GRASSLANDS

California Native Grasslands Association

Published quarterly by the California Native Grasslands Association

Vol. 32, No. 1 Winter 2022

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.

P.O. Box 485, Davis, CA 95617
cnga.org
530.902.6009 admin@cnga.org

CNGA Board of Directors

Officers

Jean-Philippe "JP" Marié, President
Kendra Moseley, Vice President
Michele Hammond, Secretary
Jodie Sheffield, Treasurer

At-Large Directors

Chad Aakre
Emily Allen
Sarah Gaffney
Michelle Halbur
Haven Kiers
Richard King
Billy Krimmel
Justin Luong
Leticia Morris
Patrick Reynolds

Administrative Director

Diana Jeffery

Grasslands

Whitney Brim-DeForest, Editor
Michelle Halbur, Editorial Committee Chair

For membership and other organization information, contact CNGA Administrator via admin@cnga.org.

Grasslands is published quarterly by CNGA.
©2022 CNGA
ISSN No. 1540-6857
Layout design: Julie St. John

From the President's Keyboard

Dear CNGA Members, Sponsors, and Friends,

I would like to wish you all a wonderful year 2022. We are still living through the COVID crisis but have adapted to the new, and hopefully temporary, normal. We are resilient, very much like our native landscapes, enduring climate change with extreme drought and extended fire season.

I want to thank our returning Board members and congratulate our re-elected members. They put a lot of work into CNGA, and I am very grateful for their passion and dedication to our organization. We are still shy of one key board member: CNGA Secretary. If you or someone you know is interested, please get in touch with us. Knowledge of native grassland ecosystems is helpful but is not necessary.

I also would like to thank our Members, Sponsors, and Donors: you are a vital component of our organization, and we are looking forward to your renewed trust.

While planning for workshops and our proposed 2-day conference, we ran up against the uncertainty of the continuing health situation. The Workshop Committee turned this problem into an opportunity, and therefore we have some exciting news to start the year. To reach more people and get outdoors together, we have decided to move the two-day conference into a one-day virtual conference with some great speakers and RESILENCE as a theme. For the in-person outreach and learning we are all yearning for, we are planning half- and full-day field trips throughout California during the year. We have some sites and field trip leaders lined up but are looking for additional potential sites and field trip leaders. We want to offer everyone the opportunity to attend a grassland site tour near you this year. You can also email us to propose some sites.

I hope you will enjoy this first 2022 edition of *Grasslands*. We are looking forward to a great year of advocacy and education.

On behalf of CNGA,

JP Marié, Board President

CNGA Events

Coming Spring and Summer 2022:

In-Person Grassland Field Trips and a Virtual Symposium

We are eager to see everyone in person, so we are planning a series of outdoor field tours at multiple sites throughout the state, culminating with a Virtual Symposium focusing on resilience during climate change and drought. *Details to come soon!*

Ongoing On-Demand Recorded Workshops

14th Annual Field Day at Hedgerow Farms, Irvine Ranch, and Dos Rios Ranch — *Sowing the Seeds of Grassland Restoration*

Follow the life of a seed from wildland harvest through the restoration process in these recorded presentations and tours featuring the beautiful scenery at Hedgerow Farms in Winters, and thanks to our virtual format, in other areas of the state. Recorded on June 11, 2021.

13th Annual Field Day at Hedgerow Farms — *From the Ashes: Fire and Restoration*

Watch at your own pace the presentations and field tours amidst the beautiful scenery at Hedgerow Farms Inc. in Winters, CA. Recorded on July 10, 2020.

Landscaping with Nature: Engaging with Evolutionary Ecology in Your Native Garden

This highly acclaimed workshop is suitable for landscape professionals and anyone interested in maximizing habitat values in their landscaping. Expert instructors present cutting-edge methods of design, installation, management, and maintenance including site evaluation, plant selection, evolutionary interactions, habitat features, and planting best practices to create a wildlife-friendly landscape. Recorded talks & supporting materials available online. Recorded in August, 2020.

***Register online and watch at your own pace:* https://cnga.org/Events/**

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.

In this issue

Submission deadlines for articles:

Spring 2022: 15 Feb 2022 ❊ **Summer 2022**: 15 May 2022 ❊ **Fall 2022**: 15 Aug 2022 ❊ **Winter 2022** 15 Nov 2022

Inter-annual Variation in Plant Community Composition and Structure Informs Passive Restoration Actions in Western Mojave Desert Rangeland, Tejon Ranch, California

by C. Ellery Mayence[1,2], Laura Pavliscak[3,2], Neal Kramer[4], Mitchell L. Coleman[5,2], and Michael D. White[6,2]*

Abstract

The Mojave Desert is a unique assemblage of plant and animal species, habitats, and ecosystems. Overlain on this landscape is a diverse array of land uses including livestock grazing. In desert ecosystems, vulnerable habitats (e.g., spring-fed wetlands) and populations of rare native plants, for example, are susceptible to overutilization by livestock, resulting in loss of biodiversity and ecosystem function. Excluding livestock from vulnerable habitats is a common passive restoration practice. Such habitats, however, often exist in a mosaic of habitats and management-focused research evaluating responses to grazing exclusion tends to be habitat-type specific. In this study, we assessed the effects of cattle exclusion on three habitat types (i.e., upland, transitional, and wetland) subjected to long-term grazing. Upland habitat was dominated by non-native annual species, exhibited notable inter-annual changes in vegetation cover, and non-equilibrium behavior driven by variable annual precipitation rather than cattle exclusion. Wetland habitat exhibited a pronounced increase in native cover and equilibrium behavior with community structure driven by interspecific competition mediated by cattle grazing. Transitional habitat was the most species-rich but least variable in terms of inter-annual variability in cover. Our results are insightful for managing rangeland where a mosaic of habitats and resources are present, strongly suggesting that grazing exclusion is not universally beneficial for maintaining or increasing species richness at the landscape scale. Habitat type, pre-existing non-native species presence, and plant life-history traits were the main factors.

Introduction

In a global context, many rangelands including grasslands suffer from resource overexploitation (Briske 2017). Livestock grazing, perhaps more than any other single activity, profoundly affects the ecological integrity of these ecosystems (Alkemade *et al.* 2012). California rangelands exemplify the pressures affecting the sustainability of rangelands more broadly (Brooks 1999; Bartolome *et al.* 2007; D'Antonio *et al.* 2007). In most California rangelands, sheep and cattle have replaced native ungulates as the primary herbivores and introduced non-native grasses and forbs often dominate. The result is that many rangelands have become novel ecosystems (Hobbs *et al.* 2006) with altered fire and soil moisture and nutrient regimes (D'Antonio and Vitousek 1992; Seabloom *et al.* 2003; Bartolome *et al.* 2014). These changes represent significant challenges for native biodiversity conservation and are exacerbated by the fact that many introduced plants are competitively superior to their native counterparts (Keane and Crawley 2002; Abraham *et al.* 2009; DiTomaso *et al.* 2010; HillRisLambers *et al.* 2010). Ironically, in rangeland with novel conditions, light to moderate grazing may be

continued next page

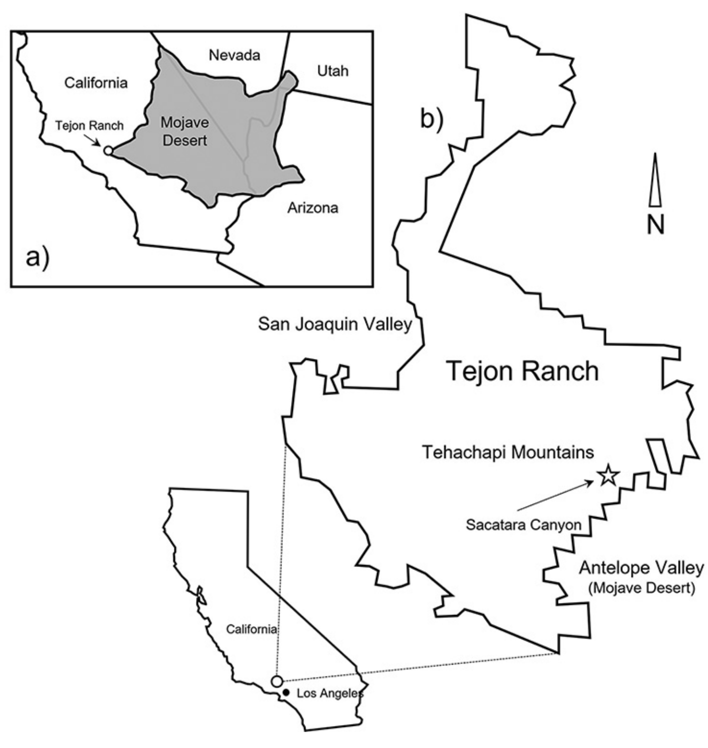


Figure 1. Approximate locations of a) the Mojave Desert, and b) Sacatara Canyon on the Mojave Desert side of Tejon Ranch.

[1]New Zealand Department of Conservation, Private Bag 4715, Christchurch, 8140, NZL. [2]Tejon Ranch Conservancy, PO Box 216, Frazier Park, CA 93225, USA. [3]Santa Clara River Conservancy, PO Box 789, Santa Paula, CA 93061, USA. [4]Kramer Botanical, PO Box 1582, El Granada, CA 94018, USA. [5]Department of Evolution, Ecology, and Organismal Biology, University of California Riverside, Riverside, CA 92521, USA. [6]Michael White Consulting, 7616 Old Santa Fe Trail, Santa Fe, NM 87505, USA. *Corresponding author

the most practical and cost-effective means for managing remnant native biodiversity (Bartolome *et al.* 2014, Barry and Huntsinger 2021). For example, grazing may help retain rare native flora and important ecological processes by reducing non-native annual grass cover and thatch (Jackson and Bartolome 2007; Bartolome *et al.* 2014; Spiegal *et al.* 2014).

Rangelands of the western Mojave Desert (Figure 1a) have been grazed since the mid-1800s (Webb & Stielstra 1979). Embedded within these drylands are discrete habitats (e.g., spring-fed wetlands, riparian corridors) that greatly enhance regional biodiversity. Rangeland pastures in the western Mojave can be large (i.e., >1000 ha) and habitats such as those noted above often occur at much smaller sub-pasture scales, allowing for selective overutilization by livestock. Whilst livestock exclusion is a common land management and restoration practice (Elmore and Kauffman 1994), the effects of livestock exclusion are less clear when a mosaic of habitats is subjected to a single grazing regime.

Biodiversity conservation is a management objective of the Tejon Ranch Conservancy, a land trust with conservation responsibility for parts of Tejon Ranch. To inform land management, the Conservancy assessed the effects of a single grazing regime, in this case, five years of grazing exclusion, in rangeland with habitats ranging from upland grassland to perennial spring-fed wetland. Direct comparisons with comparable but grazed habitats were not possible when this study was conducted. We recognize this is a limitation of this work but are confident owing to years of pre-and post-study observations across Tejon's rangelands that our findings are in a large way influenced by grazing exclusion and not simply inter-annual variation in precipitation. We would like to have carried out a more comprehensive study, but at the time our intent was to implement a stopgap measure to conserve biodiversity and share the outcomes with other conservation practitioners operating under similar fiscal constraints.

The specific objectives of this study were to:

- Assess plant species richness and composition of unique western Mojave rangeland,
- Determine how plant species richness and cover of plant guilds and individual species' dominance change across habitats in response to grazing exclusion, and
- Evaluate whether a passive ecological restoration approach promotes native plant species richness and cover while discouraging that of non-natives, or if greater investment is required to achieve these objectives.

Study area

The study area is a ±40 ha portion of Sacatara Canyon in the western Mojave Desert on Tejon Ranch, a 109,000 ha cattle ranch straddling Kern and Los Angeles counties in Southern California (Figure 1b). Sacatara Canyon has a mean elevation of ~1150 m ASL and a cold semi-arid (BSk) climate (Kesseli 1942). Mean annual precipitation for the period 2010–19 is estimated to be 330 mm (Table 1); the 30-year (1981–2010) estimated mean is 389 mm (PRISM 2020). All precipitation falls as rain/snow between November and April; summer monsoonal precipitation is rare.

Sacatara Canyon is located at the nexus of two floristic provinces: Desert and California Floristic (Baldwin *et al.* 2012). It is a botanically rich area (Jensen 2018) where desert taxa intermingle with taxa of more mesic foothill and montane ecosystems (Figure 2). Within the canyon, habitats were classified (based on hydrology and vegetation) as upland, transitional, or wetland. Upland habitat is reliant on precipitation and supports only upland plant taxa. Transitional habitat occurs between true upland and true wetland (Figure 3a-b) and supports facultative wetland (but not obligate) and upland plant taxa. Wetland habitat is fed by precipitation and perennial springs and supports obligate and facultative wetland and upland plant taxa.

Livestock grazing in Sacatara Canyon likely dates to the late 1800s (Crowe 1957), initially involving sheep but mainly cattle since the early 1900s. The canyon serves as a holding pasture during roundups, and some upland habitat may have been cultivated. Infrastructure for managing cattle in Sacatara Canton was limited until 2014, at which time standard five-strand stock fencing and swing gates were installed to create three exclosures ranging in area from 1 to 10 ha. Each exclosure contained representative examples of each habitat type.

continued next page

Table 1. Annual precipitation (2010-2019) estimated for a 4 km^2 grid cell containing Sacatara Canyon, Tejon Ranch, by the Parameter-elevation Regressions on Independent Slopes Model (PRISM 2020).

Year	Total estimated precipitation (mm)
2010	645
2011	367
2012	247
2013	149
2014	294
2015	214
2016	302
2017	291
2018	248
2019	538
10-year (2010–19) mean	330
30-year normal (1981–2010)	389

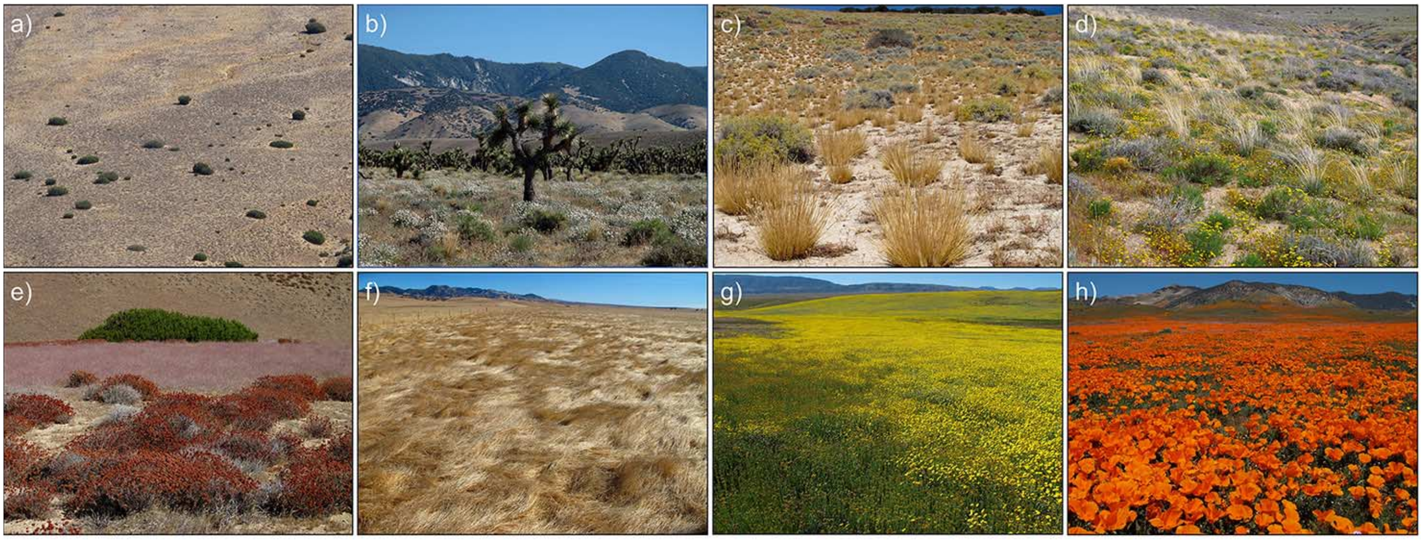


Figure 2. Botanical landscape of western Mojave Desert rangeland, Tejon Ranch, including a) grassland with scattered California Juniper (*Juniperus californica*) shrubs, b) Joshua tree (*Yucca brevifolia*) woodland, c) grassland dominated by desert needle grass (*Stipa speciosa*), d) mosaic of nodding needle grass (*Stipa cernua*) and native forbs/herbs, e) flowering buckwheat (*Eriogonum* spp.), f) non-native grass-dominated rangeland, and flowering forbs/herbs on g) clayey loam soil, and h) sandy loam soil. *Photos: C. Ellery Mayence*

Inter-annual Variation in Plant Community Composition and Structure Informs Passive Restoration Actions in Western Mojave Desert Rangeland *continued*

Methods

Vegetation sampling

Vegetation was sampled annually in April/May using two methods: point intercept and quadrat (Elzinga *et al.* 1998). Sampling commenced in 2014 prior to fence installation and cattle exclusion. Therefore, 2014 data are considered baseline and the reference point for interpreting change in vegetation over the period 2015–19. For the point intercept method, point samples were taken at l-m intervals along transects (21 in total) 50 or 100 m in length. For consistency, transects followed lines of contour where possible. Nine transects were sampled in upland habitat; six each in transitional and wetland habitat. Transects of both lengths were sampled in upland and transitional habitat; only 50 m transects were sampled in wetland habitat. Transect number and length varied within and across habitats according to topography, fence configuration, and the areal extent of each habitat type. Wetland habitat was the most discrete and could not accommodate transects longer than 50 m. At 1-m intervals along each transect, all plants encountered when lowering a 2 mm-diameter steel pin through the vegetation canopy were recorded.

To ensure species richness was representative, point-intercept sampling was supplemented with quadrat sampling. A 0.25 m^2 (50 x 50 cm) quadrat was used because relatively few rare plants occur within the study area (Kramer 2019), and these dimensions were an optimum trade-off between spatial coverage and time to sample. Quadrats were placed at 5-m intervals along point-intercept transects and all taxa rooted within a quadrat were recorded.

Statistical analyses

Statistical Analysis Software (SAS) Version 9.2 (SAS 2010) was used for all analyses. For species richness and cover, taxa were grouped into one of six plant guilds: 1) native grasses, 2) non-native grasses, 3) native forbs/herbs, 4) non-native forbs/herbs, 5) native non-grass graminoids, or 6) native shrubs/trees. No non-native non-grass graminoids or non-native shrubs/trees occur in Sacatara Canyon. Point-intercept data were used to analyze vegetation cover; quadrat data for analyzing species richness.

One-way repeated-measures ANOVA was used to assess change in species richness and vegetation cover; Tukey's adjustment was used to assess between-year significance. Pearson's correlation coefficient (r) was used to report among-guild relationship strength. The significance for all analyses was $p \leq 0.05$.

Results

Sacatara Canyon vegetation composition

At least 196 plant taxa occur in Sacatara Canyon (Kramer 2019; Table 2 and S1): 154 native and 42 non-native. The forb/herb guild is dominant, accounting for 112 of the native taxa and 27 of the non-native. In comparison, 25 grass taxa (15 non-native and 10 native), 22 shrub/tree taxa, and 10 non-grass graminoid taxa are present. The mean number of taxa observed in this study was 98, whilst the mean number of unique taxa (i.e., turnover in species richness) was 4 (Table 2). Native taxa accounted for 71% of mean richness (non-native 29%). Forbs/herbs were dominant (62% of observations), followed by grasses (18%), and shrubs/trees and non-grass graminoids (each 10%).

continued next page

Upland habitat

Mean species richness in upland habitat was 11 (Table 3). Richness fluctuated significantly ($p \leq 0.01$) over time, though 2019 and 2014 richness were similar. Non-native grasses and forbs/herbs, and native forbs/herbs were most prevalent (collectively 91–94% of richness), though only the forb/herb guild changed significantly ($p < 0.01$). However, forb/herb richness in 2019 and 2014 was similar.

continued next page

Table 2. Plant species richness over the period 2014–19 in Sacatara Canyon, Tejon Ranch. Total species pool represents all plant taxa known to occur in Sacatara Canyon (Kramer 2019). Yearly (2014–19) values determined from systematic point and quadrat sampling. For total species pool (X%) is percent of grand total, for yearly values (X%) is percent of total within that guild, and for 5-year mean (X%) is percent of the 5-year mean grand total. Sub-totals distinguish native and non-native taxa. Grand total is inclusive of all taxa per row. Grand total$^{(x)}$ is number of taxa unique to that year. 2014 data are pre-cattle exclusion.

	Native taxa					Non-native			All taxa
	Forb/herb	Grass	Non-grass graminoid	Shrub/tree	*Sub-total*	Forb/herb	Grass	*Sub-total*	*Grand total*
Total species pool$^{\Psi}$	112 (57%)	10 (5%)	10 (6%)	22 (11%)	154 (79%)	27 (14%)	15 (8%)	42 (21%)	196 (100%)
2014	43 (38%)	7 (70%)	7 (70%)	10 (45%)	67 (44%)	15 (56%)	13 (87%)	28 (67%)	95$^{(5)}$ (48%)
2015	41 (37%)	6 (60%)	10 (100%)	10 (45%)	67 (44%)	18 (67)	12 (80)	30 (71)	97$^{(5)}$ (49%)
2016	48 (43%)	5 (50%)	10 (100%)	12 (55%)	75 (49%)	17 (63%)	9 (60%)	26 (62%)	102$^{(7)}$ (52%)
2017	37 (33%)	6 (60%)	10 (100%)	10 (45%)	63 (41%)	19 (70%)	11 (73%)	30 (71%)	93$^{(1)}$ (47%)
2018	45 (40%)	5 (50%)	10 (100%)	10 (45%)	70 (45%)	15 (56%)	10 (67%)	25 (60%)	96$^{(1)}$ (49%)
2019	47 (42%)	7 (70%)	9 (90%)	10 (45%)	73 (47%)	17 (63%)	9 (60%)	26 (62%)	99$^{(3)}$ (51%)
5-year mean % of grand total	44 (45%)	6 (6%)	10 (10%)	10 (10%)	70 (71%)	17 (18%)	11 (11%)	28 (29%)	98$^{(4)}$ (50%)

$^{\Psi}$Total species pool determined from opportunistic vegetation surveys conducted across all years and seasons.

Table 3. Upland habitat a) plant species richness, and b) vegetation cover over the period 2014–19 in Sacatara Canyon, Tejon Ranch. 2014 data are pre-cattle exclusion. Values are means ± SE.

a) Plant species richness		Native (no.)				Non-native (no.)	
Year	Total no. (native + non-native)	Forb/herb	Grass	Non-grass graminoid	Shrub/tree	Forb/herb	Grass
2014	11.6±1.5^{a}	3.3±0.8^{a}	0.0	0.0^{a}	0.9±0.5^{a}	3.8±1.1^{a}	3.6±0.3^{a}
2015	10.6±1.5^{a}	3.8±1.1^{a}	0.0	0.0^{a}	0.9±0.5^{a}	2.1±0.4^{a}	3.8±0.4^{a}
2016	11.0±1.7^{a}	4.6±1.5^{a}	0.0	0.0^{a}	0.9±0.5^{a}	2.3±0.3^{a}	3.2±0.3^{a}
2017	7.3±1.2^{b}	2.0±0.7^{b}	0.0	0.0^{a}	0.9±0.5^{a}	1.1±0.2^{b}	3.3±0.5^{a}
2018	10.9±1.4^{a}	3.9±1.1^{a}	0.0	0.0^{a}	0.9±0.5^{a}	3.0±0.3^{a}	3.1±0.4^{a}
2019	12.2±1.9^{a}	4.8±1.7^{a}	0.0	0.1±0.1^{a}	0.9±0.5^{a}	3.0±0.3^{a}	3.4±0.2^{a}
F-value$_{(df5,53)}$	7.14**	7.59**	—	1.00^{NS}	0.0^{NS}	4.88*	0.75^{NS}

b) Vegetation cover		Relative (%)				Relative (%)	
	Absolute (%)	Native				Non-native	
Year	Total (native + non-native)	Forb/herb	Grass Grass	Non-grass graminoid	Shrub/tree	Forb/herb	Grass
2014	83.0±2.7^{a}	10.5±2.5^{ba}	0.0	0.0^{a}	10.0±4.1^{a}	13.2±3.8^{bc}	66.3±4.6^{ba}
2015	71.3±2.9^{b}	6.2±1.5^{bc}	0.0	0.0^{a}	8.3±3. ^{a}	28.3±7.1^{a}	57.1±7.2^{bc}
2016	84.2±3.0^{a}	13.7±4.5^{ba}	0.0	0.0^{a}	8.0±3.6^{a}	30.4±7.3^{a}	47.9±9.0^{c}
2017	75.2±4.5^{ba}	1.9±0.9^{d}	0.0	0.0^{a}	10.0±4.7^{a}	13.5±6.7^{c}	74.6±8.0^{a}
2018	77.9±3.7^{ba}	2.4±0.8^{dc}	0.0	0.0^{a}	10.8±4.7^{a}	22.5±6.3^{ba}	64.4±6.3^{ba}
2019	75.6±4.8^{ba}	18.3±5.9^{a}	0.0	0.5±0.2^{a}	6.6±3.1^{a}	30.4±6.1^{a}	44.1±6.8^{c}
F-value$_{(df5,53)}$	3.32*	8.51**	—	2.19^{NS}	0.52^{NS}	6.54**	9.28**

Means without shared letters indicate significance at $p \leq 0.05$ (Tukey's multiple comparison adjustment). F-values are ANOVA results for each column. Model significant at $^{*}p \leq 0.05$ or $^{**}p \leq 0.01$); ^{NS}model not significant ($p > 0.05$).

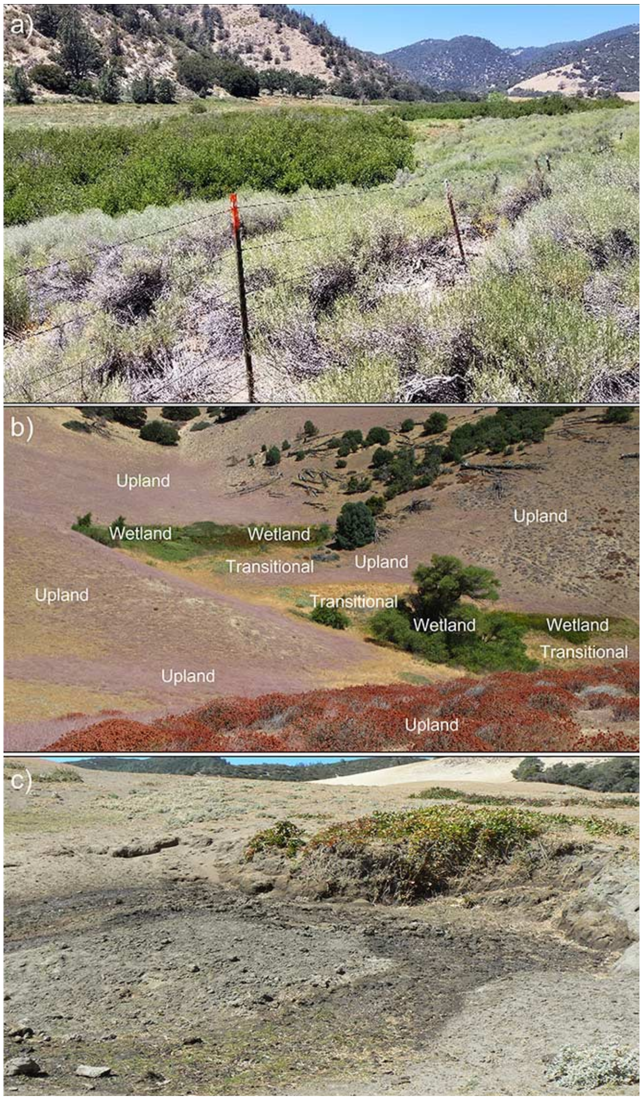


Figure 3. Sacatara Canyon, Tejon Ranch, including a) rubber rabbitbrush (*Ericameria nauseosa*) scrub, arroyo willow (*Salix lasiolepis*) thicket, and perimeter fence on canyon floor, b) mosaic of upland, transitional, and wetland habitats, and c) denuded spring-fed wetland prior to cattle exclusion. *Photos: C. Ellery Mayence (a,b) and Michael D. White (c)*

Inter-annual Variation in Plant Community Composition and Structure Informs Passive Restoration Actions in Western Mojave Desert Rangeland *continued*

Absolute vegetation cover fluctuated significantly over the period 2014–16, with noticeably less change over the period 2017–19 (Table 3). Relative cover by guild, on the other hand, exhibited considerable change, though not consistently in any one direction. Forb/herb cover (both native and non-native) reached five-year maximums in 2019, though their respective values were similarly high in 2016. In comparison, non-native grass cover dropped to a five-year minimum in 2019, though it was similarly low in 2016.

Non-native grass cover was inversely coupled with that of forbs/herbs, such that when grass cover decreased, forb/herb cover increased, and vice versa (Figure 4a). This coupling was stronger for non-native forbs/herbs (r_{106} = -0.80; $p < 0.01$) compared to their native counterparts (r_{106} = -0.54; $p < 0.01$). Native grasses were a non-factor in upland habitat and native shrub/tree cover did not change appreciably.

Ripgut brome (*Bromus diandrus*), cheatgrass (*B. tectorum*), wall barley (*Hordeum murinum*), and, to a lesser extent, the forbs/herbs red-stemmed filaree (*Erodium cicutarium*) and tumble mustard (*Sisymbrium altissimum*), were the greatest contributors to upland relative vegetation cover (collectively accounting for 74–87%; Figure 4b). Rubber rabbitbrush (*Ericameria nauseosa*), and the forbs/herbs bicolored lupine (*Lupinus bicolor*), Arizona popcorn flower (*Plagiobothrys arizonicus*), and bristly fiddleneck (*Amsinckia tesselata*), were the only native taxa consistently present (collectively accounting for 7–16% of relative cover).

Transitional habitat

Mean species richness in transitional habitat was 21 (Table 4). Non-native forbs/herbs and grasses, and native forbs/herbs were most prevalent (collectively accounting for 75–78% of richness). Richness decreased over time, but 2019 and 2014 values were not significantly different. Non-native

continued next page

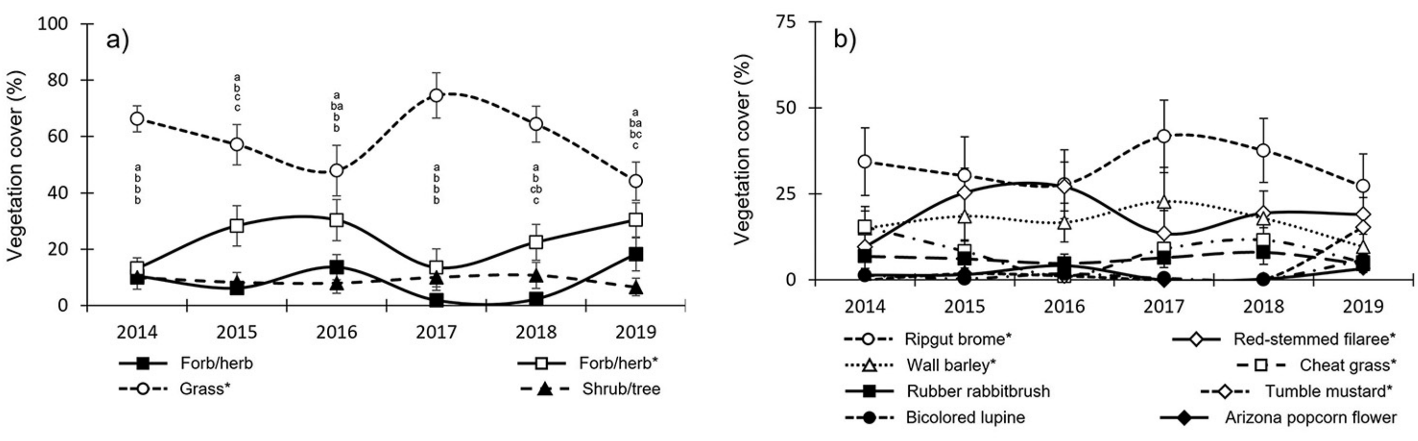


Figure 4. Upland habitat relative vegetation cover in Sacatara Canyon, Tejon Ranch, over the period 2014–19 by a) guild, and b) dominant plant taxa. Values are means ± SE. Means without shared letters (left panel) indicate significance at $p \leq 0.05$. Native grass cover not shown due to negligible contribution. Dominance at the species level (right panel) shown for descriptive purposes and was not statistically analyzed. *Non-native.

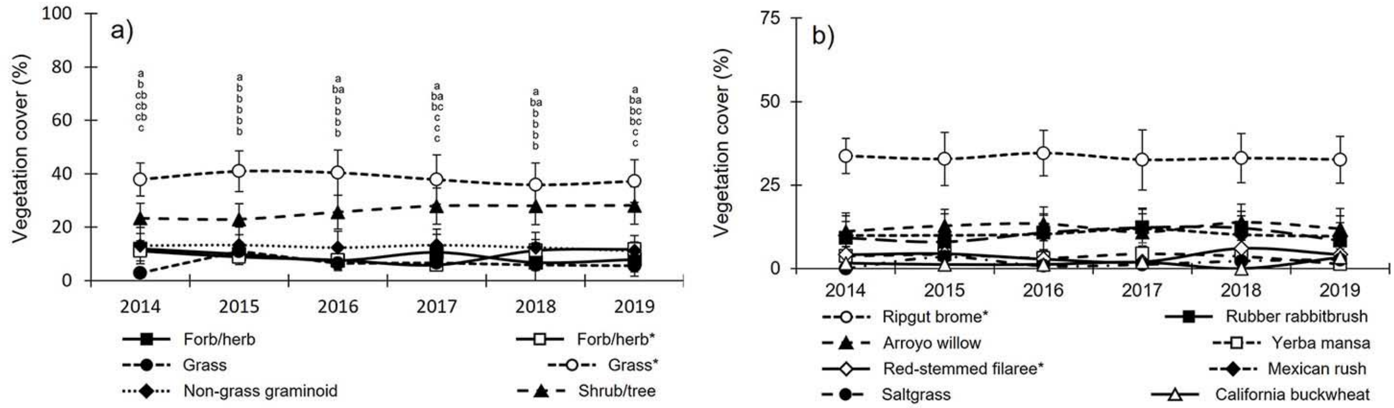


Figure 5. Transitional habitat relative vegetation cover in Sacatara Canyon, Tejon Ranch, over the period 2014–19 by a) guild, and b) dominant plant taxa. Values are means ± SE. Means without shared letters (left panel) indicate significance at $p \leq 0.05$. Dominance at the species level (right panel) shown for descriptive purposes and was not statistically analyzed. *Non-native.

Inter-annual Variation in Plant Community Composition and Structure Informs Passive Restoration Actions in Western Mojave Desert Rangeland *continued*

grasses largely accounted for this decrease. The richness of other guilds changed very little.

Absolute vegetation cover decreased significantly ($p < 0.01$; Table 4) over the five years notwithstanding an uptick in 2018. The change in relative vegetation cover was more variable and guild-dependent. For the native component, grass and shrub/tree cover increased whilst forb/herb and non-grass graminoid cover decreased. For the non-native component, forb/herb cover decreased then increased, whilst non-native grass cover increased then decreased.

Non-native grass cover was inversely coupled with shrub/tree cover, such that grass cover decreased as shrub/tree cover increased ($r_{70} = -0.77$; $p < 0.01$; Figure 5a). A similarly strong relationship was observed between shrub/tree and non-native forb/herb cover ($r_{70} = -0.73$; $p < 0.01$).

continued next page

Table 4. Transitional habitat a) plant species richness, and b) vegetation cover over the period 2014-19 in Sacatara Canyon, Tejon Ranch. 2014 data are pre-cattle exclusion. Values are means ± SE.

a) Plant species richness		Native (no.)				Non-native (no.)	
Year	Total no. (native + non-native)	Forb/herb	Grass	Non-grass graminoid	Shrub/tree	Forb/herb	Grass
2014	22.5±1.6^{a}	5.5±0.7^{a}	1.3±0.4^{a}	1.8±0.3^{a}	2.0±0.5^{a}	6.3±0.7^{a}	5.5±1.0^{a}
2015	21.5±2.3^{a}	5.2±1.4^{a}	1.2±0.4^{a}	1.8±0.3a	1.8±0.5^{a}	6.0±0.9^{a}	5.5±0.8^{a}
2016	19.7±1.9^{a}	5.2±1.5^{a}	1.5±0.6^{a}	1.8±0.5^{a}	1.8±0.5^{a}	4.8±0.5^{a}	4.5±0.6^{a}
2017	19.7±2.5^{a}	5.0±1.1^{a}	1.7±0.6^{a}	1.8±0.4^{a}	1.7±0.4^{a}	5.3±1.6^{a}	4.0±0.4^{a}
2018	20.5±1.3^{a}	5.2±1.2^{a}	1.3±0.4^{a}	1.7±0.3^{a}	2.0±0.5^{a}	6.8±1.2^{a}	3.5±0.3^{a}
2019	20.2±1.0^{a}	5.2±1.2^{a}	1.5±0.5^{a}	1.5±0.2^{a}	1.5±0.4^{a}	6.7±0.9^{a}	3.8±0.4^{a}
F-value$_{(df5,53)}$	0.81^{NS}	0.21^{NS}	0.99^{NS}	0.26^{NS}	1.85^{NS}	1.57^{NS}	2.41^{NS}

b) Vegetation cover		Relative (%)				Relative (%)	
	Absolute (%)	Native				Non-native	
Year	Total (native + non-native)	Forb/herb	Grass	Non-grass graminoid	Shrub/tree	Forb/herb	Grass
2014	93.6±2.4^{a}	11.9±3.2^{a}	2.7±1.0^{b}	13.1±6.8^{a}	23.3±5.7^{a}	11.1±3.8^{a}	37.9±6.2^{a}
2015	85.5±3.3^{b}	9.9±2.0^{a}	10.9±3.6^{ba}	13.3±6.7^{a}	22.9±5.8^{a}	8.9±2.8^{ba}	40.9±7.6^{a}
2016	83.0±4.2^{b}	7.5±1.3^{a}	6.5±2.9^{ba}	12.4±6.2^{a}	25.6±6.4^{a}	7.7±3.6^{ba}	40.4±8.5^{a}
2017	80.6±3.6^{cb}	10.5±3.1^{a}	6.5±2.7^{ba}	12.4±5.2^{a}	27.9±6.7^{a}	5.7±1.8^{b}	37.0±9.4^{a}
2018	86.6±2.0^{b}	6.8±2.7^{a}	5.8±2.1^{ba}	12.4±5.7^{a}	27.9±6.9^{a}	11.2±4.1^{a}	35.8±8.1^{a}
2019	75.1±4.9^{c}	7.9±1.6^{a}	5.5±2.5^{a}	10.5±5.4^{a}	28.1±7.1^{a}	11.6±2.7^{a}	36.3±8.2^{a}
F-value$_{(df5,53)}$	13.73**	1.27^{NS}	2.15^{NS}	0.65^{NS}	2.83*	3.77*	0.84^{NS}

Means without shared letters indicate significance at $^{*}p \leq 0.05$ or $^{**}p \leq 0.01$ (Tukey's multiple comparison adjustment). F-values are ANOVA results for each column; ^{NS}model not significant ($p > 0.05$).

Ripgut brome was dominant, accounting for an average 33% of vegetation cover (Figure 5b). Also prominent were arroyo willow (*Salix lasiolepis*), rubber rabbitbrush, and Mexican rush (*Juncus mexicanus*), all native taxa accounting collectively for 32% of relative cover. Less prominent but noteworthy were two forbs/herbs, the non-native red-stemmed filaree and the native yerba mansa (*Anemopsis californica*), contributing 4% and 3%, respectively.

Wetland habitat

Mean species richness in wetland habitat was 18 (Table 5). Native forbs/herbs were dominant (42% of richness), followed by non-native forbs/herbs and grasses (22% and 17%, respectively) and non-grass graminoids (15%). Shrub/tree and native grass contributions were negligible.

Absolute vegetation cover was relatively consistent in the first four years of cattle exclusion (Table 5) but decreased markedly in 2019. Relative vegetation cover changed significantly within and across guilds, with the decrease in non-native grass and forb/herb cover and increase in native forb/herb and non-grass graminoid cover of greatest interest. Shrub/tree cover was consistently small and native grass cover was sparse.

Non-grass graminoid and native forb/herb cover were inversely coupled with that of non-native grass cover (r_{70} = -0.75; $p < 0.01$ and r_{70} = -0.71; $p < 0.01$, respectively; Figure 6a) such that as grass cover decreased, non-grass graminoid and native forb/herb cover increased. In terms of change, non-native grass cover decreased by 15% whilst non-grass graminoid and native forb/herb cover collectively increased by 20%.

Ripgut brome was ever-present in wetland habitat, accounting for as much as 52% of relative cover (Figure 6b). However, by 2019 it had decreased to 35%. The non-native grasses, annual beard grass (*Polypogon monspeliensis*) and water beard grass (*P. viridis*), also exhibited precipitous declines (from 12% to <1%). In terms of natives, cover by cobwebby hedge nettle (*Stachys albens*), stinging nettle (*Urtica dioica*), and yerba mansa collectively increased from 8% to 25%. Over the same period, non-grass graminoid cover increased from 7% to 14%. Accounting for this increase were several rush species (Mexican [*Juncus mexicanus*], wire [*J. balticus*], iris leaf [*J. xiphioides*], common toad [*J. bufonius*], and wrinkled [*J. rugulosus*]), and two sedges, field (*Carex praegracilis*) and Hasse's (*C. hassei*). Red-stemmed filaree and annual yellow sweetclover (*Melilotus indicus*) represented the downward trending non-native forb/herb guild that in 2019 still accounted for nearly 10% of cover.

continued next page

Table 5. Wetland habitat a) plant species richness and b) vegetation cover over the period 2014–19 in Sacatara Canyon, Tejon Ranch. 2014 data are pre-cattle exclusion. Values are means ± SE.

a) Plant species richness		Native (no.)				Non-native (no.)	
Year	Total no. (native + non-native)	Forb/herb	Grass	Non-grass graminoid	Shrub/tree	Forb/herb	Grass
2014	19.5±3.0^{a}	8.0±0.9^{ba}	0.0^{a}	2.5±0.6^{a}	0.3±0.2^{a}	4.3±1.0^{a}	4.3±0.4^{a}
2015	20.2±1.1^{a}	7.0±0.6^{ba}	0.3±0.1^{a}	3.7±0.4^{a}	0.7±0.2^{a}	4.2±0.3^{a}	4.2±0.3^{a}
2016	17.2±1.2^{a}	8.3±0.6^{a}	0.2±0.1^{a}	2.5±0.4^{a}	0.5±0.2^{a}	3.3±0.3^{a}	2.3±0.3^{b}
2017	15.2±2.3^{a}	5.7±0.6^{b}	0.3±0.1^{a}	2.8±0.7^{a}	0.7±0.2^{a}	3.3±0.9^{a}	2.3±0.3^{b}
2018	19.3±1.9^{a}	9.0±0.9^{a}	0.3±0.2^{a}	2.5±0.8^{a}	0.7±0.2^{a}	4.5±1.0^{a}	2.3±0.6^{b}
2019	18.7±1.8^{a}	7.7±0.7^{ba}	0.2±0.1^{a}	2.8±0.6^{a}	0.8±0.3^{a}	4.7±0.7^{a}	2.5±0.2^{b}
F-value$_{(df5,53)}$	1.70^{NS}	2.97*	0.69^{NS}	1.19^{NS}	0.98^{NS}	0.87^{NS}	6.34*

b) Vegetation cover		Relative (%)				Relative (%)	
	Absolute (%)	Native				Non-native	
Year	Total (native + non-native)	Forb/herb	Grass	Non-grass graminoid	Shrub/tree	Forb/herb	Grass
2014	92.8±3.2^{a}	20.1±1.8^{ba}	0.0^{a}	7.4±2.8^{a}	4.3±2.8^{a}	16.6±3.7^{a}	51.5±5.3^{ba}
2015	89.3±1.8^{ba}	15.4±2.5^{b}	0.2±0.2^{a}	10.9±5.6^{a}	5.1±3.2^{a}	8.7±1.5^{ba}	60.1±8.0^{a}
2016	88.2±1.7^{ba}	17.1±2.3^{b}	0.3±0.3^{a}	18.2±5.1^{a}	4.7±2.7^{a}	7.3±1.9^{ba}	52.5±8.7^{ba}
2017	86.5±2.7^{ba}	34.8±6.8^{a}	0.0^{a}	14.8±5.9^{a}	6.4±3.3^{a}	3.6±1.1^{b}	40.5±8.9^{bc}
2018	93.2±1.6^{a}	31.3±7.3^{a}	0.1±0.1^{a}	12.8±5.9^{a}	6.4±3.1^{a}	10.1±2.4^{a}	39.3±8.8^{bc}
2019	79.8±3.5^{b}	34.9±6.3^{a}	0.2±0.2^{a}	13.5±7.1^{a}	6.0±3.2^{a}	9.0±2.1b^{a}	36.5±10.0^{c}
F-value$_{(df5,53)}$	3.32*	5.78*	0.59^{NS}	1.91^{NS}	0.31^{NS}	4.99*	5.14*

Means without shared letters indicate significance at *$p \leq 0.05$ (Tukey's multiple comparison adjustment). F-values are ANOVA results for each column; ^{NS}model not significant ($p > 0.05$).

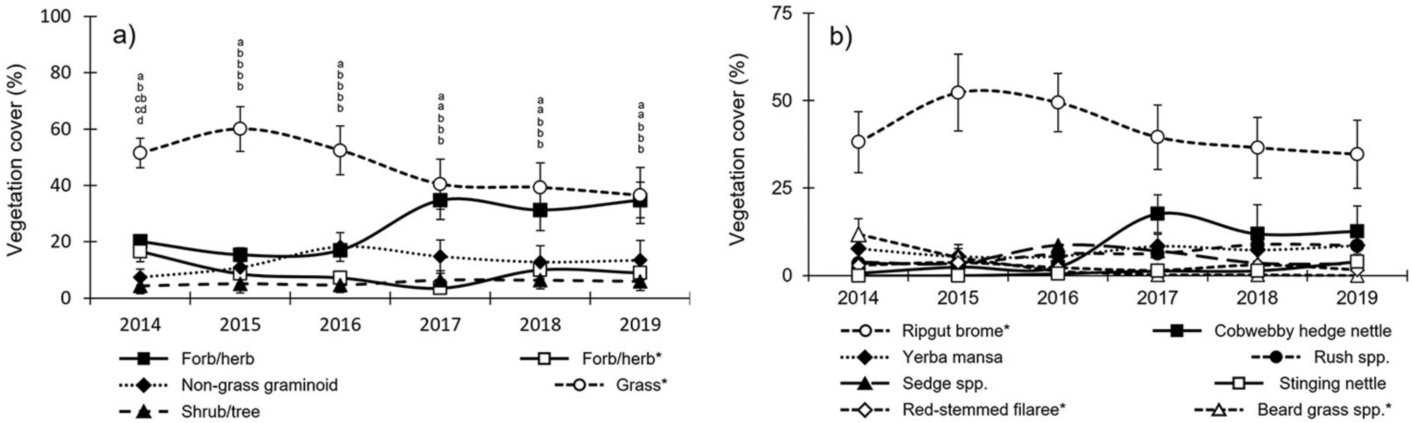


Figure 6. Wetland habitat relative vegetation cover in Sacatara Canyon, Tejon Ranch, over the period 2014–19 by a) guild, and b) dominant plant taxa. Values are means ± SE. Means without shared letters (left panel) indicate significance at $p \leq 0.05$. Native grass cover not shown due to negligible contribution. Dominance at the species level (right panel) shown for descriptive purposes and was not statistically analyzed. *Non-native.

Inter-annual Variation in Plant Community Composition and Structure Informs Passive Restoration Actions in Western Mojave Desert Rangeland *continued*

Discussion

In this rangeland study, spring-fed wetlands and transitional habitats supported nearly twice the number of plant taxa and a higher proportion of native taxa compared to upland habitat. Wetland plant species richness was comparable to richness in other Mojave Desert and Great Basin spring systems (Fleishman *et al.* 2006; Abella *et al.* 2014) despite wetlands in Sacatara Canyon being in very poor condition prior to cattle exclusion (Figure 3c). Unlike Abella *et al.* (2014), we did not observe increasing species richness with increasing distance from wetlands. Compared to the flora of other desert springs systems (Fleishman *et al.* 2006, Abella *et al.* 2014), the proportion of non-native taxa in Sacatara Canyon is relatively high. Like Fleishman *et al.* (2006), who found native plant species richness to be inversely related to the magnitude of human disturbance, our results reflect a legacy of land-use disturbances.

Ripgut brome is pervasive in Sacatara Canyon. It is not common in the Mojave Desert (Brooks 1999; Abella *et al.* 2009, 2014), nor was it found to be notable in any Mojave Desert grassland type on Tejon Ranch (Spiegal 2015). It is more typical of habitats on the Great Central Valley side of Tejon Ranch in the California Floristic Province where soils and precipitation are more accommodating (Bartolome *et al.* 2007; Spiegal 2015). We think historical land-use change provided the mechanism by which ripgut brome established, and that disturbance, associated with cattle grazing combined with its transformer species traits (HillRisLambers *et al.* 2010), benefits its pervasiveness. We recognize too that the climate of Sacatara Canyon is somewhat mesic by Mojave Desert standards.

Vegetation dynamics in Sacatara Canyon are driven, in part, by differences in plant growth form and life-history traits, and differences in soil moisture availability. In upland habitat cover of non-native taxa (grasses primarily) and native forbs/herbs exhibited significant annual variation during this study but no pronounced directional change. This is consistent with other drylands where highly stochastic precipitation and soil moisture regimes drive strong intra- and inter-annual variation in annual plant species composition (Hereford *et al.* 2006). In wetland habitat, decreased disturbance, combined with groundwater-derived and perennially available soil moisture, resulted in significant directional change as reflected by native forbs/herbs gaining a competitive edge over non-native grasses (Figure 7). Wetland habitat supports more native rhizomatous plant taxa that are competitively superior compared to non-native grasses when cattle are excluded. Though some native taxa that contributed to this shift are unpalatable (e.g., yerba mansa) or tolerant of grazing (e.g., Mexican rush), we attribute the poor condition of the wetlands in Sacatara Canyon prior to cattle exclusion to sustained overexploitation amplified by their small (10 to 500 m^2) areal extents. Native vegetation cover was greatest in Sacatara Canyon's transitional habitats, which is consistent with the finding that plant species richness along an upland-wetland gradient is highest at intermediate distances (Abella *et al.* 2014). Our findings are not consistent, however, with conventional wisdom or research (e.g., Hood and Naiman 2000; Fleishman *et al.* 2006) showing wetlands to be more susceptible than uplands to invasion.

The habitat-specific responses observed in this study are consistent with equilibrium and non-equilibrium ecological theory (Vetter 2005; Spiegal *et al.* 2014). Equilibrium systems have relatively stable environmental conditions and inter-specific competition and biotic disturbance drive community structure. Non-equilibrium systems exhibit more variable environmental conditions and stochastic abiotic factors drive community structure (Westoby *et al.* 1989; Briske *et al.* 2003). The effects of livestock grazing vary across this equilibrium gradient with stronger effects observed in equilibrium

continued next page

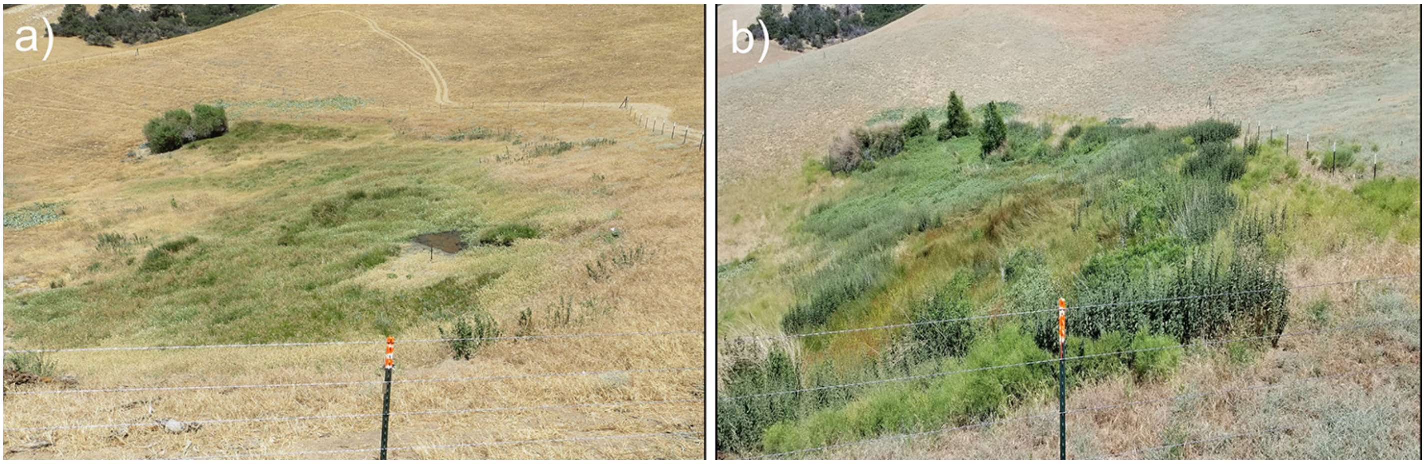


Figure 7. Wetland habitat in a) 2014 before grazing exclusion, and b) 2019 after five years of cattle exclusion. Notable changes include decreased non-native grass cover, increased native forb/herb and shrub/tree cover, and improved habitat structure and condition. *Photos: Laura Pavliscak (a) and Mitchell L. Coleman (b)*

Inter-annual Variation in Plant Community Composition and Structure Informs Passive Restoration Actions in Western Mojave Desert Rangeland *continued*

systems (Vetter 2005). In this study, upland habitat behaved as a non-equilibrium system with community structure driven by variable annual precipitation rather than cattle exclusion. Wetland habitat with more reliable soil moisture exhibited equilibrium behavior with community structure driven by interspecific competition mediated by cattle grazing. Transitional habitat was most resistant to change, showing little annual variation except for a modest trend of increasing shrub/tree cover which is consistent with grazing exclusion (Elmore and Kauffman 1994).

The key question from a conservation management perspective is — did the management intervention work? In Sacatara Canyon, native wetland plant cover increased, non-native grass cover and species richness in wetland habitat decreased, and transitional habitat shrub/tree cover increased, all positive passive restoration outcomes of cattle exclusion. However, Sacatara Canyon is predominantly upland, which showed no detectable response to grazing exclusion, positive or negative. The upland habitat responses are consistent with non-equilibrium behaviors seen in other annual species-dominated rangeland systems (Spiegal *et al.* 2014). Our results suggest that excluding cattle from rangeland wetlands can be a successful passive restoration strategy, but not for regulating species composition in upland habitat. Larger pastures supporting multiple habitats of conservation interest may benefit from livestock management practices other than complete exclusion, such as seasonal or pulsed grazing (George *et al.* 2011). Such practices also deter the accumulation of non-native grass thatch which can become problematic where grazing is excluded (Bartolome *et al.* 2014). Thatch was only sparsely present in Sacatara Canyon and was not considered a driver of the vegetation responses we observed.

Acknowledgments

We thank the many CSU-Bakersfield undergraduate biology students and Conservancy summer interns that assisted with data entry, the Tejon Ranch Company and Centennial Livestock for modifying grazing activities in Sacatara Canyon over the study period, and the two reviewers of this manuscript.

Supplementary information (Table S1) can be found on the Tejon Ranch Conservancy website: **https://www.tejonconservancy.org/**.

References

Abella, S.R., J.E. Craig, S.L. McPherson, and J.E. Spencer. 2014. Watercourse-upland and elevational gradients in spring vegetation of a Mojave-Great Basin Desert landscape. *Natural Areas Journal* 34(1):79–91.

Abella, S.R., J.E. Spencer, J. Hoines, and C. Nazarchyk. 2009. Assessing an exotic plant surveying program in the Mojave Desert, Clark County, Nevada, USA. *Environmental Monitoring and Assessment* 151:221–230.

Abraham, J.K., J.D. Corbin, and C.M. D'Antonio. 2009. California native and exotic perennial grasses differ in their response to soil nitrogen, exotic annual grass density, and order of emergence. *Plant Ecology* 201:445–456.

continued next page

Inter-annual Variation in Plant Community Composition and Structure Informs Passive Restoration Actions in Western Mojave Desert Rangeland *continued*

Alkemade, R., R.S. Reid, M. van den Berg, J. de Leeuw, and M. Jeuken. 2012. Assessing the impacts of livestock production on biodiversity in rangeland ecosystems. *Proceedings of the National Academy of Sciences of the USA* 110(52):20900–20905.

Baldwin, B.G., D.H. Goldman, G.J Keil, R. Patterson, T.J Rosatti, and D.H. Wilken, eds. 2012. *The Jepson manual: Vascular plants of California*, 2nd edition. Berkeley: UC Press.

Barry, S., and L. Huntsinger. 2021. Rangeland land-sharing, livestock grazing's role in the conservation of imperiled species. *Sustainability* 13(8). **https://doi.org/10.3390/su13084466**.

Bartolome, J.W., B.H. Allen-Diaz, S. Barry, L.D. Ford, M. Hammond, P. Hopkinson, F. Ratcliff, S. Spiegal, and M.D. White. 2014. Grazing for biodiversity in Californian Mediterranean grasslands. *Rangelands* 36(5):36–43.

Bartolome, J.W., W.J. Barry, T. Griggs, and P. Hopkinson. 2007. Valley grassland. Pp. 367–393 in *Terrestrial Vegetation of California*, 3rd ed., M.G. Barbour, T. Keeler-Wolf, A.A. Schoenherr, eds. Berkeley: UC Press.

Belsky, A.J., A. Matzke, and S. Uselman. 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States. *Journal of Soil and Water Conservation* 54:419–431.

Briske, D.D. 2017. Rangeland systems: Foundation for a conceptual framework. Pp. 1–21 in *Rangeland Systems*, D.D. Briske, ed. Springer, NY.

Briske, D.D., S.D. Fuhlendorf, and F.E. Smeins. 2003. Vegetation dynamics on rangelands: A critique of the current paradigms. *Journal of Applied Ecology* 40:601–614.

Brooks, M.L. 1999. Habitat invasibility and dominance by alien annual plants in the western Mojave Desert. *Biological Invasions* 1:325–337.

Crowe, E. 1957. *Men of El Tejon, empire in the Tehachapis*. Ward Ritchie Press, Los Angeles.

D'Antonio, C.M., and P.M. Vitousek. 1992. Biological invasions by exotic grasses, the grass fire cycle, and global change. *Annual Review of Ecology and Systematics* 23:63–87.

D'Antonio, C.M., C. Malmstrom, S.A. Reynolds, and J. Gerlach. 2007. Ecology of invasive non-native species in California grassland. Pp. 67–87 in *California Grasslands: Ecology and Management*, M.R. Stromberg, J.D. Corbin, C.M. D'Antonio, eds. Berkeley: UC Press.

DiTomaso, J.M., R.A. Masters, and V.F. Peterson. 2010. Rangeland invasive plant management. *Rangelands* 32:43-47.

Elmore, W., and B. Kauffman. 1994. Riparian and watershed systems: degradation and restoration. Pp. 212–231 in *Ecological implications of livestock herbivory in the West*, Vavra, M., W.A. Laycock, and R.D. Pieper, eds. Society for Range Management, Denver.

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. *Measuring and monitoring plant populations*. Technical Reference 1730-1. USDI BLM National Business Center, Denver.

Fleishman, E., D.D. Murphy, and D.W. Sada. 2006. Effects of environmental heterogeneity and disturbance on the native and non-native flora of desert springs. *Biological Invasions* 8:1091–1101.

George, M.R., R.D. Jackson, C.S. Boyd, K.W. Tate. 2011. A scientific assessment of the effectiveness of riparian management practices. Pp. 213–252 in *Conservation benefits of rangeland practices: assessment, recommendations, and knowledge gaps*, Briske, D.D., ed. USDA-NRCS, Washington DC.

Hereford, R., R.H. Webb, and C.I. Longpré. 2006. Precipitation history and ecosystem response to multidecadal precipitation variability in the Mojave Desert region, 1893–2001. *Journal of Arid Environments* 67:13–34.

HillRisLambers, J., S.G. Yelenik, B.P. Colman, and J.M. Levine. 2010. California annual grass invaders: drivers or passengers of change? *Journal of Ecology* 98(5):1147–1156.

Hobbs, R.J., E. Higgs, and J.A. Harris. 2006. Novel ecosystems: Implications for conservation and restoration. *Trends in Ecology and Evolution* 24(11):599–605.

Hood, G., and R.J. Naiman. 2000. Vulnerability of riparian zones to invasion by exotic vascular plants. *Plant Ecology* 148(1):105–114.

Jackson, R.D., and J.W. Bartolome. 2007. Grazing ecology of California grasslands. Pp. 233–253 in *California Grasslands: Ecology and Management*, M.R. Stromberg, J.D. Corbin, C.M. D'Antonio, eds. Berkeley: UC Press.

Jensen, N. 2018. A floristic study of Tejon Ranch initiates a systematic study in *Streptanthus* and the description of two new species in southern California. Ph.D. Dissertation, Claremont Graduate University, Claremont, CA.

Keane, R.M., and M.J. Crawley. 2002. Exotic plant invasions and the enemy release hypothesis. *Trends in Ecology and Evolution* 17(4):164–170.

Kesseli, J.E. 1942. The climates of California according to the Köppen Classification. *Geographical Review* 32(3):476–480.

Kramer, N. 2019. Mojave Desert enhancement areas botanical surveys. Unpublished data collected for the Tejon Ranch Conservancy, Frazier Park, CA.

PRISM–Parameter-elevation Regressions on Independent Slopes Model. 2020. PRISM Climate Group, Oregon State University. Accessed September 20, 2021. **https://prism.oregonstate.edu**.

Seabloom, E.W., W.S. Harpole, O.J. Reichman, and D. Tilman. 2003. Invasion, competitive dominance, and resource use by exotic and native California grasslands species. *Proceedings of the National Academy of Sciences of the USA* 100(23):13384–13389.

SAS–Statistical Analysis Software. 2010. *SAS/STAT 9.3 user's guide*. SAS Institute Inc, Cary, NC.

Spiegal, S., L. Larios, J.W. Bartolome, and K.N. Suding. 2014. Restoration management for spatially and temporally complex California grassland. Pp. 69–104 in *Grassland Biodiversity and Conservation in a Changing World*, P. Mariotte, and P. Kardol, eds. New York: Nova Publishers.

Spiegal, S. 2015. The ecological basis for grassland conservation management at Tejon Ranch, California. Ph.D. Dissertation, UC Berkeley, Berkeley, CA.

Vetter, S. 2005. Rangelands at equilibrium and non-equilibrium: recent developments in the debate. *Journal of Arid Environments* 62:321–341.

Webb, R.H., and S.S. Stielstra. 1979. Sheep grazing effects on Mojave Desert vegetation and soils. *Environmental Management* 3:517–529.

Westoby, M., B.H. Walker, and I. Noy-Meir. 1989. Opportunistic management for rangelands not at equilibrium. *Journal of Range Management* 42:266–274.

View of the blue oak (*Quercus douglasii*) and gray pine (*Pinus sabiniana*) woodland and associated grasslands nestled under overcast-late-April-skies.

VISIT A NATIVE GRASSLAND: *by Leticia Morris*[1] *Photos courtesy of the author*

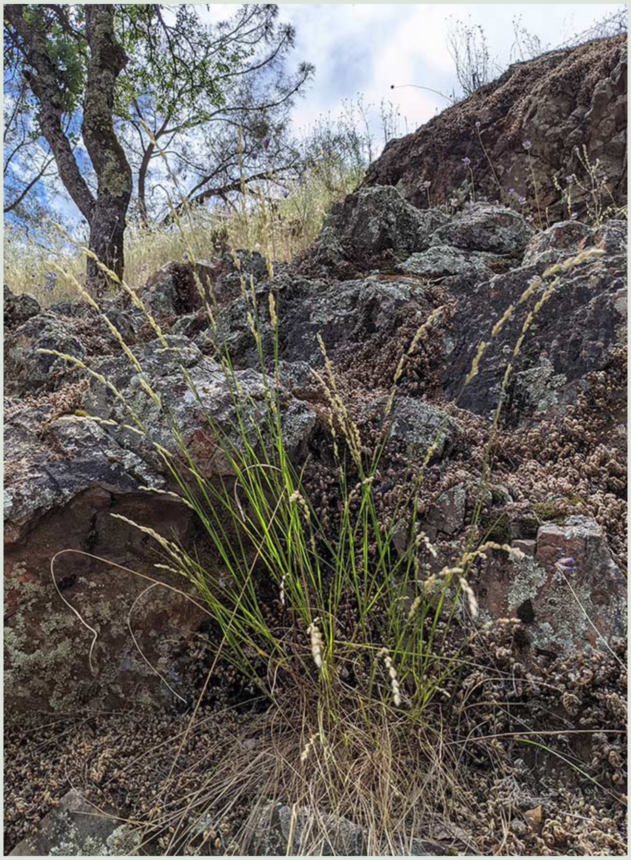
Spenceville Wildlife Area, Yuba and Nevada Counties, California

The Spenceville Wildlife Area (SWA) is home to nearly 12,000 acres of open savanna, managed by the California Department of Fish and Wildlife (CDFW). Straddling the Yuba and Nevada County border, SWA is located east of Beale Air Force Base (AFB) and north of Camp Far West Reservoir. The main access to SWA is from Spenceville Road off of Highway 65 east of Wheatland. CDFW acquired the land from Beale AFB in 1968 when it was designated as a Wildlife Area. Originally, prior to the gold rush, the SWA was inhabited by the Indigenous Nisenan people who stewarded the Sierra Foothills for thousands of years.

Along these cattle-grazed rolling hills of SWA, grasslands comprise a mighty percentage of this predominantly blue oak (*Quercus douglasii*) and gray pine (*Pinus sabiniana*) woodland. The perennial Dry Creek and its intermittent tributaries are the main drainages that flow through SWA, providing ample riparian corridors which traverse various step pools, from blue oaks in the lower elevations to gray pines at higher elevations. These step pools are especially visible on the trails within the SWA. One popular out-and-back hike to a dazzling waterfall is Fairy Falls Trail, which begins in the SWA and provides a visual ascent to portions of this low-elevation rolling hill woodland. Just beyond the SWA, Fairy Falls Trail

[1]Ecologist, GEI Consultants, and CNGA Board of Directors.
lmorris@geiconsultants.com

continued next page



Above: On the walk up to Beale Falls, you might see rusty popcornflower (*Plagiobothrys nothofulvus*) trickle in close to the Parking area at Fairy Falls Trailhead.

Left: I spy a native grass lover's favorite: California melic (*Melica californica*) dangling at higher elevation rocky outcrops at Beale Falls.

Spenceville Wildlife Area, Yuba and Nevada Counties, California *continued*

connects to Beale Falls Loop (approximately 5 miles in total) where views of waterfalls can be enjoyed from just about every nook!

In early spring, starting from the parking area at Fairy Falls Trailhead, grasslands are situated throughout the landscape scattered with wildflowers. The hues of white and purple trickle in with rusty popcornflower (*Plagiobothrys nothofulvus*), royal larkspur (*Delphinium variegatum*), chick lupine (*Lupinus microcarpus*), and fork-toothed ookow (*Dichelostemma congestum*). Then comes the splattering of orange and yellow, like California poppy (*Eschscholzia californica*) and mariposa lily (*Calochortus luteus*). Many more are sure to catch your eye at the right time of year!

Before the late summer heat sets in, a few dazzling stands of native purple needlegrass (*Stipa pulchra*) and deergrass (*Muhlenbergia rigens*) can be spotted amidst the annual grassland matrix of non-native grasses such as wild oats (*Avena fatua*), soft chess (*Bromus hordeaceus*), and brome fescue (*Festuca bromoides*). A visit during the spring is often the best occasion to catch these infrequent but persisting stands of native bunch grasses when the temperature of the sun is still hospitable to the family fun game of I-Spy-A- Native-Grass!

Amid the higher elevation rocky outcrops is California melic (*Melica californica*) which can be spotted along the waterfall — perhaps a visual reward for reaching Beale Falls? California melic-grass lovers like to think so.

In the late fall and early winter, blue oak acorns may be encountered both in the grasslands along the trail and beneath the canopy a short distance from trails. These acorns are food sources for many animals seen in the Wildlife Area, including the numerous deer and songbirds seen throughout. As many researchers are still pondering the relationship of blue oak acorn production, regeneration, and urbanization, this grassland–woodland site may make for an excellent case study for future students!

Whether you're in it for the birding, hunting season, wildflowers, the native-grassland hunt, or the waterfalls, every season within the SWA offers a stunning experience! Come for the wildlife. Stay for the mingling grasslands and oak savannah landscape. To find out how you can access the grassland portions of SWA, check out the CDFW website at: **https://wildlife.ca.gov/Lands/Places-to-Visit/Spenceville-WA#1179590-recreation**.

HANFORD

Hanford is a licensed general engineering and landscape contractor specializing in ecological restoration and heavy civil construction in environmentally and culturally sensitive areas.

755 BAYWOOD DR, SUITE 380 PETALUMA, CA 94954
707.996.6633 | WWW.HANFORDARC.COM

HEDGEROW FARMS

Specializing in native grassland and riparian seed and transplants

Our products and services include:
- Origin-known seed of grasses, forbs, sedges and rushes from northern and central California
- Plug transplants in stock
- Custom seed mixes
- Contract seed increases and plug plant grow-outs
- Native grass straw sold by the bale or by the ton
- Project consulting for project implementation and management
- Equipment rentals, custom seed cleaning

www.hedgerowfarms.com
Visit our website or contact us for more information:
tel: (530) 662-6847 | fax: (530) 662-2753
info@hedgerowfarms.com

Turn your weedy areas into native grassland!

wra
ENVIRONMENTAL CONSULTANTS

2169-G E. Francisco Blvd.
San Rafael, CA 94901

(415) 454-8868 tel
(415) 454-0129 fax

info@wra-ca.com
www.wra-ca.com

Rare Plant & Wildlife Species Studies
Environmental Impact Assessment
Wetland Delineation & Assessment
Permits & Regulation
Mitigation & Restoration
Landscape Architecture
Resource Mapping & Analysis
Expert Consultation & Witness Service

GRASSROOTS EROSION CONTROL INC
VETERAN OWNED FAMILY OPERATED
(866) 615-0520
www.grassrootserosion.com
estimating@grassrootserosion.com

Hydroseed
Hydromulch
Hydrostraw
Straw Blowing
BMP Installation
Wattles
Silt Fencing
Safety Fencing
Dust Control
Water Trucks
Street Sweeping

Westervelt™
ECOLOGICAL SERVICES

ECOLOGICAL CONCERNS INCORPORATED
eci

A Design-Grow-Build
Ecological Landscape Firm
Enriching habitats since 1992
Santa Cruz, California
(831) 459-0656
info@ecologicalconcerns.com

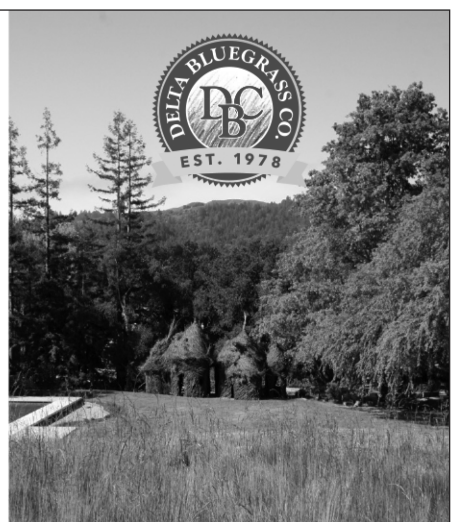
Along with
Central Coast Wilds Nursery

California Native Sod™

LEADING THE INDUSTRY IN
RESTORING CALIFORNIA'S NATURAL RESOURCES

50% Water Savings
Low Maintenance
Less Inputs

Native Mow Free™ • Native Bentgrass™
Delta Grasslands Mix™
Native Preservation™ • Biofiltration Sod™



DELTA BLUEGRASS CO.
DBC
EST. 1978

Call us at 800.637.8873 for more Information • deltabluegrass.com •

DUDEK

PLAN | DESIGN | PERMIT | CONSTRUCT | MANAGE

California Focused
Environmental Planning

- Biological Studies
- CEQA/NEPA
- Contract Planning
- Cultural Resources
- Fire Protection Planning
- Hazardous Materials
- Mitigation Monitoring
- Natural Resources Management
- Native Habitat Design/Restoration
- Water Resources Development
- Wetlands Delineation

Dudek.com | info@dudek.com

800.450.1818

Charismatic Coastal Communities

by Alexis LaFever-Jackson[1], California Native Plant Society, Vegetation Program

Northern California's coast is home to many iconic habitats. The natural beauty of the coast draws swaths of people and, subsequently, development. While species like the coast redwood (*Sequoia sempervirens*) are often spared from demolition due to the rugged terrain of the coastline, smaller species like California hairgrass (*Deschampsia cespitosa* subsp. *holciformis*) that inhabit open, often flat, areas of the coastal prairie are the first to disappear. Open coastal areas are often deemed "non-native grasslands" because they appear to have little to no native species, however all it takes is a few steps and a close look to find an abundance of native species. At first it may be difficult to look past these invasive grasses, planted to stabilize coastal dunes or naturalized from range improvement efforts. I found over and over again that what is seemingly an eyesore may turn out to hide an amazingly rich vegetation community once the time is taken to explore. The coastal prairies are wonderfully diverse habitats; sadly, little remains of their historical extent.

In light of this unmitigated loss of habitat, the California Native Plant Society (CNPS) launched an initiative to categorize, map, and conserve California's grassland vegetation including coastal prairie because sampling sensitive communities assists in conservation and helps classify cryptic coastal types. The CNPS Barbara Rice Internship, initiated in 2020, supported CNPS' grassland initiative by sampling vegetation patterns in coastal prairie along 77 miles of the northern Californian coast. This stretch of land between MacKerricher State Park in Mendocino County and Salt Point State Park in Sonoma County was lacking in digitally accessible data. The CNPS Barbara Rice Internship honors Barbara Rice, who was an avid botanist around The Sea Ranch, a coastal community founded on an ethos to conserve nature. Upon her passing, her husband, David Rice, funded this internship position [in affiliation with the Dorothy King Young Chapter (DKY) of CNPS] to continue botanical exploration along the north coast. Vegetation sampling was conducted on public and private properties owned by California State Parks, The Mendocino Land Trust, and The Redwood Coast Land Conservancy.

Throughout the project area, a total of 113 surveys were conducted, 85 were collected by the Barbara Rice Intern, Alexis LaFever-Jackson. While the other 28 were completed by volunteer DKY Chapter members Teresa Sholars, Renee Pasquinelli, Jim Gibson, and Peter Warner. In the 113 surveys, more than 250 species were identified (187 native and 82 non-native species), and categorized into 22 mapping alliances and 35 associations. Alliances describe the diagnostic species in any given vegetation layer type, with co-dominant species, or species often present, following the name of the dominant species (Table 1). Associations show the variety in species composition and structure in each alliance.

continued next page

Table 1. List of vegetation alliances (Sawyer 2009) sampled along the north coast in 2020 with a count of surveys and the CNPS Rare Plant Ranking (S1 = rare or extinct elsewhere, S2 = extirpated in California but common elsewhere, S3 = more information is needed, S4 = limited distribution, S5 = Demonstrably secure to ineradicable in California)

Alliance	Survey Count	Rarity Rank
Tree		
Pseudotsuga menziesii	1	S4
Shrub		
Baccharis pilularis	3	S5
Rubus spectabilis —Morella californica	1	S3
Salix hookeriana — Salix sitchensis – Spiraea douglasii	1	S3
Herb		
Abronia latifolia — Ambrosia chamissonis	3	S3
Argentina egedii	1	S2
Bromus carinatus — Elymus glaucus	13	S3
Calamagrostis nutkaensis	5	S2
Carex obnupta	5	S3
Deschampsia cespitosa — Hordeum brachyantherum — Danthonia californica	12	S3
Distichlis spicata	1	S4
Eleocharis macrostachya	1	S4
Eriophyllum staechadifolium — Erigeron glaucus — Eriogonum latifolium	29	S3
Festuca idahoensis —Danthonia californica	13	S3
Gaultheria shallon —Rubus (ursinus)	8	S4
Holcus lanatus — Anthoxanthum odoratum	5	SNA
Juncus (effuses, patens)	2	S4
Leymus mollis	3	S2
Lupinus arboreus	3	SNA
Mesembryanthemum spp. —*Carpobrotus* spp.	1	SNA
Sarcocornia pacifica (Salicornia depressa)	2	S3
Schoenoplectus (acutus, californicus)	1	S3

SNA = Semi-Natural Alliance

[1]Alexis LaFever-Jackson is the Barbara Rice Intern whose focus was sampling the coastal prairie of the Mendocino and northern Sonoma counties. The data collected from her efforts will help inform classification of nearby coastal communities.

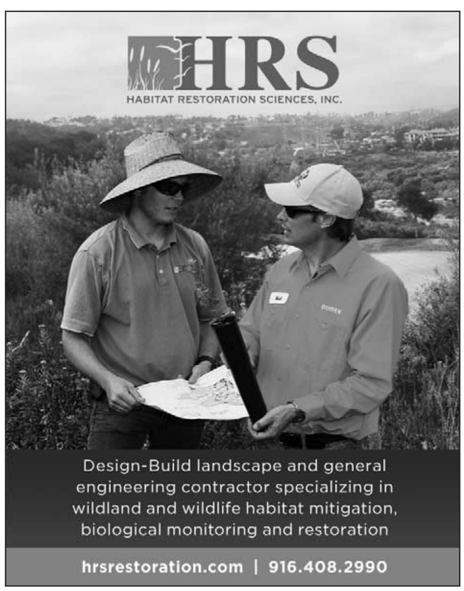
A photo of the *Plantago maritima–Armeria maritima* Provisional Association in Salt Point State Park. *Photo: Alexis LaFever-Jackson*

Charismatic Coastal Communities *continued*

Out of the 22 alliances identified, 13 are considered sensitive natural communities with a ranking between S1 and S3. The rarity rank ranges from very rare and threatened (S1) to demonstrably secure (S5). Some vegetation types sampled include semi-natural alliances (SNA) Semi-natural alliances are dominated by non-natives species and therefore do not receive a state rarity ranking. Generally, the SNA ranking is applied when an association is more than 90% non-native cover, or less than 10% native cover. The most species rich alliance is classified as Seaside woolly sunflower-seaside daisy-buckwheat patch (*Eriophyllum staechadifolium-Erigeron glaucus-Eriogonum latifolium*) comprising a total of 36 species. This vegetation type currently has six different associations.

By sampling more common alliances, like the *Baccharis pilularis* alliance, we reinforce known associations or document new patterns. Additionally, alliances that are not considered sensitive

continued next page



may contain associations that are. For example, the *Plantago maritima* — *Armeria maritima* provisional association is one example of a new pattern that was found along the coast. Alliances are provisional when there are fewer than 10 samples. However even provisional associations with more than 10 samples may remain provisional if there is not enough regional information to determine their status in California. This particular association was found across multiple properties up and down the coast with a higher cover of both species than previously observed in other counties. Since the Pink Sea Thrift (*Armeria maritima*) was in full bloom this pattern in the vegetation was hard to miss (Figure 1). The current understanding of California's coastal vegetation does not recognize this pattern as a type. This type was sampled six times within the project area and will become an official association once this vegetation assemblage is observed more frequently.

A total of 14 properties were sampled varying from privately owned land to public properties (Figure 2). Most of the surveys (84 out of 113) were conducted on California State Parks properties due to the ease of accessibility and the vast amount of land. However, within the 77 miles of coastline there exist large unexplored gaps with the potential for more alliances or associations. We found an average of 17 species per 10-meter by 10-meter plot in our sampling, and 12 provisional associations have been identified. The data collected along the Mendocino County coast provided evidence of two more possible associations including the *Plantago maritima–Armeria maritima* provisional association and *Horkelia californica* provisional association.

Often these new patterns are discovered by walking through areas that at first glance are overgrown with non-native European beachgrass (*Ammophila arenaria*) or sweet vernal grass (*Anthoxanthum odoratum*). After careful examination, the majority of the species found were native in these seemingly dilapidated coastal habitats. Returning to these coastal communities throughout the year also yields striking differences in the cover of species. In the early winter months the landscape may appear semi-desolate, but in the spring many species have exponentially grown and almost dominate the once empty landscape. Paying special attention to the seasonality of these communities is vital because invasive grasses often hide a lot of the native species richness.

To better understand the extent and habitat quality of coastal prairie and bluff scrub types, additional sampling in this area should be a high priority. Even though we surveyed much of the project area, there are large gaps between sampling sites that need further exploration. Gaining access and conducting sampling in these unexplored areas would provide additional data to confirm the 12 provisional associations identified on this portion of the coast. By collecting data along the coast, these beautiful inconspicuous prairie types are recognized and thus can be protected.

Reference Cited

Sawyer, J.O., T. Keeler-Wolf, and J.M. Evens. 2009. A Manual of California Vegetation, Second Edition. California Native Plant Society, Sacramento, CA. 1300 pp.

Figure 2. Project area spans across Mendocino and Sonoma counties.

Est. 1993
Friends of Edgewood
PRESERVE • EDUCATE • RESTORE

JONI L. JANECKI
& ASSOCIATES
Landscape Architect
515 Swift Street, Santa Cruz
www.jlja.com (831) 423-6040

S&S SEEDS
CARPINTERIA, CA
T: 805.684.0436 F: 805.684.2798
INFO@SSSEEDS.COM
WWW.SSSEEDS.COM

SEEDS FOR EROSION CONTROL, REVEGETATION & LANDSCAPE PROJECTS
PROMPT CUSTOMER SERVICE
EXTENSIVE INVENTORY OF HIGH-QUALITY SEEDS
CALIFORNIA NATIVE GRASSES, SHRUBS & WILDFLOWERS
CUSTOM SEED DESIGNS AND MIXES
SITE-SPECIFIC SEED COLLECTION
EROSION CONTROL SOLUTIONS & PRODUCTS
MYCORRHIZA, HUMATES & ORGANIC FERTILIZERS
CALIFORNIA NATIVE SOD VARIETALS

GEI Consultants

MARIN MUNICIPAL WATER DISTRICT

Sun City Lincoln Hills
Community Association
965 Orchard Creek Lane, Lincoln, CA 95648
916-625-4000; www.suncity-lincolnhills.org
Active adult retirement community
It's more than a place to live. It's a way to live.
We protect and preserve the 500 acres of open space and preserved wetlands, riparian, and oak-woodlands that surround Sun City Lincoln Hills. You can go to HTTP://WILDLIFEHERITAGE.ORG for more information.

GREAT VALLEY SEED CO
Great Valley Seed Company
11609 Hereford Road
Los Banos, CA 93635
(209) 827-3000 Office
(209) 737- 4454
doug@farm.com
https://www.habitat.farm/
California Native Seed Production
Custom Contracts & Grow Outs
Native Restoration Partner

Pacific Restoration Group, Inc.
PRG
PO Box 2061 Lake Elsinore, CA 92531
(951) 457-4118

Summer–Dry
Celebrate Plants in Summer–Dry Climates
The Summer-Dry Project
https://summer-dry.com/
Adding Functionality to the WUCOLS Database
Gardens matter. Every small act we do adds resiliency.
PhotoBotanic
Garden Library of Saxon Holt

MEET A GRASSLAND RESEARCHER **Lina Aoyama**

University of Oregon, Environmental Studies Program/Institute of Ecology and Evolution laoyama@uoregon.edu

What is your study system?

I study grasslands and shrublands, many of which are used for livestock grazing. Over the years, I have been lucky to work in various grasslands from annual grasslands in San Joaquin Valley to vernal pools in Sacramento Valley, mountain meadows in the Cascade, and sagebrush steppe in the Great Basin. I am eager to learn so much more of the grassland diversity out there.

What are your primary research goals?

I aim to produce applied science grounded in ecological theories. In general, my approach to science is solution-based research where I focus my research on pressing environmental problems. For example, rather than asking how climate change is affecting grassland ecosystems, I ask what practices could be used to mitigate climate impacts, and what information is needed for practitioners to adopt these practices. Due to the complexities of environmental problems, I take a multi-disciplinary approach to research. For my dissertation, I am using community ecology, population biology, and landscape genetics to work on the problem of wildfires exacerbated by cheatgrass invasion and drought in the Great Basin.

Who is your audience?

My primary audience are ranchers, land managers, and other range scientists. But I'd like to expand my audience to the native plant nurseries and seed producers as well, because I am finding that seed provenance (where seeds come from) makes a difference in restoration.

Who has inspired you, including your mentors?

I was first inspired by Dr. Cheryl Hojnowski, Executive Director at Biosphere Institute of the Bow Valley, when I worked with her as a field technician on her dissertation work in Alberta, Canada. She showed me how hard but rewarding it is to do field-based research, and encouraged me to pursue a career in ecology. Dr. James Bartolome, Professor at the University of California, Berkeley, gave me confidence as his masters student that I can do research. He taught me how to identify grasses, what grazing and fire can do to California grasslands, and the basic principles of range science. My current advisor, Dr. Lauren Hallett, Assistant Professor at the University of Oregon, is not only an outstanding grassland ecologist, but also a fantastic teacher I aspire to be. She has shaped the way I think about restoration, and introduced to me the world of synthesis research where we work collaboratively with other people across disciplines.

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"?

I hope my work will facilitate land management decisions to help project proponents decide what and where to plant after wildfires.

Why do you love grasslands?

I love grasslands because they are vast, diverse, and simply beautiful. I love thinking about how it's not just the plants and animals that make up the place, but it's everything from geology, soil, climate, fire history, and people that shape the grasslands we see today.

Inset: Planting transplants at Northern Great Basin Experimental Range in 2020. *Photo: Maddy Case*. Right: Lina at Tamolitch Falls, McKenzie Bridge, Oregon, 2019.

CNGA's Bunchgrass Circle

A Special *Thank You* to our Bunchgrass Circle Members!

As a nonprofit organization, CNGA depends on the generous support of our Corporate and Associate members. Ads throughout the issue showcase levels of Corporate membership ($1,000, $500, $250). Associate members ($125) are listed below. Visit **www.cnga.org** for more information on joining at the Corporate or Associate level.

Corporate Members

Muhlenbergia rigens

Delta Bluegrass Company

Hedgerow Farms

S & S Seeds

The Summer Dry Project, PhotoBotanic Garden Library of Saxon Holt

Stipa pulchra

Dudek

Habitat Restoration Sciences

Hanford Applied Restoration & Conservation

Kamprath Seeds

Pacific Coast Seed

Poa secunda

Ecological Concerns Inc.

Friends of Edgewood Natural Preserve

GEI Consultants

Grassroots Erosion Control

Great Valley Seed Company

Heritage Growers

Joni L. Janecki & Associates, Inc.

Marin Municipal Water District

Pacific Restoration Group, Inc.

Precision Seeding

Sun City Lincoln Hills

Westervelt Ecological Services

WRA, Inc.

Associate Members

Buck and Associates Consultants

Cache Creek Conservancy

Carducci Associates

City of Davis

CNPS, Los Angeles Chapter

Djerassi Resident Artists Program

East Bay Regional Park District

Steven Foreman, LSA

Friends of Alhambra Creek, Martinez, CA

Golden Gate National Parks Conservancy

Jim Hanson, Landscape Architect/Land Conservation

Irvine Ranch Conservancy

Master Gardener Program, UCCE, Mariposa County

McConnell Foundation

Miridae Landscape Architecture and Construction

Oakridge Ranch, Carmel Valley

OC Parks, Orange County, CA

Orinda Horsemen's Association

Ozark Hills Insurance

Putah Creek Council

Riverside-Corona RCD

Roche + Roche Landscape Architecture

Sacramento Regional County Sanitation District

San Luis National Wildlife Refuge Complex

Sequoia Riverlands Trust

Sonoma County Agricultural Preservation & Open Space District

Sonoma Mountain Institute

Sonoma Mountain Ranch Preservation Foundation

Tassajara Veterinary Clinic

The Watershed Nursery

Truax Company, Inc

Yolo County Flood Control and Water Conservation District

Yolo County Resource Conservation District

Grasslands Provide Resilience *in a Changing World*

JOIN ❊ RENEW ❊ DONATE

The California Native Grasslands Association represents people concerned with the continued loss and degradation of California's grasslands. Our dedicated Board of Directors volunteer their valuable time to educate and promote awareness of the beauty and importance of healthy grassland ecosystems.

We invite you to support our mission **with your donation** or through **CNGA membership**.

Four ways to make your gift:

1. **Online — cnga.org**
2. **By Mail** — send your check or credit card information to:
   CNGA, PO Box 485, Davis CA 95617
3. **By Phone** — call us at **(530) 902-6009** with your credit card info
4. **Consider Donating your Time and Expertise** — join the CNGA Board of Directors! Contact **admin@cnga.org** for more information.

Please Support the Next Generation of Grassland Researchers

CNGA provides opportunities for students and donors to further our understanding of California's native grasslands.

Each year, we promise students to fund four or more $500 scholarships for basic undergraduate and graduate research in native grassland ecosystems through our scholarship program, California Grassland Research Awards for Student Scholarship (GRASS).

This year, *fifteen students (!) have applied for funding* and we must decide who among them will receive awards by March 15th. You can help us to fund more of these worthy students by making a donation to the GRASS program.

Visit our website at **https://cnga.org/Donations** and select "**Grass Student Grants**" in the fund dropdown list. Visit **https://cnga.org/GRASSgrants** for more information about the program, and to see the awardees for student researchers from previous years.

Questions? Email **admin@cnga.org** or call (530) 902-6009.

California
Native
Grasslands
Association

P.O. Box 485
Davis, CA 95617
www.CNGA.org

NON PROFIT ORG
U.S. POSTAGE
PAID
TUCSON, AZ
PERMIT NO. 3341

FSC
The mark of responsible forestry
10% Post Consumer Waste

Support the Next Generation of Grassland Researchers *(see page 22)*

Front cover: Gumplant (*Grindelia* spp.) plants coated in a thick ice from a freeze event at Pepperwood Preserve February 2019. *Photo: Michelle Halbur, CNGA Board Member*

Back cover: Purple needlegrass (*Stipa pulchra*) plants at Pepperwood Preserve in March 2015. *Photo: Michelle Halbur, CNGA Board Member*