California/Nevada Amphibian Population Task Force
2009 Annual Meeting

PRESENTATION ABSTRACTS

Photo: *Rana boylii* by Kevin Wiseman

Bodega Marine Laboratory
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California-Nevada Amphibian Populations Task Force
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ABSTRACTS

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Comparative Microhabitat Characteristics at Oviposition Sites of the California red-legged Frog (*Rana draytonii*)

Understanding aspects of the reproductive natural history of threatened and endangered species is crucial in facilitating species recovery. Microhabitat characteristics associated with four California red-legged frog (*Rana draytonii*) breeding sites in three counties in west-central California were studied and compared. Our observations indicate that egg masses in Central California are observable from early January to mid April. We found frogs in pond, creek, and channelized stream habitats oviposited egg masses within an average of 0.5 meters (n = 270) of the shoreline edge, while frogs in the marsh habitat showed no association with the shoreline. California red-legged frogs typically attached their egg masses (n = 435) to emergent substrate (63%) comprised of various types of vegetation. Cattail (*Typha* sp.) (29%) represented the most frequently utilized substrate, with a variety of other vegetation also being used including spike rush (17%), annual grasses (10%), and woody debris (8%). Water depth surrounding egg masses was variable and ranged from 0.0 (egg resting on soil) to 0.81 meters ($\bar{x}$ = 0.26 m, n = 483). We also noted that this species of frog appears to delay egg-laying in lotic habitats. We speculate that this may represent a method of avoiding flood events. Understanding the factors related to the reproductive needs of this species can contribute to creating, managing, or preserving appropriate habitat and promoting species recovery.

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Ranid Frog Update in Southern California and Repatriation Discussion

Two species of ranid frog still occur in southern California, the California red-legged frog (*Rana draytonii*) and the mountain yellow-legged frog (*Ran muscosa*). Both species have experienced severe declines in past decades and have been reduced to small isolated populations. Populations of *R. draytonii* found in San Francisquito Creek, Los Angeles County, and *R. muscosa* in City Creek, San Bernardino County were both impacted by landscape level fires (2002 and 2003 respectively) and subsequent debris flows the destroyed the majority of the riparian habitat. In 2008, we detected recruitment for the first time since 2003 in *R. draytonii* and *R. muscosa* at these sites. Recruitment was based on observations of newly metamorphosed frogs. Restoration efforts have been underway for several years and captive breeding and translocation has been agreed upon as the primary tool to increase populations and repatriate historic sites. A captive breeding colony of *R. muscosa* was developed at the San Diego Zoo's Conservation and Research for Endangered Species by collecting tadpoles through an emergency salvage operation in 2006.

In 2009 we expect this breeding colony to lay eggs and we will be able to implement the first phase of our restoration plan. We would like to lead a discussion on our repatriation plan to get feedback before implementation.

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Prevalence of Parasites and Pathogens in Foothill Yellow-legged Frogs (*Rana boylii*) in Humboldt County, California.

Foothill yellow-legged frogs (*Rana boylii*) have declined in significant portions of their range in Oregon and California in the past few years. Reasons for declines include habitat loss, manipulation of water flow in regulated river systems, competition with introduced species, and toxic contaminants. Diseases have not been implicated but are associated with declines of other amphibian species in the region. From 2004 to 2007, ten foothill yellow-legged frog specimens were collected for helminth parasites and two significant amphibian pathogens, *Ranavirus* and *Batrachochytrium dendrobatidis*, at ten sites in Humboldt County, California. These sites were previously visited in 1964 and 1965 for a helminth species survey of foothill yellow-legged frogs. Our goals were to compare current parasite diversity and distribution with the historical records and report on the prevalence of both *Ranavirus* and *B. dendrobatidis*. In the current study for helminth parasites, 8 species occurred in foothill yellow-legged frogs with prevalence ranging from 10% to 70% infection by site. The most wide ranging parasite was *Haematoloechus varioplexis* (7 sites) followed by *Rhabdius ranae* (5 sites). *Ranavirus* was detected at 2 sites with PCR, and *B. dendrobatidis* occurred in one site of ten, detected by histological examination. Here we report significant parasitism of foothill yellow legged frogs, including pathogens that cause significant mortality and amphibian decline.

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Synopsis of 2008 California Department of Fish and Game (CDFG) Activities Related to Amphibian Conservation

Brief updates on the following activities will be provided: a statewide amphibian and reptile ”strategic plan”, the revision of Jennings and Hayes 1994 “Amphibian and Reptile Species of Special Concern in California” document, various CDFG-funded student projects at UC Davis, a multi-state State Wildlife Grant proposal to address amphibian and reptile conservation needs, status of the state listing process for California tiger salamander, and status of the CDFG/USFWS joint EIR/EIS being prepared in response to the fish stocking lawsuit.

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The USFS Sierra Nevada Amphibian Monitoring Program: What Long-term Monitoring Can Tell Us.

The USDA Forest Service Sierra Nevada Amphibian Monitoring Program is a long-term, bioregional monitoring program targeting two aquatic frog species, the mountain yellow-legged frog (*Rana sierrae, Rana muscosa*) and Yosemite toad (*Bufo canorus*), in the Sierra Nevada, CA. The monitoring assesses the status and change of populations and habitat for these two species at the scale of the species' ranges in the Sierra Nevada. The monitoring combines extensive and intensive components in one integrated design. Extensively, for each species, small watersheds (2-4 km^2) are surveyed throughout the range of each species over a 5-year cycle, with 20% revisited annually. Population trends are measured by breeding occupancy and habitat trends are measured by attributes that assess hydrologic condition, habitat matrix, cover, water temperature, disturbance, and general characterization. Intensively, more detailed abundance, life history, and habitat data are collected in two small watersheds for the Yosemite toad. In addition to meeting the program's primary objectives, insights on various aspects of the species' natural history are gained. Results will aid in management of these species contributing to more informed management decisions.

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Overview of the Lower Colorado River Multi-Species Conservation Program with Emphasis on Covered Amphibian Species

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a 50 year cooperative Federal-State-Tribal-County-Private endeavor which will manage the natural resources of the LCR watershed, provide regulatory relief for the use of water resources of the river, and create native habitat types along the LCR. The Bureau of Reclamation is the lead implementing agency. In order to restore native habitats for covered species, the LCR MSCP will create over 8,000 acres of habitat. A total of 26 covered and 5 evaluation species are included within the LCR MSCP Habitat Conservation Plan (HCP). There are three amphibian species listed within the HCP. The relict leopard frog (*Rana onca*) is listed as a covered species, and the lowland leopard frog (*Rana yavapaiensis*), and Colorado River toad (*Bufo alvarius*) are listed as evaluation species. The relict leopard frog has one conservation measure which requires the MSCP to provide funding to support existing relict leopard frog conservation programs. The lowland leopard frog and Colorado River toad each have three identical conservation measures. A research project is expected to begin in 2010 to implement the first conservation measure for the lowland leopard frog and Colorado River toad which is to conduct research to better define the distribution, habitat requirements, and factors that are limiting the distribution of each species. Once this project is complete, work will begin for the other two conservation measures which include protecting unprotected, unoccupied habitat, and determining the feasibility of establishing populations of each species in unoccupied habitat.

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Growth, Development, and Susceptibility to Parasites of Larval Foothill Yellow-legged Frogs (*Rana boylii*) in Relation to Water Temperature: Implications for Management of California's Hydroelectic Dams.

Rana boylii, the Foothill Yellow-legged Frog, has become a focal species in the re-licensing of hydroelectric projects. Dams can either raise or lower water temperatures compared to free-flowing conditions. Retention of water can result in artificially low discharge, causing unnaturally warm temperatures. Alternatively, if base flows are maintained with releases from a reservoir's hypolimnion, downstream temperatures are un-naturally cold. To understand the consequences on recruitment to frog populations, we reared tadpoles under a range of thermal regimes in flow-through enclosures at the Angelo Coast Range Reserve (Mendocino Co.). Maximum weekly average temperatures were 17.3, 18.2, 20.9, and 22.7°C in four study streams. Survival to metamorphosis was highest at intermediate temperatures and was significantly influenced by food quality. When we supplemented the ambient periphyton with macroalgae epiphytized by nitrogen-fixing diatoms, survival was 46.7% vs. 26.8% for ambient periphyton. Supplementation allowed metamorphosis at the colder temperatures, but development was slow: 111 and 118 days in the cooler streams vs. 69 days post spawning at the warmer sites. Contrary to expectation, tadpoles grew to larger size at warmer temperatures. Periods of warm temperatures were associated with outbreaks of the parasitic copepod *Lernaea cyprinacea* in *R. boylii*. Infestation varied spatially in the watershed with prevalence increasing concomitantly with temperature along a 5.2 km longitudinal transect. Copepods were absent from upstream sites and infested up to 28.6% of individuals at downstream locations. Our results suggest that thermal regime should be considered when weighing the risks and benefits of alternative flow proposals to frog populations.

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Conservation and Ecological Studies of the Endangered California Tiger Salamander in Sonoma County (update).

The California tiger salamander (*Ambystoma californiense*) has gone from local obscurity to national lime-light in recent years. This presentation will summarize past and ongoing ecological and conservation studies, including: status of CTS in Sonoma County and its historic and current range, demography and breeding phenology in an urban landscape, distribution of migrating adults related to the location of remnant grassland around an urban breeding pond, breeding ecology at 8 preserves containing 99 natural and constructed vernal pools, and the impact of roads on migrating CTS.

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Are Contaminants Contributing to the Decline of Cascades Frogs in California?

Earlier research had suggested contaminants may be contributing to the decline of Cascades frogs (*Rana cascadae*) in California. Yet no studies had examined field measurements of contaminants in Cascades frogs and frog habitat. Our study had two specific research aims. First was to determine if Cascades frogs and Pacific chorus frogs (*Pseudacris regilla*) living at the same sites accumulate contaminant residues at similar levels. Second was to use chorus frogs as a proxy for Cascades frogs to determine if contaminant residue levels in chorus frogs are significantly higher in areas where Cascades frogs have disappeared than in areas where Cascades frogs are still present.

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The Role of Pesticides in the Decline of Amphibians in the Sierra Nevada, California

Contaminants appear to be playing a significant role in the decline of amphibians in California, especially in areas downwind of the Central Valley where application rates exceed 500,000 kg (active ingredient) per year for the four most commonly used compounds. Organophosphorus pesticides are now ubiquitous in the environment and highly toxic to amphibians. We examined the toxicity of chlorpyrifos, malathion, diazinon, and their oxon breakdown products on *Rana boylii*. Median lethal concentrations of the parent forms during a 96 hr exposure were 3.00 mg/L (24 hr) for chlorpyrifos, 2.14 mg/L for malathion, and 7.49 mg/L for diazinon. Corresponding oxons were 10 or 100 times more toxic than their parental forms. We conclude that environmental concentrations of these pesticides can be harmful to *R. boylii*. We also looked at chronic toxicity of two commonly used insecticides (chlorpyrifos and endosulfan) on larval *Pseudacris regilla* and *R. boylii*. Chlorpyrifos was three times as toxic to *R. boylii*. For endosulfan, *R. boylii* were > 40 times as sensitive; all *R. boylii* exposed to concentrations > 0.8 µg/L died before they metamorphosed. Each of the most commonly used compounds can be found in air, snow, or amphibian tissue. Parent compounds of the most commonly used pesticides are present in the Sierra Nevada in sufficient concentration to cause significant amphibian mortality. Our work adds to the increasing evidence that pesticides are harmful to amphibians that live in areas up to 100 km from pesticide application.

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PG&E Relicensing Studies: An Overview of our Current Amphibian Surveys

The problem as to how to generate hydroelectric power, and balance that generation with the health of biotic communities within, is a confounding one. Pacific Gas and Electric Company (PG&E) operates approximately 174 dams on 25 streams and rivers throughout our service territory in California. While PG&E was established in 1905, several facilities were already in existence at that time and have been in operation for over 100 years. While amphibian populations have declined for many reasons, one issue that is receiving more attention now than ever is the manipulation of natural flow regimes of rivers. I

summarize three recent Federal Energy Regulatory Commission (FERC) re-licensing studies for our hydroelectric projects; DeSabla-Centerville, McCloud-Pit, and Drum-Spaulding Projects. Initial relicensing studies are developed in collaboration with agency and stakeholder groups and performed during the three-year license application process. Methods generally consist of three or four visual encounter surveys, at individual sites or stretches of river, for all lifestages of target species. Results are used to determine management and mitigation processes for each specific project. In all cases thus far, continued population monitoring has been written into the final license and the original study data is used as a baseline for future comparisons and new flow regimes. Particular attention is paid to the foothill yellow-legged frog, a USDA Forest Service Sensitive species, but also includes surveys for California red-legged frog, Sierra mountain yellow-legged frog, Shasta salamanders, Yosemite toads, and western pond turtles.

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Population Estimates, Listing Petitions and Land Sales: True Tales of the Amargosa Toad

Estimates of the population size of the Amargosa toad, *Bufo nelsoni*, in Oasis Valley decreased in 2007 and 2008. The reason or reasons for the decline are not obvious. While some habitat has degraded or been lost, other habitat has been created or improved. Cold weather during the short amount of allotted survey time has also likely contributed to the decrease; but does anything need to be done to increase the estimates? A new petition to list the toad under the Endangered Species Act was received by the US Fish and Wildlife Service in February 2008. They have not published a finding to date. One of the issues that prompted the petition was a proposed BLM land sale in and around the town of Beatty which would have included substantial areas of occupied and potential toad habitat. This land sale has been postponed until the town can complete a master land use plan. In the mean time, the entities that make up the Amargosa Toad Working Group continue to work together to restore habitat, remove threats and monitor the population.

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Differential Impact of Chytridiomycosis on Amphibians Across an Elevation Gradient

Chytridiomycosis is an emerging disease caused by the amphibian chytrid fungus (*Batrachochytrium dendrobatidis* – "Bd"), and is increasingly implicated as an important cause of global amphibian declines. Temperature is known to influence the effect of Bd on amphibians, with amphibians in cooler climates being the most seriously affected. In Yosemite National Park chytridiomycosis is widespread in populations of the declining Sierra Nevada yellow-legged frog (*Rana sierrae*) but its impact is highly variable. Some *R. sierrae* populations persist with chytridiomycosis while others are driven to extinction. The objective of this study was to determine whether these contrasting disease outcomes are a consequence of different temperature regimes, and was accomplished by analyzing patterns of Bd infection intensity, frog population size, and frog population persistence across a broad elevation (i.e., temperature) gradient. Bd infection intensity was negatively correlated with elevation, and frog population size and the probability of frog population persistence were both positively correlated with elevation. I hypothesize that colder water temperatures at high elevations reduce Bd growth rate, leading to lower Bd infection intensity, higher frog survivorship, larger frog populations, and a higher probability of population persistence at high elevations relative to low elevations. Preliminary results from a frog

translocation experiment conducted across a broad elevational gradient are generally consistent with this hypothesis. These results have important implications for the design of future frog conservation efforts.

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Assessing Effects of Altered Hydrologic Regimes on *Rana boylii* Using a Population Projection Model

The decline of the riverine-associated foothill yellow-legged frog (*Rana boylii*) has been attributed to the altered flow regimes and habitat fragmentation associated with water storage and hydropower dams. Recent research has provided insights into the mechanisms for these declines by confirming that early life history stages (especially embryos and tadpoles) are negatively affected by aseasonal pulses in water flows and changes in local water velocities and depths in oviposition and rearing habitats. To understand how these effects on early life stages influence overall population viability, we developed a matrix population model for *R. boylii*. We collected new field data and analyzed data from other researchers on fecundity and life-stage specific survival rates to develop a reference life table and matrix population model. We then evaluated 20 scenarios based on expected effects of altered hydrologic regimes on different life stages. We also evaluated changes in population viability relative to the modeled starting population size and quasi-extinction thresholds. The likelihood of extinction (projected for 30 years into the future) increased substantially with small starting population sizes and for scenarios that simulated stranding and/or scouring of egg masses or tadpoles. Sensitivity analyses demonstrated that adult and tadpole survival and embryo scour rates were the key factors in determining overall population growth rate (lambda). When parameterized with stream-specific survival rates, this model can be an important tool for evaluating proposed changes to flow regimes during hydropower project relicensing and other water management planning.

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Habitat Characteristics of the Shasta Salamander and Recent Findings from PG&E Re-licensing Studies

The Shasta salamander (*Hydromantes shastae*) is a state-listed threatened species endemic to a small region of the southeastern Klamath Mountains generally located north and northeast of Redding, Shasta County, California. This species has long been known to occur in habitats associated with limestone formations and was later found to occur in various non-limestone habitats. Following discovery of the species in non-limestone habitats, two large survey efforts were conducted to determine the extent of non-limestone habitat occurrences and further define the species' geographic range. Work since those efforts includes additional surveys in non-limestone habitat, detailed plot-based descriptions at non-limestone habitat Shasta salamander discovery sites, and surveys to determine the species' elevational range. PG&E included surveys for this species in a suite of technical studies performed to support re-licensing for the

McCloud-Pit Hydroelectric Project in eastern Shasta County. The results from this study provide additional insight into the species ecology and geographic range. The current known habitat characteristics, geographic range, and elevation range for the Shasta salamander are summarized and discussed.

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Movement Patterns and a Proposed Core Habitat Protection Zone for the Yosemite Toad (*Bufo canorus*)

To determine the movement patterns and habitats utilized by *Bufo canorus*, this study used radio transmitters and cocoon bobbins to track the movements of 21 adult *B. canorus* and also used the opportunistic collection of an additional 172 toads of all terrestrial life stages. Adult *B. canorus* were found to disperse a distance of up to 657m ($\bar{X}$ = 278m) from breeding pools to upland foraging habitats that were well away from the meadow habitats these animals were thought to prefer. This study provides a mean total home range estimate for adult *B. canorus* of 8,457m^2 and a mean foraging (post migration) range of 4,003 m^2, which is considerably larger than the previously suggested home range of perhaps tens of square meters. Further, this study found that *B. canorus* conducts much of its movements at night and is therefore not strictly diurnal as previously reported. The habitat utilized by *B. canorus* was found to include meadows, which were used predominantly by subadult toads and matched the reported preferred habitat of lush meadows with willows and a mean vegetation height of 25cm; upland foraging habitat, which is predominantly occupied by adults and is characterized by rocky substrate and lush vegetation dominated by lupines occurring on mountain slopes with a mean vegetation height of 11cm; and overwintering habitat, which is characterized by a gravel and duff substrate that occurs on the margins of old forest with a mean vegetation height of 3cm. This study suggests the need for a *B. canorus* core habitat protection zone that extends a minimum of 500m from the center of all actively used breeding pools.

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Monitoring Columbia Spotted Frog in Northeastern Nevada

Three Districts of Humboldt-Toiyabe National Forest in northeast Nevada support Columbia spotted frog (Great Basin Population), a Candidate species. Long-term monitoring sites utilizing PIT tags, one per District, were established in 2004 and 2005 to better understand local characteristics of this frog. Presented here are emergent patterns of population fluctuation for adults and juveniles. While many amphibian species, including spotted frog, are known to exhibit variations in annual population numbers, herein are suggested several factors which may be contributing to local observations - weather events (cold, drought) and watershed connectivity. Management implications are also presented.

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Translocation of California red-legged frogs (*Rana draytonii*)

We translocated California red-legged frogs (*Rana draytonii*) during two separate East Bay Municipal Utility District dam improvement projects between February and September, 2008. The translocation was approved by the U.S. Fish and Wildlife Service under the Biological Opinions for the San Pablo Dam seismic retrofit project and the Upper San Leandro Dam spillway restoration project. In both cases CRLFs were relocated from the permanent wetlands located directly below the dam spillway structure. Nine frogs, five female and four males, were translocated 3.5 kilometers from the USL spillway to a stock pond with an existing CRLF population. Twelve frogs, six males, two females and four juveniles, were translocated from the San Pablo project area to one of three watershed stock ponds 2.6-5 kilometers from the spillway. All frogs were uniquely marked using PIT tags and fifteen adult individuals were fitted with radio transmitters. Weekly locations of individuals with radio transmitters were recorded using GPS and some individuals were recaptured and identified. Of the 21 CRLF translocated, four shed their transmitters and were never recaptured. Five transmitters were recovered at some distance from the transrelocation ponds; however, two were likely predated from the relocation pond. Twelve frogs remained at the ponds for an average of 56 days.

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Pathogenicity of *Batrachochytrium dendrobatidis* In Two Threatened California Amphibians: *Rana draytonii* and *Ambystoma californiense*

Infection by the amphibian chytrid fungus, *Batrachochytrium dendrobatidis*, can be lethal but the effects of infection are species-specific. California, with the highest level of amphibian endemism in the US, also harbors the greatest number of at-risk species, but few taxa occurring there have been tested for the effects of *B. dendrobatidis* infection. For this reason, I examined the consequences of infection in two threatened California species: *Rana draytonii* and *Ambystoma californiense*. Consistent with previous reports, both species were found to be susceptible to infection, but no animals died and all infected animals survived the 18-month study. Comparisons of skin slough rates for *A. californiense* revealed that infected salamanders sloughed at three times the rate of uninfected salamanders, a pattern that may have long-term energetic costs. My results indicate that long-term studies are needed to understand the population-level consequences of sublethal infection by *B. dendrobatidis*.

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***Batrachochytrium dendrobatidis*, A Novel Pathogen Approaching Endemism in Central California?**

The recent emergence of amphibian chytridiomycosis has precipitated competing hypotheses regarding the endemic versus novel nature of the causative agent, *Batrachochytrium dendrobatidis* (BD). We conducted a retrospective survey of the California Academy of Sciences' [(CAS) San Francisco, California, USA] amphibian collection, testing for presence of BD in four amphibian species collected from central California between 1897 and 2005. The earliest detection of BD was found in two *Rana catesbeiana* in 1961 and the data support the hypothesis that BD was a novel pathogen introduced into

central California prior to 1961 that spread out geographically and taxonomically from at least one central location and is now endemic throughout most of central California. The taxonomic pattern of infection prevalence, and the ecological constraints of the four species we tested, suggests that although BD was initially detected in *R. catesbeiana*, the more efficient and most likely local vector for BD in Central California is actually *P. regilla*.

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Geographic and Historical Distribution of Ranaviruses and the Potential for Spread into Uninfected Areas

Pathogens are associated with annual population die-offs, longer term population declines, and extinctions of amphibian species around the world. Ranaviruses infect amphibians, reptiles, and fish, and occur in wild and commercial amphibian populations. In the United States, ranaviruses are mainly associated with annual tiger salamander (*Ambystoma tigrinum*) die-offs. Tiger salamanders in the western United States are often used as bait for recreational and sport freshwater fishing. Ranaviruses occur in the tiger salamander bait trade in the western United States, and in wild populations in a number of states in the western United States and in several provinces in Canada, but are not reported in tiger salamanders in California. Management and policy recommendations regarding this pathogen would differ depending on whether or not wild populations of tiger salamanders in California harbor ranavirus infections. We surveyed tiger salamanders from ten states associated with the tiger salamander bait trade and from wild populations in California to determine whether ranaviruses occurred in these states from 1978 through 1994. In addition, we sampled populations of hybrid tiger salamanders in California from 2000-2001. Ranaviruses were present in wild and commercial populations from three of the ten bait-trading states and as far back as 1984, but were not detected in California populations of tiger salamanders. These historical samples of ranaviruses suggest that this pathogen may be endemic to large areas of the Midwest and Intermountain areas of the United States, but that ranaviruses appear absent in tiger salamanders in California.

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Incidence of a Fungal Pathogen in *Rana cascadae* and Other Amphibian Species in the Mountains of Northern California

The fungus *Batrachochytrium dendrobatidis* (*Bd*), has been implicated in die-offs and extinctions of amphibians worldwide, including in California's Sierra Nevada. In 2006 we discovered *Bd* in the Trinity Alps of California, on several swabs taken from Cascades frogs (*Rana cascadae*). In the summer of 2008 we performed a 140-lake survey of amphibians across the Klamath Ranges and in the Lassen area at sites that were inhabited by *R. cascadae* 6 – 9 years ago. We performed visual encounter surveys and swabbed individuals of 7 amphibian species for *Bd*. Preliminary results of the visual encounter surveys suggest declines in the occurrence of *R. cascadae* and *Ambystoma macrodactylum*, but not *Taricha granulosa* or

Bufo boreas, over the past 6 – 9 years. Swabs were analyzed for the presence of *Bd* using quantitative PCR. We collected over 2000 swabs, 644 of which have been analyzed to date. Approximately 12% of these swabs tested positive for the pathogen. We examine the relative frequency of *Bd*-positive samples across species and their distribution across the range of *R. cascadae* in California. The implications for populations of *R. cascadae* and other native amphibians will be discussed.

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PARC (Partners in Amphibian and Reptile Conservation), Emphasis on Southwest PARC Region

Partners in Amphibian and Reptile Conservation (PARC) is a United States (US)-based partnership dedicated to the conservation of reptiles and amphibians and their habitats. Membership includes individuals from state and federal agencies, conservation organizations, museums, pet trade industry and hobbyists, nature centers, zoos, energy industry, universities, herpetological organizations, research laboratories, forest industries, and environmental consultants. PARC is divided into six geographical regions across the US. Southwest PARC is an all-volunteer working group organized for the purpose of implementing the PARC mission within the southwestern US, including Texas, Oklahoma, New Mexico, Colorado, Utah, Arizona, Nevada, California, and Hawaii. We are also working with scientists in Mexico and in other regions of PARC to promote cross-border herpetological conservation awareness. The southwest United States is home to the world's largest rattlesnake diversity and contains some of North America's most threatened and rare frog species. The Southwest faces a number of conservation challenges, including ongoing drought and water resource consumption, habitat destruction, and the introduction of crayfish, bullfrogs, and non-native fish into amphibian and reptile habitat. Southwest PARC is meeting these challenges through annual meetings and working groups focused on Habitat Management guidelines, international issues, venomous reptile awareness educational materials, herpetofauna collecting regulations, species of conservation priority, outreach to herpetological enthusiasts, and inventory and monitoring training and development. Of particular note, a southwest herpetological conservation training module is currently being developed and will occur in conjunction with the Southwest PARC annual meeting in St. George, Utah, in June 2009.

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Spatial Distribution, Habitat Preference, and Detection of the Northern Red-legged Frog in Ephemeral Wetlands: A Baseline for Future Monitoring?

Rana aurora (Northern red-legged frog) is listed as a Sensitive Species by the USFS and a Species of Special Concern by the state of California. Monitoring of the northern red-legged frog is important to be able to accurately assess changes in the population. The species distribution is fragmented and much of its habitat has been reduced in California. Proactive management can help to conserve this species before they become rare or threatened and cost more to protect. I conducted research on this species in an ephemeral environment to determine breeding and foraging habitat preferences. I used site occupancy models to model breeding distribution and detection. The egg mass occupancy models showed that gravid females preferred oviposition sites with deeper water and less than 50% emergent vegetation. Egg mass detection probabilities were affected by fluctuating water levels throughout the survey period.

Adult and juveniles in the post-breeding season selected sites with longer hydroperiods that were farther from sites which had contained egg masses. This is the first study to research R. aurora egg mass site occupancy incorporating detection probability. The top models can be used as a foundation to predict egg mass occurrence in palustrine wetlands and as a baseline for development of a larger monitoring program to research spatial dynamics and population fluctuations of the species.

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The California Amphibian and Reptile Species of Special Concern Update: Progress, Future Work, and Involvement by the CA/NV Community.

The first edition of Amphibian and Reptile Species of Special Concern (ARSSC) in California was authored by Mark Jennings and Marc Hayes and released in 1994. This California Department of Fish and Game (CDFG) document plays an important role in management and conservation planning for California's native reptiles and amphibians. In the 15 years since this document's publication, our understanding of the conservation status, management needs, and systematics of California's native reptiles and amphibians has changed dramatically. A revision that updates this document with current knowledge is essential, because SSCs are central to California's Wildlife Action Plan, and the SSC designation is used with laws, regulations, state policies, and various state and national conservation initiatives to help conserve species at risk. In collaboration with the CDFG, we are producing an update of this important document. Our first goal was to produce a current list of amphibian and reptile "taxa" in California (~230 taxa), and a set of quantitative metrics to evaluate each taxon for SSC status. Our next goal is to evaluate each taxon, produce a list of SSC taxa, and create species accounts and maps that can be vetted by the community of experts on California amphibians and reptiles. Our goal is to make the SSC process a community effort that best reflects the collective knowledge of experts on California taxa and constitutes an active, ongoing effort to protect species at risk in the face of challenges ranging from habitat destruction to global climate change.

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Rapid Spread of *Batrachochytrium dendrobatidis* Causes Chytridiomycosis Outbreaks and Extinctions in Yellow-legged Frogs of the Sierra Nevada.

Chytridiomycosis, an emerging infectious disease caused by the fungal pathogen *Batrachochytrium dendrobatidis* (*B.d.*), is found in collapsing amphibian populations and has been implicated as a major cause of worldwide amphibian declines. The effect of this pathogen on amphibians has been called the worst case of disease-caused biodiversity loss in recorded history. However, because many amphibian species appear to not be susceptible, some question whether it is the causative factor in many declines. Our 11-year study tracks rapid spread of *B.d.* through > 500 populations of two closely related frog species (the Sierra Nevada mountain yellow-legged frog, *Rana sierrae*, and the southern mountain yellow-legged frog, *Rana muscosa*) in California, USA. Repeated surveys show a marked easterly spread of *B.d.* across the Sierran range causing a wave of chytridiomycosis outbreaks. These epidemics resulted in >100 population extinctions since 1997. To better understand the dynamics of the disease, we used

quantitative PCR to trace the spread and infection load of infected frogs through three widely separated metapopulations of frogs consisting of 73 subpopulations. The disease swept through all three areas at approximately 1 km/ year. At all three sites, frog metapopulations were relatively stable prior to *B.d.* arrival but declined precipitously following the arrival of Bd. Within weeks of first detection, infection prevalence reached 100%, and an exponential growth rate of infection on individual hosts resulted in mass mortality, rapid population crash and extinction. In individual frog populations, infection intensity predicted the onset of population collapse.

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A Review of Current Research at the Redwood Sciences Laboratory on Amphibian Population Status on Northwest California Landscapes

The herpetology research group at the Redwood Sciences Lab, in collaboration with graduate students at Humboldt State University and the University of California at Davis, has been studying the natural history, demography, and landscape ecology of amphibian assemblages in aquatic and terrestrial environments of Northern California for 23 years. A primary focus of our research has been the interactions between amphibian life histories and human land management practices and how these practices may contribute to amphibian declines. In this talk I discuss four studies that are a continuation of this trajectory. The first study examines the use of stream amphibians as biometrics of ecosystem stress. The second study explores links between disturbance regimes and herpetofaunal species assemblages. The third study details the mating strategy and breeding patterns of the foothill yellow-legged frog in a natural (undammed) stream system and the implications for altering natural flow regimes. The fourth study involves monitoring remnant populations of the Cascades frog in the Lassen Region of California, with an experiment designed to recover populations in two mountain meadow systems.

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Mitigation and Monitoring Efforts for California Red-legged Frog (*Rana draytonii*) and California Tiger Salamander (*Ambystoma californiense*): Successful Breeding in a Constructed Pond

As part of mitigation requirements for Pacific Gas and Electric Company's Tri-Valley 2002 Capacity Increase Project located in Alameda and Contra Costa Counties, California, a 0.12 hectare pond was constructed adjacent to an unnamed tributary to Tassajara Creek in 2005. Surveys conducted in 2006 documented *R. draytonii* adults inhabiting the newly constructed pond following inundation. Despite favorable habitat conditions in 2006 and 2007, no evidence of breeding was observed for both *R. draytonii* and *A. californiense*. In 2008, both species successfully bred in the pond. We observed ten *R. draytonii* egg masses and four *A. californiense* larvae. This three-year lag time between pond creation and successful breeding by *R. draytonii* is consistent with results from other studies conducted in the San Francisco Bay Area. In 2008, we initiated a mark-recapture study of *R. draytonii* using PIT tags. Data from this study will be used to provide additional information about *R. draytonii* life history characteristics, including individual use of the mitigation pond and seasonal movement patterns.

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Estimating the Distribution of Genetic Variation within the Narrow-headed Gartersnake (*Thamnophis rufipunctatus*) and it's Utility in Informing Conservation Management Practices.

We analyzed the phylogeography and population genetic variation of the Narrow-headed Gartersnake complex (*Thamnophis rufipunctatus*) using rapidly evolving mitochondrial and nuclear DNA sequence data. This highly aquatic species is distributed along the headwaters of the Gila River system in Arizona and New Mexico, and sporadically throughout much of the Sierra Madre Occidental in Mexico. Due to the threatened status of *T. rufipunctatus* in the U.S., forthcoming petitions for listing under the ESA, and questions regarding relationships among populations in the U.S. and Mexico, understanding how these amphibious snakes use their rare and often patchy aquatic habitat is a key component of their future management. Phylogenetic analyses based on mtDNA recovered three well-supported and geographically cohesive haplogroups. One group consisted of populations from Arizona and New Mexico, and two were recovered within different regions of the Sierra Madre Occidental. Nuclear DNA sequences from two unlinked introns displayed low levels of variation but were largely congruent with the clades recovered from mtDNA. An analysis of molecular variance based on major drainage systems revealed significant variation among drainages, suggesting that dispersal outside of natal drainages is limited. In particular, the Salt and Gila River drainages contain a unique proportion of the total genetic variation found in the species. Since these two drainages contain populations that are known to be in decline and are threatened by habitat disturbance, we discuss important management practices that would help to mitigate critical losses of genetic diversity.

*Indicates speaker in multi-authored presentation.