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

I admire and occasionally envy the annual wildflowers of California's grasslands—not their showy beauty, but their ability to wait out unfavorable conditions underground and emerge when conditions are right.

This year was a good one for deervetch (*Acmispon* spp.), lessingia (*Lessingia* spp.), and dwarf flax (*Hesperolinon* spp.) in the Bay Area and beyond. While "superblooms" garner press and road trips, each year likely has dozens or hundreds of native forbs replenishing their seedbanks—for what are flowers but a way of refreshing the belowground storage? Some annuals may have thousands or tens of thousands more seeds "in the bank" than express as plants in any given year.

Each year, in the same grassland, the expression of the seedbank can be vastly different. As an ecologist, I can wonder at the complex interaction of dormancy mechanisms, rainfall timing and amount, temperature, and competition that produces such interannual variability. As a nature lover, grasslands are my "toy surprise" plant community and I always enjoy seeing what the season brings.

I'm encouraged and comforted by the thought of all those plants biding their time in the soil, and the hope that if we don't develop the land—if we protect, manage, restore it—they will have the chance to reveal their presence.

Andrea Williams, President

Submit your photos for publication!

Have you converted or restored your landscape to a native meadow or grassland habitat? We are looking for photos to accompany our landscaping column in our *Grasslands* journal and on our website.

- All photos must be original — please only submit photographs that you took and for which you own the copyright.
- Please include caption information including photographer, date, place, and photo description.
- We will always credit you as the photographer.
- Photos should be at least 300 dpi.
- Send photos as email attachments (not embedded in email or a document).
- By submitting a photo, you give CNGA permission to print or display your submitted photo on our website.

Submit your photos to: **admin@cnga.org**

In this issue

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. 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 Kristina Wolf at grasslands@cnga.org. Include a caption and credited photographer's name.

Submission deadlines for articles:

Fall 2018: 15 Aug 2018 ❊ **Winter 2019**: 15 Nov 2018 ❊ **Spring 2019**: 15 Feb 2019 ❊ **Summer 2019**: 15 May 2019

CNGA Workshops & Events

It's been a busy year for our all-volunteer CNGA Board of Directors and Workshop Committee. We kicked off the year with a **Grass ID Workshop** and the **Grasslands and Prairies Session** at the CNPS Conservation Conference in Los Angeles. Our first **Landscaping with Nature Workshop** in March was followed quickly by **CNGA's 11th Annual Field Day at Hedgerow Farms**. May brought SERCAL 2018, where we hosted the **Restoration of Native Grasslands Session**. We finished the Spring season with the **Marin Grass ID Workshop** in May and **Oakland Grass ID** in June. All our workshops sold out! Many thanks to our members for supporting our work.

We are taking a short break to plan events for Fall and Winter including:

Soils and Grasslands Workshop
Two locations: The Bay Area and Winters.

Herbicide Safety and Use Workshop — Location TBA

Dates and details to come soon:
Watch **www.cnga.org**

Calochortus vestae (Coast range mariposa lily) on a serpentine slope in Potter Valley, Mendocino County. *Photo: Emily Allen*

Pine Mountain viewed from Azalea Hill. *Photo: Andrea Williams*

VISITING CALIFORNIA GRASSLANDS: *by Andrea Williams, CNGA Board President*

Azalea Hill / Pine Mountain, Marin County, California

Offering a fantastic diversity of species and grassland types, Azalea Hill is a year-round attraction in the heart of Marin County. Within the span of a few hundred feet, the attentive hiker will notice purple needlegrass (*Stipa pulchra*), serpentine, and Idaho fescue (*Festuca idahoensis*) grasslands; serpentine chaparral and oak woodlands dot the landscape as well. In winter, the parking lot off Bolinas-Fairfax Road is the popular starting spot for hikers to Little Carson Falls via Pine Mountain Road; the 1.5-mile trek to the falls passes through serpentine prairie, chaparral, and grassy seeps.

In spring, the wildflower shows begin. Season, amount of rainfall, and temperature dictate which natives flourish each year: goldfields (*Lasthenia* spp.), babystars (*Leptosiphon* spp.), and tarweeds (*Hemizonia* spp.) alternate in prominence; dot-seed plantain (*Plantago erecta*) is always present but less showy. Dozens of grass species form the foundation of these communities, including the rare serpentine reedgrass (*Calamagrostis ophiditis*) in large numbers at the ecotone of grassland and shrubland.

Summer brings breezes to cool the afternoon hiker; strong winds make waves through the grasslands, rippling sun-bleached stems. Tiny annuals found only in Marin show themselves: Tiburon buckwheat (*Eriogonum luteolum* var. *caninum*) and Tamalpais lessingia (*Lessingia micradenia* var. *micradenia*) make up in abundance what they lack in stature. The native—and locally rare—few-leaved thistle's (*Cirsium remotifolium*) cream-colored flowers rise above wetter grasslands, in contrast to western thistle's (*C. occidentale*) brilliant crimson heads in chaparral.

What little fall color can be seen in coastal California is on display on Azalea Hill. The "back" side of Azalea Hill has California black oak and Oregon white oak (*Quercus kelloggii* and *Q. garryana*) woodland with a California fescue understory, and brilliant yellow drifts of oak leaves contrast nicely with blue-gray fescue clumps. A proposed re-route of the trail will pass by the surprisingly few western azaleas (*Rhododendron occidentale*) turning red and orange before dropping their leaves.

In just under a mile, at the right time of year, a sharp-eyed botanist can spot over 300 species of plants, including a dozen clover species and two dozen kinds of grasses! It's no wonder CNGA "featured" this site for a field portion of its recent workshop "Identifying and Appreciating Native and Naturalized Grasses of California." Go back season after season, and year after year, for a changing kaleidoscope of species palettes!

Patrick Reynolds, General Manager of Hedgerow Farms and CNGA board member, and Andrea Williams, President of CNGA, talked prior to the lunchtime talks.

CNGA's 11th Annual Field Day at Hedgerow Farms

by Pat Reynolds[1] *Photos courtesy of Phil Hogan*

CNGA's 11th Annual Field Day at Hedgerow Farms was once again an enormous success. The event, which is CNGA's largest, was sold out early and included a substantial waiting list. This year's theme of maximizing biodiversity and pollinator habitat in California grasslands was particularly relevant given the continued decline of pollinator habitat and the array of insects it supports. Participants enjoyed hay rides and walking tours of Hedgerow Farms seed production fields and demonstration garden with many species in full bloom. Local restoration professionals Chris Rose of the Solano County Resource Conservation District (RCD), Bryan Young of the Sacramento County Sanitation District, Tanya Meyer of the Yolo County RCD, and CNGA vice-president JP Marié of University of California at Davis (UCD) led the driving tours while sharing their in-depth knowledge of grassland restoration. Field tours included an examination of the beneficial insects utilizing Hedgerow Farms' native wildflower fields and close-up examinations of mounted insect specimens. The instructor at this stop, UCD Research Associate Kimiora Ward, fielded many in-depth questions from enthusiastic Field Day participants. At another tour stop, Corey Shake of Point Blue Conservation Science teamed with Don Hildebrandt and Pete Martin of the California Hawking Club to discuss the wildlife habitat values associated with native grasslands.

The walking tours were led by Pat Reynolds (Hedgerow Farms and CNGA board), Emily Allen (Hedgerow Farms and CNGA board), Andrea Williams (Marin Municipal Water District and CNGA president), and Andrew Fulks (UCD), all of whom incorporated grassland restoration tips and strategies into their respective presentations. The many elements that go into the production of native grass and wildflower seed of known genetic origin (Hedgerow Farms' focus) were touched upon including planting, maintenance, harvesting, cleaning, and storage. The seed cleaning facilities were described by Jim Mast of Hedgerow Farms who demonstrated a few of the machines' abilities to sort seeds by shape, size, and weight. Some of the research currently being conducted at Hedgerow Farms was shared, including trials of various techniques to establish narrow leaf milkweed (*Asclepias fascicularis*) and showy milkweed (*A. speciosa*). The walking tour also featured Dr. Stephen Peterson, who described his research on potential hybridization of regional populations of the blue orchard bee (*Osmia lignaria*) from

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[1]Pat is the General Manager at Hedgerow Farms and a CNGA Board Member.

Above: Hedgerow's Northern California Wildflower Mix showed off its April blooms.

Right: Some attendees browsed the Demo Garden during the walking tour.

CNGA's 11th Annual Field Day at Hedgerow Farms *continued*

Utah that are being shipped to different regions of the country. Hedgerow Farms' demonstration garden (featuring the 110+ species grown at Hedgerow Farms), and the various seed mixes that it sells, were particularly popular with participants.

The break for lunch featured several excellent and informative presentations by experts in their respective fields. Dr. Robbin Thorpe, distinguished professor emeritus of entomology at UCD—and one of the world's experts on bees—gave a well-received presentation on bee diversity. Dr. Valerie Eviner, associate professor of plant science at UCD, talked about the importance of using species mixes with a high degree of plant diversity in native grassland restoration sites to "hedge your bets" against events that heavily influence vegetation composition — yearly shifts in climate, natural disturbance, and site management. Rachael Long, a Farm Advisor with the UC Cooperative Extension, shared the results of her most recent research on the benefits and cost-effectiveness of incorporating hedgerows into agricultural landscapes. Finally, Jessa Kay Cruz, a senior pollination conservation specialist at The Xerces Society, spoke of the alarming loss of pollinator habitat across the United States in recent years but also highlighted the extraordinary response of individuals and institutions that are working furiously to reverse this trend.

Overall, Field Day at Hedgerow Farms was, once again, an outstanding success. Hedgerow Farms and CNGA are already starting to plan for next year's Field Day and we hope you can be a part of it.

Photos 1 and 2

SPECIES SPOTLIGHT: *by Jeffery T. Wilcox*[1] *Photos courtesy of the author*

Jerusalem Cricket (*Stenopelmatus* spp.)

Jerusalem! I see linkages: The community value of a misunderstood insect

As I was growing up in the San Francisco Bay Area in the '60s and '70s, new tracts of homes quickly filled vacant fields as erstwhile orchards and rangelands were sold off ahead of the rising land values that augured a burgeoning population. When we weren't in school, those vacant fields were our playgrounds, places we escaped to after being pent up indoors, after weekend chores—and especially, once spring arrived. On those first warm, sunny days of the year we bounded through the new grass, saltating from rock to rock, or between old boards, flipping each in hopes of finding a mouse, a toad, or the first snake or salamander of the season. Invariably, a cry would rise from the grasses: "Oh, gross, a potato bug!" followed by "Kill it, they bite!" Unfortunately, fear being the root of that disgust, the potato bug often got squished.

We said "potato bug," but a more widely accepted name for members of the genus *Stenopelmatus* is "Jerusalem cricket." Four genera comprise the family Stenopelmatidae, which ranges from British Columbia to Costa Rica and inhabits grasslands, forests, and sandy habitats from beaches to deserts (Sánchez-Xolalpa et al. 2017; Weissman 2005). *Stenopelmatus* are large, flightless members of the insect order Orthoptera (from the Greek, "straight wings"). More familiar members of this large order include grasshoppers, locusts, katydids, camel crickets, and true crickets. Like most members of Orthoptera, *Stenopelmatus* feed primarily on plant material, although they're also known to eat other insects (Weissman 2001). They are often found under rocks, logs, boards, or in underground burrows of their own making, where they use large, powerful jaws to feed on roots and decaying plant matter. Those jaws are reputed to deliver a painful bite, but when handled gently in an open hand, none has ever offered to bite this author (Photo 1).

But what's with the name? Across its extensive range, this insect goes by many names—potato bug and Jerusalem cricket, as mentioned, but also stone cricket, sand cricket, and skull insect (Riley 1888; Weissman 2005), each rooted in a behavioral or physiognomic anecdote. Although not a significant pest of the "propitious esculent" (as John Reader subtitled his 2011 book, *Potato*), *Stenopelmatus* species are indeed opportunistically fond of potatoes ("potato bug"). The insects are often found under rocks ("stone cricket"), and many Stenopelmatidae species are sand-dune or desert-sand specialists ("sand cricket") (Sánchez-Xolalpa et al. 2017; Weissman 2005; CNDDB 2018). The Hopi call it Sősȍöpa, meaning "skull insect"—which makes perfect sense when you examine the insect closely: The prominent, smooth, flesh-toned head and thorax, especially when contrasted with the striped, bulbous abdomen, indisputably resemble a human head (Photo 2). In parts of Mexico to which the species is native, these features evoke a child's face (*insecto cara de niño*) because the eyes look more like those of a doll than an insect (Sánchez-Xolalpa et al. 2017), or *niño de la terra* (child of the earth) because the bald head looks like that of a newborn child (Weissman 2005).

Still, the most common name for *Stenopelmatus* is Jerusalem cricket. Weissman (2005) investigated the origins of this name quite extensively. He wasn't convinced by the explanation that (at rest) *Stenopelmatus* looks like a Jerusalem cross. And the genus doesn't exist in Israel, so the city of Jerusalem is not its namesake.

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[1]Jeffery is Managing Ecologist at the Sonoma Mountain Ranch Preservation Foundation and a member of the CNGA Board.

Jerusalem cricket *continued*

Its habit of feeding on roots lends to the idea that it may have been named for eating Jerusalem artichokes, but the two do not overlap in their natural ranges. Or perhaps Franciscan priests heard Navajos call the cricket "skull head" and associated this with Skull Hill, the ostensible burial place of Jesus (Stoffolano, Jr. and Wright 2005). Entomologist Richard L. Doutt provided my favorite proposed origin of the name when he reminded Weissman (2005) that young men of the late 19th century used "Jerusalem!" and "crickets!" as expletives. Doutt imagined a young boy rolling over a log and saying, "Jerusalem! What a cricket!" (In 20th century parlance: "Oh gross, a potato bug!").

Despite their considerable size (30–50 mm), these powerfully built insects fall prey to countless (particularly nocturnal) predators. (This is also because of their size; what a hefty store of protein they are!) I have found *Stenopelmatus* remains in the digestive pellets of several owl species, including great horned (*Bubo virginianus*), barn (*Tyto alba*), short-eared (*Asio flammeus*), burrowing (*Athene cunicularia*), and saw-whet (*Aegolius acadicus*). American bullfrogs (*Lithobates catesbeianus*) eat a lot of them, and they are known to be preyed on by adult California tiger salamanders (*Ambystoma californiense*) (Wilcox, unpubl. data). One winter day, while walking the wind-swept grasslands on the west end of Santa Cruz Island off the coast of California, I came across a pile of boards that had once been a makeshift research shelter. Half a dozen Channel Islands spotted skunks (*Spilogale gracilis amphiala*) had taken shelter under the rubbish pile and bounded away when I lifted a couple of boards, leaving behind a treasure trove of information for an ecologist like me. I grabbed a handful of fresh scats and bagged them, and on later analysis was startled to learn that the scats indicated a diet of nothing but earwigs (Dermaptera)...and Jerusalem crickets!

As an ecologist, my interests lie in what functional role an organism plays in the environment it inhabits. In the case of Jerusalem crickets, it starts with their equipment. They are superb excavators, using powerful legs, equipped with long spines at the terminus of each tibia, to tunnel underground to feed on living and dead plant roots. Dead and decaying roots can be vectors for plant diseases, so it may benefit vegetation for the senescing structures to be excised in this way (Menkis et al. 2006). Jerusalem crickets consume and then defecate digested plant materials, which provide a supply chain of food for soil microbes. In turn, those microbes release nutrients and minerals back into the soil where growing plants can take them up. Tunneling by Jerusalem crickets may also bring atmospheric oxygen to roots and to soil microbes. Recent research indicates that small invertebrates are important contributors to the "detrital food web" and more important drivers of ecosystem processes than their relative numbers would indicate (Yang and Gratton 2014).

Classic food webs are graphical models depicting "who eats whom" in a given ecosystem. Plants are autotrophs (organisms that can synthesize their own food from inorganic substances), and as such are primary producers in a food chain. Plants convert sunlight (solar energy) and carbon dioxide + water (chemical energy) into plant tissue, which in turn is taken up by heterotrophs (organisms that derive their nutrition from complex organic substances); that is, eaten either aboveground by grazing herbivores, or underground by rootivores such as Jerusalem crickets. This converts the plant energy to another nutritional (trophic) level (Elton 1927). In a further link of the food chain, carnivores may eat the herbivores, and then die naturally or be eaten by other carnivorous predators or by scavengers. Eventually the animals (herbivore or carnivore) decompose, returning energy to the soil. Each predation event

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Jerusalem cricket *continued*

transfers energy from one trophic level to the next (Lindeman 1942), with energy being lost in each interaction. These energy transfers are also known as linkages, and linkage strength is measured by how efficiently this energy transfer happens (Paine 1980).[1]

As root predators and plant-matter scavengers, Jerusalem crickets function as important contributors to the larger food web. Many animals prey on Jerusalem crickets when they leave their burrows at night. By day, the insects have been feeding on roots and decaying plant material underground, converting plant tissue to usable energy not available to traditional grazers feeding aboveground. The energy derived from underground plant matter normally goes to fungi and bacteria and is released back to the soil, where plants take it up again; little of it gets to top predators such as owls or ground-hunting pallid bats (*Antrozous pallidus*), for example. But imagine a juicy, calorie-rich Jerusalem cricket, belly full of root and underground plant matter, venturing out at night into the open where an owl, skunk, fox, or bat can pounce on it. (Bonus: Jerusalem crickets are easier to catch than a fast mouse!) This particular transfer of trophic energy (plant subsurface–rootivore–carnivore, bypassing surface herbivory) supplants traditional linkages (plant surface–herbivore–carnivore), and delivers the energy to top predators without the participation of aboveground herbivores in the food chain. How's that for playing a key role in the food web?

I wouldn't be surprised if future research reveals many other beneficial community functions of Jerusalem crickets. Perhaps they carry beneficial hitchhiking bacteria or fungal spores to new root zones? We just don't know yet. Genetic research is revealing new *Stenopelmatus* species (Vandergast et al. 2017), some of which, like the Coachella Valley Jerusalem cricket (*S. cahuilaensis*), are already rare. Whatever their community value, and notwithstanding the fear or revulsion they may elicit in humans, I've learned to appreciate this odd, majestic insect species.

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[1]It should be said that omnivory also plays a significant role in food web linkages: see Hunter, M. D. 2009. Trophic promiscuity, intraguild predation and the problem of omnivores. *Agricultural and Forest Entomology* 11:125–131.

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Left: Over-rested grassland near Auburn, CA. in April 16, 2014, suffering from excessive litter from previous year.

Right: Over-rested land near Carrizo Plains in April 13, 2018, with abundant gray litter from previous growing season except in adjacent field managed differently (left center).

A VIEW FROM THE FIELD:

Invasive Annual Weeds — Problems or Symptoms? Part 2

by Richard King[1] *Photos courtesy the author*

Introduction

This is the second part of a series focused on California's invasive annual weeds, exploring if they are indeed a serious problem or whether they are a symptom of other factors. The first article examined how four ecosystem processes are simultaneously functioning in grasslands, and when one or more of the processes are disrupted, or become less effective, some plants can behave more invasively as the community of organisms becomes more simplified (King 2018). The four ecosystem processes referred to here are the water cycle, nutrient cycles, energy flow from sunlight, and community dynamics (i.e., biodiversity and productivity), all of which interact and affect each other. Bare soil was the first factor I examined in Part I of this series, and it can lead to simplified grassland communities by disrupting the four ecosystem processes, allowing invasive annuals to establish and prosper rather easily. This current article will focus on another factor that can allow invasive annuals to dominate or co-dominate a site: "over-rest" in grasslands.

Over-Rested Land

A visit to the Page Museum at the La Brea Tar Pits in Los Angeles or to the Fossil Discovery Museum in Chowchilla will reveal that large herbivores once lived in California grasslands long before humans arrived. Fierce predators were also present and included species that hunted in packs. Large herbivores found safety in numbers, and they co-evolved over millennia with other species in the grassland community: straying from the herd would likely mean death. Since there were few barriers to restrict movement, the herd stayed bunched and kept moving across the land seeking fresh forage, water, or respite from predators. Animals in the herd grazed vegetation, fertilized the ground with nutrients in their dung and urine, and trampled plants and soils. Trampling broke up soil crusts that had developed from splash ("raindrop") erosion on bare soils, pushed seeds into the soil, and laid down growing plants or dead standing litter onto the soil surface. Although some of the preferred vegetation was consumed, much of the remaining was spoiled with dung and urine so the herd kept moving, and it may have been months or more before a herd returned to the same spot (Savory & Butterfield 2016).

Today one of the management tools commonly used in an effort to manage or passively restore native plant or animal species in our grasslands is "resting" land from any disturbance. Prolonged rest occurs when the landscape, or small areas of it, are protected year after year from disturbances, including livestock grazing and trampling, mowing, tillage, and fire. The belief that protecting Nature from disturbance always allows healing and recovery is still widespread among some preservationists and land managers, thus many strive to restore native species by curtailing disturbance as much as possible. It works well in grassland environments of the world where the annual distribution of rainfall and humidity helps

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[1]Richard King is a CNGA board member who worked for 36 years with USDA-Natural Resources Conservation Service as a rangeland specialist. Richard earned a Bachelor's degree in Wildlife Management and a Master's degree in Biology. He enjoys seeing native perennial grasses and forbs 'invading' the non-native annual grasslands on his ranch in Petaluma.

Left: Cattle avoided stepping on bunchgrasses with elevated, stiff, highly lignified old stems emerging from the crown. Annuals between bunchgrass plants are readily trampled as are bunchgrass individuals without considerable old stems (May 21, 2018 in Petaluma, CA).

Right: Over-rested roadside with dense yellow starthistle near Hollister, CA.

Invasive Annual Weeds — Problems or Symptoms? *continued*

break down plant litter effectively, with or without the presence of large herbivores or other disturbances. However in California's seasonal rainfall environments, many people have observed that prolonged rest can quickly impair biological decay of old litter and disrupt the four ecosystem processes (Savory & Butterfield 2016). I prefer calling such land "over-rested." How over-rest suppresses the four ecosystem processes and simplifies communities deserves an explanation.

During the year, the bulk of old plant litter from the previous rainfall season biologically decays in one of two ways: 1) Either herbivores must consume the grassland litter and digest it with the microbes in their gut's microbiome to extract energy and nutrients, or 2) Microbes outside the herbivores (in the external environment) must similarly break down dead tissues. Both require moisture to be present for the microbes to live and actively consume and break down the litter. A quick look at over-rested grasslands in California's short, seasonal rainfall environments reveals that microbial decay of litter not consumed by herbivores can occur slowly, and in some cases, not at all. Rather than breaking down biologically, the dead yellow or brown litter turns gray and then black, oxidizing like rusty fence wires. When storms are sporadic or seasonal, like in California, moisture for sustained microbial growth is not available. Litter then dries too quickly between storms to support the bacterial and fungal growth that could otherwise effectively digest and break down the lignified litter. Good soil cover (i.e., vegetation) can lengthen the time the soil surface will remain moist and help foster biological decay of litter.

You may have observed that some tall, dead, invasive annual forb skeletons appear to have fallen over. They often stand up like scarecrows all summer until the following rainy season, when they finally decompose near the soil surface and fall over. Or you may have seen grasslands rested for several years that had become a mix of old, blackish oxidized litter from previous growing seasons, with relatively little new green growth of annuals or perennials trying to grow up through it during the growing season. Looking more closely at the litter layer, you may have seen litter decomposed effectively only very close to the soil surface, where moisture was available to sustain microbial life for a longer period of time. Even well into the next rainy season, the gray or black litter from the previous growing season(s) remains prominent. The resulting grassland is full of old gray litter that is not effectively breaking down biologically due to over-rest.

When old oxidizing litter is too dense or thick, it can suppress germination and successful recruitment of annual plants and perennials when the rainy season returns (Thomsen et al. 1993). The accumulation of excessive litter not only suppresses germination, growth, and vigor for many plant species, it can suppress nutrient cycling because the biological decay of litter by living organisms in the food web is reduced. The grassland community will also tend to lose species and functional diversity over time as many species suffer from lack of recruitment or loss of vigor due to excessive shading from the previous year's litter. The water cycle may become less effective when the community of living organisms becomes more simplified and bare soil increases, and/or the abundance, diversity, or vigor of deep-rooted species decreases from over-rest. In other words, the lack of effective biological decay of litter can suppress all four of the ecosystem processes in seasonal rainfall environments and simplify the community present (Savory and Butterfield 2016). Some invasive annuals (e.g., some thistles, mustards, medusahead [*Elymus caput-medusae*], and goatgrass [*Aegilops* spp.]) thrive in over-rested areas, which frequently include roadsides, preserves, parks, and backyards where old litter accumulates and suppresses growth.

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Invasive Annual Weeds — Problems or Symptoms? *continued*

Invasive annuals can also thrive in over-rested areas being managed for large wildlife herbivores (e.g., deer, antelope, elk, bison) or livestock. Fields typically have areas that receive little grazing or trampling by large animals and suffer from over-rest and excessive accumulation of gray and black litter. Animals will typically avoid grazing or trampling these areas, preferring instead to spend the majority of their time in the best forage areas, shady spaces, and near water sources. Invasive weeds can develop and thrive in over-rested areas either because they are unpalatable and aren't eaten, or because the patch is full of old oxidizing material animals don't want to eat. Excessive litter can also accumulate within individual perennial grass plants, especially taller bunchgrasses. The center of a bunchgrass, or the entire plant, can die when the erect dead litter prevents adequate sunlight from reaching the crown of the plant where new buds need adequate sunlight to emerge and grow. Where large herbivores are present, a single species bunchgrass stand can even include a mix of individual plants suffering from over-rest, while others remain vigorous because they are occasionally grazed or trampled. Still other plants in the stand might be overgrazed because highly nutritious regrowth was grazed before the plant had fully recovered after the first grazing. Productivity, vigor, and root mass are thus lost on these individuals. Such stands with various stages of plant health can occur when the herbivores are thinly scattered on the land and don't stay bunched as herds once did. When animals are neither bunched nor excited, they also tend to avoid stepping on the taller over-rested bunchgrass individuals, just as you and I would when calmly walking across land, exacerbating over-rest for individual plants.

Some ranchers are discovering that if they manage their herd to mimic how Nature allowed wildlife herds to naturally operate (e.g., with high stock density or excited animal behavior), they can utilize livestock to more effectively trample excessive litter that is oxidizing and suppressing new growth and recruitment. This can be done without forcing animals to eat the very low-quality litter, and it can be done quickly. When bunched tightly or in excited behavior, animals no longer watch where they place their hooves. To do this, some managers use supplemental feed as an attractant to treat over-rested areas. As animals rush in for a flake of hay, or whatever they are anxious to eat, they more effectively trample the over-rested area. Active herding techniques, whether on foot, horseback, vehicle, and with or without stock dogs, can also be used with little stress to the animals (particularly in comparison to how predators

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Left: Mustard plant skeletons from the previous year's growth on right side of fence in Carrizo Plains area, April 13, 2018.

Right: Mix of individuals ranging from highly vigorous (lower left) to severely over-rested (upper center) near San Rafael, CA, Dec. 7, 2012.

Invasive Annual Weeds — Problems or Symptoms? *continued*

concentrate animals in the herd and excite their behavior). These simple tools (i.e., attractants, herding) provide the opportunity to quickly shift the four ecosystem processes in areas suffering from over-rest by trampling old litter onto the soil surface where it will more effectively break down biologically during the rainy season.

I used high stock density and excited animal behavior to trample a patch of dense oxidizing litter on my property near Petaluma that had become 100% medusahead (*Elymus caput-medusae*). Livestock had largely quit walking through it to graze or trample the loose and thick litter; they just walked around it to where much more palatable grass or litter existed. Since that single trampling treatment, the patch quickly became a mix of annual species with only 10–30% cover of medusahead when the erect seed heads emerge in late May. This patch has not yet begun reverting back to a monoculture after many subsequent years, despite producing ample medusahead seeds every year. That is, the four ecosystem processes changed quickly from one effective trampling of the patch. That patch no longer suffers from over-rest, because livestock are now attracted to grazing plants there while also more effectively trampling any litter present. Both grazing and trampling help minimize the accumulation of loose and oxidizing litter. My observations of this patch and the rapid change in plant species composition illustrate the idea that the mere presence of an invasive annual species that is growing and reproducing does not mean it will behave invasively and become problematic on a site with management that keeps the four ecosystem processes more effectively functioning.

Some invasive annuals can thrive year after year even if excessive shading from litter is not occurring. A large patch of yellow star thistle (*Centaurea solstitialis*) persisted year after year on my property with only their seed germinating and establishing among the standing dead skeletons every winter. The old flowering skeletons did not seem to excessively shade the site. None of the four ecosystem processes were functioning well. So ten or more years ago, I used my small herd of beef cattle to effectively trample the old skeletons and much more of the soil surface than had been occurring. I wanted to mimic what might happen if a great herd of wildlife had moved through the area, surrounded by predators waiting for an animal to leave the herd. I applied higher stock density and provoked more excited behavior for twenty minutes during the winter, making sure the herd had trampled nearly all the erect skeletons and disturbed much of the soil surface. I did it only one time in early winter when only star thistle seedlings were germinating in that patch, while a host of other annual species had begun growing outside the patch. Within two years, the star thistle patch had completely disappeared. Annual grasses and forbs now dominate the site and not a single star thistle plant is present. The community was completely altered by briefly changing animal density and behavior to knock down standing litter and disturb the soil surface.

Using stock density and herd behavior is a very different approach to control invasive annuals than severely grazing them to reduce seed production, as some researchers have done (Thomsen et al. 1993). Severe grazing that targets one or more undesirable species may well reduce seed production and number of seeds in the seed bank, but it may also reduce the seed production and/or vigor of other, more desirable species also present. Much less costly approaches such as the one described above can shift grassland plant composition and productivity dramatically, and are possible by focusing on managing the ecosystem processes of the whole community rather than just species or parts of it.

Over-resting areas with bare soil and lack of litter in seasonal rainfall environments can similarly simplify communities or keep them simplified because bare soils develop crusts (or caps) that make it more difficult for seeds to successfully establish. As described

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Invasive Annual Weeds — Problems or Symptoms? *continued*

previously (King 2018), bare soil is an ideal environment for many of our invasive annual species. Higher animal density and/or excited herd behavior provides more hooves per unit area that more effectively break the hard soil surface, improve rainfall infiltration, and create new microenvironments that can enable seeds of other species, including perennials, to more effectively germinate and establish (Savory & Butterfield 2016).

In summary, when grasslands are over-rested in California's seasonal rainfall environments, invasive annual grass and forb species can become ever more problematic as thatch accumulates and fails to effectively decay biologically or when excessive bare soil remains present. Some of our invasive annuals thrive in these simplified communities where new growth of other species is suppressed. Herds that once roamed our grasslands not only grazed plants and litter, they more effectively trampled what they didn't eat, preventing the accumulation of thick litter that can smother new growth and vigor. Trampling helped the thick or standing litter decompose more quickly when in contact the soil surface. Hooves also broke bare soil crusts, passively distributed and planted seed, and laid down standing litter to better cover the soil. The herd even fertilized the grassland while moving across the landscape. We can still use animal density and behavior to mimic what our native grassland species and communities once depended upon to improve the four ecosystem processes. This article focused on the importance of large animal herding and trampling to treat over-rest and bare soil in seasonal rainfall environments, herds of animals also graze. While bare soil and over-rest are factors that invite many invasive annuals to become dominant or expand their ranges and communities become more simplified, grazing can also dramatically affect whether populations of invasive annuals increase or decrease. Grazing will be addressed next in this series.

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Grasslands Celebrated at 25th Annual SERCAL Conference *by Emily Allen*[1]

The theme of this year's California Society for Ecological Conservation (SERCAL) conference was "In the Blink of an Eye," and the topics presented outlined the current state of conservation in California, highlighted lessons learned from past projects, and provided space for updates on developing topics that are relevant in restoration today. The conference was developed as a space for restoration practitioners and researchers to share and discuss current methodologies, concerns, and successes. The conference continues to play a vital role in promoting learning and facilitating discussion and collaboration within the restoration field. Concurrent session topics at the conference included Adaptive Management, Native Habitat Design, Grassland Ecosystems, Impacts of *Phytophthora*, Urban Forestry Management, and Storm Water and Erosion Control.

CNGA hosted the highly attended session on Grassland Ecosystems chaired by JP Marie, CNGA's vice president. The first talk of the session, given by JP, started with an overview of the history and current state of grasslands and the factors that should be considered to create a functional grassland ecosystem. Pat Reynolds, CNGA board member and general manager of Hedgerow Farms, followed with an overview of how seeds from locally sourced populations are wild collected, planted for seed amplification, and then made available to projects. Quality seed is a critical factor in most active restoration projects and Pat provided a framework on how to improve seed specifications to be both reasonable and specific enough to ensure the seed supplied for a project is of the quality and source needed to make it successful.

A new topic to the conference was presented by Brianne Palmer, a PhD candidate at San Diego State University. She spoke on biological soil crusts (BSCs) and how these rarely noticed communities on top of the soil are worth a closer look when doing restoration. These BSCs are usually associated with dry areas like the Colorado Plateau, but Palmer described how she has observed them in a variety of systems, including grasslands and under redwoods. She is currently working on San Clemente Island,

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[1]Emily is a CNGA Board Member, has worked with native grassland species at Hedgerow Farms for over 9 years, is currently a consultant out of Ukiah, and has her B.S. in Natural History from Westmont College in Santa Barbara. **eallen624@gmail.com**

Grasslands Celebrated at 25th Annual SERCAL Conference *continued*

comparing BSC response within grasslands to burning, and will continue to look at how BSC might interact with native and nonnative seeds and their ability to germinate after a fire. She left us with the motto of those passionate about BSCs: "Don't bust the crust (unless it's for science)."

Eric Smith of Vollmar Consulting gave a presentation on a promising approach to vernal pool restoration and highlighted that vernal pool mitigation often neglects the upland mima mounds and grassland habitat around the pools. Some of the current methods of constructing vernal pools often lead to failures in hydrology and function of the created pools. The approach used on a site in Merced and Madera County included digging pits to find the duripan, looking at the soil profile, and designing soil mounds that allowed ponds to form in freeform shapes. The shapes were close to the historic shape of the pools that were previously on the site before it was farmed. A tractor with a blade controlled by a radio signal created the shallow pools and mounds and the resulting landscape appears to have functional hydrology. These types of inventive approaches and discussion of strategies make SERCAL a relevant and valuable conference for restoration practitioners year after year.

Phytophthora has become a regular and relevant topic at conferences relating to native plant material, and SERCAL had a session dedicated to the impacts and current research on *Phytophthora* species in restoration. The major topics of the session included mitigation for introduced *Phytophthora* in restoration sites, protective measures nurseries are taking to prevent spread, newly discovered host plants, and newly discovered *Phytophthora* species in California. There were several talks on how projects are responding to concerns by moving towards using seed over container plants when introduction of *Phytophthora* is a concern. Matt Quinn (H.T. Harvey & Associates) presented a poster describing their program to test training dogs to detect *Phytophthora* by scent. The initial tests were very promising, and this may become a tool that is used for early detection to limit spread of *Phytophthora* in the future.

A panel discussion looked back at what has been successful and what can be improved upon. Vic Claassen (Department of Land Air and Water Resources, UC Davis) touched on wanting to see more technology used to make accessing information and data easier. He suggested the possibility of using databases for projects that interested parties could use to stay updated and find contact information. An outcome from the discussions during this session was the goal of having more representatives of agencies at next year's conference to promote productive conversations about how permit requirements can be adjusted to make restoration and mitigation projects more realistic while still achieving the desired system functionality. It was also discussed that while there appears to be a lot of women in the field of restoration today there is still a lack of overall diversity within the restoration field in California.

I look forward to next year's conference, possibly located somewhere on the central coast, to continue to discuss, learn, and share about the exciting new research and topics within conservation.

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Agoseris grandiflora. *Photo courtesy of Jim Coleman*

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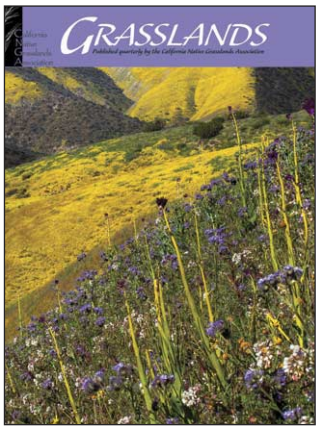

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Our native landscaping column will return next issue. Please send your photos!

(see page 1 for details)

Front cover: A serpentine hillslope of *Elymus multisetus* (big squirreltail) in rangeland managed with cattle in Potter Valley, Mendocino County. *Photo: Emily Allen*

Back cover: California fescue along a seasonal creek at Azalea Hill / Pine Mountain (see page 3). *Photo: Andrea Willams*