Vernal Pool Landscapes Conference, April 11 and 12, 2018
Abstracts of talks

Wednesday, April 11

BARBARA VLAMIS
Executive Director, AquAlliance, P.O. Box 4024, Chico, CA 95927
(530) 895-9420
www.aqualliance.net

Welcome to the Vernal Pool Landscapes Conference

Session 1. Moderator: Barbara Vlamis, AquAlliance

SCOTT MCMILLAN
AECOM, 1420 Kettner Boulevard, Suite 500, San Diego, CA 92101
Scott.McMillan2@aecom.com

The Conservation and Management of Vernal Pools in Southern California: Tracking our Path to Today and Planning our Path to Tomorrow

RUSSELL HUDDLESTON
Applied Technology & Science, 5 Third Street, Suite 1010, San Francisco, CA 94103
russell.huddleston@a-t-s.com

Vernal Pool Conservation, Research, and Education at the Jepson Prairie Preserve

In 1980 the Nature Conservancy purchased 634 hectares (1,566 acres) of land in Solano County to safeguard some of the most intact northern California clay-pan vernal pool and native prairie habitat remaining in the Sacramento Valley. Ownership of the Jepson Prairie Preserve was later transferred to the Solano Land Trust, whom presently manage the preserve along with the University of California Natural Reserve System (UCNRS). The habitat quality and high diversity of flora and fauna have long attracted scientists and researchers to the preserve. Several new taxa have been discovered on the preserve including native solitary bees, Solano grass, and conservancy fairy shrimp. Both Solano grass and conservancy fairy shrimp were discovered in Olcott Lake, a large playa vernal pool that is the centerpiece of the preserve. In the last 15 years, over 140 research projects have been implemented on the preserve, including studies on vernal pool ecology, pollination of native vernal pool plants, plant genetics, California tiger salamander life history, effects of invasive species, soil microbial communities, and many others. Public education is also an important component of the preserve. Since the late 1980's the Jepson docent program has been leading free public tours of the preserve every spring. A group of well-trained volunteer docents share information on vernal pool ecology, flora and fauna of native California prairie, as well as the importance of conserving and protecting these special resources and landscapes.

BARBARA CASTRO[1] (speaker) and ROBERT SCHLSING[2]
[1]California Department of Water Resources, Northern Region Office, 2440 Main St., Red Bluff, CA 96080
barbara.castro@water.ca.gov
[2]Department of Biological Sciences, California State University, Chico, CA 95926 (retired)
rschlising@csuchico.edu

The Vernal Pool Landscape at The Nature Conservancy's Vina Plains Preserve

The Nature Conservancy (TNC) began purchasing property and conservation easements in the Vina area north of Chico in 1982 to safeguard the region's grassland and vernal pool habitats. An impervious hardpan derived from volcanic mudflows underlies the region, but soils have developed, and weathering and wind erosion have scoured out numerous Northern Hardpan Vernal Pools. The original 1525 acres was dedicated as the Vina Plains Preserve (VPP) in 1983 and tours given by Conservancy staff and local docents started in 1984. TNC has maintained ownership of the Preserve and has used both prescribed fire and (after a trial period without grazing) strategic

livestock grazing as management tools to control invasive plants. VPP is an active cattle ranch, now open to the public on a reservation basis. Use of this vernal pool landscape has been hosted by TNC for college classes and for research on organisms and habitats. A good deal of peer-reviewed research here has been published by students and scientists, and this information constitutes a major resource. TNC continues to welcome research on the Preserve. Research done at VPP has been on geomorphology, soils, habitats, invertebrates and plants (including endangered species), as well as on vertebrates and micro-organisms. TNC has enlarged the VPP and now owns 4600 acres, and this now constitutes a portion of its larger Lassen Foothills Project. This vernal pool landscape lies within the "Northeastern Sacramento Valley Vernal Pool Region" of the U.S. Fish and Wildlife Service's Vernal Pool Recovery Plan that was published in 2006. It is thought that 95% of California vernal pools have been lost to agriculture and development, so the importance of this land preserved and managed by The Nature Conservancy cannot be over-emphasized!

Session 2. Moderator: Kyle Merriam, Plumas National Forest

KIRSTEN M. BOVEE[1] (speaker), KYLE MERRIAM[2], and MEREDITH GOSEJOHAN[3]
[1]USDA Forest Service, Lassen N.F., Chester, CA, 96020
kirstenbovee@fs.fed.us
[2]USDA Forest Service, Sierra Cascade Province, Quincy, CA 95959
[3]Susanville Indian Rancheria, Susanville, CA 96130

Livestock Grazing Affects Vernal Pool Specialists More Than Habitat Generalists in Montane Vernal Pools on the Modoc Plateau

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 many Central Valley vernal pools. We sought to understand the effects of livestock grazing in high elevation pools on the Modoc Plateau that lack this invasive species component. We sampled 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 over time, livestock exclosure 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 livestock exclosure 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 livestock utilization may also result in adverse impacts to annual species. Late-season grazing in some years may be the most effective strategy to support the entire suite of species endemic to montane vernal pool habitats.

KYLE MERRIAM[1] (speaker), MEREDITH GOSEJOHAN[2], and P.J. WEISBERG[2]
[1]USDA Forest Service, Plumas National Forest, 159 Lawrence St., Quincy, CA 95971
kmerriam@fs.fed.us
[2]Natural Resources and Environmental Science, University of Nevada – Reno, 1000 Valley Road, MS 186, Reno, NV 89512

Hydrologic Influences on Plant Community Structure in Vernal Pools of Northeastern California

Plant communities in vernal pools are distributed along continuous elevation gradients associated with subtle variations in microtopography, reflected in spatially heterogeneous hydrologic regimes. We quantified the role of hydrologic and environmental variables for influencing species assemblages within two vernal pool landscapes in northeastern California. A novel combination of approaches including remote photography of water depth stage gauges, vegetation sampling along elevation gradients, and topographic surveys were used to measure hydrology and plant community composition at precise locations. Multivariate analyses were used to classify vernal pool plant communities and classification tree analysis was used to model plant community distribution across hydrologic thresholds. Three plant community groups were distinguished according to localized hydrologic regimes. Inundation period and maximum depth were the only variables found to be predictive of plant distribution. Hydrologic thresholds for the three community groups were based on inundation period: Short (< 71 days), Medium (≥ 71 days but <209 days), and Long (≥ 209 days). The distribution of plant assemblages was

strongly correlated with key hydrologic gradients. Quantification of such relationships will be useful in forecasting eco-hydrological responses of vernal pool vegetation to climate change, helping to guide future monitoring, management and restoration efforts for these unique ecosystems.

EVA S. BUTLER
Sacramento Splash, 4426 Excelsior Road, Mather, CA 95655
eva@sacsplash.org

Falling in Love with Vernal Pools: How Splash Turns Kids into Conservationists
The year 2018 marks the 100th anniversary of the establishment of Mather Field as an Air Force Base (AFB) in Sacramento County, CA. For a century, the fences that surrounded Mather Field protected many of its vernal pools from advancing urbanization. When the base realignment and closure process began in 1993, a community-based conservation effort arose. It started with the Sacramento Valley Chapter of the California Native Plant Society and evolved into the place-based science program known as Sacramento Splash (Splash). The result: an effective vocal, local constituency for vernal pools, mobilized for conservation action. Splash's popular science curriculum *Life in Our Watershed: Investigating Vernal* Pools has been used by over 46,000 students. They and many thousands of citizens have been escorted by Splash as they visit Mather Field and learn to care about the fate of vernal pools and their resident species. Looking back over the past 25 years, the founder of Splash reflects on what works, what matters and how to engage the next generation of vernal pool scientists and advocates. She lauds past contributions of professional and lay scientists to the Splash program and reveals our essential role moving forward. Whether it's short videos, photos, observations, vignettes or fabulous factoids, Splash wants to share your stories about vernal pools and the natural world with the next generation.

Session 3. Moderator: Barbara Vlamis, AquAlliance

WEDNESDAY KEYNOTE ADDRESS

DON HANKINS
Department of Geography and Planning, California State University, Chico, CA 95929-0425
dhankins@csuchico.edu
and California Indian Water Commission, c/o P.O. Box 627, Forest Ranch, CA 95942

Ecocultural Species of Vernal Pool Ecosystems: Case Study from the Miwko? Waali?
Vernal pool ecosystems are frequently considered in relationship to endemic and rare species, hydrologic processes, and rangeland; but what deeper cultural connection is entwined with vernal pools? Vernal pool ecosystems are integral to traditional cultural properties of many California Indian tribes. They provide traditional foods, medicines, fibers, and functional attributes that are rooted in a reciprocal relationship between people and their ancestral landscapes and cultures. The significance of vernal pools in this context has largely been overlooked in their conservation and stewardship. Recent project-specific threats to vernal pools has created an opportunity to draw upon this knowledge to further trust responsibilities to promote a broader understanding and regulatory support for ecocultural conservation and stewardship objectives. Here the unique ecocultural relationship of vernal pools species within the *Miwko? Waali?* (AKA Plains Miwok homelands of the Delta region) is illustrated to discuss how these relationships are being utilized to uphold cultural obligations to the landscape.

CARA CLARK
Central Coast Wetlands Group at Moss Landing Marine Laboratories, 8272 Moss Landing Rd., Moss Landing, CA 95039
cclark@mlml.calstate.edu

CRAM Vernal Pool Module Validation and Applications in Vernal Pool Landscapes
The California Rapid Assessment Method (CRAM) is a field-based, cost-effective, and scientifically defensible tool for monitoring wetlands. It is organized to guide the user through the wetland's structure from landscape level to site-specific plant community composition. We validated vernal pool CRAM by examining correlations between CRAM data and intensive field measures, including macroinvertebrate and vegetation surveys. We

leveraged data collected by project partners throughout California. The study included sites in the Central Valley and Bay Area sampled by Vollmar Natural Lands Consulting, Madera sites sampled by CalTrans, sites in the Don Edwards National Wildlife Refuge sampled by the USFWS, sites in the Santa Rosa area sampled by Larry Stromberg and company, sites in the San Diego area sampled by ICF and AECOM, and sites on Ft Hunter Liggett, Camp Pendleton, and Marine Corps Air Station Miramar sampled by military personnel and contractors. The Vernal Pool CRAM Index score was significantly correlated with large branchiopod species richness and the Shannon Evenness Index for vegetation. Individual CRAM Attributes were also correlated with invertebrates and vegetation. The Vernal Pool CRAM module provides a meaningful, repeatable, and accurate assessment of wetland condition across the state of California. There are appropriate places to use CRAM and other applications where it is not the optimal tool (for example, endangered species monitoring). It has been used in many monitoring applications, both regulatory and voluntary. Examples include High Speed Rail impact assessment, regional Specific Plan evaluations, vernal pool reference site characterization, and condition assessment of military lands.

JENNIFER BUCK-DIAZ[1] and CAROL WITHAM[2](speaker)
[1]California Native Plant Society, 2707 K Street, Suite 1, Sacramento, CA 95816
jbuck@cnps.org
[2]1141 37th Street, Sacramento, CA 95816
carolwwitham@gmail.com

Rings Around the Posies: Updates on the Classification of Vernal Pool Vegetation

We all know that vernal pools have concentric rings, ribbons, and patches of showy flowers in the spring. These pink, yellow, white, and blue blossoms can serve as a diagram to the complex community types that occupy vernal pools. Early ecologists classified pools based on substrates and locations. Later they were grouped into regions characterized by locally restricted plant species. Dr. Michael Barbour, along with a team of international scientists, took into account the extensive flora of vernal pools and created a fine-scale vegetation classification system. The Barbour project identified a new class of vegetation and named it after two iconic vernal pool species — *Lasthenia fremontii* and *Downingia bicornuta*. This class now includes 50 associations nested under 13 alliances, demonstrating that vernal pool vegetation diversity is high. This talk will cover the context of vernal pool vegetation classification, discuss primary groups and keys, and highlight future needs. Special emphasis will be placed on the why and when of using vegetation for regulatory and management purposes.

Session 4. Moderator: Richard Lis, California Department of Fish and Wildlife

DANIEL J. ROHLF
Lewis & Clark Law School,10015 S.W. Terwilliger Boulevard, Portland, OR 97219
rohlf@lclark.edu

Vernal Pools: Evolving Legal Protections and an Uncertain Future

Federal laws protecting vernal pools and their associated plant communities and other species are in a state of flux. The Trump Administration is actively attempting to reduce the scope of wetlands protected under the Clean Water Act, and has acted to weaken requirements to mitigate or compensate for impacts on wetlands and other natural resources. Protections for endangered species are also under fire in both Congress and administrative agencies. The courts will also continue to play an important role in defining protections crucial for vernal pools and the life forms they support. For example, a crucial Ninth Circuit decision limits the value of critical habitat designation for protecting vernal pools, and the U.S. Supreme Court may be poised to place further limitations on designating critical habitat. Nevertheless, federal law still provides important protections for vernal pools, as well as means for concerned citizens to enforce those protections.

NIALL F. MCCARTEN
Institute for Ecohydrology Research, 1213 Carriage Drive, Woodland, CA 95776
nmccarten@ecohydrology-research.org
and Dept. of Land, Air, and Water Resources, University of California, One Shields Avenue, Davis, CA 95616
nfmccarten@ucdavis.edu

Landscape Structure and Geophysical Parameters that Control the Hydrology of Vernal Pools

The physical landscape, including topography and soil types, represent the setting that interacts with annual rainfall to form vernal pools. The area, shape, and elevation gradient of the catchment surrounding vernal pools are physical variables that determine how precipitation intercepted outside a pool basin can increase pool water. The effect of the surrounding catchment can lead to 20% up to 60% or more of a pools' water. The presence and depth of a soil water-restricting layer contributes to having a seasonal, perched water table and the amount of surface water in a pool. The amount of water stored in the soil is often 30% up to 90% of water stored within a pool and affecting the amount of surface water. Landscape information gathered from topographic and soil data were used to create models of natural vernal pools. These physical models were then evaluated using hydrological analyses to determine individual pool hydrology. Research on pools from different soils and landscape in California are presented. This approach was then used to evaluate sites for potential vernal pool restoration. Examples for vernal pool restoration projects in Sacramento Valley and Coastal Southern California are presented including the steps taken in the evaluation of the site, the method of hydrological engineering and predicting outcomes. Methods using global positioning systems, Lidar, and ground-penetrating radar are shown as important tools for the understanding of the physical environment of vernal pools. The variability of annual rainfall is briefly mentioned to demonstrate how it influences natural and restored vernal pool hydrology.

RICHARD LIS
California Department of Fish and Wildlife, 2440 Athens Avenue, Redding, CA 96001
Richard.Lis@wildlife.ca.gov

The United States Versus Duarte Nursery: A Summary of the Hydrological and Biological Effects of the Tillage as Assessed by the Federal Expert Team, and Description of the Final Settlement Agreement

Duarte Nursery Inc. owns a parcel of property, approximately 450 acres in area, approximately 5 miles south of Red Bluff, Tehama County, California. In November 2012, ground disturbing operations were observed that were being undertaken without permits from the Army Corps of Engineers (ACOE). A cease and desist order was issued by the ACOE for violations of Section 404 of the Clean Water Act (CWA), for discharge of a pollutant (soils) into waters of the United States which have significant nexus with traditionally navigable waters under the CWA. Duarte Nursery Inc. initially sued the U.S. and then the U.S Department of Justice (DOJ) countersued Duarte Nursery. The DOJ convened an Expert Team which assessed the Duarte property for effects to hydrology, soils, vegetation, and violation of the CWA. The Expert Team identified 43.9 acres of waters/wetlands, a substantial portion of which were depression wetlands (vernal pools) and 9.82 miles of streams on the site. The Expert Team identified eight direct impacts to waters/wetland area and ecosystem functioning, and indirect, cumulative, and temporal impacts to hydrologic, soil, plant community, and faunal support/habitat resources. The case reached settlement immediately prior to the planned start date of the trial in August 2017. Primary elements of the settlement agreement were: (a) a civil penalty of $330,000.00; (b) No disturbance to the 43.9 acres of waters/wetlands plus a setback of 35 feet for 10 years except for grazing and weed control; (c) permanent protection for Coyote Creek on the property and one major stream; (d) remediation to 22 acres of wetlands; and (e) off-site mitigation compensation of $770,000.00.

Thursday, April 12

BARBARA VLAMIS
Executive Director, AquAlliance, P.O. Box 4024, Chico, CA 95927
(530) 895-9420
www.aqualliance.net

Welcome to the Second Day of the Conference

Session 5. Moderator: Barbara Castro, California Department of Water Resources

BRENT HELM
4600 Karchner Road, Sheridan, CA 95681
bhelm69485@aol.com

Monitoring and Managing California Endemic Large Branchiopods

Twelve of the 37 species of large branchiopods (fairy shrimp, tadpole shrimp, and clam shrimp) that occur in California are considered endemic. Of these endemics, six are listed under the federal Endangered Species Act as either threatened or endangered. These California endemics inhabit temporary wetlands, chiefly vernal pools. Yet, only 1/3 of the remaining California vernal pool terrains are under some form of protection (e.g., conservation easement, deed restriction). Often these protected lands support endemic large branchiopods whose stewards are charged with their long-term monitoring and management. Given the differing life histories among these endemic large branchiopods, the task of applying management decisions based on monitored population trends and can be problematic. Therefore, monitoring techniques are discussed that are simple to execute, easy to repeat, and obtain useful data in a cost-effective manner. In addition, management decisions concerning grazing, exotic aquatic weeds, and current rainfall patterns are examined. Lastly conservation units are introduced, based on recent genetic analysis below the species level, which may be used to guide future mitigation and restoration efforts.

SHANNON ROSE KIERAN[1](speaker), JOSHUA M. HULL[2], and AMANDA J. FINGER[1]
[1]University of California, Davis, Genomic Variation Laboratory, One Shields Ave, Davis, CA 95616
sckieran@ucdavis.edu
[2]U.S. Fish and Wildlife Service Sacramento Regional Field Office, 2800 Cottage Way, Sacramento, CA 95825
josh_hull@fws.gov

Using Environmental DNA to Monitor Vernal Pool Organisms

Environmental DNA (eDNA), a method of detecting the presence of an organism by sampling its environment, has enjoyed a recent surge in popularity as a tool for monitoring aquatic ecosystems and their inhabitants. Vernal pools have the potential to be an excellent ecosystem for this method, both due to their insularity and to the many rare and endemic species present in them. This project seeks to develop eDNA monitoring protocols for five vernal pool species, including four large Branchiopods and the California Tiger Salamander. After developing species-specific qPCR assays, we developed field protocols to test this method in the field. Over the last two years, 130 eDNA samples and dip-net samples have been taken side-by-side from 82 vernal pools in California. Early results suggest that eDNA monitoring could be a complementary method to traditional dip-net surveys for the monitoring of specific organisms.

JORGE A. MONTIEL M.
University of California, 5200 N. Lake Road, Merced, CA 95340
mandussi.jam@gmail.com

Understanding the Spatial and Temporal Distributions of Microbial Communities in Vernal Pools of California

This proposed research focus on the study of different microbial groups (archaea, bacteria and eukaryotes: fungi, protista) using vernal pools as study system, which are well delimited ecosystems, and fundamentally they have

the same environmental characteristics. In order to understand the diversity and community composition of microorganisms within vernal pools, I plan to address the following questions: 1) Do microbial communities vary by distance? 2) Do microbial communities vary across the Californian Mediterranean region? 3) How much of the variance is explained by each pattern? The distribution of the vernal pools across the Californian Mediterranean region provides a suitable geographical extent to characterize biogeographical patterns such as distance decay and/or a latitudinal diversity gradient. Finally, since vernal pools tend to become terrestrial habitats after inundation, I have a final question: 4) How do the aquatic vernal pools communities compare with terrestrial vernal pools communities? Is any existing overlap indicative of taxa exchange? My methods comprise the analysis of eDNA using the high throughput sequencing platform MiSeq and different diversity metrics. Vernal pools are very understudied in terms of microorganisms, and this natural component may be important for ecological equilibrium at local and global scales.

Session 6. Moderator: Jenny Marr, California Department of Fish and Wildlife (retired)

LEIGH JOHNSON
S.L. Welsh Herbarium, Brigham Young University, 3107 MLBM, Provo, UT 84602
Leigh_johnson@byu.edu

Vernal Pool *Navarretia* and Their Near Relatives: What we Know and What We Have Yet to Learn About Relationships and Genetic Structure

Many *Navarretia* germinate in response to extended periods of moisture and are often found in shallow depressions, yet only a few have adapted tightly to vernal pool habitats. These latter species are closely related and part of a 14-species clade recognized formally as *Navarretia* section *Navarretia*. Comparative sequencing of chloroplast and two nuclear DNA regions reveals complex patterns of hybridization and genome merging, including polyploidization in some species of this clade. The core vernal pool species form a subclade with minimal phylogenetic resolution based on these genetic loci, consistent with hypotheses of a relatively recent and rapid morphological radiation with some species limits obscured in areas of contact via probable hybridization and introgression. These evolutionary patterns and processes, combined with limited material available for study for some species, contribute to the difficulty in presenting unambiguous field identification characters in dichotomous keys. Nevertheless, recently developed microsattelite DNA markers in conjunction with morphometrics and a community-approach to geographic sampling have the potential to accelerate the development of a clearer understanding of population-level relationships and species limits, and an improved set of diagnostic morphological characters for field identification of the vernal pool *Navarretia*.

MOLLY STEPHENS (speaker), DANNISE RUIZ RAMOS, DANIEL TOEWS, and JASON SEXTON
School of Natural Sciences, 5200 North Lake Road, University of California, Merced, CA 95343
mstephens3@ucmerced.edu

Diversity Above and Below Ground: The Genetics of Vernal Pool Plants and Seed Banks

Habitat conversion has greatly reduced vernal pool lands over the past century, with eastern Merced County among the hardest hit. Identifying vernal pool species, both common and threatened, in these communities is essential for understanding their ecology, evolution, and conservation needs; however, species surveys require time, expertise, and proper timing to ensure adequate identification. We describe research underway at the UC Vernal Pool and Grassland Reserve using a soil environmental DNA analysis approach to identify and understand plant diversity. We are currently piloting different soil sample processing methodologies to determine the effects of sampling volume, depth, and sample processing (sieved versus whole soils) on species identification. We will be comparing our above-ground surveys of vegetation to eDNA soil sampling in three inundation zones (pool bottom, edge, and upland) and correlating species diversity (alpha, beta, and genetic) with soil type, hydrology, and spatial structure. Our efforts sampling soils with [volunteer group] CALeDNA citizen scientists have already identified plant and animal species in five pools, including some federally listed plants. Additional research is also underway to create single nucleotide polymporphism (SNP) markers for four Orcuttieae species: *Neostapfia colusana, Orcuttia inaequalis, O. pilosa,* and *Tuctoria greenei*; these markers will be used in a population genetics of *N. colusana,* for which we have obtained rangewide population samples. We have sequenced a

reference genome for *N. colusana* that is 2.2GB in size and approximately 87% complete that will be useful for marker development and for future efforts to understand neutral and adaptive genomic variation in native plants.

DANIEL J. TOEWS
School of Natural Sciences, 5200 North Lake Road, University of California, Merced, CA 95343
dtoews@ucmerced.edu

Soil Effects on an Endemic Vernal Pool Annual Plant, *Limnanthes douglasii* ssp. *rosea* (Meadowfoam)
The heterogeneity of soil environments found across vernal pool landscapes makes the question of adaptation to local conditions relevant to understanding population biology and conservation of vernal pool plant taxa. To examine the plant-soil relationship in *Limnanthes douglasii* ssp. *rosea* (Meadowfoam), an endemic vernal pool annual plant, I employed a common garden experiment in a greenhouse and assessed plant fitness of plants grown among Corning, Keyes and Redding soil types from nine populations across a large intact vernal pool landscape, including three local populations to each soil type. Phenotypic trait measurements indicative of plant fitness (e.g. reproductive output, and plant size) of the reciprocally transplanted populations reveal statistically significant soil type effects. We found that on average all plants from each soil type performed best on Keyes soil and that plants grown on Redding soil had the poorest performance. Additionally, plants originating from Keyes soil displayed higher fitness than all other plants when transplanted across Corning and Redding soil types. Aside from Keyes derived plants, local populations never performed best in their home soils, however, Corning and Keyes populations are the top two performers in each soil treatment. Our findings indicate that fitness variation of Meadowfoam is significant across a landscape scale continuum of high and poor quality soils. This work suggests that vernal pool plant populations distributed among small-scale soil gradients could conceivably be adapted to local conditions.

Session 7. Moderator: Richard Lis, California Department of Fish and Wildlife

THURSDAY KEYNOTE ADDRESS

JOHN E. VOLLMAR
Vollmar Natural Lands Consulting, Inc., 1720 Solano Avenue, Berkeley, CA 94707
jvollmar@vollmarconsulting.com

Preserving Vernal Pool Landscapes One Property at a Time: How We Work within Our Socioeconomic System to Achieve Meaningful Landscape-Scale Conservation
While vernal pool landscapes throughout California have been heavily decimated, there are some key locations where large, contiguous preserves have been established. These preserves have been stitched together, one property at a time, through a years-long process involving *ad hoc* conservation planning, willing landowners, engaged easement holders, multiple funding sources, and a dedicated core of people committed to preserving a particular region. This talk explores how this process has played out in two distinct regions in the Great Valley (eastern Merced County and southeast Solano County) and presents ideas on how we can continue working in remaining intact vernal pool landscapes to achieve meaningful landscape-scale conservation. Much of the data underlying this presentation comes from a USEPA-funded study recently completed by Vollmar Natural Lands Consulting that analyzed patterns and trends in vernal pool habitat conservation and management throughout the Great Valley.

ANA MARIA SAENZ
Water Quality Certification and Wetlands Program, California State Water Resources Control Board,
1001 I Street, Sacramento, CA 95814
Anamaria.saenz@waterboards.ca.gov

State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State
The State Water Board is proposing the State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State (Procedures), for inclusion in the forthcoming Water Quality Control Plan for Inland Surface Waters and Enclosed Bays and Estuaries and Ocean Waters of California. The Procedures consist

of four major elements: 1) a wetland definition; 2) a framework for determining if a feature that meets the wetland definition is a water of the state; 3) wetland delineation Procedures; and 4) procedures for application submittal, and the review and approval of Water Quality Certifications and Waste Discharge Requirements for dredged or fill activities. The Procedures are being developed to address several important issues. First, current regulations need to be updated to ensure adequate wetland protection and prevention of losses in the quantity and quality of wetlands in California. The Regional Water Boards may have different requirements and levels of analysis with regard to the issuance of water quality certifications. The Procedures will provide consistent requirements across the Water Boards for discharges of dredged or fill material and strengthen protection of wetlands no longer protected under the CWA due to U.S. Supreme Court decisions. The Procedures will also provide a single accepted definition of wetlands at the Water Boards. The proposed wetland definition represents the various forms or kinds of landscape areas in California that are likely to provide wetland functions, beneficial uses, or ecological services.

Session 8. Moderator: John Hunt, Northern California Regional Land Trust

ERIC SMITH (speaker) and JOHN VOLLMAR
Vollmar Natural Lands Consulting, Inc.,1720 Solano Avenue, Berkeley, CA 94707
esmith@vollmarconsulting.com jvollmar@vollmaraconsulting.com

Whole-landscape Restoration of a Leveled California Vernal Pool Terrain

Vernal pool creation has traditionally happened in one of two contexts: adding pools to an existing vernal pool landscape, or excavating new pools into a flat terrain lacking any existing pools. The first approach changes the distribution, density, and hydrology of existing pools, while removing upland habitat from an intact system. The second approach tends to create disconnected "bathtubs" that lack the connectivity and complex shaping of natural vernal pool landscapes. We present a novel project to restore an entire topography of vernal pools, mounds, and both wetland and non-wetland swales on a leveled site with partially modified subsurface soils. By using high-and-low tech data gathering including LiDAR, historical aerial photography, landowner interviews, and soil pit analysis, we designed a complete replacement terrain to expand neighboring intact landscapes and provide biological, hydrologic, and aesthetic values. GPS-controlled earth-moving equipment and drone-based elevation surveys were used to bring the design to life with 1-inch accuracy. Year-1 hydrologic monitoring indicated 95% hydrologic success; vegetation monitoring is now underway.

KEALIE PRETZLAV and BARRY HECHT
Balance Hydrologics, Inc., 800 Bancroft Way, Suite 101, Berkeley, CA 94710
kpretzlav@balancehydro.com bhecht@balancehydro.com

A Simplified Classification and Water-balance Model of Pools for the Efficient Characterization of Hydroperiod: Adaptive Habitat Management under Changing Climates in the Guadalupe-Coyote Valley, California

Vernal pools and seasonal wetlands support complex ecosystems, providing valuable habitat for native wildlife and wetland vegetation. Changing climates are expected to have significant impacts on vernal pool habitats, the degree of expected change perhaps depending on climatic region, underlying pool geology, soil types, or contributing watershed size. We present a genetic classification scheme for vernal pools (e.g. Pedogenic, Tectogenic, Landslide Head Scarp, etc.), which can be distinguished using easily acquired watershed-scale information such as underlying geology and soil types. We focus our discussion of genetic classification on hydrologic response and pool hydroperiod, and the related impacts on habitat, salinity, and temperature for species such as California red-legged frog, and California tiger salamander. An efficiently-deployed water-balance model, calibrated using Google Earth historical imagery, is used to quantify the relative contributions of surface runoff, groundwater fluxes, and evapotranspiration. Model results are consistent with hydrologic expectations of genetic classifications. Once built and calibrated over a range of years and conditions, an individual pool model provides an invaluable tool for habitat conservation and hydroperiod optimization for target species, under both historical and projected climatic forcing. This approach allows developing an understanding of each pool or pool cluster at a level greater than individual observations alone typical of CRAM or the US Army

Corps HGM with the same level of effort. Furthermore, time-intensive, multi-disciplinary investigations required to manage landmark pools, coupled with a water-balance model allow informed decisions regarding park and open-space management, grazing policies, and potential co-evolution with climate change.

JOHN W. HUNT and PAUL KIRK
Northern California Regional Land Trust, 580 Vallombrosa Ave., Chico, CA 95926
john@landconservation.org pkirk@landconservation.org

Landowner-led Strategies for Conserving Vernal Pool Rangelands

The Northern California Regional Land Trust works with landowners to identify acceptable practical means of permanently conserving private lands and natural resources. The Land Trust serves as a hub to coordinate a frequently complex array of conservation partners, diverse perspectives, and overlapping objectives to accomplish this work. Land Trust staff will provide an overview of this work and how the insight gained can expand the rate of substantive conservation of vernal pool landscapes.

Abstracts of posters, April 11, 2018
* = primary poster author

REBEKAH BERGKOETTER*[1]JAMIE KNEITEL[1], and JUSTIN MILLER-SCHULZE[2]
[1]California State University - Sacramento, Department of Biology, 6000 J Street, Sacramento, CA, 95819
rebekah.bergkoetter@gmail.com
[2]California State University - Sacramento, Department of Chemistry, 6000 J Street, Sacramento, CA, 95819

***Daphnia* Morphological and Behavioral Defense of UV-B Radiation in California Vernal Pools**

Intense exposure to ultraviolet radiation is a significant health risk to all organisms. To prevent extreme damage from shortwave radiation (UV-B), *Daphnia* [commonly called water fleas] express more melanin and migrate within the water column to areas of lower exposure. All previous investigations into the behavior and morphology of UV-B defense in *Daphnia* have taken place in permanent aquatic systems. In this experiment, we show that *Daphnia* from vernal pools in California had an average melanin concentration of 7.133 µg/mg and tend to inhabit the lower water column. This is similar to results found in *Daphnia* inhabiting nearby permanent water bodies.

KIRSTEN M. BOVEE*[1], KYLE MERRIAM[2], and MEREDITH GOSEJOHAN[3]
[1]USDA Forest Service, Lassen N.F., Chester, CA, 96020
kirstenbovee@fs.fed.us
[2]USDA Forest Service, Sierra Cascade Province, 159 Lawrence Street, Quincy, CA 95971
[3]Susanville Indian Rancheria, 745 Joaquin Street, Susanville, CA 96130

Livestock Grazing Affects Vernal Pool Specialists More Than Habitat Generalists in Montane Vernal Pools on the Modoc Plateau

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 many Central Valley vernal pools. We sought to understand the effects of livestock grazing in high elevation pools on the Modoc Plateau that lack this invasive species component. We sampled 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 over time, livestock exclosure 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 livestock exclosure 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 livestock utilization may also result in adverse impacts to annual species. Late-season grazing in some years may be the most effective strategy to support the entire suite of species endemic to montane vernal pool habitats.

JULIA MICHAELS*[1], EVAN BATZER[2], and VALERIE EVINER[3]
[1,2]University of California, Davis, Graduate Group in Ecology, 1 Shields Avenue, Davis, CA 95630
jmichaels@ucdavis.edu
[3]University of California, Davis, Plant and Environmental Sciences, 1 Shields Avenue, Davis, CA 95630

Assessing Diversity at Multiple Scales in Grazed Ephemeral Wetlands

Maintenance of vernal pool flora is a high conservation priority, and livestock grazing has been shown to increase plant diversity within individual pools. A large amount of diversity is also distributed across pools, which can host different communities due to abiotic factors such as hydrology, chemistry and topography. It is important to know whether grazing reinforces this across-pool spatial heterogeneity (beta diversity), or if it makes pools more similar

to one another. To address this, we compared pools that have been grazed continuously and pools that have been fenced off for over 40 years at a site in E. Sacramento County. For three years, we sampled vegetation in 14 grazed and 14 ungrazed pools. Hill numbers were calculated to compare species richness and abundance, while PermANOVA and PermDISP were used to compare compositional differences. Similar to past studies, grazing tended to increase alpha diversity of vegetation, although the effect varied across year and pool zone, with the pool edge and upland zones having a more consistent response than the deepest parts of the pools. While grazing tended to increase within-pool diversity, it also tended to reduce heterogeneity, make vegetation composition more similar across pools. Across-pool (beta) diversity was lower in grazed pools compared to ungrazed pools in 2015 and 2016 (2015: PERMDISP $F=10.36$, $p>0.003$, $df=1$ and 2016: PERMDISP $F=6.82$, $p>0.01$, $df=1$). This study highlights that management efforts focused on increasing alpha diversity may also affect the variability found across the landscape.

KYLE MERRIAM*[1], P.J. WEISBERG[2], and MEREDITH GOSEJOHAN[2]
[1]USDA Forest Service, Plumas National Forest, 159 Lawrence Street, Quincy, CA 95971
kmerriam@fs.fed.us
[2]Natural Resources and Environmental Science, University of Nevada – Reno, 1000 Valley Road, MS 186, Reno, NV 89512

Livestock Use Has Mixed Effects on *Orcuttia tenuis* in Northeastern California Vernal Pools

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 seasonal wetlands that support many rare and endemic species, such as *Orcuttia tenuis* Hitchc. (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 as a result 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.

ROBERT F. HOLLAND
Geobotanical Phenomenology, 3371 Ayres Holmes Road, Auburn, CA 95602
drbobholland@gmail.com

A Longer View of Vernal Pool Biogeography

For the first time in this poster, the distribution of California vernal pools over more than 35 million acres has been plotted by Holland in a single map. This represents a compilation of many years of Holland's mapping and remapping vernal pools in California; mapping projects from different years (1997, 2005, 2012) are overlaid with distinct color schemes. The Great Valley has been mapped 3 times, each with incongruent footprints. Polygons show habitat extant at the time aerial imagery was acquired. GIS data for all studies are available on the CDFW BIOS website at https://www.wildlife.ca.gov/Data/BIOS/About. Colored points represent California Natural Diversity Database (CNDDB) occurrence of vernal pool-dependent organisms [e.g. crustaceans, other invertebrates]. These point data indicate that more mapping of vernal pools is needed from Mt. Shasta to Alturas, to Lake Tahoe and behind the 'redwood curtain'. Thanks to US Fish & Wildlife Service, US Bureau of Reclamation, US Forest Service, Calif. Dept. of Fish & Wildlife, and Calif. Dept. of Water Resources for underwriting components of this map. Carol Witham and John Vollmar were coauthors in the 2005 and 2012 studies.