# California/Nevada Amphibian Populations Task Force 2019 Meeting

**Humboldt State University**
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## ABSTRACTS

## ORAL PRESENTATIONS

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### Foothill Yellow-legged Frog Assessment Model (FYFAM) [ALTERNATE PRESENTATION]

The Foothill Yellow-legged Frog (*Rana boylii*, FYF) relies on river edgewaters for reproduction, timing its oviposition with hydrograph cycles to minimize scour and desiccation risks to eggs and tadpoles while maximizing first-year development time for offspring. Individual frogs initiate breeding using a suite of environmental cues. Dams can decouple the hydrology, hydraulics, and thermal regimes from other natural environmental cues, hampering oviposition choices of breeding FYF, increasing scour and desiccation risk, and thus diminishing reproductive success. Managing water resources for biotic benefits downstream requires better insight on how organisms such as FYF will respond to alternative flow release schedules. Climate and flow modeling simulations are often used to predict river conditions under a given flow release schedule and set of meteorological conditions. The Foothill Yellow-legged Frog Assessment Model (FYFAM, developed using support from US Forest Service) uses water temperature, depth, and velocity outputs from hydrologic, hydraulic, and water temperature models to assess potential differences in cohort success under various hydrograph scenarios. FYFAM uses cell-specific environmental inputs and probabilities to simulate decisions by virtual frogs and tadpoles, and predicts developmental rate of eggs and tadpoles through metamorphosis on a daily time step. Number of froglets produced per breeder and median date of metamorphosis are the primary output metrics, but many secondary metrics are useful in evaluating results. We will describe the model and explain how to interpret model outputs for two potential management actions: 1) alternative dam release hydrographs, and 2) alternative channel restoration site designs. These examples draw from rivers in California where FYFAM is providing insights on how flow management and channel restoration can influence reproductive success for this imperiled, river-breeding frog.

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### The Role of Salamanders in the Capture of Forest Carbon: Take Two

Forest soils are regions of profound carbon capture as well as home to myriad terrestrial amphibians which are both food for small predators (mesocarnivores) and top predators of the invertebrate guilds that directly mitigate the transfer of carbon from leaf litter into soil. In North American temperate forests salamanders store and transfer energy into amphibian biomass and upwards through the carnivore guilds of the terrestrial food webs. In recent past research we demonstrated the predatory impacts of the Plethodontid salamander Ensatina on litter dwelling shredder and predator invertebrates (meso-arthropods), which acts to increase litter retention and

also to release micro-arthopods from competition and predation. These interactions promote downwards accumulation of carbon in the form of stable and soil enriching humus from the enhanced amounts of leaf litter via the process of humification (conversion of carbon in litter into stable soil humus). Our initial examination of this process found litter retention on plots with salamanders to be 11% higher than adjacent control plots without salamanders. In this new research we have revisited this question with a more robust study design, and again found litter retention significantly higher on plots with salamanders (3-4%) when compared to adjacent plots without salamanders. We have not yet completed the invertebrate and stable isotope analysis of this new experiment; however, we report on revealed trends in rainfall patterns and carbon retention amounts on our study site between the initial experiment (2007-2009) and this current experiment (2013-2015).

**CUMMINGS, ADAM K.[1]*, KAREN POPE[1], MOURAD GABRIEL[2], and GRETA WENGERT[2].** [1]US Forest Service Pacific Southwest Research Station, Arcata, CA, adamcummings@fs.fed.us; [2]Integral Ecology Research Center, Blue Lake, CA.

**Assessing the Impact of Illegal Pesticide Use on National Forest Headwater Stream Communities**

Cannabis cultivation is a major industry in Northern California and illegal cannabis cultivation on public lands poses a unique threat to adjacent ecosystems. Unregulated grow operations on both public and private land are having dramatic, acute effects on the local ecology. In addition to drawing down headwater streams at the peak of the dry season, cannabis cultivators use numerous pesticides to prevent crop loss to herbivory and to kill nuisance animals. Trespass cannabis cultivation sites have been linked to the deaths of terrestrial mammals including fishers (*Pekania pennanti*) and black bears (*Ursus americanus*), but effects on aquatic communities are not well known. In 2016 and 2017 we established access to six cultivation sites on the National Forest lands, delineated survey reaches up- and down-stream of the site run-off footprint, and deployed water quality monitoring devices in each reach. To assess potential and realized impacts from the cultivation, we surveyed the stream reaches for benthic macroinvertebrates and amphibians. Amphibian species encountered during initial surveys include coastal giant salamander (*Dicamptodon tenebrosus*), foothill yellow-legged frog (*Rana boylii*), coastal tailed frog (*Ascaphus truei*), and southern torrent salamander (*Rhyacotriton variegatus*). We detected carbamate contamination in stream water at the site with the lowest Index of Biological Integrity during both sampling periods. This site had the lowest BMI taxa richness, including sensitive taxa and EPT species. Ongoing and future work into quantifying the watershed-scale impacts of trespass cannabis cultivation is also addressed.

**EDWARDS, JONATHAN P.*, and DEREK J. GIRMAN**. Department of Biology, Sonoma State University, Rohnert Park, CA, cyclokinesis@gmail.com.

**Climate, Topography, and Hydropattern: An Interaction of Abiotic Factors Affecting Larval Abundance and Phenology of the California Tiger Salamander, *Ambystoma californiense*, in Sonoma County, CA [ALTERNATE PRESENTATION]**

See Poster Presentations below for abstract.

**EPPINGER, EMILY C.*, SARA VIERNUM*, and BERNADETTE BEZY.** Stantec Consulting Services Inc., Nevada City, CA, emily.eppinger@stantec.com.

**Rock Corrals, a Novel Low-Tech Approach to Successful Foothill Yellow-legged Frog (*Rana boylii)* Egg Mass Relocation**

Foothill yellow-legged frog (*Rana boylii*; FYLF), currently a California State Candidate for Threatened Species under the California Endangered Species Act, reside in numerous Sierra Nevada foothill streams. Many of these streams, such as Greenhorn Creek, located in Nevada County, contain mine tailings as a result of California's hydraulic mining days from the 1800s. Greenhorn Creek has been mined for aggregate material for the past 50 years, and is also home to a known breeding population of the FYLF. Environmental conditions within the creek are such that the annual harvesting of gravel coincides with the breeding season of FYLF, and therefore, for the past five years local biologists have conducted capture and relocation of FYLF in order to mitigate impacts to this FYLF population.

While FYLF typically attach their egg masses to the downstream side of cobble-sized rocks to ensure their stability in the current, FYLF may also attach egg masses to bedrock, boulders, or other substrates that are too large to move safely. With the newly issued Incidental Take Permit for the project, in 2018 the biologists negotiated with CDFW to attempt a novel egg mass relocation method. This innovative approach involved biologists carefully detaching egg masses from their original substrate and relocating them into a "rock corral" within the stream current. Herein, we present the methods and results of the relocation of over 1,000 FYLF adults, juveniles, and egg masses.

**FISHER, ROBERT N.[1]*, TODD ESQUE[2], ADAM R. BACKLIN[3], and ELIZABETH A. GALLEGOS[3].** [1]San Diego Field Station – San Diego Office, USGS Western Ecological Research Center, San Diego, CA, rfisher@usgs.gov; [2]Henderson Field Station, USGS Western Ecological Research Center, Henderson, NV; [3]Santa Ana Substation, USGS Western Ecological Research Center, Santa Ana, CA.

**How Do We Determine When a Cryptic Species is Extirpated Versus Not Detectible? The Case of the Desert Slender Salamander (*Batrachoseps aridus*)**

The desert slender salamander (*Batrachoseps aridus*) was one of the first species listed as endangered under the Endangered Species Act by the U.S. Fish and Wildlife Service and one of the first species listed under California's Endangered Species Act. It has now been over two decades since a verified sighting of the species has been documented. It remains as the most range restricted terrestrial amphibian from the west. No new locations for the species have been discovered since 1981. The two known historic locations for this species were surveyed over the last two years, several times each, and during prime activity periods, to determine the status of the habitat at the sites, and to attempt to detect any salamanders. Sampling was done with surrogate species for amphibian fungal disease detection, and remotely triggered cameras were deployed at one site to determine the source of illegal human sign. For both of the field sites, we duplicated methods for direct comparison of field results to either the same observer (Esque) over a 30-year period of time (Guadalupe Canyon) or to a previous thorough California Department of Fish and Wildlife report from 40 years earlier (Hidden Palms Canyon). At neither

site were salamanders detected even though 2017 was the first high rainfall year in almost a decade. We additionally discuss what is the threshold for determining extirpation of a species with very low detectability, especially during an extenuated drought cycle.

**GRASSO, ROB L.*, and COLLEEN KAMAROFF**. Resources Management and Science Division, Yosemite National Park, El Portal, CA, rob_grasso@nps.gov.

**Annual Amphibian Update for California Red-legged Frog, Sierra Nevada Yellow-legged Frog, American Bullfrog, and Western Pond Turtle in Yosemite National Park**

The federally threatened California red-legged frog (*Rana daytonii*) was introduced to Yosemite Valley starting three years ago. In 2018, an additional 125 captive reared *R. draytonii* were released in partnership with the San Francisco Zoo and the Yosemite Conservancy. The park will provide an update and status of the introductions to date. An update to the ongoing effort to remove the invasive American bullfrog (*Lithobates catesbeianus*) from historically occupied *R. draytonii* wilderness sites (Swamp Lake & Gravel Pit Lake) will also be provided. We will also discuss the long-term strategy for reintroducing *R. draytonii* as well as efforts to monitor the western pond turtle (*Emys marmorata*) at these locations where bullfrogs may have suppressed turtle populations. Lastly, we will present results of restoration efforts for the federally endangered Sierra Nevada yellow-legged frog (*Rana sierrae*).

**HANSEN, ROBERT W**. *Herpetological Review*, Clovis, CA.

**A Remarkable Cave-dwelling Population of *Hydromantes* from the Lower Sierra Nevada Foothills**

In 2009, a caving group from the SF Bay Area took a field trip to a little known cave on the San Joaquin River in the Sierra Nevada foothills of central California. Their trip was summarized in the group's newsletter, and included a fuzzy photo of an unidentified salamander. This salamander photo was noticed in 2015 by a cave biologist, who in turn sought expert opinion as to what it might be. The photographed salamander appeared to be a juvenile *Hydromantes*, but the very low-elevation and semi-arid setting seemed a most unlikely place for a member of that genus. Beginning in the Fall of 2015, surveys of this cave system were begun, which is located within the San Joaquin Gorge Recreation Area, administered by the U.S. Bureau of Land Management. It was not until the summer of 2018 that specimens were finally obtained, confirming their affiliation with *Hydromantes* and permitting comparison to known species of that genus. This discovery requires us to reevaluate our understanding of *Hydromantes* ecology and distribution in the Sierra Nevada.

**JOHNSON, PIETER T. J.[1]*, DANA M. CALHOUN[1], TRAVIS McDEVITT-GALLES[1], WYNNE E. MOSS[1], CHERYL J. BRIGGS[2], and JASON T. HOVERMAN[3].** [1]Department of Ecology & Evolution, University of Colorado, Boulder, CO, pieter.johnson@colorado.edu; [2]Ecology, Evolution and Marine Biology, University of California, Santa Barbara, Santa Barbara, CA; [3]Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN.

**Effects of Severe Drought on Pathogenic Infections Within California Amphibian Communities**

Lentic-breeding amphibian species in California can become infected by a diversity of macro- and microparasites. Concurrently, large portions of California have recently experienced exceptionally severe drought, yet how drought influences patterns of infection remains largely unknown, particularly across multiple pathogens and host species. Between 2013 and 2017, we sampled 12,217 amphibians from 133 ponds distributed across Alameda, Contra Costa, and Santa Clara counties. Our focus was on late-stage larvae and recently metamorphosed individuals of the following species: *Pseudacris regilla*, *Anaxyrus boreas*, *Lithobates catesbeiana*, *Taricha torosa* and *T. granulosa*. We quantified infection by the trematode, *Ribeiroia ondatrae*, the chytrid, *Batrachochytrium dendrobatidis* (Bd), and the ranavirus, FV3, using a combination of necropsy and qPCR methods. Overall, 23% of hosts were infected with *R. ondatrae*, 18.9% with Bd, and 8.5% with FV3. Drought severity correlated negatively with infections by both Bd and *R. ondatrae* (1-year time lag), whereas FV3 prevalence was positively linked to drought. Among parasites, the influence of species, site and year varied sharply: for *R. ondatrae*, which requires a specific snail intermediate host, 81% of infection variance was associated with site, with only 11.5% and 7.1% linked to year and host species, respectively. For Bd, host species and year accounted for 46.5% and 33.6% of the variation, respectively, reflecting the consistently higher infections in *P. regilla* and *A. boreas*, regardless of study site. For FV3, which declined progressively from 32% prevalence in 2013 to <1% in 2017, sample year was the most influential term and accounted for 65% of variance in the random effects.

**KLEEMAN, PATRICK M.[1]*, BRIAN J. HALSTEAD[2], JONATHAN P. ROSE[2], and ADAM DUARTE[3].** [1]U.S. Geological Survey, Western Ecological Research Center, Point Reyes Station, CA, pkleeman@usgs.gov; [2]U.S. Geological Survey, Western Ecological Research Center, Dixon, CA; [3]Oregon State University, Corvallis, OR.

**Monitoring Protocol Development and Assessment for a Narrowly Endemic Species of the Great Basin: The Dixie Valley Toad (*Anaxyrus williamsi*)**

Recent genetic and morphological examination suggests that an isolated population of toads in Dixie Valley, Nevada, may be a distinct species: the Dixie Valley toad (*Anaxyrus williamsi*). A diverse group of stakeholders including USGS, USFWS, BLM, USFS, NDOW, Oregon State University, and the U.S. Navy met in February 2018 to discuss information needs for this population and to develop a monitoring protocol that would detect population changes over time. The resulting multi-state occupancy survey protocol was implemented in the spring of 2018. Detection probabilities were high for both adults and tadpoles when the 20 m x 20 m plots were surveyed for 10 minutes or more. Water temperature affected both adult toads and larvae, with adults more likely to occupy plots with cool, but not cold, water, and tadpoles more likely to

occupy plots with warm, but not hot, water. This monitoring protocol could be used in subsequent years to monitor for key characteristics of population change in Dixie Valley and at other isolated toad populations in the Great Basin.

**KLUBER, MATT R.*, MATTHEW R. HOUSE, and WILLIAM D. DEVENPORT**. Green Diamond Resource Company, Korbel, CA, matt.kluber@greendiamond.com.

**Foothill Yellow-legged Frog (*Rana boylii*) Distribution and Oviposition Sites in Streams Located on or Adjacent to Managed Timberlands in Coastal Northern California**

As brought to light in December 2016 when *Rana boylii* was petitioned to be listed as threatened under the California Endangered Species Act, there is a lack of published information, and very few recent accounts, regarding the distribution and abundance of *R. boylii* in coastal northern California. Since 2008, Green Diamond Resource Company (GDRCo) has been conducting annual egg mass surveys along a reach of the Mad River. To our knowledge, the highest densities of *R. boylii* egg masses in California were observed in 2017 along our annual survey reach (625 egg masses/km). In an effort to establish a better understanding of *R. boylii* distribution and where they are breeding across GDRCo's ownership, during the spring of 2018 *R. boylii* egg mass survey efforts were expanded, surveying over 100 km of watercourses in eight watersheds. Here we present the results from this survey effort.

**KNAPP, ROLAND A.[1, 2]*, ROB L. GRASSO[3], STACEY L. BROWN[4], ERICKA E. HEGEMAN[1, 2], and THOMAS C. SMITH[1, 2]**. [1]Sierra Nevada Aquatic Research Laboratory, University of California, Mammoth Lakes, CA, roland.knapp@ucsb.edu; [2]Earth Research Institute, University of California, Santa Barbara, CA; [3]Resources Management Division, Yosemite National Park, El Portal, CA; [4]Rural Health Clinic, Northern Inyo Healthcare District, Bishop, CA.

**Where Do Mountain Yellow-Legged Frogs Go in Winter? Remote Underwater Observations in the Alpine Zone**

Mountain yellow-legged frogs are one of the best-studied amphibians, but our knowledge is based almost exclusively on studies conducted during the summer active season. Much less is understood about these frogs during winter, and especially in high elevation habitats that are covered with several meters of ice and snow for 6-8 months a year. In these habitats, it is assumed that frogs utilize ice-free areas, but the characteristics of those areas remain largely undescribed. To overcome the logistical challenges of making direct observations of frogs under winter conditions, we deployed a small remotely operated vehicle (ROV) in an ice-covered lake that is occupied by a large mountain yellow-legged frog population. Three deployments have been completed and more are planned in 2019. Preliminary observations indicate that frogs and tadpoles were scarce in the relatively uniform deep-water habitats. In contrast, adults and tadpoles were commonly observed in crevices and overhangs associated with large boulders and bedrock features located in shallower water. These features were sometimes occupied by dense aggregations of both life stages. However, based on the known population size of frogs in the study lake, many frogs and tadpoles are likely utilizing habitats that are inaccessible to the ROV, including narrow crevices and shallow shoreline areas. Collectively, these results may have

important implications for the conservation of this endangered frog and suggest the utility of remote observations to describe winter habitat use.

**LAVIN, BRIAN R.*, B. CALLAHAN, R. CONNELL, and D. J. GIRMAN**. Department of Biology, Sonoma State University, Rohnert Park, CA.

**Genetic Structure in the California Giant Salamander (*Dicamptodon ensatus*): A Large Salamander with a Small Range**

The California Giant Salamander (*Dicamptodon ensatus*) is an ancient lineage of large salamanders primarily limited to old growth Redwood forest between Mendocino and Santa Cruz regions. We amplified 130 samples of *D. ensatus* for the mtDNA control region and a subset of those samples for the anonymous nuclear loci E16C7 in order to examine genetic structure in the species and determine the pattern of evolutionary significant units in this species. We examined phylogenetic structure with Maximum-likelihood, Bayesian inference approaches, and haplotypes networks as well as past population size. We also examine population structure under a Bayesian Clustering approach taking into account geographical information. Finally, we use historical collection localities to generate an ecological niche model for the species in order to examine the niche of the species and quality of habitat. We found that at minimum, *D. ensatus* should be comprised of at least two evolutionary significant units, North and South of San Francisco Bay, but is more accurately described by three, South, North, and Marin area. Our ecological niche model shows interior Coast Range habitat which is prone to fires to be poor habitat. Finally, we compare our results to other species to briefly examine if patterns in *D. ensatus* are unique or a result of larger climatic and geological processes acting on organisms in Coastal California.

**LODA, JENNY**. Center for Biological Diversity, Oakland, CA, jloda@biologicaldiversity.org.

**An Update on the Center for Biological Diversity's Work to Protect Amphibians in California and Nevada**

The Center for Biological Diversity works to secure a future for all species, great and small, especially those hovering on the brink of extinction. The Center has a dedicated campaign focused on the protection of imperiled amphibians and reptiles and works to obtain federal and state safeguards and protected habitat for herps in California and Nevada and across the country. The Center also works to insure compliance with the Endangered Species Act for species that are already listed under the ESA and uses advocacy at the local, state, and federal levels in its campaign to address the amphibian and reptile extinction crisis. In this presentation, I discuss the Center's work to protect frogs and salamanders in California and Nevada. These efforts include work to protect the Shasta salamander, recently described as three unique species, and other amphibians from threats posed by plans to raise the level of Shasta dam. I will also discuss efforts to protect the Dixie Valley toad in Nevada and to defend critical habitat for endangered frogs in the Sierra Nevada.

**McDEVITT-GALLES, TRAVIS*, WYNNE E. MOSS, DANA. M. CALHOUN, and PIETER T. J. JOHNSON**. Department of Ecology and Evolutionary Biology, University of Colorado, Boulder, Boulder, CO.

**Host – Parasite Synchronization Drives Variation in Amphibian Malformation Patterns**

Understanding the drivers of variation in amphibian malformations is a key first step in providing an effective strategy to address this conservation concern. A potential factor in shaping malformation patterns is variation in the phenological matchup between host and parasite. Because hosts often vary in their susceptibility to infection across development or life history, shifts in the phenology of hosts or parasites could alter the risk of infection or pathology. We quantified how the degree of phenological matching between susceptible stages of an amphibian host, *Pseudacris regilla,* and the timing of infection by the trematode parasite, *Ribeiroia ondatrae,* alter infection prevalence, load, as well as parasite-induced limb malformations. Across populations of *P. regilla* in both the San Francisco Bay Area and the Southern Cascades (Mt. Lassen), we tracked how infection likelihood and the proportion of susceptible hosts changed during the developmental season. Where the degree of overlap between highly susceptible host stages and the likelihood of infection was high, as in the Bay Area, each established parasite incurred a much higher probability of causing severe limb malformations than at Mt. Lassen where overlap was lower. Our results indicate that developmental malformations are driven by not only infection load, but also by its interaction with timing. These results highlight the sensitivity of this parasite-host relationship to shifting phenologies and the need to understand the direction and variation of organismal responses to forecasted shifts in climate.

**MELLISON, CHAD[1]*, RACHEL VAN HORNE[2], AND KENT MCADOO[3]**. [1]U.S. Fish and Wildlife Service, Reno Fish and Wildlife Office, Reno, Nevada, chad_mellison@fws.gov; [2]U.S. Forest Service, Humboldt-Toiyabe National Forest, Sparks, Nevada; [3]University of Nevada Cooperative Extension, Elko, Nevada, deceased.

**Beaver Ponds as Crucial Habitat for a Sensitive Great Basin Amphibian**

Based on the accounts of early fur trapper forays in the 1820s, beavers (*Castor canadensis*) were abundant along the Humboldt River at early Euro-American contact and an important resource for Great Basin Indian tribes, but by the late 19th century, they had been highly over-exploited. Excessive reduction of beaver from this region probably caused changes in stream channel morphology, reduced perennial wetlands, and altered riparian vegetation. However, as the result of hunting restrictions and re-introductions (1920s through 1950s), beaver populations have rebounded to inhabit much of their former range and possibly even areas where they did not occur before European contact. Over the last 20 years, beaver activity in northeastern Nevada has increased substantially as these animals respond to and contribute to the functionality of streams. Many wildlife species are favored by beaver-created habitat including the Columbia spotted frog (*Rana luteiventris*). Functioning as ecological engineers, beavers create pools of slow-moving water that serve as sites for frog reproduction and wet meadows for foraging habitat and protective cover. In northern Nevada, spotted frogs are closely associated with slow-moving or ponded surface waters that are clear and have little or no vegetation canopy cover. Habitat changes caused by beaver may increase the resilience of Columbia spotted frog populations in

the face of threats from drought, climate change, overgrazing by livestock, and predation. Proper beaver management is essential for sustaining Columbia spotted frogs and a host of other wildlife species in the Great Basin.

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**Population Trends and Drought Responses of California Tiger Salamanders (*Ambystoma californiense*) and California Red-Legged Frogs (*Rana draytonii*) in the California Bay Area**

California tiger salamanders (CTS) and California red-legged frogs (CRLF) are federally and state-listed amphibians of conservation concern threatened by factors like land use change and exotic species invasions. The ranges of both species have declined by about 70%, and small livestock ponds or other constructed wetlands have now become essential breeding sites and refugia for these species. However, during California's recent mega-drought (2011-2014), many breeding sites failed to hold water, impacting breeding success for several years. Yet, the longer-term impacts of drought may actually benefit native amphibians by suppressing exotic species (fish and bullfrog) that rely upon permanent water. To our knowledge, no study has assessed the longer term implications of the mega-drought on CTS and CRLF. We analyzed a long-term dataset (2007-2018) of pond surveys ($n$ = 104) in California's Bay Area. We will present results using multi-season occupancy models to quantify changes in population distribution and estimate the effects of drought, invasive species, and grazing practices. We will offer insights on the possible recovery of these listed species and potential management targets, and discuss the overall impacts of drought. Future work will synthesize survey efforts by other Bay Area land management agencies for a longer term and wider scale perspective on the Bay Area's endangered amphibians; we will discuss unique challenges to compiling and integrating diverse survey efforts.

**OLSON, DEANNA H. (Dede)**. US Forest Service, Pacific Northwest Research Station, Corvallis, OR, dedeolson@fs.fed.us.

**Strategic Learning: The Science of Climate Change Adaptation Management for Herpetofauna**

A renewed focus on the priorities for amphibian research and conservation is emerging regionally, nationally, and internationally. Similar themes are being raised across taxonomic groups as part of the global biodiversity crisis, yet with reptiles being recognized as somewhat neglected, but with concerns echoing those of amphibians. There is a heightened awareness of the need for improving conservation effectiveness for declining populations of all groups, with a shift to proactive management approaches. This trend is particularly apparent as climate projections and species risk are assessed, and climate change adaptation management is planned. Research findings provide a critical foundation to inform management, and the science behind climate change adaptation management is multifaceted. I will present several research vignettes

to show the role of strategic learning in bridging the science-and-management interface for herpetofaunal climate change adaptation management.

**PATTERSON, LAURA C**. California Department of Fish and Wildlife, Sacramento, CA, laura.patterson@wildlife.ca.gov.

**California Department of Fish and Wildlife Conservation and Policy Update**

Some significant changes in CDFW regulation and policy have become effective over the past year relating to how research is approved and permitted, including a new Scientific Collecting Permit system and Conservation Translocation and Captive Propagation policies. This talk will briefly discuss these new processes and how to obtain additional information. It will also provide updates on ongoing and new projects such as the Foothill Yellow-legged Frog and Cascades Frog status reviews, "annual" and 5-year status reports for California Endangered Species Act listed species, Competitive State Wildlife Grants for Western Pond Turtles and Bsal, and other conservation efforts undertaken by CDFW.

**PEEK, RYAN A.[1,2]*, MALLORY BEDWELL[3], SEAN O'ROURKE[2], GRETA M. WENGERT[4], Caren Goldberg[3], and Michael R. Miller[1,2].** [1]Center for Watershed Sciences, University of California, Davis, CA, rapeek@ucdavis.edu; [2]Department of Animal Science, University of California, Davis, CA; [3]School of the Environment, Washington State University, WA; [4]Integral Ecology Research Center, Blue Lake, CA.

**Hybridization Between Two Sympatric Ranid Frog Species in the Northern Sierra Nevada, California**

Cross-breeding between species, or hybridization, in vertebrates has generally been considered a rare occurrence. Hybridization between species may combine parental genotypes in ways that yield reproductively sterile or isolated lineages, and hybridization events may be short-lived and difficult to detect. Furthermore, hybridization between closely related taxa can promote gene flow (introgression) between species, which may be an important evolutionary mechanism for either homogenization (reversing initial divergence between species) or reproductive isolation (potentially leading to speciation). Here, we used thousands of genetic markers from nuclear DNA to detect rare hybridization between two co-occurring frog species (*Rana boylii* and *Rana sierrae*) in the Sierra Nevada of California. Hybridization events are rare but have occurred in the Feather River basin between these two species; however, it appears these are terminal events based on principal components analysis, admixture, and tests of heterozygosity using species diagnostic SNPs.

**RICHMOND, JONATHAN Q.*, ADAM R. BACKLIN, ELIZABETH A. GALLEGOS, and ROBERT N. FISHER.** U.S. Geological Survey, San Diego CA.

**The Mystery of Whitewater Canyon: A Tale of Survival for the Declining California Red-legged Frog *Rana draytonii* in Southern California**

Discovery of living populations of a species in decline can generate new optimistic narratives for conservation in geographic regions suffering from losses in biodiversity. Southern California is now infamous for its high number of threatened and endangered species, with amphibians experiencing some of the most severe declines since the 1960s. In 2017, a population of the threatened California red-legged frog *Rana draytonii* was discovered in Whitewater Canyon, a south facing drainage in the San Bernardino Mountains of Southern California, where the species was presumed to be extirpated. Several explanations for the emergence of this population were feasible: (1) it was there all along, but the presence of trout and a robust raccoon population kept the frogs below a detectability threshold; (2) trout removal and raccoon population thinning provided an opportunity for frogs to colonize the area from nearby sites; (3) clandestine herpetoculturists transplanted the frogs from an unknown location. In this talk, we present the results of a genomic study used to pinpoint the source of these frogs and discuss a potential role for this population in restoring the species at extirpated localities. This study presents an interesting dilemma for managing and conserving *Rana draytonii* in the southern portion of its range, where extirpation of local populations is widespread.

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**Time-to-detection Occupancy Modeling: An Efficient Method for Analyzing the Occurrence of Amphibians and Reptiles**

Occupancy modeling has proven effective for studying ecological drivers of amphibian distributions. Most occupancy studies require repeated site visits or surveys by multiple observers to model the detection process. The need for repeated surveys can limit the number of sites sampled, which constrains the ability to infer ecological relationships between occupancy and habitat characteristics. Time-to-detection occupancy models are a promising alternative because by recording the time at which a species is first detected, we can model the detection process with one observer conducting a single survey. We tested the effectiveness of time-to-detection models for estimating detection and occupancy probabilities, for five pond-breeding amphibians at Point Reyes National Seashore, California. We surveyed 72 ponds using dipnets and visual detection from April to August 2017. For the three most commonly detected species (*Hyliola sierra*, *Rana draytonii*, and *Taricha granulosa*), we were able to estimate effects of survey and site characteristics on detection and occupancy, respectively. Time to initial detection of *H. sierra* was affected by pond area, complexity, and emergent vegetation cover, whereas *T. granulosa* detection was affected by pond area and survey date, and *R. draytonii* detection was affected by pond depth. Occupancy of *H. sierra* and *T. granulosa* was negatively related to pond area and the presence of fish. For two rarely-detected species (*Lithobates catesbeianus* and *T. torosa*), fitting models required stronger prior information about the detection process. Time-to-

detection models can be an efficient method for studying amphibian and reptile occupancy and enable broader sampling of the landscape without additional effort.

**SHAFFER, H. BRADLEY**. Department of Ecology and Evolutionary Biology, and La Kretz Center for California Conservation Science, UCLA, Los Angeles, CA.

**Conserving California (or at Least Our Amphibians) [Banquet Presentation]**

California poses a unique conservation problem, for amphibians (and amphibian-like reptiles) as well as the rest of our biota. We have more biodiversity, more and better research universities, state and federal agencies with real experts who want to collaborate on conservation solutions, and a liberal voting public willing to fund conservation. We also are home to 1/8$^{th}$ of the US population, a massive agricultural industry, and some of the most expensive real estate in the world. Starting with Bob Stebbins, California has been a leading voice in amphibian conservation, and the APTF and other groups continue this tradition to this day. I'll review some of the work that has come out of our lab on taxa ranging from tiger salamanders to ranid frogs and those amphibian-like pond turtles, and lessons learned in terms of science, policy and their interface. Some of the most intriguing conservation solutions are the most novel, like reintroduction programs for ranid frogs in Southern California. We need more of these proactive solutions, and our community is the perfect one to test them out.

**SHAFFER, H. BRADLEY**. Department of Ecology and Evolutionary Biology, and La Kretz Center for California Conservation Science, UCLA, Los Angeles, CA.

**How Can the APTF Community Do More for California/Nevada Conservation?**

The APTF is a great venue for the exchange of data and ideas on amphibian conservation and networking, but we can (and should) do more. I would like to take this time to discuss real projects that we can work on with agency colleagues that are most important for conservation decision-makers. This is a brainstorming session, with the goal of coming up with a few projects that would be most useful to state and federal agencies that we could work on and report on as group activities. Potential ideas include: The ARSSC (Amphibian and Reptile Species of Special Concern) as a living document; monitoring taxa that may be candidates for future listing actions; quantifying effects of fire and climate change; collating and making available unpublished data on sensitive species. Please come with ideas!

**SHARP CHANEY, MATTHEW J.[1]*, and BRIAN J. HALSTEAD[2]**. [1]Midpeninsula Regional Open Space District, Los Altos, CA, mchaney@openspace.org; [2]U.S. Geological Survey, Western Ecological Research Center, Dixon, CA.

**Using Dynamic Occupancy and State Space Models to Identify Trends in a Population of California Red-Legged Frog (*Rana draytonii*)**

Conservationists working to recover California red-legged frog (CRLF, *Rana draytonii*) require methods for assessing trends in CRLF populations over time. This study uses a dynamic occupancy model to determine the number of ponds occupied by CRLF at a preserve in La

Honda California over a ten-year period. In addition, the population of breeding female CRLF in each individual pond, and a site-wide analysis combining 13 ponds, was estimated through time using a state space model. Precipitation amounts and the maximum depth of each of the thirteen ponds on site were compared with egg mass detections. Results indicated that CRLFs occupied an average of 25% more ponds per year than surveys suggested. The population trend indicates that the number of breeding female CRLFs is generally stable after recovering from a drought that occurred from 2010 to 2015. Egg mass detections had a moderate positive correlation with rainfall, and no correlation with maximum possible pond depth. The results from the dynamic occupancy model, and state space model, are valuable for assessing population trends if the number of CRLF does not approach zero in a given year. These methods can contribute to CRLF recovery by providing statistically robust estimates of population trends over time.

**SMITH, THOMAS C.[1]*, ROLAND A. KNAPP[1,2], and BRIAN HALSTEAD[3]**. [1]University of California Santa Barbara, Earth Research Institute, Santa Barbara, CA; [2]Sierra Nevada Aquatic Research Laboratory, Mammoth Lakes, CA; [3]USGS Western Ecological Research Center, Dixon, CA.

**Mountain Gartersnake Diet and Mountain Yellow-Legged Frog Restoration**

Many threatened and endangered species experience natural predation, independent from the stressors driving their declines. Such predation can also challenge efforts to recover some species. We are testing strategies to restore endangered mountain yellow-legged frogs (*Rana muscosa* and *R. sierrae*) - including translocation and reintroduction - but predation by mountain gartersnakes (*Thamnophis elegans elegans*) can cause mortality of released frogs and may slow or prevent reestablishment of populations. Our objectives in this study were to establish whether gartersnakes prefer mountain yellow-legged frogs to other prey, and to test the extent to which gartersnakes at restoration sites exploit recently released frogs versus extant prey. We observed snake predation on recently released mountain yellow-legged frogs at several restoration sites. However, across all sites, snakes almost exclusively fed on the locally most abundant amphibian species and life stage. Where mountain yellow-legged frogs dominated, snake diets contained mostly mountain yellow-legged frog larvae. Where Pacific treefrogs (*Hyliola regilla*) were most abundant, snake diets contained mostly treefrog larvae in early summer and subadults in late summer, mirroring treefrog phenology. At mountain yellow-legged frog restoration sites, snake diets did not shift after the release of adult frogs, likely because of snakes' apparent preference for the most abundant amphibian. These results can guide MYL frog restoration strategies. Releasing adult mountain yellow-legged frogs into habitats with abundant alternate prey should reduce predation pressure on recently released frogs, and enhance survival of individuals and reestablishment of populations.

**SNEE, ETHAN H. *, and JOHN O. REISS**. Humboldt State University, Arcata, CA.

**A Novel Method for In-Situ Videography of Amphibian Behavior in Aquatic Habitats**

Amphibian behavioral videography has historically been limited to in-lab studies. We report a novel method of videography for in-situ night-time use in aquatic habitats, along with preliminary behavioral findings. A video set up was constructed using an Eyoyo® Fish Finder

camera, a Coomatec® mini DVR, and a Talentcell® Rechargeable Li-ion battery. The camera itself was attached to a telescoping pole using a microphone clip. Coastal Giant Salamanders (*Dicamptodon tenebrosus;* N = 50) were videoed in lotic habitats and Northwestern Salamanders (*Ambystoma gracile*; N = 38) were videoed in lentic habitats using the same method, as part of a study examining differences in locomotor behavior. In addition to documenting normal exploratory and foraging behavior, the method has the potential to capture predator-prey interactions; for example, a predation event of *D. tenebrosus* on a small fish was observed. We believe this method will prove a valuable addition to the toolkit of amphibian field biologists.

**WESTPHAL, MICHAEL F**. US Bureau of Land Management, Marina, California.

**Creating Large Oxbow Ponds Parallel to a Coastal Stream for *Rana draytonii* Breeding Habitat: Lessons Learned**

Loss of natural habitat and its replacement with manmade stock tanks is an ubiquitous feature within the present range of the California red-legged frog, *Rana draytonii*. Cotoni-Coast Dairies National Monument, on the coast of the San Francisco Peninsula just north of the city of Santa Cruz, adds to the portfolio of Federally-managed habitat for *R. draytonii* and represents a conservation opportunity. Unfortunately, the coastal estuaries on the property have been historically degraded to create passage for a railroad and Highway One, thus the sole breeding habitat for *R. draytonii* is in artificial ponds, many of which are failing. We sought to create quasi-natural habitat by excavating very large shallow pools parallel to Yellowbank Creek. Approximately $75,000 was budgeted for construction, which took approximately 2 weeks to complete. Ponds immediately filled with ground water and created challenges for traditional heavy excavation equipment. However, the final ponds successfully created shallow breeding habitat for *R. draytoni*.

**YARNELL, SARAH M.[1]*, RYAN A. PEEK[2], NEIL KEUNG[2], BRIAN TODD[3], SHARON LAWLER[4], and CATHY BROWN[5]**. [1]Center for Watershed Sciences, University of California, Davis, CA, smyarnell@ucdavis.edu; [2]Center for Watershed Sciences, University of California, Davis, CA; [3]Dept of Wildlife, Fish & Conservation Biology, University of California, Davis, CA; [4]Dept of Entomology and Nematology, University of California, Davis, CA; [5]Stanislaus National Forest, US Forest Service, Albany, CA.

**Sierra Nevada Yellow-legged Frog (*Rana sierrae*) Habitat Suitability in Northern Sierra Nevada Streams**

Ecology of the Sierra Nevada Yellow-Legged Frog (SNYLF; *Rana sierrae*) is well understood in high elevation lakes, but data on habitat preferences in stream-dwelling populations is lacking. We sought to expand understanding of SNYLF stream habitat use by developing habitat suitability models at the microhabitat and reach scales. We collected habitat availability and use data across the 2016-2017 seasons at four stream sites in the northern Sierras, representing the geomorphic diversity typical to the species' northern range. At each frog use and availability location, data was collected on geomorphic unit type (e.g., riffles, pools), water depth, water velocity, substrate (e.g., gravel, cobble) and percent cover, including herbaceous, canopy and total cover. Using logistic regression modeling, we found water depth and velocity were the

strongest predictors of adult SNYLF use, while substrate and total cover provided moderate improvement in habitat use predictions. Specifically, adults had the highest probability of use in microhabitats with <0.3 m depth and <0.1 m/s velocity. For tadpoles, we found velocity was the strongest microhabitat predictor, with the highest probability of use in habitats with < 0.01 m/s. At the reach-scale, we found hydraulic conditions varied widely in geomorphic units over time and units providing suitable microhabitat conditions over the course of the season were preferentially used by both adults and tadpoles. These data indicate that SNYLF, like other Ranid species, may be limited by hydraulically suitable habitat availability, but habitat preferences can be met in a variety of aquatic environments when variations in temporal and spatial scales are considered.

## POSTER PRESENTATIONS

**ANDERSON, RACHEL B**. Hartnell College, Salinas, CA, rachel.betts.anderson@gmail.com.

**Monitoring Amphibian Communities on a Passively Restored Golf Course**

Expansion of urban and agricultural development destroys wetlands, but on the Monterey Peninsula, a valuable opportunity exists to monitor and document the opposite process. The former Rancho Canada Golf Course on the Carmel River is now parkland for permanent wildlife preservation and habitat restoration. This human-modified habitat will be converted to parkland and almost all of the water formerly used to irrigate the golf courses will be dedicated to restoring the lower Carmel River and its threatened run of native steelhead trout (*Oncorhynchus mykiss*), benefiting the floodplain and riparian habitat. The rehabilitation of natural water regimes and passive restoration (allowing succession to proceed) of the golf course landscape provides an opportunity to measure the effects of these tactics on the amphibian and reptile community. The Carmel River is heavily invaded by the American Bullfrog (*Lithobates catesbeianus*), and it is likely to have used the 6 golf course ponds as breeding habitat. Restoration of this valuable riparian habitat provides a natural experiment to determine how the herpetofaunal community, including T/E species will respond. This study will also determine changes in abundance over time of more common species.

**BACKLIN, ADAM R.*, E.A. GALLEGOS, K.L. BAUMBERGER, and R.N. FISHER.** U.S. Geological Survey, Western Ecological Research Center, Santa Diego, CA, abacklin@usgs.gov.

**The Southern Mountain Yellow-legged Frog: New Challenges and New Insights after Nearly Two Decades of Research**

The southern mountain yellow-legged frog (*Rana muscosa*) is a critically endangered species and is continuing to decline. Southern California, where this frog calls home, is in its eighth year of drought which is reducing surface waters in creeks throughout its range. Through 19 years of data collection we can identify threats exacerbated by this drought to help focus recovery actions. One threat that appears to be affected is amphibian chytrid fungus. We present our observations that detection frequency and infection intensity in frogs are increasing. We also present movement data collected through mark recapture studies; these studies have helped us understand an aspect of this species' natural history which more traditional techniques such as telemetry had not elucidated. With continued research on this species, we aim to further inform the threats faced by the mountain yellow-legged frog to guide future recovery.

**DEVENPORT, WILLIAM D.*, MATT R. KLUBER, and MATTHEW R. HOUSE**. Green Diamond Resource Company, Korbel, CA, william.devenport@greediamond.com.

**Western Pond Turtle Monitoring: 23 Years on the Mad River**

In 1996 Green Diamond Resource Company began monitoring a Western Pond Turtle (*Emys* (*Actinemys*) *marmorata*) subpopulation on a 5.2 km (3.2 mi) reach of the Mad River, Humboldt

County, California. This project has continued to build upon a long-term data set monitoring: growth, sex ratios, movement, recruitment, and population size. In the 23 year mark-recapture study there have been 719 total captures, consisting of 348 individual turtles, of which 345 were marked. The average annual number of captures is 31 individuals, with an average annual recapture rate of 43%. The overall average maximum carapace length observed for adult turtles (males: 163 mm; females: 159 mm) is similar to the findings of Ashton et al. (2011) on the South Fork Trinity River. On an annual basis, there often appears to be an inverse ratio of females to males in the proportion of captures; however, when assessed across all years the average proportion of female to male has been 40.6% to 47.1%, respectively, with 12.2% unknown sex. Preliminary assessment of movement shows high site fidelity, with some outliers moving throughout the survey reach. To date, this is the longest continuous data set for Western Pond Turtles on the Mad River, and one of only a few studies of the species on this particular system.

**EDWARDS, JONATHAN P.*, and DEREK J. GIRMAN**. Department of Biology, Sonoma State University, Rohnert Park, CA, cyclokinesis@gmail.com.

**Climate, Topography, and Hydropattern: An Interaction of Abiotic Factors Affecting Larval Abundance and Phenology of the California Tiger Salamander, *Ambystoma californiense*, in Sonoma County, CA**

Persistence of the endangered Sonoma County population of the California tiger salamander (CTS) is dependent on mitigating vernal pool breeding habitat loss through pool construction. Pool construction over prior decades has been largely successful, with annual rates of larval CTS presence comparable to those observed at natural pools. However, the frequency of annual larval presence shows extreme variation in consistency across pools regardless of pool provenance. We examined aspects of pool basin morphologies across both constructed and natural pools on the Santa Rosa Plain to determine if pool basin morphology affected the frequency of larval CTS presence over a 7-year period. Utilizing simple field measurements, we found annual larval presence at individual pools to be affected by the coaction of morphological components of pool basins. Modeling these non-linear interactive effects using boosted regression tree computer learning presents the potential for computer models with high predictive performance, which can potentially be used to optimize past and future vernal pool construction designs for more consistent annual larval CTS presence.

**GALLEGOS, ELIZABETH A.*, KATHY L. BAUMBERGER, CHERYL S. BREHME, JEFF R. TRACEY, and ROBERT N. FISHER**. U.S. Geological Survey, Western Ecological Research Center, San Diego, CA, egallegos@usgs.gov.

**Arroyo Toad Upland Habitat Use on Marine Corps Base, Camp Pendleton, 2011-2017**

Little is known about the use of upland habitat by arroyo toads (*Anaxyrus californicus*), yet it is considered a key component of the arroyo toad's life history. To examine upland habitat use by arroyo toads, we conducted a radio-tracking study from 2011-2017 on Marine Corps Base, Camp Pendleton. We looked at the proportion of arroyo toads at each study site and their use of floodplain zones (10, 25, 50, 100, and ≥100-year) based on sex, breeding season, and drought. For microhabitat selection, we compared microhabitat use at observed toad locations to available

habitat conditions at randomly selected locations at each study site using mixed-effect logistic regression models. We compared alternative regression models that used different combinations of covariates (precipitation, distances to stream (Euclidian vs. vertical movement cost), upland use, substrates, and vegetation cover) to determine which covariates are more predictive of habitat use. We found that 30.3% of arroyo toads used upland habitats (outside of 100-year floodplain) for foraging or burrowing one or more times during the radio-tracking. The top resource selection model showed that arroyo toad locations were best predicted by the cost of moving away from the stream (accounting for both horizontal and vertical energetic costs), monthly rainfall, the proportion of sand, and proportion of open ground and forbs. Our resource selection results also showed that arroyo toads select sandy habitats with greater vegetation cover. These attributes may help to better assess habitat suitability and probability of toad occupancy to aid in management decisions.

**GHOSE, SONIA L.[1]*, and JONATHAN A. EISEN[1,2,3]**. [1]Department of Evolution and Ecology, University of California, Davis, CA, slghose@ucdavis.edu; [2]Department of Medical Microbiology and Immunology, University of California, Davis, CA; [3]Genome Center, University of California, Davis, CA.

**Biogeography of the Skin-associated Microbiome across Body Regions of the Sierra Nevada Yellow-legged Frog (*Rana sierrae*)**

The Sierra Nevada yellow-legged frog, *Rana sierrae*, has been driven close to extinction in part by the amphibian fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*). Skin-associated microbes can inhibit *Bd* infection, and several studies have shown that overall microbial community structure may result in distinct disease outcomes for the host. In addition, *Bd* infection in frogs is primarily limited to the ventral abdomen, legs, and hind-feet. The central goal of our project was to assess whether the microbiome is heterogenous across distinct regions of the skin of an individual, and whether differences in community structure correspond to regions where *Bd* preferentially infects. We collected skin swabs from 10 body regions of *Rana sierrae* individuals (n=13) at the San Francisco Zoo. We sampled *Rana sierrae* at the Zoo because they were reared there in order to reintroduce them in parts of the Sierra Nevada where they had previously gone extinct. We conducted Illumina sequencing of the bacterial 16S rRNA gene to look for differences in the taxonomic composition of microbiomes within individuals. We found that the microbiome of the hind-feet had significantly different composition than other body regions. When we compared the microbial composition of the hind-feet, abdomen, and back, we saw that the relative abundance of the family Burkholderiaceae (Phylum Proteobacteria) on the hind-feet and abdomen were significantly higher than on the back. Some members of this family are known to inhibit *Bd* through production of the anti-fungal metabolite violacein. Their enrichment on the abdomen and feet supports our hypothesis that specialization of the microbiome corresponds to regions where *Bd* infects the skin.

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**Life History Variation of the Coastal Tailed Frog (*Ascaphus truei*) Across an Elevational Gradient in the Trinity Alps Wilderness, CA**

Since the 1950s global amphibian declines have surpassed those of birds and mammals, and montane and stream dwelling amphibians are those that are most prevalent in recent declines. The causes of these declines are complex and consequently a better understanding of the life history strategies of these amphibians is vital in their conservation. The Coastal Tailed Frog (*Ascaphus truei*) is an ideal species for the study of geographic variation on life history because they range across most of the Pacific Northwest from northern California into British Columbia, and along their range they have been described to vary geographically in larval period and morphology. During a recent California Department of Fish and Wildlife restoration project in the Trinity Alps Wilderness, we started having incidental captures of Coastal Tailed Frog larvae and adults. To date, no population across the species' range has been described above 6,500 ft. These populations discovered in the Trinity Alps range from 800 ft to 7,000 ft in elevation, and those that are in the higher part of the range are likely living at their maximum elevational limits. We report an extended larval period from two years in low and mid-elevations to four years in high elevations, decreased body size, age at sexual maturity, and longevity across an elevational gradient in the Trinity Alps Wilderness of northern California. These findings indicate a need for special management of high elevations populations.

* Indicates presenter in multi-authored presentation