California Native Grasslands Association

GRASSLANDS

Published quarterly by the California Native Grasslands Association

Vol. 33, No. 1 Winter 2023

CNGA's 15th annual Field Day 2023

Community Supporting Grasslands, Grassland Supporting Community

California Native Grasslands Association

HEDGEROW FARMS WINTERS, CA

CNGA Members: $95
Non-Members: $130
Students (with ID): $45
Register at www.CNGA.org

Friday March 31st at Hedgerow Farms

21905 County Road 88, Winters, CA
8:00 am Check in and refreshments
8:45 am – 4:00 pm Program

Enjoy hay rides and walking tours within incredible grassland habitats and native plant production fields. Lunch is provided, bring a water bottle and comfortable clothing for outdoor activities.

EXPERT SPEAKERS

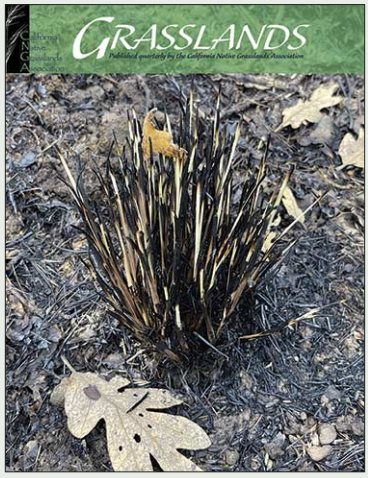
Jessa Cruz, XERCES
Valerie Eviner, UCD
Neal Williams, UCD
Justin Luong, USDA, UCD
...and more!

DRIVING TOURS LED BY

Bryan Young, SRCSD
Chris Rose, Solano RCD
JP Marie, CNGA President

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:

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

In this issue

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

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From the President's Keyboard

Dear Members, Sponsors, Donors, Supporters, and Friends,

I am writing this a little late as I was waiting for the New Year to share my thoughts with you.

First and foremost, as many of you have been living under severe weather conditions, I hope you are well and safe or are getting community help in your area if you have been directly affected by the series of storms.

Secondly, on behalf of the Board of Directors, I wish you a Happy New Year. May the coming year be successful, productive, and healthy for you all.

Thank you for re-electing our Board Members and for the trust you put in me to lead CNGA for yet another year. I will do my best to be a good leader and inspire people.

I am grateful to all of you who donated to our end-of-the-year campaign. We reached our $10,000 goal and it was matched by the generous contribution from Victor Schaff, one of our founding members. Your donations will help us deliver our programs, specifically educating the public on the importance of conserving and restoring California native grasslands, and our GRASS scholarships that help new researchers with their grassland studies. With the upcoming 30x30 initiative, many more people are becoming invested or more curious about protecting the environment, so we will do our best to support and educate them.

I am looking forward to seeing many of you on March 31st for our 15th Field Day at Hedgerow Farms, and I thank you again for your support.

JP Marié, Board President

CNGA Elections

CNGA members voted in the elections for the 2023 Board of Directors in December. We welcome our newest member, Julia Michaels, and our new secretary, Sarah Gaffney. Congratulations to JP Marie, Kendra Mosely, Jodie Sheffield, Emily Allen, Michelle Halbur, Justin Luong, and Michele Hammond on their re-election.

Giving Tuesday and Year-End Donation Drive

We are grateful to our donors who rose to the challenge of meeting the $10,000 matching funds campaign made possible by the generosity of S & S Seeds Founder and long-time CNGA member Victor Schaff. Thank you!

MEET A GRASSLAND RESEARCHER

Becca Nelson

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. She can be reached at **ranelson@ucdavis.edu**.

What is your study system?

I study mosaics of serpentine and non-serpentine grasslands at the University of California McLaughlin Reserve near Lower Lake, California. The reserve is located in California's inner North Coast Range near Clear Lake in Lake County. The serpentine grassland contains a biodiverse community of California native plants, many of which are endemic species. The non-serpentine grassland contains mostly invasive plant species with a few patches of remnant native plants remaining. I focus on grassland wildflowers including lupines, clovers, and larkspurs, and their pollinators.

What are your primary research goals?

I research how an invasive plant species, hairy vetch (*Vicia villosa*), affects relationships between native grassland plants and their pollinators. Hairy vetch occurs primarily in non-serpentine grasslands and is pollinated by long-tongued bees such as honeybees and bumblebees. These bees can move between the serpentine and non-serpentine grassland. My goals are to 1) examine whether these bees prefer visiting vetch or functionally similar native plants in the serpentine such as lupines, clovers, and larkspurs; and 2) investigate whether proximity to invasive vetch affects the reproductive success of these native wildflower species. I will use my findings on which native plants pollinators prefer to inform the restoration of plant-pollinator interactions in California grasslands.

Who is your audience?

As a PhD student, my research interfaces between community ecology theory and applied management, with both academic and applied audiences and collaborators. For academic audiences, I share research that tests theory related to the spatial ecology of plant-pollinator interactions. For land stewards and management practitioners, I share work that examines the restoration of grassland plant-pollinator mutualisms. As a freelance science writer, I communicate my findings through stories for the general public via science blogs such as *The Ethogram*.

Who has inspired you, including your mentors?

My undergraduate research mentors from Stanford University, Dr. Rodolfo Dirzo, Dr. Deborah Gordon, and Dr. Leander Anderegg, inspired me to pursue a PhD in ecology and showed me how to do research that examines the impacts of human-caused changes to the environment on biodiversity and ecosystem function. My PhD advisors at the University of California–Davis, Dr. Susan Harrison and Dr. Fernanda Valdovinos, combine a wealth of knowledge about California serpentine grasslands with expertise on plant-pollinator networks. Moreover, I learned so much from interacting with other faculty, grad students, reserve managers, and postdocs at UC Davis including Dr. Jen Funk, Dr. Neal Williams, Dr. Rachel Vannette, and Dr. Ash Zemenick. McLaughlin Reserve Directors Cathy Koehler and Paul Aigner really inspire me with their unwavering commitment to restoring California grasslands, and their ability to bring together a diverse coalition of grassland stakeholders. My friends Jerry Hearn and Rebecca Reynolds are role models with their ongoing work on restoring Bay Area native plants.

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

continued next page

GRASSLAND RESEARCHER

Becca Nelson *continued*

grassland ecosystems through education, advocacy, research, and stewardship"?

I am very grateful to be the recipient of a CNGA GRASS Scholarship. This funding has supported my investigation of how invasive plant species affect California native plants and their pollinators. Empirically testing how restoration strategies affect plant-pollinator interactions will provide information that directly benefits ongoing grassland restoration work and informs grassland management — the goals of CNGA. As a California Invasive Plant Council Student Liaison, I share information about how invasive species affect California grasslands with relevant stakeholders and practitioners. I have presented my research on California grasslands at the California Invasive Plant Council Symposium and the Invasive Species Council of British Columbia Symposium. Through my science writing and mentoring of high school and undergraduate students, I work to inspire a new generation of grassland researchers and protectors. Ultimately, I aim to conduct research that benefits the conservation of plant and pollinator diversity in California grasslands.

Why do you love grasslands?

Growing up in Illinois, my heart always held a special place for grasslands. As a kid, I walked with my dad through restored prairies, admiring the tall swirling stalks of compass flowers and the purple flashes of blazing stars. I feel really grateful to have grown up near such a biodiverse grassland and hope that through stewardship, more people will have the opportunity to experience grasslands. After I moved to California for college, I fell in love with California's grasslands. An undergraduate field course at the Jasper Ridge Biological Preserve introduced me to serpentine grasslands. I remember lying down and looking at owl clovers and goldfields through a hand lens. These feelings of deep immersion drew me into grassland research. I also love that as working landscapes, grasslands can speak to relationships between people and land. Grasslands provide a unique lens into understanding these social-ecological relationships and what they might mean in a changing climate.

Inspiring the Next Generation of Grassland Researchers and Stewards is One of CNGA's Most Important Missions

"California has an amazing diversity of biomes, but to have an organization dedicated specifically to grasslands is something so precious. Having received the GRASS Award, the support of CNGA means more than just having funds for research, but also a boost in confidence and an affirmation of my work – something which means a lot to a student. The community and connection with not just academics but also practitioners across the state reminds me of the broader connections between my research of belowground soil microbes with aboveground grasses and the implications for human management." — Suzanne Ou, PhD Candidate at Stanford University studying serpentine soils

California Grassland Research Awards for Student Scholarship (GRASS) provides an opportunity for students and donors to further our understanding of California's native grasslands.

Students! Applications are due by January 31st. Awards announced March 15th.

Donors! Each year, we promise students to fund four or more $500 scholarships for basic undergraduate. You can help us inspire the next generation of student researchers through your donation to the GRASS scholarship program.

Visit **https://cnga.org/GRASSgrants** for more information about the program, and to see the outstanding student researchers who have received GRASS awards.

LETTER TO THE EDITOR

Response to "Ornamental California Native Grasses, Sedges, and Rushes for the Landscape" by David Amme

Pacific Reedgrass *(Calamagrostis nutkaensis)*

My first experience with Pacific reedgrass was 15 years ago when I purchased 60 plugs from the CNPS North Coast Chapter. They were grown from seed collected in Redwoods National Park. Back then, the Chapter didn't have a nursery — the plugs were sitting around someone's backyard, getting rootbound, so I got a good deal on them!

My garden is four miles from the Pacific Ocean as the crow flies, but there is a mountain range in between, and summers here are hot and dry. I figured I'd better plant my new Pacific reedgrass plugs in the shade and chose a spot beneath a big canyon live oak, *Quercus chrysolepus*, which is mostly dappled shade. I planted them during the rain in early November and have never watered them since. They rooted right in and have looked fabulous all these years. Every once in a while I'll de-thatch them with a rake, but have never had to cut them back to rejuvenate them.

Several years later, I bought a cultivar of Pacific reedgrass called 'The King', collected by Roger Raiche in the King Range, right next to where I live. It has wider blades and is a little larger and more robust than the species. I decided to try growing it in full sun and planted it on my leach field, thinking it would appreciate the water. Being a thrifty person, I divided that plant up and planted several divisions of it. It has thrived on the leach field ever since, reaching 3 feet all around (taller when blooming) in a short while. Every 3 or 4 years it starts to look a little thatchy and its vigor declines, so I chop it back almost to the ground in March. I use hedge shears for this which work great, but I have learned to shake the plant and make a ruckus before doing so in an attempt to scare any critters away; I once chopped a salamander in half which was a pretty horrible thing to do.

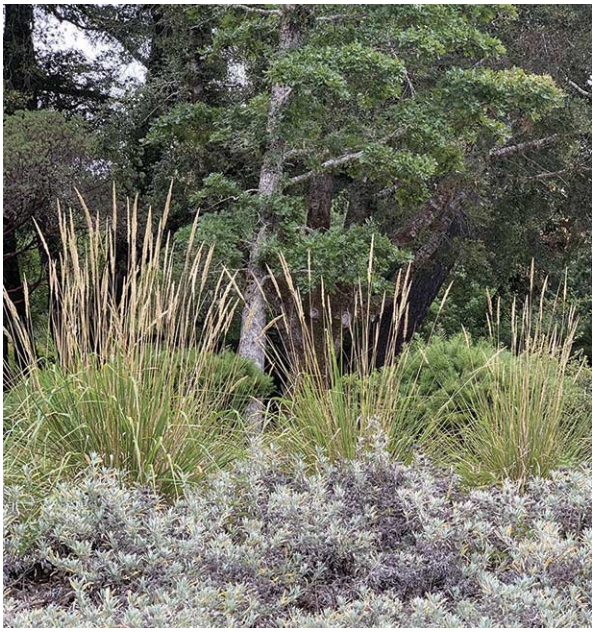
It is easy to make divisions of Pacific reedgrass and I had several in pots, so I decided to plant some in full sun with no supplemental water. These have surprised me with how great they look year-round, staying green and lush-looking. They have been in the ground for 4 years now and have not needed cutting back yet.

The one regular maintenance task I do on all my Pacific reedgrass is to cut the flower stalks off when they start to look untidy in winter. Easy-peasy — Pacific reedgrass is a great low-maintenance, drought-tolerant evergreen grass for your landscape!

Thank you,

Cheryl Lisin

Cheryl Lisin is a Landscape Designer and Native Plant enthusiast who lives and gardens in Southern Humboldt County.



From top, all photos taken in late September after a long, dry summer:

Pacific reedgrass, *Calamagrostis nutkaensis* 'The King', and *Salvia* x 'Bee's Bliss' growing in the full sun without supplemental water.

'The King' growing in the full sun on the author's leach field.

Seed-grown Pacific reedgrass growing in dappled shade.

Grasslands Provide Resilience in a Changing World

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

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.

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


LOCAL GRASSLAND RESTORATION AFFECTS INSECT COMMUNITIES
IN THIS STUDY:
WE WERE INTERESTED IN HOW LOCAL-SCALE GRASSLAND RESTORATION COULD BE USED TO IMPROVE HABITATS FOR NATIVE INSECTS THAT ARE DECLINING, ESPECIALLY NATIVE BUMBLEBEES.
SCAN FOR PAPER
Quercus agrifolia
DOI: 10.1111/een.12721
ART BY VICKY CHEUNG
with feedback from J.C.L.
STUDY BY JUSTIN C. LUONG, PATRICK L. TURNER, CELINA N. PHILLIPSON, AND KATJA C. SELTMANN!

INTRODUCTION

1) Land use change causes loss of native grassland habitats, leading to declines in native insects.[1]

2) Ecological restoration is a tool designed to recover damaged ecosystems and has been shown in other places to support a greater diversity of native insect species.[2]

3) Because restoration can lead to more functional redundancy in grasslands, loss of a single species from the ecosystem would be less likely to impact overall ecosystem function.[3]

4) The microhabitats that restoration may create, can support diverse communities and more functional redundancy.[4]

METHODS

observing for 9 weeks

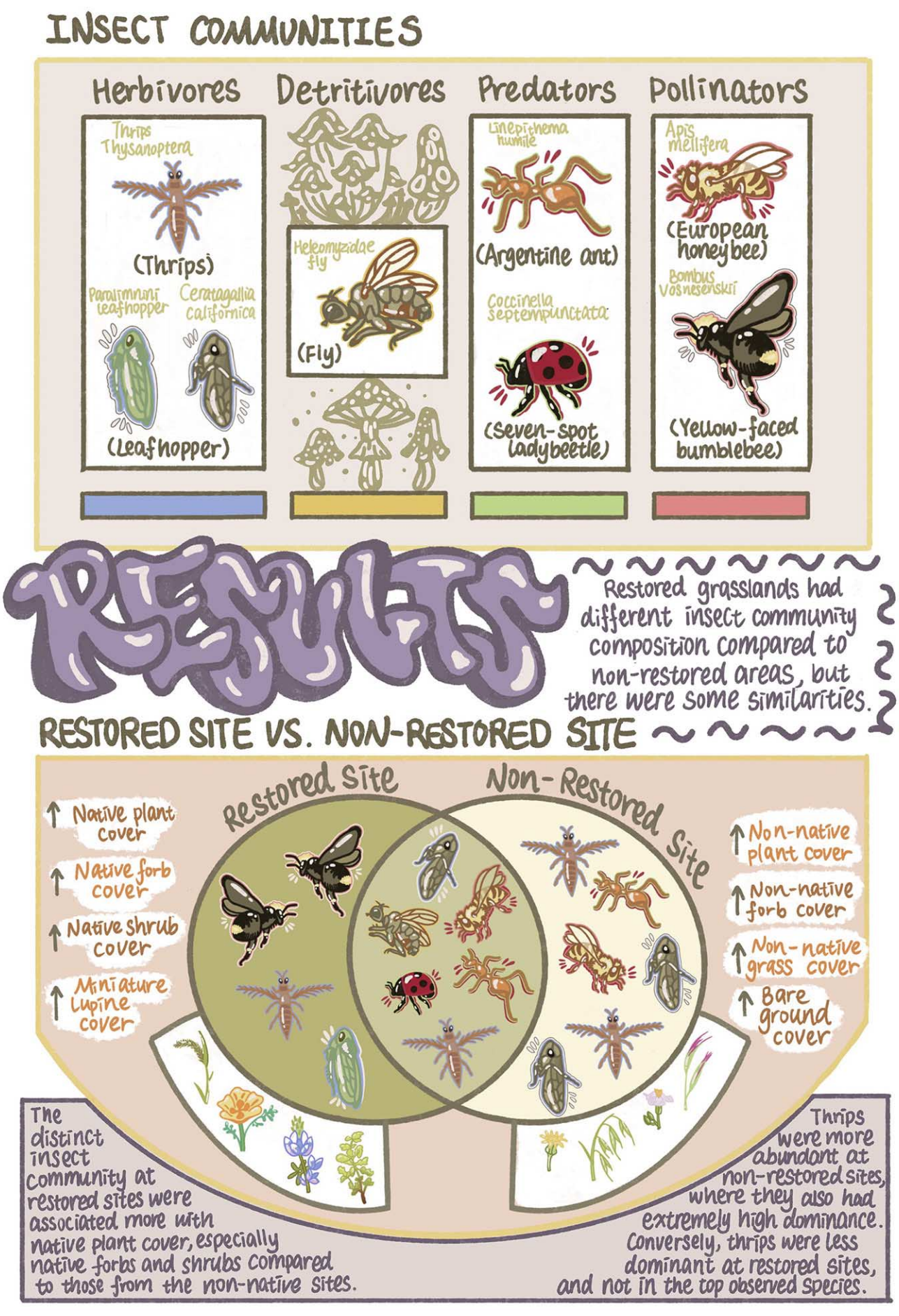
plants & insects Measured Variables:

1) Identification
2) Abundance
3) plant abundance
4) Plant life form

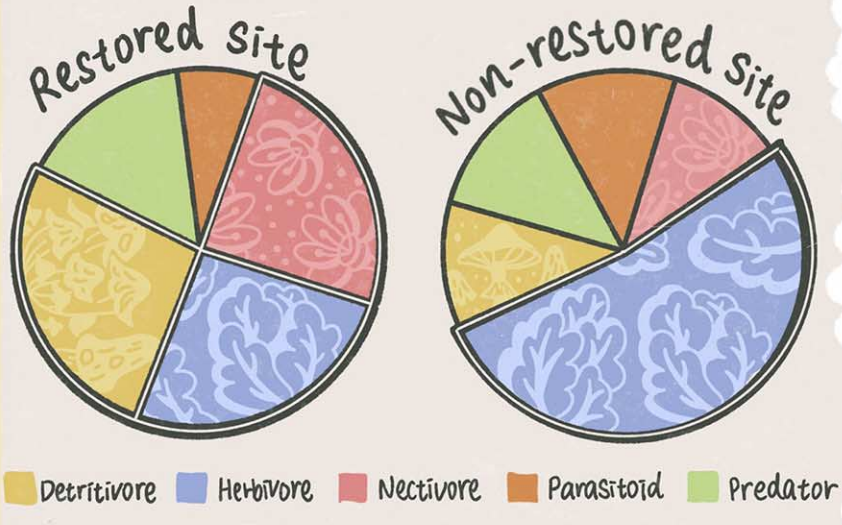
Nets	Aspiration	Dissection	Hand collection	Beating

Lupinus bicolor (Miniature lupine) is an annual pea family plant (Fabaceae) commonly used for California grassland restoration. It was selected as a target species for focused insect collection.


No.1
Non-restored sites
These sites were selected because L.bicolor was documented at each site in previous years.
No.1
Restoration consisted of planting native species and weeding non-natives.
Restored Sites


INSECT COMMUNITIES
Herbivores
Detritivores
Predators
Pollinators
Thrips Thysanoptera
(Thrips)
Paralimnini leafhopper
Ceratagallia californica
(Leafhopper)
Heleomyzidae fly
(Fly)
Linepithema humile
(Argentine ant)
Coccinella septempunctata
(seven-spot ladybeetle)
Apis mellifera
(European honeybee)
Bombus vosnesenskii
(Yellow-faced bumblebee)
RESULTS
Restored grasslands had different insect community composition compared to non-restored areas, but there were some similarities.
RESTORED SITE VS. NON-RESTORED SITE
Restored Site
Non-Restored Site
↑ Native plant cover
↑ Native forb cover
↑ Native shrub cover
↑ Miniature lupine cover
↑ Non-native plant cover
↑ Non-native forb cover
↑ Non-native grass cover
↑ Bare ground cover
The distinct insect community at restored sites were associated more with native plant cover, especially native forbs and shrubs compared to those from the non-native sites.
Thrips were more abundant at non-restored sites, where they also had extremely high dominance. Conversely, thrips were less dominant at restored sites, and not in the top observed species.

FEEDING GUILD PERCENTAGE



- Non-restored sites were dominated more so by herbivores than any other feeding guild.
- Although herbivores were also abundant at restored sites, they were only more dominant compared to parasitoid and predatory insects, but not compared to detritivore and nectivores.

INSECT COMMUNITY RANKING BASED ON ABUNDANCE

* The font size represents the relative dominance of insect species.
Red = non-native; Blue = native

1) Bumblebees were the most observed species at restored sites, but not even in the top five in non-restored sites.

2) Thrips are more commonly found in non-restored sites, where there was also less even distribution of species diversity compared to restored sites.


CONCLUSION!
Based on this study from Santa Barbara, we found that local restoration is a potential tool for insect conservation in coastal CA, USA.
1) RESTORATION LED TO DIFFERENCES IN INSECT COMMUNITIES AND FEEDING GUILDS.
2) At RESTORATION SITES, HERBIVORES ARE LESS DOMINANT AND POLLINATORS ARE MORE COMMON, COMPARED TO NON-RESTORED SITES.
3) NATIVE BUMBLEBEES, ARE KNOWN TO BE DECLINING, BUT OUR WORK SHOWS THAT LOCAL GRASSLAND RESTORATION CAN PROVIDE THEM HABITAT REFUGIA.

REFERENCES

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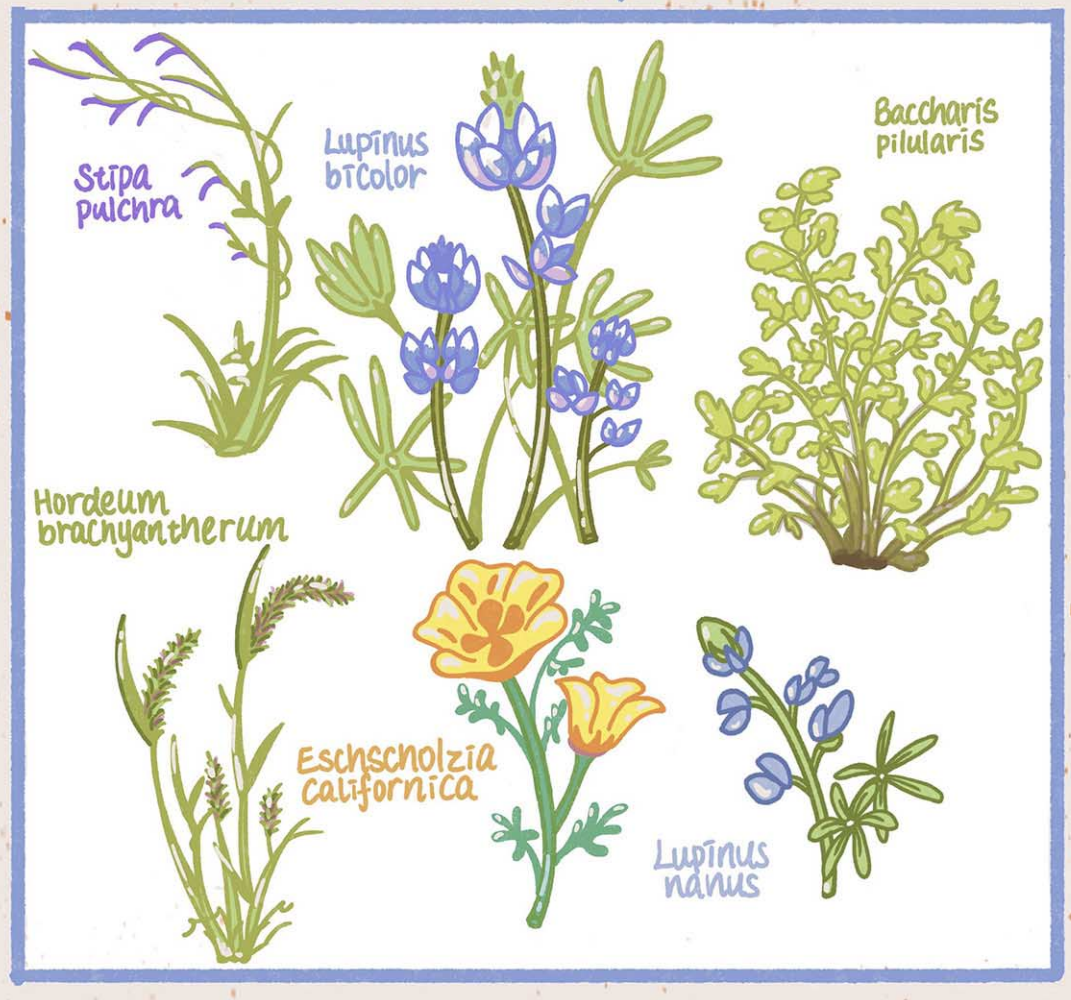
ACKNOWLEDGMENTS

We thank UC Santa Barbara Cheadle Center for Biodiversity and Ecological Restoration (CCBER) undergraduates who assisted in the collections and identification, especially Barry Lao and Chelsea Chung. We thank CCBER staff and Dr. Matt Guilliams at the Santa Barbara Botanic Garden for additional support and resources. We thank Dr. Jorgge Menna Barreto for sponsoring a collaboration between Vicky Cheung and Justin Luong.

APPENDIX

Common non-native plants

Common native plants



Ineffective water cycle with continuous grazing on October 24, 2021, during a three-day atmospheric river storm. In contrast, ungrazed annual roadside (left), tilled field (right), and the author's nearby fields with holistic planned grazing did not shed water.

More effective energy flow during the year where perennials are present and annuals must start from seed or die in spring. December 3, 2021.

A VIEW FROM THE FIELD:

Invasive Annual Weeds — Problems or Symptoms? Part 5

by Richard King[1]

Introduction and Background

Grasslands have four ecological processes operating concurrently: water cycle, nutrient cycle, energy flow beginning with photosynthesis, and community dynamics. In this series of articles, I previously described four adverse factors that simplify community dynamics: Part 1—bare ground, Part 2—over-resting land and the effect on biological decay of plant litter and bare soil, Part 3—over-grazing of plants versus over-utilization of soil cover, and Part 4—excess nitrogen deposition (King 2018a, 2018b, 2019, 2020 respectively). Simplified community dynamics from these factors create a biological vacuum, allowing adapted invasive annuals to colonize.

We blame ***invasive annuals*** for changing our grasslands. We collectively spend countless hours and millions of dollars trying to kill or suppress them. *'We need more funding!'* Yet I believe it is how and why we ***humans*** manage the living biological communities that is the root cause of the problem, not the invasive annuals. It is our management that creates bare soil, over-rests land and litter, overgrazes plants, and inadvertently (or purposefully) deposits excessive nitrogen in places. Unfortunately, grassland managers are currently driven by several beliefs about how to best manage annual grasslands which I think are faulty. In this article, Part 5, I'll describe why I believe invasive annual weeds are just one of many symptoms of the real problem—our general beliefs about grassland management.

Nature's Approach Differs from Ours

It may help to first speculate how grasslands functioned prior to humans arriving and changing the megafauna. Evidence of the large herbivores and predators that no longer exist can be found at the La Brea Tar Pits (previously The Page Museum and Tar Pits) in Los Angeles and the Fossil Discovery Center in Chowchilla. These museums help us quickly visualize how nature may have once managed our grasslands and affected the four adverse factors that invite annuals.

Bare ground and **over-resting perennial plants and land** were minimized by herds that kept moving while grazing. Herds more effectively trampled vegetation, which more effectively recycled old standing litter because of faster biological decay at the soil surface. **Overgrazing** of plants during the growing season was minimized as the great herds kept moving to better grass, leaving areas that now reeked from the herd's dung and urine. They would not return to graze that area for weeks, months, or longer. **Excessive nitrogen deposition** from their dung and urine was far less concentrated around waters or shade because both pack-hunting and stalking predators were always nearby. Herds kept moving. Nature didn't need human technology to manage these four adverse factors that simplify grassland communities. Perennial forbs and grasses could thrive. While this is only a rough approximation of how California's grassland ecosystem may have once functioned, our current management bears no resemblance to it.

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

Community dynamics on Carrizo Ranch (7-10" average rainfall) improving from planned grazing as evidenced by the bunchgrass population increase on former cropland. March 3, 2022.

Riparian community dynamics improving in complexity with young willows and cottonwood on Carrizo Ranch after switching to planned grazing. June 1, 2022.

Invasive Annual Weeds — Problems or Symptoms? Part 5 *continued*

Today, we keep livestock in a field for weeks, months, entire seasons, or continually. Instead of functioning as a large herd moving across the landscape, the predominant cattle and horses of today are thinly scattered across the land, unless we feed them, with little fear of predation. We have extensive grassland landscapes where **too much bare soil** exists because of overgrazing of plants during the growing season and/or over-utilization of dead plant litter in the dry season. In contrast, our 'long-protected' or 'preserve' areas **suffer from over-rest**, often turning into weed patches or being invaded by woody vegetation; much of the herbaceous component loses plant vigor or diversity when biological decay of old litter is poor. Livestock now **overgrazes countless growing plants** during the growing season wherever we leave animals in a field for a long time or we rotate (move) them elsewhere and bring them back to the same field too soon. The plant's solar panels and root mass are not given adequate time to fully recover from the first grazing. Finally, we create small or large **patches of nitrophilous weeds**, species that thrive on excessive soil nitrogen, inhibiting growth of most other plants, typically near water, shade, or hay-feeding areas where animals repeatedly rest to chew their cud or where animal waste is spread.

These four adverse conditions, all the result of our management, now characterize California's annual grasslands. I can drive for hours through California grasslands and rarely find significant areas of grasslands not suffering from too much bare soil, countless overgrazed plants, over-rested perennial plants, and litter, or areas with excess manure/urine. Why is this happening? I believe that several grassland management beliefs largely explain why invasive annuals are so successful and how we attempt to control them. Our beliefs control our management.

Plant Succession

Faulty Belief #1: Perennials can't compete with the exotic annuals

California's Mediterranean climate grasslands are dominated by exotic annuals introduced from Eurasia. California scientists still debate whether large areas of annual grasslands ever had significant perennials. Few grassland managers believe perennial forbs and perennial grasses can be established without first suppressing or killing the introduced annuals. The belief is that succession toward perennials is prevented by the exotic annuals. So, we must first use herbicides, tillage, mowing, overgrazing, cover crops, or even genetic engineering to reduce competition in order to jumpstart establishment of perennials and/or keep annuals from suppressing perennials already present.

Competition for moisture with exotic annuals is viewed as a primary problem for perennials (Everard et al. 2010). My own observations for forty years as a range specialist and livestock producer in California are that our perennials are primarily suffering from 1) excessive bare soil and compaction creating an ineffective water cycle; 2) excessive prolonged rest from disturbances needed to improve both nutrient cycling and soil cover by grazing, trampling, and nutrient re-distribution; 3) widespread overgrazing of plants and attendant soil compaction due to inadequate recovery periods; and 4) excessive localized nitrogen deposition where livestock repeatedly congregate for too long. In my view, those four outcomes of our management simplify living communities and stress adapted perennials more than competition for soil moisture as seedlings.

The major competition I have observed between annuals and perennials is for sunlight. Annuals can simply shade out the

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Close-up vertical view of current year's litter (light color) and previous years' litter (blackish); clear evidence of poor biological decay of lightly grazed and ineffectively trampled grassland next to Carrizo Ranch. December 3, 2021.

Chronic rest producing radish and mustard weed patch in annual grassland (left) and poor biological decay of litter on author's property in Petaluma (20-24" average rainfall). April 29, 2020.

Invasive Annual Weeds — Problems or Symptoms? Part 5 *continued*

perennial seedlings, which turn yellow and die for the same reason the lowest leaves of annuals can yellow and stop photosynthesis, even while the soil is still moist. I see more young plants of perennials where excessive shading has not occurred from fast-growing annuals, and where plant litter is not too thick to hamper perennial seedling growth. Research too has found that perennial seedling establishment is improved when herbivores graze more aggressively growing annuals (Love 1944), and perennial plant vigor can improve when grazing defoliates perennials (Bernstein 2022). I enjoy mentioning to people I meet that a variety of perennials are 'invading' my annual grassland—a true statement. I do so because I am curious how they will react to what most grassland managers would find hard to believe. Perennials can compete but generally require planned grazing to ensure plants are vigorous, producing seeding, and seedling vigor of the incoming generation occurring. The belief that perennials cannot compete with exotic annuals is faulty.

Technology

Faulty Belief #2: Our technology can fix the problem

The incredibly rapid advancements in technology after WWII provided all manner of new tools in our toolbox: herbicides, pesticides, tillage, power, mechanical equipment, electronics, genetic engineering, and fertilizers, especially nitrogen. Today, the vast array of technology being researched, marketed, sold, and utilized is phenomenal. The rate of change and invention is increasing. Every year, new and better 'silver bullets' are available to help grow or kill whatever we want. We love quick fixes and tend to lose sight of what the land is telling us.

We no longer think much about why the invasive annuals dominate one side of a fence but are scarce on the other side. Nor do we pay attention to why the invasive annuals are abundant in certain parts of a field but not in others, or why the invasive population has been present in low numbers for many decades and has never become dominant or rapidly spread elsewhere—it doesn't behave invasively. But, because we don't like invasive annuals, it makes perfect sense to control or get rid of them before they take over. Technology is available to help us and are the best tools available. That's what our neighbors and the experts tell us.

Farm Advisors help us find the best options available to kill thistle, grass, or mustard. Or we can jump online to buy or use California's most popular reference to identify a problem plant species and how to get rid of it (DiTomaso et al. 2013). Or we can go to the California Invasive Plant Council (Cal-IPC) or UC Integrated Pest Management (UC IPM) web tool for recommendations based on peer-reviewed research. I sometimes examine these reference tools to see what others think and find they nearly always ignore the complex interrelationships occurring in any living system. Effects of using the technology on the four ecosystem processes or on the four adverse factors that simplify living communities are poorly addressed, if at all. Instead, the focus is to effectively control or exterminate the invasive annually rather than asking why the species is behaving invasively in that locale and not others.

Rarely do these expert science-based technologies help you identify the root cause of why the weed had become such a problem, how to fix the root cause of the invasion, or how to adequately follow up with the management needed to prevent re-invasion of that same weed or others. The most bothersome part to me is that most human technology fix-it tools will further simplify grassland

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Roadside never disturbed for over 30 years (left) and author's field with planned grazing (right). More perennial forb and perennial grass species are present with planned grazing (community dynamics are higher). March 10, 2021.

Right side of picture just grazed and old litter effectively trampled to improve ecosystem processes. Objectives include keeping soil covered from raindrop energy, providing effective litter decay, avoiding grazing regrowth too soon, and good animal performance. November 18, 2022.

Invasive Annual Weeds — Problems or Symptoms? Part 5 *continued*

community dynamics, often in unforeseen ways, by stressing or removing many other species living above and below the soil surface. We forget that nature never needed human technology to manage its grasslands. The belief that technology is needed to control or eradicate invasive annuals in our grasslands is faulty.

Well-Managed Grazing

Faulty Belief #3: Residual Dry Matter (RDM) is an Adequate Standard

The University of California developed *Guidelines for Residual Dry Matter on Coastal and Foothill Rangelands in California* to assess grazing on annual grasslands and associated woodlands (Bartolome et al. 2006). It is the current statewide standard widely used by state and federal agencies that manage grazing land. The University of California Cooperative Extension (UCCE) helps private ranchers and agencies learn how to use this evaluation. It is used to measure or estimate the litter present on the land in fall, just prior to the first significant rain. It helps the manager judge whether litter may be adequate or inadequate. Measuring RDM in pounds per acre can also be used to help estimate how much cool season forage remains where RDM is still more than minimal. A premise is that "*Properly managed RDM can be expected to provide a high degree of protection from soil erosion and nutrient losses.*"

The RDM standard appears to have become a default guide to assessing grazing management in our grasslands. I doubt the authors intended it to be used that way. Additional guidelines are needed to better manage grassland ecosystem processes and services desired by ranchers, other land managers, and the greater public. Guidelines I find more useful in the management of my own grassland include:

1) The amount of bare soil present and how/why it changes over time,
2) Soil stability where concentrated overland flow occurs,
3) Plant vigor and which plant species are being overgrazed during their growing season and whether adequate seed production of the desired perennial species occurs,
4) The effectiveness of biological decay in standing or horizontal litter and whether poor biological decay may be suppressing establishment or vigor of perennial species or whether photosynthesis and energy flow are reduced on the overall site by excessive litter,
5) Change in desired plant species populations or functional groups, including invasive species; observed changes in non-plant populations (insects, fungi, mammals, birds, etc.); how grazing management might be altered to improve any desired populations,
6) Site productivity of vegetation and livestock productivity over time, and whether the cause might be grazing management related or due to weather pattern differences,
7) Rainfall amounts recorded over time,
8) Severity of defoliation occurring by field or by species; adjustments of grazing or recovery periods or stocking rates occurring, and
9) A written grazing planning chart and record for planning grazing of fields prior to the grazing season as well as the actual grazing periods and recovery periods when grazing occurs, along with notes or simple data on all the issues listed above.

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Grazed left and right side of single wire temporary electric wire with much less visible litter. Cattle do not step on and recycle litter under the wire, and they may not eat it although they can. Trampling and fertilization are important attributes of herds. March 10, 2021.

Excessive litter suppresses germination and growth of annuals and perennial bunchgrass seedlings in author's field. Community dynamics and especially energy flow are suppressed that year. April 6, 2021.

Invasive Annual Weeds — Problems or Symptoms? Part 5 *continued*

I use that information to improve management in a complex and dynamic system where I am concerned about both livestock performance and ecosystem processes. I cannot imagine monitoring or judging the success of my own adaptive grassland management without these.

I am hopeful the next revision of the RDM standard will clarify for the user that it does not adequately guide the grazing manager to assess bare soil, perennial plants or areas suffering from excessive rest and poor litter decay, the degree of plants being overgrazed, invasive annual weeds, or gully and streambank erosion. The current belief that the RDM standard is an adequate tool to assess grazing management and/or infer the health of California grasslands is faulty.

Faulty Belief #4: Overgrazing Invasive Species Works

Grazing may or may not reduce invasive annuals (Davy et al. 2015). From the plant's point of view, overgrazing annuals at the right time, so they have little chance of recovery, can be used to dramatically reduce their viable seed production (Thomsen et al. 1993). This approach can work well for many target species, but it can also severely stress or kill any remnant native perennial species present. Will the invasive return? Will erosion be accelerated if bare soil increases? Will the animals adequately consume that invasive species? Will the severe grazing need to be repeated the next year or for several years? Will this create an ideal environment for another invasive species to quickly repopulate the area? Without a very close

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Excessive bare soil and high nitrogen deposition next to water trough invite invasive annuals. Very large field on Carrizo Ranch, where providing shorter grazing periods is difficult to balance with ranch economics. December 3, 2021.

Potential proportion of herbaceous annuals and perennials are largely determined by available moisture (soil water holding capacity) and sunlight for seedling establishment of both when all plants are managed for vigor and reproduction. June 1, 2022.

Invasive Annual Weeds — Problems or Symptoms? Part 5 *continued*

look at the site to be treated and the many variables needing close attention, many of which are difficult to observe in the field, overgrazing invasive annuals may be a much less desirable option than others. Changing how livestock grazes or tramples the area without needing to overgraze invasive annuals is another possibility.

On my own grassland, I approach the invasives not as a problem but as a symptom of biodiversity loss and dysfunctional ecosystem processes. I focus my management on providing good plant vigor for all the species, including the invasives, good soil cover year-round, and not allowing excessive and prolonged litter accumulation. My invasive annuals diminished greatly, but why? I believe the living community above and below the soil surface became more complex over time in response to my management which focuses on managing the ecosystem processes instead of only parts in a complex system with thousands of species and trillions of individuals underfoot.

Beware of solutions to reduce invasive annual weeds that simplify the living community. Many variables and interrelationships in a complex living system may be unknown or beyond control. Every site, situation, and context is different. I think the belief that overgrazing invasive annuals works to remove the seed crop and seed in the seed bank, and reduces the site's population without creating undesirable consequences, is a belief full of traps and will often prove faulty.

Faulty Belief #5: Planned Grazing Doesn't Work

In the range management profession, the long-established principles that guide livestock grazing management are to use the correct kind, class, and number of animals, the appropriate season of use, and provide a good distribution of animals. Most grassland managers in California are following these principles and try to leave adequate litter on the soil. Great controversy has long existed about whether changing continuous or season-long grazing into other grazing strategies on properly stocked land provides any ecologic or economic benefits. Dozens of 'deferred,' 'rotational' and other forms of planned grazing beyond simple set stocking exist. No two managers implement any of them in the same way because contexts are always different.

In 2008, a scientific paper reviewed the world's published peer-reviewed data to see whether any of the various grazing systems work any better than continuous or season-long grazing on commercial grazing operations (Briske et. al. 2008). Conclusions included: "*…experimental results conclusively demonstrate that rotational grazing is not superior to continuous grazing across numerous rangeland ecosystems;*" and "*This synthesis establishes that the ecological relationships of grazing systems have been reasonably well resolved, at the scales investigated, and that a continuation of costly grazing experiments adhering to conventional research protocols will yield little additional information.*" Like many others who read Briske's review, I was shocked by some of their conclusions. It contradicted what I observe happening on the land.

In contrast to Briske's interpretation of the literature, a growing new cadre of scientists, both young and old, are researching why using holistic planned grazing has indeed produced very different outcomes than season-long, continuous grazing or any grazing system. I have long been a fan of Allan Savory's holistic planned grazing method (Butterfield et al. 2019, Savory and Butterfield 2016), having used it for thirty years to better manage my own grassland and to help others learn and benefit from it too. Briske's

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Invasive Annual Weeds — Problems or Symptoms? Part 5 *continued*

literature review missed capturing the impressive ecologic and economic results many ranchers are producing. Dr. Richard Teague, a research scientist who recently retired from Texas A&M, has pointed this out in several published articles highlighting results of case study research. His conclusions are totally different than Briske's about whether Savory's planned grazing produces different ecosystem results than continuous or seasonal grazing. I highly recommend watching an hour-long interview with Teague (Savory Institute 2021) for his perspective on what science shows is possible on grasslands.

Researchers like Teague often refer to holistic planned grazing as adaptive management planning (AMP) in their published papers. It is not a particular grazing system to manage complex dynamic systems with a recipe or a prescription. Instead, a simple step-by-step planning process is used to work out the best possible grazing plan for the coming grazing season that addresses all the variables needing attention environmentally, socially, and economically. In other words, Savory's holistic planned grazing is not a grazing system of any kind; it is a way for managers to create the ideal, practical, and flexible grazing plan for the coming season without having a wreck. It never ignores probable effects on the ecosystem processes, economics, and people; it emphasizes the importance of monitoring data to accurately judge the effects of management over time; and it presumes management of any complex system always needs adjustment.

The belief that planned grazing can work no better than continuous or season-long grazing for ranchers or others to address invasive annuals is faulty, and more specifically, the belief that Savory's holistic planned grazing doesn't work better than how we have been managing our grassland landscapes is simply wrong.

Summary & Conclusions of this Series, Parts 1–5

Management controls the status of invasive annuals in our grasslands because management controls the ecosystem processes: water cycle, nutrient cycle, energy flow from photosynthesis that powers all life above and below the soil surface, and community dynamics of the living community. Four factors we can directly control with our management adversely affect those processes and create conditions that favor invasive annuals: 1) bare soil, 2) overgrazing plants during the growing season, 3) over-resting

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perennial plants and land, and 4) applying excessive animal waste. Any of these factors, singly or in combination, can simplify grassland community dynamics and invite invasive annuals to fill the vacuum. Our grasslands can have all four of these adverse factors happening within a management unit or different areas of a single field. Parts 1–4 of this series explained these adverse factors in more detail.

This Part 5 identifies five widespread faulty beliefs that strongly influence our management, which in turn simplifies our grassland environments, inviting invasive annuals to prosper. These **faulty** beliefs include: 1) plant succession from exotic annuals to perennials doesn't work in California because the exotic annuals are too competitive; 2) we now must use human technology to control or eradicate the invasive annuals or to establish native perennials (e.g. mowing, herbicides, tillage, genetic engineering); 3) RDM guidelines are adequate to help us manage and monitor how well the grassland resource base is being protected and functioning; 4) we can control invasive annuals if we graze or overgraze them at the right time to reduce their seed; and 5) if stocking rates are appropriate, season-long or continuous grazing will work to improve or protect ecosystem functions and economics as well as any type of planned grazing, including Savory's holistic planned grazing. I believe these five faulty beliefs are largely responsible for how and why we manage the bulk of our grasslands the way we do. The management that results from these faulty beliefs simplifies communities, and invasive annual weeds can thrive, even where minimum RDM is provided.

Invasive annuals are certainly problematic over vast areas of California's annual grasslands where they are now dominant or co-dominant. But in those millions of acres, I believe their abundance is a symptom of our beliefs about annual grassland management, and those beliefs drive how we manage grasslands. Should we use limited time and money to treat the symptom (i.e. invasives taking over grasslands), or use it to treat the root cause of their abundance (i.e. how we manage grassland ecosystem processes)? Clearly, I do not believe invasive annuals are a problem.

Addendum

The purpose of this series of five articles has been to challenge some widespread beliefs that still drive how we manage California's grasslands. I believe they are generally accepted among grassland managers but are faulty. Transforming these faulty beliefs will change management needed to benefit ranchers, environmentalists, scientists, agencies, the public, and our grasslands. I could have also addressed a long list of other 'problems' our grasslands and the people managing them face, but it would be more complicated and difficult for me to write. None of us would read it. But everybody hates invasive annuals and wants them gone, including me, so a much simpler question to address was: *"Invasive Annual Weeds—Problems or Symptoms?"* I have given you my answer and reasoning. How would you answer the question?

For people interested in learning more about managing complex systems holistically using Allan Savory's framework, I recommend asking people who practice it. Savory developed a simple decision-making and planning framework to make it easier. His books are helpful references that explain how the framework works (Savory and Butterfield 2016), and then how to use it in your own situation (Butterfield et al. 2019). Ann Adams wrote a simplified version of the framework for those who don't manage land but want to manage their own resources, decisions, and planning—holistically (Adams 1999). Global organizations that evolved from Savory's work can be found online if you search for *Holistic Management International* or the *Savory Institute*. I am not aware of another framework that is comparable or as simple to use. I welcome your questions or comments.

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Native Perennial Plants Invade Annual Grassland!

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Front cover: California fescue (*Festuca californica*) in Oregon oak (*Quercus garryana*) understory, just starting to regrow a week after a prescription burn at Pepperwood in late October 2022. *Photo credit: Michelle Halbur, CNGA Board Member.*

Back cover: California fescue (*Festuca californica*) graces a trailside stream crossing in winter (December 2009). *Photo credit: Andrea Williams, CNGA Member and Past-President.*