



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

RARE PLANTS

This session focuses on research, management, and conservation of California's rare plants. The session includes a panel discussion focused on conserving cryptic species in light of the increased recognition of plants that are difficult or impossible to identify solely on the basis of morphology. It also includes a subsession on new rare plant discoveries in California.

1.01 The conservation of California's rare, threatened, and endangered plant taxa requires more information about occupied sites than we currently have

John Hunter

WSP, Sacramento, CA, USA

I used the California Natural Diversity Database (CNDDDB), California Protected Areas Database, and California Conservation Easement Database to evaluate the extent of the current protection, management, and conservation needs of California Rare Plant Rank 1B taxa. Because there are more than 1,050 1B taxa, presumed extant at nearly 28,000 documented sites (occurrences), preserving, monitoring, and managing them everywhere they grow would be a large effort. In fact, 42 percent have not been observed in 20 years, need say formally monitored and only 66 percent of occurrences have specifically documented locations (i.e., CNDDDB Accuracy Class 1 and 2). Combined, specific occurrences occupy roughly 600,000 acres: 41 percent privately owned, unpreserved land, 59 percent land under conservation easement or publicly owned (little of which is managed to benefit 1B plants). Current management, regulatory, and preservation efforts are insufficient to conserve all this land. Obtaining the required billions in additional funding is unlikely. However, a taxon's needs differ dramatically: 377 taxa have <10 percent and 126 taxa >90 percent of their documented acreage unprotected on private lands. Also, at only some public sites are actions needed. Thus, opportunity exists to target actions where most needed to forestall extinctions. To implement such a strategic approach, we need more information on the continued existence, exact location, and site-specific stressors affecting a large portion of these rare plant populations. Moderate change or expansion of existing activities (revision of CNDDDB forms, expansion of rare plant treasure hunts) and new activities (land manager surveys) are necessary to meet this need.

1.02 There's no place like home: Five endemic plants from southern California and the soils they love

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The California Floristic Province is one of the most biodiverse regions in the world and home to a large number of endemic plant species. The high degree of endemism is attributable to a diversity of climatic, topographic, and edaphic conditions creating unique microcosms for species specialization. Unfortunately, many of these microcosms have been lost to urbanization and populations of edaphic endemic plants have been isolated by habitat fragmentation and loss of pollinators. In addition, specialists are extinction-prone and vulnerable to climate change. Land managers need more specific information about habitat requirements to successfully conserve these species. This study focuses on soil chemistry and physical properties of five edaphic endemic plants in San Diego County including two clay-endemic species: *Deinandra conjugens* (Asteraceae) and *Brodiaea filifolia* (Themidaceae), two species restricted to gabbroic soils: *Nolina interrata* (Ruscaceae), and *Tetracoccus dioicus* (Picrodendraceae), and *Acanthomintha ilicifolia* (Lamiaceae), which occurs on clay and gabbroic soils. We used a spatially matched design to compare occupied and unoccupied soils. Results indicate that each species is associated with a unique suite of physical and chemical soil conditions that vary over a fine spatial scale. This information can help prioritize areas for management activities. It also improves our ability to identify suitable but unoccupied habitat for population expansion and translocation efforts within the species' current range and under shifting climatic conditions.

1.03 Natural history and distribution of woolly mountain parsley, *Oreonana vestita*

Jane Tirrell

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A study of woolly mountain parsley, *Oreonana vestita* (Apiaceae), California Rare Plant Rank 1B.3, may yield information on how these plants adapt to climate change. *O. vestita* occurs primarily on ridges and summits that are intermittently covered with snow during the winter and spring. A changing climate may result in more rain and less snow. Although there are several occurrences of *O. vestita* in the San Bernardino and Scodie Mountains, this study focuses on plants in the San Gabriel Mountains. Occurrences were mapped and compared with those known from the California Natural Diversity Database and CalFlora, and from vouchers included the Consortium of California Herbaria. New occurrences were noted as well as reported locations where the plants were not found. *O. vestita* habitats were compared to the type location, the summit of Mount San Antonio, with respect to soil type, elevation, slope, aspect, plant associates and flower color. In addition, two study sites, accessible year-round, were visited at regular intervals to observe *O. vestita* phenology. Phenology plots were constructed and compared over several drought years and one non-drought year. The plants exhibit an earlier, shorter growing season during drought years that may leave them with lower reserves over time. At present, *O. vestita* populations appear robust; they have withstood five years of drought and increasing human encroachment. A map of *O. vestita* occurrences and detailed information about its habitats and phenology can provide a baseline for comparison of the distribution and adaptation of these plants over the coming decades.

1.04 Ecological niche modelling of *Ivesia webberi* in Nevada and California

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Statistical algorithms are used to develop ecological niche models for predicting distributions focal species, for applied management, or to develop hypotheses for further empirical research. In this study, three algorithms-random forest (RF), generalized linear (GLM) and additive (GAM) models-were used to fit distribution models for *Ivesia webberi* (Rosaceae), a federally listed rare and threatened species in the western Great Basin Desert, using both presence and true absence points. We compared modeling approaches using linear (GLM) and non-linear (RF, GAM) relationships among predictor and response variables. Selected predictors for the study included 30-year (1981-2010) monthly temperature and precipitation data, digital elevation model (DEM), normalized difference vegetation index (NDVI), solar radiation, soil classes, land cover classes, cover of bare ground, and a species distribution layer for *Artemisia arbuscula* (Asteraceae), a species known to broadly co-occur with, and hypothesized to have facilitative effect on *I. webberi*. Best models were selected using area under curve of the receiver's operating characteristics plot, Cohen's Kappa, sensitivity, specificity and true statistic skill. The results show that models fitted with NDVI performed significantly better and explained the highest deviance, compared to models without it. Overall, RF-fitted models indicated that winter temperature, DEM and NDVI were the most important variables for fitting niche models of *I. webberi* accurately. Comparatively, RF and GAM performed better than GLM, but models fitted using RF and GAM were not significantly different. The relative importance of NDVI in these models shows that vegetative community productivity is crucial in predicting the distribution of *I. webberi*.

1.05 Introduction and reintroduction as an aid to species recovery

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Members of the Orcuttieae tribe (Poaceae) are entirely endemic to vernal pools of the California Floristic Province. Both prior and subsequent to their listing under the California and federal Endangered Species Acts in the 1990s, numerous individual populations of these rare grasses have been extirpated through habitat conversion and other factors. As California continues to expand both its urban centers and its agricultural base, the vernal pool habitat that supports these and other species is becoming highly fragmented thereby reducing the chances of natural (re-)colonization. In 2014 and 2016, Sacramento Orcutt grass (*Orcuttia viscida*) was planted into unoccupied suitable habitat within its natural range. These out-plantings were intended to compensate for unregulated losses that occurred prior to listing. In 2015, Solano grass (*Tuctoria mucronata*) was replanted into Olcott Lake, its type locality. This population was probably extirpated due to stochastic events following overzealous herbarium specimen collecting. The plantings consisted of simply scattering seed collected from nearby donor sites. Both the donor sites and the newly established populations are being monitored annually for special distribution, population size and plant vigor. Since the initial plantings, the rare grasses have occurred in the recipient vernal pools every year and the new populations appear to be relatively stable. For both species, these recently established populations will serve as a buffer against extinction. This research may also serve to illustrate possible conservation approaches for rare vernal pool plants in the face of both habitat fragmentation and climate change.



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1.06 Cryptic species recognition and rare plant biology: Impractical taxonomic splitting or an inconvenient truth?

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Focused study of species is a fundamental activity of taxonomic research. Such studies led to the discovery of new species throughout the 19th and 20th centuries and will continue to result in new species discovery via continued study and expanding methodologies for discerning biological uniqueness. Many new species are labelled "cryptic" because they have been collected repeatedly but escaped taxonomic recognition due to similarity to other species. Most of these taxa are not, however, truly cryptic. That is, in most cases, these similar species can be distinguished morphologically by characters or character suites that were not previously noticed, appreciated, or emphasized. The genus *Navarretia* (Polemoniaceae) has increased in size by ~ 25 percent over the past decade through renewed field and laboratory work including studies of both DNA and morphological variation. New *Navarretia* include examples of species simply overlooked, those that may be considered "nearly cryptic", and some that are challenging to differentiate morphologically despite strong genetic differentiation. Some new species are diploid, while others are polyploid. Allopolyploids, formed by hybridization of distinct diploid species, bring their own set of challenges in that the available morphospace for visible physical differentiation is related to the degree of physical differentiation between the progenitor species. Understanding the answers to two fundamental questions, 'what is a species?' and 'what are we trying to conserve?' is essential to working through the tension that can occur when biologically unique entities are difficult to differentiate in the field with a 10x hand lens.

1.07 The next generation of conservation genetics: Genome sequencing reveals cryptic lineages and management-relevant genetic patterns in two rare species of the southern maritime chaparral: Del Mar manzanita (Ericaceae) and Nuttall's scrub oak (Fagaceae)

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Next-generation DNA sequencing has drastically lowered the cost of genetic data, making it possible to apply genomic analyses to virtually any organism. The low cost of genomic data makes it an attractive tool for rare plant conservation, where it can be used to identify plants and quantify conservation-relevant genetic variation. Here, we present the results of a project in which next-generation DNA sequencing was applied to two rare taxa, *Arctostaphylos glandulosa* subsp. *crassifolia* (Del Mar manzanita; Ericaceae) and *Quercus dumosa* (Nuttall's Scrub Oak; Fagaceae). Both taxa form part of the southern maritime chaparral of California and northern Baja California Mexico, one of the most imperiled vegetation types in North America. Del Mar manzanita is federally listed as endangered, and Nuttall's scrub oak is considered rare. Both are difficult to identify, and may hybridize with other species, leading to difficulties for conservation efforts. We use high-throughput sequencing of restriction site associated DNA markers (RADseq) to develop single nucleotide polymorphism datasets for each taxon. Results indicate that in both groups, many populations previously considered to belong to the rare taxa are more closely related to widespread taxa. In some cases, this may be due to genetic introgression. However, our results do not suggest that introgression is widespread in either genus. Also, in both the manzanita and oak system, our research revealed cryptic lineages that do not correspond to currently recognized taxa. Our results have implications for conservation, including the use of high-throughput genetic methods to identify plants and set conservation priorities.

1.08 The cryptic conundrum: A panel discussion on the conservation of cryptic plant species in an age of increasing advancements in molecular systematics

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Modern systematists continue to use robust molecular and/or morphological data to shed light on the evolution of many California lineages. Numerous recent studies have found that when we look closer at many groups of plants, non-trivial amounts of diversity were hidden to botanists. In some cases, taxonomists have chosen to recognize this hidden, or

cryptic, diversity as taxa new to science. Following the discovery of cryptic taxa, taxonomists will ideally be able to identify traits or suites of traits so that these taxa can be differentiated by 'normal means.' In other cases, new taxa are not identifiable without molecular or morphometric analyses. To further complicate this situation, many cryptic taxa are rare and have now been ranked by the California Native Plant Society (CNPS). How do field botanists deal with the challenging task of identifying cryptic taxa? How do agencies advocate for their protection? And, furthermore, how do land managers employ measures to conserve taxa that cannot easily be identified? These questions and more need to be addressed urgently, as taxonomists use modern techniques to discover and describe California's cryptic biodiversity.

1.09 Clarifying the conservation status of northern California black walnut (*Juglans hindsii* [Juglandaceae]) using microsatellite markers

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Despite previous research, the original distribution, subsequent radiation, and genetic identity of northern California black walnut (*Juglans hindsii* [Juglandaceae]) remains a source of considerable perplexity and debate. This confusion is confounded by the perception that hybridization of *J. hindsii* offspring has occurred from both native and non-native *Juglans* species. The overarching goals of this study were to get a clearer understanding of the historic and current distribution, as well as the rate of hybridization throughout its current range. With this information, an informed decision can be made on the future conservation status of this native tree, which is currently recognized as rare by the California Native Plant Society. A primary source of concern is the fact that, despite the current widespread distribution in northern California and southern Oregon of trees that match *J. hindsii* morphologically, there are only three or four sites where the species is known to have occurred prior to European settlement of California. This has led to the suspicion that trees found in other places may not be genetically pure *J. hindsii* due to presence of the widely cultivated walnut (*J. regia*) which readily hybridizes with *J. hindsii*. The resulting morphologically identifiable 'paradox' hybrids occur spontaneously and are widely planted as rootstocks and street trees. Genetic analysis of 160 wild *Juglans* individuals from California and southern Oregon, including putative indigenous populations, showed that two-thirds of the trees sampled represent genetically pure members of *J. hindsii*. These results suggest *J. hindsii* should not be considered a rare species.

1.10 Rediscovering Baja California's lost plants

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After more than 20 years of floristic research in the Baja California region, we recently published an annotated, voucher-based checklist of the vascular plants of Baja California, Mexico. Consequently, this new publication identified several plants in Baja California that are extremely rare and only known from one to very few specimen collections. As a result, the National Geographic Society provided a grant to conduct extensive botanical research via binational collaboration throughout the Baja California peninsula in an attempt to re-discover 15 native plant species that are endemic to the Baja California peninsula and have been documented with only one historical specimen (the type specimens). This activity is planned for the duration of one year, during which time we will conduct wide-ranging field surveys at appropriate times of the year in the states of Baja California and Baja California Sur. The plants being sought are very rare endemics that are only known from the original type specimen that was used to describe each species for science. Have these plants gone extinct? No one knows for sure but it is likely that rare populations still exist in very specific localities for many of these "lost" species. It should be noted that none of the extremely rare plants are listed as endangered or threatened by the Mexican government. The reason for the deficit of conservation measures on these ultra-rare species is likely due to a lack of detailed information on their populations and possible threats.

1.11 A dozen years of rare plant discoveries on Tejon Ranch

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Tejon Ranch, the state's largest contiguous piece of privately owned land, located primarily in the Tehachapi Mountains of Kern County, has long been recognized as a black hole by botanists. Until recently, a survey of records in the California Natural Diversity Database showed that the Tehachapi Mountains Ecoregion (as defined by the Jepson Manual, 2nd Edition) had the lowest number of rare plants and lowest density of rare plant occurrences in the state. Over the past 12 years, however, we have learned that the low numbers on Tejon Ranch and the Tehachapi Mountains, in general, resulted from a lack of botanical survey work. Prior to 2006 only 14 rare plant species had been documented on Tejon Ranch. Since then, because of surveys associated with proposed development projects, and more recently made possible by the Tejon Ranch Conservancy, this number has blossomed to 51. Some of these discoveries are exciting! Botanists discovered the rare Tejon Ranch endemic, *Eriogonum callistum* (Polygonaceae), in 2006. *Caulanthus californicus* (Brassicaceae), once thought to be extirpated in the San Joaquin Valley was found in large number in the Tejon Hills in 2016 and 2017, and in 2015, a large population of *Lupinus peirsonii* (Fabaceae), a species previously thought to be endemic to the San Gabriel Mountains, was discovered on Tejon Ranch. These discoveries, and many others, are proof that shining a light on botanical black holes can yield results that are not only scientifically interesting but also important for California rare plant conservation.

1.12 Digging into our data: Rare plant hotspots in the CNPS Santa Clara Valley chapter

Elan Alford

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Where are rare plant hotspots located in the California Native Plant Society (CNPS) Santa Clara Valley Chapter counties? This mapping effort was inspired by the statewide organization's Important Plant Areas (IPAs) initiative in the 2015-2016 Conservation report, conversations with Don Mayall, and reviewing the East Bay Chapter's Guidebook to Botanical Priority Protection Areas. Armed with an array of data and free Quantum Geographic Information System (QGIS) software application, now more than ever we can generate map data to help inform us on where conservation efforts can be focused. This work is an initial analysis to help raise interest in rare plants and can aid state CNPS goals. To make the maps, I conducted density analysis of California Natural Diversity Database (CNDDB) plant point records in San Mateo and Santa Clara counties, the two counties represented by the chapter. A total of 41 hotspots were identified. San Mateo County has 17 hotspots, with 13 in the central coast subregion of the California Floristic Province and four in the San Francisco Bay subregion. Santa Clara County has 24 hotspots, with five hotspots in the central coast subregion and 19 in the San Francisco Bay subregion. I review the methods and give some caveats and critiques of the data and the resulting maps. The maps allow for drawing contrast between the two counties in the Santa Clara Valley service area. Brief summaries about the hotspots are provided and related to land conservation status as assessed by the Bay Area Greenbelt Alliance.

1.13 Approaches and methods for the quantification of soil seed banks: Overcoming seed blindness

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A plant is 'born' when a seed (dormant embryo) is produced and dispersed from the parent plant. Most dispersed seeds eventually become mixed into the soil as seed bank. Seeds mixed in soil are virtually invisible to the naked eye. Due to their invisibility, soil seed banks are a rarely monitored segment of the plant population. In many cases, however, the soil seed bank may represent the majority of the individuals in a plant population. Soil seed banks are the foundation of all plant species populations, buffering them from extirpation and extinction against unpredictable environmental conditions (e.g. drought, habitat disturbance). A plant species has either a transient (short lived; < one year) or persistent seed bank (long lived; >>one year). The specific approaches and methods used in the quantification of soil seed banks are dependent upon the specific life history and ecology of the species. This review will examine the approaches and methods to the quantification of persistent soil seed banks of several rare California endemic plant species with disparate life history and habitat characteristics. Rare plant population monitoring programs and California Rare Plant Rank (CRPR) assessments should include soil seed bank quantification, in addition to the traditional emergent plant census. Not including soil seed bank quantification in monitoring and CRPR assessment can lead to incorrect conclusions about the stability of populations and the overall rarity of a species, particularly for infrequently (erratically) emergent desert species and fire/disturbance-following species.



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1.14 Island barberry (*Berberis pinnata* subsp. *insularis* [Berberidaceae]) conservation on the northern Channel Islands, California

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Island barberry (*Berberis pinnata* ssp. *insularis* [Berberidaceae]) is an endangered shrub endemic to three of the California Channel Islands. In 2016, there were five wild individuals known only from Santa Cruz Island, along with living plants collected from Santa Cruz Island at seven California botanic gardens. Recovery Plans call for island barberry population establishment on each island where it occurred. These are the sources for reintroductions, but it was unclear which plants were represented in the gardens. Genetic studies conducted in 2016 found distinct differences among the five wild plants, but only one of them is in the living collections. Ironically, a second island barberry plant common among the botanic gardens is not one of these five wild plants. During intense searches in July 2017, we found about 14 previously unknown clusters of island barberry stems growing in dense brush in a Santa Cruz Island canyon. Upcoming genetic work will show whether one of these is that common botanic garden plant, while others may be new finds. Frustratingly, island barberry is difficult to propagate from seeds or cuttings. Wild plants are decreasing in size; taking cuttings from them increases their jeopardy. We are collaborating to better understand pollination ecology, seed development and germination requirements, genetic diversity, propagation from cuttings and tissue culture, and habitat requirements. Our intent is to use both garden and wild plants to source a genetically diverse conservation collection that can be planted on the islands for recovery in the next few years.

1.15 The paradox of Nevin's barberry, *Berberis nevinii* (Berberidaceae): Saved from extinction by its horticultural appeal?

Loraine Washburn
Rancho Santa Ana Botanic Garden, Claremont, CA, USA

Nevin's barberry, *Berberis nevinii* A. Gray, an endangered shrub in the Berberidaceae, which is endemic to southern California, has been grown in gardens for over a century, and also lives where urban and wilderness areas come into contact. Botanists have therefore long wondered whether certain small populations of *B. nevinii* were lucky survivors from formerly widespread populations, or whether they were escapes from cultivation. In a population genetic study of *B. nevinii* I sampled plants from throughout the species' distribution. Microsatellite analysis provided insight into the relationship of plants between populations, and revealed genetic diversity within a ninety-year-old outplanted population in San Francisquito Canyon in the Sierra Pelona Mountains north of Los Angeles. The San Francisquito Canyon population, derived from a now-extirpated population in the San Fernando Valley, is genetically distinct from the sizable population surrounding Vail Lake in Riverside County. However, other small populations from throughout southern California appear generally genetically similar to the original San Fernando population and do not bear distinct genetic signatures based on location - suggesting a possible horticultural or at least anthropogenic origin of many plants found in natural communities in southern California. Alternatively, a past population bottleneck may have restricted genetic diversity in the species, homogenizing microsatellite signatures. The anthropogenic origin of the San Francisquito Canyon population raises questions about how these plants should be considered in a conservation context.

1.16 Piecing together the best available information for a status assessment of *Chlorogalum purpureum* var. *reductum* (Agavaceae)

Chris Kofron, Connie Rutherford
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The abundance of federally-listed plant species and the lack of dedicated funding for plants within the federal agencies can make it challenging to do the monitoring and research necessary to assess the status of populations and the threats to those populations. The life history of *Chlorogalum purpureum* var. *reductum* (Camatta Canyon amole [Agavaceae]), a

species that occurs only on red clay soils in interior San Luis Obispo County provides an additional challenge to this effort. As a geophyte (a bulb-forming perennial), it responds more like an annual species to local climatic conditions, making it difficult to detect long-term trends. Our three-fold strategy included: 1) making the best use of historical data from California Natural Diversity Database and old surveys; 2) conducting limited new surveys based on a rapid assessment of suitable habitat; and 3) estimating population size based on a stratified density mapping approach. By piecing together fragments of information from these different perspectives, we have a much more complete understanding of the status of the species than we have had over the previous 30 years.

1.17 Habitat management mitigates climate impacts for an endangered plant

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Population-wide monitoring of the disjunct Humboldt Bay population of Menzies' wallflower (*Erysimum menziesii* [Brassicaceae]) was carried out at nine-year intervals from 1988-2015, providing a record of changes over three decades. Positive population growth is explained by a combination of available habitat allowing for dispersal into new areas, and management of occupied habitat allowing higher densities of wallflowers. Focused demographic monitoring of a subset of the population found that climate warming has the potential to limit population growth. Analysis of climate trends and population changes over three decades demonstrates that habitat management mitigates potential negative climate impacts.

1.18 Hidden Lake bluecurls, *Trichostema austromontanum* subsp. *compactum* (Lamiaceae): Conservation success for a diminutive annual

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Trichostema austromontanum subsp. *compactum* (Hidden Lake bluecurls) is an annual herb in the mint family (Lamiaceae); it was listed as threatened by the Federal Government in 1998 due to trampling and small global population size. Plants of this species are restricted to the margins of Hidden Lake in the San Jacinto Mountains, Riverside County, California and the entire known range for this taxon is an area of 0.8 hectares (two acres). The standing population (plants present versus seeds in soil) fluctuates widely from year to year depending on the amount of winter precipitation and the extent of suitable habitat along the margins of the lake. Population monitoring indicates that the standing population can range from 243,000 individuals (2012), to as few as 50 individuals (2000). Conservation actions and recovery efforts taken in the last 15 years include: 1) population monitoring and visitor monitoring at Hidden Lake, 2) new regulatory mechanism to enforce the policy of no off-trail visitation, 3) the establishment of Hidden Divide Natural Preserve within Mount San Jacinto State Wilderness 4) development of a floristic inventory of the vascular plants at Hidden Lake, 6) establishment of a multi-year ex-situ conservation seed collection at Rancho Santa Ana Botanic Garden, 7) establishment of a long term protocol for use of seeds for recovery efforts, 8) development of a conservation strategy. In 2017, based on the success of these efforts, this taxon was proposed for removal from the Federal List of Endangered and Threatened Plants.



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GRASSLANDS & PRAIRIES

California grasslands are among the most endangered ecosystems in the United States and are important subjects of ecological research and experimentation. This session focuses on native grassland research and management including invasive species, livestock grazing, and restoration within our unique California grassland/prairie ecosystems.

2.01 Updates to classification and ranking of California grasslands and prairies

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Upland herbaceous vegetation in central California, such as annual grasslands and prairies, is difficult to quantify because of the variable and ephemeral nature of this distinctive system. The vegetation exhibits shifts in species composition and cover within different seasons of the same year, across different years, and along latitudinal and longitudinal gradients. California Native Plant Society's Vegetation Program uses quantitative definitions and tools to define, map and rank vegetation across the state. We have sampled and analyzed grasslands across 5+ years to track vegetation dynamics within two California ecoregions; the Great Valley and the Central California Coast Ranges. Species composition and abundance has fluctuated widely, primarily based on variation in temperature, the timing and amount of precipitation, plus other factors such as parent material and soils. California's episodic droughts create difficulty in recognizing semi-arid native types due to a lack of germination. Overall, grasslands that we studied appear to have cyclical dynamics with patchy spatiotemporal processes, which enable the coexistence of both native and non-native plant species. Establishing definitions of grassland vegetation must be based on a combination of indicator species presence, temporal persistence, and richness with less emphasis on the dominant cover of non-diagnostic, invasive plant genera such as *Bromus*, *Avena* and *Schismus* (Poaceae). A quantitative classification and a transparent and defensible rarity ranking system will ultimately aid in the continued conservation of this imperiled ecosystem.

2.02 Grasses versus forbs: What a long term, repeat study can tell us about California's native prairie landscapes

Paul Laris, Chelsea Seymour, Chrys Rodrigue
California State University, Long Beach, Long Beach, CA, USA

Much of the foothill and valley areas of southern California are covered by stands of non-native grasses. Researchers have long hypothesized as to the original vegetation cover of these landscapes. For decades, the dominant view held that the original vegetation was native bunch grasses including *Stipa pulchra* (Poaceae). This so-called "bunchgrass hypothesis" put forth by Clements has been gradually overthrown through careful examination of historical records and critiques of Clements' methods. Today it is thought that forbs and not bunch grasses dominated some grasslands prior to European arrival. This study uses a long term, repeat study design to analyze and compare data from three surveys of 15 permanent quadrats in La Jolla Valley, California to determine changes in grassland cover over 35 years. A unique aspect of the study is that the original site was selected precisely because it contained excellent stands of *Stipa pulchra* and was conducted shortly after the area was released from grazing and placed under conservation management. We compared data on species frequency and percent cover collected using the same sampling routine for three time periods: 1979-81, 1993-95 and 2015 to document the shifts in vegetation. We found that native grass cover decreased dramatically, exotic grass cover fluctuated widely while both native and exotic forb cover increased greatly. The findings support the notion that forbs, and not bunch grasses, were historically the dominant vegetation cover in the area. The findings also suggest that grazing management practices caused the former stands of *Stipa pulchra*.

2.03 Livestock grazing as a tool for enhancing native grassland in the East Bay Regional Park District

Michele Hammond¹, Denise Defreese¹, Lech Naumovich²
¹East Bay Regional Park District, Oakland, CA, USA, ²Golden Hour Restoration Institute, Berkeley, CA, USA

Looking at ongoing experimentation and vegetation management in the East Bay Regional Park District, this talk covers examples of using targeted livestock grazing to enhance native grassland and manage special status plant species. The Serpentine Prairie Restoration Project at Redwood Regional Park uses a combination of sheep and goat herd grazing

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experimentally to increase native cover in a serpentine grassland that includes the Presidio clarkia (*Clarkia franciscana* [Onagraceae]; Federally and State endangered, CRPR 1B.1). The Santa Cruz tarplant (*Holocarpha macradenia* [Asteraceae]; Federally threatened, State endangered, CRPR 1B.1) is managed with field rotation and grazing incentives as part of a native grassland enhancement management program with year-round cattle grazing in Wildcat Canyon Regional Park. Results from the *Clarkia* project show a decrease in non-native annual grasses, an increase in annual native forb cover, and an increase in total native species richness after three years of late summer grazing. Results from the *Holocarpha* project are mixed and appear to be more weather dependent.

2.04 Livestock use has mixed effects on *Orcuttia tenuis* in northeastern California vernal pools

Kyle Merriam¹, Meredith Gosejohan², Peter Weisberg², Kirsten Bovee³

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Land managers often face the dilemma of balancing livestock use with conservation of sensitive species and ecosystems. For example, most of the remaining vernal pools in California are grazed by livestock. Vernal pools are a unique type of seasonal wetland that support many rare and endemic species, such as *Orcuttia tenuis* (Poaceae). Although there is evidence that livestock use may benefit some vernal pool specialists, grazing has been considered a threat to *Orcuttia tenuis* in northeastern California. We evaluated the effects of livestock use by comparing *Orcuttia tenuis* frequency, density, and cover in plots where livestock had been excluded with plots where grazing occurred. Livestock do not directly graze *Orcuttia tenuis*, so the effects of livestock use on this species are indirect. Year had the largest effect on *Orcuttia tenuis*, probably because of variation in annual precipitation patterns. Livestock use had no effect in some years; in other years *Orcuttia tenuis* was twice as abundant in unfenced than in fenced plots. Litter cover was also lower in unfenced plots in these years, suggesting that livestock use may benefit *Orcuttia tenuis* in some years by reducing litter accumulation. Conversely, livestock use negatively affected *Orcuttia tenuis* in pastures where livestock hoof print cover was high, including pastures that were grazed early in the season. Our results suggest that by considering environmental factors such as precipitation, site conditions, and season of grazing, land managers may be better able to balance the needs of sensitive vernal pool species with maintaining livestock utilization.

2.05 Novel fine-scale aerial mapping approach quantifies grassland weed cover dynamics and response to management

Scott Butterfield¹, Carolyn Malmstrom², Laura Planck², Christopher Long², Valerie Eviner³

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Invasive weeds threaten the biodiversity and forage productivity of grasslands worldwide. However, management of these weeds is constrained by the practical difficulty of detecting small-scale infestations across large landscapes and by limits in understanding of landscape-scale invasion dynamics, including mechanisms that enable patches to expand, contract, or remain stable. While high-end hyperspectral remote sensing systems can effectively map vegetation cover, these systems are currently too costly and limited in availability for most land managers. We demonstrate application of a more accessible and cost-effective remote sensing approach, based on simple aerial imagery, for quantifying weed cover dynamics over time. In California annual grasslands, the target species include invasive weedy grasses (*Aegilops triuncialis* [Poaceae] and *Elymus caput-medusae* [Poaceae]) and desirable forage grass species. Detecting invasion of annual grasses into an annual-dominated community is particularly challenging, but we were able to consistently characterize these two communities based on their phenological differences in peak growth and senescence using maximum likelihood supervised classification of imagery acquired twice per year (in mid- and end-of season). This approach permitted us to map weed-dominated cover at a 1-m scale (correctly detecting 93% of weed patches) and to evaluate weed cover change over time. We found that weed cover was more pervasive and persistent in management units that had no significant grazing for several years than in those that were grazed, whereas forage cover was more abundant and stable in the grazed units. This application demonstrates the power of this method for assessing fine-scale vegetation transitions across heterogeneous landscapes.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

CALIFORNIA'S CHANGING CLIMATE: TRANSLOCATION, TRANSPLANTATION, ASSISTED MIGRATION

Transplantation, translocation, and assisted migration of plant populations are often considered when restoring, recovering, and conserving plant populations, whether rare or common. The choices one makes are now further complicated by projected changes in climate and how different populations, taxa, and interacting species might be affected. The purpose of this session is to explore when there may be a need for translocation, transplantation, and assisted migration to restore, recover, and conserve plant populations, how information about projected changes in climate might alter choices, how populations may be selected and deployed in a way that reduces risk, and to identify knowledge gaps and future research needs.

3.01 Population-level genetic variation and climate change in California plant species

Kristina Schierenbeck

California State University, Chico, Chico, CA, USA

Estimated future climate scenarios can be used to predict where hotspots of endemism may occur over the next century, but species-specific traits will be important in informing the varying responses within myriad taxa. Essential to predicting the consequences of climate change to individual species will be an understanding of the factors that drive genetic structure within and among populations. I review the factors that influence the genetic structure of plant species in California. Persistence in the face of climate change is likely determined by: dispersal ability, generation time, reproductive ability, degree of habitat specialization, plant-insect interactions, existing genetic diversity and availability of habitat or migration corridors. Existing levels of genetic diversity in plant populations vary based on a number of evolutionary scenarios that include endemism, expansion since the last glacial maximum, breeding system and current range sizes. A number of well-documented examples are provided from the California Floristic Province. Some predictions can be made for the responses of plant taxa to rapid environmental changes based on geographic position, evolutionary history, existing genetic variation, and ecological amplitude. The prediction of how species will respond to climate change will require a synthesis drawing from population genetics, geography, paleontology and ecology. The important integration of the historical factors that have shaped the distribution and existing genetic structure of California's plant taxa will enable us to predict and prioritize the conservation of species and areas most likely to be impacted by rapid climate change, human disturbance and invasive species.

3.02 Climate change and open space conservation: Lessons from TBC3's researcher-land manager partnerships in the San Francisco Bay Area

David Ackerly¹, Naia Morueta-Holme⁵, Sam Veloz³, Lisa Micheli², Nicole Heller⁴

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Translating climate change projections into informed conservation action is both an immediate priority and a 'wicked' problem given the inherent uncertainties about future impacts. In 2012, we created the Terrestrial Biodiversity Climate Change Collaborative (tbc3.org), a group of researchers and conservation planners dedicated to advancing climate change science to inform open space conservation in the San Francisco Bay Area and beyond. Our work includes development of high resolution climate and watershed hydrology layers under multiple future climate projections, modeling potential impacts on vegetation distributions, and evaluating the robustness of regional conservation priorities in relation to current and future climatic diversity. We strive to enhance understanding of how to appropriately apply climate change projections, co-produce applied tools for land and water managers, incorporate managers' feedback into long-term research priorities, and promote meaningful exchanges capable of generating new approaches to conservation in the face of inevitable rapid change in ecosystems. In a recent workshop, we engaged land managers in three narrative scenarios for climate change impacts on vegetation: extreme drought, catastrophic fire, and increased rainfall. Collectively, researchers and managers evaluated a range of strategies to promote specific management objectives-e.g., biodiversity conservation, reduced catastrophic fire risk-under different scenarios. Participants spoke to the value of



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

having researchers help reframe "how to think about the problem" in a meaningful regional context, rather than dictating specific management recommendations. By incorporating managers' local knowledge, this approach empowers informed yet flexible site-specific solutions, while avoiding the pitfalls of overgeneralization in the face of uncertainty.

3.03 Fire management, managed relocation, and land conservation options for long-lived obligate seeding plants under global changes in climate, urbanization, and fire regime

Helen Regan¹, Timothy Bonebrake², Alexandra Syphard³, Janet Franklin¹, Kurt Anderson¹, Akcakaya H. Resit⁴, Toni Mizerek¹, Clark Winchell⁵

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Few studies have quantified the potential value of multiple conservation interventions in light of multiple threats. We linked spatial distribution and population models to explore conservation interventions under projected climate change, urbanization, and changes in fire regime on a long-lived obligate seeding plant species, a dominant plant functional type in many fire-prone ecosystems, including the biodiversity hotspots of Mediterranean-type ecosystems. First, we investigated the relative risk of population decline for plant populations in landscapes with and without land protection under an existing habitat conservation plan. Second, we modeled the effectiveness of relocating seedlings and seeds from a large patch with predicted declines in habitat area to two unoccupied recipient patches with increasing habitat area under two projected climate change scenarios. Finally, we modeled eight fire return intervals (FRIs) approximating the outcomes of different management strategies that control fire frequency. Invariably, long-lived obligate seeding populations remained viable only when FRIs were maintained at or above a minimum level. Land conservation and seedling relocation efforts lessened the impact of climate change and land-use change on obligate seeding populations to differing degrees depending on the climate change scenario, but neither of these efforts was as generally effective as frequent translocation of seeds. While none of the modeled strategies fully compensated for the effects of land-use and climate change, an integrative approach managing multiple threats may diminish population declines for species in complex landscapes. Conservation plans designed to mitigate the impacts of a single threat are likely to fail if additional threats are ignored.

3.04 A decision tree for determining whether to re-introduce extirpated plants

John Randall¹, John Knapp¹, Kathryn McEachern²

¹The Nature Conservancy, California Chapter, San Francisco, CA, USA, ²United States Geological Survey, Western Ecological Research Center, Ventura, CA, USA

At least twelve taxa of native plants are presumed to have been extirpated from Santa Cruz Island (voucher specimens document past occurrences, but no detections in recent decades) and we faced questions about whether to re-introduce them. Finding inadequate guidance in the literature, we created a decision tree and are now using it to inform decisions about re-introductions proposed on the northern Channel Islands. The tree includes fourteen steps. Step 1 addresses the timespan under consideration, steps 2 and 3 the evidence the taxon in question was once present, steps 4 - 7 the evidence that it was extirpated, steps 8 and 9 whether threats deemed responsible for the extirpation have been abated, and steps 10-12 cover the suitability of prospective re-introduction sites. Step 13 requires evaluation of potential benefits and costs of a re-introduction, and step 14 of appropriate donor populations. To date, we have used the tree to evaluate proposed re-introductions for six extirpations (taxa x island). We have taken another nine extirpations part-way though the tree and are gathering data necessary to complete remaining steps. We are now moving ahead with initial actions necessary to re-introduce one island-endemic taxon to two islands (total of two extirpations). The decision tree can be used for plants on mainland sites or other islands, and slight modifications will make it suitable for animal taxa. In addition, it may require few modifications to be useful for decisions about translocating taxa beyond their native ranges, decisions many will face as the climate changes.

3.05 California's multiyear drought predisposed a deep-rooted chaparral species to fungal-induced mortality: Hydraulic mechanisms and future prognosis

Natalie Aguirre¹, Marissa Ochoa², Guinevere Mesh³, Cristian Garcia¹, Helen Holmlund⁴, Stephen Davis¹

¹Pepperdine University, Malibu, CA, USA, ²Whittier College, Whittier, CA, USA, ³Swarthmore College, Swarthmore, PA, USA, ⁴University of California, Santa Cruz, Santa Cruz, CA, USA

Between 2012-2016, southern California experienced extreme drought that predisposed a keystone shrub species in coastal chaparral (*Malosma laurina* [Anacardiaceae]) to fungal-induced dieback. Whole-plant mortality exceeded 50% at some sites. We hypothesized that the mechanism of mortality was a naturally occurring endophytic fungus (*Botryosphaeria dothidea* [Botryosphaeriaceae]) that invaded xylem and phloem tissue, greatly reducing water and sugar transport, leading to protracted water stress and carbon starvation. We tested these possibilities in controlled pot experiments that compared irrigated controls inoculated with the fungus to inoculated non-irrigated plants and inoculated carbon-starved plants. Fungal elongation rates in pot experiments were over two fold greater in water stressed plants than irrigated controls, leading to increased incidence of whole branch dieback. Carbon starved plants showed an intermediate pattern relative to controls. Gas-exchange data indicated that potted plants undergoing water stress also experience significant carbon starvation, due to stomatal closure and reduced quantum yield of photosystem II. Minimum water potentials at the time of whole plant death and vulnerability to water stress-induced embolism of xylem conduits indicated that the host plant, *M. laurina*, could not survive water potentials more negative than -4 MPa, whereas fungal elongation continues well below -4 MPa. Taken together, these results were consistent with field observations of fungal blockage in water transport of xylem leading to branch dieback and eventual whole plant mortality. Our results are also consistent with the hypothesis that both water stress and carbon starvation contribute to mortality, facilitated by the dehydration tolerance of the fungal pathogen.

3.06 Population decline and microsatellite diversity of the endangered annual *Streptanthus glandulosus* subsp. *niger* (Brassicaceae)

Sarah Swope, Brittany Burnett, Hannah Horten, Hannah Lu-Way
Mills College, Oakland, CA, USA

Consecutive droughts such as that experienced in California (2011 - 2016) can have devastating effects on plant populations. Drought may not only lead to population decline but also a loss of genetic diversity. Species that are found in small, isolated populations, are self-compatible, and have poor dispersal abilities ought to be especially vulnerable to an erosion of genetic diversity. Using periodic matrix models I have documented a steep decline in population growth rate in the endangered plant *Streptanthus glandulosus* subsp. *niger* (Brassicaceae). The annual population growth rate has varied from 0.21 - 5.5 in the last three years with a 3-year mean of 0.80. Using seven microsatellites I have found low within population genetic diversity ($A_r = 2.2 - 3.4$) and differentiation between the two extant populations with strong genetic structure ($F_{st} = 0.405$), indicative of isolation by distance due to a lack of gene flow. It is occasionally hoped or assumed that a large seed bank will provide demographic or genetic rescue. I have found no evidence of a seed bank large enough to provide either. Droughts in California are characterized by heavy rainfall in the fall, which triggers germination of seeds, but drought through the winter and spring, leads to low seedling survival. This can deplete the seed bank, leaving the population more sensitive to variation in rainfall. We are currently testing whether a lack of genetic diversity may be contributing to population decline and whether admixture between the populations could restore genetic diversity and reverse the decline.

3.07 Incorporating intraspecific variation in plant trait and arthropod community responses to environmental change into restoration planning

Jessica Pratt, Jordan Croy, Daniel Sheng, Maria Meza-Lopez, Kailen Mooney
University of California, Irvine, Irvine, CA, USA

Local adaptation and plasticity pose significant obstacles to predicting plant responses to environmental change. Climatic gradients may select for clinal adaptation in plants with implications for interactions with herbivores and response to climate change. We examined variation in plant traits, performance, and arthropod communities for the shrub *Artemisia californica* (Asteraceae) in a series of common garden studies with plants collected from along a 700km gradient in California. In two studies we examined intraspecific variation in plant and arthropod responses to manipulations of precipitation and nitrogen. An additional study with 20 populations examined clinal variation in plant growth and associated arthropods with respect to the abiotic conditions characterizing population source sites. We collected whole arthropod communities from experimental plants to assess the consequences of intraspecific variation and responses to environmental change for plant-herbivore interactions. We found that most traits varying among populations did so clinally. Notably, variation in plasticity for plant performance (plant growth, flowering) was strongly correlated with intra- and interannual variation in precipitation at population source sites, suggesting this is a key selective factor driving clinal adaptation. We found clinal population variation in arthropod density but not species richness, with plants from the north

hosting higher densities, a pattern mirrored in our collections from wild plants. In conclusion, precipitation environment can be a strong selective force for functional traits, resistance to herbivory, and plasticity in response to altered precipitation. Therefore, we predict that response to future climate change will vary along the species range, with larger effects on northern populations.

3.08 Using provenance studies to develop guidelines for resource management and restoration plans: Valley oak as a case study

Victoria L. Sork¹, Brandon MacDonald¹, Jessica Wright²

¹University of California, Los Angeles, Los Angeles, CA, USA, ²United States Forest Service, Pacific Southwest Experimental Station, Davis, CA, USA

Oak species represent a critical component of California ecosystems. Because their ability to respond to change climate will influence the fate of many ecosystems, forest management and restoration projects may need to consider assisted migration of seed sources to optimize adult survival under future climate conditions. Traditional provenance studies, which are comprised of individuals with seed sources collected from throughout the species range and grown in one or more gardens, provide valuable data on the genetic basis of phenotypic differences across provenances (e.g., source populations). In this talk, we will present findings of a large-scale provenance study of range-wide populations of valley oak (*Quercus lobata* [Fagaceae]), a keystone tree oak of California that is already in jeopardy due to landscape transformation. In 2011, we collected over 11,000 acorns that were germinated in greenhouses and eventually planted into two common gardens using progeny from 5-8 families per 95 provenances. Measurements of 6-year-old plants taken within each garden in Fall 2016 revealed differences in family growth rates among provenances and genetic differences in family leaf traits across provenances. In particular, we found a genetic basis for leaf traits, such as leaf thickness and trichome density, which are related to response to drought. Using these data, we explore different strategies that could be employed for management practices. We will also present a set of questions that could be considered before translating findings from provenance studies into resource management and restoration plans that may benefit from assisted migration.

3.09 Ecological and evolutionary impacts of water availability on pollination: Lessons for translocation of species

Wilnelia Recart, Diane Campbell

University of California, Irvine, Irvine, CA, USA

Pollination is a crucial process in the persistence of most plant populations. Any effects that climate has on the pollination of a native plant will likely have implications for strategies used in translocation, transplantation and assisted migration. Pollination can be influenced by changes to water availability and invasive species, both of which are expected to be altered under climate change. We studied the effects that changes to water availability and the invasive plant, *Brassica nigra* (Brassicaceae) have on the pollination of the native California plant, *Phacelia parryi* (Boraginaceae). We measured pollinator visitation and seed production for *Phacelia* individuals exposed to two different water treatments, in both the presence and absence of *Brassica*. Increasing water availability led to larger flowers and higher seed production. Although we did not detect treatment effects on average pollinator visitation, other experiments with this system have shown impacts of *Brassica* on visitation. Furthermore, the treatments did change natural selection on some floral traits. Pollinators preferred plants with higher nectar production only when plants received low levels of water and no invasive *Brassica* was present. Our research shows that the effects of drought will likely influence seed production but can also influence selection on floral traits. Thus, while translocating plants to a wetter region might ameliorate detrimental impacts of climate change on average seed production, it could also have unintended effects on pollination and floral evolution.

3.10 Tools for seed sourcing decisions in a changing world: Using species distribution models with climate change projections and species traits to help inform restoration of southern California shrublands

Arlee Montalvo¹, Erin Riordan², Jan Beyers³

¹Riverside-Corona Resource Conservation District, Riverside, CA, USA, ²University of California, Los Angeles, Los Angeles, CA, USA, ³United States Forest Service, Pacific Southwest Research Station, Riverside, CA, USA



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

In ecological restoration, practitioners strive to give restored communities their best shot at long-term success in part by using plant material from appropriately adapted populations. Decision tree formats for sourcing native plants consider information about a species' geographic distribution, pattern and scale of genetic differences, dispersability, habitat connectivity, potential for adaptive evolution, and risk of maladaptation upon translocation. Understanding the planting site, its fragmentation history, and traits of plants appropriate for the site are important to navigating decision trees designed to minimize risks of translocation. Available decision frameworks now include pathways to evaluate if assisted migration, with its associated risks, should be considered to mitigate for habitat fragmentation and geographic shifts in expected future habitat suitability. Species distribution models (SDMs) can be used with future climate scenarios to provide estimates of climate exposure, measured in terms of projected change in suitable habitat. We explored geographic patterns of habitat suitability under baseline (1951-1980) climate and five mid-century (2040-2069) future climate scenarios, for 36 common taxa from coastal sage scrub, alluvial scrub, and chaparral plant communities of southern California, identifying areas of projected habitat stability, loss, and gain for each. The results are being paired with ecological and genetic information on each taxon - such as habitat heterogeneity, fragmentation, and variety of natural barriers, life-history, mating system, and dispersal mechanisms - and collected into plant profiles. These species profiles provide land managers with the type of information needed to navigate modern decision tree frameworks designed to guide seed transfer decisions.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

MANAGING LANDS FOR NATIVE PLANT CONSERVATION

Whether mandated by law, required by regulatory oversight, or simply done at the request of a private landowner, effective native plant conservation emerges from a common set of well-designed land management practices. This session presents examples of California plant conservation on federal, state, and local public lands; and on private lands. These examples both clarify the differences among laws and regulations pertaining to different land ownership categories, and highlight underlying themes common to successful land management in all.

4.01 Just when you think you have those rare plants protected...

Ileene Anderson, Aruna Prabhala, John Buse, John Rose
Center for Biological Diversity, Los Angeles, CA, USA

Dedicated native plant conservationists spend copious amounts of time working tirelessly to conserve rare plant populations that often yield strong results through carefully crafted land use plans, Habitat Conservation Plans (HCP) and Natural Communities Conservation Plans (NCCP). But over time, even with constant vigilance, these carefully crafted plans end up being changed, are not appropriately applied, or not even enforced, which ends up decreasing hard-won conservation efforts for critically endangered plants. Tragically these types of sagas are not uncommon in southern California. The Carbonate Habitat Management Strategy was adopted by the San Bernardino's National Forest in 2006 to safeguard the suite of carbonate endemic plants found only on the north-facing slopes of the San Bernardino Mountains, but in 2016, the Forest Service proposed a mine expansion into the Habitat Reserve. The California Department of Fish and Wildlife's San Jacinto Wildlife Area is a "core" conservation area for a suite of rare alkali floodplain dependent plants, yet the State bulldozed habitat for these rare plants when redoing their duck ponds. Lastly, Riverside County did a land swap of a conserved San Diego ambrosia population under the Western Riverside MSHCP/NCCP, with the promise that transplantation would be paid for with conservation funds from the HCP/NCCP. The failure of responsible agencies to implement the adopted required conservation obligates rare plant enthusiasts' constant vigilance. Early notification of non-compliance can result in subsequent adherence to the conservation requirements, but legal action can be required to force compliance.

4.02 The San Francisco Public Utilities Commission's response to introduced plant pathogens (*Phytophthora* spp.) in large scale restoration sites

Mia Ingolia, Jessica Appel, Greg Lyman, Ellen Natesan
San Francisco Public Utilities Commission, San Francisco, CA, USA

The San Francisco Public Utilities Commission (SFPUC) watershed lands primarily support water collection, storage, and maintenance of water quality for its customers in the Bay Area. To compensate for unavoidable impacts associated with critical water infrastructure capital improvement projects, the SFPUC restored over 2,000 acres of riparian, wetland, and upland habitat on watershed lands in Alameda, Santa Clara, and San Mateo counties. Despite having strict bio-sanitation protocols in place, plant pathogens (*Phytophthora* spp.) were introduced at multiple habitat restoration sites. Many of these introduced plant pathogens have wide host ranges, and concerns over the pathogens' potential destabilizing effects have led to a comprehensive *Phytophthora* sampling, monitoring, research, and management program within the sites and across the watersheds. SFPUC has made numerous changes to their restoration specifications based on the adoption of new practices that minimize the risk of *Phytophthora* introduction, and currently serves as an active member of the Phytophthoras in Native Habitats Work Group, a voluntary coalition of California native plant nursery managers, land management agencies, researchers, and non-profit organizations whose primary purpose is to coordinate a comprehensive program to minimize the spread of *Phytophthora* pathogens. Through a research partnership with the USDA Forest Service Research and Development, the SFPUC is exploring multiple in-situ treatment techniques including soil solarization, soil steam injection, dog detection, and soil amendments to contain and treat plant pathogens in these large-scale restoration sites.

4.03 The impacts of mountain biking on plants - a review of the literature

Mike Vandeman
None, Berkeley, CA, USA



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

Mountain biking is expanding rapidly, putting intense pressure on wildlife habitat, worldwide, as well as inhibiting efforts to protect additional lands. It is important, therefore, to assess its impacts on plants and habitat. I reviewed all the available studies to date. All of the studies on mountain biking that attempt to compare the impacts of hiking and mountain biking (which address primarily erosion) conclude that their impacts are essentially the same. However, their research designs all have serious flaws: they ignore speed and distance travelled, and nearly all ignore impacts on plants; they also make no attempt to test mountain biking under realistic conditions (e.g. normal speeds). A more accurate conclusion from the data presented would be that the impacts of mountain biking are actually from two to six times those of hiking, due in part to the greater speed and distance travelled by mountain bikers.

4.04 Improving land management through native plant conservation

Frazier Haney, Madena Asbell, Peter Satin
Mojave Desert Land Trust, Joshua Tree, CA, USA

The Mojave Desert Land Trust (MDLT) has been acquiring and managing land throughout the Mojave Desert for over 10 years, protecting over 68,000 acres to date. Typical stewardship activities include preventing destructive incursions, conducting site clean-ups, and implementing passive restoration practices such as vertical mulching to promote native revegetation. In 2016, MDLT established a native plant restoration nursery and conservation seed bank to increase its conservation and restoration efforts. In order to make restoration plans as site-specific as possible, management activities now include collecting and storing native seed, collecting environmental data for spatial analyses, and documenting the location of both non-native and rare, threatened, or endangered native plant species. Since implementing these practices, MDLT staff and trained volunteers have identified several rare plant species on their properties, including a previously undocumented population of white-margined beardtongue (*Penstemon albomarginatus* [Plantaginaceae]), and have added records to the California Natural Diversity Database. MDLT restored hundreds of acres of degraded sites and is currently devising plans for two major revegetation projects, a former aggregate mine and an abandoned agricultural property. Both of these were previously beyond the abilities of MDLT to properly restore, prior expansion of the nursery and seed bank programs. In addition to restoration, the establishment of a conservation seed bank serves as an ex-situ conservation tool, that will continue to support post-disturbance re-seeding efforts in the face of future disturbances. These activities demonstrate the role land trusts can play in managing, monitoring, and restoring large scale landscapes.

4.05 Living in simpler times: Extirpated and locally rare plants around Mt. Tamalpais, Marin County

Andrea Williams
Marin Municipal Water District, Corte Madera, CA, USA

Plants can be rare for a variety of reasons, and their extinction or extirpation (local or regional population loss) can be cryptic and difficult to point to causal agents. The "Likely Extirpated" list for a defined area around Mt. Tamalpais was compiled from comparing notes in the Marin Flora and herbarium specimens to recent observations. Climate change, loss of native grassland habitat, changes in fire regimes, and invasion by non-native species may all be driving species locally extinct. Having few populations to begin with is a strong risk factor, so the "Locally Rare" list can serve as an important watch list and conservation tool. Reintroducing or mimicking natural disturbance processes, removing invasive species, and searching for populations of plants on both lists are all actions we can take.

4.06 San Diego County regional rare plant management and monitoring program

Kristine Preston¹, Jessie Vinje², Patricia Gordon-Reedy², Emily Perkins¹, Spring Strahm², Sara Allen³, Betsy Miller⁴
¹United States Geological Survey Western Ecological Research Center, San Diego, CA, USA, ²Conservation Biology Institute, San Diego, CA, USA, ³AECOM, San Diego, CA, USA, ⁴City of San Diego

The San Diego Management and Monitoring Program (SDMMP) coordinates a regional monitoring and management program for 57 rare plant species in western San Diego County, using *The Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County* to specify monitoring and management goals and objectives. SDMMP depends on collaboration among scientists, conservation practitioners, land owners, and personnel from local, state, and federal government agencies, non-profit organizations, volunteer groups, and environmental firms. Objectives of the SDMMP include monitoring 30 high priority species on over 300 occurrences at 1-, 2-, or 5-year intervals using a

standardized protocol to assess status, habitat and threats, while 22 other species are monitored less frequently or with a different protocol. Monitoring data are used by land managers to identify and prioritize management needs and inform selection of projects for regional funding. SDMMMP research objectives include: genetic studies, testing best management practices, soil and habitat studies, and habitat modelling under changing environmental conditions. Research and monitoring data inform development of seed collection and management plans to enhance, restore, and establish new occurrences for greater resiliency and long-term persistence. A rare plant management group is being created to help inform management strategies and practices and facilitate communication among scientists and land managers. Examples of different program components are illustrated using three federal and state-listed endemic plant species: *Acanthomintha ilicifolia* (Lamiaceae), *Baccharis vanessae* (Asteraceae) and *Deinandra conjugens* (Asteraceae). This collaborative approach is essential for the successful regional management San Diego County's many rare plant species.

4.07 Inspect and manage: A regional and collaborative approach to monitoring rare plant species in San Diego County

Jessie Vinje¹, Patricia Gordon-Reedy¹, Spring Strahm¹, Sara Allen², Emily Perkins³, Kristine Preston³

¹Conservation Biology Institute, San Diego, CA, USA, ²AECOM, San Diego, CA, USA, ³United States Geological Survey, San Diego, CA, USA

In 2016, the Conservation Biology Institute (CBI) and AECOM coordinated and implemented the San Diego Management and Monitoring Program (SDMMP) Management Strategic Plan (MSP) Inspect and Manage (IMG) regional rare plant monitoring protocol for 24 rare plant species on conserved lands in western San Diego County. SDMMMP, in collaboration with the City of San Diego, CBI, and The Nature Conservancy, developed the threats-based monitoring protocol based on existing rare plant and habitat assessment protocols. The 2016 monitoring effort involved 37 entities, including federal and state wildlife agencies, local jurisdictions, non-profit land conservancies, private landowners, and volunteer organizations. We trained agency staff and volunteers through workshops and site visits, assisted land managers with monitoring, and monitored 'orphan' populations (populations that ...provide an explanation). A total of 219 rare plant occurrences were monitored in 2016. For each occurrence, we collected data on species status, habitat attributes, and threats. Data indicated that 10 species had an average of 1,000 or more plants per occurrence and 14 species had an average of less than 1,000 plants per occurrence. Non-native grasses and forbs were the most common threat to rare plants; other threats included fire, dumping, trampling, itinerant encampments, vandalism, historic agriculture and grazing, altered hydrology, and soil disturbance. Management recommendations included site protection, weed treatments/management, erosion control, and pollinator studies. Monitoring as many occurrences of a species within the same year using the same method improved our understanding of species status, threats, and management priorities. High priority occurrences will be eligible for regional management funding.

4.08 Conservation efforts in northwest Baja California

Jim Riley, Sula Vanderplank, Jorge Simancas

Jardín Botánico San Quintín, AC, San Quintín, Baja California, Mexico

Associates of Jardín Botánico San Quintín, AC will describe the natural resources of the Vernal Pool Nature Reserve, Medina Complex and other natural reserves in the southern California Floristic Province. The Medina Complex has vast populations of three listed species under the Federal Endangered Species Act: *Navarretia fossalis* (Polemoniaceae), *Eryngium aristulatum* var. *parishii* (Apiaceae), and *Orcuttia californica* (Poaceae). Perhaps more significantly, the Complex is home to the largest population of the Colonel Mesa and vernal pool endemic, *Centromadia perennis* (Asteraceae). The fairy, clam, and tadpole shrimp populations are staggering. The pools are an essential breeding ground to the Baja California Treefrog and Western Spadefoot Toad, and much more. The maritime succulent scrub and proposed maritime succulent scrub reserves have a similarly rich natural history. Following a discussion of our reserves, we will discuss the following conservation challenges in Northwest Baja California: 1) rapid loss of coastal habitat; 2) title issues in Baja; 3) protecting reserves from poachers and illegal grazing; 4) identifying sensitive and at risk habitats; 5) engaging the local communities; 6) federal and state government protection designations UMA, ANP, and others; and 7) alternative strategies—opportunities for landowner voluntary participation with discussion of BerryVeg's protection of vernal pools on agricultural land under our management agreement.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

4.09 Botanical discoveries inform riparian conservation in southern California

Sophie Parker¹, Naomi Fraga²

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The Santa Clara River in Ventura County is southern California's last non-channelized and least ecologically disturbed major river system, and its watershed encompasses an area of great botanical richness. Because the watershed's habitats are increasingly threatened by land use conversion and hydrological modifications, The Nature Conservancy (TNC) works to protect intact lands and enhance riparian biodiversity through restoration projects. The pace, scale, and funding for this work have been improved by prioritizing conservation and restoration activities within areas designated as high priority "conservation nodes." This approach guides the TNC's land acquisition and riparian restoration activities. Over 18 years, TNC has acquired nearly 4,000 acres in fee and easements constituting about 20 river miles and large-scale restoration underway. As restoration proceeded, the Rancho Santa Ana Botanic Garden began to botanize protected lands and map vegetation along the river. Prior to the initiation of their plant surveys in 2015, many locales had no existing botanical records. Working on TNC-owned property, RSABG documented a surprisingly rich flora that includes 676 plant taxa, 23 records new to Ventura County, and over 30 previously undocumented rare plant populations. These findings increase our understanding of the flora of the Santa Clara River in the context of other southern California riparian systems, and they provide specific locations for populations of rare plants, as well as previously-unrecorded non-native species. TNC is using this information to inform stewardship and restoration decisions, and to update parcel prioritization for conservation acquisitions along the Santa Clara River.

4.10 Preliminary results of an adaptive management experiment for many-stemmed dudleya (*Dudleya multicaulis* [Crassulaceae]), Rancho Mission Viejo, Orange County, CA

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Rancho Mission Viejo has conducted a two-year adaptive management pilot study to test the effectiveness of management activities on many-stemmed dudleya (*Dudleya multicaulis* [Crassulaceae]). Fifty, 1 m² test plots were established and divided into control and treatment plots to evaluate the effects of removal of non-native grasses and forbs on extant many-stemmed dudleya populations. The fifty plots were divided into five treatments with ten replicates in each: Control 1 (non-native grasses and forbs not present), Control 2 (non-native grasses and forbs present), Treatment 1 (removal of non-native grasses), Treatment 2, (removal of non-native forbs), and Treatment 3 (removal of both non-native grasses and forbs). Variables measured within each plot included the number of many-stemmed dudleya seedlings (cotyledons only), the number of vegetative dudleyas, the number of flowering dudleyas, cover by non-native grasses, cover by non-native forbs, cover by native grasses, cover by native forbs, cover by native shrubs, cover of cryptogamic crust, and use of many-stemmed dudleya by nurse plants. Following two years of data collection, results show that removal of non-native grasses significantly benefits many-stemmed dudleya, as does removal of non-native grasses and forbs combined. Removal of non-native forbs did not result in statistically significant benefits to many-stemmed dudleya. Based on the results of this two-year pilot study, these adaptive management techniques should continue to be evaluated.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

RESTORATION

Restoration is one of the most meaningful ways to assess our understanding of flora and its associated ecology. Presentations in this session will share techniques, research, implementation strategies, successes, and failures around flora-focused restoration. Topics likely include planning for resiliency, novel technologies and insights into restoration implementation, soil-plant interactions in restoration, ecological trajectories and succession, establishing meaningful success criteria, restoration and agency permitting strategies, philosophy, and restoration in a world of soil pathogens.

5.01 Using locally-sourced species in field-based seed production for regional restoration projects

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California native species can be found growing in a wide range of habitats throughout the state, e.g. *Baccharis pilularis* (Asteraceae), *Stipa pulchra* (Poaceae), while other species are found growing in a single habitat, e.g., *Arctostaphylos sp.* (Ericaceae), *Malacothamnus sp.* (Malvaceae). Morphologic and molecular data show that individuals selected at different locations within a range can vary significantly, and although abundant within that range, they can be genetically unique. In addressing the use of locally-sourced vegetation in specific restoration work, the option to obtain high quality material, drawn on local, distinct populations, composed of multiple individuals is essential. This is especially important when much of the seed used in California restoration lacks adequate documentation and/or a diverse genetic basis. Using an agronomic approach and locally hand-collected species from known locations, twelve species commonly employed in restoration projects in San Luis Obispo County were sampled and grown using high-density plantings at Nipomo, CA in 2016-2017. Results indicate that such an approach works well despite the variable nature of these species. When grown in closely-spaced field populations, high quality seed in ample quantities was obtained.

5.02 Restoring Mojave Desert native plant communities through implementation of the National Seed Strategy.

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Increasing large-scale wildfires, along with expanding renewable energy development, continue to negatively impact large acreages of native plant habitat across the Mojave Desert Ecoregion. Through implementation of the National Seed Strategy for Rehabilitation and Restoration 2015-2020, the Mojave Desert Native Plant Program (MDNPP) is coordinating interagency efforts to prioritize restoration species, increase availability of Mojave Desert native plant materials, and improve success of restoration projects. Multi-faceted research supporting native plant restoration is underway to: 1) develop empiric seed transfer zones based on genetic analysis and common garden tests, 2) develop restoration decision-making tools for land managers, 3) develop seeding strategies to circumvent granivory on restoration sites, 4) develop Mojave Desert germplasm releases and species-specific growing techniques of use to commercial growers, and 5) support increased container stock production capability for the Mojave Desert Ecoregion. A major emphasis of the MDNPP is restoration of habitat for the federally threatened Mojave desert tortoise (*Gopherus agassizii* [Testudinidae]). Desert tortoise habitat has been heavily impacted by wildfires and subsequent annual brome infestations, and priority restoration species include those important for desert tortoise forage and cover. Additionally, the MDNPP is prioritizing restoration of pollinator habitat by including plant species of benefit to pollinators.

5.03 Establishing a native seed bank in an urban center: The LA Regional Native Seed Bank

Genevieve Arnold¹, Cheryl Birker², Marty Dumpis³, Naomi Fraga², Cris Sarabia⁴, Kat Superfisky⁵, Aaron Thomas⁶, Marcos Trinidad⁷, Justin Yee⁸

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TECHNICAL PRESENTATION ABSTRACTS BY SESSION

The LA Regional Native Seed Bank was established to increase the availability of genetically appropriate native seed in the Greater Los Angeles Area with a goal to protect and enhance the ecological health of plant communities and sustain resilient ecosystems. With over nine million people, Los Angeles County is the most populous county in the United States, and the Greater Los Angeles Area is the second-largest metropolitan region in the United States. Urbanization and habitat fragmentation are major causes of biodiversity loss, and continued urban expansion in an already considerably urbanized region provides significant challenges to habitat restoration. Urban greening efforts that will steward and protect the precious and threatened biodiversity of Greater Los Angeles (e.g. the LA River) are underway, and the LA Regional Seed Bank will be a critical component of these initiatives. Improving open spaces in urban areas is critical to supporting wildlife, opportunities for recreation, clean air, carbon sequestration, and local water supplies, making habitat restoration imperative to the health and well-being of the Greater Los Angeles Area. Locally-sourced seed is urgently needed to address this demand by providing material that is essential to grow plants that are well adapted and historically present within our watersheds. Securing locally adapted and genetically appropriate native seed will support relationships with wildlife populations, contribute to a healthy environment for residents, and connect our local community with nature. In this presentation The LA Regional Native Seed Bank will provide an overview of our challenges, goals, and our accomplishments thus far.

5.04 The influence of seed sourcing on the establishment and growth of *Stipa pulchra* (Poaceae) during an extreme drought

Madeline Nolan, Carla D'Antonio
University of California, Santa Barbara, Santa Barbara, CA, USA

Perennial bunchgrasses, such as purple needle grass (*Stipa pulchra* [Poaceae]), were likely an important source of structure in native California grasslands. Yet today, many grasslands are now dominated by exotic annuals and restoration to native grasses is challenging. Current restoration projects emphasize the use of locally sourced plant material, but this practice is criticized for not considering how climate change will impact this practice. For example, drought tolerance of *S. pulchra* populations could be important for restoration planning because drought is expected to become more common in California in the future. Because populations of *S. pulchra* adapt to local variation in water availability, we hypothesize that using seeds from a variety of local populations may be important to establishment success. We addressed this hypothesis through a field-based experiment. We had two seed source treatments, a local treatment sourced from two populations adjacent to the restoration site and a mixed treatment sourced from six local populations that occurred within 2km of the restoration site. These two population treatments were then crossed with a watering treatment to understand how a long-term drought would affect restoration success. We found that in ambient and drought conditions, the mixed treatment produced more biomass and seeds than the local populations over the first growing season. Additionally, when compared to the ambient watering treatment, populations in the mixed treatment had a smaller decrease in biomass and seed production. This study suggests that small differences in seed sources can influence the establishment and persistence of *S. pulchra* restoration projects.

5.05 Why are wildland plant pathologists fixated on native container stock: The threats to California's vegetation from *Phytophthora* (Pythiaceae)

Susan Frankel¹, Diana Benner², Alisa Shor³, Janice Alexander⁴, Tyler Bourret⁵, David Rizzo⁵, Matteo Garbelotto⁶, Tedmund Swiecki⁷, Elizabeth Bernhardt⁷

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Why are forest pathologists eager to talk with plant lovers about diseased and dying plants? Over the past few years, two of the top five most feared, *Phytophthora* (Pythiaceae) species have been recovered from restoration plantings in California. Detections of *P. tentaculata* on sticky monkey flower (*Diplacus aurantiacus* [Phrymaceae]) in 2012, followed by the discovery of *P. quercina* on *Quercus lobata* (valley oak, Fagaceae) in 2015, have been accompanied by discoveries of several new, or new hybrid *Phytophthora* taxa with only provisional names, since they have never been detected before (i.e. *Phytophthora* taxon mugwort, and *Phytophthora* taxon *Juncus*). There is no way to precisely define the risk to wild vegetation that all these *Phytophthora* introductions pose. However, the establishment of *P. ramorum* from nursery stock, which was first recognized in the mid-1990s, resulted in the loss of millions of *Quercus agrifolia*, (coast live oak,

Fagaceae) and *Notholithocarpus desiflorus* (tanoak, Fagaceae) and irreversibly altered California coastal landscapes. Nursery stock movement is the highest risk pathway for invasive pathogen introduction; to protect our wildlands we need to recognize and prevent the potential environmental damage to sensitive habitats posed by *Phytophthora* taxa and other plant pathogens. A cultural shift is needed to address the risks these pathogens pose. Tolerance for their presence on native plant nursery stock threatens the resources that restoration plantings aim to protect. We must work collaboratively to protect the native plant resources that we all value and unite us at this conference.

5.06 Guidelines to reduce the risk of *Phytophthora* (Pythiaceae) introductions and *Phytophthora*-induced mitigation failure in restoration projects

Julie Garren¹, Charles McClain², Janell Hillman³, Cindy Roessler⁴, Susan J. Frankel⁵

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Phytophthoras (Pythiaceae) (a.k.a. "plant destroyers") are pathogens responsible for the Irish potato famine (*Phytophthora infestans*) sudden oak death (*P. ramorum*). Between 2014 and 2016, well over 50 *Phytophthora* taxa were identified in native plant nurseries and restoration sites, including taxa new to the USA, new hybrid species, and new taxa still being described. The incidence and number of new taxa detected raises concerns about outplanting of nursery stock because the plants can serve as an introduction pathway of *Phytophthora* into wildlands. The inadvertent spread of *Phytophthora* species into natural ecosystems threatens environmental, social and economic resources of the restoration site and adjacent wildlands. Once an area is contaminated, it is difficult to eradicate the pathogen and restore lands. The Working Group for Phytophthoras in Native Habitats, with input from restoration professionals and regulators, developed guidance for reducing the risk of *Phytophthora* spread through restoration sites while allowing for successful mitigation projects and maintaining the integrity of the ecosystem. These guidelines include direct seeding, outplanting container stock grown in nurseries with *Phytophthora* prevention accreditation, reducing planting densities, limiting imported products and soil movement, and maintaining phytosanitary best management practices throughout the life of the restoration project. If direct seeding or reduced planting densities are utilized, then success criteria thresholds for cover should be reduced and survivorship criterion should be reduced or replaced with target densities. Additionally, including multiple years of direct seeding and credit for natural recruitment can compensate for high direct seeding mortality and create age structure within the site.

5.07 A southern California nursery's conversion to follow best management practices

Billy Sale

Rancho Santa Ana Botanic Garden, Claremont, CA, USA

Nurseries producing container plants for restoration projects have proven to be a source for plant killing pathogens, such as *Phytophthora* (Pythiaceae) species, that can have devastating impacts on wild habitats. Recently, these pathogens were found persisting within restoration sites in southern California, providing strong evidence that nurseries in relatively arid climates in California should also adopt strict best management practices (BMPs). Over the past three years, the native plant nursery at Rancho Santa Ana Botanic Garden in Claremont, California has been working to overhaul its operations in an effort to follow BMPs set forth by the California Native Plant Society (CNPS) and the *Phytophthora* Working Group. Efforts have included steaming of pots and soil, bleaching of all surfaces, converting to metal or plastic benches, and testing of plant effluent. These efforts have required changes in the nursery workflow and retraining of staff and volunteers. Efforts such as these require a financial contribution from the institution and, in turn, increase the cost to produce plants. The journey to adopt these types of changes has created challenges for the staff and institution as a whole, but it is believed that plants produced in this manner will ultimately be stronger and healthier. The process of converting to BMPs significantly enhances our ability to produce clean plant stock that will help to restore and protect California's habitats, and also healthy plants for RSABG's grounds and for sale in the Grow Native Nursery.

5.08 Restoring prairie habitat quality for a federally endangered annual forb: A ten-year report on *Presidio clarkia*

Lech Naumovich

Golden Hour Restoration Institute, Berkeley, CA, USA

Presidio clarkia, *Clarkia franciscana* [Onagraceae], is a federally endangered annual forb that is limited to serpentinite outcrops in Oakland and one population in San Francisco. The remnant habitat is predominantly classified as coastal prairie grassland and rock outcrops. Over the course of the past ten years, we have conducted extensive applied experiments including grazing, phenological mowing, scraping, habitat fencing, and raking to better understand the life history of this taxon and how to best restore and maintain habitat in Oakland. After numerous experiments, observations and even a few surprises, it became evident that well timed disturbance within a certain range of intensity proved to be highly beneficial for the taxon. A minimum of 5 years of monitoring data is necessary to capture variation in annual populations. Upon noting key differences in responses to management between the Oakland and San Francisco populations, our results full-heartedly reinforce that restoration and management must be site-specific.

5.09 Restoration techniques and planning for the rare, native annual grass *Dissanthelium californicum* (Poaceae), formerly considered extinct, on San Clemente Island, CA

Emma Havstad¹, Emily Howe²

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First described in 1847 from collections on Catalina and Guadalupe Islands, *Dissanthelium californicum* (Poaceae) was collected on San Clemente Island in 1903 and not recorded again for over 100 years. By 1963, it was considered potentially extinct throughout its range on the three islands. Its rediscovery on Catalina in 2005, and Clemente in 2010, is a testament to the recovery of native species following control/management of exotic herbivores. In 2014, the Navy and Soil Ecology and Restoration Group (SERG) initiated a multi-phased project to create additional populations outside of heavily used training areas on San Clemente in order to: preemptively prevent extirpation from the island, learn more about the habitat requirements of the species, and develop best restoration practices. The translocated reserve populations established in the first phase are now in their second and third years of recruitment without supplemental planting or seeding, irrigation, or maintenance weed control. These populations appear to be persisting in a variety of habitat types and through distinct precipitation regimes. This success heralds the initiation of the second phase of the project and allows for further focus on more efficient installation methods, overcoming monitoring challenges, and fostering population sustainability.

5.10 Preventing extinction of an endangered annual forb, San Mateo thornmint

Christal Niederer, Stuart B. Weiss

Creekside Science, Menlo Park, CA, USA

San Mateo thornmint (*Acanthomintha duttonii* [Lamiaceae]) is a federal- and state-endangered annual forb known only from Edgewood Natural Preserve, San Mateo County, CA. The original population, occupying relatively bare patches within a < one hectare patch of serpentine vertisol soil, had been in decline for decades, from >50,000 plants in 1994, to 395 plants in 2009 (occupying 35 square meters (m²), to <30 plants in 2017 (occupying only 6 m²). In 2008, a restoration project began to census the population, increase seeds ex-situ, enhance existing habitat, find suitable introduction sites, and seed to augment the existing population and establish new populations. Seedling establishment rates have averaged 27 percent, and first-year survival to flowering 11 percent. Fecundity of individual plants is low, with most plants producing only one whorl (maximum 16 seeds). Unfortunately, abundance declined in subsequent years with few exceptions. In 2015 spring irrigation in seeded plots greatly increased fecundity, and numbers increased the following year. In 2016 and 2017 seeding included three additional serpentine vertisol sites within Edgewood, and produced a total of 7,549 plants occupying 237 m² in 2017. In both seasons, the additional sites produced numbers similar to or better than the original site, producing cautious optimism. Challenges in the past decade include annual grass growth, drought (especially dry spring seasons), flooding rains post-seeding, dodder parasitism, deep cracks in the clay soils, and intermittent funding. In the long run, seeding multiple sites and creating opportunities for the thornmint to occupy suitable bare microsites will be necessary for self-sustaining populations.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

5.11 The significance of functional diversity over percent cover: A call to use more native forbs in habitat restoration

Jennifer Burt, Lynn Hermansen
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Native forbs are an important and essential component of California's varied ecosystems. Yet faced with the many challenges in ecological habitat restoration (including invasive plant competition, often high native cover performance criteria required, and expense), it remains relatively uncommon for restoration practitioners to include native forbs as significant components of restoration planting palettes. Aspects of the importance of the functional diversity provided by native forbs in California ecosystems are reviewed and discussed, including: functional diversity in below-ground root architecture and effects on soil shear strength, water infiltration, and soil biota; niche partitioning and competition with non-natives; provision of floral resources for native pollinators and other beneficial insects; and the important roles that forbs play in ecosystem food webs and wildlife habitat. The historical and current reasons for the relative lack of emphasis on forbs in habitat restoration will be explored, along with the challenges presented to establishing native forbs in large scale restoration projects, based on multiple case studies. Finally, practical recommendations will be provided to restoration practitioners motivated to include more native forb diversity and cover in habitat restoration projects.

5.12 A struggle against pathogens and pests: Lessons learned while restoring lupine habitat for the endangered mission blue butterfly in the Golden Gate National Recreation Area

Ruby Kwan, Christina Crooker
Golden Gate National Parks Conservancy, San Francisco, CA, USA

The mission blue butterfly was one of the first insects to be listed as endangered in 1976. In the Golden Gate National Recreation Area, a small population can still be found at Milagra Ridge, Pacifica, San Mateo County. There, the biggest threat to the butterfly is a fungal pathogen (*Colletotrichum lupini* [Glomerellaceae]) which has caused dieback of the silver leaf lupine (*Lupinus albifrons* [Fabaceae]) host plant habitat. Since 2010, summer lupine (*Lupinus formosus*), a species less susceptible to the pathogen, has been planted to diversify the host plant population and buffer against the impacts of the pathogen. Silver and summer lupines have been successfully outplanted but only after investing time to identify optimal planting areas and techniques, protecting lupines from pests, and maintaining lupines for a minimum of one year. As this project enters its eighth year, new challenges have surfaced that will impact the future of this effort such as the significant loss of lupine propagules due to pests and predation. Identifying propagule sources outside of park boundaries, exploring seed amplification, and researching ways to reduce predation of field propagules will be necessary to ensure that there are enough seeds to grow the lupines for the protection of the mission blue.

5.13 Lessons learned from 20 years of habitat management for the federally listed mission blue butterfly

Christina Crooker¹, Ruby Kwan¹, Susie Bennett², Meghan Steinharter¹, Alison Forrestel², Bill Merkle², Alisa Shor¹
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The Bay Area endemic mission blue butterfly (*Icaricia icarioides missionensis* [Lycaenidae]) relies on certain species of lupine (*Lupinus albifrons*, *L. formosus*, and *L. variicolor* [Fabaceae]) growing in coastal grasslands to complete its life cycle. Despite 20 years of habitat restoration, mission blue butterflies (MBBs) have declined in many parts of the Golden Gate National Recreation Area. We will present our successes and challenges given limited resources, and how habitat management has adapted over time. Long-term vegetation monitoring shows success in controlling woody invasive plants that outcompete lupines, but that native scrub is encroaching into those same areas. Lupine cover has declined over this same period. Left unchecked the scrub could have a negative long term impact on lupine recruitment. Despite time spent on managing woody scrub, the data suggests that a fungal pathogen, *Colletotrichum lupini* (Glomerellaceae), that causes dieback in lupines is the main threat to MBBs. While we can't manage *Colletotrichum* itself, one host species of lupine, *L. formosus*, is known to be more resistant than other lupine species. In order to buffer against the impacts *Colletotrichum* has on lupine host plants, and thus MBBs, we are introducing *L. formosus* to existing MBB habitat and mixing sources across geographic boundaries. This will provide genetic and habitat resiliency now and as the climate changes. We are also controlling for native scrub encroachment and using small scale disturbance to create conditions for lupine seedling

recruitment. Finally, we are relocating the MBBs from nearby populations to provide genetic variation and boost numbers in the population.

5.14 A comparative study on the vegetation of western snowy plover habitat within urban and natural coastal dune systems of southern California

Josh Weinik

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Urbanization of the Southern California coastline has altered native coastal dune ecosystems and reduced their ability to support native wildlife including endangered and threatened species such as the western snowy plover (*Charadrius alexandrinus* subsp. *nivosus* [Charadriidae]). My study investigated the plant communities of western snowy plover habitat within an urban (disturbed), and a natural (undisturbed) coastal sand dune system of Southern California in an effort to inform the restoration and management of urban dune systems. I performed vegetative analyses across sites (urban vs. natural) and within the urban site (comparing sub-sites of varying restoration levels) using a quadrat sampling method to determine total, native, non-native, and species-specific percent cover. In the cross-site analysis I found that total and native cover were higher in the natural system, whereas non-native plant cover was higher in the urban system. Interestingly, beach bur (*Ambrosia chamissonis* [Asteraceae]) cover was similar across both sites. The within-site analysis revealed a similar total vegetative cover among all sub-sites as well as some degree of un-assisted recovery of native species to a potential carrying capacity of these dunes. This recovery of the native plants suggests that there is "ecological memory" retained within the urban dune system. I also observed an increase in total vegetation and beach evening primrose (*Camissoniopsis cheiranthifolia* [Onagraceae]) cover in response to protective fencing. This finding implies that fencing may play a role in increasing plant species diversity and improving total vegetative cover up to a critical limit necessary for occupation and nesting by western snowy plovers.

5.15 Use of songbirds and other observable wildlife as metrics for selective acceptance of non-natives in restoration

Sandra DeSimone

Audubon Starr Ranch Sanctuary, Trabuco Canyon, CA, USA

A fundamental goal in restoration is to limit non-native species. However, some researchers advocate an impact-based assessment to prioritize established non-native plant species for either control or "acceptance" into otherwise native ecosystems. We provide vegetation and wildlife monitoring results from three rare southern Californian habitats to demonstrate use of a relatively easy to measure parameter of ecosystem function, habitat provision, to assess impacts of non-native plant species. We monitored vegetation in restored needlegrass grasslands, coastal sage scrub (CSS) and riparian woodland sites. We trapped small mammals in all habitats over three consecutive nights per season. We surveyed birds using spot mapping (CSS) and qualitative assessments of two songbird species selected as indicators of habitat provision (grasslands). In CSS restoration sites native shrubs colonized annual grass-dominated areas that developed into shrub-dominated ecosystems over time. Trends of increasing native bird species richness and small mammal species richness and abundance indicated that, without control of annual grasses, increasing shrub cover provided improved native wildlife habitat. In needlegrass grasslands comprised of mixed native/non-native (*Bromus* and *Avena* species) grasses, *Sturnella neglecta* (Western Meadowlark) and *Ammodramus savannarum* (Grasshopper Sparrow) populations persisted over seven years. In riparian woodlands native small mammal captures from *Vinca major* (periwinkle)-dominated ground layer sites were > two times those in sites without *V. major* and species richness 1.75 times that of sites without *V. major*. Wildlife monitoring has stimulated us to view non-native species through a new lens to reduce workload and meet our goal of providing habitat for native fauna.

5.16 Conservation grazing to manage *Stipa pulchra* (Poaceae) populations: A demographic evaluation

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Due to the historic conversion of California's native grasslands to non-native annual grasslands, the management and conservation of native plant species is a central target of most management efforts within California. A key part of these

TECHNICAL PRESENTATION ABSTRACTS BY SESSION

efforts has been maintaining remnant populations of the iconic purple needlegrass (*Stipa pulchra* [Poaceae]). Conservation grazing has emerged as a useful management tool in these efforts, but we still have a poor understanding of how and when to implement these grazing practices. Here we present the results of a multi-year experiment evaluating the effects of grazing on population dynamics of *Stipa* at Vasco Caves Regional Preserve, CA. Within six paired grazed and ungrazed plots that were set up across an environmental gradient, we tagged *Stipa* across three demographic stages (seedling, juvenile and adult). For three years, we monitored survival and reproductive effort of tagged individuals. We used integral projection models to evaluate the population growth rates. *Stipa* population growth rates tracked rainfall such that they declined in dry years but increased in wet years. These patterns were exacerbated by resource environment and grazing. In dry years, grazing reduced the growth of individuals in low resource areas where overall *Stipa* populations were in decline, whereas grazing increased growth rates in high resource areas where overall *Stipa* population growth rates were increasing. Grazing can be a useful tool for maintaining and enhancing *Stipa* across a landscape when environmental conditions are additional taken into consideration when implementing grazing practices.

5.17 Do invasive grass water use strategies serve as a barrier to chaparral restoration?

Michala Phillips, Edith Allen

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Global change contributes to shifts in vegetation composition and one important example is vegetation community type conversion from native shrubland to invasive grassland. Chaparral was previously thought to be resilient to disturbance, yet has recently undergone invasion in some areas. Invasive species often have life history traits with flexible resource acquisition strategies. Flexible responses to precipitation could make invasive species stronger competitors in a changing climate when compared to natives. In addition, invasive grasses may rapidly deplete soil moisture disrupting deep water percolation that natives depend on. We hypothesized that invasive grass density would affect restoration success through the depletion of soil moisture. We set up twenty 1m² restoration plots in an area of chaparral that has type converted to exotic annual grass. In these plots, we created three levels of invasive density (0%, 50%, and 100%) by hand weeding and planted an *Adenostoma fasciculatum* (Rosaceae) seedling in each plot. We deployed soil moisture sensors at two depths in each plot to track differences in soil water percolation. Preliminary data show that invasive grass stands rapidly depleted soil moisture starting in early April to lower levels than the under both the native canopy as well as unvegetated areas. This research will provide information to land managers about ecosystem impacts of type conversion and possible barriers to restoration, as well as advise on the extent of grass removal required for shrub survival and establishment.

5.18 Effects of fire on herbicide

Noreen Murano¹, Jessica Morrison¹, Sam Lantz¹, Laura Riege²

¹*Resource Conservation Partners, Inc., Ventura, CA, USA*, ²*The Nature Conservancy, Ventura, CA, USA*

The Santa Clara River is one of the most dynamic river systems in southern California. The river drains the coastal mountain ranges north of Los Angeles by flowing west onto the Oxnard Plain and into the Santa Barbara Channel. The Nature Conservancy owns 146 acres of floodplain in the Santa Clara River in the City of Santa Paula. On June 22, 2015, a wildfire burned approximately 100 acres of riparian vegetation including strands of giant reed (*Arundo donax* [Poaceae]). Only one week after the fire, giant reed was sprouting within the burn area. In August 2015, The Nature Conservancy awarded Resource Conservation Partners the contract for *Arundo* treatment on the Banman property in the Santa Clara River. The site is now full of diversity boasting many species that have not been seen in bloom in quite a while, including blue elderberry and sandbar willow. Spring rain and heat greatly supported native growth and provided a nesting site for least Bell's vireo. The critical lessons learned that will be valuable expertise in future post-fire *Arundo* treatment projects are: fire creates nitrogen and nutrient rich ash; ash creates a barrier netting and lower herbicide efficacy; ash dust on plants bound with glyphosate decreased efficacy and recommended calibration of herbicide was ineffective for given scenario.

5.19 Thirteen years of restoration activities in San Diego County using the Bradley method

Robert Byrnes, Elizabeth Mather, Arne Johansen

California Native Plant Society, San Diego Chapter, San Diego, CA, USA



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

Restoration of degraded native habitat is generally regarded as costly and labor intensive. The Restoration Committee of the San Diego Chapter has utilized the Bradley method to restore a variety of habitats in a variety of jurisdictions in central and northern San Diego County over a 13-year period. The areas comprise 1100 acres. The Bradley method relies upon recovery of the seed bank over a period of time, repeatedly removing invasive species from areas coexisting with significant numbers of native plants. Native species are thus "recruited" as replacements. Whole or partially restored areas are then gradually expanded to encompass more heavily impacted areas. Our organization structure is non-jurisdictional, being able to work geographically across property lines with multiple partners. Our training-based approach provides for the dissemination of knowledge while also providing a workforce that may be expanded as necessary. The year-round, every week approach provides for persistence while also providing the flexibility to deal with factors such as plant growth, weather, individual schedules, and nesting season. Some ability to identify natives is necessary, but this is readily achievable by our volunteers who receive continuous training but who work over the long term. Following common implementation of restoration work, hand tools are our first line of attack. Committee members are encouraged to obtain certification or licensing to use herbicides, but this is not a requirement. While the extent of restoration varies and activities are ongoing, our total costs averaged \$15 per acre for our first 1,000 acres over 10 years.

5.20 Direct install turf replacement: Changing an old concept

Jacob Shiba, Lindsey Stuvick, [Shavonne Mays](#)
Moulton Niguel Water District, Laguna Niguel, CA, USA

In an effort to support landscape market transformation, the Moulton Niguel Water District piloted a turn-key, direct install turf replacement program in spring 2017. The program simplified the turf rebate process for customers by providing a pre-selected network of contractors to complete the design, turf removal, and new landscape installation processes from start to finish. The District selected a contractor network that aligned philosophically with the watershed approach to residential landscape design in an effort to showcase the variety and floral aesthetic of "California friendly" and regionally-native plant species. Additionally, the District selected this approach to ensure creative and quality controls that prevent landscape design outcomes that promote a negative stigma of drought tolerant landscapes and to achieve multiple environmental benefits, including the creation of habitat for local fauna. Education is the keystone of the program; the District required applicants to attend a landscape workshop and receive onsite education covering the basics of irrigation efficiency, plant water needs, and watering schedules. The program provides funding for a pre-qualifying audit, landscape design, and a \$2 per square foot incentive toward total project costs. The District worked directly with the contractor network to streamline administrative process and eliminate the need of writing individual checks to customers. The District designates a project manager within the contractor network to be the customer's primary point of contact, which allows the District to step aside and save valuable employee time. The District will be starting the full-scale program this fall.



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OAKS & OAK-RANGELANDS

California oak woodlands have been enduring anthropogenic threats since the state was formed in 1849. These threats include urban and agricultural development and ranching, fire suppression, and a mosaic of pressures – disease, drought, invasive species, and fire—associated with and exacerbated by fire suppression and a changing climate. This session is designed to examine critical oak woodland habitats in the oak “belts,” which surround California river valleys. It will explore the science, policies, and practices necessary to conserve, stabilize, and regenerate critical oak woodlands ecosystems in the face of ever-increasing social, climatic, and ecological pressures.

6.01 Trends in California oak woodlands and forests

Tom Gaman

California Wildlife Foundation, Oakland, CA, USA

California oaks are impacted by urbanization, changing land uses, tree mortality, fire, harvest, and mismanagement. Other drivers of change, such as climate, disease, invasive plants, drought and fire exclusion have also affected oak woodlands and forests over recent decades. Some woodland oaks have grown larger or denser, while oak forests have become dominated and over topped by native conifer species. Others are burned up and gone. This sets the theme for the Oak and Oak-Rangelands session of the conference with an analysis of U.S. Forest Service's Forest Inventory and Analysis (FIA) data, tracking changes in oak populations that have occurred since the program was initiated in 2000. Trends in five regions of the state are compared with the results of Oaks 2040, a statewide analysis by county, published in 2007.

6.02 Drought and beetle impacts to native trees: What can a wildland park do?

Rosi Dagit

Resource Conservation District of the Santa Monica Mountains, Topanga, CA, USA

Since 2014 hundreds of native trees (alders, oaks, sycamores, willows) in the Santa Monica Mountains have died, mostly due to the drought, but many are also victims of the polyphagous shot hole borer (*Euwallacea* sp. [Curculionidae]) and a new pathogen carried by the western oak bark beetle (*Pseudopityophthorus pubipennis* [Curculionidae]). Concerned about the ecological implications of massive native tree loss, the Resource Conservation District of the Santa Monica Mountain (RCDSMM) initiated a citizen science based study of drought impacts in 2015 using randomly selected 25 meter plots tagging over 100 trees in critical park areas near the urban wildland interface throughout the western Santa Monica Mountains National Recreation Area. This effort was augmented in 2017 by the deployment of over 30 homemade beetle traps in sensitive riparian areas to monitor direction and rates of spread of invasive beetles, and to document tree responses. Concurrently, these data provided on the ground information used in a NASA DEVELOP Project using remote sensing tools and satellite data to help understand the landscape level impacts over time. Preliminary results show that extensive drought impacts occurred in 2015, followed by increased loss associated with invasive pathogens in 2016-17. To date, infected tree removal is the only recommended way to reduce impacts from amplifying host trees. The RCDSMM is working with regional and local parkland managers and other concerned stakeholders to develop a more appropriate and realistic management strategy for wildland trees.

6.03 The fire ecology, history, and management in the oak woodlands of California

Carol L Rice

Wildland Resource Management, Alamo, CA, USA

This presentation focuses on the role of fire in oak woodlands, along with the impacts of fire management and land use policies. A discussion of the fire ecology of oak woodlands forms the foundation of the presentation. The presenter will describe the many attributes that make oak woodlands more and less resilient to the many types of wildland fire. The history of fire (both recent and pre-historic) in oak woodlands will be included, with comments regarding trends of fire size, severity, and spatial distribution. In some places, wildland fire policies have been a boon to development and maintenance of oak woodlands, whereas in most circumstances the lack of wildland fire has been a threat to this vegetation type. The intersection of policies guiding land use and fire management will be explored. The implications of the disparity between the fire regimes in which oaks were adapted and the current situation will be addressed.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

Management activities, such as an increase in prescribed burning, will be offered as a remedy to some of the impacts. Because oak woodlands are often found in private as well as publicly owned lands, management activities sometimes span boundaries. The opportunities and challenges of both types of land ownership are to be discussed.

6.04 Vegetation metrics to inform implementation of groundwater law

Sara Sweet¹, Melissa Rohde², Craig Ulrich³

¹The Nature Conservancy, Galt, CA, USA, ²The Nature Conservancy, San Francisco, CA, USA, ³Lawrence Berkeley National Laboratory, Berkeley, CA, USA

California's recent groundwater legislation offers some protection to groundwater-dependent ecosystems (GDEs) such as riparian forests dominated by valley oak (*Quercus lobata* [Fagaceae]). Although information on rooting depth is available for some individual species, groundwater requirements for several plant communities are largely unknown. This lack of knowledge makes it difficult for policy staff to implement the protection described conceptually by the law. In summer 2016, we measured community-level attributes of riparian forest in three sites at the Cosumnes River Preserve, California. In addition, we characterized soil moisture using electrical resistivity tomography at each site. Six biologic indicators of vegetation quality were deduced: canopy density, species diversity, recruitment, vertical structure, nativity, and survivorship. All six indicators were significantly lower at one site compared to the other two, which were similar. Likewise, all six indicators showed a positive correlation with greater groundwater availability. These results begin to provide implementers of policy with the information necessary to effectively protect GDEs. In addition, these results justify the importance of using plant community metrics in implementation of groundwater law, rather than requirements for a single dominant species.

6.05 Protecting oak woodlands via a medical cannabis cultivation ordinance

Kate Marianchild

California Wildlife Foundation/California Oaks, Oakland, CA, USA

The interior portions of Mendocino County support vast expanses of relatively wild oak woodlands, most of which are privately owned and largely unprotected by state or local regulations. On the local level, the county has notably lacked an oak woodland protection ordinance and a grading ordinance. Mendocino County has also been home, since the 1970s, to a multi-million-dollar underground marijuana industry. In spring of 2016, motivated by a desire to collect taxes and exercise environmental and other controls over the medical cannabis industry, Mendocino County officials began the complex process of creating an ordinance to regulate the permitting and cultivation of medical cannabis. A draft version of the proposed ordinance was analyzed by an environmental consulting firm, which determined that the potential impacts of increased cannabis cultivation would require preparation of an Environmental Impact Report for the California Environmental Quality Act--unless those impacts could be sufficiently mitigated through revisions to the draft ordinance. Recognizing a chance to finally create an oak woodland protection ordinance in Mendocino County, a small group of citizens, led by Ellen Drell of the Willits Environmental Center, went to work. Kate Marianchild, a member of the group and author of *Secrets of the Oak Woodlands*, will present on the group's strategies, which added significant protections for oaks to the Mendocino Medical Cannabis Regulation Ordinance (adopted on April 4, 2017) and played a key role in a commitment by the Board of Supervisors to adopt an oak woodland protection ordinance by January 1, 2020



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LIGHTNING TALKS

Lightning talks are strictly-timed 5 minute presentations intended to spark discussion among conference participants. Presentations should focus on one key point such as results from a successful project, a report on lessons learned, an invitation to collaborate, an especially provocative or original idea, or a demonstration of a new tool or technique.

7.01 Ethnomedicinal assets of plants collected from Nasarawa State, North Central Nigeria

Enock Emmanuel Goler, Emmanuel Hala Kwon-Ndung, Gbenga Festus Akomolafe, Paul Terna, James Okogbaa, Markus Musa

Federal University Lafia, Lafia, Nasarawa State, Nigeria

An ethno-medicinal survey of plants used in treating various diseases and ailments was carried out in the study area of Nasarawa State, North Central Nigeria to obtain information on their uses and potentials. The ethno-medicinal survey was administered through structured questionnaires among local inhabitants from areas with high plant density and diversity within the various Local Government Areas of the State. A total of 84 (eighty-four) plant species belonging to 45 (forty-five) families were found to be useful in treatment of various ailments such as diabetes, measles, fever, asthma, jaundice, pneumonia, sexually transmitted diseases (STDs), aches, diarrhea, cough, arthritis, yellow fever, typhoid, erectile dysfunction, and excessive bleeding. Different parts of the plant such as the roots, leaves, and stems are used in preparing herbal remedies which could be from dry or freshly collected plants. The main methods of preparation are decoction or infusion, while in some cases the plant parts used are consumed directly. Residents in the study areas find the herbal remedy cheaper and more accessible and claim that there are no side effects compared to orthodox medicine. This study has confirmed the need towards the conscious conservation of plant genetic resources in order to ensure sustained access to these ethno-medicinal plant materials.

7.02 CNPS garden ambassadors - restoring nature one garden at a time

Kristen Wernick

California Native Plant Society, Sacramento, CA, USA

California Native Plant Society Garden Ambassadors are a community of individuals committed to sharing their California native gardening knowledge and enthusiasm to inspire widespread adoption of California native plants. These garden ambassadors are taking active roles by sharing their California native gardens, inspiring others through photography, social media, and blog posts, and growing their communities by teaching and leading workshops. Join us to learn about the success of this new and exciting program taking root in Southern California, and meet the honorary California Native Plant Society Garden Ambassadors!

7.03 PlantID.net - a writer's tool for building plant ID guides

Bruce Homer-Smith

California Native Plant Society, Marin Chapter, Marin County, CA, USA

PlantID.net is set up to allow plant experts to write ID guides on focused topics. Topics might range from "Early Spring Wildflowers of Mount Burdell" to "The Clovers of Edgewood Park" to "A Non-Dichotomous Illustrated Key to Ceanothus at Pinnacles National Park". The key purpose of these ID guides is to get users to a short, illustrated, annotated list of possible plants - something they can run their finger down - so they can make a final selection by comparing photos, captions and ID tips. Once a user finds a likely plant, she clicks it to get to a full-size photo slideshow, optionally with captions, to look at the plant from many points of view (e.g., how the leaves attach to the stem, phyllary side view, etc.). The PlantID.net writer's tool is designed to be efficient to use. Writers can pick from over 80,000 full-size curated taxon photos to illustrate their points. They can take advantage of default ID tips and photos, or write and choose their own. Once entered, reviewed for accuracy, and edited for style, the local expert's ID guide is electronically published on PlantID.net and available to the public. Almost everyone has been frustrated by not knowing the plants in an unfamiliar setting. The goal of PlantID.net is to collect and present thousands of ID Guides by local experts, to give you easy access to their knowledge.



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7.04 Using ArcGIS Online and CollectorApp to monitor a coast live oak restoration project in the Crafton Hills, San Bernardino County, CA

Marshall Webb, Thunder Wellhausen, Timothy Krantz
University of Redlands, Redlands, CA, USA

A coast live oak restoration project was completed for 103 trees using an ArcGIS Online data server and CollectorApp system to monitor the trees and irrigation system for the first two years of required monitoring. The Crafton Hills comprise nearly 3,500 acres between the cities of Redlands and Yucaipa in southern California. The dominant vegetation is California sagebrush scrub and chamise chaparral. Historically, coast live oaks (*Quercus agrifolia*, [Fagaceae]) were distributed in and around the Crafton Hills, but most of these were harvested for mine shaft timber supports in the late 1800s. The Crafton Hills Open Space Conservancy (Conservancy) oversees the area, with ex-officio members representing the County of San Bernardino, cities of Redlands and Yucaipa, and Crafton Hills College. The California Department of Water Resources approached the Conservancy regarding an oak tree mitigation program to replace 22 oak trees at a 4:1 ratio, for 88 trees; and, in conjunction with an air quality violation settlement agreement, another 15 coast live oaks were installed at another location in the Crafton Hills, for a total of 103 new 15-gallon oak trees. More than 70 volunteers installed the trees on January 21-22, 2017. The locations of the trees and irrigation systems were entered into a GIS and a CollectorApp interface was constructed to enable monitoring of the irrigation and tree conditions by volunteers using their cell phones. A GIS StoryMap presentation was developed for use with the volunteer training program.

7.05 Dispersal of spicebush (*Calycanthus occidentalis* [Calycanthaceae]) achenes by carnivorous wasps of the genus *Vespula*

Dylan Burge
Southern Oregon University, Ashland, OR, USA

The California-endemic spicebush (*Calycanthus occidentalis* [Calycanthaceae]) produces achenes with an auxiliary organ that is attractive to carnivorous wasps of the genus *Vespula* (Vespidae). Studies on the presentation, dispersal, and chemistry of the achenes suggest that these wasps may be a major agent of dispersal of spicebush diaspores, and that a protein reward is involved (the auxiliary organ is more than 22% protein by dry weight). Foraging worker wasps appear to be attracted to volatile compounds that mimic the high-protein items (e.g., carrion) that are the typical targets of these wasps. Studies are currently underway to determine if a similar dispersal system exists in the other members of the Calycanthaceae, found in the southwestern United States and China. In addition, there is preliminary evidence that seeds of the California endemic pipevine (*Aristolochia californica* [Aristolochiaceae]) are also dispersed by these wasps.

7.06 The patronus charm in the San Joaquin Desert: A contrast of foundation plant specificity

Christopher Lortie², Alex Filazzola¹, Jenna Braun¹
¹York University, Toronto, ON, Canada, ²National Center for Ecological Analysis and Synthesis, Santa Barbara, CA, USA

Deserts globally are subject to significant anthropogenic pressure. Global change, agriculture, energy projects, urbanization, and other ongoing drivers introduce stressors on the resilience of arid and semi-arid ecosystems. The capacity to buffer against these changes in the environment and biodiversity are important considerations for ecosystem functioning and applied decision-making frameworks. Foundation species analyses can be a solution to rapidly assess ecological function for a specific region. A foundation species is defined as species that exerts and promotes a positive set of processes for the network of resident species. Shrubs and cacti in California are both candidate representative functional groupings of plant species that benefit other plants and often animals within a region. Herein, we sampled the effect of shrubs and cacti on other plant species through systematic plant surveys on environmental gradients. The hypothesis tested was that the direct effects of dominant plants lead to facilitation of other plant species and thereby function as buffers to undue change. Colloquially, this can be termed a patronus charm effect within facilitation ecology because regardless of the form of the protector, the species provides a talisman against local loss of function. From the northern extent of the San Joaquin Desert to the southernmost extent, we documented consistent positive effects of dominant plants including cacti on other plant species. Richness was not always increased and environmental context was important but this research suggests that using landmark species within an impact desert region accelerate identification of fundamental positive dynamics locally irrespective of species identity.



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7.07 Initial trends comparing restoration of riparian forest by natural process versus horticultural techniques

Sara Sweet¹, Judah Grossman¹

¹The Nature Conservancy, Galt, CA, USA, ²The Nature Conservancy, Sacramento, CA, USA

Restoration of riparian forest has been successful using both horticultural and process-based techniques. However, the threshold at which one becomes more cost-effective than the other has not been well characterized. The Lower Cosumnes River Restoration Project experimentally addresses this knowledge gap at a site that spans a variety of hydrologic regimes. Three treatments - process only, minimal planting, and fully horticultural - have been implemented since 2015. Initial results show that the duration of flooding exerts a controlling influence on the plant community. However, the fully horticultural treatments have not yet completed establishment, as the native grasses were only seeded in fall 2017. As time progresses, we hope to provide practical guidelines to inform the design of riparian restoration projects.

7.08 Community based restoration of native Californian grasslands

Michael Rada

Humboldt State University, Arcata, CA, USA

Native Californian grasslands have been heavily reduced and altered over the past 200 years, now comprising less than 1% of the grassland crop. This is primarily due to the overgrazing of cattle, urban development, and agricultural development, to the point of ecological insignificance. The shift from a native perennial grassland system to an invasive annual system has had widespread impacts on watershed health, species diversity and richness. Restoration efforts should be implemented to restore degraded ecosystems and promote native flora and fauna. For restoration to be successful many private and public entities such as Homeowner Associations, Community Centers, volunteers, park districts, federal and state agencies must work together. This would reduce costs, bring communities together, educate the public, engage citizens and most importantly promote native plant usage. Benefits of restoring native grasslands include slope stability, erosion control, promotion of native plants, less water usage, less risk of fire, habitat for native wildlife, low maintenance and reduction of pesticide use. With a climate that is rapidly changing, these benefits are increasingly important for the safety and security of human and wildlife health. Community based restoration would include community outreach and engaging homeowner associations. Project monitoring would include a comprehensive scientific analysis consisting of recording soil moisture, organic matter, bulk density, as well as a flora and fauna diversity and richness survey. Resampling will occur every 5-10 years to analyze the changes after restoration has occurred. Expectations for this project are to conserve, restore and stabilize.

7.09 Learn about a database of 3,700 nectar plants correlated with specific U.S. butterflies that promotes their care and feeding

Susan Dunlap

Aerulean Plant Identification Systems, Inc., Menlo Park, CA, USA

Ms. Dunlap created a new resource for butterfly enthusiasts that correlates the foraging habits of extant U.S. nectar-feeding adult butterflies with specific plants. Her database contains 3,700 entries of butterfly nectar plants. Her analysis of over 16,000 images identified that 75% of U.S. butterflies are nectar feeding. Initially, the adult food preferences of all U.S. butterflies fit into three groups: a) 125 unknown (15%); b) 284 that fed on flower nectar, plant unknown (35%); and c) 391 species (60%) that correlated with common-named plants. Her database provides common name and plant binomial data for 61% of the butterflies in group a, 60% of those in group b, and more specific plant species information for 43% of those in group c. Many photographs referenced in this study, taken by individuals photographing insects in the wild, could not be used to expand the database for a variety of reasons. The plant database could expand by roughly 30% if citizen scientists had more guidance on what information to record while enjoying wildlife in a local park or hiking in a nearby habitat. A great deal was learned about how to improve information-gathering related to the gleaned habits of butterflies - techniques that also apply to bees. Ms. Dunlap will present information about what to capture in an image set that documents insect nectar-feeding activity, how to select the top cultivated nectar plants, and how to empower those who care about providing food for pollinators.



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7.10 Avoiding inadvertent introductions of the invasive Argentine ants during landscaping and native plant restoration

Jessica Appel

San Francisco Public Utilities Commission, San Francisco, CA, USA

The Argentine ant (*Linepithema humile* [Formicidae]) is an invasive ant species associated with human development that can be a nuisance for plant nurseries because of its ability to cause aphid and scale outbreaks. The Argentine ant is also able to displace most native ant species in California, with the potential to disrupt ant-plant mutualisms such as pollination, seed dispersal, and protection from herbivores. Argentine ant queens and workers cannot fly after leaving their nests, so the only way to disperse on their own is to crawl to new sites, a slow process compared to the dispersal of other ant species. However, Argentine ants can also be transferred to new sites by being carried in landscaping and native plant restoration supplies such as the potting soil surrounding the roots of container plants. The use of Best Management Practices to avoid inadvertent introductions of Argentine ants, including periodic monitoring and the use of weatherproofed quarantine and bait materials, is an important consideration for native plant restoration and landscaping near wildlands.

7.11 *Chaenactis suffrutescens* (Asteraceae) reintroduction study

Lusetta Sims, Twyla Miller

United States Forest Service, Shasta Trinity National Forest, Weaverville, CA, USA

Chaenactis suffrutescens (Asteraceae) is a sub-shrub endemic to northern California and has a California Rare Plant Rank of 1B.3. During the winter of 1996/1997, several thousand cubic yards of flood spoils from slide events along California State Route 3 were moved and the fill was deposited on the south side of Ramshorn Creek immediately east of the bridge. This location had supported an existing population of *C. suffrutescens*, which was effectively extirpated as a result of project activity. The goal of this management effort is to create new viable populations of *C. suffrutescens* in an effort to replace the biomass and seed bank of the original, extirpated population at Ramshorn Creek. Project success is measured by assessing the extent to which short-term and long-term goals are met. Project goals are: 20% survival of planted individuals, evidence of recruitment, dominance of robust reproductive individuals, and no evidence of competition with non-native species. In October 2015, 150 individuals were transplanted into two separate permanent plots. In October of 2016, we measured vigor and size class of individuals via census of *C. suffrutescens* planted within both plots. Dead or missing individuals were noted on data collection forms. Surprisingly, after one year only 125 plants out of the 300 were documented as dead. Both plots had similar growth patterns of survivors which could be attributed to the site selection criteria for optimal habitat and abiotic site conditions. Substrate type of cobble and sand, sun exposure, and proximity to water attributed to surviving individuals after the first year.

7.12 Species distribution model for southern California coastal species

Cristian Sarabia¹

¹California State University, Long Beach, Long Beach, CA, USA, ²Palos Verdes Peninsula Land Conservancy, Rolling Hills Estates, CA, USA

GIS models are used to enable computers to mathematically represent real geographical elements and objects, and then analyze and visualize natural phenomena in a geospatial context. In this applied research project, I created a GIS model in ArcMap ModelBuilder to predict two rare plant species distributions, *Atriplex pacifica* (Chenopodiaceae) and *Aphanisma blitoides* (Chenopodiaceae). The area of focus was the southern California coastal region of the Palos Verdes Peninsula. The model analyzed environmental factors that were concluded to produce a reliable estimation of where these species can survive. A model was created by looking at the statistical information for occurrence within the chosen factors. The factors used included aspect, slope, and soil type. Using the weighted overlay and weighted sum tools, I looked at the variability of input assumptions and combined them to receive an average of the results. The results show a zone of probability throughout the area of focus that looks favorable and field survey points validate portions of these zones. This model will continue to be refined and other inputs will be added as they become available to strengthen results. The model can be applicable to similar southern California coastal areas.



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7.13 California Plant Rescue: A collaborative vision to conserve the California flora

Stacy Anderson¹, Cheryl Birker², Holly Forbes³, Naomi Fraga², Tony Gurnoe⁴, Brett Hall⁵, Christa Horn¹, Vanessa Handley³, David Magney⁶, Evan Meyer⁷, Joyce Maschinski¹, Bart O'Brien⁹, Heather Schneider¹⁰, Aaron E. Sims⁶, Shannon Still¹¹

¹San Diego Zoo Global, San Diego, CA, USA, ²Rancho Santa Ana Botanic Garden, Claremont, CA, USA, ³University of California Botanical Garden, Berkeley, CA, USA, ⁴San Diego Botanic Garden, Encinitas, CA, USA, ⁵University of California, Santa Cruz Arboretum, Santa Cruz, CA, USA, ⁶California Native Plant Society, Sacramento, CA, USA, ⁷University of California, Los Angeles, Mildred E. Mathias Botanic Garden, Los Angeles, CA, USA, ⁸Center for Plant Conservation, Escondido, CA, USA, ⁹Tilden Regional Park, Regional Parks Botanic Garden, Berkeley, CA, USA, ¹⁰Santa Barbara Botanic Garden, Santa Barbara, CA, USA, ¹¹University of California, Davis Arboretum, Davis, CA, USA

The California Plant Rescue (CaPR) is a collaboration of not-for-profit botanical institutions working to conserve the wild species of California and the California Floristic Province. CaPR has the over-arching goal to secure the future of California's native flora by collecting seeds of California native plant species for long term preservation in regional seed banks (ex-situ conservation), and to record information from wild populations to support information needed for land management efforts (in-situ conservation). Since being founded in 2015, CaPR has made significant progress. Through partnerships with the Millennium Seed Bank and Bureau of Land Management, seed collection of rare species has increased significantly, and regular communication and standardization of practices among CaPR partners has improved the conservation value of these collections. While much progress has been made, the organization is still in its first chapter. I'll discuss the future of CaPR, emphasizing the collaborative nature of the project, and ways in which the California botanical community can help advance these efforts. The issues facing plant diversity in the 21st century will require novel and creative solutions, drawing on multiple areas of expertise. CaPR seeks to help organize those efforts and ensure that the flora of California flourishes in this century and beyond.

7.14 Using UAVs (drones) to collect greening up data on normalized difference vegetation and red edge indices (NDVI and NDRE) to improve California vegetation mapping

Paul Laris, Scott Winslow, Alex Pakalniskis
California State University, Long Beach, Long Beach, CA, USA

Remotely sensed imagery has long been used to map vegetation. Recently the data and methods available have gone through a transformation. The spatial resolution of commercially available imagery has reduced an order of magnitude from meters to centimeters, while the image processing software for classifying has developed to allow the user to include both spectral and spatial data facilitating vegetation mapping. The development of low cost Unoccupied Aerial Vehicles (UAVs or drones) further advances the capability to distinguish vegetation formations because imagery can be gathered cheaply and at high resolution for multiple dates. By adding multi-temporal data, on infrared reflectance in particular, users can potentially distinguish between native plant species with similar reflectance signatures by focusing on their phenological cycles. In this study we use UAVs to fly and image a study area in Serrano Valley, California comprised of a mix of Coastal Sage Scrub, Chaparral and grassland species. We use two cameras: one with a true color lens and the other a Sequoia multi-spectral camera that has red, green, infrared and "red-edge" (730-740 nm) bands. We collect bimonthly images for the study areas, processing them using Pix4D software to document the "greening up" of vegetation using both normalized difference vegetation and red edge indices (NDVI and NDRE). We then use E-Cognition software to classify the imagery and map vegetation alliances. We conclude that multi-temporal imagery gathered from UAVs holds the potential to produce vegetation maps at the alliance scale, which will be of great use for researchers and conservationists.

7.15 How connecting to nature relates to the future's health

Blanca Diaz
Mama Maiz, Long Beach, CA, USA

How is our futures health affected by the way we connect with nature? We are having conversations about the rise of diabetes, we even discuss how technology has taken the place of outdoor activities. With this awareness, how are we taking action, and what changes are being made? Children in America spend an average of 943 hours in a classroom each year and when they get home they spend an average of 4 hours outdoors. Can this create a sense of disconnect in



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the forms of physical and emotional "illness"? Our children and future generations are those who will protect our earth and who will carry the roles of steward, botanist, naturalist and so on. How can we incorporate traditional practices to introduce all the beauty by the river bed, deep in the woods, under the desert sky or even in the middle of the urban city? How can a lack of connection to nature affect our lives? When we get kids and adults outdoors we experience the elements, we feel the air, dig our hands in the earth and if we are fortunate enough, we can eat straight from our gardens. Being outdoors reduces emotions like anxiety and sadness, and may assist with mental and physical imbalances. But how do we begin to connect with nature?

VEGETATION CLASSIFICATION, MAPPING, & MONITORING

Government agencies, NGOs, academic institutions, and consulting firms have been improving standards and products in vegetation mapping and classification since Geographic Information System and remote sensing technology have expanded in the late 20th century. Vegetation mapping and classification are important tools for species, habitat, and landscape assessment, analysis, monitoring, and conservation, driving many of today's decisions for land-use planning. This session showcases promising recent uses of vegetation mapping and monitoring for decision-making in conservation and management efforts throughout California.

8.01 Improvements in analyzing and classifying vegetation survey data

Anne Klein, [Rachelle Boul](#), Patrick McIntyre, Rosalie Yacoub, Todd Keeler-Wolf
California Department of Fish and Wildlife, Sacramento, CA, USA

The Vegetation Classification and Mapping Program (VegCAMP) of the California Department of Fish and Wildlife (CDFW) and the Vegetation Program of the California Native Plant Society (CNPS) use similar statistical techniques to analyze data defining vegetation types across California. For over 15 years, the process of analyzing and classifying field survey data lacked a standard process for screening out auto-correlated surveys, included time-consuming analysis steps, and used a Braun-Blanquet cover-abundance scale for categorizing species data. New approaches to removing auto-correlated surveys from datasets, automating analysis steps, and adjusting species cover data show success in improving the classification process and results. Starting in 2017, the new methods were tested on two separate, large-scale ecoregional datasets from Southern California and the Sierra Nevada Foothills. After similar surveys grouped together based on species abundances and frequencies determined by cluster analysis, location information was analyzed using a spatial proximity tool in ArcGIS. Distances between closely related surveys were determined and auto-correlated field surveys within 200m of each other were removed. Additionally, some analysis steps were automated using R statistical package, and tables exceeding the limits of our MS Access databases were generated in Excel. This reduced human error in data processing and improved efficiency for analysis and classification. Finally, relativizing percent cover by species within surveys produced more reliable cluster analysis outputs, facilitating a more straightforward classification process. These findings show promise for more efficient, reliable, and repeatable analytical processes supporting a unified vegetation classification for California.

8.02 Habitat mapping at Rush Ranch Open Space Preserve, Suisun Marsh, Solano County

[Michael Vasey](#)¹, Jared Lewis¹, Kristin Byrd², Matt Ferner¹, Anna Deck¹

¹*San Francisco State University, San Francisco, CA, USA*, ²*United States Geological Survey, Menlo Park, CA, USA*

From the pioneering work of Herbert Mason last century until the present, tidal wetlands in the Suisun Marsh have been recognized for their exceptional native plant diversity and local species endemism. During the 19th and early 20th Centuries, the marsh was diked for agriculture and later managed ponds for waterfowl conservation and hunting. The largest remnant tidal marsh in the region (1050 acres) is Rush Ranch Open Space Preserve, owned and managed by the Solano Land Trust. Rush Ranch hosts several rare plant species including the federally-listed Suisun thistle (*Cirsium hydrophilum* [Asteraceae]) and soft bird's-beak (*Chloropyron molle* [Orobanchaceae]). In 2003, Rush Ranch was designated as one of two components of the San Francisco Bay National Estuarine Research Reserve (NERR) because of its outstanding tidal wetland values. The NERR System emphasizes long term research and monitoring in its 29 NERR sites around the country. Habitat mapping is a core part of its mission. The creation of a habitat map for Rush Ranch has been a collaborative effort. It has benefitted from a relatively coarser-grained mapping project by the California Department of fish and Wildlife, a moderate-grained mapping effort by Dr. Kristin Byrd of USGS, and recent tests of fine-grained unmanned aerial vehicle (UAV) imagery. Each of these approaches presents trade-offs between accuracy, area covered, potential disturbance, and costs. This presentation explores these different trade-offs and how they relate to requirements of the NERR System for long term habitat monitoring.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

8.03 Mapping vegetation community types in a highly-disturbed landscape: Integrating hierarchical object-based image analysis with digital surface models

Rachel Snavelly¹, Douglas Stow², Kellie Uyeda², John O'Leary²

¹The University of Texas at Austin, Austin, TX, USA, ²San Diego State University, San Diego, CA, USA

Increased demand for more accurate vegetation cover data and greater availability of high spatial resolution imagery have furthered object-based image analysis (OBIA) for faster and more reliable mapping of vegetation communities. Definitions of boundaries with spectrally heterogeneous vegetation types may be inconsistently or poorly defined, particularly with challenges pertaining to varying percent cover or minimum mapping units (MMU), rendering community-level vegetation mapping even more complex. Advances in OBIA technology, however, facilitate novel remote sensing methods to address these challenges. A combination of OBIA, high-resolution imagery, and a LiDAR-derived normalized digital surface model (nDSM) was used to map vegetation communities on San Clemente Island, the southernmost of California's Channel Islands. Its long history of ecological disturbance, ranging from exotic herbivore grazing to tactical military use, has created an extremely heterogeneous vegetative landscape. A multi-level segmentation routine was developed: the individual shrub object or patch level, and a larger community level. Community level objects were tested for MMU and percent cover rules per vegetation cover type, and boundaries between same-class adjacent objects were generalized. Next, classification sensitivity was compared for whether an nDSM was incorporated. Accuracies for the combined areas of interest (AOIs) were equal (63%) for both classification methods, but individual AOI results reveal that nDSM inclusion resulted in higher mapping accuracies (84% and 70% compared to 72% and 53%), and nDSM-aided individual vegetation classes were generally greater. These results demonstrate the effectiveness of the OBIA approach particularly with nDSM, and emphasize advantages and limitations of conducting multi-scale analyses when characterizing a highly-disturbed landscape.

8.04 One if by land, two if by air: A model for expedited vegetation mapping and accuracy assessment via helicopter support

John Knapp¹, Morgan Ball², Katrina Olthof², Ken Niessen², Dirk Rodriguez³

¹The Nature Conservancy, Ventura, CA, USA, ²Wildlands Conservation Science, Lompoc, CA, USA, ³Channel Islands National Park, Ventura, CA, USA

Vegetation mapping at the landscape scale can be time consuming and costly. Field mapping and accuracy assessments can take multiple seasons to complete with many botanists involved, thus influencing the consistency of the data collected. Merely getting to sites where relèves and accuracy assessments are conducted may take far more time and cost far more than actually conducting them. To reduce the time and money required for this work, we conducted them with the support of a small helicopter to deploy botanists to pre-selected relève sites and conduct aerial based accuracy assessments with high-definition, geo-referenced digital photography. We found that we can conduct the same work 12 times faster and at half the cost compared to traditional ground-based methods on 64,000 acres of Santa Cruz Island, California. Four hundred relèves were completed by a daily average of 3.5 staff members over a single growing season in less than four weeks, and 1,400 accuracy assessments were conducted by a team of two in less than two weeks. This approach proved to be so cost-effective that it was adopted by the Department of Defense to conduct an aerial-supported vegetation classification of a 660,000-acre property near Fallon Naval Air Station in Nevada in under 20 days with two surveyors. Utilizing helicopter support to conduct field work at the landscape scale as proven to be an efficient method to conduct both relèves and accuracy assessments consistently, in less time and fewer people in support of vegetation mapping in California.

8.05 Development of a fine-scale vegetation and habitat map for Sonoma County, CA

Mark Tukman

Tukman Geospatial LLC, Santa Rosa, CA, USA

The Sonoma County fine-scale vegetation and habitat map is an 83-class vegetation map of Sonoma County with over 200,000 polygons. The fine-scale vegetation and habitat map represents the state of the landscape in 2013 and adheres to the National Vegetation Classification System (NVC). CNPS and the California Department of Fish and Wildlife collected plot data and developed the classification for this project. The map was designed to be used at scales of 1:5,000 and smaller. The Sonoma County fine scale vegetation and habitat map was developed using a semi-automated

approach. The approach combines Ecognition segmentation, extensive field data collection, machine learning, manual editing, and expert review. Ecognition segmentation and classification provides stand delineations and lifeform class labels. Field data collection results in a large number of training polygons labeled with their field-validated map class. Machine learning relies on the field collected data as training data and a stack of GIS datasets as predictor variables. The resulting model is used to create automated fine-scale labels countywide. Machine learning algorithms for this project included both Random Forests and Support Vector Machines (SVMs). Machine learning is followed by extensive manual editing, which is used to 1) edit segment (polygon) labels when they are incorrect and 2) edit segment (polygon) shapes when necessary.

8.06 Whitebark pine in California: State-wide forest health monitoring using ground- and remote sensing-based detection of vegetation disturbance

Michele Slaton¹, Alexander Koltunov², Carlos Ramirez¹

¹United States Forest Service, Remote Sensing Lab, McClellan, CA, USA, ²Center for Spatial Technologies and Remote Sensing, University of California, Davis, Davis, CA, USA

Vegetation mapping at the landscape scale can be time consuming and costly. Field mapping and accuracy assessments can take multiple seasons to complete with many botanists involved, thus influencing the consistency of the data collected. Merely getting to sites where relèves and accuracy assessments are conducted may take far more time and cost far more than actually conducting them. To reduce the time and money required for this work, we conducted them with the support of a small helicopter to deploy botanists to pre-selected relève sites and conduct aerial based accuracy assessments with high-definition, geo-referenced digital photography. We found that we can conduct the same work 12 times faster and at half the cost compared to traditional ground-based methods on 64,000 acres of Santa Cruz Island, California. Four hundred relèves were completed by a daily average of 3.5 staff members over a single growing season in less than four weeks, and 1,400 accuracy assessments were conducted by a team of two in less than two weeks. This approach proved to be so cost-effective that it was adopted by the Department of Defense to conduct an aerial-supported vegetation classification of a 660,000-acre property near Fallon Naval Air Station in Nevada in under 20 days with two surveyors. Utilizing helicopter support to conduct field work at the landscape scale as proven to be an efficient method to conduct both relèves and accuracy assessments consistently, in less time and fewer people in support of vegetation mapping in California.

8.07 Does the California Native Plant Society/California Department of Fish and Wildlife vegetation sampling and mapping process work outside of California? How about East Africa?

John Vollmar¹, Jake Schweitzer¹, Todd Keeler-Wolf², Jennifer Buck-Diaz³

¹Vollmar Natural Lands Consulting, Inc., Berkeley, CA, USA, ²California Department of Fish and Wildlife, Sacramento, CA, USA, ³California Native Plant Society, Sacramento, CA, USA

The California Native Plant Society/California Department of Fish and wildlife vegetation classification and mapping process, widely applied in California, has been minimally tested elsewhere. In 2015-2016, we directed a project in East Africa, supported by the Tanzania Wildlife Research Institute (TAWIRI), where all aspects of the integrated process (sample allocation, data collection, species identification, data analysis, mapping, and map accuracy testing) were applied to a 25,000 ha area in NE Tanzania between Lake Manyara and Tarangire National Park known as the Kwa Kuchinja Wildlife Corridor. It supports acacia savanna, seasonal wetlands, riparian forest, grasslands, and thorn scrub. The area is rapidly changing from population growth and conversion of the traditional Masai pastoral lifestyle to agriculture. However, it still supports migratory herds of wildebeest, zebra, elephant, giraffe, and other animals. In April 2015, we collected 200 relevés and rapid assessments. Back in California, we analyzed the data and produced a draft vegetation classification and map. In March 2016, we collected an additional 250 field verification points for accuracy assessment. We analyzed and integrated these data to produce a final classification and map. The CNPS/CDFW methodology translated well to this tropical savanna ecosystem, though we did encounter some challenging and humorous difficulties working across international boundaries. The map is being used by TAWIRI and locally-governed Wildlife Management Areas to understand habitat conditions and land use priorities to maintain a functional wildlife corridor. Tanzanian botanists participated in all aspects of this study and are convinced of the usefulness and applicability of the process elsewhere in the country.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

8.08 Coordinated monitoring of wildlife and native plants in California: Vegetation alliances explain variation in avian community composition

Brett Furnas¹, Lindsey Rich², Andrew Engilis³, Todd Keeler-Wolf¹

¹California Department of Fish and Wildlife, Sacramento, CA, USA, ²University of California, Berkeley, Berkeley, CA, USA,

³University of California, Davis, Davis, CA, USA

As a public trust agency, the California Department of Fish and Wildlife is responsible for conserving and managing fish, wildlife, and botanical resources throughout the state. Effective planning to protect these resources requires comprehensive monitoring of species populations and distributions at large spatial scales. The Department in collaboration with the University of California is working towards coordinating multi-species wildlife surveys and vegetation mapping throughout the state. For example, 226 random sites throughout the Mojave Desert ecoregion were concurrently surveyed for birds, reptiles, bats, other mammals >0.5 kg, and vegetation in 2016. Breeding passerine birds were surveyed at each site using automated sound recorders at different times of the morning over three consecutive days. We modeled avian occurrence using a multi-species occupancy model that adjusted for heterogeneities in detection probability. We also measured and classified vegetation alliances at these same sites using the National Vegetation Classification System that is used widely throughout the USA. Using hierarchical cluster analysis, we found that the composition of avian metacommunities estimated from occupancy modeling was partially explained by differences among vegetation alliances grouped on dominant plant genus. This finding highlights the value of coordinated natural resource monitoring for wildlife and plants. The conservation implication is that this type of data could help planners to protect wildlife species in part through a better understanding of the vegetation communities that support wildlife.

8.09 Measuring the health of a mountain: Vegetation indicators for ecosystem health of Mount Tamalpais

Andrea Williams¹, Rachel Kesel², Janet Klein¹, Sharon Farrell², Elizabeth Edson², Michelle O'Herron³

¹Marin Municipal Water District, Corte Madera, CA, USA, ²Golden Gate National Parks Conservancy, San Francisco, CA, USA, ³O'Herron & Company, San Francisco, CA, USA

Mt. Tamalpais in Marin County is a biodiversity hotspot, hosting over 1,000 plant taxa in more than 100 recognized communities—as well as the animals and physical processes that maintain this rich landscape. Determining whether Mt. Tam is "healthy" was the focus of a year-long process, selecting indicators and metrics and determining status and trend in relation to goals, with information gleaned from available sources such as vegetation maps, species lists, rare and invasive plant inventories and monitoring, research, and plant community monitoring. Initial indicators included grasslands, redwood forests, oak woodlands, maritime chaparral, serpentine barrens, Sargent cypress stands, riparian areas, and wet meadows; these communities represented high diversity, iconic or rare plants, and sensitivity to stressors such as climate change, disease, absence of natural fire regime, and presence of invasive species. After workshop feedback, shrublands were added. The overall species list, percent of non-native and invasive plants in the flora, and provisional list of likely extirpated species were also examined. Having repeated landscape-scale vegetation maps, up-to-date rare and invasive plant population data, and reasonably comprehensive historic and recent local floras were essential in the process.

8.10 Interactive web platforms drive conservation assessments and planning: West Mojave ecoregion case study

Dustin Pearce, Rebecca Degagne, James Strittholt, John Gallo, Heather Rustigian-Romsos, Tim Sheehan, Mike Gough, Justin Brice, Annie J. Prisbrey

Conservation Biology Institute, Corvallis, OR, USA

Conservation planning and assessments continue to progress rapidly as computing and prioritization methods become more advanced. However, there remain large challenges for organizations in terms of data access, usability of platforms, and collaboration among groups. The online web platform Data Basin allows users to easily share spatial datasets and bridges the divide between conservation planners, organizations, and stakeholders of all technical skill levels. Integrated tools such as the Environmental Evaluation Modeling System (EEMS) and new interactive tools such as EEMS Online facilitate participation and drive co-production of planning and prioritization in a transparent and easily understood process. This method of integrative conservation planning has taken place in the San Joaquin Valley and most recently in the Mojave Desert. In the West Mojave Ecoregion, a group of diverse environmental stakeholders came together to help



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

drive, direct, and review a planning effort that identified areas of high conservation value and areas of lower conflict for solar energy development in the region. This involved the creation of a conservation value model that identified areas of high vegetation value, focal species habitat, occurrences of threatened and endangered species, and connectivity corridors. The process was facilitated by sharing data on Data Basin, synthesizing disparate data with EEMS logic models, and allowing for review and analysis to be undertaken by environmental stakeholders via EEMS Online. Ultimately the group identified 200,135 acres (6.2%) out of the 3.2 million acre study area as lower conflict land that may be suitable for solar development.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

RARE NATURAL COMMUNITIES

This session examines the identification of rare natural communities and the use of vegetation mapping to inform their conservation.

9.01 Red listing ecosystems in the Americas - some preliminary findings for California

Patrick Comer

NatureServe, Boulder, CO, USA

Everyone knows that coral reefs are in danger, and that the rainforests are disappearing - or do we? How much of these ecosystems are left, what are they threatened by, and how likely are they to disappear across their range? Accelerating land use and climate change threatens ecosystems worldwide. Conserving biodiversity hinges on our ability to understand changes in the condition of the ecosystems and the species they support. One important step is documenting the at-risk status of ecosystems. With generous support of major foundations and others, we have initiated the development of the IUCN Red List of Ecosystems across the Americas. Like the IUCN Red List of Species, a system that ranks species based on their risk of extinction, the Red List of Ecosystems ranks which ecosystem types should be considered "Vulnerable" "Endangered" or "Critically Endangered." Side-by-side with species ranking of conservation concern, the Red List of Ecosystems provides a more complete picture of the status of biodiversity. This process requires that we address a series of the technical issues and challenges, including how ecosystem types are classified, how we map their distribution, and then identify key ecological processes that could lead to their decline. How do we define and measure ecosystem degradation? And how does that differ across different ecosystem types? Starting with initial findings from Mediterranean ecosystems more broadly, we will identify some of California's more endangered upland and wetland ecosystems, the underlying reasons for their status, and information needs to complete the picture.

9.02 Global, regional, and local rarity of vegetation communities as a foundation for the Bay Area Conservation Lands Network

Stuart Weiss¹, Tom Robinson¹

¹*Creekside Center for Earth Observation, Menlo Park, CA, USA*, ²*Bay Area Open Space Council, Berkeley, CA, USA*

The Bay Area Conservation Lands Network (CLN) is a conservation vision for 10 counties around San Francisco Bay (www.bayarealands.org). Vegetation rarity was central to the CLN process. A custom vegetation map, synthesized from available sources, was used as a "coarse filter" for biodiversity. The medium resolution classification into 51 vegetation types, including serpentine variants and climatic stratification of annual grasslands, represented ecological complexity of the region. Vegetation types were stratified by 33 "landscape units"--mountain ranges and valleys--to capture biogeographic diversity and local rarity. Conservation goals for each of the 500+ vegetation x landscape unit combinations were set at 90% for globally and regionally rarest, 75% for locally rare (<5% of the landscape unit), and 50% for common types. Marxan software generated local networks within landscape units to meet the goals, while maximizing conservation suitability. The serpentine community variants captured numerous rare endemics, and all rare species were explicitly included as a "fine-filter" based on CNDDDB records. Consideration of local rarity, especially mesic vegetation within arid landscapes or conversely, arid vegetation within mesic landscapes, naturally created a "climate-smart" network. CLN was first released in 2011, followed by a 2014 Progress Report, and has been widely used to guide conservation decisions and assessments. In 2017, a CLN "Science Expansion" was started, with goals of incorporating ~140,000 acres of new protected lands to reconfigure the network, updating data sets including newer fine-scale vegetation maps, and incorporating conservation co-benefits such as water resources, viewsheds, rangelands, agriculture, and carbon storage.

9.03 Sonoma Veg Map: High resolution mapping in support of habitat and rare plant community conservation

Karen Gaffney, Allison Schichtel

Sonoma County Agricultural Preservation and Open Space District, Santa Rosa, CA, USA

The Sonoma County Agricultural Preservation and Open Space District permanently protects the diverse agricultural, natural resource, and scenic lands of Sonoma County for future generations. A voter-approved and community-funded special district, Sonoma Ag & Open Space relies on high resolution spatial data to prioritize lands for conservation.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

Sonoma Veg Map is a collaboration initiated by Ag & Open Space with multiple agency, NGO, private sector and academic partners, including California Department of Fish and Wildlife, California Native Plant Society, NASA, University of Maryland, Sonoma County Water Agency, Tukman Geospatial, Kass Green Associates and Prunuske Chatham. High resolution vegetation and plant community data and countywide LiDAR were created through this initiative, and are being used for a variety of applications - including hydrologic modeling, climate change assessment, carbon mapping, habitat restoration planning and the prioritization of land conservation actions. Products from Sonoma Veg Map have been critical to the evaluation and prioritization of rare habitats and plant communities - including riparian ecosystems, serpentine plant communities and old growth forests - and applied most recently in the development of Sonoma Ag & Open Space's long term conservation plan, the Vital Lands Initiative. Sonoma Ag & Open Space is using LiDAR and fine-scale vegetation data - in concert with modeling and expert input - to develop a county-wide approach to mapping floodplain riparian corridors. This information will support the Sonoma Ag & Open Space and its partners in establishing conservation easements along these corridors and ensuring permanent protection of associated benefits.

9.04 Bigcone Douglas-fir mapping and inventorying in the Angeles National Forest

Michael Kauffmann¹, Jaime Ratchford¹, Julie Evens¹, Ken Lindke²

¹California Native Plant Society, Sacramento, CA, USA, ²California Department of Fish and Wildlife, Arcata, CA, USA

Previous mapping and monitoring of the California endemic bigcone Douglas-fir (*Pseudotsuga macrocarpa* [Pinaceae]) has been done remotely in the National Forests of southern California through the Remote Sensing Lab's California Vegetation (CALVEG) system. CALVEG is a vegetation mapping tool, but is not used for monitoring the status or threats to species. The California Native Plant Society (CNPS), working in collaboration with the US Forest Service, Angeles National Forest, Pacific Southwest Regional Office, Above & Beyond Ecosystems Enterprise Unit, and TEAMS Enterprise Unit initiated field surveys in 2015 to assess the extent and status of bigcone Douglas-fir in the Angeles National Forest. Over the course of the project, 370 field assessments were conducted. In this process we verified distribution and status of bigcone Douglas-fir by ground-truthing polygons designated by CALVEG as bigcone Douglas-fir regional dominant and also visiting previously unidentified stands we found through heads-up digitizing. Results of our surveys included verifying approximately 35,300 acres of bigcone Douglas-fir in the Angeles National Forest which was 9,236 more acres than previously mapped in ELEG. We also assessed the current health of the species found mortality levels to be significant in about 20% of stands forest-wide. These surveys and proceeding mapping efforts now provide important baseline data for tracking the effects of climate change, altered fire regimes, and subsequent shifts in forest health.

9.05 The expansion of the hazelnut (*Corylus cornuta* subsp. *californica*) scrub type into Humboldt County and its relationship to the Wiyot Tribe on Table Bluff and Humboldt Bay

Adam Canter

Wiyot Tribe Natural Resource Department, Loleta, CA, USA

The hazelnut (*Corylus cornuta* ssp. *californica* [Betulaceae]) scrub vegetation alliance is a rare vegetation type (G3S2?) which occurs at less than 300 m., and was thought to only occur along the central coast of California, where populations are known from Montara Mountain in San Mateo County and Pt. Reyes National Seashore in Marin. Hazelnut scrub was recently identified in Humboldt County, around 200 miles north of its known range, where it occupies hypermaritime sites which are exposed to coastal fog and salt-laden winds. Populations have been noted within the ancestral territory of the Wiyot Tribe at Table Bluff, on Humboldt Bay, where the Tribe has an established history of harvesting and tending hazelnuts, which suggests these stands could be relics of historic Wiyot land management. As part of a Bureau of Indian Affairs funded geospatial project, the Wiyot Tribe has been able to begin mapping locations of hazelnut scrub, and other culturally important species and vegetation types, creating the foundation of a Wiyot ethnobotanical geodatabase. Significant ethnobotanical sites have been identified through a combination of methods such as geographic information systems (GIS) analysis, tribal ethnographic and oral history, traditional ecological knowledge, and research into historical herbarium records data provided by the Consortium of California Herbaria. Preliminary results have shown a correlation between important cultural plant communities and archaeological sites and trails. Most hazelnut scrub sites have been found on private lands and are experiencing forest or invasive species encroachment, highlighting the need for public awareness, eco-cultural restoration, and environmental protection.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

9.06 Soil chemistry patterns in an edaphic endemism hotspot: The Pebble Plains of the San Bernardino Mountains, California

Dylan Burge¹, Thomas Stoughton², Diana Jolles²

¹*Southern Oregon University, Ashland, OR, USA*, ²*Plymouth State University, Plymouth, NH, USA*

Pebble plains are a unique edaphic environment known only from the high valleys of the San Bernardino Mountains. The pebble plains are celebrated for the plant diversity they support, including at least six taxa endemic to the San Bernardino Mountains. Past research has shown that pebble plains soils differ from nearby non-pebble plains soils in terms of their high clay content and loose, stony structure. The stony character of these soils is probably the result of frost-heaving and erosion. This dynamic, harsh environment is thought to limit recruitment of trees and foster the persistence of the unique pebble plains flora. Despite decades of research on pebble plains, the soil chemical properties of pebble plains soils has not been investigated. This study investigates the chemistry of pebble plains soils to determine if they are chemically divergent from adjacent non-pebble plains soils. To answer this question, we collected soils from nine pebble plains areas, sampling from both the plains themselves and from surrounding forests. These samples were subjected to chemical analysis. Multivariate analyses indicate that habitat type (pebble plains versus non-pebble plains) is the most important factor explaining variation in soil chemistry. Our results suggest that while physical factors such as frost heave may be the primary agents responsible for the formation of the pebble plains, the soils of the pebble plains are chemically unique, which may reinforce physical constraints on floristic composition. Our results have implications for the conservation of pebble plains and the rare plants they support.

9.07 Livestock grazing affects vernal pool specialists more than habitat generalists in montane vernal pools on the Modoc Plateau

Kirsten Bovee¹, Kyle Merriam², Meredith Gosejohan³

¹*United States Forest Service, Lassen National Forest, Chester, CA, USA*, ²*United States Forest Service, Sierra Cascade Province, Quincy, CA, USA*, ³*Susanville Indian Rancheria, Susanville, CA, USA*

Although livestock grazing was initially considered a threat to California's rare vernal pool species, 21st century conservation strategies have utilized grazing as a tool to reduce non-native species cover and litter in Central Valley vernal pools. We asked whether livestock grazing conferred conservation benefits to montane vernal pools, which lack this dominant non-native species component. We further asked whether vernal pool specialists and habitat generalists respond differently to livestock grazing, reflecting the different evolutionary histories of these species. To explore the relative effects of livestock grazing and seasonal precipitation on montane vernal pools, we evaluated plant communities in 20 vernal pools on the Modoc Plateau, some of which had been fenced to exclude livestock for up to 20 years. We found that livestock enclosures strongly favored perennial vernal pool specialists over annual vernal pool specialists. By contrast, the cover of habitat generalists was influenced more by seasonal precipitation than by livestock grazing. Results suggest that over time, livestock enclosure may lead to a loss of cover of annual vernal pool specialists, species that land managers often wish to promote due to their endemism and rarity. However, perennial vernal pool specialists could be lost or greatly reduced where livestock grazing has been the long-term management strategy, and heavy utilization may also result in adverse impacts to annual species. Management that includes both fencing and grazing at varying spatial and temporal scales may be most effective at supporting the entire suite of species endemic to montane vernal pool habitats.

9.08 Panel: Crossroads for using tools in highlighting California's vegetation, diversity, rarity, and integrity

Pat Comer¹, Rebecca Degagne², Todd Keeler-Wolf³, Tom Robinson⁴, Jake Schweitzer⁵, Michele Slaton⁶, Rachel A. Snavely⁷, Misa Werner⁸

¹*NatureServe, Boulder, CO, USA*, ²*Conservation Biology Institute, Corvallis, OR, USA*, ³*California Department of Fish and Wildlife, Sacramento, CA, USA*, ⁴*Bay Area Open Space Council, Berkeley, CA, USA*, ⁵*Vollmar Natural Lands Consulting, Inc., Berkeley, CA, USA*, ⁶*United States Forest Service, Bishop, CA, USA*, ⁷*San Diego State University & University of Texas at Austin, Austin, TX, USA*, ⁸*California Energy Commission, Sacramento, CA, USA*

California is long renowned for its abundance of natural landscapes and agricultural bounties. Civilization has pushed aside much of California's native vegetation, but the wildlands that remain intact offer an opportunity for us to sustain the incredibly varied landscapes that support an impressive array of natural communities. Over 400 vegetation alliances occur



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

in California. No other state in the Nation boasts richness as high; for example, Nevada has less than 200 alliances and Oregon has less than 275 alliances. California's unique suite of environments – the result of Mediterranean and semi-desert climates and complex topography, geology, and geographic positions – have conferred upon it a rich bounty of endemic species nested within an unparalleled diversity of vegetation patterns and habitats. Ecologists, geographers, statisticians, and conservation biologists have been developing data and tools to capture, analyze, and quantify the complexity and diversity of vegetation. We now have medium to fine-scale maps and ground-based data in over 40% of California, along with tools that help us quantify change over time for adaptive management. However, we are faced with increasing pressures of civilization. While we hone these tools to target conservation and management actions, how can we develop, present, and utilize information to convince the public, agencies, and elected officials to protect these patterns of native vegetation-and the natural processes influencing them?



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

CHAPARRAL

Chaparral contains 24% of California's native vascular plant species, more of which are considered rare than can be found in any other plant community. Since it exists in every single county, chaparral represents the most accessible native plant experience to the greatest number of Californians, providing unique research and educational opportunities. This session will explore the chaparral's remarkable biodiversity, resilience, and value it provides to all the life forms that call it home.

10.01 California chaparral in a global context

Philip Rundel

University of California, Los Angeles, Los Angeles, CA, USA

Chaparral ecosystems represent the iconic vegetation of California, and in particular southern California, where they form the dominant vegetation cover over broad areas of the foothills of the Coast, Transverse and Peninsular Ranges. Evergreen sclerophyll shrubs which make up the characteristic component of chaparral communities parallel a similar dominance of this growth form in the Mediterranean Basin, central Chile, the Cape Region of South Africa, and Southwest Australia, regions of the world with a mediterranean-type climate of warm dry summer and cool wet winters. The Mediterranean Biomes comprised of these five regions are biodiversity hotspots that contain about one-sixth of the vascular plant species in the world in just 2.2% of the world's land area, and evergreen shrublands are a major component of this diversity. Despite the convergent evolution demonstrated by these shrublands, there are distinct differences in community structure and diversity between the regions. Chaparral floras include not just the dominant woody shrubs but a diverse assemblage of annual and herbaceous perennial species, many of which have life histories linked to post-fire succession. Chaparral as well as these other mediterranean-climate shrublands continue to be heavily impacted by urbanization, land-use change, climate change, and invasions by exotic species.

10.02 We are not alone out there

Harold Mooney

Stanford University, Stanford, CA, USA

Just over 50 years ago, scientists from all of the mediterranean climate regions came together for the first time to compare and discuss their findings on convergent ecosystems of the five mediterranean-climate systems of the world. This tradition has continued every few years since that time. This process has built new knowledge and international collaborations. The basis for the similarities and differences of these disjunct systems has been revealed and has stimulated further research. These meetings have revealed major findings as well as highlighting issues that still need attention.

10.03 Chaparral community diversity

Jon Keeley

United States Geological Survey, Three Rivers, CA, USA

Communities designated as 'chaparral' comprise diverse assemblages of shrubs in 15 or more genera and an order of magnitude more species. Since Jepson's first treatise on chaparral over 100 years ago, there have been numerous attempts to define chaparral. These definitions have sometimes been tied to geographical location, edaphic characteristics, species assemblage, leaf traits, postfire regeneration strategies, and other characteristics. This paper will outline the history of chaparral community definitions and evaluate the extent to which these 'communities' describe real entities and a model of how to envision chaparral community definitions.

10.04 Veiled by chaparral, born of fire, formed by time - Pinnacles National Park

John Sanders¹, Richard Halsey²

¹*Delphinus School of Natural History, San Luis Obispo, CA, USA*, ²*California Chaparral Institute, Escondido, CA, USA*



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

Within Pinnacles National Park in the chaparral-covered Gabilan Mountains, east of central California's Salinas Valley, are the spectacular remains of an ancient volcanic field. Millions of years of erosion, faulting and tectonic plate movement have defined this volcanic formation, providing habitat to more than 500 native plant species and nearly 300 lichens. Flowers are pollinated by the park's 400 species of bees, a higher density of species per area than any other known place in the world. About 1 in 6 species are kleptoparasites, and ¼ of the species are plant specialists. With its highly varied topography, soil types, and solar orientation, five natural plant communities exist within the park, with chaparral being the most dominant, characterized by old-growth stands of chamise (*Adenostoma fasciculatum* [Rosaceae]), big-berry manzanita (*Arctostaphylos glauca* [Ericaceae]), wedgeleaf ceanothus (*Ceanothus cuneatus* [Rhamnaceae]), Scrub Oak (*Quercus berberidifolia* [Fagaceae]) and Toyon (*Heteromeles arbutifolia* [Rosaceae]). Because of its long-term protected status, Pinnacles maintains a relatively high proportion of native plants compared to areas outside the park. In fact, the chaparral at Pinnacles is a showcase example of an intact shrubland ecosystem that elsewhere in the central part of the state has been largely been extirpated by agriculture, ranching, and development. Students enrolled in Delphinus School of Natural History's Summer Camps take advantage of this year-round outdoor science classroom to examine both the diversity of the chaparral's flora and fauna and the geological history that produced Pinnacles' challenging landscape.

10.05 Divergent evolutionary pathways enrich woody plant endemism in maritime chaparral

Michael Vasey

San Francisco State University, San Francisco CA, USA

Maritime chaparral is renowned for its number of local woody endemic species, particularly in *Arctostaphylos* (Ericaceae). How and why are there so many different endemics in a group with such long-lived individuals? And why are these woody endemics so prominent in coastal uplands and lowlands? Over the past two decades, the author has participated in a research program focused on understanding the ecology and evolution of *Arctostaphylos*. He will identify maritime chaparral endemics within this genus and, using a few examples from this genus, provide paleogeographic, ecological, genetic, life history, and morphological evidence suggesting that, although these species and subspecies share local endemism in common, their evolutionary journey to arrive at this condition has probably been quite divergent. For example, several species are apparently of recent origin (neoendemics) most likely as a result of hybridization when species' ranges overlapped during climatic shifts in the Pleistocene or more recently. Other species (paleoendemics) are likely to have been widespread over the past several million years and now are "trapped" in habitat refugia in more mild climatic conditions along the Pacific coast. The concept of neoendemics and paleoendemics has been recognized since Stebbins and Major in the 1960's, however, not as prominently within a single genus. Understanding the processes that lead to patterns of local endemism provides important insights for conservation purposes. Different pathways to endemism reflect the different histories of the maritime chaparral communities in which these endemics are situated and lead to more refined strategies for their protection and persistence.

10.06 Inspiring connections with and preservation of a unique maritime chaparral plant community through the protection of a threatened species - *Hazardia orcuttii* (Asteraceae)

Tony Gurnoe

San Diego Botanic Garden, Encinitas, CA, USA

Several plants native to maritime chaparral in Encinitas, California are threatened, largely by human development, but *Hazardia orcuttii* (Asteraceae) is noteworthy in its limited locality. A few hundred plants on a single mesa compose the entire remaining natural U.S. population. The San Diego Botanic Garden is part of a decades-long reintroduction project for *H. orcuttii*, in partnership with the California Department of Fish and Wildlife and the Center for Natural Lands Management. We're working to propagate *H. orcuttii*, among other endangered species including *Arctostaphylos glandulosa* ssp. *crassifolia* (Ericaceae) and *Ceanothus verrucosus* (Rhamnaceae) using clonal and sexual propagation methods to ensure that genetic diversity is preserved and to provide redundancies for our living collection. Despite our successes, horticulturists cannot preserve threatened plant populations without involving a broader percentage of the public. Residents of Encinitas regularly walk through Lux Canyon where the last natural population of *H. orcuttii* survives, without gaining any understanding of the context of their surroundings. Improving the public's awareness of local, native plant communities is as important as any of the horticultural work public gardens accomplish. Public gardens are an ideal platform to educate and engage people new to native plants and to continue to inspire those who are already interested in botany. Therefore, a crucial complement to the Garden's in-situ and ex-situ conservation work is fostering a sense of



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appreciation and excitement among our community. By helping people develop personal connections with local, native plants, they are more likely to support conservation efforts to protect them.

10.07 The flowering of chaparral geophytes post-fire - an unexpected role of cyanide

Winslow Briggs, Tong-Seung Tseng
Carnegie Institution for Science, Stanford, CA, USA

It is well known that many geophyte species flower in profusion following chaparral wildfire with subsequent decline in flowering frequency in the following years. Among these species are *Calochortus albus* (Liliaceae), *Calochortus venustus* (Liliaceae), *Toxicoscordion fremontii* (Melantheaceae), *Chlorogalum pomeridianum* (Agavaceae), *Bloomeria crocea* (Themidaceae) and *Triteleia laxa* (Themidaceae). The post-fire floral display in chaparral can be dramatic. Several reasons have been proposed to account for this flowering response: increased light on canopy removal; heat shock; fertilizer influx from ash; chemical(s) in smoke. Recently two chemicals, karrikin 1 (a butenolide) and glyceryl nitrile, that stimulate seed germination in sensitive species, have been isolated from smoke. Using corms of *Triteleia laxa*, we inquired whether either of these chemicals could bring about a flowering response or at least break their dormancy. Initial experiments with karrikin 1 failed to show any effect on the corms. Rooting was the same as in water controls as was shoot emergence and flowering. Glycolic acid nitrile (a commercially available compound with the same chemistry as glyceryl nitrile) caused dramatic rooting, shoot emergence, and acceleration of flowering. Since hydrolysis of both of these compounds releases trace cyanide, we tested whether cyanide vapor application would cause the response. Cyanide caused a dramatic increase in rooting, shoot emergence, and flowering. As dormancy declined, the effect of cyanide also declined.

10.08 The role of tracheids in drought resistance of angiosperm species that occur in chaparral shrublands

Robert Brandon Pratt, Marta Percolla, Anna Jacobsen
California State University, Bakersfield, Bakersfield, CA, USA

The chaparral shrub species that occur in low to mid-elevations throughout much of California tolerate the long hot and dry summers that characterize the climate in the region. One of the challenges for chaparral species is to sustain vascular water supply to evergreen leaves when tissues are dehydrated (xylem safety). Decades ago, Sherwin Carlquist found that many chaparral shrubs have a specialized tracheids as well as vessels in their xylem tissues, while more mesic species have only vessels and fibers. Tracheids are hypothesized to facilitate safe water transport after vessels fail when water is limited. The two chief types of tracheids among the evergreen chaparral species are true tracheids that are abundant throughout the xylem along with vessels, and vasicentric tracheids that are located only around vessels. Lack of data has limited analysis of tracheids; however, the data generated since the original studies allows for fresh analyses. In the present study, we used new data to show that species with tracheids do indeed have greater water transport safety during dehydration and this includes new 3D imaging (high resolution computed tomography, HRCT) analyses to directly examine dehydrated tissues of intact plants. We show that tracheids are critical for dehydration tolerance; however, some tracheid-bearing species have succumbed to drought-induced mortality during recent extreme droughts including iconic and diverse chaparral genera (*Ceanothus* spp. [Rhamnaceae] and *Arctostaphylos* spp. [Ericaceae]). The presence of tracheids facilitates dehydration tolerance, but deep roots appear to be more important to resisting extreme droughts for established species.

10.09 Niche segregation in water utilization as a mechanism of fern survival in chaparral shrub understories during extreme drought

Helen Holmlund¹, Natalie Aguirre², Jarmila Pittermann¹, Stephen Davis²
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California experienced severe drought between 2012 and 2016. During this period, we compared seasonal changes in tissue-water relations among eight fern species in the understory of shrubs and trees in a chaparral ecosystem of the Santa Monica Mountains. We tested the hypothesis that niche segregation in water utilization is a mechanism of drought survival during extreme water deficits. We monitored seasonal changes in water potential (Ψ_{md}) and dark-adapted chlorophyll fluorescence (F_v/F_m), assessed tissue-water relations including osmotic potential at saturation and the turgor

loss point ($\Psi_{s,sat}$ and $\Psi_{s,tlp}$), and measured xylem-specific and leaf-specific hydraulic conductivity (K_s and K_l) and vulnerability of stem xylem to water stress-induced embolism (water potential at 50% loss hydraulic conductivity, Ψ_{50}). Fern species grew in either riparian or chaparral understory. The five fern species in the understory of chaparral had a wider range of seasonal water potentials, root depths, and frond phenological traits, including one evergreen, two summer-deciduous, and two desiccation-tolerant (resurrection) species. Evergreen species were especially diverse, with an evergreen riparian species maintaining seasonal water potentials above -1.3 MPa, while an evergreen chaparral species had seasonal water potentials below -8 MPa. In those two species the Ψ_{50} values were -2.5 MPa and -4.3 MPa, respectively. Observed differences in physiological performance among eight fern species reflected niche partitioning in water utilization and habitat preference associated with distinct phenological traits. We predict differential survival among fern species as future drought events in California intensify, with desiccation-tolerant resurrection ferns having highest survival and evergreen ferns lowest survival.

10.10 Plant hydraulics of chaparral shrub species along an elevational gradient in the southern Sierra Nevada: Foothill woodland, chaparral, and mixed forest

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Chaparral shrubs form a locally important community within the Sierra Nevada mountains of California; however, the ecophysiology of shrubs within this community are relatively little studied compared to the chaparral communities of the coastal and transverse ranges. Within the Sierra Nevada, conservation and management planning activities often focus on the forest communities rather than these shrublands. We established sites along an elevational gradient to evaluate the seasonal water status and ability to resist water stress associated hydraulic failure (i.e., cavitation resistance) of chaparral species within the southern Sierra. Sites extended from a mixed chaparral and foothill woodland community (low elevation), to a well-developed chaparral community (mid-elevation), and a mixed forest and chaparral community (high elevation). Species were sampled at their lower and upper occurrence along the gradient, so that we could evaluate differences both within and between species. Plant access to water varied across the gradient, with low elevation sites experiencing greater water stress than upper elevation sites. Species differed in their cavitation resistance and cavitation resistance differed along the elevation gradient. There was substantial drought-associated dieback at the lowest elevation site, especially in *Ceanothus* (Rhamnaceae). Sierran chaparral species differ in their ability to resist water stress as well as in the amount of stress that co-occurring species experience. Low elevation chaparral may be operating close to their hydraulic limits, making them particularly sensitive to drought. Future drought may alter chaparral distributions within the Sierra and shift their elevational distribution.

10.11 Chaparral in the so-called Anthropocene

Paul Zedler
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It has been difficult for many, including some scientists, to accept that shrub dominated vegetation can cover vast tracts of land. A common view has held that in "proper" closed canopy vegetation, either grass or trees are dominant. Sober scientists of the early last century attempted to resolve the issue by classifying chaparral as a "fire disclimax" -- vegetation that wants to be something else, but is prevented from achieving it because of the perverse intervention of fire. The impending alteration of our climate will test the resilience of shrub ecosystems. Current understanding suggests that increased burning is likely to push the system into a state in which it is vulnerable to the invasion of exotic grasses, with positive feedback favouring transition to a kind of degraded grassland or sub-shrubland. But at the other end of the gradient, forests that in the past supported shrub vegetation as a temporary stage in recovery from fire may convert to closed-canopy chaparral. Although these likely shifts in vegetation patterns may not necessarily cause catastrophic extinctions, they will almost certainly result in a decrease in local biodiversity.

10.12 Connecting Californians with the chaparral, the state's most extensive, native ecosystem

Richard Halsey¹, Victoria Halsey², Rochelle Gaudette³
¹*California Chaparral Institute, Escondido, CA, USA*, ²*Ken Blanchard Companies, Escondido, CA, USA*, ³*San Diego Natural History Museum Canyoneers, San Diego, CA, USA*



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To discover how chaparral is being presented to the public, we examined nature centers, volunteer naturalist programs, publications, and curricula in Southern California. A number of nature centers do an excellent job presenting accurate content. However, the majority need updates to reflect current science and the major contribution chaparral makes to the state's biodiversity. Publications and curricula also need significant improvements. More than half of the nature centers reviewed offer extensive naturalist training courses. Passion and enthusiasm of staff and volunteer naturalists are as important as content in creating successful natural history programs. Utilizing active learning methodology vs. lecturing can be a key factor in a program's success. This approach combines active learning where students participate in the teaching process and meaningful interpretation that establishes personal connections with nature. The greater understanding resulting from this approach can inspire a diverse, new generation of long-term nature advocates and create an informed public that will appreciate the chaparral's value.

10.13 Exploring chaparral: Ecology and evolution of chaparral as reflected in student research and discoveries over a 35-year period

V. Thomas Parker

San Francisco State University, San Francisco, CA, USA

Chaparral is one of California's quintessential vegetation types with a high diversity of plants and animals. At the same time, its widespread distribution, edaphic and climatic diversity have made it a complex system to study. Having infrequent high-intensity wildfire as a core process places a further barrier to research. Yet the plants that make up the system provide incredible examples of ecology and evolution to a historically changing western North America. I have been fortunate to research this vegetation for almost the last 40 years, principally using a cadre of graduate students at the forefront. Training students is a powerful way of learning itself, as 'he who teaches learns the most' is actually a true statement for me. This talk reflects on the work of over 30 student researchers from my lab. These students have focused on 3 major areas of research, seed and seed bank dynamics, mycorrhizal mutualisms in chaparral dynamics, and the evolution of *Arctostaphylos* (Ericaceae) and the Arbutoideae subfamily. These student foci show the interplay between major processes driving chaparral ecology and the adaptive evolutionary responses of plants within the ecosystem. Here I synthesize the importance of student's research, mostly CNPS supported, as much of their research has uncovered dynamics that was not well known before, such as the co-evolutionary connection of seed bank dynamics with seed predators, the connection between mycorrhizal mutualists of chaparral and coastal forests and fire cycles, and the evolutionary divergence of clades in *Arctostaphylos* and the phylogenetic oddities of the Arbutoideae.

10.14 How educating California's children on chaparral ecology through hands-on exploration of the chaparral helps to foster a meaningful relationship with the land and how that relationship directly influences the future of preservation in California's chaparral

Victoria Monteleone

California Chaparral Institute, Escondido, CA, USA

Educating California's children on the chaparral ecosystem through hands-on outdoor exploration of the chaparral allows children to have a personal relationship with the land, a relationship that directly influences and affects future preservation of California's chaparral. As a California naturalist, I have observed in children an increased respect for the chaparral and heightened awareness of its intrinsic value as they begin to realize that the chaparral is right in their own backyard. With the combined powers of awareness and curiosity, an interest in knowing the chaparral on a more scientific level naturally develops and allows the conversation to mature into discussing basic concepts of the chaparral ecosystem such as drought tolerance and fire frequency, the biodiversity of the native plant community, and the affects of human interference from many years of land misuse and misunderstanding. Exploring this concept of land ethics and nature philosophy through my observations and experiences as a chaparral chaperone, I will illustrate my methods of inspiring children to foster a relationship with the chaparral, how that relationship evolves to scientific understanding of the chaparral ecosystem, and why a child's understanding of the chaparral is detrimental to the future of preserving California's chaparral.

10.15 In diversity is the preservation of the natural world - embracing Ralph Waldo Emerson's philosophy of self reliance and transcendentalism to help create a wider audience to appreciate, protect, and preserve California's native shrublands



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Daniel Briceno

Southwestern Community College, Chula Vista, CA, USA

Chaparral, a place of chaparral, dwarf, dense oaks and shrubbery, came to symbolize independence, self-reliance, and wildness in coastal central and southern California during the time of the Spanish vaquero. Ignoring royal decrees, Spanish ranchers taught the local indigenous peoples the skills of horsemanship and incorporated them into the rich and diverse vaquero culture. Today, thousands of Hispanic families continue to enjoy the region's chaparral-covered landscapes like those found in the San Gabriel Mountains. However, the composition of organizations that promote the protection and preservation of California's wildlands do not typically reflect the state's increasingly diverse population. By blending Emerson's philosophy with the historical connection that the Hispanic community has with wild California, the environmental community can reorganize itself to better reflect the changing mix of cultures in the state. As a consequence, a stronger constituency to support the chaparral's preservation can be formed.

10.16 Chaparral distribution - past, present, and future

Richard Halsey¹, Jon Keeley²

¹California Chaparral Institute, Escondido, CA, USA, ²United States Geological Survey, Three Rivers, CA, USA

Chaparral currently covers approximately 10% of California's landscape. The ecosystem has expanded and contracted over the past 10 million years as the climate has changed. Now chaparral faces additional pressures from an expanding human population, which brings increased fire frequencies, development, and higher carbon emissions that are altering the climate in dramatic ways. Early researchers speculated that chaparral was much more expansive than it is today, prior to the migration of humans to California, by identifying what they viewed as relic stands. Impacts by Native Americans, early settlers from Europe, and recent activities have all played a role in reducing the amount of land the chaparral occupies. The potential for continued loss will have significant impacts on California's biodiversity and culture.

10.17 How healthy is the shrubland? - A simple integrity monitoring protocol for chaparral and coastal sage scrub

Dawn Lawson¹, Jon Keeley²

¹United States Navy, Space and Naval Warfare Systems Command, Systems Center Pacific, San Diego, CA, USA,

²United States Geological Survey, Three Rivers, CA, USA

Shrublands in Mediterranean-type ecosystems support high levels of biodiversity and are threatened by multiple factors in heavily used landscapes. To be effective, management and land use decisions should be informed by up-to-date information on ecosystem quality and resilience. We present an integrity monitoring protocol based on ecosystem components readily understood by non-specialists, which is expected to enhance communication between stakeholders. Community integrity is defined by plant functional group (shrub and non-native annual grass) composition. The ability to use these simple, easily observable metrics results from 1) the relatively good alignment of characteristic bird, mammal and insect communities with shrub cover, 2) the positive feedback between annual grasses and fire, and 3) the inhibitory effect of annual grasses on shrub seedling establishment. The protocol is designed to: 1) categorize habitats into ecosystem integrity classes, 2) forecast likely integrity class changes caused by threats (e.g. short fire interval) and environmental conditions (e.g. annual patterns in precipitation), and 3) provide a simple reporting mechanism (annual maps) that can be overlain with data on conservation status (e.g. endangered species status) and vulnerabilities (i.e. short fire interval). It incorporates streamlined updating initially using annual fire maps, which over time will be based on a more complex model of ecosystem drivers. Annual map and integrity classification system validation and refinement utilize a two-tiered vegetation sampling system that employs rapid visual estimation techniques and plot-based measurements. Monitoring data is also anticipated to help identify and characterize emerging threats over time.

10.18 Argentine ants - the silent saboteurs of native plant gardens? The possible role of an invasive species in increasing mortality, distribution of weeds, and the spread of disease in native plant landscapes and along the wildland/urban interface

Greg Rubin

California's Own Native Landscape Design, Inc., Escondido, CA, USA

Far from being an aggravating nuisance, Argentine ants (*Linepithema humile* [Formicidae]) may pose enormous hidden dangers to both native horticulture and the wildland/urban interface. Observations from hundreds of native installations appear to confirm that Argentine ants are a major cause of plant mortality, which may provide an explanation for vexing losses experienced in landscapes and restorations. Ant support for Hemipteran colonization of root systems, and their possible role in spreading pathogens like *Phytophthora* spp. may be primary reasons for such losses. Observational data would also indicate that Argentine ants may be responsible for sowing and spreading numerous common, invasive plant species (and even some natives) within their radius of infestation. Photographic documentation and limited scientific research support many of these observations. Control methodologies are being developed that may ultimately lead to reduction in plant mortality and invasive weed concentrations. Nevertheless, many specific hypotheses will need to be tested through additional scientific research.

10.19 Habitat fragmentation threatens chaparral conservation via negative impacts on pollinators

Jess Davids¹, Keng-Lou James Hung², David Holway¹

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Chaparral harbors diverse assemblages of insect-pollinated plant species as well as insect pollinators, whose fates are intricately tied. As with many other ecosystems in California, chaparral is threatened by habitat loss and fragmentation due to human development. We compared chaparral and coastal sage scrub habitats in natural reserve versus habitat fragment sites with respect to the species richness, functional diversity, and mean geographical range size of native bees, the most important pollinators in our region. We found that habitat fragmentation in scrub habitats in San Diego markedly reduced bee species richness. Scrub fragments also harbored bee assemblages with lower functional diversity, which may potentially lead to decreased quality and stability of pollination services. Additionally, bees in scrub fragments are dominated by widespread species with large geographical range sizes. Such preferential loss of range-restricted bee species in fragments may indicate loss of endemic plants, endanger pollination services to endemic plants, or perhaps both. Thus, while chaparral fragments in urbanized landscapes may harbor populations of key foundational plant species and retain the overall appearance of healthy habitats, preserving large expanses of habitat will be crucial for conserving plants, bees, and their interactions.

10.20 Where to restore the chaparral? The use of ecological and ecosystem service data to prioritize restoration efforts

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Chaparral shrublands are the most extensive ecosystem type in southern California. Despite their perceived resilience, these shrublands have the potential to become degraded from a diversity of human-induced disturbances, including human-caused short interval wildfire and associated type-conversion to non-native annual grasses, which in turn alters ecosystem functioning and provision of associated ecosystem services. Ecological restoration of shrublands is a key tool for resource managers to combat chaparral degradation following disturbance. Given the increased interest and need for restoration particularly on public lands, we developed a prioritization framework to identify areas of greatest need and determine the most suitable areas to focus restoration efforts within disturbed chaparral ecosystems. Ecological data, such as the pre-disturbance cover of non-native annual grasses, nitrogen deposition, past fire history and climatic data, can be used to identify the most susceptible areas to degradation following disturbance. To further refine priority restoration areas, ecological data can be coupled with a quantification of ecosystem services, such as sediment erosion, water provision, biodiversity, carbon storage, and recreation to determine high value restoration sites. We will demonstrate our approach using the 2016 Sand Fire on the Angeles National Forest as a case study to highlight the utility of this post-disturbance restoration strategy, and illustrate some of the spatial data that is available to inform such an approach.

PATHOGENS & PESTS

The California flora is increasingly threatened by the invasion of non-native species which include a broad array of organisms such as plants, arthropods, fungi, and bacteria. The susceptibility and resistance of native species will be evaluated through a combination of ecological techniques, population genetics, genomics, and management. This session will focus on exotic pathogens and pests currently threatening native California flora.

11.01 Exotic root-rotting *Phytophthora* species detected in restoration plantings on the Angeles National Forest have implications for chaparral health

Katie VinZant¹, Susan Frankel², Tedmund Swiecki³, Elizabeth Bernhardt³, Janet Nickerman⁴

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The Angeles National Forest (ANF) utilizes thousands of nursery-grown native plants for the restoration of areas disturbed by special uses, fire, and recreation activities. Recent pathogen testing has shown plants being grown in several southern California native plant nurseries and outplanted at restoration sites are contaminated with at least seven root-rotting *Phytophthora* (Pythiaceae) species, including a new, or new hybrid species. *Phytophthora* species were recovered from field-planted nursery plants that were dead, dying, or showing other root rot symptoms. *Phytophthora* was detected in field-planted nursery-grown stock of *Adenostoma fasciculatum* (chamise [Rosaceae]), *Eriodictyon crassifolium* (yerba santa [Boraginaceae]), *Malacothamnus fasciculatus* (chaparral mallow [Malvaceae]), *Quercus agrifolia* (coast live oak [Fagaceae]), and *Q. john-tuckeri* (Tucker oak [Fagaceae]). Most of the same root-rotting *Phytophthora* species were also detected in largely symptomless plants of these or other plant species at several restoration nurseries. These preliminary results show that nursery stock can serve as a high-risk pathway for introduction of plant pathogens into wildlands. Furthermore, multiple *Phytophthora* species can survive in arid chaparral ecosystems on outplanted stock that has been irrigated to enable plant establishment. In many sites, *Phytophthora*-infected restoration plantings are in close proximity to native site vegetation, increasing the risk that the introduced pathogens could spread to native stands. Restoration areas are conservation investments. Both restoration areas and surrounding vegetation may be irreparably harmed by introduced plant pathogens. Preventive measures are needed to sustain restoration area health, including procurement of stock from nurseries using strict phytosanitary measures, or direct seeding and other changes to restoration practices.

11.02 From alarm to coordinated action: The Golden Gate National Parks' response to *Phytophthora*

Alisa Shor¹, John Doyle¹, Alison Forrestel², Christa Conforti³, Lew Stringer³

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Over the last few years, species of the plant pathogen, *Phytophthora* (Pythiaceae), have been discovered in native plant nurseries and restoration sites at an alarming rate. In response to this and in an effort to minimize the risk of harboring and dispersing these introduced pathogens, cross-departmental managers of the Golden Gate National Parks work proactively to problem solve at critical junctures. This session presents a frontline perspective of the events and ongoing management decisions in response to the elevated concerns of *Phytophthora*. *Phytophthora* has become part of the vocabulary of restoration, and managing for it is part of the cost of responsible restoration. The Parks' Nursery Program has invested significant resources in retooling and improving growing practices to produce uninfected nursery container stock. The Nursery Program has also established and refined protocols to test container stock to verify the efficacy of phytosanitary best management practices. Discussion includes a comparison of the testing regime and results for nursery container stock from 2014, before heightened BMPs were instituted, compared to 2015-2017 container stock that was produced with improved sanitation practices. Since implementation of phytosanitary measures, detections of *Phytophthora* in nursery container stock have been minimal, and plant health has improved overall. This session will include an overview of operational shifts, the personnel and financial resources invested, preliminary survey results of *Phytophthora* detections in the field and restoration sites, discussion of the intended approach moving forward, and why this matters to conservationists and restorationists at all levels.



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11.03 Risk factors associated with the occurrence of *Phytophthora* species in native California plant communities

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In 2002, root rot caused by the exotic water mold *Phytophthora cinnamomi* (Pythiaceae) was identified as the cause of widespread mortality of the threatened lone manzanita (*Arctostaphylos myrtifolia* [Ericaceae]) in its limited Sierra Nevada foothills range. Since that time, root rots caused by exotic *Phytophthora* species have been associated with dying and declining vegetation in a number of native plant communities in the greater San Francisco Bay Area. We have now conducted enough sampling in a variety of native plant communities to begin to address how widespread *Phytophthora* infestations are, and what risk factors are associated with the presence of these infestations. Sampling has included both symptomatic and asymptomatic plants. *Phytophthora* was detected in samples by baiting with green pears, followed by isolation from symptomatic pear tissue and DNA sequencing to identify isolates. Results indicate that in the sampled plant communities, *Phytophthora* species are most commonly associated with symptomatic vegetation. Infestations vary in size but are generally limited to discrete areas rather than being broadly distributed across landscapes. Nursery-grown plant material, including both ornamental landscaping and restoration plantings, are clearly associated with some infestations. The original sources of other introductions are often obscure, but most infestations have clear links to human activities. Impacts on vegetation health vary with the *Phytophthora* species present and community composition, but multiple native plant species are affected in most infested areas. To protect native habitats from these invasive pathogens, efforts are needed to prevent new *Phytophthora* introductions and minimize secondary spread from established infestations.

11.04 Native or non-native *Phytophthora* species: How can we tell the difference?

Tyler Bourret
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A *Phytophthora* species' status as native or non-native may influence pest rating determinations, regulations or actions following an unintentional introduction, yet there is not scientific consensus on the native range of a single species of this pathogen. The underlying reasons for this knowledge gap are explored, especially for *Phytophthora*, composed of microscopic organisms whose study is predated by the widespread intercontinental movement of plants and soil by humans. Until recently researchers infrequently looked for *Phytophthora* in natural ecosystems, and changing species definitions have rendered historical records difficult or impossible to verify. In light of this, the status of most species of *Phytophthora* are likely to remain in a gray area for some time, requiring that most be treated as non-native and potentially invasive. A recent wide-scale survey of European nurseries and outplanted areas determined that 59 of the 68 *Phytophthora* species isolated were non-native; only 3 were considered native to Europe. Given appropriate circumstances, it may be relatively easy to label a particular species as non-native or invasive. Further surveys of Californian natural areas are needed to allow for definitions of a list of "resident" species of *Phytophthora* and to determine what level of precaution is warranted.

11.05 Protecting California's native flora: Practical guidance to reduce the introduction and spread of *Phytophthora* during restoration

Janell Hillman
Phytophthoras In Native Habitats Work Group and California Native Plant Society Ad Hoc Committee on Phytophthoras, Albany and Sacramento, CA, USA

The inadvertent spread of *Phytophthora* species into natural ecosystems is a threat to environmental, social and economic resources in restoration areas and adjacent wildlands, including rare and endangered native California plants. Once these pathogens are introduced into the wild, they are extremely difficult – if not impossible – to eradicate. Avoiding planting is not an ideal long-term solution to *Phytophthora* prevention since many of the benefits of restoration are lost when nursery stock is prohibited. How can we continue to restore and protect native plant communities while reducing the risk of pathogen introductions? Several groups have been formed to address this emerging threat. The Phytophthoras in Native Habitats Work Group (www.calphytos.org), formed in 2015, is a coalition of plant pathologists, restoration practitioners, horticulturists, land managers, and vegetation ecologists who have been working to address this emerging threat through educational outreach, scientific research, collaborative partnerships, and development of a series of



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guidance documents and best management practices. The California Native Plant Society (CNPS)'s Ad Hoc Committee to address *Phytophthora* has developed a CNPS Policy on *Phytophthora* and offers assistance to CNPS Chapters in evaluating nursery stock, plant sales and retrofitting a Chapter nursery (<https://sites.google.com/site/cnpsphytophthoraresources/>). Resources available from the two groups include guidelines for developing restoration success criteria, growing clean plants in a restoration nursery, testing procedures, restoration planting practices, working in sensitive sites, and various fact sheets.

11.06 Emerging pests can devastate native trees in natural and urban forests

Sabrina Drill

University of California Cooperative Extension, Los Angeles, CA, USA

New insect pests and pest/disease complexes pose a devastating threat to natural and urban native trees throughout California. These include the goldspotted oak borer, which attacks native oaks; invasive shot hole borers, which vector a fungal pathogen that can affect a wide variety of native and urban trees; and walnut twig beetle, which spreads thousand cankers disease to native walnuts. These pest/disease complexes have been found to target over 50 species of native, ornamental, and agricultural species, and are capable of causing or contributing to widespread habitat loss and vegetation type conversion. Vectors for spread can include firewood, green waste and mulch, as well as nursery stock used for restoration or landscaping. Management generally includes removing and properly treating infested wood; in some cases, there is the potential for chemical and biological control, but these may not be feasible across large acreages. Efforts to develop regional management approaches are being led by resource agencies, county agricultural commissioners, non-governmental land managers, and university researchers. UC Cooperative has developed several resources for accessing the latest information about these pests.

11.07 Invasive shot hole borers in Orange County Parks

Hannah Vasilis

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The polyphagous shot hole borer (PSHB) and kuroshio shot hole borer (KSHB), collectively referred to as the invasive shot hole borers (ISHB), are morphologically identical, but genetically distinct non-native ambrosia beetles (*Euwallacea* sp. [Coleoptera: Curculionidae: Scolytinae]). These beetles cause Fusarium Dieback (FD) in their host tree species due to a symbiotic relationship with Fusarium fungi. PSHB was first found in Los Angeles County in 2003 and has since been found throughout Orange County (OC). KSHB was initially found in San Diego County in 2014, spreading into OC. The list of reproductive hosts has grown to 57 tree species; 18 are native trees or shrubs. Out of 31 OC Parks inspected from May 2016 to June 2017, only five parks were negative for ISHB. Many parks in OC are landscaped turf parks; however, there are nature preserves, wilderness parks, and historic parks. OC Parks are not only located in urban areas, but are also nestled against State and National forests and along creeks and rivers. Mitigation sites, riparian habitats, oak woodlands, and trees of historic significance are all at risk. OC Parks have suffered a dramatic loss of trees. Options for controlling the beetle populations are limited, especially in sensitive habitats where pesticides are restricted, making early detection, tracking the spread and severity of infestations, and trapping the crucial first steps to managing an ISHB infestation. The effects of ISHB will be examined in sites within the OC Parks system, in addition to symptoms associated with the beetle on native plants.

11.08 Shot hole borer - an invasive invertebrate pest: Local efforts to monitor and manage this critter

Hans Sin

California Department of Fish and Wildlife, San Diego, CA, USA

Shot Hole Borer (SHB), an invasive beetle, has recently caused the die back of large stands of trees in Southern California, starting along the border in the Tijuana River near large urban human populations (San Diego, USA and Tijuana, Mexico). That specific infestation has caused the loss of over 1000 acres of riparian habitat. SHB, which reproduce within suitable host plant species, can damage the vascular system and may spread symbiotic fungal pathogens within the host plant, which can cause branch dieback and even plant death. SHB has currently over 50 host plants and the spread of the invasive beetle has been alarming for conservation efforts that can potentially be at risk.



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These conservation efforts include large mitigation areas for urban development that has impacted listed species. Already the SHB has caused widespread economic losses to the avocado industry, extensive destruction to Orange County Parks, and has infested and damaged large natural areas. Current monitoring efforts include looking at bored holes in host plants, and trapping efforts with traps with lures (Lingren, Vane, bottle, and sticky traps). Control of the invasive beetle has been limited on the landscape level and currently chipping trees and covering chip piles with tarps (to increase temperatures to kill SHB) is a method being used. Also inoculating host plants with systemic endophytes to kill the fungus is currently being researched. Challenges arise in coordinating efforts across agencies, various jurisdictions and the general public in data management, monitoring, and control efforts.

11.09 The CALINVASIVES database management system

Matteo Garbelotto¹, Sabrina Drill², Mark Hoddle³

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Invasive species represent a major threat to native biodiversity worldwide and California is at the forefront of the invasive species debate because of the extremely large number of biological introductions (i.e., 9 arthropods per year). Geographic distribution and host range of invasive species changes at varying rates depending on the biology of the invasive organism, on host distribution, topography, climatic change, and human interference. Information on the host and the geographic ranges of invasive species is often gathered rapidly, but access to such data by stakeholders may be difficult and often delayed due to the long time necessary for the publication of scientific data. CALINVASIVES represents a single clearinghouse to inform stakeholders about the presence of invasive plant pathogens and pests, their current distribution, and their known host range. CALINVASIVES is a content management system in which current information available will be consolidated and displayed both in a graphic format and as a searchable key, similar to the way data are displayed in the CALFLORA database. New information will be easily uploadable both by specialists and possibly by the public, using a web-based form and a mobile application specifically designed for this purpose. CALINVASIVES is being designed in collaboration with CALFLORA and the two databases will be fully interconnected.

11.10 How to engage the federal government in protecting California's flora from invasive species

Faith Campbell

Center for Invasive Species Prevention, Bethesda, MD, USA

A rising number of California plants are being damaged by non-native "plant pests". Plant taxa at risk include various pines, oaks and tanoaks, sycamores, palms, and several native herbaceous and shrub species. Pests on the horizon would threaten *Opuntia cacti* (Cactaceae). Additional introductions on imports are likely. Regulating pests associated with imports and interstate trade is a federal responsibility, led by the USDA Animal and Plant Health Inspection Service (APHIS). APHIS and the USDA Forest Service also lead in researching and implementing strategies for mitigating pests' impacts and restoring native species. APHIS regulations don't provide needed protection. Funding for federal agencies' pest efforts is insufficient to address the threat. Californians can influence national policy through electing 53 members of the U.S. House and two Senators. I propose several actions that California's plant conservationists can take to improve phytosanitary policies and increase funding for key programs. Examples include: 1) several actions that APHIS & the Bureau of Customs and Border protection should take to improve importers' compliance with regulations governing wood packaging material and reduce the likelihood that imported plants will transport pests; 2) amendments proposed for the 2018 Farm bill to strengthen APHIS' programs and support restoration of pest-decimated tree species to the forest; 3) actions that the Governor and leaders of state agencies could take to support these proposals; 4) outreach to various stakeholder organizations to engage them on these issues; and 5) a coordinated media strategy to support these proposals.



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INVASIVE PLANTS

Invasive plants are a major threat to native plant biodiversity in California. This session will highlight cutting-edge research and new techniques to prevent introduction, and scientifically manage existing infestations, of the most damaging invasive plants in California.

12.01 Tamarisk control in maritime succulent scrub: Method refinement for region-wide control in Baja California

Katie Gallagher¹, Landy Figueroa², Melissa Lippencott³, Jim Riley⁴

¹Psomas, Los Angeles, CA, USA, ²Environmental Intelligence, LLC, Los Angeles, CA, USA, ³Power Engineers, Anaheim, CA, USA, ⁴Jardin Botanico San Quintin, San Quintin, BC, Mexico

Tamarisk (*Tamarix ramosissima* [Tamaricaceae]), commonly known as salt cedar, is an exotic and invasive tree that grows in dense stands in desert environments with ample groundwater. This project utilized lessons learned from unrelated tamarisk control projects and applied them experimentally to a small and relatively discrete tamarisk population to determine region-specific methods. It is located in maritime succulent scrub habitat, an ecosystem dominated by drought deciduous shrubs on thin rocky soils within the range of frequent coastal fog in Arroyo Hondo, Reserva Natural Valle Tranquilo, Baja California, 140 miles south of Ensenada. Two questions regarded details of the on-the-ground methods: 1) Which equipment (herbicide, pitcher, paintbrush, spill kit, etc.) and how much manpower (team of two or three?) are needed to work at a practical and efficient pace? 2) Is it more effective to cut-stump many small stems above ground or to dig underground and cut-stump the single big stem? Three steps were needed to answer these questions: 1) 2015, map the population; 2) 2016, perform pilot treatment and 3) 2017, monitor success and expand treatment to more populations. Monitoring and treating more populations will continue in 2018. These methods were refined to be the most effective and to minimize herbicide usage. Lessons were applied to more tamarisk populations on protected land in Baja California with permission from the appropriate land managers.

12.02 A private lands partnership to restore fire-prone river habitat in southern California: A unique synergy

Jonathan Snapp-Cook¹, Jessica Norton³, Arne Johanson², Robert (Bob) Byrnes², Caitlin Kreutz⁴

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In 2007 and 2014, wildfires impacted the San Dieguito River Valley in San Diego County. Landowners experienced close calls with fires burning dangerously near structures. After the 2007 fire, it was concluded that highly combustible invasive plants such as *Arundo donax* (Poaceae) and eucalyptus (*Eucalyptus* sp. [Myrtaceae]) had served as a wick that carried the fire down the river channel that connected properties. One landowner attempted to remove invasives from the river channel; however, the number of permits required, along with high costs, became overwhelming and she abandoned these efforts. In 2014, fire again swept through the river channel, fueled by invasive plants that had returned in the interval. The landowner reinitiated her efforts and contacted the U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program. A partnership was formed, with the objective of lowering the fuel load in the river channel by removing invasive plants. Partners for Fish and Wildlife was attracted to the project, not only for health and human safety, but to assist the return of native plants and wildlife to the riparian corridor. To be effective, the project was subsequently expanded from an initial six acres to nearly 100 acres and now includes 30 neighboring landowners in the river channel. In the process, the Partners for Fish and Wildlife Program formed alliances with other organizations that brought in money, expertise, and a knowledgeable workforce to enable this ongoing effort. This partnership demonstrates how synergy can accomplish the goals of a single individual.

12.03 Understanding habitat preferences of Little San Bernardino Mountains linanthus (*Linanthus maculatus* [Polemoniaceae]): Is *Schismus barbatus* (Poaceae) invading *Linanthus* microhabitat?

James Heintz, Lynn Sweet, Cameron Barrows
University of California, Riverside, Palm Desert, CA, USA

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Little San Bernardino Mountains linanthus (*Linanthus maculatus* [Polemoniaceae]) is a minute annual herb endemic to the western edge of the southern California deserts, threatened by multiple pressures including invasive species, climate change, urban development and OHV recreation. Over the last few decades the habitat preferences of *Linanthus* have become better understood and researchers have noted an increase in *Schismus barbatus* (Poaceae) density in the areas containing endemic *Linanthus* populations. This study sought to quantify the degree to which *Linanthus* populations may be negatively impacted by *Schismus* and other stressors, to better understand habitat characteristics through soil particle analysis and plot-level species data collection and lastly to determine current abundance and distribution. First, historic areas of *Linanthus* occurrence were mapped, a species distribution model was created to predict suitable habitat in the region, and maps of known stressors were overlain. Large areas of the mapped suitable range coincided with increased atmospheric nitrogen deposition (NO_x), *Schismus* presence and off-highway vehicle operation. Subsequently, transects were run through patches of *Linanthus* within predicted suitable habitat in which areas supporting *Linanthus* were characterized by lower cover of *Schismus* and slightly coarser soils, indicating potential for different habitat preferences between *Linanthus* and *Schismus*. Further investigation will be necessary to determine whether *Schismus* may be impacting *Linanthus* within these microhabitats, and if *Schismus* has competitively excluded *Linanthus* from upland benches where it is now absent.

12.04 Effects of manual and mechanical *Ammophila arenaria* (Poaceae) removal techniques on coastal dune plant communities and dune morphology

Monique Silva Crossman, Alison O'Dowd
Humboldt State University, Arcata, CA, USA

European beach grass (*Ammophila arenaria* [Poaceae]) invades and stabilizes the foredune in coastal sand dune ecosystems and can cause a decline in native species. The objective of this study is to examine the effects of manual and mechanical removal techniques of *A. arenaria* on sand dune morphology, and vegetative cover and species composition over time. Study sites were located within three California State Parks: Little River State Beach, Gold Bluffs Beach, and Tolowa Dunes State Park. Two removal treatments were utilized at these sites: mechanical, which utilizes bulldozers to bury *A. arenaria*; and manual, digging the plant up with shovels. Vegetation cover and species composition was measured in 25 meter² plots at each site (n=69). Dune morphology was measured at restored and unrestored sites using a Real Time Kinematic Global Positioning System device to measure the elevation of the dunes in transects at each site for each removal technique. An Unmanned Aerial Vehicle (UAV) was also utilized to measure dune elevation by taking high resolution photographs of the dunes in the treatment and control sites that were then converted to topographic data with Structure for Motion software. Moreover, height measurements were taken with a tape measure at established waypoints along each transect. These three techniques were compared to determine which is the most accurate and effective for measuring elevation. Results will provide insight into the long-term recovery of native species and will compare the effectiveness of mechanical versus manual removal in restoring natural sand movement.

12.05 Controlling annual grasses in San Francisco's Lands End dune habitat

Naomi LeBeau, Ruby Kwan, Christina Crooker, John Peyton Anderson
Golden Gate National Parks Conservancy, San Francisco, CA, USA

Annual grasses present the largest threat to healthy dune habitat at Lands End in Golden Gate National Recreation Area. Annual grasses inhibit native plant recruitment, including rare annual and biennial wildflowers like the San Francisco wallflower (*Erysimum franciscanum* [Brassicaceae]) and dune gilia (*Gilia capitata* [Polemoniaceae]). Following restoration of the dunes in 2006, ripgut brome (*Bromus diandrus* [Poaceae]), mouse barley (*Hordeum murinum* [Poaceae]), and slender oat (*Avena barbata* [Poaceae]) have been manually controlled by volunteers and staff with limited long term success. Experimental plots were installed over three years to determine if hand pulling, hula hoeing, or tarping- and at what frequency- best controls these species. To date, hand weeding once in mid to late spring is most effective. Tarping an infested area for six weeks after the first flush of grass seedlings is similarly effective, but difficult to implement in areas with large, established shrubs. This method is also more expensive in terms of materials, requires upkeep, and may be considered "ugly" by park users. Further experimentation with brush cutting is planned for winter 2017-2018. As a result of this experiment, large volunteer programs and extra staff time is scheduled for the months of February through April. In areas where the native cover is low-growing, tarping may be used.



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12.06 100 years of county coordination and statewide eradication of noxious and invasive weed species in California: A brief history

Steve Schoenig

California Department of Food and Agriculture, Sacramento, CA, USA

The California Department of Food and Agriculture (CDFA) maintained a statewide program to eradicate terrestrial noxious weeds from 1910 to 2012, ending due to funding shortages. This program worked with Agricultural Commissioners, USDA, UC and others. Most CDFA noxious weeds are non-native, predominantly introduced to California *accidentally*, as agricultural contaminants or *intentionally*, through horticulture. Early on, there were not fully effective weed eradication tools. Local eradication success required decades of manual application and harsh chemicals. Coordinated control efforts were focused mainly at the local level. With the advent of modern herbicides in the 1940s, weed eradication tools became cheaper and more effective. Ambition and program scope increased. Success was achieved in completely eradicating 13 species from California overall, and locally eradicating hundreds of populations. Despite continued success of the program into the later decades of the 20th century, there were challenges: 1) sustaining program efficacy, and 2) demonstrating the importance of the program to the agricultural industry, government decision makers and the citizenry of California. As economic downturns repeatedly hit California, CDFA and the County Ag Departments faced funding cuts and weed programs were disproportionately downsized due to assignment of low relative priority. Reasons the program "fell out of grace" are slower spread of weed pests, high cost of insect pests to crops, failure to engage the support of large environmental groups in eradication and failure to advertise program success. Luckily, many organizations still eradicate weeds and some foster statewide coordination and advocate for revived government leadership.

12.07 Mi casa es tu casa: The importance of regional-based invasive plant eradications

John Knapp¹, Morgan Ball², Paula Power³, William Hoyer⁴

¹The Nature Conservancy, Ventura, CA, USA, ²Wildlands Conservation Science, Lompoc, CA, USA, ³Channel Islands National Park, Ventura, CA, USA, ⁴United States Navy, Port Hueneme, CA, USA

Invasive plants know no boundaries. One preserve may conduct invasive plant management while continuously being bombarded by wind-born propagules from an infested adjacent preserve that does not. Invasives management, specifically eradication, cannot stop at the preserve border and must continue to neighboring lands where target invasive plant species are present and pose a threat. Along the California Coast where strong northerly winds play a role in the dispersal of plants, working at the regional level is key to meet eradication criteria of preventing new or reinvasions. We present how The Nature Conservancy's Santa Cruz Island Preserve and the Channel Islands National Park, which are the closest neighbors to one another, have worked in tandem to take a regional approach to invasive plant eradications. The Northern Channel Islands are comprised of four of the eight Channel Islands, which are separated from one another between 3.6 - 5.5 miles. Island managers have developed a program to manage invasive plants at the regional-level across 52 miles. After conducting landscape-level surveys of three of the four islands, it was discovered that each island was infested with a suite of invasive species that pose a risk of invasion to the others. Just as invasives spread across borders, island managers now work across property lines to approach invasives more efficiently. Thirty-six invasive plant species have been targeted for eradication across three islands, with planning in process to address the fourth island with the US Navy to manage the chain as a single ecological unit.

12.08 Matching management strategies to the infestation of a new invasive species *Volutaria tubuliflora* (Asteraceae) in southern California

Christopher McDonald

University of California Cooperative Extension, San Bernardino, CA, USA

The highly invasive *Volutaria tubuliflora* (Asteraceae) is found in three locations in Southern California. It was discovered in the small desert community of Borrego Springs in 2010, a second population was re-discovered in Newport Beach in 2015 and a third population was discovered in Chula Vista in 2016. Each population appears to be spreading at different rates, with the fastest rate of spread in Borrego Springs where the Sonoran Desert habitat most closely matches the semi-arid to arid habitat of *Volutaria's* home range. In its home range of North Africa, the Mediterranean and the Middle East, *Volutaria* grows in a wide variety of plant communities. Many similar plant communities can be found across California



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and the Southwestern US. This is the first introduction of *Volutaria* to North America; however it has been spreading in the hyper-arid Atacama Desert of Chile for 30 years. Strategies for eradication of this species have differed in each of the three Southern California locations. In Chula Vista *Volutaria* has been found on only one property. This is where containment has been relatively straightforward. In Newport Beach several different public properties are infested. However, several populations border popular hiking and biking trails with eradication efforts focusing on preventing the spread and treating all individuals. In Borrego Springs nearly 100 properties have been invaded and the majority of them are privately owned. The desert infestation is large and complex with a combination of volunteers and professionals collaborating on large- and small-scale reduction efforts.

12.09 From identifying plants to tracking treatments over time, the Calflora Database offers a robust suite of tools for conservationists

Rachel Kesel¹, Cynthia Powell²

¹One Tam, Marin County, CA, USA, ²Calflora Database, Berkeley, CA, USA

California conservationists looking to identify new invasive plants, map plant distributions or track population change often turn to the Calflora Database (Calflora). With a vibrant web presence and the Observer Pro mobile app, Calflora provides conservationists with 21st century tools. Freely available features include robust identification tools with photos, maps, bloom calendars, and links to the Jepson EFlora. While these features are widely used, improvements, including the What Grows Here app and Email Alerts service, offer opportunities to dig deeper. Observer Pro allows all users to map weeds. Sharing these records is as easy as sending a hyperlink. These tools increase accessibility of botanical information, engaging a range of users. The Weed Manager system, a subscription service, uses the OATS model (Observation, Assessment, Treatment, Survey) to link species records through time. The Tamalpais Lands Collaborative (TLC) adopted Weed Manager and Observer Pro for cross boundary tracking of early detection and treatment data. To facilitate collaborative use, Calflora extended existing functions to work across four Weed Manager groups. New applications include Survey Entry, which is used by the TLC to document early detection surveys. Future development with this tool aims to make it useful to track relevé and rare plant data. A Distributor tool allocates gross hours across a suite of treatment records, speeding reporting efforts. These tools enhance data sharing, which improves rapid response times. As conservationists increasingly look beyond preserve boundaries, tools within Calflora offer solutions to the challenges of collaboration.

12.10 Common ground: Connecting public lands and gateway communities with native plant gardens

Melanie Baer-Keeley

Sequoia and Kings Canyon National Parks, Three Rivers, CA, USA

Ninety-six per cent of Sequoia and Kings Canyon National Parks' lands are designated wilderness, comprising the largest contiguous protected wilderness area in this state. These federal lands are carefully monitored and managed for biological invasion, the number one threat to its wealth of diversity. However, the privately-held lands of the gateway community of Three Rivers at its southern entrance are not monitored. These neighboring rural lands are host to a spectrum of aggressive plant species, including horticultural escapees, whose presence poses real threats of invasion to protected public lands. To abate this issue, the NPS, Redbud Garden Club of Three Rivers, Alta Peak Chapter CNPS and other local organizations have partnered to design, finance and install eight public native plant demonstration gardens in prominent community locations. With these gardens, we had seven goals: 1) present visual and easily adaptable examples of low care, climate-adapted, beautiful native landscapes as alternatives to planting with exotic vegetation, 2) introduce to the residents our unique local ecology and dominant native species, 3) engage residents, business owners and the larger community in efforts to protect, preserve and create healthy habitat, 4) instill in the public an appreciation of the historical natural landscape, 5) show weed control through competitive displacement by native plants, 6) illustrate water- and resource-saving landscaping techniques, and 7) form an informal, protective buffer along the Park Service/urban land interface, thereby lessening the possibility of weedy introductions from highly disturbed adjacent areas and beyond from the nearby San Joaquin Valley.

CURRENT RESEARCH (STUDENT SESSION)

This students-only session provides a venue to highlight research that focuses on the California flora. A number of topics will be explored in this session, including plant taxonomy, rare plant biology, and plant ecology of both native and invasive plant species.

13.01 Biotic filters shaping *Limonium* (Plumbaginaceae) invasion in San Francisco Bay salt marshes

Stephanie Saffouri, Katharyn Boyer, Gretchen LeBuhn
San Francisco State University, San Francisco, CA, USA

Coastal salt marshes in San Francisco Bay have seen aggressive expansion of invasive plants, displacing native species and the broader communities and functions they support. Three recent invaders-*Limonium ramosissimum* (Plumbaginaceae), *Limonium duriusculum*, and a third, unidentified species-thrive in the mid to upper salt marsh and marsh-terrestrial ecotone. These areas host high species richness and provide critical habitat for endangered vertebrates. Marsh patches containing invasive *Limonium* have experienced a marked decline in native halophytes, including the only *Limonium* native to California, *Limonium californicum*. My project investigates the relative invasion potential of three invasive *Limonium* species. Given the spatial proximity and relatedness, the congeners likely influence each other's growth and compete for resources. I grew pairwise combinations of invasive seedlings watered with high and low salinity water to assess differences in vegetative growth. I also set up treatments of *L. californicum* paired with seedlings of each invader to simulate new introductions and quantify effects on growth of the native. Furthermore, shifting pollinator habits may favor the spread of one species and increase interspecific pollen transfer. Through controlled pollinations in the greenhouse, I will determine whether each species is self-compatible, how interspecific pollen affects seed production, and whether or not hybridization is possible. This research explores multiple ways in which invasive *Limonium* may outcompete native species and alter salt marsh biodiversity. If I find that one species dominates or hybridization occurs, my results can direct managers on targeted removals. My study will also provide a mechanistic understanding of wetland invasion more generally.

13.02 Surviving dormancy: The phenotypic plasticity of xylem parenchyma as starch storage organs across 2750m of elevation in the Sierra Nevada

Jessie Godfrey, Jason Riggio, Jessica Orozco, Paula Guzman, Aude Tixier, Maciej Zwieniecki
University of California, Davis, Davis, CA, USA

Ray and axial parenchyma cells (RAPCs) of the secondary xylem are often discussed in terms of the supportive roles they play in the storage and release of carbohydrates and/ or water and ions. The energy stored and mobilized by these cells is credited with frost protection and post dormancy growth. RAPCs likely play additional roles during or succeeding periods of stress when they are providing energy for xylem refilling, and as water capacitors for the temporally dynamic relief of sudden changes in evaporative demand. In spite of the critical role that RAPCs play in the physiology of perennial plants, there is surprisingly little information available on the phenotypic plasticity of their abundance in response to abiotic stress. This project aims to link xylem RAPC fractions with maximum non-structural carbohydrate (NSC) concentration and then to relate both values to the length of temperature-imposed or drought-imposed dormancy experienced by a given individual or species along an elevation transect in California's Sierra Nevada. Hypothesizing that RAPC fraction is phenotypically plastic (within species) but also that a genetic signal among species may be buried among other species-specific traits imparting stress resilience, we collected wood cores at several physiologically relevant time points at 72 randomly distributed south-facing sites (six sites every 250m from 500 to 3250m). With these cores, we determined RAPC volume with anatomical analysis and non-structural carbohydrate content using hydrolytic enzyme reactions coupled with a sulfuric-anthrone acid assay. Generally, we are finding that RAPC fraction increases at either end of a species' range.

13.03 Drought, fungi, and death in *Arctostaphylos glauca* (Ericaceae)

Laura Schultheis, Carla D'Antonio, Ryoko Oono
University of California, Santa Barbara, Santa Barbara, CA, USA

Synergies between extreme climate events and pathogens may lead to dramatic changes in plant communities. In the Santa Ynez mountain range in Santa Barbara County, the widespread and classically drought-tolerant shrub big berry manzanita (*Arctostaphylos glauca* [Ericaceae]) has experienced dramatic dieback related to both a multi-year drought, and pathogenic infection from latent fungal pathogens in the Botryosphaeriaceae family. In winter 2016-2017, a full factorial greenhouse experiment was conducted using the fungal species *Neofusicoccum australe* (Botryosphaeriaceae) to test the specific influences of drought and fungal infection on *A. glauca* performance and mortality. Data were collected on a weekly basis for 90 days to measure onset of disease, changes in photosynthetic output, and time until mortality. Results show a significant difference between the four treatment groups. Compared to all other treatment groups, fungal inoculation with drought yielded the fastest decline in photosynthesis, onset of symptoms, and subsequent mortality of individuals. Fungal inoculation without drought produced the next fastest onset of symptoms and mortality, followed by drought without fungal inoculation. All individuals in the control group (no fungal inoculation or drought treatment) survived. These results indicate a possible synergy between drought and fungal infection in influencing the rate of *A. glauca* mortality. The data further suggest that *N. australe* is itself highly virulent and can cause mortality quickly, at least in small individuals, even in non-drought stressed plants. These findings have important implications for similar systems that can be exposed to members of the Botryosphaeriaceae family, especially during periods of extreme drought.

13.04 Resurveying Yosemite alpine plant communities after six years of drought

Anneliese Ayers¹, Kate Miller¹, Drew Burke¹, Maxwell McCollum¹, Alison Colwell², Dena Grossenbacher¹

¹California Polytechnic State University, San Luis Obispo, San Luis Obispo, CA, USA, ²Yosemite National Park, CA, USA

Scattered along the crest of the Sierra Nevada in California are unglaciated landscapes surrounded by glacially carved chasms. These island-like surfaces harbor a diverse assemblage of long living alpine plants that are adapted to cold, short growing seasons and rely on water from winter snowpack and summer monsoons. How this specialized plant community responds to climate fluctuations, such as the recent 6-year drought, may indicate how it will fare with predicted climate warming for the region. The purpose of this study is twofold: 1) document plant diversity and abundance to establish a baseline for this plant assemblage, and 2) test whether shifts in population size and elevation have occurred since the recent 6-year drought. In 2010, more than 600 plots were established at twelve unglaciated sites in Yosemite National Park. Within each plot, we identified all species, estimated their percent cover, and recorded plot elevation, slope, aspect and moisture. We selected two sites for resampling in 2017: the south slope of Mt Conness and Skelton Ridge, north of Tuolumne Meadows. In 2010, we found that plots at these two sites contained 98 and 129 species respectively, including 11 CNPS special-status species. Within the sites, species diversity declined with increasing elevation, but was highly variable across microenvironments--wet areas harbored significantly more species, including more special status species. Ongoing comparisons between 2010 and 2017 surveys will reveal what changes, if any, have occurred during the recent drought event.

13.05 Physiological sensitivity to historic drought and deluge years for eastern Sierra Nevada conifers

Katherine Ross, Michael Loik

University of California, Santa Cruz, Santa Cruz, CA, USA

Projections of future precipitation trends in California suggest greater interannual variability in precipitation, while higher temperatures increase risk of drought. By comparing the spatial and temporal variation in photosynthesis, growth, and water status between unusually wet and dry years, and across an elevation gradient, this study improves our understanding of the mechanistic pathways by which dominant conifer species respond to climate change. Moreover, recent years provide a rare opportunity to quantify conifer sensitivity to both high and low precipitation extremes that are likely to become more common in the future, as well as interactions between elevation and annual differences in precipitation that reflect within range differences. Photosynthesis, stem water potential, and CO₂ response curves were conducted for individuals of *Abies magnifica* (Pinaceae), *Pinus contorta* (Pinaceae), and *P. jeffreyi* at four study sites along a 500 m elevation gradient in the eastern Sierra Nevada near Mammoth Lakes. Measurements were made from 2014 - 2017, spanning the historic drought and wet winter of 2017. Photosynthesis was greater earlier in the season in 2016, but was higher in the previous two drier years, and no differences were found between elevations. By contrast, needle length was greater in 2016 than the previous two years, and the effect was smaller at the higher elevation. Interactive effects of elevation, species and year on photosynthetic carbon gain and needle biomass may help explain patterns of tree responses to extreme drought. Understanding these patterns will improve the development of effective forest management strategies under future variable climate scenarios.

13.06 Adaptation to divergent competitive environments promotes speciation of serpentine endemics

Shelley Sianta, Kathleen Kay

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Speciation driven by edaphic divergence is common in biodiversity hotspots like the California Floristic Province. However, edaphic divergence does not always lead to speciation, as shown by species occupying a broad range of habitats. Reconciling the paradox of why edaphic adaptation only *sometimes* leads to speciation remains a critical gap in our knowledge. The serpentine flora is ideal for comparative studies of speciation because of the multiple times adaptive divergence has either led to speciation (i.e., resulting in a serpentine endemic) or hasn't led to speciation (i.e., resulting in a serpentine tolerator). Here, we ask whether adaptation to more divergent serpentine habitats promotes speciation. We quantify competitive environment and soil chemistry of 16 pairs of serpentine-nonserpentine sister taxa, half of which come from populations within a tolerator species and half of which come from a serpentine endemic and its sister species. When compared to their respective non-serpentine populations, we find that serpentine endemics live in more divergent competitive environments than serpentine populations of tolerator species. However, we find no difference in the magnitude of soil chemistry divergence between endemics and tolerators. Adapting to more divergent habitats can result in stronger fitness trade-offs between habitat types, which in turn promotes speciation through habitat isolation. Our results suggest competition may drive these fitness trade-offs in endemics and that adapting to low-competition serpentine habitats increases the chances of speciation. The inability for endemics to persist in competitive nonserpentine habitats fuels the need for conservation of serpentine habitats.

13.07 The morphological and ecological variation of *Arctostaphylos* (Ericaceae) fruit: A link between plant ecology and animal foraging behavior

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Most *Arctostaphylos* (Ericaceae) species are obligate seeders and regeneration of stands depends on post-fire seedling recruitment. *Arctostaphylos* seed banks are created, in large part, by scatter-hoarding rodents. Seeds produce sufficient rewards (nutritious mature embryo) to entice rodents to disperse and ultimately bury seeds in the soil. Hard seed coats increase the time required to extract the embryo, encouraging rodents to choose storage over immediate predation. Therefore, variation in fruit morphology is expected to impact the manzanita-rodent interaction. We assessed the variation of fruit endocarp fusion, size, and viability among 15 species of *Arctostaphylos*. Factors such as latitude, elevation, life history, ploidy, and phylogenetic position were also observed. A generalized mixed effects model was used to determine the factors contributing to variation in fruit viability. Our results indicate that endocarp fusion mediates the positive correlation between fruit size and viability; larger fruit have greater viability at low levels of endocarp fusion and vice versa. Additionally, the remaining observed factors show a weak correlation and are not predicted to impact fruit viability. These findings provide insight into strategies used by plants to increase reproductive success and entice scatter-hoarding rodents. Our study benefits the restoration of manzanita stands by emphasizing the importance of animal-mediated dispersal and providing estimates of seed viability for different species. With the anticipated effects of climate change, such as departures from historic fire regimes, the preservation of the relationship between plants and animal foragers is crucial for the continued survival of manzanitas and California's evergreen chaparral.

13.08 Spatial association patterns of foundational plants in the east Mojave Desert

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In arid environments shrubs can act as keystone facilitators, directly benefiting their neighbors via multiple mechanistic pathways such as stress amelioration, seed trapping and improved water and nutrient availability. This can influence the spatial distribution of the beneficiary, resulting in increased occurrences in close proximity to the nurse plant. Nurse-protégé relationships have been documented between some species of shrubs and cacti but their species-specificity in diverse shrub lands is less explored. To capture spatial associations between desert shrubs and cacti, I mapped all individuals within three 80m by 20m plots and measured their heights and widest axes; a total of 1714 plants comprised of 5 species of cacti and 15 species of shrubs. The site is located within the Granite Mountains of the east Mojave Desert

and supports a high diversity of common shrubs and cacti. It is populated by known nurse species that are co-dominant within this site, but often dominant elsewhere including *Larrea tridentata* (Zygophyllaceae) and *Ephedra* (Ephedraceae). The aim of this project is to determine if co-dominant plant associations are better explained by the presence, identity or size of a neighbor, and to look for spatial patterns that suggest facilitation between desert perennials. This project will increase our understanding of community assembly patterns of native Californian vegetation and better inform conservation practices for cacti in arid shrublands.

13.09 Functional traits and the drivers of plant species coexistence across a heterogeneous landscape

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Spatial heterogeneity has long been thought to mediate the outcome of community assembly, and plant ecologists are increasingly using functional traits to infer the processes structuring communities. However, we lack a clear understanding of how variation in plant functional traits is related to the species' differences in their demographic response to heterogeneous environments. Therefore, a better understanding of the relationship between trait differences and variation in demographic parameters across space is required to link functional trait patterns to community assembly processes. We used the annual plant community of Sedgwick Reserve in the Santa Ynez Valley to experimentally estimate demographic responses of 17 native and invasive species at 24 plots. These plots spanned a great deal of environmental variability, from sparsely vegetated serpentine soil to richer soils under oak canopies. We then asked whether differences in leaf, root, seed, and whole-plant traits are predictive of the degree to which species are correlated in their environmental responses. We found that most species pairs have imperfectly correlated demographic responses across the sites in our experiment. This satisfies an important prerequisite for the spatial variation to promote species coexistence. Further, the degree to which species pairs responded to the environment in similar ways was correlated with differences in seed and whole-plant traits. Therefore, diversity in these key traits may influence the landscape-level community dynamics in Sedgwick reserve and other annual plant communities. This study highlights the importance of understanding links between functional traits and the demographic drivers of competitive interactions at the landscape scale.

13.10 Plant-pollinator interactions in strawberry fields forever: Using native plants to boost plant-pollinator interaction diversity in agricultural landscapes

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The loss of pollinators and the pollination services they provide is a conservation concern of global ecological and economic significance. In California, some farmers have opted to plant hedgerows of native plants adjacent to their crops to ameliorate the loss of pollinators in agricultural landscapes. While we know that hedgerows boost pollinator diversity, we know less about how plant-pollinator interactions in farms with and without hedgerows compare to plant-pollinator interactions in the native California vegetation communities these farms displace. To quantify plant-pollinator interactions in natural and agricultural areas, we created plant-pollinator interaction networks for 12 sites along an agricultural intensification gradient on the Central Coast - from native maritime chaparral vegetation, to diversified farms with hedgerows, to monoculture, industrial farms with no hedgerows. We found that while natural habitats had greater pollinator diversity overall, they had fewer and less diverse plant-pollinator interactions than diversified agricultural sites. This counter-intuitive finding is likely because floral resources are patchily and widely dispersed in natural communities, whereas in diversified agricultural habitats, floral resources are concentrated and often hyper-speciose. However, greater plant diversity in diversified agricultural sites did not correspond to greater pollinator diversity, likely because other aspects of agricultural habitats limit the diversity of pollinator communities in farmland. Thus, simply increasing on-farm native flowering plant diversity may not be enough to support pollinator communities that are as diverse and structurally equal to pollinator communities in natural habitats.

13.11 Taxonomic realignment of *Calystegia* (Convolvulaceae) in California

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Calystegia (Convolvulaceae) is a pan-temperate lineage of vining perennials that has a center of diversity in California where over half of the species and the full spectrum of morphological diversity can be found. Molecular phylogenetic evidence, morphology, and distributional data were used to evaluate species boundaries and relationships. A subsequent revision of taxonomy indicates that diversity in *Calystegia* can be reasonably parsed into 16 species and 24 subspecies. Previous taxonomic work in the group recognized a slightly different set of 16 species parsed among 30 subspecies. In the revised treatment, two subspecies are elevated to the species level and two species are not recognized. In general, species complexes were previously over divided, such that the re-circumscription synonymizes six subspecies. Additionally, eight new combinations are made so that species complexes represent morphologically and genetically cohesive groups. CNPS listed taxa that are impacted by the revised circumscription include *Calystegia macrostegia* subsp. *amplissima*, *Calystegia subacaulis* subsp. *episcopalis*, *Calystegia atriplicifolia* subsp. *buttsensis*, *Calystegia malacophylla* var. *berryi*, *Calystegia sepium* subsp. *binghamiae*, *Calystegia vanzuukiae*, and *Calystegia collina* subsp. *tridactylosa*.

13.12 Evolution of the *Potentilla breweri* (Rosaceae) complex: adaptation, hybridization, and radiation in the Great Basin sky islands

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In complex, taxonomically difficult systems, different lines of inquiry frequently give disparate results. The *Potentilla breweri* complex (Rosaceae), a morphologically and biogeographically coherent group of ca. five species from the Sierra Nevada, Great Basin, and Pacific Northwest, is a perennial example: molecular and morphological evidence suggest very different taxonomies, insofar as molecular phylogenies can be resolved at all, and neither coincides entirely with leading hypotheses about the group's morphology, biogeography, breeding systems, and ploidy levels. This research will interweave multiple approaches -- molecular phylogenetics, historical biogeography, population genetics, modern morphometrics, chromosomal evolution, and niche evolution -- to develop a comprehensive perspective on a complex system. I will develop a molecular phylogenetic network based on multiple genes and RAD-Seq markers, reconstruct the complex's historical biogeography and project its future range, examine its small-scale population genetics and its patterns of chromosomal evolution, quantify its range of variation in morphospace, and use common-garden experiments to quantify the relative phenotypic contributions of adaptation and plasticity. In light of ongoing climate change, which impacts montane species disproportionately, the resulting insights could be key to preserving these species.

13.13 Decrypting phylogenetic placement and specific level relationships from a recent radiation for the CNPS listed rare plant *Mentzelia polita* (Loasaceae)

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Mentzelia section *Bartonia* (Loasaceae) is the result of a rapid recent radiation throughout the Intermountain Ranges and deserts of the western United States. *Mentzelia polita* is taxonomically placed within section *Bartonia* and is listed by CNPS as a 1B.2, rare or endangered in California and elsewhere. The 'subshrubby' *Bartonia* clade includes *M. polita* and occurs primarily within the Mojave Desert. Historically this group has been challenging, with distinctions between taxa subtle at best. Problematic species include *M. polita*, *M. oreophila*, and *M. leucophylla*. *Mentzelia polita* and *M. oreophila* both occur in California and Nevada, while *M. oreophila* ranges more widely. Both of the former taxa have been suggested to differ morphologically between their CA and NV populations. Furthermore, *M. leucophylla* is a federally listed endemic only found in Ash Meadows, NV, but has been suggested to occur in similar habitats to Ash Meadows within the boarder of California. Geographically, Ash Meadows is less than ten miles from the boarder of CA. *Mentzelia leucophylla* also has been confused historically with *M. oreophila*. Restriction Site Associated DNA Sequencing (RAD-Seq) is used to elucidate relationships among members of the *Mentzelia* section *Bartonia* 'subshrubby' clade. Further considerations are given towards a conservation plan for '*M. polita*' within California.

13.14 The influences of planting time and competition on the flowering phenology of *Lasthenia californica* (Asteraceae)

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In this study I test the question: how do biotic and abiotic conditions after germination (due to different planting dates) affect flowering time? To answer this question, I planted common goldfields (*Lasthenia californica* [Asteraceae]) seed at McLaughlin Reserve (Lake Co., CA), at three times: the beginning of November 2015, January 2016 and March 2016. All three seeding cohorts were planted just before a rain event to simulate germination. Competition removal plots were compared with control plots to disentangle biotic priority effects and competition from abiotic influences on growth. Planting date and competition treatment plots were set up in a randomized block design. Growth rate, flowering time, and number of inflorescences were measured. Both planting date and competition treatments affected flowering time. Competition removal delayed peak flowering phenology, due to a lengthening of the overall flowering period. Later planting dates served to delay the peak flowering time, due to later flowering start and end dates. Notably, in absence of competition, later flowering individuals also had shorter flowering periods and lower inflorescence numbers. Therefore, flowering phenology at this location is more constrained by abiotic factors at the end of the season (high temperature and low moisture) than at the beginning of the season, in contrast with early spring flowering described in other studies from locations with winter snowpack. This study has implications for the timing of grassland restoration, as planting time may influence both the timing of flowering and overall fitness of individuals.

13.15 A new phylogenomic perspective on *Arctostaphylos* (Ericaceae): Novel chloroplast markers as a potential tool for resolution within the manzanita genus

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More than half of the species of *Arctostaphylos* (Ericaceae) are listed as rare or endangered according to the California Native Plant Society. Similar characteristics of flowers, leaves, and fruit, among species, have made morphology-based phylogenies impractical. Previous sequencing of the internal transcribed spacer (ITS) regions established a well-defined two-clade phylogeny for *Arctostaphylos* but failed to resolve the species relationships within each clade. With the aim of developing novel genetic markers for phylogenetic resolution, we sequenced and assembled the nearly complete chloroplast genome of *Arctostaphylos canescens* Eastw. subsp. *canescens*, via a combination of de novo and reference guided assembly with both Illumina and Pacific Biosciences platforms. Through comparisons with the strawberry tree (*Arbutus unedo* [Ericaceae]) chloroplast genome, we identified highly variable protein coding genes, single nucleotide polymorphisms (SNPs), indels and genes undergoing positive selection that can all potentially serve as useful DNA markers. Additionally, repetitive structure analyses revealed simple sequence repeats (SSRs) and long repeats that can be used as genus or species specific markers. Ultimately, the newly sequenced manzanita chloroplast genome can serve as a model system for studying the evolution and rapid radiation of other similar endemic woody genera in California and can be utilized for the eventual sequencing of all other *Arctostaphylos* species in order to elucidate species relationships within the genus. Establishing species delimitations will aid in understanding patterns of ecological variation and geographical distribution and will promote conservation efforts.

13.16 The effects of cattle grazing on native annual forb persistence in California coastal prairies over 15 years

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Livestock grazing has been shown to benefit low-stature grassland plants, as grazing can keep tall exotic annual grass cover and thatch low, thereby reducing competition for light at the soil surface. Short-term studies suggest that cattle grazing can help to conserve native annual forbs, which comprise much of the native richness in northern California coastal prairies. This study is a longitudinal follow-up on a 2000-2001 comparison of native annual forbs in grazed and ungrazed northern coastal prairies. We resampled sites from Monterey through Sonoma County in 2016-2017 and compared results to the earlier surveys to determine whether the effects of grazing on native annual forb species richness and cover has remained consistent over time. Shrub cover has increased substantially in ungrazed grasslands and a small amount in grazed grasslands since 2001. Although there continued to be significantly greater native annual species richness in grazed than ungrazed grasslands, there was a marginally significant treatment x time interaction. Average species richness declined in grazed prairies, and remained nearly constant in ungrazed prairies. Native annual forb cover varied greatly across sites, and there was no significant effect of grazing management or time on native annual forb cover. Overall, differences in native annual forb richness between grazed and ungrazed prairies may be shrinking. Our results suggest that cattle grazing helps maintain native annual forb diversity and reduce shrub cover, but that the cover and richness of native annual forbs is strongly affected by other factors, including variability in annual precipitation and localized site conditions.

13.17 Riparian forest expansion and native oak regeneration after urban development in a Sacramento watershed

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Agricultural expansion in California's Central Valley contributed to the loss of more than ninety percent of its riparian forests, as well as a marked decline in native oak populations (*Quercus* spp. [Fagaceae]). A substantial portion of this agricultural land has now been converted to urban development. How has this conversion affected riparian forests, and particularly native oaks? We used aerial imagery to quantify changes in land cover and riparian tree canopy between 1937 and 2014 for the 85-km² Arcade Creek watershed near Sacramento, California. We also sampled the watershed's woody riparian plants in 2014 to characterize the current vegetation community. While watershed land cover shifted almost entirely from pasture and crops to urban development between 1937 and 2014, the median extent of riparian tree canopy more than doubled, and the density along smaller streams increased significantly. We examined potential drivers of these changes, and found that the increase in riparian forest cover was largely due to a release from agricultural pressures after land use conversion. Although non-native species were prevalent in the expanding urban riparian forests, native trees were well represented and dominated the overstory. We found robust regeneration of valley oak (*Q. lobata*) and interior live oak (*Q. wislizeni*); these two species, as well as blue oaks (*Q. douglasii*), were present in all size classes we recorded. Urban streams in the Central Valley could represent an important restoration opportunity for riparian forests and native oak populations, and could provide critical habitat in an otherwise heavily managed landscape.

13.18 A vascular flora of the Adobe Valley and surrounding hills, Mono County, CA

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This study aims to document the vascular flora of the Adobe Valley and surrounding hills in Mono County, CA. Less than 100 herbarium specimens are recorded from the 90 square mile study area based on a search of the Consortium of California Herbaria, with little botanical documentation away from well-established roads or in the alkali meadows. At the center of the study area the U.S. Fish and Wildlife Service manages the River Spring Preserve, a 638-acre alkali and freshwater wetland. The preserve emphasizes the importance of the alkali flat ecosystem, a habitat that is representative of Owens Valley, but severely threatened by drought, trampling by cattle and feral horses, off-road vehicles, and water diversion. Alkaline ecosystems farther south have experienced more severe water pumping making the Adobe Valley a good place to establish baseline information to better understand sustainable groundwater extraction. In addition, there is a need for a floristic checklist of the River Spring Preserve as specified in the Preserve's 2016 Management Plan. Many endemic species have the potential to occur in the Adobe Valley and surrounding hills, so far I have documented the following California Native Plant Society listed species: *Plagiobothrys salsus* (Boraginaceae), *Allium atrorubens* var. *cristatum* (Alliaceae), *Calochortus excavatus* (Liliaceae), *Ivesia kingii* var. *kingii* (Rosaceae), *Cymopterus globosus* (Apiaceae), *Crepis runcinata* subsp. *hallii* (Asteraceae), *Plagiobothrys parishii* (Boraginaceae), *Spartina gracilis* (Poaceae), and *Sphaeromeria potentilloides* var. *nitrophila* (Asteraceae), and *Tetradymia tetrameres* (Asteraceae). My goal is to systematically document the vascular flora of the region, publish a voucher-based checklist, and increase the overall understanding of this severely threatened ecosystem.

13.19 Planting *Carex scopulorum* (Cyperaceae) seedlings for subalpine meadow restoration

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Exclosures are shown to be an effective method in restoring above ground biomass production in meadows, yet there remains a deficit of minimally intrusive herbivore exclosure experiments adapted for restoration along a hydrologic gradient. This research focuses on the biomass accumulation, both above and below ground, associated with planted *Carex* (Cyperaceae) seedlings and determines effective establishment conditions. We are testing a restoration design by planting *Carex scopulorum* seedlings inside and outside cost-efficient, small mammal exclosures along a hydrologic gradient. We are analyzing the establishment requirements of *Carex scopulorum* seedlings to determine if: 1) plant metrics (growth, survival, total biomass) will be higher in herbivore exclosures; 2) plant metric maxima will occur equidistant from the extremities of the naturally occurring hydrologic gradient on site; and 3) the herbivory treatment will



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result in lower root-shoot ratio, higher compensatory growth, and greater bare ground and non-*Carex scopulorum* plant cover. Measurements of seedling growth include tiller density spread, leaf lengths and shoot counts, above and below biomass accumulation. In addition, variation in soil moisture, water table depth, and species composition are measured. Overall, we aim to help guide land managers in deciding where their planting efforts may be most effective with this species when restoring similarly degraded wetlands throughout the Yosemite National Park and the Sierra Nevada.

13.20 Seedling recruitment of *Atriplex polycarpa* (Chenopodiaceae) in the San Joaquin Valley of California: The roles of invasive grass competition and their residual dry matter

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Invasive annual grasses dominate much of the American West. In the San Joaquin Valley of California, grasses widely invade upland habitats, with native saltbush shrublands existing in remnant patches. We tested the hypothesis that invasive grasses limit saltbush recruitment, leading to persistently invaded grasslands. One way this could happen is through competition for resources between the grasses and saltbush seedlings. Another possibility is that the dense cover of residual dry matter (RDM) produced by the grasses alters the habitat for saltbush seedlings. An experiment manipulating competition through weeding, RDM presence, and shade cast by the RDM was conducted. We tested the effect of competition and RDM presence on seeds and seedlings of the most common upland saltbush shrub in the southern San Joaquin Valley, *Atriplex polycarpa* S. Watson (Chenopodiaceae). Seeds were sown in plots to assess germination and emergence, seedling density, and percent vegetation cover. Parametric and non-parametric analyses were conducted as appropriate to assess treatment effects. Soil moisture and temperature were also measured and statistically analyzed. We found both competitive interactions and the addition of RDM significantly adversely affected germination and survival of *A. polycarpa* seedlings (competition: $F_{1,29} = 5.57$, $P = 0.033$, RDM: $F_{1,29} = 19.72$, $P < 0.001$) with no interaction between the treatments. *A. polycarpa* coverage was significantly lower in the unweeded and +RDM treatments compared to controls ($H_1 = 11.89$, $P < 0.001$). Management efforts aimed at limiting grass competition, such as targeted grazing, may promote saltbush recruitment and enable ecological succession to mature saltbush shrublands.



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PLANT SCIENCE

This session is a place for presentation of open submission talks with a focus on genetics/genomics, ecology/population biology, classification/floristics, and other subjects that cannot be accommodated easily into one of the other sessions.

14.01 California tree diversity hot spots

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The California Floristic Province is a biodiversity hotspot and trees are the ecological keystone species of many of the state's ecosystems. In addition to sustaining the state's biodiversity, California trees are impressive individually as well, holding the records for the oldest, largest, and tallest trees in the world. Surprisingly, most tree species in California lack a detailed account of their actual range and little is known about where species' ranges overlap. To help scientists and land managers alike, we created a Geographic Information System (GIS)-based map of the individual ranges of all the tree species in California. We used herbarium records from the California Consortium of Herbaria (CCH) to map the native range boundaries of approximately 130 species in ArcGIS 10.4.1. We created a polygon layer for each species range from the CCH and then verified it against existing maps from other agencies, integrating them when necessary. For the species that were unaccounted for in the CCH or whose maps were outdated, we ground-truthed the localities ourselves by driving and hiking through suspected ranges and collecting global positioning system (GPS) data for individual occurrences. We also used existing climate and elevation range maps to predict new localities for individual populations within species' ranges. The California trees range map allows us to answer fundamental questions about tree diversity in California and will ultimately lead to better policy decisions for the conservation of the unique biological resources we have in the state.

14.02 Prototypical key incorporating novel system and method for plant identification produced an order of magnitude improvement; unique system and method for plant identification presented

Susan Dunlap

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A discovery that a novel cluster of vegetative traits exists at the branch apex of each plant species is described. An overhead view of branch apices proved to be especially relevant to distinguish one species from another. Research is presented that explores the validity of the discovery as an aid to the identification of plants. Two attributes of the discovery support its broad application: 1) the presence of a suite of vegetative traits unique to the branch apex of each species and 2) the efficiency achieved by incorporating apical photographs and novel vegetative traits into plant keys. Apical data collected from 3000+ species from diverse plant families were used to construct model keys; the methods used are described. A test case, prepared for 25% of Cactaceae, demonstrated an order of magnitude improvement. The results suggest that introducing apical complex photographs and novel vegetative traits into plant keys produces an efficient method for the identification of plant species.

14.03 Genetic diversity, gene flow, and the persistence of long-lived tree species in an era of environmental change: Lessons from *Sequoiadendron giganteum* (Cupressaceae)

Rainbow DeSilva, Richard Dodd

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During this century, climate warming and altered precipitation patterns will lead to habitat changes that may be detrimental to long-lived tree species. Giant sequoia (*Sequoiadendron giganteum* [Cupressaceae]) is an iconic Sierra Nevada tree species with populations that tend to be small and highly fragmented, making them especially vulnerable to rapid environmental change. Preservation of genetic variation is an important determinant of population persistence that, in part, depends on gene-flow within and between populations. We utilize microsatellite markers to characterize the genetic parameters of 400 *S. giganteum* individuals originating from 17 populations, to address the following research objectives: 1) assess patterns and major drivers of genetic diversity across the range of *S. giganteum*; 2) utilize paired populations to

understand genetic connectivity of groves. Our research indicates that grove area and isolation are drivers of genetic diversity, with increasing diversity associated with larger, more continuous groves. Northern groves were divergent one from another and from the more homogeneous groves south of the Kings River watershed. We found low levels of admixture at the stand-level among northern populations indicating a lack of recent gene-flow. The southern range populations and individuals were admixed suggesting gene-flow in the recent past. Our research suggests that the northern populations of *S. giganteum* should be considered high conservation priority. In contrast, southern *S. giganteum* groves will likely be more resilient to genetic diversity loss due to genetic exchange with adjacent groves. Prioritizing conservation is of great importance to land managers with *S. giganteum* on their lands.

14.04 Biodiversity in Mexico: Conifers and gymnosperms

Alejandro Rodriguez

California Native Plant Society, Baja Chapter, Bonita, CA, USA

Mexico is widely recognized as the fourth most diverse country in the world in terms of species richness, after Brazil, China and Colombia. But it is a striking fact the Mexico is perhaps second only to China in the number of conifer species, and it might as well be the most diverse country in the world regarding gymnosperm species. Among the gymnosperm genera not found in Mexico are *Welwitschia*, which is restricted to Angola and Namibia, and *Gnetum*, which reaches Central America and has the potential to be found in Mexico. The following conifers have been documented in Mexico: *Pinus* (46), *Juniperus* (23), *Abies* (11-12), *Cupressus* (7), *Picea* (3), *Podocarpus* (3), *Pseudotsuga* (2), and *Taxus* (1), for a total number of 96 conifer species. To this number, we can add *Ephedra* (9), and 53 cycads (Fam. *Zamiaceae*, with genera: *Ceratozamia* 24 species, *Dioon* 14 species, *Zamia* 15 species), for a total of 158 species of gymnosperms. Many of these species have a very limited range, e.g. *Abies hidalgensis* has been found only in a deep canyon in the state of Hidalgo. Because of limited distribution, land conversion, forest fires and exploitation, many of these species are vulnerable or in a critical status, particularly in the subfamily Abietoidea of Pinaceae. With this in mind, we can state that many conifer and gymnosperms species in Mexico are in need of immediate protection.

14.05 Evaluating the myth of allelopathy in California *Eucalyptus globulus* (Myrtaceae) plantations

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It is widely accepted that allelopathy is not only significant, but more or less singular, in the inhibition of understory vegetation in California *Eucalyptus globulus* (Myrtaceae) plantations. However, there is no published documentation of allelopathy by blue gums against California native species despite continuous references in the literature since the late 1960's. Previous studies on allelopathy have been inconclusive and criticized for their lack of meaningful, ecologically relevant controls, test species, and test conditions. We tested the effect of blue gum soil, volatile leaf extracts, and water-soluble leaf extracts on germination and early seedling growth of five California native species that are common components of the native habitats typically found adjacent to blue gum plantations. We conducted greenhouse and laboratory experiments to compare the effect of blue gum extracts to ecologically-relevant controls including water, a non-allelopathic native plant control (*Quercus agrifolia* [Fagaceae]), and a native allelopathic plant control (*Salvia apiana* [Lamiaceae]). In these experiments, we found that germination and seedling growth of the species tested were not inhibited by chemical extracts of blue gum foliage, either at naturally-occurring or artificially concentrated levels. These results are significant because they are the first to test an allelopathic effect of blue gums against ecologically-relevant species. These results may have significant implications for management and restoration of land historically occupied by blue gum plantations.

14.06 Photosynthetic recovery from thermal stress across desert and montane plants

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Climate change models predict an increase in frequency and amplitude of heat waves. To better predict how the composition and distribution of plant assemblages might respond to these changes in temperature, it is important to understand how species currently respond to these extremes. In this study we asked: is the photosynthetic thermal

tolerance threshold of both desert and montane plants correlated with their capacity to recover from short-term experimental heat stress (photosynthetic recovery)? Photosynthetic thermal tolerance (the temperature at which photosynthetic efficiency drops by 25 percent after heat stress or T25) and photosynthetic recovery (the percentage of photosynthetic efficiency that returns at T25 after an extended recovery period or RT25) were quantified in 27 plant species native to California, USA. Leaves were collected from two distinct environments representing desert and montane plant assemblages. T25 and RT25 were measured using a chlorophyll fluorescence protocol incorporating actinic light and short duration heat stress. Results highlight that the ability of leaves to recover from experimental heat stress did not differ between plants that commonly grow in biomes that experience vastly different mean maximum temperatures during the summer months. Photosynthetic thermal tolerance and not photosynthetic recovery could be a more important physiological threshold for understanding how plants might cope with increasing temperatures associated with climate change.

14.07 Genotyping using microsatellites shows strong genetic differentiation among populations of the Channel Islands endemic plant, *Malva assurgentiflora* (Malvaceae)

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Malva assurgentiflora (Kellogg) M.F. Ray (Malvaceae) is a charismatic, perennial shrub with showy rose-colored flowers. It is endemic to four of the eight California Channel Islands, where it is rare and highly localized. Philbrick hypothesized that the plants on the southern islands are morphologically distinct from those on the northern islands. The northern populations are characterized by a pubescent upper leaf surface, subentire petal apex, and a pubescent filament tube, while the southern populations have a glabrous to subglabrous upper leaf surface, erose petal apex, and glabrous to subglabrous filament tube. Philbrick created a new name *M. assurgentiflora* subsp. *glabra* for the southern plants. However, an early phylogenetic analysis by Ray failed to find evidence for two evolutionary lineages in *M. assurgentiflora* corresponding to Philbrick's taxonomic concept based on morphology. Here we use allele size data from eight microsatellite loci to examine genetic variation and structure among populations across the natural range of the species. Our sampling includes 206 individuals, 23 of which are from an anomalous and potentially naturally-occurring population on San Nicolas Island. Our preliminary results suggest that the northern and southern populations are genetically distinct. This result supports Philbrick's hypothesis based on morphology that plants from the northern and southern Channel Islands may be distinct evolutionary lineages worthy of taxonomic recognition. Plants from San Nicolas Island, including those from horticultural settings in Nicktown, are all genetically similar to northern form genotypes, suggesting that they are introduced to the island.

14.08 Alpine plant community-climate relationships across elevation gradients in the White Mountains, California

Meagan Oldfather¹, Brian Smithers², Michael Koontz², Jan Nachlinger³, Catie Bishop³, Jim Bishop³, Connie Millar⁴

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Quantifying distributions and turnover of plant communities is vital to understanding biogeographic response to climate change. We augmented Global Observation Research Initiative in Alpine Environments protocol and examined alpine plant communities across an elevation gradient on five peaks in the White Mountains, California. We analyzed the climate niche means (CNM) of communities at different elevations to explore the relationship between local community composition and climatic conditions from across the entire range of the community's constituent species. We used extracted climatic water deficit values from herbarium record locations to calculate species-specific CNM, then used their abundance-weighted average to quantify the community CNM. Using this method, we examined how the community's climate niche changed across elevation gradients. Only two of the five summits showed a significant negative relationship between elevation and CNM indicating that species with cooler/wetter ranges were more commonly found at higher elevation. Across the entire mountain range however, there was a strongly significant negative relationship between CNM and elevation. Our results suggest that there is environmental sorting of species' local distributions at the scale of a mountain range. However, across the elevational gradient of a single summit, the relationships are weak or absent. The community turnover across the elevation gradient for each summit is likely driven by smaller-scale topographic effects shaping environmental conditions. In the context of climate change, our results imply that community-climate relationships



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

are scale-dependent, and predictions of alpine plant range shifts will be limited by availability of fine-scale topoclimatic information.

14.09 De-extinction: What the California Native Plant Society is doing to bring back plant species from (presumed) extinction

David L. Magney

California Native Plant Society, Rare Plant Program, Sacramento, CA, USA

There are 22 plant species presumed to be extinct in the wild that are/were native to California, many of them California endemics. The Rare Plant Program of the California Native Plant Society (CNPS) has been focusing staff and volunteer time to bring as many of these taxa back from extinction, and our efforts have been paying off as California botanists have been finding historic or new occurrences of presumed extinction species on a fairly regular basis. Examples include: *Astragalus pycnostachyus* var. *lanosissimus* (Fabaceae), *Tropidocarpum californicum* (Brassicaceae), and *Chorizanthe parryi* var. *fernandina* (Polygonaceae). This presentation will outline how to search for and rediscover presumed extinct plant species, using our success stories to illustrate this.

14.10 Three edaphic endemic *Ceanothus* (Rhamnaceae) taxa new to science: What can they tell us about botanical exploration in the California Floristic Province?

Dylan Burge¹, Jon Rebman², Margie Mulligan²

¹*Southern Oregon University, Ashland, OR, USA*, ²*San Diego Natural History Museum, San Diego, CA, USA*

North America is home to approximately 55 species of *Ceanothus* (Rhamnaceae), more than 30 of them endemic to the California Floristic Province. Although several species of *Ceanothus* are widespread, most of the species are micro-endemics, known from a small number of occurrences and generally associated with special ecological conditions. As botanical exploration of North America continues, it is expected that more such micro-endemics will be discovered. However, field work is not the only way in which additional *Ceanothus* diversity will come to light; the strongly variable morphology of *Ceanothus* means that specimens are difficult to identify, and many biological entities that probably deserve taxonomic recognition are already represented in herbaria but have not yet been recognized as new. We report on three newly described taxa of *Ceanothus*. Two were initially noted among existing collections, and another discovered during botanical exploration of San Diego County. All three are edaphic micro-endemics found only in the southern California Floristic Province. Overall, the way in which these new taxa came to light suggests that future efforts toward discovery of botanical diversity in the California Floristic Province, especially in the case of *Ceanothus*, should be focused on existing herbarium specimens, with supplementary exploration of locations with unusual ecological conditions, such as special geological formations.

14.11 A new annotated checklist for the flora of Baja California, Mexico

Jon Rebman, Judy Gibson, Karen Rich

San Diego Natural History Museum, San Diego, CA, USA

After more than 20 years of field and herbarium research, we recently published the first voucher-based list of plants from Baja California and Baja California Sur entitled Annotated Checklist of the Vascular Plants of Baja California, Mexico. This Checklist is a catalogue of all native and naturalized vascular plants known to occur in the Baja California region. Our current count of vascular plants documented to occur in Baja California is 3,551 species (including common hybrids), and 3,892 total taxa (including subspecies and varieties). These species and taxa occur in a total of 1,093 genera in 186 families. Of these 3,551 species, 3,130 (88.1 percent) are native to the region and 421 (11.9 percent) are non-native and naturalized. The rate of endemism for the native flora in the region is 25.9 percent. The state of Baja California is documented to have 2,664 plant taxa and the state of Baja California Sur (BCS) to have 2,164 plant taxa. In summary, the documented flora of the entire Baja California region has increased by 1,207 species (44.6 percent) and 1330 total taxa (45.0 percent, 1091 taxa native, 239 taxa non-native) since the flora of the region by Wiggins (1980) was published. As part of an online resource correlated to this Checklist, at least one voucher for each taxon that is known to occur in Baja California has been digitally scanned or photographed and is available at www.bajaflora.org.

14.12 The facilitator shrub (*Ephedra californica* [Ephedraceae]) supports native plant communities at precipitation extremes in the deserts of California

Alessandro Filazzola¹, Michael Westphal², Richard Michalet³, Christopher Lortie¹

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Deserts contain extremely high levels of endemism that are sensitive to shifts in precipitation patterns. Shrubs in deserts can positively affect native plant communities through a series of mechanistic pathways and buffer against precipitation extremes. However, the facilitation effects of shrubs along gradients of aridity have been underexplored. Thus, we hypothesize that the strength of positive interactions between shrubs and annuals will be greatest at the extremes of a precipitation gradient. We selected seven sites located along a gradient of aridity with the same common shrub species, *Ephedra californica* (Ephedraceae). At each of these sites between 2016 and 2017, three phytometer species were planted within and outside shrub canopies. Plant characteristics were measured for all annual species including abundance, richness, and final biomass. We found greatest facilitation effects in sites at the ends of the precipitation gradient. The facilitation effect was greatest in 2017 where significantly more precipitation fell at the sites within the Mojave Desert. We observed significant differences in the response of each species, because of plant traits, to the facilitation effect and the site location. This suggests shrub-annual interactions to be species specific and dependent on environmental stressors. Shrubs in deserts are a critical component supporting native plant biodiversity in a changing climate. Understanding positive interactions in the context of environmental gradients will help conservation biologists make more informed decisions about habitat management for the deserts in California.

14.13 Advances in our knowledge of plants on the Baja California Pacific Islands

Sula Vanderplank², Jon Rebman¹, Exequiel Ezcurra³

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In the last three years, we have made significant advances in our knowledge of the flora of the northern Baja California Pacific Islands. The availability of herbarium specimen data has been significantly increased through digitization efforts and two major expeditions were made to the eight islands in 2015 and 2016. These events have resulted in a wealth of new plant records from the islands, with new plants documented on every island, highlighting the dynamic nature of insular ecosystems, as well as the looming threats of newly arrived non-native taxa. The results document 586 vascular plant taxa on the Baja California Northern Pacific Islands, including 118 new taxa being added, and 54 additional reported taxa being vouchered. The checklists include the nativity of the island taxa, their presence/absence on each island, and new records are highlighted. The declaration of these islands as a new Biosphere Reserve in late 2016 makes these new records of particular conservation importance, bettering our baseline understanding of these islands' ecosystems. The publication, Unique Plants and Animals of the Baja California Pacific Islands, which features the endemic island taxa, available free for download at: <http://nextgensd.com/baja-california-pacific-islands/>. There is also a website on the plants of the archipelago that is planned for migration to the website Bajaflora.org in future.

14.14 Evaluation of restoration potential in Morro Bay, California under different physical conditions

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During the last three decades, seagrasses have been declining globally at an alarming rate, and some estuaries have experienced cascading effects on the ecosystem after seagrass decline. In Morro Bay, one of California's major estuaries, eelgrass (*Zostera marina* [Zosteraceae]) has declined by 97 percent since 2007. While causes of the decline are not yet clear, bay-wide restoration was attempted in 2011-2012 with 116 outplanted plots of over 20,000 rhizomes. However, none of the plants survived. To evaluate whether eelgrass can be outplanted into the bay, we conducted a small scale, controlled, and replicated experimental transplant of eelgrass in March 2017. Eelgrass was outplanted in replicate plots in two areas with distinctly different physical conditions. To evaluate environmental conditions that may affect the health and success of future restoration efforts, I am currently measuring light, temperature, salinity, dissolved oxygen, sediment grain-size distribution, organic matter content in the soil, epiphytic and epifaunal cover of the blades, presence of disease

and grazing of blades. Thus far, there are significant differences in growth rates between the fore-bay and the mid-bay transplant sites, with slower growth at the mid-bay site, which has higher temperatures and lower dissolved oxygen.

14.15 Natural history and importance of *Selaginella* (Selaginellaceae) in California

Anthony Baniaga

University of Arizona, Tucson, AZ, USA

Selaginella (Selaginellaceae) is a cosmopolitan genus of over 750 species worldwide represented by nearly a dozen taxa in California. Populations are found on coastal bluffs, summits of our highest mountains, shaded crevices of our desert mountains, on the trunks of our oldest bigleaf maple trees, and other areas in between. Locally abundant and seasonally dormant, these plants are overlooked in their ecological importance. To garner more interest in their research and conservation, I will place these taxa in a systematic context, relate curious natural history observations of them, and provide a snapshot of what I have found out about their genomes and desiccation tolerance from my dissertation research.

14.16 Forecasting evolutionary trajectories of floral and life history traits in two *Clarkia* (Onagraceae; farewell-to-spring) sister taxa using geographic variation as a proxy for climate change

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Climate change models for California predict a warmer, drier future, potentially resulting in shorter growing seasons. Warmer temperatures and earlier onset of late-season drought could disproportionately affect late-blooming species, such as members of the genus *Clarkia* (Onagraceae; farewell-to-spring). If phenotypic differences between closely related species currently distributed across a moisture and temperature gradient represent adaptations to their abiotic environment, then as conditions become warmer and drier, populations presently adapted to cooler and wetter conditions may evolve to become more like those adapted to warmer and drier conditions. Two sister species, *Clarkia unguiculata* and *C. exilis*, are distributed across a moisture and temperature gradient in the southern Sierra Nevada, providing an opportunity to predict how this process may occur. In a greenhouse experiment using wild-collected seeds, we examined relationships among elevation, climatic conditions, and population means for floral and life history traits. *Clarkia exilis* occupied warmer, drier conditions, typically at lower elevations than *C. unguiculata* did and flowered earlier and faster, producing smaller flowers with lower herkogamy. In *C. unguiculata*, petal area, herkogamy, and the rate of flower production were positively correlated with days to first flower. If selection under warmer and drier conditions favors earlier flowering, smaller petals, or faster flower production in *C. unguiculata*, then the genetic correlations among these traits should reinforce their joint evolution. Moreover, the correlations between these traits and herkogamy may promote the evolution of self-fertilization as an indirect response to selection, a previously unrecognized potential outcome of climate change.

14.17 Patterns of speciation and polyploid formation in manzanitas

Steven Serkanic, V. Thomas Parker

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The genus *Arctostaphylos* (Ericaceae) contains 107 minimum-rank taxa that are primarily distributed throughout western North America. The California Floristic Province is home to 106 of these entities, and, of this large number, 37 taxa are documented polyploids. This large number of polyploids indicates a strong relationship between genome duplication and species richness in the group. The Sierra Nevada is home to two broadly distributed diploid manzanita species, *A. patula* and *A. viscida*. A third Sierran species, *A. mewukka*, has been hypothesized to be an allopolyploid resulting from hybridization between *A. patula* and *A. viscida*. Genome duplication is a profound mechanism for reproductive isolation and hybrid speciation in sympatry. Species formation via genome duplication has occurred numerous times during the evolutionary history of flowering plants. Recurrent formation and reciprocal parentage is commonly observed among documented allopolyploids like *A. mewukka*. This provided an opportunity to test for parentage and repeat origin of *A. mewukka* throughout its range with the use of maternally inherited cpDNA. Regions of nrDNA were also sequenced to

address broad patterns of relatedness within this species complex. Tissue was sampled from five locations throughout the range of *A. mewukka*. These samples also include tissue from each putative parent, and tissue from multiple populations of *A. manzanita* - a broadly distributed polyploid with six subspecies. Results illustrate new patterns of relatedness and striking perspectives on polyploid formation in manzanitas. Insights also encourage a re-evaluation of the history of *A. mewukka* and the taxa belonging to this important Sierran species complex.

14.18 Relationships and evolution of California Floristic Province Menthinae (Lamiaceae), with special focus on *Monardella*

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¹University of Nebraska, Kearney, Kearney, NE, USA, ²University of California, Los Angeles, Los Angeles, CA, USA

Menthinae (Lamiaceae) is the largest subtribe within tribe Menthae, and includes about 40 genera and 1000 species. Menthinae are important economically as culinary herbs, including mints (*Mentha*), oregano (*Origanium*), savory (*Satureja*), and thyme (*Thymus*), and also as ornamental plants such as bee balm (*Monarda*). Three genera of Menthinae, *Acanthomintha*, *Monardella*, and *Pogogyne*, have a center of distribution within the California Floristic Province (CFP), and two other Menthinae genera, *Clinopodium* and *Pycnanthemum*, occur within the CFP. This study investigates relationships within the CFP Menthinae, with special focus on *Monardella*. The genus *Monardella* is found to be monophyletic, but the CFP *Clinopodium* are not monophyletic.

14.19 New insights into California monkeyflowers using phylogenomic data

Dena Grossenbacher

California Polytechnic State University, San Luis Obispo, San Luis Obispo, CA, USA

California monkeyflowers (Phrymaceae) are a model system in evolution and ecology. However, our understanding of the biogeographic history of this family has been hindered by our reliance on only a few genes for estimating evolutionary relationships, and our lack of exhaustive taxon sampling. Here, I present results of ongoing phylogenetic work to 1) assess patterns of recent speciation using genomic data from 122 accessions of *Erythranthe guttata* and its close relatives, and 2) to reconstruct evolutionary relationships using a >50 gene dataset of all 204 species in this worldwide family. These data reveal a complex history of budding speciation followed by occasional introgression, and within species variation in lifespan and mating system. These results are discussed with consideration of current taxonomic revisions. I end by revisiting the question of whether the two major California clades, *Erythranthe* and *Diplacus*, originated following a single or multiple dispersal events into the region.

14.20 Eighty years and 2,500 collections: Flora of the Upper Rock Creek watershed, eastern Sierra Nevada

Joy England

Rancho Santa Ana Botanic Garden, Claremont, CA, USA

Rock Creek is on the east slope of the Sierra Nevada in Inyo and Mono counties, California. The upper watershed, the subject of this study, is about 30 square miles (mi²), varying in elevation from 7360 to approximately 13,000 feet. Quaternary glacial erosion and deposition produced striking landscape features including alpine fell fields and numerous small lakes. Annual precipitation is approximately 22 inches, most of it falling as snow. Previous floristic inventories in Rock Creek (Peirson 1938, 1942; Howell 1946) recorded a combined 396 minimum-rank taxa but were limited to the Little Lakes Valley area. My goal was to document the vascular plant flora of the watershed based on preexisting specimens and new collections. I conducted fieldwork between 2012 and 2016, made 1504 collections, and examined >1000 historical collections. The resulting checklist contains 591 minimum-rank taxa. Two species previously unknown from the Sierra Nevada [*Carex stevenii* (Cyperaceae) and *Penstemon cinicola* (Plantaginaceae)] were documented, along with 11 new county records. Thirty-two taxa are CNPS-listed while 25 taxa are non-native. Eighty-two taxa historically collected were not rediscovered in my surveys. The flora is represented by 77 families, 248 genera and 572 species. The five largest families, in numbers of minimum-rank taxa, are Asteraceae (72 plus three non-native), Poaceae (65 plus 11 non-native), Cyperaceae (54), Rosaceae (33), and Brassicaceae (31 plus one non-native). The largest genera are *Carex* (47), *Boechea* (16), *Eriogonum* (15), *Stipa* (12), *Poa* (11 plus three non-native), *Penstemon* (10 plus one non-native), *Epilobium* (10), *Erigeron* (10), *Juncus* (10), and *Potentilla* (10).



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

PLANTS & POLLINATORS

The relationships of plants and pollinators will be explored through a combination of natural resource inventories, species diversity, and habitat analysis. The effects of resource management techniques, restoration, and environmental impacts on plant/pollinator relationships will be evaluated. Presentations will include studies to help understand the role of pollinators on rare plant persistence, and how plant diversity may influence healthy populations of pollinators.

15.01 Introducing the Center for Plant Conservation pollinators of rare plants database and its applications for research, management, and outreach

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¹San Diego Zoo Global, Plant Conservation Division, Escondido, CA, USA, ²Center for Plant Conservation, Escondido, CA, USA

Native plant species rely on pollinators to sustain genetic diversity and reproductive success. Because the loss of native pollinators poses an extinction risk for many rare species, identifying the pollinators of rare plants is essential for developing successful management and reintroduction plans. Most previously available pollinator references were constructed for public outreach, and, therefore, include almost exclusively common plant species. To build a tool more specific to rare plant management, we created a database to document literature observations of pollinators of rare plants in the Center for Plant Conservation (CPC) National Collection, with funding from the National Fish and Wildlife Foundation. We leveraged open source citation management software and web-based form builders to create a platform, which allowed volunteers to transcribe over 550 rare plant references. The current database contains over 13,000 plant-pollinator interactions from over 2000 plant species and is freely available for download on the CPC website (SavePlants.org). We used this resource to evaluate patterns of rare plant - rare pollinator interactions documented in the grey and academic literature. We found over 210 records of rare animals pollinating rare plants, including 111 plant species and 38 pollinator species. Our records indicate that wide-ranging, but vulnerable bumble bee species, *Bombus pensylvanicus* (Apidae), pollinates 12 rare plant species in the CPC national collection, indicating that *B. pensylvanicus* conservation may be important for maintaining the health of many North American plant communities. We encourage researchers and land managers to utilize this dataset to include pollinator availability in conservation decisions concerning rare plants.

15.02 Diet overlap between bee and hummingbird pollinators in California

Jenny Hazlehurst, Erin Wilson Rankin, David Rankin, Quinn McFrederick, Christopher J. Clark
University of California, Riverside, Riverside, CA, USA

Plants are frequently characterized as being either a "bee plant" or a "hummingbird plant", but in this study, we demonstrate significant overlap in California native plants visited by both pollinator guilds. We documented pollination networks for bees and hummingbirds at 11 sites in California including coastal, central valley, and Sierra Nevada locations. Pollination networks were constructed using direct observation along 10 and 100-meter (m) transects, capturing bees at flowers, and by sequencing fecal samples from hummingbirds using DNA metabarcoding. Central valley locations were visited in January, February, and March; coastal sites were visited in March and April, and Sierra sites were visited in June, July, and September. We identified 36 plant species used by hummingbirds. Of these, 25 were native and 27 were shared with bees. Representative shared genera included *Arctostaphylos* (Ericaceae), *Castilleja* (Orobanchaceae), *Mimulus* (Phrymaceae), *Penstemon* (Plantaginaceae), *Ribes* (Grossulariaceae), *Salvia* (Lamiaceae), *Scrophularia* (Scrophulariaceae), and *Stachys* (Lamiaceae). Nectar robbing by bees was observed in *Castilleja*. Several invasive and non-native species were also shared by bees and hummingbirds, including *Eucalyptus* (Myrtaceae), *Prunus* (Rosaceae), *Robinia* (Fabaceae), and *Silybum* (Asteraceae) species. The mean sucrose concentration of hummingbird-visited flowers was 26.9 percent Brix (available for N = 26 species). This data provides insight into the pollination requirements and potential resiliency of California native plant species, in addition to competition from invasive and non-native plants for native plant pollinators.

15.03 Native bee diversity on gabbro soils of the Pine Hill formation, El Dorado County

Dylan Burge¹, Graciela Hinshaw², Landon Eldredge²

¹Southern Oregon University, Ashland, OR, USA, ²Bureau of Land Management, El Dorado Hills, CA, USA

TECHNICAL PRESENTATION ABSTRACTS BY SESSION

Native bees are crucial pollinators of both crops and native plants world-wide. Despite the clear value of these organisms to the health of ecosystems and human society, little is known about native bee diversity across the landscape. We do not completely understand the ecological conditions that maintain diverse bee communities and healthy bee populations. Recent research suggests that populations of many native bees are in steep decline, which means that answering these questions is especially urgent. Our work focuses on the diversity of native bees in a unique ecological setting, the Pine Hill area of El Dorado County, California. The Pine Hill area supports a unique and hyper-diverse assemblage of plants, many of them endemic to the region. Hyperdiversity in this area is associated with chemically unique gabbro-derived soils. The aim of our research was to find out how these unique plant communities affect pollinator diversity. We surveyed native bee diversity continuously for one year using cup and malaise traps. Surveys were done at three sites in the Pine Hill area, comparing botanically diverse sites to immediately adjacent sites with lower diversity. Our work revealed that the more diverse plant communities support more native bee diversity for a longer period of the year than do plant communities with less botanical diversity. Although this work must be followed up by sampling of additional sites and multiple years of monitoring, our results imply that soils should be considered when planning to conserve native bees and their plant partners.

15.04 Characterization of the impacts on bee pollinators from utility-scale solar development in the southwestern deserts: Species abundance, diversity, and community composition

Leslie Saul-Gershenz¹, Lynn Kimsey¹, Neal Williams¹, Thomas Zavortink¹, Robbin Thorp¹, John Ascher², Terry Griswold³, Douglas Yanega⁴, Jennifer Van Wyk¹, Caroline Larsen¹

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The goal of this research is to characterize and quantify the impacts of utility scale solar development on desert pollinators in the communities in which they live, specifically, in the Mojave and the western Sonoran Desert regions. We used a matched transect control design to test whether pollinator populations have changed due to solar utility scale installations. The Mojave and Sonoran Deserts both represent hotspots of bee biodiversity and support the highest bee diversity in North America, which corresponds to the rich botanical diversity of the Mojave Desert, which alone supports 1,512 plant species. We used both passive traps and hand-netting along five 200 meter (m) transects at set distances from each existing solar facility (inside, 0 m, 200 m, 500 m, 2,000 m). We found 114 pollinator species including six new species, over five collecting events from 25 March through 9 May 2016. Of these 114 species, 42 percent are oligolectic, 10 percent are polylectic and 29 percent lack data on their floral diets. A non-metric multidimensional analysis showed a significant effect of solar facility on pollinator community composition. We found lower pollinator abundance, diversity and richness inside the solar installations. However, we did not find a significant effect of distance from solar installation at 2,000 m for year one. We used archival museum pollinator specimen data from the Mojave and western Sonoran to produce 19 bee species distributions (13,983 specimen records) and used these to produce a "predicted presence of Mojave and western Sonoran Desert bees" map based on several environmental variables for future conservation planning by stakeholders and land managers.

15.05 The bees are on their knees: A re-examination of the endangered salt marsh bird's beak's insect pollinators, 30 years later

Denise Knapp¹, Chris Garoutte¹, Jaime Pawelek², Ruben Alarcon³

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The endangered salt marsh bird's beak (*Chloropyron maritimum* ssp. *maritimum* [Orobanchaceae]; CHMAMA) is extirpated from 64percent of its formerly known occurrences. It requires insects for successful pollination; however, pollinators such as bees are declining around the globe. In this project, we repeated a 1985 survey of CHMAMA pollinators at the Point Mugu Naval Base in Ventura County, and observed and quantified the broader plant-pollinator network, which can illuminate ecological interactions and identify species vital to maintaining pollination services for this rare plant. At each of two CHMAMA populations present in 2016, we measured the rate of insect visitation to CHMAMA flowers within a two by two-meter (m) plot on three days in June. After over 16 hours of observation, we observed only five bee individuals using CHMAMA, of two species (*Anthidium edwardsii* [Megachilidae] and *Melissodes tepida timberlake* [Apidae]) that were observed previously. However, one bumble bee formerly observed (*Bombus pensylvanicus* [Apidae]) was not present in any of our surveys at the site, either on or off CHMAMA, while *Lasioglossum*



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

spp.(Halictidae) were observed and collected at Mugu in 2016 but not using CHMAMA. We also surveyed the pollinators of 14 other plant taxa on one day, every three weeks between March and July. Non-parametric network analyses of these data yield an interaction diagram for two upland taxa; *Phacelia distans* (Hydrophyllaceae) and *Acmispon glaber* (Fabaceae), which also support *Anthidium* and bloom earlier in the year than CHMAMA. These taxa grow readily and, if augmented, may help support bee populations critical to CHMAMA when it is not abundant.



TECHNICAL PRESENTATION ABSTRACTS BY SESSION

EMERGING TOOLS IN CONSERVATION SCIENCE

As threats to plant diversity and habitats continue to escalate, so conservation science and its many applications must match the pace and scale of these challenges to inform effective decision-making. This session will examine new and emerging technologies, tools, and innovative resources that are developing to address plant conservation issues.

16.01 Utilization of Fulcrum and IntegraLink to provide stakeholders real-time field survey information leading to increased efficiency and problem-solving in support of conservation efforts

Jacqueline Milbank
TRC, Rancho Cordova, CA, USA

Conservation efforts require the coordination of multiple stake-holders who are best served with accurate, real-time field information to determine the appropriate course of action. Field surveys identify sensitive environmental receptors of which take or alteration may require lengthy permitting. Observations from routine monitoring provide insight into the health of restoration and mitigation sites, and aid in prescribed treatment determinations. Complicating data-collection and management efforts are remote field locations and personnel with varied levels of field experience, which can lead to inadequate data or detrimental delays in data-processing. Even the most diligent field crews are often limited by short field seasons, leading scientists and consultants to desire systems that maximize the efficiency of data collection. Elevating the capabilities of Fulcrum, a data collection application available on iOS and Android, TRC utilizes our proprietary IntegraLink program to allow stakeholders to view real-time raw information as soon as the data-collection device is synced. Field personnel utilize custom and automated field sheets, incorporating photos and videos when appropriate. Project managers can communicate to crews when data is missing or requires elaboration, avoiding unplanned remobilization efforts. Clients can view the datasheets through a Google Earth interface, influencing real-time decisions. The utilization of Fulcrum and IntegraLink throughout TRC's client-base has led to the dissemination of real-time field data to stakeholders in the planning, monitoring, and emergency portions of projects. The increased levels of communication afforded by the system have allowed for immediate team collaboration and decision making, aiding in the conservation of various sensitive environmental receptors.

16.02 Collecting, managing, and reporting environmental data - easy in, easy out - digital technology makes plant conservation and restoration efforts more efficient and more accurate

Brandon Jones, Kristen Hazard
Wildnote, San Luis Obispo, CA, USA

Climate change, destruction of habitat, and disappearing plant species are a call to action - let's use the best of our technology to make our environmental work more efficient, produce higher quality outcomes, and keep the planet healthier for everyone. The inefficiencies inherent in utilizing pen and paper, or a mish-mash of digital solutions to collect, manage, and report data are tedious work, result in errors, inaccurate data, and unnecessary stress. Replacing archaic methodologies with a comprehensive, intuitive, and easy-to-use digital solution that incorporates all three phases into a single, streamlined process improves plant conservation, monitoring, restoration, and land management efforts. Tracking pathogens, pests, and invasive species is simplified and more accurate. Efficient data collection brings more data into the collective body of data. Organized data management puts more eyes on a problem, and easy data retrieval creates more collaborative study, which expedites exploration of common issues, such as the effects of fire on native species or the relationship between pollinators and plants. The availability of searchable, systematized data fosters direct and express dissemination of information, inviting more debate, discussion, and communal contribution to important topics, such as the discovery of rare species and potential threats to those and other species. An intuitive and easy-to-use digital solution allows both professional and citizen scientists to better define the scope of work and contribute more accurate data, adding another powerful tool in the ongoing difficult task of protecting, conserving, and restoring plant populations, species, and the ecosystems on which they both depend.



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16.03 Calflora provides 21st century tools for conservation science: History stacks track change over time for restoration sites, email alerts when a species of interest is reported in your wildland area of interest, enter a survey area with plants list, and using smartphones in the field to photograph and upload observations

Cynthia Powell¹, [Rachel Kesel](#)¹

¹Calflora, Berkeley, CA, USA, ²Tamalpais Lands Collaborative, Marin, CA, USA

Calflora is an internet resource where users can search for plant occurrences and other related information about wild plants in California. Contributors add their own occurrence data and photos, building on top of what is already there. The Calflora database includes 1.2 million plant observations of 10,000 wild plant species known to grow in the state. The sophistication with which users may enter and use Calflora plant data has changed dramatically over the past 4 years; for instance, the use of phone apps to log and track data. Download free Calflora phone apps to collect photos and assessment information of wild plant populations. The phone's internal GPS makes uploading these observations with locations easy, as well as logging polygons in the field. Users conduct surveys, recording the survey area, the plants looked for, and the plants found. Using these 1.2 million Calflora observation locations as well as the soil, climate, and elevation factors of a chosen location on a map, the Calflora Planting Guide allows users to find the most suitable native plants for horticultural or restoration purposes. One Tam provides a successful case study demonstrating how sharing data across jurisdictions and working together to collect and analyze these data. One Tam also uses Calflora history stacks to track how a plant population has changed over time -- particularly the size of the population, as indicated by a polygon.

16.04 Rancho Santa Ana Botanic Garden contributions to BLM Seeds of Success: Seed collection logistics, strategies, and tools

[Sarah De Groot](#)

Rancho Santa Ana Botanic Garden, Claremont, CA, USA

Rancho Santa Ana Botanic Garden started a Bureau of Land Management Seeds of Success (SOS) collecting team in 2010, making seed collections of common native plants for seed banking and restoration. This involves determining what species to collect, what areas to target, where and how to find large populations in flower or fruit, timing seed collections, and tracking populations and seed collections. Target species are determined in large part by commonness (G4 or G5), seed fill and viability data based on previous collections, usefulness to wildlife, and ease of collection. Target areas are established based on the absence of SOS collections, and amount of precipitation received. In some cases, we target species in areas based on an analysis of seed transfer zones, and rely on herbarium records for potential sites of that species in those areas. As an aid to determining when seed might be ripe, we have compiled data by species on the length of time between flowering and fruiting, based on our previous collections. A large spreadsheet tracks populations we are watching and seed collections we have made, to ensure that each step in the process is completed. In the field, we use the ESRI Collector app via ArcGIS online on an Android tablet. For special projects involving multiple collaborators, we have found a website with an embedded Google Sheet and ArcGIS online web map to be useful. Although our methods were developed for making seed collections of common plants, they can easily be extended for other uses.

16.05 Using an ArcGIS and CollectorApp mapping project of an endangered plant montane meadow habitat as a basis for an off-highway vehicle damage assessment

[Trevor Hook](#), Benjamin Hamada, Timothy Krantz

University of Redlands, Redlands, CA, USA

A map of the distribution of bird-foot checkerblooms (*Sidalcea pedata*, [Malvaceae]), a Federal- and State-listed Endangered species, was completed in May, 2016, using ArcGIS Online and the CollectorApp. Metcalf Meadow, in Big Bear Lake, CA, was purchased with funding from the California Wildlife Conservation Board to conserve 30 acres of meadow habitat, including the checkerbloom, as well as Bear Valley bluegrass (*Poa atropurpurea*, [Poaceae], Federal- and State-listed as Threatened) and other Big Bear rare plant species. In April, 2017, two large trucks trespassed onto the meadow during saturated soil conditions, severely damaging approximately 3 acres of endangered species habitat with deep ruts and wallows before they became stuck and had to be towed out, causing even more damage. A damage assessment was completed in May, 2017, using the ArcGIS base data from the year before, together with CollectorApp



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data indicating the major ruts and extent of damaged habitat. A quantitative damage assessment was then calculated with regard to direct and indirect impacts to the endangered species. A high-resolution drone imagery coverage was also completed to refine the damage assessment and provide the basis for a restoration plan.

16.06 Developing data collection and analysis tools for rare plant surveys in western San Diego County

Emily Perkins¹, Kristine Preston¹, Jessie Vinje², Patricia Gordon-Reedy², Spring Strahm², Sara Allen³, Betsy Miller⁴
¹United States Geological Survey, Western Ecological Research Center, San Diego, CA, USA, ²Conservation Biology Institute, San Diego, CA, USA, ³AECOM, San Diego, CA, USA, ⁴City of San Diego Multiple Species Conservation Program, San Diego, CA, USA

The San Diego Management and Monitoring Program (SDMMP), in collaboration with the Conservation Biology Institute (CBI), the City of San Diego Park and Recreation Department, and AECOM, designed and implemented a coordinated effort to monitor 30 rare plant species in San Diego County. This effort was prioritized in The Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County. The survey was designed to be implemented by a wide-range of local and regional land managers, wildlife agencies, and non-profits. Coordination among these groups was required to ensure the data collection methods were uniform and met quality standards. In order to facilitate the consistent collection and analysis of field surveys, a series of tools were created. Through the SDMMP website, portal.sdmmp.com, users can access protocol information, survey forms, historical data, and a list and map of prioritized species and occurrences. Historical data is available on an interactive, online map or for download as a shapefile or excel sheet. The website uses a project database to track metadata and data of projects across Southern California. The project database allows users to standardize protocols and share field forms, allowing for better reliability in data collection. Field surveys were done using a customized form on an ESRI product called Survey123. Users followed set questions, collected GPS points, and submitted the data to single online layer and database through arcgis.com. Interactive maps and search tools allowed collaborators to collect data that is comparable among users and ready for detailed analysis.

16.07 Growing alliances: Communicating among diverse opinions and disciplines to facilitate conservation

Andra Steinbergs
San Diego State University, San Diego, CA, USA

In conservation, science is key. But so are organizations, governments, private citizens, financial institutions, and the alliances that can form between these groups. It can be easy or comfortable to talk to our fellow conservationists or native-plant enthusiasts, but what about those who are indifferent or resistant to engagement with the conservation of native ecosystems? What tools can we use to try to better communicate and effect conservation of native ecologies? As the pressures of climate change mount and as the human population of the State of California increases, we will face incredibly complex challenges that are not likely to have any simple or easy solutions. Complicating this, conflicting stakeholder groups can delay action and conflicting opinions can hinder communication. However, we can learn important lessons from other conservation efforts and we can also apply some of the principles of rhetoric to help us better form alliances that facilitate the conservation of native resources. We can benefit from the efforts of other conservation groups by using their failures and successes with conservation action to better inform our own efforts. Further, we can apply the rhetorical concepts of audience, purpose, and context when trying to communicate with our non-enthusiastic counterparts. Between learning from examples and applying the concepts of audience, purpose, and context to conservation communication, we may better serve our goal of conservation. As with any ecosystem, we can grow our interactions with others, and, ultimately, we can grow our alliances to serve and protect our native ecosystems.

16.08 Using specimen data with new quantitative approaches to study spatial patterns of richness and endemism in California's vascular flora

Bruce Baldwin, Andrew Thornhill, Will Freyman, David Ackerly, Matthew Kling, Naia Morueta-Holme, Sonia Nosratinia, Tom Madsen, Brent Mishler
University of California, Berkeley, Berkeley, CA, USA

California's vascular flora is the most diverse and threatened in temperate North America. Previous studies of spatial patterns of Californian plant diversity have been limited by traditional metrics, non-uniform geographic units, and

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distributional data derived from floristic descriptions for only a subset of species. We revisited patterns of sampling intensity, species richness, and relative endemism in California based on equal-area spatial units, the full vascular flora, and specimen-based distributional data. We estimated richness, weighted endemism (inverse range-weighting of species), and corrected weighted endemism (weighted endemism corrected for richness), and performed a randomization test for significantly high endemism. High species richness was sometimes associated with significantly high endemism (e.g., Klamath Ranges) but often not. In Stebbins and Major's (1965) main endemism hotspot, Southwestern California, species richness is high across much of the Peninsular and Transverse ranges but significantly high endemism is mostly localized to the Santa Rosa and San Bernardino mountains. In contrast, species richness is low in the Channel Islands, where endemism is significantly high, as also found for much of the Death Valley region. Measures of taxonomic richness, even with greater weighting of range-restricted taxa, are insufficient for identifying areas of significantly high endemism that warrant conservation attention. Use of enhanced metrics such as phylodiversity and phyloendemism, with a 9-gene molecular phylogeny of Californian plants, has extended perspectives on richness and endemism across the state to take in information on evolutionary divergence and relationships across our flora and address such concerns as spatial patterns of concentrated neo- and paleo-endemism.

16.09 Drought-related die-off of bishop pine (*Pinus muricata* [Pinaceae]) on Santa Cruz Island: The worst yet recorded?

Annalise Taylor¹, Kirk Klausmeyer², John Randall², Tanushree Biswas²

¹Peninsula Open Space Trust, Palo Alto, CA, USA, ²The Nature Conservancy, San Francisco, CA, USA

On California's Santa Cruz Island, the severe die-off of bishop pine (*Pinus muricata* [Pinaceae]) over the past several years has ignited ecological concerns, as have mass die-offs of conifers throughout mainland California. The island's die-off coincided with the recent drought and an accompanying bark beetle outbreak. This study aimed to place this die-off in context with previous drought-linked mortality events within California's cyclical drought regime. Using moderate resolution Landsat imagery, this study compared the mortality of the most recent extreme drought event (2012-2016) to the one previous (1987-1991), which an earlier study had identified as the worst on the island in the 20th century. We tracked the rate of change in three common vegetation indices within the study area and subtracted the slope of each index during the 2012-2016 drought from that of the 1987-1991 drought on a pixel-by-pixel basis, revealing regions of historical and current drought refugia. In total, 1,474 Landsat scenes were processed using the Google Earth Engine platform. The Palmer Drought Severity Index classified 2012-2016 as an extreme drought, the worst during the study period, and identified 1987-1991 and 2007-2009 as severe droughts. Our image analysis indicated bishop pine mortality rates were higher and cumulative mortality was greater in the 2012-2016 drought than in 1987-1991 drought. Drought frequency and severity are expected to increase with climate change, and further study will be necessary to determine whether die-off severities also increase, and whether management actions can reduce the severity of die-offs and facilitate recovery of the groves.

16.10 Rapid development of population genetic resources for California rare plants using next-generation sequencing

Nathan R. Vega, Joshua P. Der

California State University, Fullerton, Fullerton, CA, USA

With a varied geographic environment and a mediterranean climate, California is a biodiversity hotspot containing a large number of endemic and rare plant species. As the human population in California continues to grow, natural plant communities face increasing threats from energy and housing development, habitat fragmentation and loss, and intensifying recreational land use. As populations of rare plants decline, it is essential to develop conservation management plans grounded in scientific information, including natural history, population modeling, and population genetics. Recent advances in genome sequencing technology allow for the rapid development of population genetic markers in non-model organisms in a high throughput and economical way. As a proof of concept, we have initially targeted nine Federally Threatened or Endangered rare plants in Southern California identified by the US Fish and Wildlife Service in need of genetic research. At a cost of less than \$120 per sample, we obtained over 1 billion nucleotides of whole-genome shotgun DNA sequence data for each species. We identified hundreds of high-quality microsatellite loci suitable for population genetics research and assembled the complete chloroplast genome of each species. We sequenced *Ambrosia pumila* (Asteraceae), *Brodiaea filifolia* (Themidaceae), *Ceanothus ophiochilus* (Rhamnaceae), *Chorizanthe orcuttiana* (Polygonaceae), *Dudleya stolonifera* (Crassulaceae), *Eriastrum densifolium* subsp. *sanctorum*



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(Polemoniaceae), *Fremontodendron mexicanum* (Malvaceae), *Navarretia fossalis* (Polemoniaceae), and *Verbesina dissita* (Asteraceae). DNA sequence data, chloroplast genome sequences, and microsatellite primers are being made publicly available for immediate deployment in systematics and population genetic studies.



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A QUALITY ENVIRONMENT FOR ALL: JUSTICE & INCLUSIVENESS IN NATIVE PLANT CONSERVATION

Both economic and environmental inequality exist in our society and have significant lasting effects on people's quality of life. This session will examine the ideas of "Environmental Justice" and "Social Justice," address how we recognize environmental inequality and support communities facing this inequality, and how these realities relate to the native plants we work to protect and conserve.

17.01 Piñatas and penstemon: Education and training for Latinos and other underrepresented groups in California native plant conservation and horticulture

Antonio Sanchez¹, Naomi Fraga²

¹*Nopalito Native Plant Nursery, Oxnard, CA, USA*, ²*Rancho Santa Ana Botanic Garden, Claremont, CA, USA*

With over 10 million people, Los Angeles County is the most populous in the United States, and Latinos make up almost half its population (47%). Programs with the expressed goal of increasing participation of underserved and underrepresented groups such as Latinos in native plant conservation and horticulture are few and far between. This presentation outlines the successes, and lessons learned from programs that focus on training and education in California native plant conservation and horticulture to underserved youth and the community at large. 100% certified tortilla-eating Latinos Naomi Fraga (Botanist) and Antonio Sanchez (Horticulturist) guide you through their experiences connecting Latinos and other underrepresented groups to native plant conservation and horticulture through: 1) An United States Department of Agriculture (USDA) grant-funded program to increase education and participation of Latinos in natural resource management with an emphasis on ecological restoration and native plant conservation. 2) Coordinating and promoting events like the California Native Food Symposium and the California Native Sage Festival that attract a wide range of folks from diverse backgrounds. We will illustrate how programs and events like these have helped connect communities that are currently underrepresented in California native plant conservation and will provide ideas for promoting more programs like these in the future. Additionally, we will cover how important it has been to have people of color and other minorities in leadership positions to influence and help direct these programs to achieve the best, most influential results possible.

17.02 Eco-social justice field training

D. Sherwood

Theodore Payne Foundation, Sun Valley, CA, USA

In the last two years, the Theodore Payne Foundation has advanced a new kind of community field-training model of education for students, teachers, professionals, and under-served communities in Greater Los Angeles. We have worked in partnership with The Housing Authority of the City of Los Angeles and Boys and Girls Clubs. Additionally, we have worked with homeless and at-risk youth populations at Taking the Reins, an organization working to empower young women. Inspired by the late Theodore Payne's own practices and philosophy, each training has been a multi-part series of classes based on concrete practices that include scientific observation of our local environment, propagation, rudiments of design, planting, garden maintenance, and environmental advocacy in the community. Classes promote self-governance, engagement, and ownership of our shared land and support a model in which all students are introduced to tools and skills to continue in the field, or that may engender critical awareness able to serve in any field. This talk focuses on social justice through service learning environmental education and will highlight the critical importance of this field training model through a discussion of our work in partnership with Taking the Reins.

17.03 Environmental Justice for Underrepresented Communities' (EJUC) in environmental sciences education at UCD

Adriana Fernandez, Claire McLeod

University of California, Davis, Davis, CA, USA



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Environmental Justice for Underrepresented Communities (EJUC) is a student organization at the University of California, Davis founded by Claire McLeod and Adriana Fernandez in November, 2015. The organization was created out of the founders' recognition of a need and a desire to address a lack of intersectional and accessible environmental justice education within UC Davis' environmental science department. They believe if UC Davis educates and graduates students, who are ill-informed of how their professional work in the environmental field could impact historically marginalized communities disproportionately to other segments of our population, the University has failed them. EJUC is dedicated to bringing awareness to environmental injustices within historically overlooked communities. The mission of EJUC is to advocate for environmental justice and take action through student organizing, promoting environmental justice within environmental science education, and creating space to voice environmental injustices faced by underrepresented and marginalized folks both inside and outside of formal curriculum settings. This presentation shares the presenter's experiences with environmental justice and the challenges navigating the founding of the EJUC organization at UC Davis.

17.04 The unexpected growth of the nopal

Christopher Sanchez

Coalition for Humane Immigrant Rights, Los Angeles, CA, USA

Some would consider nopals (*Opuntia* spp. [Cactaceae]) an eye sore, an unwanted plant because of its prickly appearance, another form of a weed because they grow so rapidly; however, to many of Mexican decent, nopals are seen as plants that have tremendous value simply in their existence and resistance to the environment they live in. This conversation focuses on how direct advocacy by certain communities towards various levels of government have been successful - even as history has been against them because of their unexpected growth and 'eye sore' of an appearance, much like the nopal. In his remarks, Mr. Sanchez will discuss how some of California's most underrepresented communities have been used to advance political agendas in order to make those agendas pleasing to the eye, and add a narrative that is more accepted by the general public.

17.05 Environmental justice communities- how conservation impacts communities at the frontlines of our climate crisis

Michele Hasson

Center for Community Action and Environmental Justice, Jurupa Valley, CA, USA

The mission of the Center for Community Action and Environmental Justice (CCAIEJ) is to bring people together to improve our social and natural environment. We do this by developing indigenous leadership, community organizing through strategic campaigns, and building a base of community power. The CCAIEJ is a progressive, base-building, non-profit organization whose focus is to bring communities of people together to find opportunities for cooperation, agreement, and problem solving in improving their social and natural environment. Using the lens of environmental health to achieve social change, we work within communities to develop and sustain democratically based, participatory decision-making that promotes involvement of a diverse segment of the community in ways that empower the community. In the Inland Valleys of Southern California there are many synergies between the goals of allies in the conservation movement and those in the Environmental Justice (EJ) movement; this presentation, building on the work of CCAIEJ, identifies opportunities for conservation advocates to work with EJ communities to foster ownership and shared goals in conservation efforts.



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FIRE & NATIVE PLANTS

For many native plant communities fire is an essential ecological disturbance process, and the use of fire in management is essential for the health and longevity of forests and plant communities. This session will explore California native flora's relationships to fire.

18.01 Changing fire regime within conifer forests of southern California

Katherine Nigro¹, Nicole Molinari²

¹University of California, Santa Barbara, Santa Barbara, CA, USA, ²United States Forest Service, Goleta, CA, USA

Fire suppression over the last century in California has contributed to changes in fire frequency and forest structure. These changes, combined with effects of the changing climate, may allow uncharacteristically large and severe fires to impact the landscape. In Southern California, this is likely to have negative consequences for the recovery of mixed conifer and yellow pine forests post-fire, due to their scarcity and isolated nature at high elevations. We used fire return interval departure (FRID) analysis to evaluate the extent that current fire return intervals in these conifer forests of southern California's National Forests have deviated from historical conditions. We also analyzed how the proportion of forest area burning at high severity has changed over the last 30 years in these forests. We found that over 90% of the conifer forest area analyzed, which burned frequently before suppression, has a current fire return interval that is three times or longer than it was historically. This has likely created dense stands that could be more susceptible to large, high severity fires. Indeed, our data shows an increasing trend in the proportion of high severity fire over time. Our findings indicate that the structure and fire regime of southern California conifer forests today are drastically different than they were a century ago. These relatively scarce forests are in danger of succumbing to catastrophic fire events that they may not be able to fully recover from, unless proactive management is focused on areas that are most vulnerable to severe change.

18.02 Mixed-conifer understory plant diversity patterns across wildfire severity classes and associated ecological characteristics of the Sierra Nevada, CA

Clark Richter¹, Marcel Rejmanek¹, Hugh Safford²

¹University of California, Davis, Davis, CA, USA, ²United States Forest Service, Vallejo, CA, USA

A major disturbance like wildfire can re-shape the ecological characteristics of a system. In temperate forest ecosystems where understory plant species contribute significantly to overall community diversity, it is imperative to land management and conservation interests to understand how disturbance events like fire shape understory communities. However, there remains a gap in our understanding of post-fire diversity in mixed-conifer, unmanaged sites in the Sierra Nevada. We conducted complete understory plant censuses of plots across a spectrum of fire severity classes in eight wildfire perimeters of varying age to examine patterns in understory diversity. Our objectives were to determine how understory plant richness and cover varied across fire severity classes, whether environmental variables related to wildfire severity could be used to predict plant richness and cover, and how these results compared across wildfires of varying ages. We found higher values of understory diversity in moderate fire severity classes while understory diversity indexes in low and high severity classes were significantly lower. We also found understory plant compositions were similar within fire severity classes across wildfires, but varied greatly depending on the time since wildfire. These results we attribute to variations in environmental characteristics brought about by wildfire severity type that may impose lasting filtering effects through successional time. This information should allow land managers in wildfire-prone systems to more confidently commit resources towards the goal of diversity while the effects of global change and legacies of fire suppression make high severity wildfire more frequent.

18.03 Management, protection, restoration, monitoring, and education for the Federal and State Endangered Stebbins' morning-glory (*Calystegia stebbinsii* [Convolvulaceae]) and Federal Endangered and State Rare Pine Hill flannelbush (*Fremontodendron decumbens* [Malvaceae]) in an endemic fire adapted chaparral ecosystem, and candidate Rare Natural Community, in the Sierra Nevada foothills, Nevada County, CA

Denise Della Santina, Karen Callahan

Redbud Chapter, California Native Plant Society, Grass Valley, CA, USA



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In 2015, the Redbud Chapter--California Native Plant Society, Nevada County and the California Department of Forestry and Fire Protection received a U.S Fish and Wildlife Service Section-6 Grant to study one of the nine remaining federal and state endangered Stebbins' morning-glory (*Calystegia stebbinsii* [Convovulaceae]) populations; apply vegetation treatments to expand the population; create a Memorandum of Understanding with project partners and develop a Management Plan to guide actions to protect and restore populations on county property. Project goals include: survey and monitor Stebbins' morning-glory and other rare plants; reduce adverse impacts to Stebbins' morning-glory; allow necessary county operations and mitigate impacts to rare plants; expand rare plant habitat, range and population numbers; treat vegetation to mimic natural disturbance; educate workers and the community to protect the plants and habitat. Winter 2016/2017, project partners collaborated to selectively cut and broadcast burn twelve acres in chaparral considered most likely to host Stebbins' morning-glory and/or Pine Hill flannelbush seedbanks. Spring 2017 surveys in treatment areas showed high morning-glory seedling emergence, with at least 833 new plants, an increase of over 25% from 2015. This suggests a viable seed bank, suitable habitat, and opportunities for expanding the populations' range and numbers at the site. The project has resulted in a mutually beneficial scenario which supports the increase in rare plant populations through vegetation treatments; reduction of fire potential in a populated area; improved communication and understanding among project partners and a management plan to guide future actions and rare plant protection.

18.04 Evidence for pre-settlement wildfires in perennial grass-dominated landscapes of the eastern Mojave Desert and implications for fire management in the Mojave National Preserve

Joseph McAuliffe

Desert Botanical Garden, Phoenix, AZ, USA

Portions of the eastern Mojave Desert region that receive significant monsoonal precipitation contain large areas dominated by perennial C4 grasses. Some of the best representations of these grass-dominated landscapes are in the eastern portion of the Mojave National Preserve (MNP), San Bernardino County, California. Since the late 1890s, livestock ranching significantly impacted perennial grass-dominated vegetation. Removal of livestock from much of the MNP around 2000, coupled with years of abundant warm-season precipitation, has led to a resurgence of perennial grasses. In savanna-like vegetation containing scattered junipers (*Juniperus osteosperma* [Cupressaceae]), old, weathered, fire-scarred juniper stumps provide evidence of extensive wildfires in pre-settlement and perhaps early settlement times (1800s-early 1900s). Early settlers selectively cut standing, fire-killed juniper trees for fuelwood. Axe cuts superimposed on charred wood surfaces demonstrate the occurrence of fire prior to woodcutting. Materials discarded by woodcutters help constrain the timing of wood harvest and the previous wildfires. The abundance of intact stumps provide a rich potential source of materials for detailed dendrochronological analyses of wildfire history. Information from charred stumps and historic information indicate that wildfire played a significant role in pre-settlement times in maintaining perennial grass-dominated landscapes in this region. However, more than three-quarters of the MNP is zoned for full wildfire suppression, including all of the most extensive areas dominated by perennial grasses. Detailed investigations of pre-settlement fire history in this area will help inform management approaches to wildfire within the MNP.

18.05 Wild flora and fauna of Griffith Park, Los Angeles, California

Jorge Ochoa

Long Beach City College, Long Beach, CA, USA

Griffith Park is our nation's largest urban park, located at the western end of the Santa Monica Mountains, and site of a major fire in 2007. The fire provided the opportunity to survey native flora long-hidden by invasive non-native vegetation and led to the rediscovery of native species not seen for many years, as well as discovery of previously unrecorded plants. These plants and various associated animals are showcased in the talk.

BIOGEOGRAPHY & CONSERVATION OF “PLANTS” WITHOUT SEEDS

California's floristic diversity includes a wealth of lichen and bryophyte diversity. This session will explore the biogeography of our lesser explored photosynthetic biota and the resulting implications for conservation.

19.01 Biogeography of plants with spores

Daniel Palmer, Paul Wilson
California State University, Northridge, Northridge, CA, USA

Homosporous plants, such as mosses and ferns, tend to have wider distributions than angiosperms, often with close relatives more or less sympatric. Presumably having small windborne spores spreads species out resulting in geographic ranges as large as the available niche, even resulting in trans-continental species ranges. This means that species are 'defined' primarily by niches. Many examples can be given of widespread but specialized species. Some species are calcicoles, others are calcifuges, for example. Endemic species are those that have highly specialized habitat requirements. In contrast, seed plants often have an evolutionary dynamic that is different, resulting in small geographic ranges with close relatives that are allopatric. *Selaginella* (Selaginellaceae) and *Isoetes* (Isoetaceae), with their megaspores incapable of wind dispersal, are exceptions that prove the rule. Their biogeography and presumably their evolution are more like angiosperms than like ferns and mosses.

19.02 Biogeographic trends in moss reproduction

Kirsten Fisher
California State University, Los Angeles, Los Angeles, CA, USA

Unlike seed plants, mosses are characterized by a high frequency of unisexual (dioecious) as opposed to hermaphroditic (monoecious) sex systems. Approximately 60% of moss species are dioecious, and the prevalence of unisexual moss species may reflect adaptive advantages for sexual specialization beyond outcrossing. In addition, many unisexual forms seem to be perfectly able to maintain themselves at high abundance through cloning, only rarely reproducing sexually. Within dioecious moss populations, phenotypic sex ratios are often skewed towards female individuals; however, the degree and direction of sex ratio bias is idiosyncratic and may display biogeographic patterns. Male and female mosses may also be associated with different microhabitats within a local area. The desert moss, *Syntrichia caninervis* (Pottiaceae), is presented here to demonstrate the possible consequences of conflicting selective pressures on population reproductive behavior, sex ratios, and genetic diversity, with implications for conservation at multiple geographic scales.

19.03 Biogeography, systematics and conservation of the *Orthotrichum lyellii* (Orthotrichaceae, Musci) species complex

Caleb Caswell-Levy
University of California, Berkeley, Berkeley, Ca, USA

Orthotrichum lyellii (Orthotrichaceae, Musci) is a highly variable and wide-ranging complex. It occurs in Western Europe, and in North America west of the Rocky Mountains from Cedros Island, Baja California to Southeast Alaska. The complex comprises several possible species or ecotypes that vary in ecology, morphology, and sexual strategy. The most common form (subsp. *lyellii*) commonly reproduces clonally through asexual propagules, but other forms lack such propagula completely (e.g. subsp. *pappilosum*). In addition, the North American and European populations exhibit differences in ecology and morphology. Because the necessary integrated morphological and molecular systematic work on the group has been lacking, it remains unclear whether this complex is truly a variable and wide-ranging disjunct species, a pair of amphiatlantic disjunct sister-species, or up to five "cryptic species". Several of these putative species are range-restricted endemics, and the current ambiguity in their taxonomic status makes informed conservation decisions difficult. I use a combination of molecular, morphological, and ecophysiological data to clarify relationships within this wide-ranging clade, and discuss conservation implications for several endemic California putative species.



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19.04 Bryophytes and biological soil crust of the Palos Verdes Peninsula

Neil Uelman

California Native Plant Society, South Coast Chapter, Los Angeles, CA, USA

Bryophytes and biological soil crust (BSC) are both understudied components of the California landscape. In coastal sage scrub, studies looking at bryophytes and BSC are limited. Worldwide, bryophytes are also a major component of BSC communities. The purpose of this study was to provide a preliminary look at bryophytes and BSC found on the Palos Verdes Peninsula (PVP), a coastal location in southern California where information on both these components is lacking. A survey was conducted from fall 2016 to spring 2017 throughout the PVP. BSC was found to be present throughout many plant communities and was comprised of cyanobacteria, bryophytes, and soil dwelling lichens. In addition, 68 species of bryophytes were found on the PVP occupying numerous plant communities as well as within the BSC.

19.05 Characterization of microbial communities in the Mojave Desert biological soil crust and their association with *Syntrichia caninervis* (Pottiaceae) in hyper- and hypolithic habitats

Jameka S. Jefferson, Kirsten Fisher

California State University, Los Angeles, Los Angeles, CA, USA

The Mojave Desert is home to a variety of organisms including microbes, lichens, and mosses. Together, these organisms form a community known as the Biological Soil Crust (BSC). Microbes and mosses are major components in the BSC as well as microhabitats underneath semi-translucent quartz rocks in the Mojave Desert. To date, characterization of BSC composition has focused on individual organisms (mosses or microbes), which limits understanding how BSC organisms co-exist in various microenvironments. Our goal is to use environmental sequencing of 16S rRNA to characterize microbial communities in four BSC microhabitats. Characterizing BSC microbial community composition in the presence and absence of mosses will provide insight into the process of BSC formation. This project is novel in its investigation of microbial community composition in both hyperlithic (exposed surface) and hypolithic (beneath semi-translucent quartz) desert microenvironments. The presence of moss in the BSC could potentially influence microbial composition and increase its diversity by providing additional heterogeneous habitat, altered moisture regimes, and a supplemental source of carbohydrates. We predict the composition of microbial communities will vary in hyper- and hypolithic microhabitats. With this work, we aim to better characterize how the presence of BSC plants (moss) modulates microbial community composition and diversity, which could potentially inform decisions for conservation of BSC structure and function.

19.06 What would it take for bryophytes to be conserved like vasculars?

Paul Wilson¹, James Shevock², Alison McGregor¹

¹California State University, Northridge, Northridge, CA, USA, ²California Academy of Sciences, San Francisco, CA, USA

Bryophytes have been included in the *CNPS Inventory of Rare and Endangered Plants* since 2001, but consultants and agencies continue to find it hard to conserve them. At the one extreme, a National Forest won't issue permits to collect, and without collections occurrences are nearly impossible to document. Near the other extreme, surveyors who are not familiar with bryophytes sign off that none of the rare species were found (or looked for) on parcels slated for development. It is the responsibility of the bryology community to put together tools that will lead to thorough mapping and habitat characterization of rare species. Also, over the next decade the activity of surveyors should itself greatly change the status of species included in the *CNPS Inventory*. Each rare species should have a status paper that gives photos and key characters for distinguishing the species and tells all of the science to date about the rarity. This can be done in the context of improving the California Moss eFlora.

19.07 CEQA requires surveys for non-vascular plants and composite organisms too: Lichens can be a significant part of a project site's flora

David Magney

California Native Plant Society, Rare Plant Program, Sacramento, CA, USA



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The California Environmental Quality Act (CEQA) requires the assessment of impacts on the biological resources as the result of a proposed project, not just listed species. Bryophytes and lichens are often an important, but often ignored component of a site's flora. A botanical consultant cannot use the excuse that they do not know lichens or bryophytes as valid justifications to ignore this part of a site's flora. Two project sites are used as examples of when the lichen flora was especially rich and diverse, and containing species that are at least locally rare.

19.08 Forgotten but not lost - a rare endemic southern California liverwort (*Geothallus tuberosus* [Sphaerocarpaceae]): Distribution, ecology, habitat loss, conservation, and potential for listing

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¹Laguna Mountain Environmental, San Diego, CA, USA, ²California Native Plant Society, San Diego Chapter, San Diego, CA, USA

Campbell's liverwort (*Geothallus tuberosus* [Sphaerocarpaceae]) is endemic to southern California. This species has been poorly documented and the goal of this study was to understand its distribution and habitat requirements. It is a dioecious, tiny species that was originally collected unnoticed with a specimen of *Ophioglossum* (Ophioglossaceae). After many of its originally recorded locations were destroyed by development, this species was listed on the IUCN Red List in 2015 and is a CNPS Inventory list 1B.1 plant. It was even thought to be potentially extirpated from San Diego County. Conservation managers have effectively ignored this and other bryophyte species, and its survival has been dependent upon general habitat preservation and happenstance. A distribution study from 1969 was updated in 2016-2017 to review previously recorded locations and other potential habitat. While most historic locations have been destroyed or no longer support the plant, it survives in 11 small physically isolated populations. Campbell's liverwort prefers seasonally wet, intact cryptogamic crust, generally along the margins of shrub canopy. It can occur near vernal pools, but frequently does not. All known locations are on publically-owned lands, but the species remains under threat from conversion of cryptogamic crust habitat due to ongoing, fire-enhanced habitat replacement by non-native herbs and grasses. While Campbell's liverwort is a good candidate for listing under the California Endangered Species Act, the challenge is that listing requires proof of its threatened status, plus a demonstration that listing would help protect it.

19.09 A test of micro-climatic niche differences in small understory plants using very small dataloggers

Benjamin Carter

San Jose State University, San Jose, CA, USA

Fine-scale differences in humidity and temperature are likely very important to ecological patterns among small understory plant species, but they usually go un-measured. In this study, I used 50 ibutton dataloggers to test whether understory moss niches differed among four species occurring across 10 meso-sites oriented along a moisture gradient. The ibutton dataloggers are approximately the size of a nickel and capture both relative humidity and temperature at user-defined intervals. The focal species are closely related mosses in the genus *Scleropodium* (Brachytheciaceae), which is a dominant group in many bryophyte communities in California. Two of the four species had very wide niche breadths and two were restricted to relatively humid micro-sites. Species generally had identifiable but overlapping micro-site niche preferences across meso-sites. Meso-site differences were also identifiable in the data, indicating an important interaction between meso-site and micro-site climatic differences. Although the results of this study are preliminary, this approach shows great potential for understanding patterns of co-existence of small understory plants across multiple spatial scales.

19.10 Fern and bryophyte conservation hotspots: Assessing ferns as a predictor of bryophyte diversity

Nathalie Nagalingum

California Academy of Sciences, San Francisco, CA, USA

Bryophytes are often neglected in field surveys and collections, but they are significant contributors to floristic diversity. In order to gain more accurate estimates of plant richness, there must be reliable estimates of bryophyte diversity given that they are relatively under-collected. To address this, we examined whether another plant group, namely the ferns, could be used as a surrogate for bryophytes. We used datasets spanning the entire Australian continent for mosses, liverworts, liverworts+hornworts, ferns, and conifers (hornworts were aggregated into the group liverworts+hornworts). We calculated the correlations among richness of all of the groups to test the hypothesis that fern diversity is correlated with bryophyte



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diversity (because of shared ecological preferences) while conifer diversity is not. Using generalized linear models, we found that the best-correlated groups were the mosses, liverworts/liverworts+hornworts, and ferns; depending on the richness measure used, the pairs that had the highest correlations were ferns-mosses or mosses-liverworts/liverworts+hornworts. From a conservation-planning standpoint, our results suggest that using surrogates, such as ferns and mosses, can assist in the conservation of other plant groups, for instance the liverworts. However, potential surrogates that have different ecological preferences to the target groups (for example, conifers compared to liverworts) have very limited applicability as proxies.



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CITIZEN SCIENCE

Public participation in scientific research can generate multiple benefits and presents unique challenges. This session explores a variety of projects across California where volunteers have assisted professional scientists and their institutions to collect scientific data, and reports results of these efforts.

20.01 University of California's California Naturalist: Supporting community stewardship for conservation of California native plants

Sabrina Drill¹, Marisa Rodriguez², Brook Gamble², Greg Ira², Adina Merenlender³

¹University of California Cooperative Extension, Los Angeles and Ventura Counties, CA, USA, ²University of California Cooperative Extension, Davis CA, USA, ³University of California, Berkeley, Berkeley, CA, USA

University of California's California Naturalist Program (<http://calnat.ucanr.edu>) creates a committed corps of volunteer and early career naturalists and citizen scientists trained and ready to take an active role in natural resource conservation, education, and stewardship. We partner with local formal and informal science organizations to offer training and certification using our established curriculum and educational framework. Since 2012, we have partnered with 35 organizations including land conservancies, parks, arboreta, botanical gardens, museums, and several UC reserves. Together, we have certified over 1700 Naturalists (including many California Native Plant Society members) who have volunteered over 93,000 hours of service in the areas of education and interpretation, scientific monitoring, land stewardship, and organizational support. We are currently developing advanced peer-reviewed curricula about the ecology of each California bioregion as well as special topics such as fire ecology, invasion ecology, marine and nearshore systems, as well as incorporating our materials into job training programs through collaboration with conservation corps. Documented human outcomes include increased scientific literacy and critical observational, analysis, and interpretation skills, increased sense of science self-efficacy, increased engagement in different types of volunteer opportunities, and a vibrant community of practice with which to keep learning and sharing skills. Landscape outcomes include increased labor for data collection, management, and restoration of ecosystems around the state from small areas around nature centers, to private and public reserves and conservancies totaling several thousand acres primarily in coastal, chaparral, oak woodland, forest, and urban systems.

20.02 Using citizen science to understand and protect California's imperiled pollinators

Kathryn Prince¹, Sarina Jepsen¹, Rich Hatfield¹, Jessa Kay Cruz¹

¹The Xerces Society for Invertebrate Conservation, Portland, OR, USA, ²Natural Resources Conservation Service, Madera, CA, USA

California's pollinator species face intense development pressures. Bees and butterflies, including the monarch butterfly (*Danaus plexippus plexippus* [Nymphalidae]), must use resources scattered throughout a landscape of intense urban and agricultural use. Continuing efforts to protect pollinators will require plant species data recorded across vast geographic regions. To address this need, the Xerces Society has collaborated with multiple organizations to develop tools allowing citizen scientists to record their plant and pollinator observations on interactive maps. Bumble Bee Watch combines historical data with users' verified photo sightings to generate bumble bee distribution maps. The Western Monarch Milkweed Mapper offers a similar opportunity for users to track migratory monarchs and their interactions with milkweed host plants (*Asclepias* species [Apocyanaceae]) across the species' western breeding range. To supplement monarch breeding data, the Western Monarch Count takes place each Thanksgiving to assess the size and health of monarch overwintering sites. This presentation will describe the monitoring protocol used by each of these tools and their current applications to native plant restoration.

20.03 Leaf area, bulb size, flowering, fruiting and seed production in *Hesperocallis undulata* (Agavaceae)

Donald Rideout

None, N/A, USA

Desert lily (*Hesperocallis undulata* [Agavaceae]), though not rare, is a unique member of the California desert plant community. This study of *H. undulata* was undertaken as a citizen science project in response to observations of large

numbers of wild plants in the developed portions of Borrego Springs, CA. The purpose was to understand the factors that lead to flowering. A sample population of 163 individuals was observed over a three month period in 2017 to examine the relationship between leaf production, flowering and fruiting. In addition, some bulbs were excavated and weighed and some fruits were collected. Of the individuals in the sample population, flowering was clearly associated with number of leaves and leaf area. Grouping together all plants with three or more leaves, 80 of 99 plants flowered (80.8%). Rate of flowering increased dramatically as leaf surface area approached 350 cm². A total of forty fruits were produced, and total seed production for the sample site is estimated to be 3,760 which exceeds the number of plants in the sample by a ratio of 23-1. Less detailed observations were made of several other populations in the region for comparison purposes. These results suggest that vacant lots and other marginal areas could be important to conservation of the species. Further research on this population will include monitoring for changes over time, excavation of bulbs of larger plants from other sites, measurement of bulb depths, and germination studies.

20.04 The University of California CALeDNA Program: A multi-tiered education initiative generating baselines of community biodiversity from microbes to mammals

Rachel Meyer, Emily Curd, Teia Schweizer, Robert Wayne
University of California, Los Angeles, Los Angeles, CA, USA

The scientific community has built DNA barcoding references that now enable researchers to do high-throughput habitat monitoring and characterization using environmental DNA (eDNA). In 2017, a state-wide citizen science program was launched by the University of California Conservation Genomics Consortium called CALeDNA (*Cal 'ee' D-N-A*), that collects, sequences, and analyzes eDNA from small amounts of soil and sediment to identify species from all forms of life: bacteria, archaea, fungi, plants, and animals. 500 volunteer citizen scientists signed up and did online training, received a sample collection kit and a phone app, and worked with UC researchers to scout out ideal sampling locations that cover California's iconic habitats and that include the 39 UC natural reserves. They completed fieldwork and returned 1800 samples between February and June, with 90% passing quality filters that include locations, photos, and timely sample freezing. Meanwhile, the Consortium developed DNA analysis pipelines to identify DNA sequences to appropriate taxonomic levels and quantify abundance. Undergraduates who were interested in eDNA analysis chose samples that represent ecosystem latitudinal gradients (coastal, shrubland, woodland) or sets usable as case studies to dissect the heterogeneity of areas such as the Santa Monica Mountains or the Merced County vernal pools, extracted DNA, and worked with UC researchers and the informatics pipeline to generate libraries and analyze sequence data. Here, we present the patterns of biodiversity thus far generated by the CALeDNA program, we discuss the future plan to involve the public in sample collection as well as data analysis and inquiry.

20.05 Citizen science helps predict spread of emerging infectious diseases

Matteo Garbelotto¹, Doug Schmidt¹, Ross Meentemeyer²
¹University of California, Berkeley, Berkeley, CA, USA, ²North Carolina State University, Raleigh, NC, USA

Engaging citizen scientists is becoming an increasingly popular technique for collecting large amounts of ecological data while also creating an avenue for outreach and public support for research. Here we describe a unique ongoing citizen science project, in which for almost ten years citizens played a key role in the geographic assessment of an emerging infectious disease. The yearly citizen-science program called "Sudden Oak Death (SOD) Blitz" engages and educates volunteers in detecting the causal pathogen during peak windows of seasonal disease expression. SOD blitzes are designed as grassroot activities: participants are trained to survey and sample for SOD by scientists in meetings organized by local environmentalists, but are free to sample wherever they wish. SOD distribution data are regarded as public and shared with the public through the media, the internet, and through an *ad hoc* App called SODmap mobile. Each year, 4-500 participants survey over 20,000 trees, and sample approximately 2,000 of them. All samples are processed at UC Berkeley scientists who also release the data. In 2011 alone, it was estimated over one million people accessed the data. When SOD Blitz data were used to develop predictive maps of disease risk, such maps were as informative and accurate as those developed using data collected by scientists. Our results indicate that using long-term citizen-science data to predict the risk of emerging infectious plant diseases in urban ecosystems holds substantial promise.



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HORTICULTURE AS PART OF CONSERVATION

The acceleration of ongoing and emerging threats to native plant biodiversity requires proactive wildland management, land acquisitions for conservation, and conservation seed banks, among other strategies. This session will examine the following challenges: How do we propagate native plants; how can we establish aesthetically beautiful and viable habitat gardens where pollinators and wildlife are encouraged and where short and long-term soil seed banks might be established; what best practices and techniques should we be incorporating, and how can we engage the public through outreach and education.

21.01 Growing plants in the Mojave Desert, a land trust's perspective

Madena Asbell

Mojave Desert Land Trust, Joshua Tree, CA, USA

The Mojave Desert Land Trust's (MDLT) mission is to protect the Mojave Desert ecosystem, and its scenic and cultural resource values. MDLT owns and manages over 17,000 acres on which grow hundreds of species of native plants, including several rare taxa. In 2016, MDLT expanded its conservation efforts to include a native plant nursery and seed bank to conserve seed from these wild plant populations and to provide plants for revegetation projects on MDLT properties and for restoration contracts in the region. In addition, the nursery holds two community plant sales a year, which are important public outreach events and increase awareness of the importance of native plants in the landscape. The seed bank serves as a repository for native plant species found on MDLT properties while the nursery works with public and private partners on propagation of species for restoration, as well as species that are rare, threatened or endangered, and species considered difficult to cultivate. For many Mojave Desert species, germination and growing conditions are poorly understood. For this reason, the nursery attempts to grow a variety of species and keeps data on propagation methods and germination results on all wild sourced seed. The data collected are useful in making the production of native plant material more successful. MDLT's nursery and seed bank demonstrate that native plant horticulture is a valuable conservation tool for the organization and the region as California's deserts face increasing threats from climate change, wildfire, drought, invasive species, and large scale renewable energy development.

21.02 Lessons learned from 12 years of local stewardship in an urban nature park in Southern California

Barbara Eisenstein

Friends of South Pasadena Nature Park, South Pasadena, CA, USA

Cities love to cut ribbons at park openings; however, it is what happens next that determines the success or failure of urban habitat parks. Without proper care, even beautifully designed and installed landscapes will fail. For twelve years, volunteers have been caring for a nature park in the city of South Pasadena to prevent it from reverting to its formerly degraded state. Prior to the creation of the park, the site along the Arroyo Seco Flood Control Channel was used for illegal dumping, homeless encampments and passive recreation including walking and horseback riding. Within six months of the opening in 2004 the recently extirpated weeds were making an impressive comeback on the three-acre parcel. In response, I initiated a volunteer park stewardship program, *Friends of South Pasadena Nature Park*. Over the years we have developed strategies for replacing noxious weeds with locally appropriate native plants. Many of these practices would work in other newly designated urban habitat parks. Though it has taken years - and we still have much work to do - a small team of volunteers, with city support, is gradually improving conditions in the park.

21.03 Introducing the Southern California Montane Botanic Garden

Timothy Krantz

The Wildlands Conservancy, Yucaipa, CA, USA

The Wildlands Conservancy is proud to present the new Southern California Montane Botanic Garden at their Oak Glen Preserve headquarters in the foothills of the San Bernardino Mountains. Situated at 1520m (5,000ft), the garden provides a living showcase of native plants of the Southern California mountains. The garden is distributed across approximately 200 acres of the 3,200-acre Oak Glen Preserve, featuring several miles of trails, two perennial streams, ponds and water features in a mixed conifer forest, with black oak (*Quercus kelloggii* [Fagaceae]) and box elder (*Acer negundo* [Aceraceae])



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woodlands. More than 120 species are signed and interpreted, with special venues including Hummingbird Hill, with *Penstemon*, (*Plantaginaceae*) *Ribes* (*Grossulariaceae*), *Salvia* (*Lamiaceae*) and other species to attract hummingbirds and butterflies; Falling Water, featuring manzanitas, buckwheats, native grasses, sedges and rushes; and the Conifer Loop, featuring the native conifers of Southern California and the southern Sierra Nevada. Perhaps the most innovative of the venues, however, is the Artist's Palette in which an actual photograph of the French impressionist painter, Claude Monet, was digitally overlain on an aerial image of the six-acre hillside along the entryway to the Preserve; then, a palette of 24 native wildflower species was separated by color and, using the tree clusters for reference, lines were drawn on the ground and the seeds were distributed by their colors to re-create Monet's palette on six acres with wildflowers!

21.04 At the edge of California and the edge of existence: How *siemprevive de Isla de Cedros* (*Dudleya pachyphytum* [Crassulaceae]) was poached ever closer to extinction

Michael Uhler

Regional Parks Botanic Garden, Berkeley, CA, USA

Siemprevive de Isla de Cedros (*Dudleya pachyphytum* [Crassulaceae]) is the most intriguing and charismatic *Dudleya* I have ever met, it is also one of the rarest. It occupies a small, very specialized, portion of only one island in the Pacific off the coast of Baja California on Isla de Cedros. It is now ever closer to being extirpated as a group of poachers removed a huge portion of our entire global population. In the final days of May of 2017, Mexican authorities performing a routine search of a 55-foot long freightliner tractor trailer rig in Baja California, Mexico discovered a profound illegal shipment. In the enclosed trailer they counted 64 cardboard boxes loaded with a total of 4,756 rosettes of the extremely rare, single island endemic, *siemprevive de Isla de Cedros* (*Dudleya pachyphytum*). Four perpetrators were subsequently arrested in connection with this large-scale smuggling act and the rosettes are now, thankfully, in safe hands. What percentage of the entire population does this represent and can the planned repatriation ever return this population to its former health? I traveled to the crime scene to view the site of this unconscionable act first-hand and to determine the answers to the above questions.

21.05 Water two times a month and call me in the morning: Using scientific (and some not so scientific) data to calculate dry season irrigation in native plant landscapes

Antonio Sanchez

Nopalito Native Plant Nursery, Oxnard, CA, USA

Ask ten native plant landscaping experts how to water established native gardens during the dry season and you'll probably get sixteen or seventeen different responses. Opinions like 'Hand watering is best, every 7 or 14 days', 'Overhead only, twice a month max' and 'Drip is death, just turn the system off' are not only wide-ranging but extremely confusing for native plant gardeners. By introducing and explaining the real world use of 2 data-driven irrigation tools for the native plant landscaper (Water Use Classification of Landscape Species [WUCOLS] IV and a commonly used ETo-based irrigation formula), this talk helps clear out any blocked up mental emitters native landscapers may have (Flush-It-Out!). WUCOLS IV, newly published in 2014, will be explained and participants will be shown how to correctly use the list to find irrigation advice for over 3500 plant species and common cultivars, whether in Los Angeles or Redding. Participants will then be shown how to plug the WUCOLS IV data into a frequently used ETo (Reference Evapotranspiration) -based formula that takes into account specific garden features commonly found in landscapes such as plant density, garden exposure, irrigation type, square footage, etc. The formula results and irrigation recommendations for commonly used native plant cultivars in drip irrigated landscapes and overhead irrigated gardens. Formula results will also be compared to the standard 'twice a month during summer' irrigation advice and we may finally get closer to answering the question: "How often should we water natives during the dry season?"

21.06 Bee communities associated with California-native and conventional plant nurseries

Jacob Cecala, Erin Wilson-Rankin

University of California, Riverside, Riverside, CA, USA

Interest in the intersection between the horticulture industry and bees is steadily growing. Ornamental plants seldom require pollination services in practice, yet many cultivated species are bee-attractive. Thus, large-scale horticultural

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nurseries represent dynamic and diverse artificial communities of flowering plants that can provide resources for wild bees. Nurseries that cultivate mostly native plants reflect the demand for native ornamentals among consumers. This research aims to characterize bee assemblages associated with different types of nurseries and to assess these areas as pollinator habitat. Specifically, we ask if the native status of plants cultivated by a nursery influences the composition of the resident bee community and the structure of plant-bee networks. We sampled bee communities in spring, summer, and autumn at five native and five conventional plant nurseries across southern California. Using a combination of netting and passive trapping, we collected a total of 3,254 bees representing 31 genera and at least 52 species. Roughly half of these species were documented foraging on plants in nurseries that span over 30 genera. *Salvia* (Lamiaceae) cultivars and native species of *Baileya* (Asteraceae), *Eriophyllum* (Asteraceae), and *Grindelia* (Asteraceae) were visited by a wide diversity of native bees. While it remains unclear if native nurseries host a more diverse community of bees, there is an interaction between nursery type and season. In conclusion, we find a wide diversity of wild bees visit plants at nurseries throughout the year, and knowledge of community dynamics can help inform management strategies supporting bee conservation in these areas.

21.07 Cultivating plants in botanical gardens for reintroduction

Holly Forbes, Vanessa Handley
University of California Botanical Garden, Berkeley, CA, USA

Conserving endangered plant species is often a challenging goal. It requires a wide variety of expertise and facilities, not all of which can be provided in-house, depending on your business/institution. Botanical garden staff have horticultural and conservation training and facilities to provide disease-free propagules for endangered species reintroduction projects. Government agencies and environmental consulting companies can partner with botanical gardens in working toward preventing extinction, whether as a species centric project or to mitigate disturbance or loss due to development. Projects are typically funded by contracts with utilities or agencies, especially in our case the US Fish & Wildlife Service and the Bureau of Reclamation. We have successfully grown out both annual and perennial plants for seed and plug production for use in reintroduction and augmentation of endangered species.

21.08 Displaying California natives ornamentally: The new island themed garden at the Santa Barbara Botanic Garden

Bruce Reed
Santa Barbara Botanic Garden, Santa Barbara, CA, USA

Treasured by those in the know, many California natives have yet to find much attention from the public for their beauty and garden usefulness. This is especially true of the many plants found on the Channel Islands which are still often under-represented or impossible to find in the trade. The Santa Barbara Botanic Garden's new Island View Garden has been installed for more than a year now and provides a formal presentation of plants native to the Islands, including many endemics. The garden provides year-round interest, capitalizes on several natural features of the site and familiarizes the public with some uncommon and truly beautiful plants. Site preparation, concept development and installation is briefly discussed with the remainder of the time devoted to the complement of plants used and the pairings we arrived at. Among the many plants used in the garden are *Constancea nevinii* (Asteraceae), *Sphaeralcea fulva*, *S. sulphurea* (Malvaceae), *Atriplex barclayana* (Chenopodiaceae), *Diplacus parviflorus* (Phrymaceae), *Lyonothamnus fl. floribundus* (Rosaceae) and *Ceanothus arboreus* (Rhamnaceae).

21.09 Producing healthy nursery stock and keeping plants healthy on planting sites

Mike Evans
Tree of Life Nursery, San Juan Capistrano, CA, USA

California native plants intended for use in horticultural gardens or ecological restoration are propagated and produced in nurseries. Growers should be held to high standards employing appropriate Best Management Practices (BMPs) for growing, selling and shipping healthy stock, free from weeds, injurious plant pests, and disease. Receivers aware of the nursery's BMPs should develop and implement BMPs relevant to the site and the stated objectives of the project. Owners, installers, and maintenance personnel should continue with applicable BMPs to insure successful outcomes. At each



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stage, BMPs include cultural techniques, sanitation, hygiene, biological and chemical tools, seasonal inputs, and horticultural expertise. Natural gardens and restoration sites ideally are planted and cared for to require very little or no long-term maintenance, intervention, or input after a brief establishment period. Best Management Practices, applied from the start and throughout the various phases of the planting, will insure positive results, and thus support viable and strong native plant ecological restoration in all appropriate settings, including homes, commercial projects, and habitats.

21.10 A 100-acre urban landscaping potential: Native gardening at the Housing Authority of the City of Los Angeles

Tim Becker

Theodore Payne Foundation, Los Angeles, CA, USA

In 2016 the Theodore Payne Foundation (TPF) partnered with the Housing Authority of the City of Los Angeles (HACLA) to revitalize their properties with drought adapted resilient landscaping. This partnership was forged to meet an administrative mandate by HACLA to address landscapes that were severely impacted by the recent drought. The project called for both drought tolerant plants and a retraining program for HACLA grounds staff. TPF conducted one-yearlong hands on program that emphasized a comprehensive introduction to CA native plant horticulture, an uncomplicated approach to design, and a field based approach to installation and maintenance. Over the course of the year, 50-plus staff members participated and planted roughly 1,500 plants in one acre of landscapes at three separate sites across a broad geographical area in the city of LA. The first year has seen several successes and several learning opportunities; from common problems such as overplanting and under watering, to uniquely challenging situations, including vandalism, engaging multi-lingual residents, and roving maintenance crews. The project has generated large potential to expand on TPF's mission of expanding our audience and increasing the accessibility of native plants to an overwhelmingly underserved community in the greater LA area.



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MARKETING FOR MOTIVATION: IMAGERY, STORYTELLING & TALKING POINTS

Even in a world where facts do matter, fostering an informed citizenry is an uphill climb. Developing effective networks that can communicate engaging, persuasive information is a key element to getting one's message heard and understood. This session addresses ways these points are implemented in the plant conservation arena.

22.01 Engaging people who (think they) aren't interested in native plants

Lisa Novick

Theodore Payne Foundation, Sun Valley, CA, USA

Most people don't care about plants. With all the issues and distractions people face, plants are usually something to ignore unless they're food or a threatened iconic forest. Most people consider native plants merely another aesthetic choice without any value beyond water savings. How do we change this? How do we get people to *care* about native plants? Three ways: 1) *Don't start* by talking about the plants. Instead, talk about the life they support: the birds, butterflies and other charismatic creatures that need native plants in order to survive. Focus on things people already care about - pollinators, birds, edibles - indirectly educating people about the nature of where they live. Most people are astonished to learn that native plants are the foundation of functioning ecosystems and healthy food webs. 2) Confront common misconceptions, especially through *humor* and/or *cognitive dissonance*. Examples: "CA native plants = cactus? NOT" with a photo of a gorgeous native garden without cactus. Or, with a photo of baby birds eating caterpillars, "Feed a newborn meat? YOU BET. Caterpillars need native plants." 3) Tell empowering stories about native gardening and its benefits. People evolved with stories, and we must use stories to connect, create buy-in and a sense of agency. People are longing for accessible and local ways to help the environment. We must answer this longing by inspiring people to care about native plants, understand their role in ecosystems, and use this knowledge to revitalize the nature of California.

22.02 The Native Plant Conservation Campaign - a national native plant society for the United States

Emily Roberson

Native Plant Conservation Campaign, San Francisco, CA, USA

Plants are second-class conservation citizens. They are discriminated against in every aspect of law, policies and budgets for science and conservation. Even environmental groups often overlook native plants in their work. Botanists have coined the term "plant blindness" to refer to this phenomenon. It is "the inability to see or notice plants in [the] environment." The Native Plant Conservation Campaign (NPCC) was created to combat these problems. The NPCC is a national network of Affiliate plant conservation groups including native plant societies, botanic gardens and others. In 2017, the NPCC passed the 50 Affiliate mark and now represents more than 200,000 native plant enthusiasts. The mission of the NPCC is to promote the conservation of native plants and their habitats through collaboration, education, research, and advocacy. This presentation will discuss the NPCC, our approach to native plant conservation advocacy, and our plans for 2018 and beyond. We will also examine how the Trump administration has affected the conservation landscape. NPCC programs include (i) "Equal Protection for Plants" which seeks to improve funding, staffing and legal protections for plants; (ii) "Important Plant Areas", which is a partnership with CNPS and other botanical organizations. Its goal is to identify and conserve natural areas of great botanical significance; (iii) "Speak Out for Plants" which offers tools to help advocates more easily and effectively communicate native plant issues to policymakers and the public; and (iv) "Right Plant, Right Place" which promotes the use of locally appropriate native plants in gardening and land management.

22.03 Superbloom or bust: Lessons from a year of golden opportunities in public outreach

Allyson Ayalon

Jepson Herbarium, University of California, Berkeley, Berkeley, CA, USA

Successful conservation of California's flora is contingent upon the botanical community's commitment to educating the public on why plants are worth protecting. Social media platforms have been an increasingly popular way to reach the



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public; in the right circumstances educators have had much success sparking interest with the use of botanical "cheap thrills" such as a carnivorous species, or charismatic "celebrity species" such as the Coast Redwood (*Sequoia sempervirens* [Cupressaceae]). Yet taking time to be the voice of plants for the people is costly and time consuming. Furthermore, measuring the impact of our outreach efforts is hard to quantify. Outreach professionals rely on the intangible idea that education involving California's native flora will encourage the public to consider plants when choosing policy, endorsing scientific research, the extent of their carbon footprint, or even their physical footprint, as was the case during the 2017 "superbloom." Are we, as plant liaisons, effectively promoting the protection of California flora through current outreach efforts?

22.04 Planting hope: Restoring the ecological function of our communities and supporting bird conservation by landscaping with native plants

John Rowden

National Audubon Society, Los Angeles, CA, USA

Native plant species are better at supporting California's (and America's) native birds and research is demonstrating that even small patches of habitat planted with natives - down to the yard and neighborhood scale - can benefit birds. With that in mind, the National Audubon Society investigated whether birders and bird-loving gardeners are willing to modify their own yards to benefit birds. In 2015, Audubon asked our members and supporters about their interest in planting native species, receiving 14,000 responses. The results showed broad support for the concept: 94% of respondents indicated that they were interested to extremely interested in supporting growing more native plants in their community; more than 50% said they would be willing to dedicate at least half of their own outdoor space to native plants; and more than 50% said they would be willing to volunteer to help others in their communities install native plants. With regard to support they would need, respondents prioritized information on local bird-friendly native plants, and nurseries or growers that carry native bird-friendly plants. Armed with this information, Audubon introduced Plants for Birds in fall 2016 - a nationwide initiative that provides the resources and support suggested by our research. We have used our communication and social media channels to promote the program, reaching millions of people with our message and empowering people to put thousands of native plants in the ground.

22.05 Building business and relationships through storytelling as told by a non-profit specializing in environmental restoration

Jessica Morrison

Resource Conservation Partners, Ventura, CA, USA

When was the last time you made a decision strictly based on data? In this industry we make decisions with our hearts, and it is our hearts that process information through stories. All of our environmental passions began with an unforgettable experience that stimulated our senses, inspired us, and will forever guide our life choices. But perhaps we have forgotten what this moment was, how it made us feel, and the energy it created; hindering our ability to make deeper connections with stakeholders and clients. Therefore, to expand our environmental restoration initiatives and build strong partnerships, we need to reconnect our passions and reasons for why we do all of this by remembering our journey and using it to connect with the journey of others. When trying to gain support for funding of projects, marketing, or partnerships; remember to make connections through your stories and with empathy. Learn how to use empathy to discover what obstacles stand in your stakeholder's or customer's way and what their needs are, then you can know how to meet their needs. Business growth is about meeting the needs of others within your mission. As much as we think so, data does not drive decision making of stakeholders. Our hearts make the choices and then our brains rationalize these decisions. Take a journey to remind yourself of your story and how to draw energy from it to drive business and build meaningful industry relationships.



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OPENING PLENARY

0.01 Restoring Nature's Relationships

Doug Tallamy

Department of Entomology and Wildlife Ecology, University of Delaware, Newark, DE, USA

Specialized relationships between animals and plants are the norm in nature rather than the exception. Plants that evolved in concert with local animals provide for their needs better than plants that evolved elsewhere. Tallamy will explain why this is so, why specialized food relationships determine the stability and complexity of the local food webs that support animal diversity, why our yards and gardens are essential parts of the ecosystems that sustain us, how we can use our residential landscapes to connect the isolated habitat fragments around us and produce valuable ecosystem services, and what we can do to make our landscapes living ecosystems once again. Managing landscapes in this crowded world carries both moral and ecological responsibilities that we can no longer ignore.

BANQUET KEYNOTE

0.02 Smog is fertilizer: The long and winding road from the pages of *Conservation Biology* to a Habitat Conservation Plan

Stuart Weiss

Creekside Center for Earth Observation, Menlo Park, CA, USA

The road from scientific discovery to conservation action is rarely straight and narrow, nor is it fast. In this talk, Stu will recount how a revelation in 1993 - that nitrogen fertilization from Silicon Valley smog threatened the listed Bay checkerspot butterfly by driving annual grass invasions in serpentine grasslands, and that cattle grazing was the key to controlling the impacts - was turned into a scientific publication, and then leveraged to eventually create the Santa Clara Valley Habitat Plan. Publishing the paper in 1999 was only a first step; mitigation precedents for powerplant nitrogen emissions led to mitigation for freeway widening that included a commitment to a regional HCP in 2001. After more than 10 years of additional science and advocacy, including "Operation Flower Power" tours for elected officials and others and building a "Habitat Conservation Now" coalition, the Habitat Plan was adopted in 2013. The 50-year, \$665,000,000 HCP/NCCP promises coordinated conservation and long-term stewardship, and the first major conservation acquisition, >1800 acres of mostly serpentine grasslands, was closed in 2015. Nitrogen deposition is a major, if underappreciated, threat to biodiversity of native plants across much of California and the Santa Clara Valley experience provides one model for addressing it.

CLOSING PLENARY TALKS: BEST KEPT SECRETS!

0.03 Tiny but mighty: How viruses influence plant ecology

Carolyn Malmstrom

Michigan State University, East Lansing, MI, USA

Viruses are some of the smallest microbes but can have oversized effects on plant evolution and ecology. Centuries ago, European explorers introduced novel diseases to the New World that decimated Native American human populations. Did European introductions likewise influence the disease pressure experienced by native plants?

0.04 Climatic nuclei, refugia and climate change conservation

Blair McLaughlin¹, David Ackerly²

¹*Hampshire College, Amherst, MA, USA*, ²*University of California, Berkeley, Berkeley, CA, USA*



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Xeric microclimates at the mesic edges of species distributions may have provided climatic microrefugia for relatively warm-adapted species in the context of historical regional cooling trends. Currently, these isolated climatically suitable pockets may support relict populations from the former northern extent of species main distributions during the altithermal period in California. We used herbarium records, field surveys, and fine-scale climate and species distribution modeling to analyze the importance of these isolated leading edge populations to distributional expansion with projected regional warming/drying trends. We have identified potential climatic nuclei in some plant species with predominantly southeastern California and desert distributions, but which also occur in isolated pockets of unusually hot and dry microclimates in the East San Francisco Bay Area, beyond the northern/western limits of their main distributions. Under multiple climate futures derived from the CMIP5 ensemble model, large parts of the Bay Area shift vegetation types, becoming more suitable for semi-desert-adapted vegetation. Thus these current warm/dry 'microrefugia' may create important nuclei for future native species' dispersal and colonization of a climatically shifting Bay Area. Considering warming/drying trends and model-projected vegetation shifts, these areas may have a disproportionate influence, compared to southeastern contiguous areas of the distribution, on leading edge migration.

0.05 A Ministry of the Future

[Kim Stanley Robinson](#)

American Science Fiction Writer, Davis, CA, USA

In a global crisis of representation, future generations and the biosphere have even less of a voice than the world's current voting citizens. How can we speak for and protect those who cannot speak for themselves for one reason or another? Some ideas will be gathered and presented.



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