimate, substrate, and species functional traits. In particular, resource-poor, low productivity grasslands, such as those on serpentine soil, may be more resistant to climate change because they host stress-tolerant species that likely respond to change slowly. At the same time, such habitats may be more sensitive to climate change if the relatively sparse community limits the ability of vegetation to buffer changes in temperature or precipitation. Here I share results from multiple studies comparing grasslands on serpentine and "normal" sedimentary soils to natural and experimental variation in precipitation. Observations of community dynamics of 80 sites on serpentine and normal soil showed that grasslands on serpentine had species with more "stress-tolerant" traits than non-serpentine communities. In addition, variability in species composition was lower on serpentine than normal soils. In a three year experiment drought productivity was significantly lower in drought plots than ambient plots on normal soils, but was unaffected on serpentine. These results suggest that the functional traits of species occupying stressful habitats may confer some resistance and that serpentine communities may be slower to respond to changes in climate, particularly precipitation.

11. KNAPP, E.K., and RITCHIE, M.W.

USDA Forest Service, Pacific Southwest Research Station, 3644 Avtech Parkway, Redding, CA 96002.
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Effects of Salvage Logging on Native and Non-native Understory Species Diversity and Cover

Timber is frequently salvage logged following high-severity stand-replacing wildfire, but the practice is controversial. One fear is that compound disturbances could result in more deleterious impacts than either disturbance individually, with mechanical operations having the potential to set back recovering native species and increase invasion by non-native species. Following the 2002 Cone Fire on the Lassen National Forest, three replicates of five salvage treatments were applied to 15 units formerly dominated by ponderosa pine, covering a gradient of disturbance intensities from unsalvaged to 100% salvaged. Understory species richness and cover data were collected every two years between 2006 and 2012. Richness of both native and non-native species did not differ among salvage treatments but both showed strong changes over time. Shrubs was the only growth form with cover affected by salvage, presumably because the three main species are all stimulated to germinate by fire, leaving seedlings vulnerable to mechanical disturbance. Many other native perennial species emerge from rhizomes or other deeply buried underground structures and appear to be less affected by salvage. Over time, the plant community in all salvage treatments shifted from dominance by shrubs and forbs to shrubs and grasses. Most of the grasses were native, except *Bromus tectorum* (cheatgrass), which was found in 4% of measurement plots in 2006 and 52% in 2012. Our results indicate that understory vegetation change four to ten years post-high severity wildfire appears to be influenced more strongly by factors other than salvage logging.

12. McCARTEN, N.

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Response of Plant Species to Modification in Hydrological Functioning in Vernal Pools Due to Predicted Changes in the California Climate

Regional variation in meteorological parameters, including precipitation (P) and temperature dependent evapotranspiration (ET), due to climate change will result in changes to vernal pool hydrological functioning. Individual vernal pools respond differentially to P & ET due to soil and topographic setting and regional climate differences. Plant species are adapted to specific ranges of hydroperiod, depth of inundation, soil moisture and soil anaerobic conditions. Research on vernal pool hydrology and vegetation determined that plant species abundance varies within pool hydrological gradients and among pools. The response of plants to within vernal pool hydrological gradients is due to their physical and physiological adaptations and life history characteristics. Perennial species, such as *Eleocharis macrostachya*, dominate pools or portions of pools that have longer hydroperiod while annual species, such as *Lasthenia fremontii*, dominate pools or portions of pools that have shorter hydroperiods. Variation in the abundance of these

two species represents just two examples that show how vernal pools species are very sensitive to variation in P & ET. Climate change models predict increases in P higher than increases in temperature from south to north in the Central Valley of California. Hydrological models of vernal pools were used to calculate changes in pool hydrology due to regional climate change. The result is San Joaquin Valley vernal pools will become drier while northern Sacramento Valley vernal pools will become wetter relative to current conditions. Regional differences in plant species presence and abundance will occur. However, annual variation in P & ET will help maintain plant species diversity overall.

13. STOUGHTON, T.R.
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An Update Concerning the Tuberous *Claytonia* of Northern California: How Many Unique Species are we Calling *Claytonia lanceolata*?

I present a case study supporting recognition of multiple rare *Claytonia* species in both northern and southern California with a primary focus on the former. I used morphometric and molecular analyses to assess diagnosability of lineages, and this information was used to clarify a long-standing history of confusing taxonomic treatments in California. *Claytonia obovata* Rydberg is taxonomically "resurrected" for northern California and southern Oregon, and a new species endemic to serpentine soils in the Klamath Region is also described. These species have been found to be morphologically and genetically distinct from each other and a considerably more widespread congener, *C. lanceolata,* and exhibit threats to their persistence if suitable habitat is not preserved. Interspecific hybridization has been observed but appears to occur at low frequency. Uncertainty concerning the application of infraspecific taxa to populations of *C. lanceolata* in northern California is also discussed. This case study on tuberous *Claytonia* highlights the need for integrated conservation management strategies that prioritize accurate identification of diverse plant genera occurring on "unusual" substrates in California and elsewhere.

14. RITTER, M.K.
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California's Big Trees

California floristic province is regarded as a world hotspot of biodiversity. This diversity also applies to the tree species that occur within the state. When Willis Lynn Jepson published his *The Trees of California* in 1923, he included 121 species of woody plants in his book, of which he considered 92 species to grow as trees. Included in California's iconic tree species are four of the world's six tree species capable of heights over 300 feet, three of the world's four tree species capable of ages greater than 2,500 years, and many species that occur nowhere else in the world. I will be presenting information about the California Big Tree Program as well as updated information about the location and identity of various species officially listed on the register of California Big Trees. As of Fall 2015 the register has more than 300 listings, with over 120 National Champion trees.

15. YORK, D.A.
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Shasta Fawn Lily (*Erythronium shastense*): Road (or Lake) to Discovery

Erythronium shastense D.A. York, J.K. Nelson, & D.W. Taylor was recently described as a new species restricted largely to limestone outcrops near Shasta Lake, Shasta County, California. Style, leaf, and anther characters are used to distinguish *E. shastense* from the similar *E. californicum* and *E. helenae*.

16. TAYLOR, D.W.
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Calcareous Endemics of the California Region

Substrate endemism is a strong theme in the California vascular flora. Strong fidelity or strict restriction to serpentine is well documented. By comparison, endemic richness of plants restricted to limestone, marble and related calcareous rocks is under-appreciated and in need of study. Spectacular new discoveries in the recent era include the new genus *Dedeckera* (Polygonaceae) from dolomite and the relict *Neviusia cliftonii* from limestone. My tally is that we have ~42 strict calciphile endemics, 40% of these recently discovered. Compared to serpentine, calcareous rock exposures in California are smaller, overdispersed, and form generally more rugged topography (thus, are more difficult to inventory). Limestone outcrops are often not depicted on standard-scale geologic maps owing to their small size. Calcareous endemics are concentrated in the Shasta Lake region, the southern Sierra Nevada, the White Mountains, and in desert mountain regions. Discovery history of limestone endemics of the Shasta Lake region is introduced briefly. Summary discussion of pattern of recent plant discovery in California is offered. Forecast modeling based on the discovery history of 3,326 California region endemics predicts 442 ± 17 undescribed endemics remaining to be discovered in our rich flora. "You too can discover a new species," so look on limestone.

17. LINDSTRAND III, L.[1], and NELSON, J.K.[2]
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[2] Shasta-Trinity National Forest, 3644 Avtech Parkway, Redding, CA 96002. jknelson@fs.fed.us

A New Species of *Vaccinium* (Ericaceae) from the Southeastern Klamath Mountains and the Sierra Nevada, California, with Two Subspecies.

We recently described *Vaccinium shastense* as a new species from interior California. This new species is most similar to red huckleberry, *V. parvifolium*, but differs by its ciliate, inrolled leaf margins, much wider hypanthium scar, dark blue, glaucous, quickly deciduous fruits, greater seed count, and pitted seed surface sculpturing. Moreover, *V. shastense* and *V. parvifolium* are allopatric, occur in distinct habitats, and have distinct genetic characters. Two subspecies of *Vaccinium shastense* are described: *Vaccinium shastense* subsp. *shastense* (Shasta huckleberry), endemic to the southeastern Klamath Mountains in Shasta County, California, and *Vaccinium shastense* subsp. *nevadense* (Sierra huckleberry) from the western slope of the Sierra Nevada, California. The new subspecies differ from one another in flower color, length of persistent calyx ring, growth habit, geographic range and habitat, and distinct genetic characters. This presentation focuses on the story behind Shasta huckleberry; however, we also summarize the distribution of Sierra huckleberry.

18. HUIET, L.[1], LENZ, M.[2], NELSON, J.K.[2], PRYER, K.M.[1], and SMITH, A.R.[3]
[1]Department of Biology, Duke University, Durham, NC 27707. layne.huiet@duke.edu
[2]USDA Forest Service, Shasta-Trinity National Forest, 3644 Avtech Parkway, Redding, CA 96002.
[3]1001 Valley Life Sciences Building, # 2465, University Herbarium, University of California, Berkeley, CA 94720-2465.

A California Maidenhair Fern (*Adiantum*) Eludes Discovery for Over One Hundred Years

The genus *Adiantum* L. (Pteridaceae) comprises over 200 species found almost exclusively in the tropics and subtropics. However approximately ten percent of species can be found in temperate regions–the majority of these are found in Asia but a few occur in North America. There are four species that have a broad geographic range within North America: *Adiantum aleuticum*, *A. capillus-veneris*, *A. jordanii* and *A. pedatum.* Two of these, *A. capillus-veneris and A. pedatum*, have distributions beyond North America. Of the four, all except *A. pedatum* occur in California, but none is endemic. One, *A. aleuticum*, is easily distinguished by its pedate blade architecture but the other two, *A. capillus-veneris* and *A. jordanii,* can sometimes be difficult to distinguish, especially when sterile or juvenile. While using DNA barcoding to verify the identity of a population of *A. capillus-veneris* in Shasta County, California, we have discovered a new endemic species. This species, *Adiantum shastense*, is found only in Shasta County and is the only

endemic *Adiantum* within the United States. We will discuss this surprising discovery of a new fern in a very well-studied floristic region and how it serves as a prominent example of how herbaria are underexplored reservoirs of new species that are important to our phylogenies.

19. GROSSENBACHER, D.
NCB 2009-2010 Research Scholarship awardee
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Lightning talk: Geographic Range Size is Predicted by Plant Mating System in California and Beyond

20. MAGNEY, D.L.
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Lightning talk: The California Botanist Certification Program

21. HENDERSON, A.
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Lightning talk: Fine-Scale Vegetation Sampling, Classification, and Mapping of 644,000 acres in Modoc and Lassen Counties

22. CAMPBELL, D.
Division of Resources Management and Science, Yosemite National Park. david_m_campbell@nps.gov

Lightning talk: Fire Followers of Yosemite National Park

23. SCHWEIGKOFLER, W.
National Ornamentals Research Site at Dominican University of California.
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Lightning talk: Research on Invasive Plant Pathogens at NORS-DUC

24. SIMS, A.E.
California Native Plant Society. asims@cnps.org

Lightning talk: Storing Seeds Today for an Uncertain Tomorrow

25. HARRISON, S.
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KEYNOTE PRESENTATION: The Future of Plant Diversity in a Warmer, Drier California

For many of us, climate change is still "in the future" or is "just one problem" among many environmental problems, and we have little concrete idea of what our natural communities will look like under the "no-analog climates" of the future. Based on recent climate literature, I will argue that California's climate is on a long-term trend of becoming effectively drier under the influences of anthropogenic warming and increasingly erratic precipitation. Moreover, based on several recent studies in California and elsewhere, I argue that plant community diversity is declining—and is likely to continue doing so—in arid and semiarid climates such as California's that are becoming even drier under climate change. Drought-intolerant species are especially vulnerable, and losses of these species may have predictable consequences for community functions such as nutrient cycling. It may be time to reconsider, in an even more serious and immediate way than we are already doing, whether it makes sense for conservation and restoration practices to be based on the climates of the past or the climates of the future.

26. MERRIAM, K.E.[1], COPPOLETTA, M.[1], and MARKWITH, S.H.[2]
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[2]Florida Atlantic University, Department of Geosciences, Boca Raton, FL 33431. smarkwit@fau.edu

On the Fens: Can Excluding Livestock Restore Degraded Fen Wetland Ecosystems?

Fens are rare wetland ecosystems that accumulate peat. Many fens on federal lands are grazed by livestock, which may be detrimental if removal of vegetation, hoof punching, and trampling lead to desiccation and loss of the peat body. Concerns about the potentially negative effects of livestock use have led land managers to fence some fens. However, the extent to which fencing can restore degraded fens is not known. We evaluated two fenced fens and two adjacent fens subject to grazing on the Plumas National Forest over a nine-year period. We found that livestock exclusion increased species turnover and richness, including increases in the number of early and mid-seral species. At one fen, disturbance indicator and nonnative species also increased after fencing. In highly degraded fens, fencing may initially favor species with adaptations that allow them to disperse into and colonize sites rapidly. These changes in species composition may be short-lived as succession proceeds. Although land managers in the Sierra Nevada often use species composition as an indicator of functioning condition in fen ecosystems, our results suggest that other factors, such as hydrologic function, may be a better indication of function in actively grazed fens. Our results suggest that excluding livestock alone may not be sufficient to restore degraded fens, particularly where fen hydrology has been altered.

27. BENECH, M.C.
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Rim Fire Restoration: Large Scale Reforestation

The Rim Fire (2013) burned 257,314 acres, 154,530 of those on the Stanislaus National Forest. The Rim Fire is the third largest wildfire in California history and the largest wildfire in the recorded history of the Sierra Nevada. It is also California's largest forest fire, burning across a largely conifer dominated landscape. Approximately 49% of the forested landscape burned at high vegetation severity, leaving few living trees within those areas. The ability of forests to regenerate after stand-replacing fire is highly dependent on seed sources. Larger patches of burn areas (such as those in the high severity areas) can result in openings in the forest that are larger than the reach of surviving neighboring conifers, whose seeds cannot cover the open area (Bonnet 2005). Based on the current scientific information and surveys done throughout the proposed reforestation area, regeneration of conifers, especially of pine in high severity areas, will be limited compared to other areas of the fire that burned at lower intensity. I will present the process the Forest Service is taking to restore this landscape, beginning with the removal of much of the dead material (salvage logging and biomass removal) through the 40,000-plus acre reforestation, thinning and noxious weed eradication proposal that is currently being analyzed under the NEPA process. Additional projects, such as sensitive plant protection, meadow restoration and habitat improvement are also part of the work being done throughout this landscape.

28. DITTES, J.C.
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Bringing Back a Floodplain: Wetlands Restoration at Ash Creek State Wildlife Area, Lassen and Modoc Counties, California

Ash Creek State Wildlife Area encompasses 14,451 acres of emergent marsh, wet and dry meadow, vernal pool and sagebrush scrub on the Modoc Plateau in Lassen and Modoc Counties in northeastern California. The floodplain of Ash Creek had been substantially degraded over the last century as a result of channelization, cattle grazing, erosion and channel down-cutting, ditching/draining, pond construction, water diversions, agricultural development and invasive plant-species introductions. In 2008, the Pit Resource Conservation District and California Department of Fish and Wildlife initiated the largest floodplain restoration project ever implemented in California using the "Plug and Pond" technique. Sierra Ne-

vada Conservancy, California Wildlife Conservation Board, Army Corps of Engineers, and California Department of Water Resources provided funds totaling approximately $3.5 million for the project. Approximately 3,235 acres of degraded floodplain, which had been "dewatered," were hydrologically "reconnected" with Ash Creek. The last of 3 project phases was completed in summer 2015. A total of 25 linear-miles of existing channel were filled and 92 ponds created, involving moving 900,000 cubic yards of earth. A monitoring program was implemented to measure the effects of restoration efforts on hydrology, vegetation and wildlife. Monitoring of groundwater with 50 piezometers and vegetation at 37 permanent transects began in 2011 and will continue until 2019. Vegetation and hydrology data have not yet been analyzed; however, preliminary observations indicate a positive response and an increase in wetland vegetation and wetland-dependent wildlife over significant portions of the floodplain, coincident with changes in surface-flow and groundwater parameters.

29. WILLITS, M.L.
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Mountain Ladyslipper (*Cypripedium montanum*) Restoration Before and Following the Rim Fire

Cypripedium montanum is close to its southern limit on the Stanislaus National Forest. We undertook two projects to protect occurrences of this species. The first was fuel reduction immediately around the plants as part of the Twomile Ecological Restoration projects. Two years later, the Rim Fire burned all but one of the known occurrences on the forest. Monitoring found that 6 of the 14 locations in the Twomile area had some plants that survived. None of the plants in the high and moderately high vegetation burn severity survived. In the moderately low and low severity areas 60% survived. Survival depended on small microsite differences in the understory that were not captured by the severity measure. The effectiveness of the fuel reduction will be discussed. Following the Rim Fire, we installed structures to protect many of the surviving plants from cattle. These installations began the second year post fire when cattle were brought on in full numbers, and involved collaboration with three different groups. Long-term restoration for those areas where *C. montanum* were not found post Rim will include planting Douglas-fir (*Pseudotsuga menziesii*).

30. BALDWIN, B.G.
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Origins of Vascular Plant Diversity in the California Floristic Province

Recent biogeographic and evolutionary studies have led to improved understanding of the origins of vascular plant diversity in the California Floristic Province (CA-FP). Spatial analyses of Californian diversity and endemism have reinforced the importance of geographically isolated areas of high topographic and edaphic complexity as floristic hotspots, where the relative influence of factors promoting evolutionary divergence and buffering of lineages against extinction has gained increased attention. Molecular phylogenetic studies spanning the flora have corroborated and refined conclusions of Raven and Axelrod concerning geographic sources of CA-FP lineages. Immediate sources of CA-FP lineages bearing endemic species diversity have been mostly within North America, especially within the west and southwest. That conclusion holds even for groups of north temperate affinity, notwithstanding important counterexamples, such as paleoendemic disjuncts between the CA-FP and Eurasia. The CA-FP also has been a limited source area for floras elsewhere, within and beyond North America. Available evidence from calibrated phylogenies indicates that most diversification within extant CA-FP clades has occurred since mid-Miocene, after the summer-drying transition began. Process-focused studies continue to implicate environmental heterogeneity at different geographic scales in evolutionary divergence within the CA-FP, often associated with ecological shifts in habitat, reproductive system, or life history, and sometimes hybridization. The above patterns indicate the importance to conservation of preserving high integrity areas of complex topography, geology, and climate within the CA-FP and more widely within North America, where much of the endemic diversity of the CA-FP originally stemmed and where close relatives of diverse ecologies often remain.

31. HUANG, D.I.
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Why are there so Many Species of Lupines? Insights from the *Lupinus albifrons* Species Complex

The perennial lupines (*Lupinus* L.: Fabaceae) of western North America, a highly diverse and species-rich group, have stymied generations of taxonomists. Molecular evidence suggests that part of the reason for the confusion is that the perennial lupines are a species flock of recent origin, constituting parallel species radiations from multiple widespread ancestral species. The most plausible interpretation of the phylogenetic data is that the chloroplast phylogeny is confounded by overlapping species radiations of separate "tribes," similar to those proposed by C.P. Smith and others. The best way to understand the taxonomy of each "tribe" is to look at it separately, removing the homoplasy caused by the parallel radiations of the other "tribes." However, the same evidence supports the hypothesis of multiple peripatric speciation events from several paraphyletic ancestral species. The *Lupinus albifrons* Benth. species complex is used as a model system to demonstrate these phylogenetic and demographic implications.

32. COLUMBUS, J.T.
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California Grasses: Diversity, Geography, and Ecology

Some 267 grass (Poaceae) species in 58 genera are native to California. An additional 180 species in 42 genera are nonnative. Of the 11,000+ grass species in the world, less than 3% are native to California. However, seven of the 12 grass subfamilies are represented in the state. By far, subfamily Pooideae is best represented, with 69% (184) of all native species. The largest pooid genera in the state are *Elymus*, *Poa*, and *Stipa*. Pooideae are distributed in diverse habitats throughout California. All pooids undergo C_3 photosynthesis, which is favored in Mediterranean climates with winter precipitation and dry summers. Pooids are also cold-adapted and the dominant grasses at higher elevations. Subfamily Chloridoideae is the next largest subfamily in the state, with 59 (22%) native species. *Muhlenbergia* is the most diverse genus. Unlike Pooideae, all Chloridoideae undergo C_4 photosynthesis. Most chloridoids are distributed in the deserts and warmer and drier areas of the California Floristic Province. A remarkable chloridoid group is the *Orcuttia* lineage, with eight of its nine species and all three genera found in California. *Orcuttia* and close relatives are morphologically divergent annuals of vernal pools. The remaining subfamilies with native species in California are Aristidoideae (6, C_4 species), Arundinoideae (1, C_3), Danthonioideae (3, C_3), Oryzoideae (1, C_3), and Panicoideae (13, mostly C_4), collectively representing only 9% of the native grass species diversity.

33. DREW, B.T.
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Age, Diversity and Origin of the California Mints, with Special Emphasis on the Genus *Salvia*

The California Floristic Province (CFP) extends from Southern Oregon to Northern Baja California, and is largely defined by a Mediterranean-type climate. The CFP has long been known for its biodiversity and high degree of endemism. In a broad overview of relevant examples, Raven and Axelrod (1978) argued that *Lepechinia* and *Salvia* (Lamiaceae), among others, diversified in the CFP following dispersal from southwesterly regions as part of the Madrean floral assemblage, approximately 10-20 million years ago in the Miocene. Raven and Axelrod's two part hypothesis regarding a Madrean origin of the CFP (1. CFP lineages each are derived from, or sister to, a more southern Madrean lineage, and 2. Each of the stem lineages dates to the Miocene) is tested by estimating the origin of *Acanthomintha*, *Lepechinia, Monardella*, *Pogogyne*, and *Salvia* within the CFP, using dated phylogenies of the order Lamiales and Lamiaceae in a stepwise fashion. These chronograms are calibrated with multiple fossils representing several subfamilies

within the Lamiaceae and other families within Lamiales. Evolution of the genus *Salvia* within the CFP will be explored in particular detail.

34. COPPOLETTA, M.[1], and BELSHER-HOWE, J.[2]
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[2] USDA Forest Service, Plumas National Forest, 39696 State Highway 70, Quincy, CA, 95971. jbelsher-howe@fs.fed.us

One Step Forward and Two Steps Back: The Long Journey Toward Conservation of a Rare California Endemic

Webber's milkvetch (*Astragalus webberi*) is an extremely rare species (CRPR 1B.2) endemic to the upper Feather River region of the northern Sierra Nevada in central Plumas County. In 2003, an inventory of known occurrences documented fewer than 2,000 individuals and revealed that many of the occurrences were in decline. These findings prompted a series of experiments focused on increasing the number of Webber's milkvetch occurrences and individuals. In this presentation, we highlight some of the successes and challenges we have faced working with this rare species over the past decade. In one study, we were able to increase the number of Webber's milkvetch from 28 to 448 plants by implementing thinning and prescribed fire treatments; these treatments also resulted in over 40 new plants in treated areas outside of the known occurrence. In additional studies, local high school students helped propagate 1200 seedlings in the greenhouse, sow 1500 seeds in experimental field trials, and plant over 950 seedlings in field sites outside of known occurrences. While we have had success propagating plants in the greenhouse, we have had little success outplanting in the field, where survival of seedlings has been very low. We are currently working on identifying barriers to success, which we hypothesize may be a combination of prolonged drought and local site conditions.

35. KNIGHT, M.A.
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Conservation of the Siskiyou Mariposa Lily, *Calochortus persistens*

Siskiyou mariposa lily, (*Calochortus persistens*), is restricted to 3 locations in NW California and SW Oregon. A petition to list *C. persistens* as Federally Endangered was filed in 2001, and the species was subsequently designated as a candidate for listing by the U.S. Fish and Wildlife Service. Status within other organizations is as follows: Sensitive—Region 5, U.S Forest Service; Rare—State of California; and critically imperiled—State of Oregon. Since 2001, efforts began to conserve the species through projects that addressed the threats: intensive surveys of all occurrences, working with private timberland owners, and the development of a Conservation Agreement between all concerned parties. The final Conservation Agreement between the Forest Service, Bureau of Land Management, and the Fish and Wildlife Service was signed in the fall of 2013. On October 7, 2015, due to our efforts to conserve the species, *Calochortus persistens* was removed from the Candidate Species list. This presentation will include the highlights of the process and on-going activities that have led to a successful partnership to conserve the Siskiyou mariposa lily.

36. SHOLARS, T.A.
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Pygmy Forest Mapping and Vegetation Classification as the Path Toward Effective Conservation

The pygmy forest has long been recognized as a rare plant community filled with rare plants. However our conservation efforts have been hampered by the ambiguous nature of defining what is pygmy forest and what it isn't. In the past we have generally defined pygmy forest as that plant community that is dominated by the pygmy cypress (*Hesperocyparis pygmaea*) and Bolander or pygmy pine (*Pinus contorta* ssp. *bolanderi*). But the growth stature of cypress and pine is determined by the soils. At first we focused on Blacklock and Aborigine soil types. These soils produced the "classic" short stature of pygmy pine and

cypress. We then broadened our search parameters to oligotrophic (nutrient poor) soils to clarify the alliances that might be confused with cypress-dominated ecosystems. This search led to collecting data to describe the associations that occurred with the cypress and pine. This project would never have been accomplished without the support and leadership of the California Department of Fish and Wildlife (CDFW) Veg Camp group in Sacramento, Eureka and Fort Bragg and local and regional volunteers. Thirty five people from14 groups were represented (in the order of the most participants) CDFW 17, CNPS 6, Botanical consultants 4, California State Parks 4, Coastal Commission 2, Mendocino Land Trust 2, The Nature Conservancy, Sierra Club, Mendocino Redwood Co., Campbell Global Timber, Mendocino Botanical Gardens, California Department of Forestry and Fire, San Francisco State University and University of California Santa Cruz arboretum.

37. NELSON, J.K.
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Pushing the Boundary—an Updated Jepson Herbarium Klamath Range Geographic Subdivision Better Represents Underlying Geology and Regional Floras of the Klamath and Cascade Ranges.

When published in 1993, the Jepson Manual departed from the common practice of using county boundaries to describe geographic ranges and instead used natural landscape features and biota to delimit geographic subdivisions, providing a context for plant diversity to aid in locating known populations of particular taxa and predicting where additional populations may be found. Over time it became clear that the Jepson subdivision boundary between the eastern Klamath Range and the southern Cascade Range did not accurately reflect the underlying geologic or floristic differences between the Klamath and Cascade Ranges. Using subsequently published geology and ecological subregion maps and descriptions, a changed boundary was proposed by a group of people familiar with the flora of the area, collaborating with Jepson Herbarium staff. Records of over two hundred selected taxa from the proposed boundary change zone were reviewed, using the California Consortium of Herbaria. This review resulted in range description changes for 113 taxa. The Jepson eFlora bioregional distribution text strings have been changed for the affected plants; and new distribution maps show in the eFlora and on linked sites, including Calflora.

ABSTRACTS FOR POSTERS

Abstracts in alphabetical order by primary author name; index on page 37
See also the List of Common Acronyms on page 36

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California Cushion-Plants

Cushion-like plants occur in different California habitats: coast, desert, and mountains. Plants belonging to this unusual life form are chamaephytes (usually woody plants with perennating buds borne close to the ground) or hemicryptophytes (herbaceous perennials with buds at or near the soil surface) that, growing singly, take on a hemispherical or subhemispherical shape due to the close branching of their shoots and their short internodes. Cushion plants are wider than tall with a long taproot and multiple above-ground branches of about equal length to provide symmetrical structure to the mound morphology of the plant. Certain plant species have developed cushion growth forms as an adaptation to strong winds, cold, snow, dry conditions, and heat. The compact and low growth form of the cushion plants creates a relatively favorable microclimate within and immediately beside the plant that reduces the effects of harsh conditions. This favorable microclimate allows them to become nurse plants that facilitate the colonization of the cushion by other species. Cushion plants belong to different families and are an example of convergent evolution. This poster shows a variety of cushion plants from different habitats in California.

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A Hundred Years of Headlines Hidden in Herbaria

For over 150 years botanists have been using newspapers to collect plant specimens in order to document plant diversity. To do so, plants are placed inside newspaper, which is then placed between blotter papers and then corrugated cardboard while it is pressed and dried inside of a plant press. Understandably, these newspapers are usually regarded as unimportant compared to the specimens they hold, which provide vouchers and data for botanical research. No curator likes to admit that past collections sometimes sit in herbaria for decades before the mounting process is completed and the newspapers discarded, but it turns out that newspapers storing forgotten botanical treasures has unexpected value. Recent curatorial projects at the UC Davis Center for Plant Diversity have revealed newspapers dating between 20 to 100 years old depicting what was once headlining news in our society. These newspapers illustrate how our mindset towards major issues such as sexuality and gender, science and technology, and even the food we eat (or used to eat) everyday has changed. Moreover, they shed light on the collectors who left unfinished work behind—where they traveled and what was going on in the world while they were trekking in the back-country documenting the world's flora. This winter at our annual Botanical Tea, as well as Picnic Day, The UC Davis Center for Plant Diversity presents an exhibit of newspapers that were once just storage for backlogged herbarium specimens, but now serve as historical artifacts of both our cultural and botanical past.

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Rejuvenation of Fire-Dependent Rare Plants: Responses of *Hesperocyparis bakeri* and *Iliamna bakeri* to the 2014 Eiler Fire and Management Implications

The Eiler Fire of 2014 burned at high severity through stands of Baker cypress (*Hesperocyparis bakeri*), a rare tree with serotinous cones. This resulted in high cypress mortality, but a flush of Baker cypress seed-

lings in spring of 2015. During the 2015 field season, we also discovered a new occurrence of *Iliamna bakeri* (Baker's globe mallow), a rare, fire-following perennial forb that germinated in the understory of Baker cypress stands. Post-fire management has focused on treating fuels that surround the cypress, and on re-establishing a cypress and montane chaparral mosaic within a former pine plantation. We have established monitoring plots to identify factors that influence post-fire regeneration of Baker cypress, and to determine how pre-fire stand conditions and post-fire shrub and overstory canopy cover affect Baker cypress seedling survival over the long-term. In addition, we are monitoring *Iliamna bakeri* to determine how long these populations persist after a fire event, and to identify pollinator species.

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A First Look at the Reproductive Biology of *Astragalus applegatei*: Oregon's Most Imperiled Plant

Applegate's milkvetch*, Astragalus applegatei,* is one of Oregon's most imperiled plants. It is a narrow endemic of moist alkali meadows in southern Klamath County, Oregon. Once thought to be extinct, it was rediscovered in 1983 and is now known to exist at only three major sites and two minor sites. A variety of factors are known to threaten this species, most notably habitat loss and competition from invasive species. Small population size has also been postulated as a threat to the species' survival, as there is often a relationship between population size and reproductive success in rare and endangered plants, particularly if the species requires allogamy (out-crossing) for reproduction. In the *Astragalus* genus, autogamy (self-pollination) is a common mating system, yet nothing is known about the reproductive biology of *A. applegatei*. Does autogamy result in fruit and seed set in *A. applegatei*, and if so, how does it compare to that of out-crossed individuals? Further, does seed-set vary across sites? In 2014 (one site) and 2015 (three sites) we conducted a pollinator exclusion experiment to test the effects of self-pollination on fruit and seed production. In both years, we found that pollinator exclusion (e.g., self-pollination) resulted in a significant decrease in legume and seed production, as compared to an open-pollinated control. In addition, legume and seed production varied significantly across sites. These results indicate that pollinators are important for improving seed-set in this species of *Astragalus*, and future conservation efforts should focus on increasing allogamy.

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Rare Fire Followers of Yosemite National Park

While Yosemite wildfires receive national media coverage and are a major concern of the public, many people remain unaware of the large segment of our flora that benefits from fire. We call these species "Fire Followers," and the recent fires, such as the Rim Fire, have played a key role in their survival. While many are common, some are California Native Plant Society rare species and Yosemite National Park Special Status Plants. In 2015, botanists surveyed large tracts of land seeking to determine the rare and special status plants' true ranges, document their population sizes, and gather the location-specific data to ensure their long term protection. Many of these species have a limited spatial *and* temporal distribution and surveys must be accomplished before the environmental cues that induce them to germinate subside, and later successional species take over. These data are stored and curated in Yosemite's Special Status Plant Geodatabase, and are shared with the California Natural Diversity Database (CNDDB). The park's database is used for several administrative functions, including to determine if construction, fire-fighting operations, installation of research equipment, or any other ground disturbance will impact rare plant populations, and to inform the management of invasive non-native plants. Few visitors have the opportunity to experience these unique and charismatic species personally. Celebrating Fire Followers'

ephemeral existence helps visitors see the role of fire as a driver of diversity and a necessary component of our ecosystem, rather than solely as a destructive force to be lamented.

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The Effect of Climate Change and Site on the Above- and Belowground Bacterial Endophytic Communities of Subalpine Conifer Seedlings

Bacteria form relationships with all multi-cellular organisms but knowledge of most such associations is just beginning to emerge. For example, endophytes, microbes that reside within the tissues of healthy plants, can contribute to plant health in nutrient-limited and stressful environments, yet little is known about their role in natural ecosystems. Previous research has shown that the foliage of adult *Pinus flexilis* and *Picea engelmanii* is consistently dominated by a group of potentially nitrogen fixing acetic acid bacteria. This and similar relationships could potentially be disrupted by climate change with the predicted range shifts of the host species. Alternatively, the endophytic community could potentially increase the host's survival in these expanded environments. We characterized the bacterial endophytic community of 1-year-old seedlings of *P. flexilis* and *P. engelmanii* in a warming experiment. We looked at the effect of four climate change treatments (control, watered, heated, heated & watered) on the endophytic community and contrasted it to the natural variation in the endophytic community across three elevations. We used 16S rRNA Illumina sequencing to characterize the endophytic community. We found that the climate change treatments had no effect on the endophytic community of the seedlings but that there was natural variation in endophyte communities due to elevation. *Betaproteobacteria*, a group that is known for their growth promoting abilities and antifungal properties, dominated the seedlings. This study suggests that bacterial endophytes are robust to environmental change at short timescales and that beneficial partnerships formed during this developmental stage would not be disrupted.

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Rare Stony Creek Spurge Found in DWR Flood-Control Channel at Elder Creek near Gerber, Tehama County

In Elder Creek near the town of Gerber, summer 2015 pre-project surveys for a proposed sediment excavation and vegetation removal project turned up a large occurrence of the rare annual Stony Creek spurge (*Euphorbia* [*Chamaesyce*] *ocellata* ssp. *rattanii*) in the gravelly creekbed. While this CRPR 1B.2 species has been reported from 3 miles upstream of Gerber, it was not expected in this downstream location only about 1 mile from the creek's mouth at the Sacramento River. Common non-native look-alike valley spurge (*E. ocellata* ssp. *ocellata*) was not found, and does not appear to occur west of the Sacramento River. Conversely, Stony Creek spurge has generally not been found east of the river. Characteristics distinguishing Stony Creek spurge from the common subspecies consist mainly of minute hairiness, on herbage and on the tiny involucre and capsule, which generally does not show up in field photos. Only voucher specimens or high-resolution close-up photos will be definitive for these characters. In the Elder Creek channel, the few spurge plants found within proposed excavation areas were removed and relocated. In consultation with a CDFW staff biologist, a monitoring plan has been established to assess reproductive success of the 'transplants' and to document avoidance of seedbeds left in the channel, which will be protected during excavation with ESA fencing. This occurrence has been reported to CNDDB, and a voucher specimen has been accessioned to the Chico State Herbarium. Questions remain regarding total Elder Creek population size and source-population location (Inner Coast Range foothills?). Channel-bed associates include *Heliotropium europaeum, Polanisia dodecandra* ssp. *trachysperma, Chamaesyce serpyllifolia, Hirshfeldia incana, Mentzelia laevicaulis, Kickxia elatine,* and *Dysphania botrys.*

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Observations on Post-Fire Floristic Diversity in the Central Sierra Nevada: 1985-2015

Over the past 30 years, post-fire floristic diversity has been chronicled by Sierra National Forest botanists via herbarium specimens and photographs. These records are currently being summarized in a report intended to aid consideration of fire-dependent species by USFS managers and to educate the public. Records exist for at least 12 wildfires, ranging in size from < 100 to >20,000 acres, located in the foothill through upper montane zones. Large, high intensity wildfires are predicted to continue to increase and it will be crucial to conserve native herbaceous and shrub diversity when actions such as salvage logging, fuels treatments, and reforestation are proposed. Recent articles on "Complex Early Seral Forests" bring needed attention to post-fire biotic diversity, but tend to focus on forest overstory dynamics, often related to wildlife. More consideration of "fire-followers" (e.g. *Emmenanthe penduliflora, Ehrendorfia chrysantha*), that germinate only in response to smoke, leachate, or heat is due. Sustaining soil seed banks of fire followers over the long term is important for ecosystem sustainability. This poster displays highlights of the information gathered in Sierra NF burned areas: native plant species that emerged from 100-year-old soil seed banks or proliferated from bulbs after fire in great abundance likely play vital roles in sustaining ecosystems in mixed chaparral and coniferous forests. For example, small-flowered miner's lettuce (*Claytonia parviflora* ssp. *parviflora*) is often seen in extraordinary abundance the first 3 years after fire, and must be important for soil protection, native pollinator abundance, and production of seeds to replenish the seedbank and for insects and wildlife.

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Back in the Day: Documenting 125 Years of Vegetation Change in Sonoma County

General Land Office surveys, made under the U.S. Department of Interior, are the most detailed record of California's 19th-century landscape. This record remains largely untapped. Surveyors collected two kinds of data for every mile surveyed: 1) Line descriptions—the 'types of trees and undergrowth in order of their predominance';* and 2) Point observations—the type and diameter of six 'bearing' trees. This study's goal was to develop an approach to the survey record which allows long-term changes to be confidently identified and quantified. Historical conditions were estimated for 75 mi^2 and compared to recent habitat data. Because of demonstrable bias in the choice of bearing trees, line descriptions were used as the primary data source. Survey data was mapped in GIS. Crosswalk tables were created to translate historical names into modern terms, and line descriptions were converted into the three major lifeform groups—Forbs & Grasses, Shrubs, and Woodland. Statistical analysis verified these classifications. Initial change analysis revealed a modest increase in Woodland; a significant decrease in Shrubs (chaparral); and little change in Forbs & Grasses. Further analysis should reveal shifts in individual species' distributions; it should also provide site-specific identification of habitat loss, resilience and range of variability. One potential use for this information is the prioritization of habitats and locations for preservation and restoration. This project was funded by the Sonoma County Agricultural Preservation & Open Space District and Audubon Canyon Ranch. It is an Enhancement to the Sonoma County Vegetation and Habitat Mapping Program.

*1855 Surveyors' Manual

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Characterizing Quantitative Variation in the Glossopodia of Three Western North American *Isoëtes* Species

One of the challenges when working with the genus *Isoëtes* is the scarcity of in-depth comparative analyses of its morphological characters. This paucity is partially due to the long-held conclusion that most of the genus's traits, aside from spore morphology, are too variable to be informative. As a result, knowledge on the morphological variability among *Isoëtes* is weak. Recent workers have attempted to address this deficiency by examining the glossopodia, a structure embedded in the adaxial surface of the microphyll of *Isoëtes* and its sister genus *Selaginella.* These structures have been shown to potentially have interspecific variability in the few studies in which they have been examined. However, these prior works were limited to qualitative comparisons. This study improves upon these early comparisons by utilizing 3D reconstructions of the glossopodia of three Californian species, *Isoëtes howellii*, *I. bolanderi* and *I. nuttallii,* and applying morphometric analyses in addition to more traditional qualitative comparisons. MANOVA of measurements taken on 3D reconstructions of the glossopodia from each specimen show significant differences in size among the species. Similarly, elliptical Fourier analysis of these reconstructions demonstrates differences in shape among the species. This study aims to provide a repeatable, statistical framework for future work on this structure and potentially other traits in *Isoëtes*.

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Discovery of a Diamond-Petaled California Poppy (*Eschscholzia rhombipetala*) Population on DWR Property in Alameda County

During the spring of 2015, DWR botanists located a population of the rare diamond-petaled California poppy (*Eschscholzia rhombipetala)* in Alameda County. Prior to this survey, the only known local occurrence of this species was identified in 1888 by E.L. Greene "near Byron" and was presumed to be extirpated from the area. This CNPS list 1B species has only been observed in two areas in the last 65+ years: near the Alameda/San Joaquin County boundary and at Carrizo Plain. We have submitted this new finding to CDFW's California Natural Diversity Database (CNDDB) and the information has been incorporated, ensuring other botanists have access to data on this new population. This new record in CNDDB has allowed for refinement of a 5-mile radius polygon which was based on Greene's 1888 record. The new DWR polygon is specific to the occurrence and has a radius of ~100 feet. The 1888 record was reexamined and remapped with a smaller 1-mile radius polygon. This finding should encourage other botanists in the area to consider *Eschscholzia rhombipetala* when surveying in potential habitat, keeping in mind that the plant's small stature may allow it to be easily overlooked, particularly when growing amongst exotic annual forbs. Although DWR is traditionally a management agency for water resources, our Mission Statement also guides us to protect, restore, and enhance the natural environment. In support of this directive, Division of Environmental Services botanists plan to develop a monitoring plan and strategy for encouraging the persistence of the occurrence going forward.

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Seeking Symbiosis: Art and Science in the Classroom

To make real progress towards protecting and effectively managing species and their complicated interactions, we need both informed scientists and the support of an ecoliterate public. We need to develop interdisciplinary approaches that engage the public to protect our resources for a more sustainable future. During the past year, Geoffrey Thomas, Postdoc, Art Department UCSC, and Juniper Harrower, PhD student, Environmental Studies UCSC, collaborated on an art-and-science project that looked at the effects of climate change on Joshua trees. As part of this project, we invited students in Geoffrey's studio art class to explore the question: How can art contribute to the debate about climate change? Juniper presented her research on desert ecosystems to the art students who then created digital-print triptychs that engaged with the history, culture, biology, and habitat of Joshua trees. Students also visited Juniper's roof-top lab where she grows Joshua tree saplings. The work that resulted not only bridged the gap between the disciplines of Art and Environmental Studies but also connected with parts of the university and surrounding community: student work was highlighted in Santa Cruz's local paper, Santa Cruz Sentinel, and exhibited in UCSC's Environmental Studies department and the Student Environmental Center's Earth Summit event. Bringing science into a studio art classroom provided a rich area of content that inspired students' aesthetic and conceptual experiments. Mixing art with science helped students engage with real-world concerns while learning studio art skills and gave them a new view into the concerns and practices of scientific research.

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Habitat and Distribution of *Cornus canadensis* on Snow Camp Mountain

Cornus canadensis is a listed plant with a California Rare Plant Rank of 2B.2. When *Cornus canadensis* was given this rarity status in 2012, Green Diamond Resource Company botanists searched their database for incidental detections of the species. An observation of *Cornus canadensis* was recorded for a project in the Snow Camp Lake area and it was subsequently relocated. Using the location of this population as a model for what could be considered suitable habitat, other areas within the Snow Camp Mountain area were identified and selected for surveys focused on the detection of *Cornus canadensis.* In mid-June of 2013, survey efforts in these areas led to 9 new detections. Floristic surveys of timber harvest plans since that time have resulted in a total of 14 *Cornus canadensis* detections in the Snow Camp Mountain area. The habitats in which these populations are located tend to be the headwaters of small streams, creeks, wet meadows and seeps surrounded by *Pseudotsuga menziesii* var. *menziesii, Abies concolor* and *Notholithocarpus densiflorus* var. *densiflorus* dominated forest at approximately 4000 ft. elevation. *Cornus canadensis* is often found trailing over woody debris in late stages of decay and through dense vegetation. Populations range in number from 5 plants to as many as 10,000. *Cornus canadensis* has also been found co-occurring with rare taxa *Erythronium revolutum* and *Bensoniella oregona.*

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Differential Seed Predation Dynamics of *Ceanothus*

Chaparral is a community threatened by climate change. *Ceanothus* is an important, fire-adapted genus dependent on a long-lived soil seed bank. *Ceanothus* demonstrates great variability in seed bank accumulation due to high seed predation. Important granivores impacting *Ceanothus* seed banks include both

birds and rodents. Birds are as important as rodents in seed predation of the post-dispersal phase. However, whether rodents continue to reduce the seed bank during the winter and spring until the next fruiting season is unclear. I plan to examine the temporal, annual seed predation dynamics of birds and rodents. I intend to investigate this question in two ways: (1) an exclusion experiment comparing bird and rodent granivory from one seed dispersal event to the following year's, and (2) the seasonal influence of cache discovery. I expect bird seed predation to drop in the winter months because the rain will likely bury the seeds. Birds rely on visual cues to discover the seeds, while rodents also utilize scent. In addition, I expect bird seed predation to decrease during the spring because hatchlings require a diet of amino acids found in invertebrates. I anticipate cache discovery to increase by rodents during the winter months because water causes seeds to release volatile chemicals. This study will investigate the temporal, differential seed predation of birds and rodents on *Ceanothus* seed bank accumulation.

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Special-Status Plants in the Bucks Lake Area of Plumas National Forest

In 2015, Pacific Gas & Electric Company conducted a comprehensive floristic survey and mapped vegetation in the vicinity of Bucks Lake for the Bucks Creek Hydroelectric Project. Botanists documented 617 vascular plant species and 56 bryophyte species, including 93 occurrences of 13 special-status vascular plant species and two special-status bryophytes. In addition, 58 vegetation alliances were mapped, including 18 rare natural communities and 14 provisional alliances. The two most common special-status species were Mildred's clarkia and Clifton's eremogone; giant checkerbloom and obtuse starwort were also prevalent. Less frequently documented species included clustered lady's slipper, yellow willowherb, closed-throated beardtongue, Coleman's rein orchid, long-leaved starwort, and Siskiyou Mountains huckleberry. One hotspot for plant diversity included a fen community dominated by western blueberry; botanists recorded four different special-status plants in this community including round-leaved sundew, slender cottongrass, and two bryophytes (three-ranked hump moss and sphagnum moss). Surveyors also documented an occurrence of the new taxon, fern-leaved monkeyflower, which extends its known range farther to the northeast. Only two of the 15 special-status plants documented in 2015 had been documented in the area previously.

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Allelopathic Inhibition of Understory Vegetation in California *Eucalyptus* Groves

Allelopathy is a biochemical interaction, in which plants release chemicals into the environment that inhibit the survival of competing plant species. Release of allelochemicals can occur via root exudation, volatilization, or precipitation-mediated leaching. *Eucalyptus globulus* Labill. (blue gum) is a tree native to southeastern Australia and Tasmania, which also occurs worldwide as a plantation tree. In California, 40,000 acres of abandoned blue gum plantations occupy primarily coastal habitat. These stands are well-known for their characteristic lack of understory vegetation, a trait typically attributed, both anecdotally and in the literature, to the release of allelochemicals from the trees. However, the actual mechanism of understory inhibition is not well documented. To investigate the mechanism of understory inhibition, we conducted a greenhouse experiment to compare seed germination and seedling growth of native species in field-collected soil from two blue gum plantations and the adjacent coastal scrub communities. Further, we exposed germinating seeds in petri plates to volatile or water-soluble compounds extracted from fresh leaves of blue gum, white sage, or coast live oak and compared seed germination between treatments and

a water control. Compared to native soil, seed germination and early seedling growth (dry biomass) in blue gum soil varied from somewhat inhibited (<33%) to strongly enhanced (1400%), which also varied by species and soil collection site. We found no effect of volatile or water-soluble compounds from blue gums on seed germination, compared to the controls. We conclude that allelopathy alone cannot explain the lack of understory vegetation in California blue gum stands.

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Interactions of Mycorrhizae, Native Grasses and *Quercus douglasii* in California Blue Oak Woodlands

California's endemic *Quercus douglasii* (blue oak) is not regenerating throughout the state and although many hypotheses have been made, no conclusive evidence has been brought forward as to why. The goal of this study is to find evidence of a relationship, if any exists, between *Q. douglasii*, mycorrhizae and the native grasses that once dominated the landscape. Using 3 test groups, *Q. douglasii* acorns were germinated and grown in pots containing native soil, seeded with a native grass mix (*Stipa pulchra, Elymus glaucus* and *Bromus carinatus*), invasive annual grass mix found on site (mostly *Avena sativa*) and in the absence of grasses respectively. After several months of growth, root tissue was then sampled, stained and examined under a microscope for the presence of mycorrhizal infection sites. In 2013 when this experiment was first performed at Butte Community College, it was shown that this symbiotic relationship begins very early in the oak's life. However, not enough data was generated between the groups to state any conclusions as to native grasses influence on the growth and establishment of *Q. douglasii*. In 2014, this experiment was replicated in Humboldt County with 0% germination due to damp, humid coastal conditions and mold overtaking the acorns. This experiment is currently being repeated in Butte County, with 30 replicates in each of the three groups.

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Development and Implementation of a Before-After / Control-Impact Experiment to Determine Effects of Two Aquaculture Methods on Native Eelgrass Shoot Density

Native eelgrass (*Zostera marina* L.) is a perennial monocot seagrass that grows in shallow marine embayments and estuaries throughout the northern hemisphere. It provides numerous ecological services and receives protection under state and federal no-net-loss wetland policies in addition to being designated as essential fish habitat by the National Marine Fisheries Service. Humboldt Bay is home to nearly half of the eelgrass in California and also produces over half of the oysters grown in California. Historical aquaculture production methods in Humboldt Bay have resulted in pulses of eelgrass impacts and recoveries during the 20th century. More recent off-bottom shellfish cultivation methods were designed to minimize impacts to eelgrass, utilizing lines elevated above mudflats and eelgrass. A proposed 622 acre aquaculture expansion project in Humboldt Bay will partially occur in areas of dense eelgrass meadows. To monitor potential impacts of the aquaculture expansion on eelgrass, a before-after / control-impact (BACI) experiment was developed to determine effects of specific line spacings for cultch-on-line and basket-on-line cultivation methods. The BACI experimental design includes randomized transects with quadrat measurements stratified by their distance to longlines. The experiment is configured in a blocked design with a control nested within two treatment plots. 30 block locations were randomized after stratifying by elevation and sediment type proportional to the expansion area. Two years of "before" data and two years of "after" data will be collected, with 2015 data (presented here) being the first year of before conditions and 2018 the final year of after conditions.

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Comparison of *Dichelostemma capitatum* Subspecies Reveals Variation in Life Cycle Parameters

Dichelostemma capitatum (Benth.) Alph. Wood is a geophyte (herbaceous perennial with underground storage organs) with three subspecies in California. Plants from populations of *D. capitatum* subsp. *capitatum* and *D. capitatum* subsp. *lacuna-vernalis* (L. Lenz) D.W. Taylor grown under common garden conditions maintain their diagnostic morphological distinctions and also demonstrate differences in their life cycle parameters. Although both subspecies share many traits in common, *D. capitatum* subsp. *lacuna-vernalis* has shorter scapes and fewer flowers per scape, transitions from the juvenile stage to the reproductive stage at a smaller corm size, and rarely produces cormlets. Larger corms produce plants with more scapes and more flowers, but the effect on scape number is more pronounced in *D. capitatum* subsp. *lacuna-vernalis*, and the effect on flower number is more pronounced in *D. capitatum* subsp. *capitatum*. The differences seen in *D. capitatum* subsp. *lacuna-vernalis* may be associated with life in a "flashy" habitat, i.e., thin soils that rapidly dry up in early spring. In addition, the effects varied from year to year, suggesting that environmental variation may affect the expression of growth and reproductive characters.

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California Botanist Certification Formation: Purpose, Need and Future Goals

For many years botanists have been actively involved in setting environmental policy and assisting in science-based decision-making in California. Private environmental consulting and engineering firms and public natural resource agencies offer employment opportunities for botanists in field surveys and environmental document preparation, but until now there has not been an organization to offer professional certification to these practitioners. An organizational structure and broad collaborative effort is now being formed called California Botanist Certification (CBC). The CBC is run by a Board of Certification (BOC) composed of certified botanists and is administered by California Native Plant Society. The goals of the CBC are to establish standards of proficiency and professionalism that guide the training, development, and performance of botanists, and to facilitate relevant professional training. Certified botanists will receive an annual newsletter and be listed on a Register of California Certified Botanists. Certification will be granted through examinations, and is designed for those with 5 or more years of experience. Prior to becoming certified, an applicant will submit a testing fee and take and pass an examination. After successfully passing the examination, certified botanists will be required to pay an annual fee, submit evidence of continuing education every 5 years, and agree to abide by a Code of Ethics. In the future this effort will provide the larger environmental community with a way of identifying qualified botanists and will serve as an organizing force to direct future botanists toward the profession. More information is available at http://cnps.org/botanistcertification.

21. ROSE-PERSON, A.
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Soil-Mediated Impacts of the Invasive Grass *Ehrharta erecta* on Northern California Ecosystems

Invasive plants have the potential to drastically alter the structure of native plant communities in California and throughout the world. The effect of these invasions on soil remains understudied, and learning more about soil-mediated impacts could improve restoration efforts and help preserve native biodiversity. Here, I aim to determine whether an invasive grass changes soil through abiotic or biotic pathways, and

whether these changes reduce native plant growth. *Ehrharta erecta*, a perennial grass native to South Africa, has invaded 14 counties in California and outcompetes native plants in the understory communities it invades. To examine how *E. erecta* impacts soil, I used a soil-conditioning experiment. I planted 3 native species, and *E. erecta* itself, in both sterile and nonsterile soil that has been conditioned by *E. erecta,* as well as in field soil that has been conditioned by *E. erecta.* I will measure plant growth traits, soil fertility, and percent mycorrhizal colonization of each species at the end of each phase. Results of this experiment will help improve attempts at native habitat restoration by informing ecologists of a possible way to enhance restoration with the use of mycorrhizal inoculation or nutrient addition. This knowledge will promote the conservation of native biodiversity in the face of an invasive threat throughout California.

22. SANVILLE, C., and DESHAIS, J.
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Hunting the Elusive Rare Plant and the Golden By-Products of a Good Survey: A CDFW Guide to Conducting Quality, Effective, and Efficient Botanical Surveys

CDFW has jurisdiction over the conservation, protection, and management of wildlife, native plants, and habitat necessary to sustain populations. As trustee agency under the California Environmental Quality Act (CEQA) §15386, CDFW provides expertise in reviewing environmental documents and makes protocols regarding potential impacts to biological resources. As a Review Team member, pursuant to the California Forest Practice Rules, CDFW reviews THPs and makes recommendations designed to avoid or mitigate potential impacts. Surveys conducted according to the "Protocols for surveying and evaluating impacts to special status native plant populations and natural communities" (CDFW 2009) meet CEQA requirements for adequate disclosure and avoidance of potential adverse impacts to public trust resources.Timber harvesting can significantly reduce the viability and persistence of rare species, or conversely, may benefit the species by creating or enhancing rare plant habitat. The outcome is largely dependent upon the quality of the pre-disturbance survey and availability of species-specific information derived from prior surveys, monitoring, and research efforts. Currently, many surveys fall short, and opportunities are passing by to better manage a landscape under mounting anthropogenic pressures for a diversity of values. We present a guide to conducting quality botanical surveys, highlighting common deviations and omissions from the protocol that can result in project delays, missed detections, and avoidable impacts. We cover: the requirements of a "qualified botanist", adequate scoping, survey methodology, resources, and adequate reporting. This guide may offer insights to both the seasoned professional, and the aspiring student.

23. SCHNEIDER A.C., CHUN, H., and SENG, A.
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Host to Parasite Horizontal Gene Transfer of the Coding Plastid Gene *rbcL* in an Undescribed, Cryptic Lineage of *Orobanche*

The importance of horizontal gene transfer (HGT) in plants is becoming increasingly recognized as an important mode of reticulate evolution. Studies of several holoparasitic [obligate parasite] lineages, most notably *Rafflesia*, have shown the integration of xenogenous DNA [DNA from distantly related organisms] into the genome. Here, we show (1) phylogenetic support for several undescribed or unrecognized species of California *Orobanche* and (2) the first evidence of host-to-parasite HGT in western hemisphere *Orobanche*. We show that the gene coding for the large subunit of the enzyme ribulose-bisphosphate carboxylase *(rbcL)* in an undescribed species of *Orobanche* parasitic on several species of *Galium* is a derived form of the *rbcL* gene found in a clade of Western North American *Galium* and was not inherited from the common ancestor of *Orobanche*. In contrast, several other plastid and nuclear loci support a close evolutionary relationship between this undescribed lineage and *Orobanche fasciculata*. More broadly, this research highlights the important role of host relationships in the evolution of parasitic plants, and the consequent need for careful determination of host relationships when collecting or surveying. Another

important result emphasized by this research is the cryptic (undescribed) diversity in the genus *Orobanche*.

24. MARTY, J.[1], SWEET, S.[2], and BUCK-DIAZ, J.[3]
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Single Burn Controls Goatgrass for at Least 7 Years

Prescribed burns are one of the few landscape-scale tools available to grassland managers for reducing invasive exotic grasses like barb goatgrass (*Aegilops triuncialis* and/or *A. neglecta*) while also favoring native plant biodiversity. Burning, however, requires a large amount of preparation and coordination, plus permitting and potential liability. Documentation of a long-term benefit is desired for such investment, but few studies last more than 2-3 years. We conducted a prescribed burn in goatgrass-infested rangeland in early June 2005, and collected data on percent cover of the plant community pre-burn and for 7 years after treatment (YAT) in paired burned and unburned plots. One YAT, goatgrass cover was 3% in burned plots vs. 21% in unburned. This strong effect was maintained 2 YAT (6% burned vs. 27% unburned) and was weaker but statistically significant for 4 of the next 5 years, where goatgrass cover in burned plots remained less than half of that in unburned. Native plant cover was higher in burned plots (33%) than unburned (13%) 1 YAT, but no differences were detected in any subsequent years. Our study shows that a single late-spring burn can provide control of barb goatgrass for at least 7 YAT, and can increase native plant cover 1 YAT. Based on *Invasive Plant Science & Management* 2015 8:317-322.

25. JAMES, C. and TAYLOR, D.W.
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Vegetation Successional Pattern Following a Forest Fire in Northern California

In August 2012, the Ponderosa Fire burned about 28,000 acres in the Cascade Range in Tehama and Shasta counties. Successional pattern and trajectory following a forest fire is poorly described for California. For three growing seasons we monitored vegetation change in 10 small watersheds (ca. 1 acre each), supplemented with plots throughout the burned area in the second season. Vegetation cover increased at a linear rate over the three years, from 8.9 ± 4.6 % in the first growing season to 45.0 ± 18.8 % in the third. Vascular plant species richness also increased in linear fashion: from 24.4 ± 4.0 taxa in the first season, to 37.6 ± 18.8 taxa in each watershed in the third. Sixty-two taxa total were documented in the first growing season, increasing to 110 taxa in the third. Rarefaction analysis (using several different indices) yields extrapolated richness estimates between 129-137 total taxa for the third growing season, 77% to 85% of our documented richness. Some native annual herbs appeared only in the first growing season (*Acmispon grandiflorus, Nemacladus rigidus*). Initial cover in the first year is largely composed of native annual herbs (e.g. *Clarkia rhomboidea*), with non-natives less important. By the third season, the ratio had switched: exotic herbs increased (e.g. *Lactuca serriola*), native herbs decreased. The cover of shrubs (4 taxa each of *Arctostaphylos* and *Ceanothus*) exploded in the third season. Multivariate analysis of cover shows strong divergence between the watersheds as a function of time, the degree of divergence increasing greatly in the third season. Other vegetation studies are underway on our private timberlands at the Rim Fire (2013; 257,000 acres) and King Fire (2014; 94,000 acres).

26. WHITAKER, L.[1], HALL, J.[2], and STEINMAUS, S.[1]
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How Best to Manage for Biodiversity in the Guadalupe Nipomo Dunes Complex

The Guadalupe Nipomo Dunes Complex is home to a large population of endemic and endangered species and is located within the California Floristic Province, a world biodiversity hotspot. Current threats

to this important region include spread of invasive species, such as *Ehrharta calycina* and *Ammophila arenaria*; lack of conservation funds; and multiple stakeholders and landowners who must coordinate for overall success. In the face of these threats, protected areas are key to maintaining biological diversity. The strategies for planning and executing biodiversity conservation have long been debated. We have completed a collaborative planning process that utilizes local experts in each taxonomic group (Flora, Mammals, Birds, Reptiles and Amphibians, Invertebrates and Lichen) in combination with the aid of GIS-compatible modeling software to produce two strategies for creating conservation areas. We used Marxan and Zonation software to model the best regions for conservation. These strategies will be used by the stakeholders of the Guadalupe Nipomo Dunes Complex to create a biodiversity conservation management plan, which will dictate the conservation of the Dunes for the next 10 years.

27. WININGER, K. and RANK, N.
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This Tree's Not Big Enough for Both of Us: Symptoms of Sudden Oak Death on California Bay Laurel are Lower When Insect Herbivores are Abundant

Leaves of California bay laurel (*Umbellularia californica*) are considered the primary natural source of inoculum for the devastating forest disease sudden oak death (*Phytophthora ramorum*), and yet this plant & insects associated with its leaves remain understudied. This is unfortunate due to the role herbivorous insects may play in disease transmission and alterations to plant disease susceptibility. There is also a deficit of knowledge about how landscape-level variability or the effect of microclimate may influence insect presence, and about systems involving both a plant's pathogen and its insect herbivores. Since 2003, two hundred woodland plots within a 275 km2 region of Sonoma County have been assessed for disease progression. Insect diversity and abundance on leaves of California bay have been monitored since April 2014, with species appearing most often from the suborder Sternorrhyncha, which includes aphids, scale, and whiteflies. We have found a negative relationship between insect and pathogen presence on the tree level for California laurel aphid ($p = 0.04$) and one species of armored scale insect ($p = 0.004$). We will investigate these interactions on a finer scale, including direction of correlation and across two microclimates, in 10 plots at Fairfield Osborn Preserve December 2015 - May 2016, using both an observational and experimental approach. We hope this may inform management strategies to slow the spread and cope of this disease that threatens to unhinge native Northern California ecosystems.

28. AMSBERRY, T., AVALOS, J., BENSON, J., GOODFELLOW, S., HAYES, T., MOLL LEE, K., MOORE, C., PELLETIER III, R., RAMIREZ, D., RITARITA, J., SILVEIRA, C., SKILES, E., and WOOLEY, S.
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Compensatory Growth and Physiological Responses of *Cucurbita foetidissima* (HBK) to Three Levels of Damage

Induced responses to herbivory or damage can influence plant physiology by altering plant allocation and growth patterns. Fast-growing vines are useful to study compensatory growth or induced responses to herbivory or damage because growth and physiological traits are simple to measure. To understand patterns of damage-induced growth in *Cucurbita foetidissima*, we damaged 12 plants by removing 25% of the vines, and 12 plants by removing 50% of the vines. Four plants were undamaged controls. We measured physiological traits, including photosynthesis and water use efficiency (WUE). We measured specific leaf area (SLA) in leaves produced previous to damage (old) and in leaves produced after damage (new). Photosynthetic rate increased in 25% damaged plants, but control and 50% damage plants had similar, lower rates indicating that moderate damage stimulates photosynthesis. Even without an increased photosynthetic rate, growth in the 50% plants was nearly 3-times greater than that of the control plants, but no different than that of 25% damaged plants. In plants with 25% damage, SLA was similar in new leaves compared with old leaves. In contrast, SLA in the 50% plants showed no relationship between old and new leaves. Taken together these results indicate that *C. foetidissima* growth is induced by moderate

damage. But when the damage is great resource allocation patterns break down. This work is part of an on-going common garden study of *C. foetidissima* aimed at understanding the ecophysiology of this drought succulent native squash.

LIST OF COMMON ACRONYMS

Found in Abstracts of Talks (starting on pg. 9)
and Abstracts for Posters (starting on pg. 23)

CDFW - California Department of Fish and Wildlife
CNDDB - California Natural Diversity Data Base
CRPR - California Rare Plant Rank
ESA - Endangered Species Act
GIS - Geographic Information System
NEPA - National Environmental Policy Act
THP - Timber Harvest Plan
USFS - United States Forest Service (USDA Forest Service)

INDEX OF AUTHORS

Talk abstract page numbers in **bold**; poster abstract page numbers in *italics*

EXHIBITORS

Backcountry Press
Representative: Michael Kauffmann
(707) 407-7686 • www.backcountrypress.com • email: mk@backcountrypress.com
An independent publisher of web and print media whose themes explore natural history, ecology, and the western landscape. Publications include *Field Guide to Manzanitas*, *Conifer Country*, *Conifers of the Pacific Slope*, *Articulate Earth*, and *Hiking Wild Rivers Country*. We print in the USA on recycled paper.

Bureau of Land Management
Representative: Christina Lund
www.blm.gov/ca/st/en.html
The Bureau of Land Management (BLM) manages 15.2 million acres of public lands in California (nearly 15% of the state's land area) and 1.6 million acres in northwestern Nevada. It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations. Among its many programs and policies, BLM works to conserve and/or recover ESA-listed species and the ecosystems on which they depend so that ESA protections are no longer needed for these species.

California Invasive Plant Council
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The California Invasive Plant Council (Cal-IPC) protects California's environment and economy from invasive plants. We provide leadership for partners across the state working to stop the spread of wildland weeds. Access our resources, network with other professionals and volunteers, and support our advocacy for strong policy and programs. Learn more at www.cal-ipc.org

California Native Plant Society – State Office
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The California Native Plant Society (CNPS) has been the leading native plant conservation, advocacy, and education organization in California since 1965. A grassroots organization, CNPS has 35 regional chapters serving 9,000 members all over the state of California and northwest Baja California, Mexico. CNPS maintains an online *Inventory of Rare and Endangered Plants* as well as *A Manual of California Vegetation*, the standard vegetation classification reference. CNPS also has an active horticulture program, supporting chapter native plant sales and demonstration gardens.

Eggtooth Originals
Representatives: Karen West
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After a federal agency wildlife biologist career, Karen West tapped into a long buried desire to study jewelry crafting. She brings an affinity for the natural world into her jewelry designs, with an emphasis on things botanical.

Flora of North America Association
Representatives: Nancy Morin
www.floranorthamerica.org • email: nancy.morin@nau.edu
The Flora of North American Association coordinates the work of hundreds of botanists to produce a Flora of North American north of Mexico. Nineteen out of the total of thirty volumes have been published by Oxford University Press; content is available online at www.floranorthamerica.org.

EXHIBITORS

F. M. Roberts Publications
Representative: Fred M. Roberts
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F. M. Roberts Publications originated as a self-publishing source for botanical guides and checklists in southern California but has expanded to include art work sales, including botanical T-shirt designs, and note cards based on gouache water color and acrylic paintings rendered by Fred M. Roberts, Jr.

Friends of the Chico State Herbarium
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The Friends of The Chico State Herbarium is a non-profit group whose goal is to provide community support for the Herbarium and to help demonstrate and publicize the value of the Herbarium. The group focuses on scientific and academic pursuits. Activities include raising funds for items that are not covered under the University budget, offering workshops on a variety of botanical based subjects, publication of a biannual newsletter, and supporting the Jim Jokerst Botany Award to encourage student research involving field aspects of botany and ecology.

Garcia and Associates (GANDA)
Representatives: Samantha Hillaire and Susan Dewar
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Garcia and Associates is a natural and cultural resources consulting firm specializing in cultural and paleontological resources compliance, state-of-the-art aquatic and terrestrial ecology, and natural resources policy and planning. Garcia and Associates' staff is committed to meeting our clients' needs with the highest professional standards. We have completed projects that range from multi-year, multi-million-dollar planning and impact studies for large facilities to small, focused studies with short deadlines and limited budgets. Headquartered in San Anselmo, we also have regional offices at Auburn, Oakland, San Francisco, Los Angeles, Lompoc, Oceanside, Palm Springs, Bozeman, Guam, and Honolulu.

Hedgerow Farms
Representative: Emily Allen
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Hedgerow Farms is a native seed production farm specializing in California native grasses, sedges, rushes, and wildflowers. We offer seed for more than 100 grass, forb, sedge species, including many bioregional ecotypes. We also provide native grass transplants, native straw, project design assistance, and contract growing.

Nature Art of Paul Reinwand
Representative: Julie Kierstead Nelson
https://society6.com/konradwerks • email: konradwerks@gmail.com
Paul Reinwand, the son of Jim and Julie Nelson, is a digital and sketch artist in Portland, Oregon. His renderings of northern California plants and animals are available as prints and stretched canvases through Society 6 at https://society6.com/konradwerks. Samples of this wall art will be displayed and available for sale. Smaller mementos celebrating the Shasta County floras, such as coffee mugs and mousepads, will also be offered for sale and amusement.

Paula Fong Illustrations
Representative: Paula Fong
(541) 778-3770 • www.prfong.com • email: prfong@cpros.com
Paula Fong is an illustrator with a background in ecology and soil science. She produces original artwork and prints for sale and creates scientific illustrations for signs, brochures, books, and other publications.

EXHIBITORS

Rancho Santa Ana Botanic Garden
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Rancho Santa Ana Botanic Garden promotes botany, conservation and horticulture to inspire, inform and educate the public and the scientific community about California's native flora. On 86 acres in Claremont, CA, the Garden displays hundreds of species of native plants. RSABG's programs focus on scientific documentation and conservation of native California plants, and, to graduate training and research in plant systematics and evolution. Through all its programs, including RSABG's retail nursery, Grow Native Nursery, the Garden contributes to the informed appreciation, enjoyment, understanding and sustainable utilization of our natural heritage.

Southern California Botanists
Representative: Nick Jensen
www.socalbot.org
Southern California Botanists is a non-profit organization founded in 1927 and is devoted to the study, preservation, and conservation of the native plants and plant communities of southern California. The journal *Crossosom*a, is published twice a year and carries articles of interest to amateur and professional botanist. The newsletter, *Leaflets of the Southern California Botanists*, published quarterly, contains notices of field trips, symposia, and other events interest. Southern California Botanists sponsor an annual symposium and have three grant programs that support botanical research in southern California.

NORTHERN CALIFORNIA BOTANISTS
2016 SYMPOSIUM

11-13 January 2016 • at California State University Chico • Bell Memorial Union Auditorium

ADDENDUM

ADDITIONAL SYMPOSIUM SPONSORS

- **California Native Plant Society (CNPS) – Sacramento Valley Chapter**
- **California Native Plant Society (CNPS) – Shasta Chapter**

ADDITIONAL TALK ABSTRACT
REPLACES TALK NUMBER 32

32. SCHNEIDER A.C.[1], FREYMAN W.A.[1], GUILLIAMS, C.M.[1,2 +], SPRINGER, Y.P.[3], and FREYMAN W.A.[1]

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The Recent, Pleistocene Radiation of the Serpentine-adapted Genus *Hesperolinon*

Hesperolinon (western flax; Linaceae) is endemic to the western United States, where it is notable for its high and geographically concentrated species diversity on serpentine-derived soils and for its recent use as a model system in disease ecology. We used a two-pronged phylogenetic framework to test a long-standing hypothesis that *Hesperolinon* is a neoendemic radiation. First, we used preexisting sequence data on GenBank to create an eight-gene, 100 taxon supermatix, which we calibrated using a *Linum* pollen fossil and a published phylogeny. Second, we robustly sampled from both the plastid and nuclear genome in a taxonomically and geographically diverse set of *Hesperolinon* populations. We find that most diversification in *Hesperolinon* has taken place in the past 1–2 million years, likely in the central Coast Range of California concurrent with an expansion of available habitat. Only the earliest diverging species, *H. drymarioides* was resolved as monophyletic. The remaining taxa form a complex of incipient species, with well-supported clades poorly aligned to traditional morphological circumscriptions. We conclude that *Hesperolinon* is an excellent example of edaphic neoendemism, and more broadly an excellent case study of the unique processes that have led to the development of the distinctive and diverse California flora.

ADDITIONAL EXHIBITORS

Santa Barbara Botanic Garden
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The Santa Barbara Botanic Garden fosters the conservation of California's native plants through our gardens, research, and education, and serves as a role model of sustainable practices. Find out more at www.sbbg.org.

Stillwater Sciences
Representatives: Megan Keever, Nicole Jurjavcic, Bruce Orr, and Emmalien Craydon
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Stillwater specializes in science-based, technical approaches to environmental issues. By integrating geomorphic and biological research to understand critical ecosystem processes, we work to identify effective measures for restoring and managing rivers and their floodplains as functioning ecosystems. Our areas of expertise include fish and aquatic ecology, geomorphology, botany and riparian ecology, water quality, wildlife, and spatial analysis/GIS. Our botanical services include rare plant surveys and monitoring; revegetation, restoration, and habitat planning; planting plan design/implementation; riparian habitat mapping; modeling of riparian-vegetation dynamics; development of invasive weed control measures; and jurisdictional wetland delineation and Section 404 permitting.