California Native Grasslands Association

GRASSLANDS

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California Native Grasslands Association

Mission Statement

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

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From the President's Keyboard

Dear CNGA Members, Sponsors, and Friends,

I would like to personally thank all of our supporters, donors and sponsors who supported us during the past two years. CNGA wouldn't be what it is now without your support.

I also would like to recognize all of our dedicated board members and our Administrative Director, Diana Jeffery, who are working countless hours to fulfill the CNGA mission.

We are looking forward to putting together in-person and hybrid workshops to reach out and educate more grassland ecosystem enthusiasts as well as guided grasslands tours for our members. These tours have started and have been well attended thus far. I hope you are enjoying this new format across the state. If you know of or would like to lead a grassland tour, please contact us!

Your board members have been hard at work advocating for improved grasslands preservation and management in the state, and for addressing climate change issues (the latest support to AB2610 that just passed the Assembly Natural Resources after passing the Assembly Water, Parks, and Wildlife Committee).

Although we are grateful that CNGA is at a stable point due to your support, we need to keep the momentum going to improve our services. Here are some ways you could help with CNGA's mission:

- Consider donating more to our programs as we are looking into going hybrid events (in-person and live) and awarding more student scholarship funds.
- Become a corporate sponsor.
- Join the Board or a committee (we still have a couple of seats open, including Secretary).
- Apply to be a member of a new committee we are creating: an advisory committee to help us deal sporadically with some aspects of non-profit laws, marketing, business management or other topics as they come up.

Please contact us for more details.

Enjoy this second 2022 edition of *Grasslands*. We look forward to continuing this year of advocacy and education.

On behalf of the CNGA Board,

JP Marié, Board President

In this issue

Grasslands Submission Guidelines

Send written submissions, as email attachments, to **grasslands@cnga.org**. All submissions are reviewed by the *Grasslands* Editorial Committee for suitability for publication. Written submissions include peer-reviewed research reports and non-refereed articles, such as progress reports, observations, field notes, interviews, book reviews, and opinions.

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

Submission deadlines for articles:

Summer 2022: 15 May 2022 ❊ **Fall 2022**: 15 Aug 2022 ❊ **Winter 2022** 15 Nov 2022 ❊ **Spring 2023**: 15 Feb 2023

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.

CNGA Events

CNGA 2022 Field Trip Series

Our in-person series of outdoor field tours for CNGA members continues this summer at multiple sites throughout the state. Find out more at https://cnga.org/Events/

CNGA Virtual Symposium

The spring and summer field trip series will culminate with a Virtual Symposium later this year featuring cutting edge presentations and discussions with professionals and experts in California grassland restoration and management. The overarching theme is resilience during climate change and drought.

Details to come!

Above: River Partners Director, Stephen Sheppard, leading tour of restoration project with native plants at Dos Rios Ranch Preserve, Modesto, California. © *Saxon Holt/PhotoBotanic*

Figure 1. An ecological boundary between a serpentine grassland (background) and a non-serpentine grassland (foreground).

The Effects of Invasive Hairy Vetch on Grassland Plant-Pollinator Mutualisms *by Rebecca Ann Nelson*[1]

Introduction

An estimated 87.5% of flowering plant species rely on animals for pollination (Ollerton et al. 2011). Plant-pollinator mutualisms contribute to biodiversity, enhance ecosystem stability, and promote food security through crop pollination (Potts et al. 2010). In particular, the California Floristic Province, which comprises most of the state of California, supports high levels of native plant diversity and endemism, hosting a high diversity of native forbs (Burge et al. 2016). California bees may demonstrate a preference for native California plants (Morandin and Kremen 2013), however, in other systems where both native and exotic forbs are present, native pollinators may prefer invasive plant species (Gibson, Liczner, and Colla 2018). Globally, populations of pollinators and pollinator-dependent plants are declining rapidly due to anthropogenic stressors, particularly invasive species (Biesmeijer et al. 2006, Potts et al. 2010, Vanbergen and Initiative 2013). Invasive species have decreased plant diversity in most of California's annual grasslands (Seabloom et al. 2003). The invasive legume hairy vetch (*Vicia villosa*) is prevalent in California grasslands and shares the same pollinators as native plants (Harmon-Threatt et al. 2017). As a nitrogen-fixing legume, hairy vetch may have unique ecological effects on California native forb communities. Understanding how hairy vetch invasion affects pollination services to California native plants remains a knowledge gap. Here, I report some preliminary results from my dissertation research.

Methods

I conducted my research at the University of California McLaughlin Reserve in the North Inner Coast Range of California during the spring of 2021. I chose four meadows, at least one kilometer apart. Each meadow contained a contact between the serpentine and non-serpentine soils (Fig. 1), with the invasive legume hairy vetch present on the low diversity non-serpentine grassland and a highly diverse native forb community present on the serpentine grassland (Fig. 2). Sites were similar in hairy vetch abundance, meadow area, and aspect. At each site, I established a grid of twenty-four 2 m^2 plots, comparing plots of hairy vetch at the serpentine-non-serpentine boundary to plots of serpentine native grassland plants forbs. I recorded the diversity of flowering plant species in each plot. During two-minute observation periods, I observed floral visitation to each plot. A floral visit was defined as an insect landing on the reproductive parts of the flower. I collected voucher specimens of

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[1]Rebecca Nelson is a Ph.D. student in the Ecology Graduate Group at the University of California Davis in the labs of Dr. Susan Harrison and Dr. Fernanda Valdovinos.

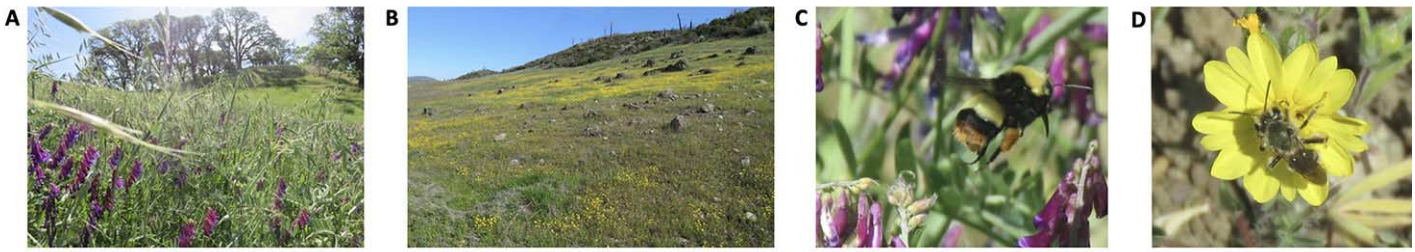

Figure 2. (A) A non-serpentine grassland contains mostly hairy vetch as its main floral resource, while (B) serpentine grasslands contain diverse native wildflowers. (C) Hairy vetch (*Vicia villosa*) is primarily pollinated by long-tongued bees such as this endangered Crotch's bumblebee (*Bombus crotchii*), while (D) serpentine wildflowers such as this lesser hareleaf (*Lagophylla minor*) are pollinated mostly by short-tongued bees such as the Andrenid bee pictured.

The Effects of Invasive Hairy Vetch on Grassland Plant-Pollinator Mutualisms

continued

each insect and identified insect pollinators to morphospecies with the assistance of Dr. Paul Aigner at the McLaughlin Reserve and Dr. Thomas Zavortink at the Bohart Museum of Entomology. I used permanovas to compare the plant and pollinator community composition between hairy vetch and serpentine plots and then visualized the results of the permanova analysis with a Non-metric Multi-dimensional Scaling (NMDS) ordination plot using R software.

Results

Plant community composition differed significantly between hairy vetch and serpentine plots (Permanova F=7.1466, p=0.001). The most common serpentine flowers visited by pollinators were goldfields (*Lasthenia californica*) and catseye (*Cryptanthea hispidula*). Pollinator communities significantly differed in composition between hairy vetch and serpentine plots (Permanova F=12.43, p= 0.001) as visualized in Figure 3. The hairy vetch pollinator community consisted mostly of long to medium-tongued bees such as honeybees and bumblebees (Fig. 4). In contrast, the serpentine pollinator community consisted mostly of short-tongued bees and flies. Native bumblebees, including the endangered Crotch's bumblebee (*Bombus crotchii*), primarily visited hairy vetch.

Differences between serpentine and hairy vetch pollinator communities resulted from trait-matching with flower size and tongue length. Shorter-tongued bees (e.g. *Andrena* sp.) and bee-mimicking flies (e.g. hoverflies

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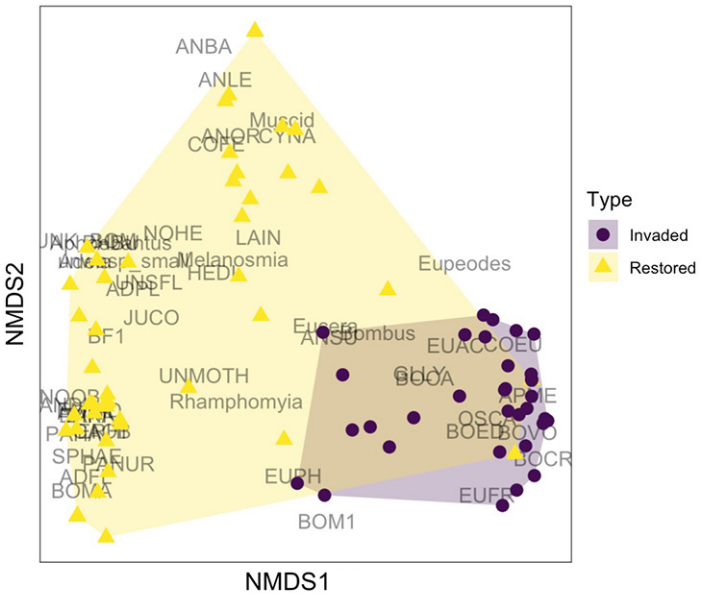

Figure 3. NMDS showing differences in community composition between restored native serpentine grasslands (yellow triangles) and vetch-invaded non-serpentine grasslands (purple circles). The more overlap between the shading, the more similarity in community composition.

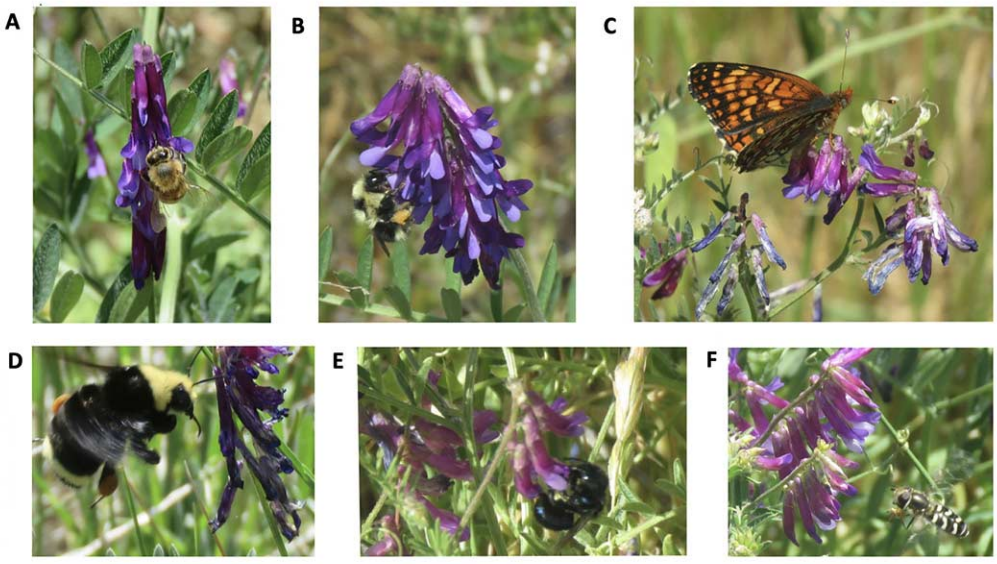

Figure 4. The pollinator community on hairy vetch included (A) European honeybees, (B) black-tailed bumblebees, (C) checkerspot butterflies, (D) yellow-faced bumblebees, (E) mason bees, and (F) bee-mimicking flies.

The Effects of Invasive Hairy Vetch on Grassland Plant-Pollinator Mutualisms

continued

and beeflies) visited small, composite serpentine flowers, while longer-tongued bees (e.g. honeybees and bumblebees) visited hairy vetch in the non-serpentine.

Although the most common pollinator of hairy vetch was the non-native European honeybee, several native pollinators visited hairy vetch. Four species of native bumblebees visited hairy vetch: the yellow-faced bumblebee (*Bombus vosnesenskii*), the black-tailed bumblebee (*B. melanopygus edwardsii*), the California bumblebee (*B. californicus*), and the IUCN-endangered Crotch's bumblebee (*B. crotchii*). Other native bees that visited the hairy vetch included the mason bee (*Osmia cara)*, and long-horned bees like *Eucera actuosa* and *Eucera frater albopilosa*, and short-tongued bees including andrenids *Andrena subchalybea.* Bee-mimicking bombyliid and syrphid flies, moths, and butterflies also visited the hairy vetch. The hairy vetch attracted a diverse community of pollinators.

During the spring of 2021, few serpentine flowers (<20 individual plants across all plots) with similar shapes, colors, and sizes to hairy vetch were present in these plots. The lack of these functionally similar species (e.g. clover (*Trifolium* sp.) and lupine (*Lupinus* sp.)) may have been a consequence of the drought.

Discussion

The hairy vetch-invaded, non-serpentine plots had a distinct plant and pollinator community composition from the uninvaded serpentine plots. Medium to long-tongued bees primarily visited the hairy vetch, while bee-mimicking flies and short-tongued bees primarily visited the native serpentine wildflowers such as goldfields and catseye. The most common pollinator of hairy vetch was the European honeybee (*Apis mellifera*) followed by native bumblebees. Bee flies, hoverflies, and Andrenid bees were the most common visitors to native serpentine plants. The hairy vetch has long, deep flowers with a nectar reward that may be difficult to reach for short-tongued insects, while the most abundant native serpentine plants such as goldfields have small, composite flowers accessible to a wide range of insects. These results suggest that matching flower size with insect tongue length may structure plant-pollinator interactions in California grasslands.

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The Effects of Invasive Hairy Vetch on Grassland Plant-Pollinator Mutualisms

continued

There was minimal overlap of pollinators between hairy vetch and the co-blooming serpentine native forbs such as goldfields, hareleafs, and catseyes. Thus, many species of serpentine wildflowers may avoid direct competition with the hairy vetch for pollinators by occupying different floral niches. These native serpentine wildflowers may be buffered from the effects of hairy vetch invasion. Although the most common pollinator of the hairy vetch was the European honeybee, native bumblebee, and other native medium- to long-tongued bees visited the hairy vetch. Hairy vetch may serve as a floral resource for a distinct community of long-tongued native bee species that were infrequent visitors to the native serpentine wildflowers.

While pollinator niche partitioning arising from morphological trait-matching may buffer abundant native serpentine flowers from the effects of invasive species, more research is needed to determine if invasive hairy vetch affects pollinator visitation in less common functionally similar native serpentine species. California serpentine wildflowers that are phylogenetically related and morphologically similar to the hairy vetch such as bull clover (*Trifolium fucatum*) and miniature lupine (*Lupinus bicolor*) were in low abundance during the year of data collection. As a next step, I will investigate whether the proximity of hairy vetch has competitive or facilitative effects on the pollination and seed set of these morphologically similar native species.

Implications for Management

Hairy vetch had minimal overlap in pollinators with many small-flowered serpentine wildflower species, suggesting that many native serpentine flowers may avoid direct competition with hairy vetch for pollinators by attracting a different community of pollinators altogether. Hairy vetch provided an abundant nectar source for several species of native pollinators including an endangered bumblebee. Bumblebees and other native longer-tongued bee species were present in low abundances in the serpentine. Removing hairy vetch may consequently affect the abundance of native bumblebees and long-tongued bees in California grasslands, presenting a conservation paradox. In non-serpentine grasslands with low native forb diversity and abundance, hairy vetch may provide a critical alternative resource for pollinators.

Acknowledgments

Thank you to Prof. Susan Harrison, Prof. Fernanda Valdovinos, Cathy Koehler, Paul Aigner, Bita Rostami, Alexis Grana, and Isabel Mendoza for their support. Thank you to members of Insect Ecology Group, the Vannette, Dirzo, Ramírez, Williams, and Yang labs, Marina LaForgia, Keith Waddington, and Ash Zemenick for providing feedback on these ideas.

For thousands of years, the land where this study took place has been the home of Patwin and Miwok peoples. **Full land acknowledgment** at: **https://politicalecologylab.ucdavis.edu/uc-davis-pe-lab-land-acknowledgement**.

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MEET A GRASSLAND RESEARCHER

Leila Maria Wahab

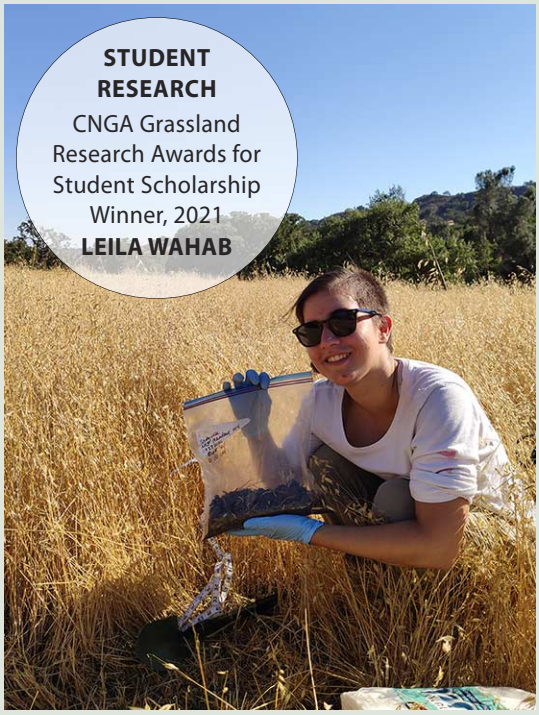
PhD candidate at the University of California–Merced lwahab@ucmerced.edu

What is your study system?

I am studying the precipitation gradient of grasslands across California, with the northernmost one being located in Mendocino County and the southernmost near Santa Barbara. The northernmost grassland also has a precipitation experiment study that has been ongoing for 20 years, allowing me and other researchers to understand the effects of changing precipitation seasonality on plant, microbial, and fungal communities as well as on soil properties like carbon stocks.

What are your primary research goals?

My primary research goals are to understand how changing precipitation patterns are changing soil carbon stocks but also other soil properties like pH and bulk density across my precipitation gradient, and also in the precipitation experiment I mentioned above. I am also very interested in how changing precipitation changes forms of nitrogen in the soil, which has cascading effects on the surrounding biology, from microbes to vegetation to animal life.



Who is your audience?

My audience is largely other researchers, but I think conservationists should also be aware of how climate change is affecting grasslands and soil conditions. Furthermore, there are those who think sequestering carbon in grasslands is an effective climate change mitigation strategy, and it very well could be, but changing precipitation patterns could affect this capability.

Who has inspired you, including your mentors?

I have been incredibly lucky to have been surrounded by incredible scientists at every step of my journey! I want to especially thank Dr. Caroline Masiello and Jim Blackburn at Rice University for showing me the power and beauty of grasslands, and for supporting me as an undergraduate in studying these beautiful ecosystems.

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"?

CNGA and their support have given me the tools to further understand and commit to promoting and preserving California's native grassland species. Those of us who are soil scientists often gloss over the importance of native versus non-native grasses and the feedback they might have on soil conditions. I want to better integrate this understanding.

Why do you love grasslands?

Grasslands are such rich ecosystems, every time I go back to my study sites, I see something or learn something new about it. From the pollinators to the vegetation, to the soil, grasslands are havens of biodiversity. My Ph.D. work has been supported by the University of California–Merced, and seeing the sun set over a California grassland is one of the most beautiful things my dissertation research has given me, and I will always hold that close to my heart.

Thatch Management Using Mowing and Grazing to Benefit the Behren's Endangered Butterfly (*Speyeria zerene behrensii*), Manchester, California, USA *by Terra Fuller*[1]

Introduction

The Behren's silverspot butterfly (*Speyeria zerene behrensii*) is a federally endangered coastal subspecies of the Zerene silverspot (*Speyeria zerene*). This butterfly is one of six subspecies distributed in northern California, Oregon, and Washington (U.S. Fish and Wildlife Service 2015). Behren's silverspot occupies early successional coastal terrace habitat containing the caterpillar's host plant – western early blue violet (*Viola adunca* subsp. *adunca*) — as well as adult nectar sources and suitable adult courtship areas (U.S. Fish and Wildlife Service 2015). Recent sightings have been detected from Navarro Point to Salt Point State Park, with the historic range extending north to Mendocino, California (U.S. Fish and Wildlife Service 2015).

The host plant, *Viola adunca,* is a perennial, rhizomatous herb with a growing season of one to ten months in length (Calflora 2022). Within the Behren's silverspot range, *Violas* have been observed blooming year-round when appropriate climatic conditions exist but are mostly summer-dormant in the project area. The annual precipitation for the *Viola* ranges from 68 to 302 cm (Calflora 2022), with the study area averaging 104 cm (U.S. Climate Data 2022). The host plant is patchily distributed on moist coastal terraces and sand dunes and can tolerate frequent disturbances. Behren's silverspot larval development to pupa depends on high densities of *Viola* (Damiani 2011, Bierzychudek and Warner 2015, Personal Communication Anne Walker, 2015). Current habitat-related threats to the *Viola* include invasion by exotic vegetation (non-native perennial grasses), natural succession, fire suppression, and development (Arnold 2006, U.S. Fish and Wildlife Service 2015, Hoffman 2012). In most areas, *Viola* numbers are insufficient to support a metapopulation (Damaini 2011, Bierzychudek and Warner 2015, Personal Communication Anne Walker, 2015).

[1]Terra Fuller is a Senior Environmental Scientist (Specialist) at Sonoma-Mendocino Coast District, California State Parks.

The largest known metapopulation of Behren's silverspot occurs in the Point Arena area. Surveys in Manchester State Park, approximately 6.5 km north of Point Arena, have documented butterfly detections and likely belong to the Point Arena metapopulation due to the availability and proximity of habitat (Arnold 2006, U.S. Fish and Wildlife Service 2015). Manchester State Park's terrestrial landscape of approximately 1,500 acres consists of a variety of coastal dunes, wetlands, coastal terrace prairie, and bluff scrubs. Historically, some of the Park's coastal terraces were farmed, including dairy operations throughout the 1800s (Fig. 1). By 1955, the area was designated as Manchester State Park and since then no farming or ranching activities have occurred. Invasive perennial grasses now occupy the grasslands due to farming combined with the absence of historic disturbances of fire and Roosevelt elk (*Cervus canadensis roosevelti*) as grazers/browsers (CDFW 2018).

Non-native grasses are a significant habitat threat to native grassland species through interspecific competition for resources (space, sunlight, and water) and through the dense accumulation of thatch. Burning, mowing, and grazing are management techniques shown to reduce thatch and improve habitat for native forb communities (Schaeffer and Kiser 1994, Weiss 1998, D'Antonio et. al 2000, U.S. Fish and Wildlife Service 2015, Reynolds 2020, Hernández et al. 2021, Maron and Jefferies 2021). To improve habitat for *Viola* by reducing invasive grass thatch, State Parks initiated two vegetation management treatments from 2016 to 2020. Treatments consisted of rotational grazing and mowing and monitoring data was collected that provided insight into treatment effects. The results of these efforts are documented in this paper.

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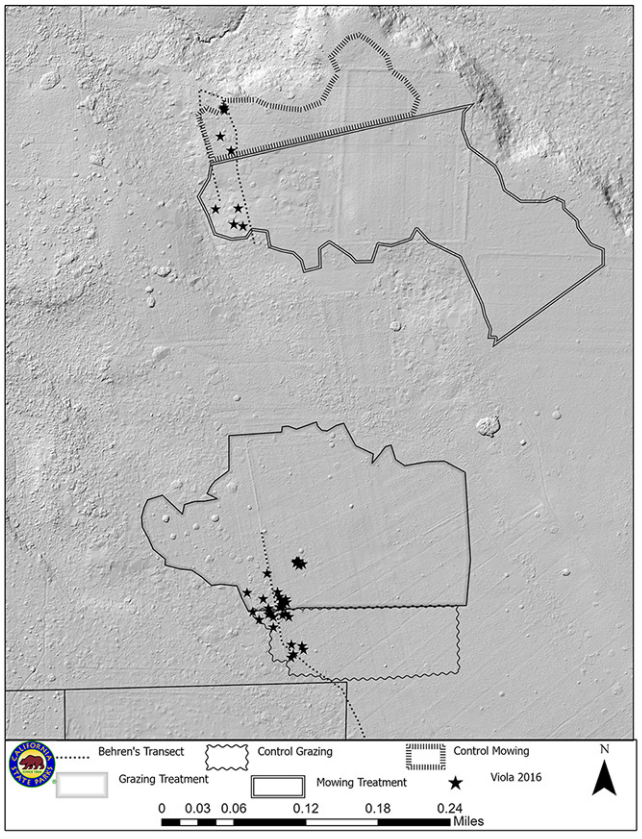

Figure 1. Project map of treatment areas, controls, pre-treatment *Viola* distribution, and Behren's silverspot transects, Manchester State Park, California. USGS lidar bare earth data (2018) shows evidence of tillage for crops prior to becoming a State Park in 1955.

Thatch Management Using Mowing and Grazing to Benefit the Behren's Endangered Butterfly *continued*

Methods

State Parks initiated *Viola* mapping and annual Behren's silverspot surveys in 2006. From this original effort, two locations were chosen in 2016 that contained *Viola* in sufficient numbers to implement treatment and control plots. Two treatment areas measuring approximately 8 ha were established with two adjacent 2 ha non-treatment areas as controls (Fig. 1). Target perennial grasses include velvet grass (*Holcus lanatus*) and sweet vernal grass (*Anthoxanthum odoratum*), with velvet grass densely occupying wetter areas in suitable *Viola* habitat. Seasonal treatments were implemented during the spring/summer or fall/winter. A large rotary mower cut and mulched the grass to approximately 12.7 cm in height. State Parks implemented a grazing treatment using a short-duration rotational grazing system where sheep were moved every few days into a new paddock. The grazer worked with State Parks to meet project goals, which varied across project years due to season, sheep numbers, water year, and the desired grazing intensity. Sheep were selected instead of cattle because they were available through a local contractor as a rotational grazing system, even though they were not the preferred herbivore to treat the dense grass. Project monitoring consisted of *Viola* counts, Robel pole surveys for optical grass density, and the continuation of Behren's silverspot flight surveys.

Viola counts occurred during the blooming season (April–May). Search methods included walking transects through treatment and control monitoring locations. Dense *Viola* patches within an approximate 1 m^2 search area were counted by the same surveyor across years (2016–2020). To capture general distribution, a GPS point in a Trimble Juno 3B was collected at each *Viola* patch along with the number of plants and the number flowering. The number of plants was determined by examining the base of individual plants and counting the number of main plant stems. Data is presented as *Viola* counts, relative percent change (V_2-V_1/ V_1 *100), and absolute change (V_2-V_1).

The Robel pole technique was originally developed to determine vegetation weight before and after grazing and for measuring vegetation's visual obstruction (hiding cover) for wildlife (Smith 2008, Norton et al. 2010, Zielinski et al. 2010). In this application, we used the Robel pole technique to estimate thatch cover that may obstruct *Viola* growth. To measure the optical height of thatch before and after treatments, Robel pole transects were established within control, grazed, and mowed areas totaling 40 sampling points for each treatment. Each sampling point was mapped with each point having an observation at each cardinal direction (see Robel pole techniques outlined by Smith 2008). To re-sample, Robel pole points were re-located using a GPS device. Sample locations were usually within a few meters of the original location with data collection occurring during the non-native grass blooming period and the Behren's Silverspot flight season, July-September. Data are presented as optical heights (cm).

Behren's silverspot flight surveys were continued along transects developed in 2006, with a minimum of five survey-days per year. Behren's silverspot surveys followed methodology developed for Oregon silverspot and are highly weather dependent, which affects survey quality and effort between years (Pickering et al. 1992).

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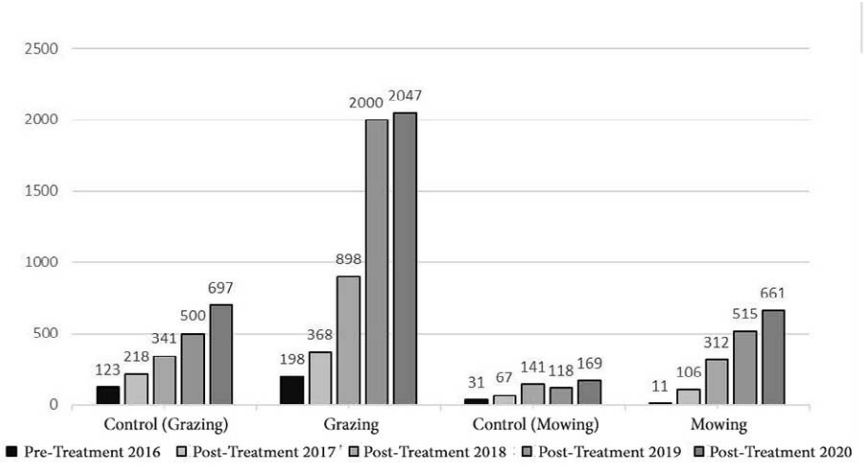

Figure 2. *Viola* counts from 2016–2020, Manchester State Park.

Table 1. *Viola* counts relative and absolute rate of change for each year and averaged across years 2016–2020 for treatments and controls, Manchester State Park.

Treatments	2016–2017		2017–2018		2018–2019		2019–2020		Average	
Rate of Change	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute
Control (Grazing)	77%	95	56%	123	47%	159	39%	197	55%	144
Grazing	86%	170	144%	530	123%	1102	2%	47	89%	462
Control (Mowing)	116%	36	110%	74	-16%	-23	43%	51	63%	35
Mowing	864%	95	194%	206	65%	203	28%	146	289%	163

Thatch Management Using Mowing and Grazing to Benefit the Behren's Endangered Butterfly *continued*

Results

Viola pre-project counts occurred in 2016 and post-treatment counts in 2017-2020 (Fig. 2). All areas experienced an increase in *Viola* post-treatment; however, the rate of change was greater for treatment areas than in the controls (Fig. 2, Table 1).

Optical grass density monitoring occurred pre-project in 2016 and during the summer or early fall in 2017, 2018, 2019, and 2020. After four years of monitoring, only spring/summer treatments reduced optical grass density (Table 2).

Survey efforts at Manchester State Park for Behren's silverspot since 2006 include 121 survey days and 326 transect surveys with only three detections. Since the beginning of the project in 2016, there has only been one detection (Table 3).

Discussion

The five-year dataset at Manchester State Park shows seasonal treatments of grazing and mowing increasing *Viola* numbers and exhibiting a greater rate of change compared to controls. Control counts of *Violas* have also increased at Manchester, but at a lesser rate than in areas with treatments. Possible reasons for this increase are improvement in detection probability, known locations from repeated years of sampling and mapping, and multiple years of normal to above-average rainfall, which appears to benefit *Violas.* One exception was a small *Viola* patch in 2017, which had standing water due to above normal rainfall and resulted in fewer *Violas* within that patch.

Also worth noting is that many of the *Violas* observed in the controlled grazing area were along wildlife trails where grasses were routinely reduced by trampling (Bartholomew 1970). In addition to the Manchester study, State Parks implemented similar treatments over a two-year period at Salt Point State Park using cattle grazing, which showed a greater increase in *Violas* compared to controls (Fuller 2021).

The Robel pole data generally illustrates optical density decreases from spring/summer treatments with fall/winter treatments showing little effect. This is an obvious finding because the treatments occurred during the grass-growing season and severely impacted growth. Visually, the fall-treated areas appeared to have less thatch during the summer than controls, especially after repeated treatments. However, this observation is not supported by the data. Therefore, either the Robel pole technique or the sample size is inappropriate to measure subtle optical changes in thatch density.

Late spring/summer treatments sufficiently reduced density and removed invasive grass seed heads well into the following summer, thus achieving the effect of a fall treatment in thatch reduction while also targeting seed production. Tall grasses have also been proposed as a negative factor in habitat suitability during Behren's silverspot flight season. Therefore, reducing grasses during this time may be an additional improvement to habitat quality (Damaini 2011, U.S. Fish and Wildlife Service 2015). The drawback to repeated spring/summer treatments, especially in the case of mowing, is the removal of late-season forbs that could serve as possible nectar sources for Behren's silverspot. Fall treatments alone appear to be sufficient in reducing grass competition through the spring, which is a critical time for *Viola* germination and growth. This is due to their early spring phenology, which occurs months prior to perennial grass growth and flowering period. In addition to *Violas*, spring forbs and native bunch grasses also appear to benefit from the treatments. For example, there were noticeable changes in the presence of harlequin lotus (*Hosackia gracilis*) (Weiss 1998, Maron and Jefferies 2001).

Given the preliminary results and visual assessments, it appears that varying seasonal combinations of grazing and mowing are warranted. Many studies document differing effects on native forbs and grasses when implementing grazing, burning, and mowing. It is appropriate

continued next page

Table 2. Optical density monitoring (cm) corresponding to treatment season and years 2016-2020, Manchester State Park. Darkened cells illustrate a considerable reduction in optical grass density.

Treatments	Average Optical Density Pre-Project (cm)	Full Mow and Fall and Spring Grazing	No Grazing Fall and Spring Mow	Full Mow and Summer Grazing	Full Mow and Fall Grazing
Year	2016	2017	2018	2019	2020
Mowing	15	18	8	22	23
Grazing	24	11	24	13	22
Control	18	25	20	21	23

Table 3. Behren's silverspot survey effort from 2006–2020, Manchester State Park.

Survey Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Behren's Observed	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0
# Survey Days	10	7	12	9	5	9	4	4	5	11	7	10	8	11	9
Transect Surveys	30	17	34	27	14	26	12	12	12	28	20	29	19	28	18

Thatch Management Using Mowing and Grazing to Benefit the Behren's Endangered Butterfly *continued*

to consider the season and frequency of applications to minimize negative effects on any specific flora (D'Antonio et. al. 2001, Hayes and Holl 2003, Helzer 2011, 2012, Kilde 2000, Hernández et al. 2021). As observed with the cattle treatment at Salt Point (Fuller 2021), cattle are more effective grazers than sheep; thus, the landscape may require periods of rest to achieve restoration goals, especially when considering annual or perennial plant composition and drought (Hayes and Holl 2003).

Based on long-term survey results, Behren's silverspot is rare to absent at Manchester State Park. Recovery of this species will likely require greater investment in increasing both *Viola* numbers and floristic diversity, especially for late-blooming nectar species, which are infrequent at Manchester (Damaini 2014 and 2011). Treatments did reduce thatch and increased the number of *Viola* plants; however, non-native grasses, including bentgrasses (*Agrostis sp.*) whose dominance was more apparent post-treatment, will likely be a long-term management challenge in restoring Manchester's native plant diversity. With some current grant funding, State Park's has initiated *Viola* outplanting efforts at Manchester and Salt Point State Parks. Future restoration efforts will require a comprehensive approach to reducing non-native grasses and restoring native species (Boyer 2013, Garrambone and Saroa 2020, Reynolds 2020 Silveira 2021).

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Thatch Management Using Mowing and Grazing to Benefit the Behren's Endangered Butterfly *continued*

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"The California Native Grassland Association's (CNGA's) leadership in the restoration of California grasslands has extended far beyond incorporating the latest science into restoration techniques, it's also pushed the frontiers of research—forging new directions and recruiting and collaborating with researchers to explore novel ways of understanding these grasslands, addressing critical knowledge gaps in our stewardship."

—Valerie Eviner & Michelle Halbur, 2021. Thirty Years of Changes in How We Understand and Steward California's Grasslands, *Grasslands* Vol. 31, No. 3. Summer 2021.

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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.

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MEET A RANCHER **Dan Macon** *Flying Mule Sheep Company*

Describe your operation and ecosystem

We graze a small flock of commercial ewes on annual rangelands, irrigated pasture, and irrigated cropland in the Sierra foothills near Auburn, CA. We winter on annual rangeland / blue oak woodland at 700–900 feet ASL. Following lambing (late February through the end of March), we move the sheep back to irrigated pasture, where we graze pairs through weaning in late June. After weaning (when the bulk of our lambs are sold), we keep our replacement ewe lambs and a handful of feeder lambs on irrigated pasture, moving the ewe flock back to annual rangeland to control invasive weeds and reduce fuel loads. Finally, during our breeding season in autumn, we graze the ewes on irrigated pasture and cropland.

What are your primary goals as a steward of the land?

My goals are to reduce the prevalence of invasive weeds on the lands we manage, create conditions favorable to native grasses and forbs, reduce fire danger, increase soil organic matter, coexist with wildlife (including predators), and make a profit from raising sheep! We also use our sheep to conduct our own research as well as collaborative projects focused on sheep and grassland management.

What tools do you use to manage the land? What tools do you wish you could use, but can't (if any)?

We use portable grazing systems (electric fences, water systems, corral systems) that allow us to intensively manage our sheep over the landscape. We also use appropriate rest periods between grazing periods to provide opportunities for regrowth of desirable species (typically using longer rest) or to severely impact undesirable vegetation (shorter rest). We use livestock guardian dogs to protect our sheep from predators. We use technology to help select ewes with solid maternal traits (which reduces labor at lambing and allows us to lamb on rangeland).

I would like to be able to utilize prescribed fire on our annual rangelands, but proximity to expensive homes — and the fact that we don't own most of the land we graze — makes this difficult.

What partners do you work with?

We work with private landowners who are especially focused on reducing fire danger. We also work with the Natural Resources Conservation Service occasionally.

Who has inspired you, and how?

Roger Ingram, my predecessor as UCCE livestock and natural resources advisor, and my current sheep business partner has inspired me to think outside the box when it comes to grazing

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[1]Dan Macon is the UCCE Livestock and Natural Resources Advisor for Placer-Nevada-Sutter-Yuba Counties. He can be reached at dmacon@ucanr.edu.

management. UK shepherd and author James Rebanks (author of *A Shepherd's Life* and *Pastoral Song*) has inspired me to think about how humans and livestock are integral to rangeland landscapes. Other California sheep ranchers have inspired me to value the lessons that they learned through a lifetime of experience.

How does the work you do on the land relate to 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 describe myself to others as a "grass geek" — I get so excited when I find a new patch of native grass on the rangelands we graze! I hope that my excitement is infectious — that others start looking for ways that grazing and healthy grasslands are interdependent. As a rancher and a UCCE livestock advisor, I hope that I can provide hands-on learning opportunities and examples to others.

Why do you love grasslands? *(assuming you do)*

Grasslands, in my opinion, are the underdogs of California landscapes — they are unappreciated, but incredibly important. They provide habitat, watershed values, carbon sequestration, viewscapes — and food and fiber! How cool is that?!

Any final/closing take-home nuggets, advice, quotes, etc., you would like to include or share?

I first heard this applied to sheep husbandry, but I think it applies to grazing management, too:

"*We miss more by not looking than by not knowing.*"

To me, this suggests that if we're looking and paying attention — and asking questions, of the land, of our sheep, of our peers, of ourselves — that we can learn an incredible amount about the grasslands all of us love. Scientific understanding is important; so is the long experience of those who spend their days living on the land.

Meet the Class of 2022: Grassland Research Awards for Student Scholarship (GRASS) Recipients

One of CNGA's most important tasks is to enable the future of grassland conservation by training future generations of grassland managers and researchers. Since 2019, CNGA has offered competitive research funds to promote student research focused on understanding, preserving, and restoring California's native grassland ecosystems.

This year, sixteen outstanding graduate and undergraduate students submitted quality research proposals to the GRASS program. Thanks to the generous support of our members and donors, we funded all of the student research projects. We congratulate and thank the GRASS Class of 2022 for their important work.

Taylor Fay Akers, 2022 GRASS Recipient

CSU Sacramento. Project Title: *How do blue oak-mycorrhizal communities respond to seasonally applied low-severity prescribed fire?*

Hello, my name is Taylor, and I am currently pursuing an MS in Ecology, Evolution and Conservation Biology at CSU Sacramento. California Native Americans seasonally applied low-severity fire across many habitats as a land-management technique. I am planning a thesis research project to investigate the response of symbiotic soil fungi to this traditional fire regime. I hope to demonstrate how intentional fire can promote native grass communities in an oak savannah and to highlight the importance of Traditional Ecological Knowledge in our modern land-management practices. In the future, I hope to pursue a PhD and develop a larger-scale research project by including further understanding of natural resource management, fire ecology and ethnobiology.

Mary Badger, 2022 GRASS Recipient

UC Davis. Project Title: *Investigating the diet of wintering American kestrels in California's Central Valley*

I am a Masters student in Josh Hull's lab in the Graduate Group in Ecology at UC Davis. For my master's research, I am investigating the diet of American Kestrels that utilize the agricultural landscapes of the Central Valley of California as critical wintering grounds. I am interested in genomic techniques that allow for rapid and non-invasive monitoring of wild populations. Other research experience I have includes using the CO1 gene to track the spread of the non-native European green crab in Maine, using genomic techniques to investigate the spatial distribution of marine ciliates in tide pools and using genetic parentage to manage the endangered delta smelt. I am thrilled to using environmental DNA and DNA metabarcoding to further our understanding of the American kestrel, a species integral to the grassland ecosystem.

Katherine Brafford, 2022 GRASS Recipient

UC Davis. Project Title: *Rapid evolution of native and non-native grassland species to changes in water availability*

I am a second-year PhD student in Dr. Jen Funk's lab in the Ecology Graduate Group at UC Davis. I am broadly interested in how plant individuals and populations respond to their environment. Currently, I am evaluating a diverse group of thirteen California grassland species for potential adaptive changes after they have had six years of exposure to altered water conditions.

Carmen Ebel, 2022 GRASS Recipient

University of Oregon. Project Title: *Environmental variability: Risk or reward for species persistence?*

I am a PhD student in Dr. Lauren Hallett's lab at the University of Oregon. My research focuses on how year to year variability in rainfall shapes the diversity of species in California grasslands and how increasing variability with climate change will alter communities. I am passionate about using science to understand the effects of climate change on ecosystems and applying that knowledge to shape our stewardship of the environment we live in.

Natalie Kataoka, 2022 GRASS Recipient

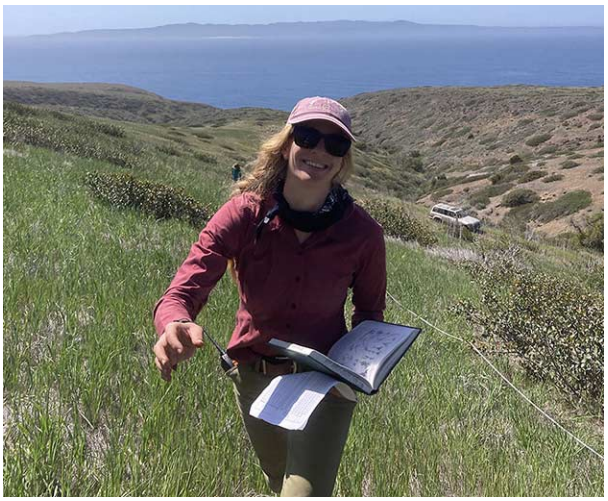
University of Oregon. Project Title: *Nitrogen fixing symbionts as a determinant of plant species coexistence in California grasslands*

I am a 4th year undergraduate Environmental Science student with minors in Biology and Public Policy, Planning and Management. I am conducting my thesis research at the Sierra Foothill Research and Extension Center in Browns Valley, California in partnership with Dr. Lauren Hallett's lab at the University of Oregon. My goal is to understand how climate change may impact the ability of California native species to compete/coexist with non-native species. In particular, I am studying the importance of nitrogen fixation and microbial community inoculation for *Trifolium hirtum* (a non-native forb species) and *Trifolium willdenovii* (California native forb species). Since various non-native species, including *T. hirtum*, are commonly used as cattle forage and cover crops, I hope to help inform agricultural management practices that incorporate the preservation of native biodiversity.

Nicholas Mazzotti, 2022 GRASS Recipient

UC Santa Cruz. Project Title: *Does seeding and planting revegetation techniques result in differentiated seed bank composition in restored California coastal grasslands?*

I am a third year Environmental Studies student with a concentration in conservation and policy at UC Santa Cruz. I am interested in the conservation and restoration of California grassland ecosystems and how current restoration efforts can be adapted to maximize their impacts. I am especially interested in the study of seed banks and how they can serve as an indicator of restoration longevity in addition to altering current restoration practices to evaluate beyond standing vegetation cover.



Annie Meeder, 2022 GRASS Recipient

CalPoly SLO. Project Title: Analysis of alternative post-eradication transitions and spatio-temporal dynamics of vegetation on Santa Cruz Island

Annie Meeder is a graduate student in the biology department with an emphasis in ecology at California Polytechnic University San Luis Obispo where she is studying vegetation dynamics on Santa Cruz Island. Annie's love for ecology and plants began in high school on a trip to Santa Cruz Island doing volunteer research — she now helps lead those trips. In her free time Annie enjoys triathlon, reading, and drawing. Her favorite plant is *Lyonothamnus floribundus* ssp. *asplenifolius*, the Santa Cruz Island Ironwood.

Sydney Metz, 2022 Grass Recipient

Stanford. Project Title: *Temporal development of serpentine plant-microbial interactions in* Plantago erecta

I am a first-year undergraduate at Stanford University pursuing a B.S. in biology and a minor in Italian. I began working this past winter in the Fukami Lab under Suzanne Ou in the ecology and evolution department. The project aims to uncover whether soil conditioning via plant-soil feedback affects plant growth. *Plantago erecta* was grown in three treatments, heterospecific (conditioned by *Festuca microstachys*), conspecific (conditioned by *Plantago erecta*), and unconditioned reference soil. The plants were collected via destructive sampling and dehydrated so that I could measure their biomasses. I also extracted the microbial DNA from the soil of each plant's pot. The project is still ongoing and the extracted soil DNA will be analyzed to collect data on the microbes present in each of the three treatments. This was my first time working in a lab, and it was a wonderful and valuable experience, so I hope to continue pursuing biological research throughout my undergraduate career.

Rebecca Ann Nelson, 2021 and 2022 GRASS Recipient

UC Davis. Project Title: *The effects of invasion and restoration on pollinator visitation for California native grassland plants*

I am a second year PhD student in Professor Susan Harrison's lab in the Graduate Group in Ecology at UC Davis with an emphasis in integrative ecology. I am co-advised by Professor Fernanda Valdovinos. I am studying how invasive species and restoration strategies affect the structure and function of plant-pollinator mutualisms in California grasslands. My project examines the extent to which hairy vetch (*Vicia villosa*), an invasive legume, competes with native California wildflowers for pollinators. Through this research, I aim to inform the restoration of plant-pollinator interactions in northern California grasslands. I am broadly interested in researching what strategies are effective for restoring grassland plant-insect interactions in the context of anthropogenic global change. I hope to foster partnerships between the applied and academic spheres of restoration ecology. I enjoy birding, nature photography, and creative writing.

See page 3 of this issue for a summary of Rebecca Ann Nelson's work.

Spencer Peterman, 2022 GRASS Recipient

UC Riverside. Project title: *Microbial mediation of native legume diversity at Tejon Ranch*

I'm a first-year PhD student studying plant-microbe interactions at UC Riverside. My research focuses on the ecology and evolution of specialization within the legume-rhizobia symbiosis. I'm planning to investigate the role that rhizobia play in shaping legume communities in California grasslands. I am also interested in exploring the use of microbes in restoration and assisted migration.

Jasmine Rios, 2022 GRASS Recipient

Sacramento State University. Project Title: *Integrated pest management (IPM) approaches to control invasive plant species in CA vernal pools*

I am a first year M.S. student at Sacramento State University, researching invasive plant management to promote and enhance vernal pool-grassland systems. I am interested in evaluating the effects of combined integrated pest management (IPM) approaches to reduce invasive plant cover in preparation for habitat restoration and land management plan efforts. I fell in love with ecology after taking an ecological restoration course as an undergraduate at UCSB. Since then, I interned with the National Park Service conducting vegetation surveys, monitoring native and invasive plant cover, habitat restoration, and working with the native plant nursery. I now work for the CA Dept. of Fish and Wildlife in the IPM program, which monitors and manages IPM approaches used to control invasive plant species in state managed ecological reserves and wildlife areas. My goal is to develop effective land management strategies for conservation and habitat restoration across various natural landscapes.

Laurel Sebastian, 2022 GRASS Recipient

UC Davis. Project Title: *Tracking tradeoffs and synergies among ecosystem services in three grassland restoration designs*

I'm a first year M.S. student studying restoration ecology in the Graduate Group in Ecology at UC Davis. I hope to identify plant communities and restoration strategies that support ecosystem functions in my home state of California. My thesis research studies the effects of four different grassland communities on soil organic carbon sequestration. Specifically, I'm interested in whether plant traits or species that increase soil carbon counteract or synergize with other ecosystem services. I spent the last five years working in botanical field research and environmental education, and hope to work directly in land management and restoration after graduation.

Isaiah Thalmayer, 2022 GRASS Recipient

UC Davis. Project Title: *Inoculant-supported restoration: A new practice with promising potential*

As a Senior Project Manager at Point Blue, my work focuses on catalyzing restoration projects throughout the Bay Area, seeding collaboration and cultivating partnerships. I lead the development of strategies and tools for climate smart restoration in riparian and salt marsh transition zone ecosystems. I work closely with Resource Conservation Districts, Land Trusts, local schools, private landowners and other partners to design and implement innovative projects that restore habitat, sequester carbon, and provide ecosystem services. As a member of the STRAW team since 2011 I've designed and implemented rural and urban restoration projects throughout central California, including 3.5 miles of stream at Tolay Lake Regional Park — one of the largest restoration efforts underway in Sonoma County. Two current efforts include designing more than 10 restoration projects on Carbon Farms in Marin County, and experimental field testing of ectomycorrhizal inoculum to improve plant survival and restoration success in Sonoma County. I grew up in the Siskiyou Mountains of southern Oregon and earned my B.S. at Warren Wilson College, a work college in Asheville, North Carolina. I'm currently a graduate student in the Eviner Lab at UC Davis where I study how the ectomycorrhizal relationships of California oaks can help improve restoration success. When I'm not at school or at work you might find me in the surf or hiking with my dog.

Brooke Wainwright, 2022 GRASS Recipient

UC Davis. Project Title: *Proposing a novel drought-response trait framework for California grasslands and beyond*

I am a first year PhD student in the Graduate Group in Ecology at UC Davis, advised by Jennifer Funk and Valerie Eviner. I am passionate about the diversity within and among California plant communities, how those types of diversity are affected by global change factors and human activity, and how they affect ecosystem health. I received my masters in Biology from the University of New Mexico in 2021, investigating the ecotonal recruitment dynamics of grassland foundation species under novel climate regimes. Currently, I am pursuing projects related belowground diversity dynamics (e.g., seed banks) under drought conditions in Northern California as well as a large-scale project examining the functional traits related to drought coping strategies of California grassland species, with the intention of creating a novel functional trait framework that helps land managers restore ecosystem functioning and prepare for the future.

Grassland Research Awards for Student Scholarship (GRASS) Recipients *continued*

Matthew Wells, 2022 GRASS Recipient

CSU Dominguez Hills.
Project Title: *Can targeted mowing promote native species recovery in invaded native plant communities*

I am a first year Master of Biology student at California State University Dominguez Hills. I am studying how to better manage invasive grasslands through timed mowing. Using mowing as a tool to reduce invasive grasslands cover, we hope to encourage native plant species recolonization and restoration of highly degraded invasive grasslands throughout the Santa Monica Mountains National Recreation Area. I am currently working for the Santa Monica Mountains Foundation as a lead restoration technician helping to restore native plant communities throughout the recreation area that were devastated after the Woolsey fire. During my time in the Santa Monica Mountains, I have also done extensive invasive species plant management in the post Woolsey fire. I have collected data for long term vegetation monitoring. The aim of my study and my passion is for restoring native plant communities that have been severely degraded by human impact.

Jacob Weverka, 2022 GRASS Recipient

UC Santa Barbara.
Project Title: *Investigating grazing effects on belowground productivity and carbon storage under native perennial grasses and exotic annual grasses*

I am a third-year PhD student at UC Santa Barbara, studying soil organic carbon. I'm interested in understanding how plant contributions to soil carbon change under varying management regimes in California grasslands. I hope that my research can inform ecosystem management for both soil health and climate mitigation. Before I was a graduate student I worked for a number of government and non-profit organizations in California, including the National Park Service and Point Blue Conservation Science. My favorite native grass is *Deschampsia danthonoides.*

CNGA's Bunchgrass Circle

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

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Bees, Bumblebees, and Butterflies! *(see pages 3 and 8)*

Meet the Class of GRASS! *(see page 22)*

Front cover: *Viola adunca*, Western dog violet, in bloom on Point Arena-Stornetta Public Lands, May 2019. It is a host plant to several butterflies including the endangered Myrtle's and Behren's. *Photo: Emily Allen, CNGA board member*

Back cover: Cream cups (*Platystemon californicus*) at Pepperwood Preserve, Sonoma County, CA. *Photo: Michelle Halbur, CNGA Board Member*