



California
Native
Grasslands
Association

GRASSLANDS

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From the President's Keyboard

Everything I feel is true; everything I think is not. I try to remind myself of this regularly, and what that means for conservation and ecology work. How you feel—your emotions—are true, so if I love grasslands or hate Mondays those things are true to me. But if I say grasslands are the best terrestrial ecosystem or Mondays the worst weekday then I better be able to back that up as an objectively valid statement. I feel California's grasslands are under threat, but I can also point to the decline in grassland acreage, the loss of grassland birds, and the lack of protection preferred in current development and fuels projects to prove my case.

How and what we measure can provide insight and answers or lead us to miss what's really happening. And measuring in ecology, particularly in field conditions, can be particularly difficult with all the interactions of space, time, and weather on plant and animal presence and phenology. The effects of management on a grassland in Southern California may not be transferrable to the Sierras or the North Coast. This edition of *Grasslands* features articles that test our assumptions and show us the importance of investigation and critical thinking.

Part of CNGA's mission is to promote, preserve, and restore the diversity of California's native grasses and grassland ecosystems through education and research. The writings in this journal, our workshop and event offerings, and promoting research with our GRASS grants help further our mission, and we couldn't do it without you!

Andrea Williams, President

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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Call for Nominations

Please Consider Joining the CNGA Board

CNGA is seeking nominations for individuals to represent their community and fields of expertise on the CNGA Board of Directors. Current board members will tell you that board service offers a unique opportunity for personal and professional growth and development. You will meet and collaborate with like-minded people from throughout the state who are working together to benefit a critical ecosystem. Nominations are open until noon on Friday, November 8, 2019.

Your Vote Counts

Online voting for the CNGA 2020 Board of Directors Elections is open December 1–20

On December 1, we will send out an email announcement to all members with links to the candidate statements candidate statements and directions on how to access to your ballot.

For more information, visit us online at **cnga.org**, contact us at **admin@cnga.org**, by phone at 530.902.6009.

Giving Tuesday: Grasslands Provide Resilience in a Changing World

We are kicking off our end-of-year donation drive on Giving Tuesday, December 3rd.

There are three ways to donate:

- 1. Donate Online** — <https://cnga.org/GivingTuesday>
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Any amount is welcome.

Photo: Prairies of Point Arena (see page 3 for article). Courtesy Jennifer Buck-Diaz

Please update your records. Our new address is:
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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.

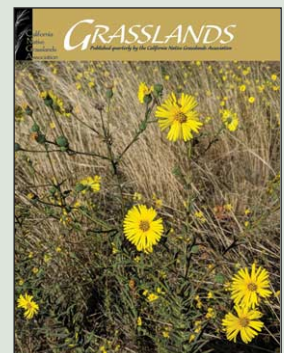
Also considered for publication are high-resolution color photographs. For each issue, the Editorial Committee votes on photos that will be featured on our full-color covers. Send photo submissions (at least 300 dpi resolution), as email attachments, to the Editor at grasslands@cnga.org. Include a caption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

Submission deadlines for articles:

Winter 2020: 15 Nov 2019 * **Spring 2020:**
15 Feb 2020 * **Summer 2019:** 15 May 2020
* **Fall 2020:** 15 Aug 2020 *

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Showy forbs, irises, and early season tufted hairgrass (*Deschampsia cespitosa*) line the coast of Point Arena.

VISIT A NATIVE GRASSLAND: by Jennifer Buck-Diaz Photos courtesy of the author

Walking in Wet Boots — Prairies of Point Arena

For those of us living inland from the coast of California, summer is the perfect time to take a trip to the western part of our state, where fog lies thick and natural air-conditioning blows all day. Consider visiting the Point Arena-Stornetta unit of the California Coastal National Monument. This BLM-managed property in Mendocino County is the only terrestrial component of the marine monument, which stretches over 1,000 miles along our coastline. The 1,600+ acres of land supports expansive coastal prairie along terraces dotted by tufted hairgrass (*Deschampsia cespitosa*) and often intertwined with native California blackberry (*Rubus ursinus*),

aptly referred to as trip-vine. As with many California grasslands, timing is everything. If you visit in May, the coastal bluff will light up with strips of pink butter 'n' eggs (*Triphysaria eriantha* ssp. *rosea*) but come September, dry bunchgrasses dominate and you won't have an inkling that butter 'n' eggs were ever there.

Water is integral to this wind-swept landscape and your boots will quickly become soaked while exploring the surprising diversity of wetlands and saturated herbaceous plant communities in the area — including hummocks of pacific reedgrass (*Calamagrostis nutkaensis*), dense coast carex (*Carex obnupta*), and common rush (*Juncus patens*). While much of the coastline north of the mouth of the Garcia River towards Manchester State Park is dominated and stabilized by European beach grass (*Ammophila arenaria*), you can still find small patches of the native dune grass (*Elymus mollis*) and shifting sands that support dune species such as beach morning glory (*Calystegia soldanella*), sand verbena (*Abronia latifolia*), and beach bur (*Ambrosia chamissonis*).

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YOU can support the Next Generation of Grassland Researchers

Please consider funding a student scholarship to encourage a new generation of grassland conservationists.
For more information or to make a donation visit <https://cnga.org/GRASSgrants>

California Grassland Research Awards for Student Scholarship (GRASS)

Call for Applications Begins November 1, 2019

CNGA is offering competitive research funds to promote undergraduate and graduate student research focused on understanding, preserving, and restoring California's native grassland ecosystems in accordance with the CNGA Mission and Goals.

Eligibility

Students from any accredited college or university doing research within California may apply (home institution may be outside California).

Awards

CNGA will fund four or more \$500 awards per year.

These awards are designed to support basic undergraduate and graduate research in native grassland ecosystems. Funds can be used to support fieldwork, small equipment purchases, visits to herbaria, materials and/or books. Students may re-apply and receive a scholarship award for a maximum of two years.

To Apply

Visit <https://cnga.org/GRASSgrants> for application information for 2020 Grants.
Application deadline is January 31, 2020.

Walking in Wet Boots *continued*

Along more protected inland slopes, purple needle grass (*Stipa pulchra*) nods in the wind, acknowledging its elevated status as California's official State Grass. Rare plant and animal species are scattered throughout the monument, attesting to the importance of protecting these lands. You might spot the endemic Behren's silverspot butterfly (*Speyeria zerene ssp. behrensi*), which is completely dependent upon its host plant, the western dog violet (*Viola adunca*), itself a striking purple treasure to find embedded in the coastal prairie. With many National Monuments under threat of being down-sized by the Trump Administration, now is a good time to visit and show your support for these magical public lands.



Reedgrass (*Calamagrostis nutkaensis*) dominates in wet areas along the coast.



Figure 1. The shrub, *Peritoma arborea* var. *globosa*, on a hillside in Tejon Ranch. The image shows the observed uniform spatial pattern of the shrub. Photo courtesy of the author

Mapping and Investigating the Spatial Distribution of *Peritoma arborea* var. *globosa*, a California Endemic Shrub

by Dylan J. Stover¹

Introduction

Spatial statistics have become increasingly important in studying vegetation patterns; this trend will only continue as ecosystem dynamics become more unpredictable (Schurr et al. 2004). Due to improvements in computing technologies, ecologists are able to more rigorously examine spatial structure in their work (Dale and Fortin 2014). Scheffer and Carpenter (2003) found that unexpected shifts in dominant plant species that harmfully alter ecosystems and their ecosystem services have been occurring at increasing rates, which can be partly attributed to the changing global climate. In California, conversions from shrubland to grassland and grassland to shrubland occur with unknown consequences to the many ecosystem services provided (Knapp et al. 2008, Wolkovich et al. 2010, Yu et al. 2016).

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Defining the spatial distribution of an ecosystem's dominant plant species is the first step to understanding ecological processes on a landscape and predicting its responses to changes within the system. For example, it can show hotspots of productivity and the distribution of biomass in the system. Combining this with soil and water maps, we can create habitat suitability maps for ecologically important species and build models to predict how those species can affect an ecosystem's responses to disturbance events. An overhead view of an area can often reveal patterns not easily seen from ground level, as demonstrated in this paper.

Bladderpod (*Peritoma arborea* var. *globosa*) spatial distribution was studied in relation to edaphic properties on Tejon Ranch in Southern California. Bladderpod is in the Cleomaceae ("bee plant") family, and it is endemic to Southern California (Calflora 2018). The plant is drought-resistant and provides habitat for many rangeland species, such as sparrows, finches, quails, kangaroo rats, and ground squirrels (Smither-Kopperl 2012). Bladderpod is common on slopes, desert

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The Spatial Distribution of *Peritoma arborea* var. *globosa* *continued*

washes, and disturbed areas, and it resprouts after fire (Smither-Kopperl 2012). At the stand scale, the shrub displays an unexplained spatial distribution. By eye from ground level, the shrubs appear dispersed, or uniformly distributed (Figure 1). Each bladderpod plant exhibits the characteristics of an island of fertility, which makes the species an important facilitator for the surrounding plants (McDonnell 2018). As the dominant shrub species and a prominent facilitator of other plants on the landscape, understanding bladderpod's ecology and natural history is vital to maintaining and managing the current ecosystem.

By examining various edaphic properties around the shrub in conjunction with the plants' spatial distribution, the study investigates the following questions: (1) Do the shrubs exhibit a dispersed spatial distribution? (2) Is there a relationship between edaphic properties and the spatial distribution of *P. arborea* var. *globosa* at the stand scale? This study also serves to validate assumptions about bladderpod spatial distribution and seasonal variation in soil nutrients from past studies (McDonnell 2018, Aoyama 2018), prompting the last question: (3) Is there seasonal variation in the edaphic properties analyzed?

Methods

Tejon Ranch study site

All field sampling took place on the San Joaquin Valley region of Tejon Ranch (109,000 ha), a privately owned ranch in Kern County, CA. From the previous studies, there are three established 5-m x 20-m plots with bladderpod present as the dominant species. On these plots, there are no other shrub species present, but there are many grasses and forbs.

Most of Tejon Ranch is under conservation easements and cooperatively managed for conservation objectives; permitted activities include cattle grazing (Spiegel 2015). The ranch's grasslands have been studied extensively to inform grazing regimens; only recently has there been an effort to better understand the shrublands on the ranch. A recent study aimed to link carbon stocks with Tejon Ranch's biophysical features in order to define shrubland ecological site descriptions (Aoyama 2018). Three of the existing shrubland study sites are dominated by bladderpod.

Soil field sampling

All field sampling took place in June 2018 and replicated the methods used in McDonnell (2018). At each of the three plots, a representative shrub was chosen and a soil sample was collected 0–15 cm deep using an auger: from the shrub's base, the edge of the shrub's canopy, and 3 m away from the shrub for a total of three soil samples from each plot. These soil collections are hereafter referred to as shrub, edge, and grass soil samples.

Soil lab analysis

All soil samples were prepared for the same soil chemical property analyses as in McDonnell (2018). The collected soil samples were ground using a pestle and mortar, then sieved to separate aggregates greater than 2 mm in size, then air-dried overnight. To test the properties Olsen-P, SO₄-S, X-Ca, X-K, X-Mg, X-Na, and CEC (Table 1), nine soil samples were sent to the UC Davis Analytical Laboratory for analysis.

Table 1. Summary of edaphic properties used in this study. Edaphic properties tested, along with function/quality in soil and plant relationships and the associated p-value results from one-way ANOVA. From McDonnell (2018).

Soil Property	Quality	p-Value
SO4-S	Sulfate-Sulfur; important for plant development	0.069
Olsen-P	Extractable Phosphorus; important for plant development	3.34 x 10 ⁻⁴
X-K	Exchangeable Potassium; an essential plant nutrient	0.548
CEC	Cation exchange capacity; ability of soil to hold essential nutrients	0.634
X-Na	Exchangeable Sodium; small amount used in plant metabolism; can affect plant health	0.626
X-CA	Exchangeable Calcium; important for plant development and soil health	0.820
X-Mg	Exchangeable Magnesium: an essential plant nutrient	0.649

Spatial analysis

The geographic distribution of bladderpod was measured using the Spatial Analyst toolbox within ArcGIS v10.6.1. Satellite imagery of the three study sites and surrounding areas was downloaded from Google Earth Pro at a resolution of 4800 x 2863 pixels at an eye altitude of 320 m. These images were imported into ArcMap and georeferenced in the WGS_1984_UTM_Zone_11N projected coordinate system. A training set was created for each plot in order to perform an Interactive Supervised Maximum Likelihood Image Classification. The output of each image classification was post-processed using the Majority Filter, Boundary Clean, and Region tools as necessary. Next, the image classification output rasters were converted to polygon feature classes. Each plot's polygon layer was reviewed and edited by hand to ensure no shrubs were overlooked and no erroneous polygons were included in the final analyses. Each polygon layer was converted to a point layer using the Feature to Point tool to run the spatial analyses. Two tests were used: Average Nearest Neighbor Analysis and Multi-Distance Spatial Cluster Analysis (Ripley's K Function). The Nearest Neighbor Analysis used the average distance from each shrub to its nearest neighbor to calculate a nearest neighbor index. The Ripley's K Function created 99 random point distributions to compare with the dataset and determine whether the features were more clustered or dispersed than expected from a random distribution.

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The Spatial Distribution of *Peritoma arborea* var. *globosa* *continued*

Statistical analysis

All statistical tests were conducted, and all graphs were made in Microsoft Excel (Microsoft 2016). One-way ANOVA tests were run comparing soil properties (Table 1) between the shrub, edge, and grass soil samples from each plot to find significant differences within each property among the three sampling locations. ANOVA only tells whether there is a difference, so a Scheffe Post-Hoc Test was run on the soil properties with significant results to find where those differences came from. This provided pair-wise comparisons between the three sampling locations to find which locations were significantly different from the others. To test for seasonal variation in soil characteristics, a two-sample t-test was performed between McDonnell’s (2018) existing soil samples from October 2017 and the soil samples collected in June 2018.

Results

Results from the one-way ANOVA show significant differences between the three soil sampling locations around each bladderpod plant in both Olsen-P ($p=0.001$) and SO_4-S ($p=0.07$). The Scheffe Tests found a significant difference ($F^* > F_S$) for the two combinations including the shrub sample in Olsen-P ($F^*=8.92$), but not in SO_4-S ($F^*=7.55$) (Table 2). This indicates that any variation detected in the one-way ANOVA comes from the shrub samples for Olsen-P. Though not significant, the result for SO_4-S suggests a similar trend. Comparing these results with the box plots for each property (Figure 2), there appears to be a pattern of

high levels of nutrients (e.g. SO_4-S , Olsen-P) in the shrub soil samples, intermediate levels in the edge soil samples, and low levels in the grass soil samples. Analysis of other edaphic properties showed a similar pattern, though not significantly different.

Both spatial analyses concluded that the shrubs follow a clustered spatial distribution rather than the hypothesized dispersed distribution. The Average Nearest Neighbor Analysis for each plot yielded a Nearest Neighbor Ratio with a z-score of less than -7 and a p-value less than 1×10^{-6} . A negative z-score implies a clustered distribution, and a large negative z-score suggests strong clustering. A low p-value shows significant results, whether the z-score is negative or positive. The Multi-Distance Spatial Cluster Analysis (Ripley’s K Function) produced the graph shown in Figure 3. With an observed K greater than both the expected K and the confidence envelope, there is significant spatial clustering at distances smaller than about 80 m.

The two-sample t-test between the soil data from October 2017 and June 2018 showed no significant differences between seasons for the means of any edaphic property.

Table 2. Scheffe values for the three combinations of the soil sample locations for Olsen-P (phosphorous) and sulfate-sulfur. There is a significant difference between the means of the two sites when $F_S > F^*$.

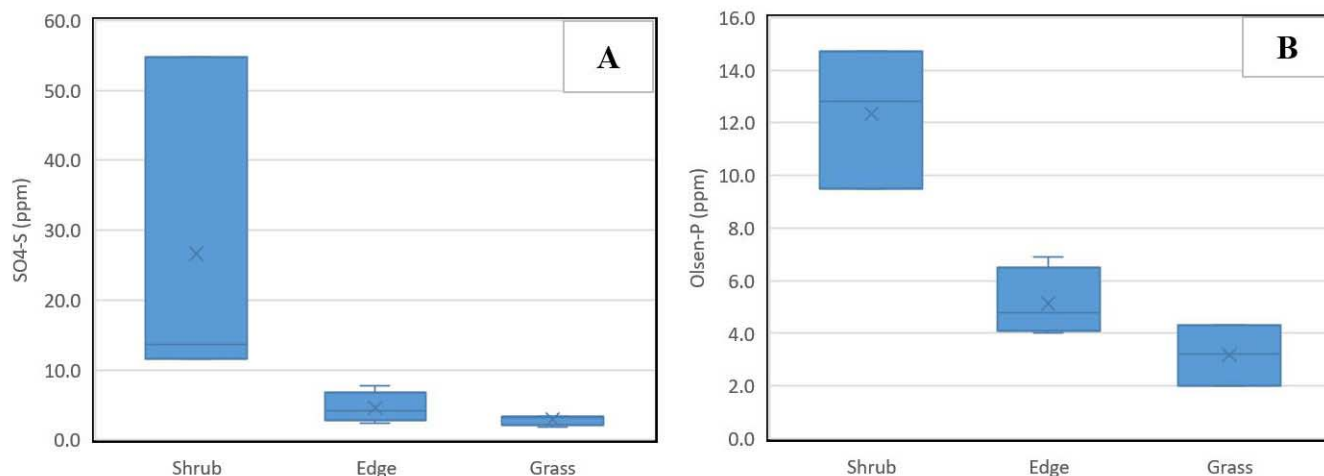
Sample Pair	F_S Value (Olsen-P) ($F^* = 8.92$)	F_S Value (SO_4-S) ($F^* = 7.55$)
Shrub + Edge	29.64001	5.526453
Edge + Grass	2.530607	0.03949
Grass + Shrub	47.84555	6.425312

Discussion

Edaphic properties

The edaphic analyses found higher levels of phosphorous directly underneath the shrubs than in adjacent grassland. This trend matches McDonnell’s (2018) finding that bladderpod exhibits the characteristics of islands of fertility. Shrubs that form islands of fertility better resist ecological disturbances, which allows their

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Figures 2a-b. Boxplots of a) Olsen-P (phosphorous) and b) sulfate-sulfur by soil samples.

The Spatial Distribution of *Peritoma arborea* var. *globosa* *continued*

populations to persist when subjected to disturbances (Schlesinger et al. 1996, Bond and Midgley 2001). The edaphic data results for Olsen-P indicate that bladderpod creates islands of fertility within the grasslands where it occurs on Tejon Ranch. Though not significant, the results for the other edaphic properties suggest the same trend. The shrub drops its leaves, fruit, and flowering bodies, adding organic matter directly under its canopy.

There was no significant difference between the means of the soil samples from each season for any edaphic property. The lack of seasonal variation in soil nutrient availability suggests that the shrubs are islands of fertility year-round. The lack of seasonal variation in nutrient levels could potentially allow for adaptations that decrease the effects of a lack of water during drought episodes in any present species. Droughts can lead to decreases in net photosynthesis and stomatal conductance of CO₂, among other responses. Seasonally stable soil nutrient levels ensure the plants present can take up enough nutrients to survive year-round (Lisar et al. 2012). It is possible this stability may lessen the need for plants to balance drought responses with responses to nutrient shortages, thus allowing for a more efficient response to dry conditions. This finding of seasonally stable soil nutrient levels verifies assumptions made in past studies (Aoyama 2018, McDonnell 2018).

Spatial analysis

The Average Nearest Neighbor and Ripley's K Analyses showed similar results of strong shrub clustering on the three plots. This evidence of spatial clustering contradicts McDonnell's (2018) assumption of spatial uniformity. Reproduction and local dispersal add new plants near an established adult and generate positive self-covariance or clustering, while competition preferentially thins overcrowded areas and generates negative covariance within and between species (Bolker and Pacala 1998). That the bladderpod exhibits spatial clustering (positive self-covariance) suggests that the effects of reproduction and local dispersal exceed any negative covariance caused by competition.

On average, the study area receives 177 mm of rainfall annually and experiences high temperatures of 38 C (Spiegel 2015). With such low annual rainfall, we expect water to act as a limiting factor on shrub populations; however, this effect appears to be mitigated by recruitment and dispersal. Bonanomi et al. (2007) found that the effect of islands of fertility is typically species-specific; *Medicago marina* shrubs have a facilitative effect on a coexisting grass, *Lophochloa pubescens*, but a negative effect on intraspecific recruitment. Conversely, bladderpod shrubs acting as islands of fertility likely promote intraspecific growth while also facilitating grasses and forbs and excluding other woody shrubs (McDonnell 2018). Though these shrubs can coexist with each other and herbaceous plant species, other woody plants have not become established in the study area, either due to competition or an inability to handle the stressful environment.

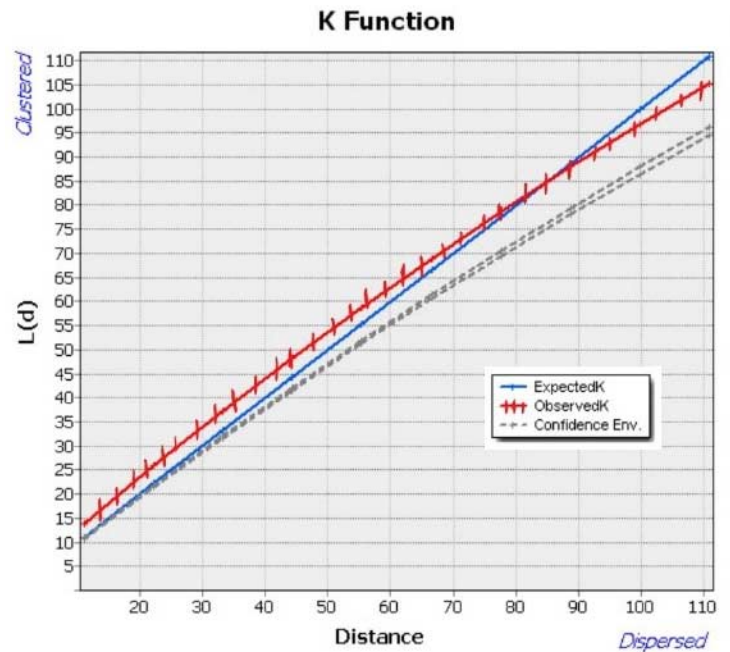


Figure 3. Multi-distance spatial cluster analysis (Ripley's K) graph. This figure was produced in ArcMap using the spatial analyst toolbox. Each plot yielded a similar result.

This suggests that the limited resources in the system favor bladderpod, which occupies an ecological niche that can tolerate these conditions.

The clustered shrub distribution was unexpected; the plants appear evenly spaced from ground level; however, the spatial analysis' main error occurs because the image classification may incorrectly lump multiple shrubs into one polygon, which would weaken any clustering effects. Because the result showed strong clustering, this error did not have an important effect; the difference between the observed and measured distributions can be attributed to human judgment error. McDonnell (2018) worked under the assumption of a uniform spatial distribution in bladderpod populations; however, after learning that the species creates islands of fertility, spatial clustering appears likely and plausible. Islands of fertility with dispersed distribution suggests some mechanism of dispersal and exclusion that prevents each individual from growing too close to another individual of the same species. However, a clustered distribution provides evidence that there is no such mechanism at work within this species. On the other hand, such a mechanism may exist and prevent the shrubs from forming one continuous cover across the whole landscape; however, this may also be caused by limited nutrients in the soil. Answering this question will require further investigation.

To understand the cause of bladderpod's clustered distribution, future studies should undertake a stable isotope analysis to trace the plants' water uptake to either the surrounding soil near the surface or water deeper underground, presumably from the water table. Bladderpod's long taproot suggests the latter; however, this will remain unsolved without an isotope analysis. If the plant obtains most of its water from

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The Spatial Distribution of *Peritoma arborea* var. *globosa* *continued*

the water table, it is unlikely the shrubs are spaced as they are due to a hydrological constraint unless the constraint only affects some life stages, like young shrubs that have not yet grown long taproots. It is possible the plants produce some allelopathic compound that increases intraspecific competition after enough individuals have grown in one cluster. It is also possible a mycorrhizal relationship exists between the species and some fungus to assist the plant with the nutrient stress of a semi-arid environment and there is an upper limit on how many plants can grow within a cluster with the help of an outside organism.

Acknowledgements

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SPECIES SPOTLIGHT: *by Laura K. Snell*¹

Photos courtesy of Selby Boerman and Laura K. Snell

Monument Plant (*Frasera speciosa*)

Monument plant (*Frasera speciosa*) is a special and unique plant that resides in alpine grasslands throughout western mountain ranges. They are more commonly recognized in the Rocky Mountains but are also prevalent in northern California mountain ranges. This beautiful plant is monocarpic, meaning that it flowers only once in its lifetime and then dies. It has been found to live up to 80 years waiting for the perfect year to bloom and often many plants bloom together in cycles every 2–7 years. They stand erect, up to seven feet tall, with upwards of 100 light green flowers with purple accents lining the stem. In non-blooming years, they appear as a low growing rosette, easy to miss compared to the blooming giants.

A couple of weeks ago, I was given the opportunity to take two interns on an overnight horseback excursion to conduct a production study in the Cottonwood Pasture of the Emerson Allotment in the Warner Mountains. The Warner Mountains are the northern- and eastern-most mountain range in California, residing in Modoc and Lassen counties and stretching into southern Oregon. The monument plants welcomed us on our journey and foiled all my attempts to identify them until we returned to the office. This year was a spectacular year for the monument plant, some might even call it a “super bloom.” They could be found as high as the hillslopes of Warren Peak (9,710 ft) and down into the lush green alpine meadows from 6,500 to 9,500 feet elevation.

UC Rangelands has been studying alpine meadows throughout California since 2012 looking at annual and long-term use, weather characteristics, and production. This particular trip was to assess a pasture that has not officially been grazed since 2012 and is part of a vacant allotment on the Modoc National Forest. Grazing has been reduced by 49% on U.S. Forest Service land from 1980 to 2010, in part due to allotments being left vacant. There are a variety of reasons why allotments are left vacant, but one of the reasons is the need for current research and data

continued next page

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Close-up of monument plant flower.



Horseback researchers Laura Snell, Selby Boerman, and Haley Dancer overlooking Warner Mountain meadows.

Monument Plant *continued*

collection to support the National Environmental Policy Act (NEPA) process. UCCE Modoc will be conducting plant surveys and utilization and production collections in the Emerson allotment over the next three years. We will be looking at the vigor and presence of different types of plants including forbs such as the monument plant.

I am so blessed to have the Warner Mountains in my backyard and a job that lets me work and play on its slopes. Even though I cannot imagine waiting 80 years for the perfect year, I welcome the sight of the beautiful flowers, full of honeybees, and commend their long wait.

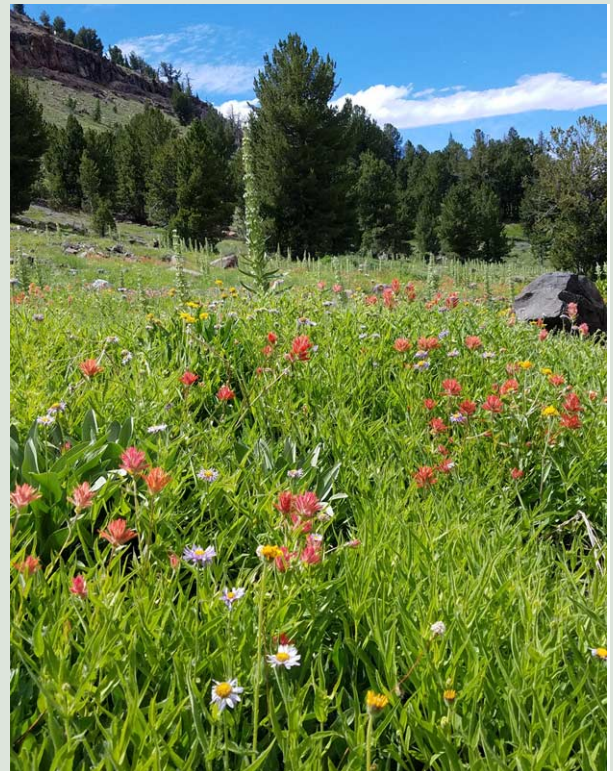


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Great numbers of monument plants rising above flowering meadows.

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Looking North toward Mount Tamalpais (shrouded in clouds) is a landscape dappled in grass and shrub. The small openings in coastal scrub were found to teem with a high diversity of native grasses.

Impacts of Coastal Scrub on the Diversity of Introduced and Native Grass in Southwestern Marin County

by Gregory Arena¹ Photos courtesy of the author

Background

Coastal Marin County, California, is host to myriad plant community types and endemic species. Much of this floral diversity occurs in meadows which populate the wide-open landscape. As an ecosystem type, grasslands are recognized for hosting roughly 90% of California's rare and endangered life, and 40% of the state native vegetation (Knops et al. 1995). A successional stepladder to so many ecosystems and an important habitat for wildlife, the greater health of our natural systems dovetails with the health of our grasslands (Elliot and Wehausen 1974). But the balance of the native grassland has been disrupted in the absence of historic disturbances such as herbivory and fire, which played essential roles in preserving and creating coastal prairies, and under the pressures of invasive species introduced to this landscape (Schloenherr 1992, Safford 1995, Keeley 2005). Since 2005, land managers such as Mount Tamalpais State Park have regularly employed mechanical methods to remove a woody shrub called coyote brush (*Baccharis pilularis*) from grasslands. State Parks based this

practice on compelling evidence that encroachment by coastal scrub—a plant community dominated by coyote brush—is rapidly diminishing the scope of meadows (Lacan et al. 2005). While prior attention has focused on the impact of coastal scrub encroachment on grass-dominated ecosystems, limited attention has been paid to the impact of coastal scrub on abundance and richness of native and introduced grasses and forbs (herbaceous plants). The objective of this research has been to investigate the relationship between coastal scrub and the quality of native diversity found in coastal grasslands.

Methods

The areas of 90 distinct meadows were mapped by hand in Arc GIS using a 2016 basemap. All 90 meadows are not currently managed for coastal shrub succession in the Golden Gate National Recreation Area—Tennessee Valley, Redwood Creek Watershed, and Homestead Valley. Two sample methods were selected to assess the interaction between grass and coastal scrub: step-point and quadrat.

Step-point surveys were conducted to explore grasslands containing a varying abundance of scrub. Fifty meadows randomly selected from the original 90 were visited for this survey. All plant life intercepting a

¹Gregory Arena is a restoration technician with the Redwood Creek Vegetation Program—a consortium of Golden Gate National Recreation Area, Golden Gate National Parks Conservancy and Mount Tamalpais State Parks.

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Larger open grasslands with little scrub component would appear to host more invasive annual grasses. Native *Agrostis* and *Stipa* can be seen at the edge, latticed in *Baccharis*.

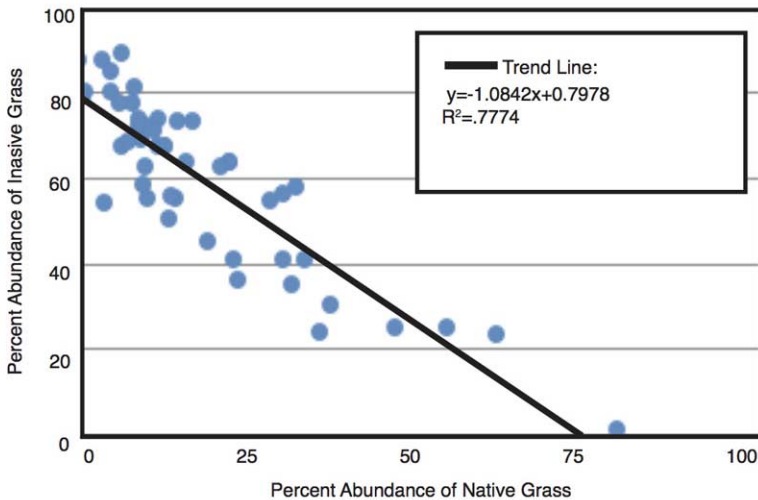


Figure 1. Relationship between the abundance of native and introduced grasses based on the 2018 data.

Impacts of Coastal Scrub *continued*

pin-flag positioned at a marked spot on the surveyors' left boot was tallied as either present or absent. Each survey was conducted along two perpendicular transects running a predetermined azimuth and overlapping at the meadow's centroid, located via GPS unit.

Percent composition of plant life in 1 m² quadrats was sampled in 30 meadows also randomly selected from the above mentioned 90 meadows. Sampling for each meadow consisted of three quadrats placed with the intention of capturing any change in species diversity as one travels from the open meadow (Meadow-baseline Plot) to the meadow-scrub interface (Ecotone Plot), and finally into coastal scrub (Scrub Plot). Two data collectors estimated the percent composition of each species and abiotic matter found within each quadrat. The Meadow-baseline Plot was placed at the meadow's centroid. If the centroid was closer than three meters to the nearest coyote brush or other woody plant life with a stem diameter greater than 1 cm or taller than 10 cm, then an alternate plot center was selected 5 m North of the centroid. If this location was also insufficient, then second, third, and fourth options would be 5 m East, South or West of the centroid. From the centroid, a bearing was taken along the slope of the grassland, and that bearing was followed to either upslope or downslope to the meadow-scrub boundary. The deciding factors on whether to move upslope or downslope were minimum distance to scrub boundary and consistent slope and topography along bearing. Along this bearing, the Ecotone Plot was selected at the first location where at minimum one whole side of the quadrat was bounded by scrub, but less than four sides were bounded by scrub. In addition, coast scrub that borders the quadrat must be within 1 m of coastal scrub on three sides. Two meters into the scrub along this same bearing the Scrub Plot was surveyed.

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Results and Discussion

Listed from most to least observed, 14 native grass species were identified in the 50 meadows surveyed via step-point method: *Stipa pulchra*, *Danthonia californica*, *Festuca rubra*, *Elymus glaucus*, *Bromus carinatus*, *Koeleria macrantha*, *Melica californica*, *Agrostis pallens*, *Festuca idahoensis*, *Elymus x hansenii*, *Festuca californica*, *Poa unilateralis*, *Elymus multisetus*, and *Festuca elmeri*. Nineteen species of introduced grasses were observed: *Avena barbata*, *Festuca bromoides*, *Festuca perennis*, *Bromus diandrus*, *Briza maxima*, *Aira caryophylla*, *Bromus hordeaceus*, *Brachypodium distachyon*, *Cynocarpus echinatus*,

continued next page

Impacts of Coastal Scrub

continued

Phalaris aquatica, *Bromus madritensis*, *Hordeum murinum*, *Dactylis glomerata*, *Holcus lanatus*, *Bromus sterilis*, *Festuca arundinaceae*, *Hordeum marinum*, and *Gastridium phleoides*.

Regarding abundance of native and introduced grasses, meadows with more introduced grasses coincides with fewer natives. An inverse correlation between the percentage of introduced grasses and the percentage of native grasses emerges, with a significance of $p < 0.001$ and R^2 of 0.78 (Figure 1). More curious is the correlation between abundance of scrub contrasted with the abundance of native and introduced grasses. Here there is an observable trend between more shrubs and less introduced grasses $p < 0.001$, $R^2 = 0.36$, and more shrubs and more native grasses $p < 0.001$, $R^2 = 0.23$ (Figure 2). Whereas the presence of scrub within a meadow does not diminish native grass abundance, the data conveys that declining grassland area, lost to scrub encroachment (Lacan et al. 2005), has no apparent influence on native abundance. When comparing abundance of native grasses or native forbs against meadow area the data is statistically significant $p < 0.001$, but returned an R^2 that approaches zero, indicating that meadow area and native diversity are not linked. However, the data does indicate that more edges, more contact between meadow and scrub, means more native and fewer introduced grasses (Figure 3). Comparing the percent abundance of native versus introduced grasses at the Ecotone Plot (where scrub is present), relative to the Meadow-baseline Plot (where no scrub is present), we find native grasses outpace introduced grasses on average by 29%, $p < 0.001$. Contrasted with the Meadow-baseline Plot, native grasses at the Scrub Plot surpassed introduced grasses on average by 12%, but with a statistically insignificant $p = 0.157$. With data also recorded for native and introduced forb diversity, it appears that native forbs outperform introduced forbs by an average of 28% in the Scrub Plot when compared to the Meadow-baseline Plot, $p < 0.001$. Though statistically insignificant at $p = 0.188$, native grasses exceeded introduced grasses by an average of 9% when comparing the Ecotone Plot to the Meadow-baseline Plot (Figure 3). To visualize: If we compared two meadows of equal surface area in which one meadow was a perfect circle and the other shaped like an asterisk, the asterisk-shaped meadow, with a higher perimeter-to-area ratio, would more likely abound in native grass diversity because the highest native grass abundance concentrates at the edges. Taken together, Figures 2 and 3 show that scrub proximity influences the abundance of native grass

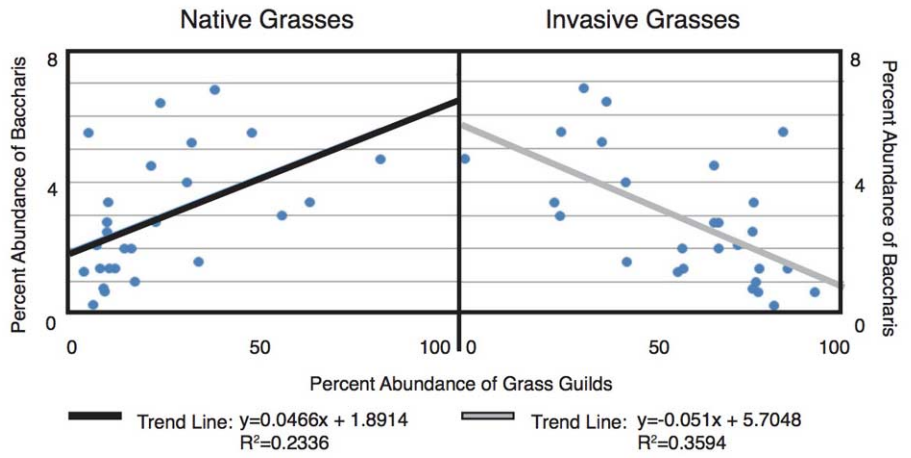


Figure 2. Impact of the abundance of coyote brush on the abundance of native and introduced grasses.

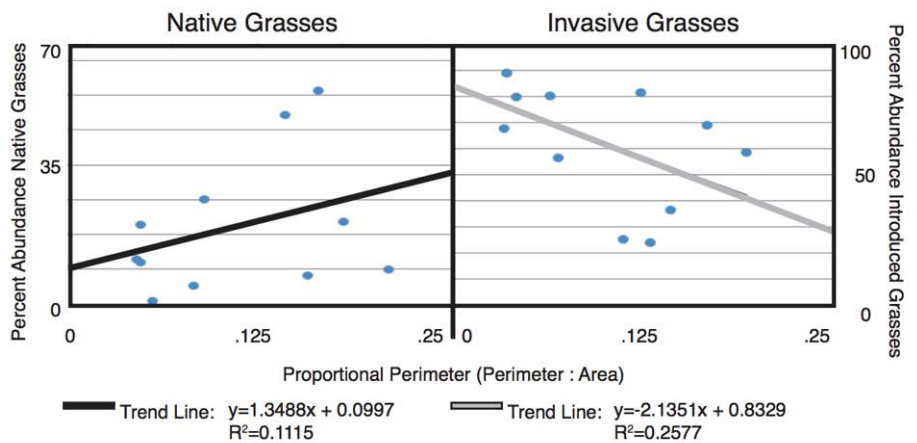


Figure 3. For each meadow surveyed via quadrat, the percent native grass abundance relative to total grass abundance was calculated at each of the three plot sites. The percentages native grass at the Meadow Plot was then subtracted from the percent native grass values from the Ecotone Plot, and also the Scrub Plot. The average of these values is represented above. This same calculation was performed for native forb abundance.

within a meadow. This occurs either by promoting native grass diversity or by creating a habitat inhospitable to introduced grasses—the only plant guild linked to depreciated native grass abundance in the data set (Figure 1).

To understand how natives could benefit in the presence of scrub, it is fundamental to understand what variable scrub introduces into these ecosystems. Extensive research illustrates that a discontinuity of native grasslands, interrupted by other plant communities, such as scrub, chaparral, or forest, may hinder seed dispersal and colonization, in this case by invasives (Alofs and Fowler 2013). Yet in the study site there are no untarnished native grasslands, with the Golden Gate National Recreation Area charting a long history of intensive ranching and dairy farming (McBride and Heady 1968, Hart 1991). From historical accounts and aerial photography, we see that much of the

continued next page

Impacts of Coastal Scrub *continued*

Recreation Area's grasslands, now enveloped in a sea of scrub, were once contiguous grassland (UCSB Library, 2012). With the exception of *Brachypodium distachyon*, these introduced grasses were established in Marin County sometime between 1860 and 1940 during the heyday of local animal husbandry (Elliot and Wehausen 1974, Choung et al. 2016, Calflora 2018). Instead, it is possible that scrub competes or introduces some competitive element into the relationship between native and invasive grasses. Native grasses dominant in the surveyed meadows, such as *Festuca rubra*, *Melica californica*, *Agrostis* spp., and *Stipa pulchra*, are all tolerant or preferential of shade (DiTomaso et al. 2013, Calscape 2013). Conversely, many of the dominant invasive grasses such as *Avena barbata*, *Festuca bromoides*, and *Briza* spp. have an affinity for full sunlight. This coincidence may be explained when considering that many of our introduced grasses hail from the wide-open pastoral settings of Europe and Asia Minor, whereas our natives have had over a millennium to adapt to coexistence with coastal scrub (DiTomaso 2013, Elliot et al. 2013). The trade-off hypothesis (Smith and Huston 1989) postulates that shade-tolerant plants are not drought tolerant. All observed native grasses are perennial and must survive the coast's dry Mediterranean summer. Fog drip, shade, and reduced wind speeds afforded by the cover of coastal scrub could limit the desiccation of grasses growing amongst the brush (Fisher et al. 2009). Foreseeably, shrubbery would hardly subtract from the area that could be occupied by an understory of shade-tolerant grasses, while at the same time excluding shade-intolerant grasses. This could explain how grassland undergoing scrub encroachment support vigorous population of native grasses, since most natives can subsist in these conditions.

Conclusion

The findings of this paper advance the importance of considering the impact of scrub on grassland diversity, not simply physical dimension. Grasslands bare of scrub or lacking interface with adjacent coastal scrub are habitats preferential to introduced grasses. It would be easy to think of grass and scrub in disparate terms—as black and white. But succession tells us these ecosystems are only two ends of a spectrum (Lacan et al. 2005). The dappled pallet of meadows, forests, and scrub found along the California Coast paint a single picture. Exploring the abundance of species that compose these meadows we find that meadows and coastal scrub cannot be contrasted when they exist intertwined and inextricable in the promotion of native grass and forb diversity on this landscape.

Acknowledgements

Without the assistance in data collection, feedback and support provided by the following individuals this report would not be possible. *In alphabetical order:* John Anderson, Bruce Badzik, Brian Charles, Alison Forrestel, Jesse Fujikawa, Martine Glaros, Elliot Gunnison, Luke Knaggs, Alexandra Kookootsedes, Emma Lasky, Monzerrat Loza, Alexander Makowicki, Elizabeth Merritt, Thomas Reyes, Christine Sullivan, Michael Valenzuela, Alexandra von Bergman, and Eric Wrubel. Special thanks to the Division of Natural Resources—Golden Gate National Recreation Area and Mount Tamalpais State Parks for permitting this research.



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MEET A GRASSLAND RESEARCHER **Daniel Toews**

Ph.D. Candidate, Environmental Systems, University of California, Merced

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

My research is almost solely conducted on the 6,500-acre Merced Vernal Pools and Grassland Reserve (MVPGR) located adjacent to the University of California, Merced. Together, the UC natural reserve, surrounding private rangelands, and conservation easements comprise one of the largest and last contiguous networks of vernal pool grassland habitat that remains in California's Central Valley. This area represents a major component of the Eastern Merced County core conservation unit of the U.S. Fish and Wildlife Service Vernal Pool Recovery Plan (2005) and exhibits a great diversity and number of threatened vernal pool species. I use genetic and traditional survey approaches as well as classical experimental biology to understand patterns of biodiversity and local adaptation in California vernal pool plant species. My research can be distilled into two major components: 1) I use a combination of traditional vegetation survey approaches and genetic survey techniques, known as environmental DNA (eDNA) metabarcoding, to genetically characterize plant species' DNA found in vernal pool soil samples and track patterns of diversity across the MVPGR; and, 2) I use a combination of field and greenhouse experiments where I transplant vernal pool plant species across different vernal pools to test the effect of different habitat characteristics on plant growth and performance. Based on those performance and fitness measures, we can make some assumptions about local adaptation to specific soil and/or community types. Ultimately, this research will develop and improve methods for detecting special status species from vernal pool soil samples and provide insight into eco-evolutionary dynamics of vernal pool plant species that are relevant when considering conservation strategies.

Who is your audience?

Although my research is targeted for the academic and non-academic science community, a primary purpose of this work is to provide government agencies, NGOs, and vernal pool grassland and rangeland conservation practitioners with information and improved survey protocols that can be used when making management decisions or

surveying for a species presence. So, I'd say our audience is anyone who wants to better understand plant diversity in vernal pool grasslands and is interested in the types of ecological and evolutionary questions we ask.

Who has inspired you, including your mentors?

Wow, what a great question! I could write an entire article on this... with that said, I continue to be inspired by so many incredible people and I will only mention some of those key folks here. I initially became

interested in biology after taking an introductory biology course at Merced Community College with professor Carl Estrella. Carl was the first person that helped me connect concepts of ecology and evolution to the real world. He paired his lectures with field trips to tidepools along the central coast and the Sierra Nevada foothills, and that is really where I fell hard for ecology and developed a keen interest in plants. During my undergraduate at UC Merced, I took courses in ecology from Dr. Marilyn Fogel and conservation biology with Dr. Jason Sexton, both of whom became my advisors in graduate school. Dr. Fogel opened my eyes to the many different aspects of ecology and

gave me the freedom to explore and the tools needed to investigate all kinds of different projects. Dr. Fogel is the catalyst that has sparked my passion for research and influenced my current trajectory. Similarly, Dr. Sexton showed me that there are no real limits to pursuing research questions, and that it is possible to study plants for a living! The experiences I had while working as an undergraduate in the Sexton Lab continue to inspire my drive for research. My love for natural history was hugely nourished by Christopher Swarth (Director of UC Merced Reserve, now retired). I worked as an undergraduate with Chris on so many different projects that revolved around the Reserve's management plans (e.g., plant and animal surveys, special status species monitoring, rangeland health and property management, etc.). Not only was Chris's enthusiasm for the natural world infectious, but he was also an incredible teacher who honed my observational skills. My love for vernal pools can be attributed to days scampering across the grasslands with Chris, Jennifer Buck-Diaz, Carol Witham, John Vollmar, and Dr. Bob Holland.



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Dec 1, 2019 Board of Directors Election. *Election closes Dec 20th.*

Dec 3, 2019 Giving Tuesday. *Our Giving Tuesday year-end fundraising will raise funds for our Grassland Research Awards for Student Scholarship (GRASS) program.*

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Apr 17, 2020 13th Annual CNGA Field Day at Hedgerow Farms

Photo: Prairies of Point Arena (see page 3 for article). Courtesy Jennifer Buck-Diaz

Daniel Toews *continued*

How has or will your research align with 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”?

The chief purpose of my research is to improve conservation, restoration, and management of native vernal pool plant species. Specifically, I aim to develop and improve protocols for rare plant species surveys and enhanced community diversity estimates that can be used to prioritize vernal pools for management. Additionally, I hope my experimental-based investigations of adaptation will be used to guide vernal pool conservation and restoration decisions that are backed by experimental evidence. Lastly, not only do I advocate for vernal pool grasslands through professional and academic meetings, but also through outreach and education at public events, K-12 and community field trips to the UC Reserve. One of the greatest privileges I’ve been given is the opportunity to work with local educators to develop the Next Generation Science curriculum based on vernal pool phenomena for public schools in the Central Valley.

Why do you love grasslands?

They are incredible! Grasslands are complex systems that represent some of the most productive, ecologically important, biologically diverse, and threatened ecosystems in the world. Unlike the grandeur of Yosemite’s towering granite monoliths and giant sequoias, California’s grasslands reveal themselves in very subtle and surprising ways that often require repeated visits across multiple seasons and your face in the weeds. I love the expansiveness, the “chi-chip” from the horned larks, and the distant songs of the coyote. It is a religious experience when you are immersed in the grasslands — when you are miles between fences, and even further from roads.



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Safeguard Native Grasses and Forbs for a More Wildfire Resilient California: CNGA weighs in on big state vegetation treatment project affecting over 20 million acres

by Jim Hanson¹, CNGA Conservation Committee Chair

There are times when society moves beyond awareness of an issue to “we’ve got to do something about this.” Fifteen of the 20 most destructive wildfires in the state’s recorded history have occurred since 2003 (Calfire, 2019). One of the ways California’s state government is responding to this threat is with a massive “Vegetation Treatment Program” (the “CalVTP”) administered through Calfire, the state’s wildfire protection agency. Over 20 million acres, mostly in the coastal ranges, the foothills, and the mountains of California, would be subject to the proposed vegetation treatment approaches described in a Draft Programmatic Environmental Impact Report (Draft PEIR) that was released this summer.

Vegetation in natural areas is often seen as the primary “something we need to do something about” to reduce wildfire risk. CNGA’s comments of the Calfire Draft PEIR focus on the important role of ground-level native and forb herbaceous vegetation. Areas with native species that provide more resiliency to wildfire and ecosystem services than weedy annuals need to be retained and managed to keep those benefits. Recent post-wildfire analyses from scientific studies and the state’s major newspapers suggest that we also not lose sight of the importance of retrofitting our homes for increased fire resiliency.

Fire Reasons and Responses

Media accounts now regularly document the reasons why California is experiencing an increase in wildfire severity and size. The state’s longer and warmer dry seasons are resulting in extensive forest tree loss from drought and disease. Past and current forest practices, such as excluding fire and logging for even-aged forest stands, have led to the buildup of forest floor litter and dense stands of small-diameter trees. Also, California’s population continues to expand with more people living adjacent to or within natural areas.

For property owners, the responses put forward to reduce risk of fire loss and damage can include: knowing evacuation routes, home “hardening” (roofing materials, retrofitting vent openings), removing “ember catchers” such as flammable shrubs under eaves or woodpiles

near a house, and by maintaining a “defensible space” of very low fuels within the Home Ignition Zone (HIZ), particularly within 5 feet of house exterior walls. For government at all levels, wildfire prevention and response activities can include: improving evacuation routes, coordinating emergency communications, public education, forest thinning, landscape-scale prescribed burns, managing fires, various forms of fuel breaks, and choosing where development is approved.

Our image of wildfire from media footage may be of giant flames reaching into the sky above conifer treetops. However, post-fire evaluations from several sites across the west are pointing to the threat of firebrands and embers under differing weather conditions, rather than the proximity of flames.

A Forest Service study of a major western Wildland-Urban Interface (WUI) fire concluded that “home destruction and survival was the result of a home’s specific flame and firebrand exposures (from) its flammable materials (e.g., siding, roof) and debris (e.g., grasses, shrubs, decorative bark)” and that “focusing on reducing home ignition potential is the key to preventing WUI fire disasters” (Graham et al, 2012). This study and other experts assert that embers, either as lofted firebrands or as surface-spreading fires that arise from ember “hot spots” after the main fire front has passed, cause over 80% of home destruction.

The *Sacramento Bee* reported that a significant percentage of newer single-family homes built in 2008 or later survived the Camp Fire that raged through Paradise. Of 350 single-family homes built after 2008, 51% were undamaged. By contrast, of 12,100 homes built before 2008, only 18% remained undamaged. In 2008, a revised building code required fire-resistant roofs, siding, and other measures for homes built in fire-prone areas (Kasler and Reese 2019).

Calli-Jane DeAnda, Butte County Fire Safe Council executive director, observed how the Paradise firestorm was not ignited by approaching flames, “it was embers landing on homes and eaves and vents.” Former Forest Service research scientist, Jack Cohen, believes that “we do fuel breaks because the premise is we’ve got a wildfire containment problem.” Instead, he argues, we largely have a home ignition problem (Boxall and Schleuss, L.A. Times, 2019).

Although fire-resistant home retrofits, community planning, and strategic wildland fuel reduction each contribute to preventing loss

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¹In addition to serving as CNGA Conservation Committee Chair, Jim Hanson serves on the East Bay CNPS Conservation Committee and the Sierra Club S.F. Chapter Public Lands Committee where he co-produced a video on wildland vegetation management, *Bring Back the Oaks*, with videographer Corinne Weber and Janis Bankoff of the Claremont Canyon Conservancy (<https://www.sierraclub.org/san-francisco-bay/hillsfacts>).

Safeguard Native Grasses and Forbs

continued

and damage from WUI fires, wildland vegetation reduction is getting the bulk of funding support from Sacramento. This spring, Governor Newsom funded 35 CEQA-exempt fuel management projects across the state as part of a larger expenditure for fuel reduction projects over the next several years (Kasler et al. 2019). A major bill to help retrofit homes to resist wildfires was recently signed but currently has no funding support.²

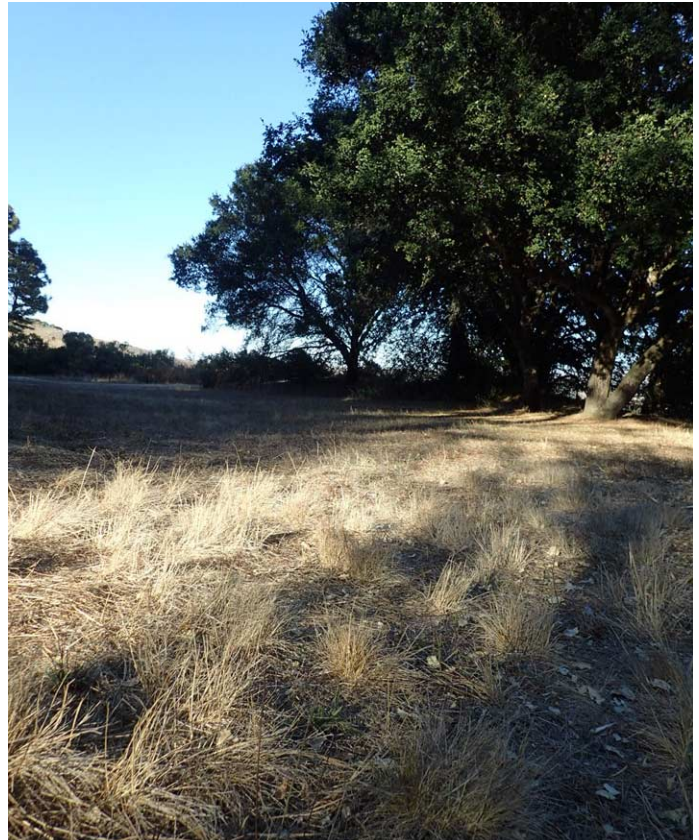
Fuel breaks — What they do, and don't do

Generally, unless the wind and weather conditions change, fuel breaks are largely ineffective during the extreme wind-driven fires (Calfire VTP Draft PEIR, Ch. 2). Their main purpose is to lessen the chance of a ground fire increasing in intensity and help fire responders contain a fire by providing accessible locations to control it.

In a study using 30 years of data from four Southern California National Forests, Syphard et al. (2011) found that fires generally don't stop at fuel breaks — they stop if there are enough firefighters to get to the fuel break and safely control the fire. Therefore, they conclude that there is a high probability that “constructing fuel breaks in remote, backcountry locations will do little to save homes during a wildfire because most firefighters will be needed to protect the wildland-urban interface...” Also, the study notes that ongoing fuel break maintenance, especially in strategic locations, “may be just as important as constructing new fuel breaks.” (Note: at last check, the 35 emergency fuel break projects authorized this year had no funding for ongoing maintenance.)

The Calfire VTP proposes to construct three forms of fuel breaks in over one-half (55%) of the total project area of approximately 20.3 million acres. These include WUI fuel breaks adjacent to communities, “non-shaded fuel breaks” in mainly shrub, chaparral, and grassland areas, and “shaded fuel breaks” in forests and woodlands. The remaining program areas would receive ecological restoration treatments intended to return “appropriate fire frequencies to the landscape” and create “forest conditions more closely associated with pre-settlement conditions” (Calfire VTP Draft PEIR, Ch. 2).

Both fuel break and ecological restoration vegetation treatments would employ a combination of treatment methods: prescribed fire, mechanical treatment, manual treatment, prescribed grazing, and herbicide treatment. Mechanical treatment involves “mastication, chipping, brush raking, tilling, mowing, roller chopping, chaining, skidding and removal, and piling, often combined with pile burning.” Pesticide applications are “ground-level applications only, such as paint-on stems, backpack hand-applicator, hypo-hatchet tree



Bunchgrasses mowed to a height that enables both fuel reduction and plant retention during recent North Orinda fuel break work (estimated to be *Stipa pulchra* based on similar unmowed plants nearby). Photo by Jim Hanson

injection, or hand placement of pellets. No aerial spray is allowed.” (Calfire VTP Draft PEIR, Ch. 2).

One thing is for certain, fuel breaks, many of which are miles long and designed to be 300 feet wide, can have significant and long-term effects — positive, benign, or destructive — within millions of acres of diverse and beneficial native vegetation. Therefore, the quantity, siting, design, and implementation of fuel breaks is important.

A better wildfire policy this time?

The policy of keeping fire out of the wildlands is attributed to the catastrophic fires in the early 1900s that burned millions of acres in Montana and Idaho, destroyed communities, and took lives (Aplet, 2006). California is experiencing that same tragedy today. However, if the policy of keeping fire out of forests and rapid-fire suppression was counter-productive in the long term, what's the better long-term approach to take now?

A policy paper on ecological forestry by The Nature Conservancy for the Sierra Nevada describes ecological thinning in forests as “prioritizing the removal of surface and ladder fuels that contribute most to wildfire hazard, while minimizing ground disturbance and impacts to those trees and shrubs that will not be removed” (Kelsey 2019, italics by author).

²Guides for home retrofitting are available through fire departments and online, such as at <https://www.firesafemarin.org/>.

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Figure 1. (from left)
WUI treatment example: Draft PEIR Figure 2–3 (Calfire, 2019).



Non-shaded fuel break example: Draft PEIR Figure 2–5 (Calfire, 2019).



Shaded fuel break example: Draft PEIR Figure 2–6 (Calfire, 2019).

Safeguard Native Grasses and Forbs *continued*

A picture is worth a thousand words, and one of CNGA’s concerns is that the CalVTP Draft PEIR only presents examples of vegetation fuel break treatments where no ground-level vegetation appears to remain (Figure 1).

The PEIR describes non-shaded fuel breaks as “typically created where there is a natural change in vegetation type, such as from forest or shrubland to grassland, and *all vegetation* is removed from the fuel break (Figure 2-5). Heavy equipment would be used to create these types of fuel breaks, except on slopes steeper than 65 percent or 50 percent in areas susceptible to erosion, where manual or prescribed burning treatments would be employed.” (CalVTP Draft PEIR, Ch. 2, italics by author). The PEIR does not fully describe how ground-level vegetation is treated in the WUI and shaded fuel breaks, except through the photo examples in Figure 1.

While the PEIR considers fuel break construction impacts to native grasses and forbs that are federally or state-listed “special-status plants” or recognized as a rare “sensitive natural community,”³ it does not adequately consider how to avoid or minimize impacts to other ground-level native herbaceous vegetation in various plant communities that can help to achieve the program objectives.

“Flashy” (quick to ignite) weedy fuels regularly fill in if predominantly herbaceous native, grass, and forb cover is removed or heavily disturbed within grassland, native shrub, and native woodland systems. Lambert et al. (2010) report on how the invasive annual grasses that colonize the disturbed edges of shrublands along roads, power lines, and fuel breaks when native shrubs are removed “dry out much earlier in the spring than the native shrubs, and with their high surface area to volume ratio, are more prone to ignition than the native vegetation.” The study noted that “Mediterranean grasses such as *Bromus* species and slender oats (*Avena barbata*) are particularly

implicated since they act as wicks, spreading fast-moving fire into the canopies of larger shrub vegetation” (Lambert et al. 2010)

Research from sage scrub, chaparral, oak woodland, and coniferous forest vegetation types indicates that non-native species cover and diversity (commonly nonnative annual grasses) are higher in fuel breaks than in surrounding wildlands (Merriam et al. 2007). The study noted that weed establishment could lead to more frequent fires and kill native plants not adapted to those fire frequencies. Also, fuel breaks created by bulldozers significantly increase nonnative plant abundance. The study concluded by saying that “fuel break construction and maintenance methods that leave some overstory canopy and minimize exposure of bare ground may be less likely to promote nonnative plants.”

Lessons from some East Bay fuel breaks

The North Orinda Fuel Break, one of the 35 emergency vegetation reduction projects funded by Governor Newsom, began operations this summer just as the Calfire VTP Draft PEIR was released. The project covers over 19 miles of ridgeline and road edges from western Contra Costa County to the Berkeley hills.

Managed by the Moraga-Orinda Fire Department (MOFD), the work includes watershed land owned by the East Bay Municipal Utilities District (EBMUD), as well as parkland managed by the East Bay Regional Park District (EBRPD). As such, the fuel break work needs to comply with the environmental standards of the park and the water district (for more information see www.mofd.org)

Conserving plant diversity has long been an integral part of EBMUD’s stated mission to protect the watershed. A major element of EBRPD’s 2010 wildfire plan is to conserve and encourage lower fuel-risk native trees, shrubs, and grasses.

Lying within the northern Central Coast region, vegetation in Contra Costa and Alameda counties is comprised primarily of grasslands, coastal scrub, chaparral, oak woodlands, and forests. The photos in Figure 2 were taken during a Sunday morning field tour with members

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³Sensitive natural communities are listed by the California Department of Fish and Wildlife as state or globally-rare communities of plants, including rare native grass and forb communities, that need to be considered in projects subject to the California Environmental Quality Act.



Figure 2. (from left)

WUI treatment example: Limbed-up oaks and moderately mowed native understory (California Native Plant Society, July 2019).

Non-shaded fuel break example: Moderately mowed mixed grass and coyote brush (*Baccharis pilularis*) shrub area. Blue wildrye (*Elymus glaucus*) re-emerging after mowing (CNGA, July 2019).

Shaded fuel break treatment: Limbed-up oaks. Ferns and low growing native grasses forbs, and sub-shrubs retained (CNGA, July 2019).

Safeguard Native Grasses and Forbs *continued*

of the East Bay Chapter of CNPS and represent work currently underway by the East Bay Regional Park District.

Compared to the photo representations in the draft PEIR, the ground-level herbaceous vegetation for the East Bay’s WUI, non-shaded, and shaded fuel breaks is trimmed, moderately mowed, or left alone, and therefore remains intact.

Ground-level vegetation composition varies considerably across the state, but, as with these examples, it is an important part of the fabric of any plant community system. Among many other practical benefits, native perennial bunchgrasses, forbs, and sub-shrubs help to hold soils in place, increase rainwater infiltration, and provide habitat. Many remain green into summer and thus hold above-ground moisture in the leaves. Wildland vegetation treatments that lay too heavy a hand on the landscape can end up converting a mostly native ground-level plant system to a largely non-native plant system and exacerbate the fuel risk conditions the project was intended to address.

Herbaceous native grasses, forbs, and sub-shrubs need to be evaluated in each site and ecoregion as potential allies in the goal to reduce wildfire risks, such as by managing vegetation treatment practices to minimize ground disturbance and retain the cover of herbaceous native grasses and forbs by incorporating these practices in fuel management contracts, by assuring compliance during fieldwork, and by expanding the practical science of “restoring fire-adapted ecosystems that resist high-intensity fire and associated property and watershed damage” (Calfire Draft PEIR, Sec. 2, 2019).

Several post-fire scientific studies and media accounts call our attention to the importance of community fire response planning and making homes more resilient to fire. Likewise, vegetation treatments in natural areas over the next one hundred years need to be designed and carried out in ways that sustain ecological diversity and reduce vegetation fuels long term, especially since the two goals often complement each other.

What you can do

Calfire will be responding to the comments submitted on the Draft Programmatic Environmental Report. You can get involved through your Fire Safe Council, City Council, Board of Supervisors, and others. Californians deserve good answers to questions about any future nearby fuel vegetation work. Here are a few to consider:

Science-based, site-specific treatment plan — How will the project make sure that vegetation treatments safeguard beneficial native vegetation and prevent the expansion of dense, easy-to-ignite weedy species?

Local plant expertise — Does the project have an on-site botanist familiar with local plant species and plant communities to walk the treatment site to identify, mark, and monitor special-status plants, sensitive natural communities, and beneficial native flora that should remain?

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Safeguard Native Grasses and Forbs *continued*

Clear, timely information to the public — How will the project provide the public with opportunities to ask questions and make comments on a specific local project, stay informed of the fuel treatment work, and be made aware of the schedule and location of future work?

Follow-up funding for succeeding years — Does program funding cover both initial work and essential follow-up monitoring and landscape maintenance?



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Figure 1: Oblong spurge (*Euphorbia oblongata*) exhibiting its invasiveness in a subdivision in Pioneer, CA.

A New Field Guide for Identifying Weeds, Forages and Natives of the Central Sierra Nevada

by Scott Oneto¹ Photos courtesy of the author

Weeds pose a significant threat to agriculture and natural ecosystems. They are capable of out-competing existing vegetation, spreading rapidly, and are difficult to control. Weed populations often decrease the biological diversity of an area, diminish wildlife values, reduce forage production and usability, lessen agricultural production, and restrict recreational opportunities (Figure 1). Understanding the threat that these species pose, reporting invasions, and treating problem areas will result in healthier, more productive, natural and agricultural communities. Identifying and controlling populations early is the best way to prevent weeds from becoming well-established and widespread.

As a Farm Advisor, I am often asked to identify plants. Frequently these are weeds that a client has pulled up from their yard or perhaps a new plant that a rancher or farmer has seen growing in one of their pastures or fields. With over 6,272 different plants in California, it is not surprising that some people find it difficult to properly identify plants. Several books are available to help aid in identification; however, some can be difficult to use, especially without proper training.

A field guide is a book designed to help the reader identify plants, animals, insects, or other objects of natural occurrence (e.g. minerals). It is generally designed to be brought into the 'field' or local area where

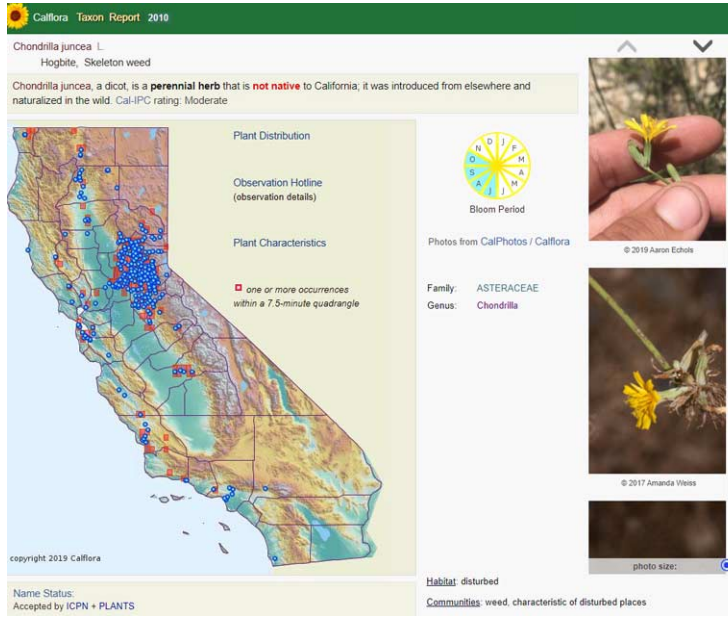
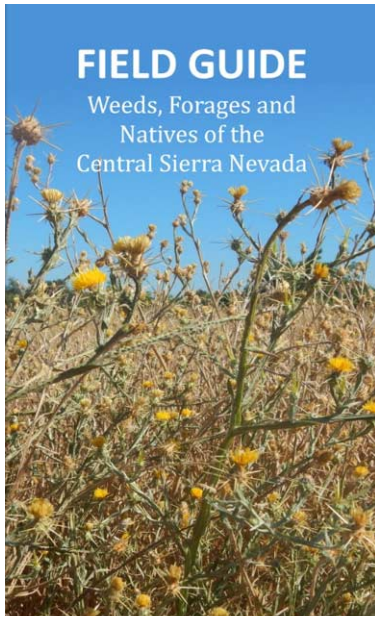
such objects exist to help distinguish between similar objects. Plant field guides are organized in a way where users can narrow their search of a particular plant either by type (tree, shrub, grass, broadleaf), flower color, and/or leaf shape. Region-specific field guides can be even more important as they highlight the plants that are most common, or in the case of a weed field guide, ones that are most problematic and/or of greatest concern.

This past year I had the fortunate opportunity to take a university sabbatical that allowed me to focus on some key projects. On the top of that list was to write a regional field guide for weeds, forages, and native plants of the central Sierra Nevada (Figure 2). When I sat down and started to list the type of information that should be in the field guide, the key elements included:

- * A detailed description of each plant that highlights key characteristics for identification.
- * Information on reproduction.
- * Identification of the country of origin and a description of the habitat type.
- * Weeds that are common and widespread along with weeds that are lesser-known and of limited distribution.
- * Highlights of the most problematic weeds that require immediate action.

¹Scott is a Farm Advisor with the University of California Cooperative Extension.

continued next page



From left:

Figure 2. New Field Guide for Weeds, Forages and Natives of the Central Sierra Nevada.

Figure 3. Distribution map for skeleton weed (Chondrilla juncea).

A New Field Guide for the Central Sierra Nevada *continued*

- * Native grasses and how to differentiate them from look-alike weeds.
- * Identification of desirable forages that are used for livestock production.
- * Native plants that can occasionally be weedy and/or problematic.
- * Information about how to control undesirable species.

In all, there are 80 plants featured with a description of each plant, key characteristics used for identification, information on reproduction, origin, habitat, and most importantly control strategies. The guide is organized into five main categories: thistles and thistle-like relatives, grasses and grass-like relatives, trees and shrubs, vines, and non-thistle broadleaves. Using these categories, users can quickly flip to a section that will help narrow the list for identification. Some weeds are identified by a red “Take Action” button that signifies that these are the worst weeds of the region and immediate action should be taken. Landowners, agencies, or land managers may determine that other plants should be included or excluded from this classification.

With financial support from numerous organizations and agencies, we are able to provide these guide for free! For those who work or live in El Dorado, Amador, Calaveras or Tuolumne counties, you can pick up a copy at one of our offices listed below. The guide is also available for free as an E-book and can be viewed on a computer or mobile device via <http://pubhtml5.com/sucj/lode>.

The E-book has additional features that users might find helpful. For many of the weeds, there is a hyperlink that will give more information on habitat, origin, reproduction, and more detailed control strategies. In addition, every plant in the E-Book has a distribution map which shows where the plant has been found in California according to the data accessible through CalFlora (Figure 3). Lastly, for any chemical control strategies, herbicides are linked directly to the pesticide label.

The *Field Guide for Identifying Weeds, Forages and Natives of the Central Sierra Nevada* is available for free from the following University of California Cooperative Extension locations: 311 Fair Lane (Placerville), 12200B Airport Road (Jackson), 423 E. Saint Charles Street (San Andreas), and 52 N. Washington Street (Sonora).



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Front and back covers: Madia elegans (common, or showy madia) seeds are attractive to birds, bees use the secretions (the "tar" of the plant) when they build their nests, and beneficial and predatory insects can be found all over the plants. The seeds can be harvested in late summer and fall by beating the dried flower heads over a vessel such as a bucket or a basket. These annuals were direct seeded at the Grace Hudson Museum in Ukiah, California, and have been reseeded and spreading each year in the grasslands of the garden. Photos by Emily Allen, CNGA board member

