California Native Grasslands Association

GRASSLANDS

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California Native Grasslands Association

Mission Statement

The mission of the California Native Grasslands Association is to promote, preserve, and restore the diversity of California's native grasses and grassland ecosystems through education, advocacy, research, and stewardship.

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From the President's Keyboard

Happy 25th Anniversary!

by J.P. Marié

As the new President of CNGA, I am happy to report that 2015 was a very exciting and important year for our organization. We offered our regular events, including native grass identification classes, the annual Field Day at Hedgerow Farms, and various hands-on restoration workshops. We added a pesticide safety workshop in collaboration with the Yolo County Department of Agriculture to cover best management practices for pesticide use in riparian and grasslands settings.

After a successful pilot project in 2014, we also started a new workshop series in collaboration with the Department of Water Resources called "California's New Front Yard" to help home-owners and agencies deal with the ongoing drought. These workshops provide guidance and suggestions for identifying and converting water-hungry lawns and landscapes to native plant landscapes to reduce water use, provide habitat for native species, and enhance landscape aesthetics. CNGA was also active in advocating for the preservation of several remnants of native grasslands around the San Francisco Bay area, while our science committee was hard at work compiling research papers and other publications relating to native grasslands and grassland species.

2016 is going to be even more exciting! Rain is finally back, but the drought is still an issue and we are pleased to be offering "California's New Front Yard" workshops in February (Santa Cruz) and March (Merced). The workshop committee is gearing up to offer our regular palette of workshops as well. With a wet winter, the annual Field Day at Hedgerow Farms should be spectacular! We are also happy to welcome Robert Evans, Billy Krimmel, Jeff Wilcox, and Michele Hammond as new Board members, and we thank outgoing Board members Meghan Skaer Thomason, Ingrid Morken, Andrew Fulks, Chad Aakre, and Jon O'Brien for their sincere commitment and dedication to CNGA.

CNGA is also marking several important milestones in 2016. First, we are in the process of hiring an interim Executive Director to lead the growth and expansion of the organization to better fulfil our mission. Please support us in this exciting journey through donations, membership renewals, and attendance at our workshops and other events. The second milestone is that this year marks our 25th anniversary! We are grateful for your continuous support and are looking forward to your extended participation and support this year, whether for education, outreach or advocacy.

Happy new year to you, and happy 25th anniversary to the California Native Grasslands Association!

Upcoming Spring Workshops

California's New Front Yard: Creating a Low-Water Landscape

Coming to Santa Cruz on February 11 and to Merced on March 10 — *See our full-page ad on page 6.*

Save the Date! 9th Annual CNGA Hedgerow Farms Field Day

April 22 in Winters — *More information coming soon! Check our website for information.*

Identifying and Appreciating Native and Naturalized Grasses

TWO workshops offered this May at different locations in Marin County — one with CNGA Vice President Andrea Williams, and the other with CNGA Board Member Michelle Cooper. *Exact dates TBD.*

Pesticide Safety Training

Early Winter in Yolo County. *Exact date TBD.*

CNGA will notify members of final details by Grass-blast emails and our Facebook page. You can also keep an eye on our website for more information: **www.cnga.org**

Grasslands Submission Guidelines

Send written submissions, as email attachments, to grasslands@cnga.org. All submissions are reviewed by the *Grasslands* Editorial Committee for suitability for publication. Contact the Editorial Committee Chair, Andrew Rayburn, for formatting specifications: grasslands@cnga.org.

Written submissions include peer-reviewed research reports and non-refereed articles, such as progress reports, observations, field notes, interviews, book reviews, and opinions.

Also considered for publication are high-resolution color photographs. For each issue, the Editorial Committee votes on photos that will be featured on our full-color covers. Send photo submissions (at least 300 dpi resolution), as email attachments, to Andrew Rayburn at grasslands@cnga.org. Include a caption and credited photographer's name.

Submission deadlines for articles:

Spring 2016 — Feb 15, 2016 ❊ **Summer 2016** — May 15, 2016 ❊ **Fall 2016** — Aug 15, 2016 ❊ **Winter 2017** — Nov 15, 2016

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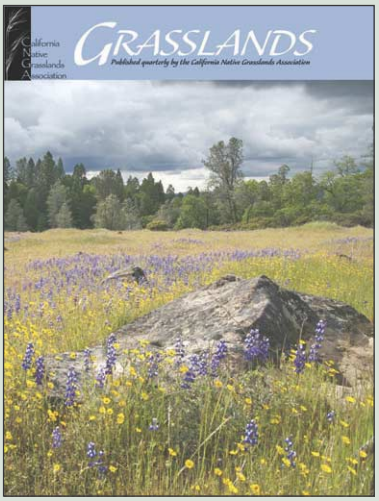

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GETTING TO KNOW GRASSLAND RESEARCHERS:

Kristina Wolf *by Andrew Rayburn,* Grasslands *Editor*

What is your study system? What are your primary research goals?

I focus almost entirely on rangeland ecosystems, and particularly California grasslands, in a variety of management contexts. I frequently study methods and mechanisms behind grassland restoration success (or failure) and restoration management, but more often delve into the dynamics of working rangelands on which livestock graze. California rangelands provide us with invaluable ecosystem services, including water and carbon storage, wildlife habitat, and forage for wild herbivores, not to mention their aesthetic and recreational value. Because we derive so many different services from rangelands, we have to manage them for potentially conflicting uses. My interests primarily lie in understanding how to best balance those multiple uses for the best mix of sustainable resource management to enhance floral and faunal diversity, natural resources (e.g., soil, water, wildlife habitat), and conservation of economic, cultural, and social resources on working rangelands.

Who is your audience?

I try to straddle research and applied fields, so I target not only the scientific community and other researchers, but I also want that research to be useful to practitioners who are out on the land making a difference every day. To that end, I work with scientists, small land holders, ranchers, cooperative extension personnel, and agencies managing land across California, including state and federal agencies, land trusts, rangeland coalitions, and NGOs.

Who has inspired you, including your mentors?

This is a very difficult question to answer, because I don't know where to start, or even where to end! Initially, as an undergraduate student in Animal Science at Cal Poly in San Luis Obispo, Robert Rutherford (Animal Science Emeritus) was the first person to open my eyes to the concept of whole systems, regenerative land management, and planned livestock grazing for conservation and sustainable ranching. I wanted to be a veterinarian my entire life, but all it took was one class with him to alter that course entirely (I don't regret it for a minute, either). Marc Horney (Cal Poly, Animal Science) was also instrumental in introducing me to many rangeland management considerations. From there, I met a cascade of influential mentors: Kent Reeves, Allan Savory, Richard Teague…the list could go on and on. At U.C. Davis, Truman Young introduced me to the world of restoration ecology, and has really supported my many disparate interests such as management of range soils and plants, livestock management, human ecology and decision-making, wildlife, and native plant restoration methods. I am very lucky to be part of a laboratory where we have the freedom to investigate so many different things.

How has or will your research support the mission of CNGA "to promote, preserve, and restore the diversity of California's native grasses and grassland ecosystems through education, advocacy, research, and stewardship"?

First of all, some of my research has been monetarily supported by CNGA via a graduate student research grant, and for that I was so excited and grateful. To give back, I will continue to not only delve into the dynamics and management of these complex systems, but I will always keep reaching out to others to spread the word. I give a lot of talks and presentations not only at professional conferences, but also at park events, workshops, and other outreach events that are open to the public. I want others to know more about these amazing ecosystems and how much we depend on them for our very survival.

Why do you love grasslands?

This will probably sound a little crazy, but when I walk into a grassland site, I feel supported, excited, and free. Even if I am sleep-deprived in the field at 4 a.m. before tromping around out there for the next 16 hours while knowing that it will be 113°F by mid-day, I feel energized and happy. Something about getting to be right *in* it — to observe the plants, insects, and animals, to hear the sounds, to smell the plants and soils, and to see how very alive these systems are — is truly a privilege. I wish everyone could get out of their cars and walk into our grasslands to feel how much energy is there. I live and breathe grasslands. We all do, whether we know it or not.

Lava Cap Wildflower Fields

by Karen Callahan[1] and Jennifer Buck-Diaz[2]

Lava caps provide a special botanical heaven in the Sierra Nevada foothills, where acres of brilliant wildflowers bloom in the spring and linger into the summer. These distinctive open habitats have shallow soils underlain by an ancient solidified volcanic mudflow, or lahar. This cement-like layer, along with gentle slopes, allows rainfall to collect in depressions before slowly draining off or evaporating. Showy, mostly native, annual plants thrive here with little competition from invasive species that have a low tolerance to restricted drainage and shallow soils.

Hell's Half Acre in Nevada County is one prime example of lava cap habitat in the north-central Sierra Nevada (featured on the cover of this issue). This 70-acre area is located about 1.5 miles northwest of Grass Valley (elevation 2,600 feet) and consists of open, rocky flats dominated by grasses and wildflowers, surrounded by foothill pines (*Pinus sabiniana*) and manzanita (*Arctostaphylos viscida*) chaparral. The lava cap supports over 100 species of native plants, including at least 10 species typical of vernal pools that occur in a matrix with upland plants. In addition, rare and uncommon plants such as Sanborn's onion (*Allium sanbornii* var. *sanbornii*), Lemon's stipa (*Stipa lemmonii* var. *pubescens*), Pratten's buckwheat (*Eriogonum prattenianum* var. *prattenianum*), and Orcutt's quillwort (*Isoetes orcuttii*) are found here with important wildlife species such as Cooper's hawk (*Accipiter cooperii*) and several species of bat (*Myotis* spp).

The California Department of Fish and Wildlife (CDFW) maintains a Natural Communities List which includes both Global and State Ranks for each plant community type across the state (CDFW 2010). However, many rare natural communities, including lava caps, have not been adequately described or defined in order to achieve recognition at the state level. Vegetation sampling and classification is currently the most effective, science-based method available to document the location, variation, and rarity of plant communities in California (CDFW 2010).

In 2009, the Redbud Chapter of the California Native Plant Society (CNPS) launched a project to document their local lava cap habitats. A vegetation sampling workshop was organized to train staff and volunteers. Through this workshop and other efforts, 23 plots were surveyed across four separate lava cap formations within a ten-mile radius. The statewide CNPS Vegetation Program compiled and analyzed the data along with more than 800 other herbaceous plots from the Great Valley and Carrizo Plain (Buck-Diaz et al. 2013). The analyses revealed that

Allium amplectens and *Festuca microstchys. Photo: Karen Callahan*

lava cap wildflower fields are uniquely distinct from other types of grassland and meadow types in California (and may be a candidate for global and state recognition as a rare natural community).

Lava cap vegetation falls within a new provisional community, named as the *Festuca microstachys–Allium amplectens* Association, based on important indicator species. This newly defined type is nested under one of the most widespread native herbaceous communities in the state, the *Lasthenia californica–Plantago erecta–Festuca microstachys* Alliance. This alliance represents a triad of native species that have a broad tolerance of adaptation to California's Mediterranean climate. Virtually all high-quality examples of this community are on shallow, rocky, or otherwise nutrient-deficient substrates. Prior to the introduction of non-natives into California, this alliance was presumably much more widespread (Sawyer et al. 2009).

The two indicator species (see above photo) of the new *Festuca microstachys–Allium amplectens* Association are found across all

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[1]Nature photographer and member of the Redbud Chapter of the California Native Plant Society. [2]Vegetation Ecologist, California Native Plant Society. Jennifer Buck-Diaz is a vegetation ecologist and botanist with the CNPS Vegetation Program where she surveys, classifies, and maps vegetation across California. She has recently focused her work on the classification and description of grassland vegetation, including the study of spatial and temporal dynamics in these systems.

Lava Cap Wildflower Fields *continued*

23 of the plots (100% constancy) and they comprised an average of 25% of the relative plant cover. *Festuca microstachys* is one of eight native grasses that occur on these sites, and it is the most widespread native annual grass in California. Species richness is extremely high within lava cap habitats, with an average of 30 unique plants detected across all surveys. When compared to other annual grasslands sampled in California, these sites were among the most species-rich in the state (top 15%).

The ancient volcanic mudflows of the Sierra Nevada foothills support some of the best remaining wildflower fields in our state, making the protection of these landforms of the utmost importance. However, the future of these lava cap meadows is still uncertain. The flat, open land of these habitats is often degraded by off-highway vehicles, trash dumping, domestic animals, and recreational use. Many important sites, such as Hell's Half Acre, are privately owned, open land zoned for commercial and residential development and thus are at risk for conversion (City of Grass Valley 1999). Conservation activities by local groups include weed removal (Scotch broom) and education in the form of wildflower field trips, stories in local newspapers and on television, slideshows, and other advocacy efforts that are key to building public interest in these sites. The Redbud Chapter of CNPS and other local groups envision the preservation of these important lava cap habitats to protect their thriving biodiversity and to enable access for wildflower lovers of all ages and abilities.

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California's New Front Yard

Creating a Low-Water Landscape

Thursday, February 11 in Santa Cruz
and **Thursday, March 10 in Merced**

Transform your thirsty lawn into a beautiful, water-saving, wildlife-friendly landscape featuring drought-tolerant trees, native grasses, flowers, perennials, and shrubs. Morning talks are followed by instructor-led activities and arboretum tours. This workshop is suitable for homeowners and landscape professionals alike, so all are welcome!

$25 CNGA Members / $30 Non-members

Includes morning refreshments, lunch, and course materials.

Advance registration required. Register on-line at www.cnga.org.

Thursday, February 11 in Santa Cruz

UC Santa Cruz Arboretum, 8 a.m.–3 p.m.
in the Horticulture II Meeting Hall

Speakers include: ❊ Andrew Fulks, Assistant Director, UC Davis Arboretum ❊ Martin Quigley, Director, University of Santa Cruz Arboretum ❊ Brett Hall, California Native Plant Program Director, UCSC Arboretum ❊ Jon Laslett, Senior Project Manager & Ecologist, Ecological Concerns ❊ Dakotah Bertsch, Landscape Designer & Project Manager, Ecological Concerns

Thursday, March 10 in Merced

University of California at Merced, 8 a.m.–3 p.m.
in the California Room of the Terrace Center

Speakers include: ❊ Andrew Fulks, Assistant Director, UC Davis Arboretum ❊ Bryan Tassey, Horticulture Instructor & Ag/IT Faculty Lead, Merced College ❊ Kris Randal, Master Gardener Representative for Mariposa County ❊ Regina Hirsch, Mountain Sage Nursery, Groveland ❊ and more!

Location: *(please check one)* ❍ **Santa Cruz** February 11, 2016 | ❍ **Merced** March 10, 2016
Fee: *(please check one)* ❍ **$ 25** CNGA Member | ❍ **$ 30** Non-member

1 Register online with PayPal at **www.cnga.org**

2 Pay with check made payable to **California Native Grasslands Assoc.**

3 Pay via credit card (please check type): ❍ Visa ❍ MasterCard ❍ American Express
Card number _____ Exp. Date:_____
Name on card:_____

and mail to: **CNGA, P.O. Box 72405 Davis, CA 95617**

For more information please email CNGA at admin@cnga.org

Participant's name (print or type, please) _____
Participant's organization or agency _____
Mailing address: *Street* _____ *City* _____ *State* _____ *Zip* _____
Preferred phone _____ Preferred email _____

Restoration is Best for Wildlife, Right?

Lessons learned and applications to grassland habitat management

by Kristina Wolf[1], Roger Baldwin[2], and Ryan P. Bourbour[3]

Introduction

Intact native grasslands are some of the rarest ecosystems in the world and wildlife species associated with grasslands have declined precipitously over the last 200 years (Samson and Knopf 1994). California's grasslands are one of the most invaded ecosystems globally (Huenneke 1989), with over 98% dominated by non-native forbs and grasses (Barbour et al. 2007). Some grassland habitats have been restored with grasses and forbs thought to be native to the Central Valley, with the goal of restoring biodiversity and ecosystem services that have been lost due to exotic species invasion, overgrazing, and other factors (see Seabloom et al. 2003). Grassland restoration is thought to increase floral and faunal native species richness, wildlife diversity and abundance, forage for livestock, and aesthetic value. However, restoration projects are expensive and time-consuming, and post-restoration monitoring is heavily constrained by limited resources (Majer 2009). Wildlife monitoring can be particularly intensive, and impacts of restoration on wildlife are not commonly monitored (Bash and Ryan 2002, Golet et al. 2008). In many cases when monitoring is conducted, only one or a few taxa are included on a limited spatiotemporal basis, the results of which may not be applicable across years or locations (Magurran et al. 2010).

In California, the diverse assemblage of wildlife that reflects the state's great variety of climates and habitats is now greatly reduced in abundance and diversity (Vander Zanden et al. 2006). One of the goals of habitat restoration and management is the provision of wildlife habitat and increased biodiversity, which extends to impacts on food webs. Beschta and Ripple (2009) concluded, for example, that the removal of large predators (e.g., wolves) in the western United States resulted in drastic changes to native plant communities. When wolves were no longer present to control elk and other large herbivores, this resulted in overgrazing by wildlife and a sweeping change to plant communities. In such cases, restoration of native flora is likely necessary for the recovery of former ecosystem services. However, while the restoration of historic

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[1]PhD Candidate, Graduate Group in Ecology, University of California Davis. [2]Department of Wildlife, Fish, and Conservation Biology, Human-Wildlife Conflict Specialist, University of California Davis. [3]Department of Animal Science and Avian Sciences Graduate Group, University of California Davis

Western yellow-bellied racer (*Coluber constrictor mormon*) under coverboard in Esparto, CA. *Photo: Kristina Wolf*

Restoration is Best for Wildlife, Right? *continued*

plant community assemblages is often assumed to provide increased resource availability for other trophic levels, how well this objective is met is rarely monitored (Boyd and Svejcar 2009).

Plants sit at the base of all other trophic levels, providing necessary habitat requirements for a variety of guilds. For example, rodents rely on plants for cover and food, and rodents are an important food source for a number of higher trophic levels, including snakes, raptors, and intermediate predators (e.g., coyotes, raccoons). Thus, the resource base provided by plants can cascade up to other trophic levels beyond rodents and influence wildlife species abundance and diversity (Terborgh et al. 2010). Grassland restoration creates at least initial disturbances and alters plant communities and cover, thereby causing a ripple of effects into wildlife communities. Theoretically, wildlife will respond by utilizing these areas more or less, depending on their habitat requirements, and as such, "utilization" may act as a proxy for changes in wildlife "abundance." However, while restoration generally assumes an increase in suitable habitat, it is still not clear how many different wildlife species respond to restoration (Majer 2009), particularly in grasslands.

Methods

We conducted a natural experiment in which we monitored plant community structure (physical attributes, including height and cover), and rodent, snake, and raptor diversity and utilization in paired restored (native perennial) grasslands, and unrestored (exotic annual) grasslands at four locations over a full year to elucidate the impacts of restoration. Our experiment was multi-season, multi-species, and multi-trophic and included sites that spanned California's heavily invaded Central Valley

The four study locations were chosen for the availability of paired restored and unrestored sites with similar soil types, topography, land-use history, grazing regimes (if any), and management. Data were collected over a 30-day period in April 2014 (spring), July 2014 (summer), and October 2014 (fall), and over a two-month period from February-March 2015 (winter). At two locations, restored sites were planted in 1992, while restored sites at the other two locations were planted in 2003.

We used a combination of live trapping at night and coverboard surveys during the day to monitor rodent populations each season. Eleven live traps were laid along each of four transects at each site, baited with oats and/or peanut butter, set at dusk, and opened at dawn. Over the course of the experiment, we totaled 8,360 trap nights.

We monitored coverboards of two materials (galvanized metal roofing and untreated plywood) in mornings for snakes and rodents. Two coverboards (one of each material) were placed next to each other at 75 m intervals along a parallel transect. A total of 12 coverboard pairs were located at each site, and were surveyed 1-8 times per location, site, and season for a total of 1,608 surveys during the monitoring year.

Native deer mouse (*Peromyscus maniculatus*) under coverboard in Zamora, CA. *Photo: Kristina Wolf*

We monitored raptor diversity and foraging behavior using a sampling approach where all individual raptors within the site boundaries were observed, and distinct hunting behaviors were recorded. We conducted surveys for 1-1.5 hours per site at each of the four locations for 5-7 days in July 2014, October 2014, and July 2015, for a total of 164 survey hours. Surveys began approximately 30 minutes after sunrise and were not conducted during high wind or heavy rainfall. For each raptor, we recorded species, age, sex when possible, time spent hunting, number of attacks on prey, and the result of each attack.

We monitored vegetation at the start of each trapping season at each site in 0.5-m^2 quadrats adjacent to each live trap along each transect. We recorded all plant species present, as well as percent cover of bare ground, litter, native and exotic forbs, and both native and exotic grasses. We estimated vertical cover using a visual obstruction method from a viewpoint approximately 1-m from the soil surface.

Results

Plant Communities

Across all seasons, unrestored sites had slightly (but not significantly) more bare ground (9%) than restored sites (8%), and more litter as well (59% unrestored, 48% restored). As expected, restored sites had more native perennial grass cover (14.5%) and forb cover (3.3%) than unrestored sites (0% native grass and 1.1% native forb). Exotic grass cover was not different between the two site types (18%), but exotic forb cover was higher at unrestored sites (25%) in the growing season (winter, spring) than at restored sites (18%).

Rodents

We captured 2,732 rodents, of which 1,738 were unique individuals each season (not recaptures). The number of rodents utilizing unrestored sites was higher by about 28% than at restored sites (Fig. 1), although this difference was driven solely by differences in the

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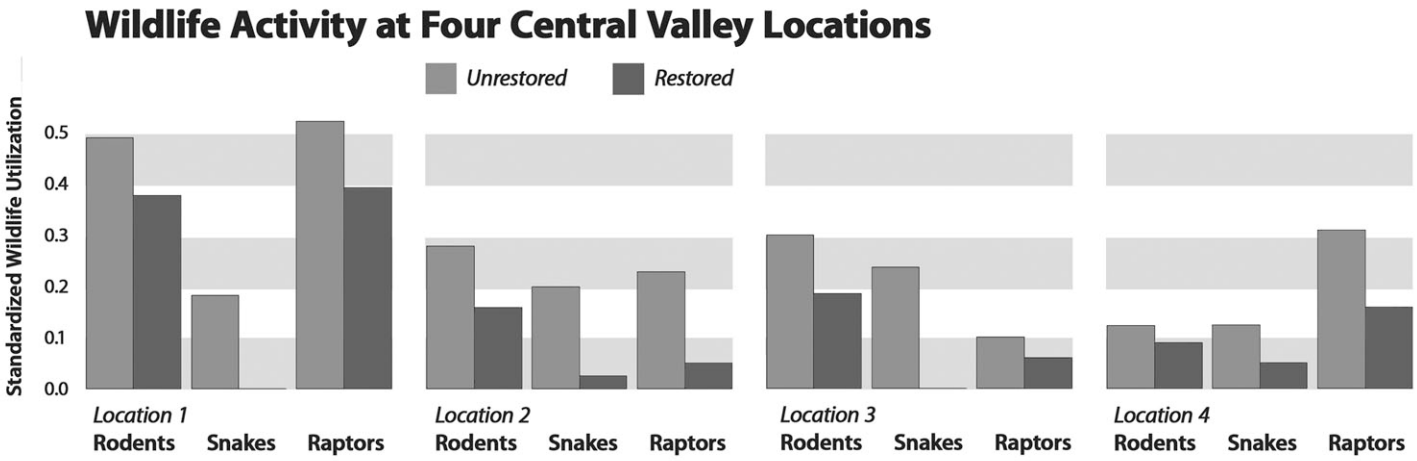

Figure 1. Standardized wildlife activity at four locations in paired unrestored and restored grassland sites in California's Central Valley by location, site, and vertebrate group.

Restoration is Best for Wildlife, Right? *continued*

non-native house mouse (*Mus musculus*). There were no significant differences in activity of the native deer mouse (*Peromyscus maniculatus*) or western harvest mouse (*Reithrodontomys megalotis*), and rodent species diversity was not different between sites. California voles (*Microtus californicus*) were rarely live-trapped, so their abundance was assessed under coverboards. Voles did not utilize coverboards differently between the two sites. Mice (not to species) were also surveyed under coverboards, and mouse observations were higher at unrestored sites, corroborating live trapping data.

Snakes

Like rodents, snakes utilized unrestored sites more than restored sites by about 90% (Fig. 1). As predators of rodents, it is plausible that higher snake utilization of unrestored sites is related to higher rodent utilization at unrestored sites. There were also twice as many species of snakes at unrestored sites than at restored sites.

Raptors

Like rodents and snakes, raptors utilized unrestored sites more than restored sites by about 36% (Fig. 1). Raptors spent more time in unrestored sites, attempted prey captures at higher rates in unrestored sites, and captured more prey items in unrestored sites. Again, it is possible that higher raptor utilization of unrestored sites is directly related to higher rodent and/or snake abundance. All observations of raptors successfully catching a prey item were of insects or rodents (not snakes), and the higher raptor utilization was of a similar magnitude as rodent utilization at unrestored sites. It may be that raptors utilize unrestored sites more due to higher rodent abundance than to higher snake abundance.

Conclusions and Implications

Despite some substantial differences between study locations in topography, land use history, time since restoration, seeded and exotic species, presence of livestock and wild pigs, and management regimes, the observed trend in rodent, snake, and raptor utilization of paired unrestored and restored sites was remarkably consistent. All three wildlife groups utilized unrestored sites significantly more than restored sites. The lower activity in restored sites could be due to legacy effects of disturbances associated with restoration, such as tillage, drill-seeding, compaction, and fire (Montalvo et al. 2002), yet wildlife utilization trends at each location were consistent despite differences in time since restoration.

Differences in habitat resources (cover, insects, seeds) may also contribute to differences in wildlife activity (Morrison 2002). Annual Mediterranean grasses common in California's invaded landscapes produce a far greater abundance of seed and biomass at different times than native grasses (Seabloom et al. 2003) and may support larger seed- and leaf-eating wildlife populations than native grass communities. Historical data regarding wildlife utilization of native grasslands prior to invasion are not available for comparison, but it is possible that our native grasslands did not support as abundant wildlife populations as do the current heavily invaded annual grasslands that now dominate California's landscapes. While we certainly do not contest that wildlife abundance was historically greater than it is today, the reduction in total habitat due to habitat conversion, fragmentation, pollution, climate change, and other human activities has reduced *total* suitable wildlife habitat, such that total abundance of some wildlife species is now substantially reduced (Marzluff and Ewing 2001, Burdett et al. 2010).

Restoration of native plant communities has merit on its own; the ecosystem services provided by native plants (e.g., pollinator habitat, livestock forage, biodiversity, aesthetic appreciation) are vitally important to retain in highly invaded California (Ehrlich and Mooney 1983). However, restoration with native plants may not automatically confer increased wildlife diversity or abundance. When a major goal of restoration is an increase in wildlife habitat, the specific habitat requirements of targeted wildlife species must be carefully considered (Miller and Hobbs 2007), as native plant restorations that seed or plant with the "usual suspects" may not actually boost wildlife habitat, at least in the eyes of the wildlife species of interest. Food webs are highly complex, and a focus on

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Restoration is Best for Wildlife, Right? *continued*

just plants, rodents, snakes, and raptors does not likely tell the full story (Terborgh et al. 2010), while herbivores also likely impact plant communities in ways we did not assess (Marquis 2010). Wildlife restoration via native plant community restoration may thus be more nuanced than we once thought. Future analyses accounting for trophic interactions are likely to enrich and clarify our understanding of how and why different wildlife species respond to the resources present in each habitat type.

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Northern mockingbird (*Mimus polyglottos*) harassing a juvenile white-tailed kite (*Elanus leucurus)* in Elk Grove, CA. *Photo: Ryan Bourbour*

California tiger salamander (*Ambystoma californiense*). *Photo: Jeff Wilcox*

SPECIES SPOTLIGHT:

California Tiger Salamander (*Ambystoma californiense*)

by Jeffery T. Wilcox, CNGA Board Member and Managing Ecologist at the Sonoma Mountain Ranch Preservation Foundation

The biodiversity that meets the eye when walking through California's grasslands is a small percentage of that which exists beneath the soil surface, where complex food webs exist among and between the roots that nourish the plants above ground. California tiger salamanders (*Ambystoma californiense*) live most of their adult lives within this root zone in burrows of rodents such as California ground squirrels (*Otospermophilus beecheyi*) and pocket gophers (*Thomomys* spp.) (Loredo et al. 1996). These large salamanders, approximately 10 inches in length (Storer 1925), are endemic to California and play an important role as underground predators of invertebrates, primarily insects (Stebbins 1951). California tiger salamanders have a biphasic life history (Wilbur 1980), which means life begins in an aquatic environment, followed by transformation through metamorphosis to a terrestrial adult phase. This unique species is adapted to breed in vernal pools (Shaffer 2004), formerly a common feature among many California grasslands.

With the onset of winter rains, adult California tiger salamanders leave their underground burrows under the cover of darkness and migrate (sometimes over 2 km.) overland to breeding ponds. Males arrive first, sometimes weeks in advance (Loredo and Van Vuren 1996, Trenham et al. 2000), where they await the arrival of females. Following courtship and mating, females deposit individual eggs (sometimes in small clusters) on submerged vegetation (Storer 1925). Larvae emerge from eggs in 2-4 weeks at a length of approximately 1 cm., but the small size belies a voracious predator. Because most vernal pools begin to dry as soon as the rains stop, larvae must eat as much as possible to grow to a size that will allow them to undergo the energetically demanding process of metamorphosis before vernal pools dry completely. The larger they are at metamorphosis, the better their chances of surviving to breeding age (Searcy et al. 2015). The smallest salamander larvae prey on zooplankton such as water fleas (*Daphnia* spp.) and then move on to larger aquatic prey as they grow, sometimes exhibiting cannibalism when the opportunity presents itself (Anderson 1968). Vernal pools are fishless, and once salamander larvae attain a large enough size, they are often the largest predator in the pools. As summer approaches and vernal pools dry, metamorphosis begins and larvae transform from gilled aquatic larvae to air-breathing terrestrial salamanders. Again under the cover of darkness, the transformed juvenile salamanders exit the pond and search for refuge in a burrow. Juvenile salamanders may travel up to 1.6 km. from their breeding pond in their first year (Trenham and Shaffer 2005). Once ensconced in their underground refugia, little is known of the behavior of juvenile and adult California tiger salamanders. Sexual maturity is attained at 2 years but female salamanders may breed only once in their lifetime (Loredo and Van Vuren 1996, Trenham et al. 2000).

Though primarily an animal of the grasslands, California tiger salamanders are linked by their biphasic life history to ephemeral water bodies, such as California's once extensive vernal pool

continued next page

California Tiger Salamander *continued*

systems. These two geographic features were historically found together throughout much of the Great Central Valley and along the coastal plains in northern and central California. Agriculture and residential sprawl have eliminated more than 85% of California's vernal pool habitats (Holland 2009), thus eliminating much of the breeding and upland habitat for California tiger salamanders. Genetic investigation has revealed three distinct population segments: the two oldest and isolated salamander populations occur in Santa Barbara and Sonoma counties, while the larger and less isolated group exists in the Great Central Valley and the San Francisco Bay area (Shaffer et al. 2004). The U. S. Fish and Wildlife Service listed the Santa Barbara population as endangered under the Endangered Species Act in 2000, the Sonoma population as endangered in 2002, and the remaining group as threatened in 2004 (USFWS 2004). The state of California listed this species as threatened in 2010.

While habitat loss is the primary reason for its declining populations, the California tiger salamander has exhibited behavioral plasticity by inhabiting fishless man-made ponds such as reservoirs constructed for flood control, and for watering livestock (Barry and Shaffer 1994, Wilcox et al. 2015). In addition, they have shown the ability to colonize fishless perennial ponds (Alvarez 2004, Wilcox et al. 2015) and have moved out of the valley floor to rangelands with ponds at elevations above 900 meters. With the exception of remaining vernal pool systems and some park lands, California's rangelands now sustain this species. As a top predator, the California tiger salamander depends on a healthy and diverse prey base, which in turn requires a healthy and functioning ecosystem. Unless you are standing at the edge of a pond on a cold and rainy night in the dead of winter, you may pass an entire lifetime without seeing this large endemic salamander. However, if we can preserve our grasslands and the vernal pools within them, the salamander will be there fulfilling its role as top predator, contributing to ecosystem function by keeping herbivorous insects in check, and cycling important nutrients back into the soil.

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Front cover: Lava cap wildflower field in the Sierra Nevada foothills. *Photo: Karen Callahan*

Back cover: Owl's clover (*Castilleja exserta*) blooms in a Sacramento Valley grassland. *Photo: Sacha Heath*