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, Friends, and Supporters,

In this column, I am not going to advocate for native grasslands ecosystems. As you are reading this issue of *Grasslands*, I know you are a member, supporter, or friend of CNGA. I speak on behalf of the entire Board of Directors to extend our thanks for your continued support.

So much has happened in 2020, even over just the past few months. In 2020, the Coronavirus pandemic has changed our lives and habits, professional and personal. The presidential election has been very stressful for many. Historical wildfires and smoke have affected our daily lives directly and indirectly.

Most seriously, our very dear friend and supporter, John Anderson, Founder of Hedgerow Farms (Yolo County) and one of the Founding Fathers of CNGA, passed away in August. Epic heartache does not describe the loss of such an astonishing legend.

So today, I am focusing on the positive things that have happened in 2020 because I know John Anderson would do the same.

Although the pandemic has created a financial burden, many of you are still giving to support the CNGA, and we are enormously thankful for this. We cannot survive without your support. Like many organizations, we are struggling because we cannot offer our in-person informative and stimulating workshops. These valuable meetings account for a significant part of our operational funds. Memberships, sponsorships, and donations also provide much-needed funding, so please keep supporting the CNGA! Any amount is truly appreciated, and there are other ways to give during these unprecedented times (stock donations, for example). The end of the year is near, and donations are tax-deductible, so consider CNGA as part of your year-end giving!

I want to take this opportunity to acknowledge the innovative measures our Board of Directors has made during these trying times. Our team brought forward to our membership and the California Native Grassland community two opportunities to participate in on-line CNGA Workshops. As a result, a record number of participants

continued next page

CNGA 2020 Board of Directors Elections — Online voting is open from December 1-20

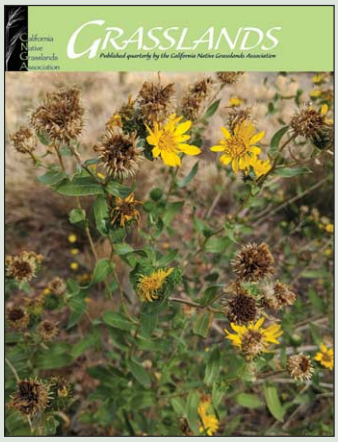
YOUR VOTE COUNTS

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

For more information, visit us online at cnga.org, email admin@cnga.org, or call (530) 902-6009.

Grasslands Submission Guidelines

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



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

Submission deadlines for articles:

Winter 2021: 15 Nov 2020 ❊ **Spring 2021**: 15 Feb 2021 ❊ **Summer 2021**: 15 May 2021 ❊ **Fall 2020**: 15 Aug 2020

In this issue

From the President's Keyboard *continued*

attended two remarkable virtual events: Field Day at Hedgerow Farms and Landscaping with Nature. It required many long hours and massive energy to make these events happen. I want to personally thank our entire team for their hard work and dedication, all of this on top of working full-time jobs.

After receiving such a positive response, everyone at the CNGA is looking forward to future virtual events. They are sure to include ways to offer both live and broadcasted workshops. Of course, we CANNOT wait until we can all assemble again in person, but perhaps the positive take away is that if you live too far away or are unable to travel, you can still attend these future events.

It takes time and money, but know that we are slowly looking into these possibilities and opportunities. Your CNGA Board of Directors has never been limited by these current times. We continue to monitor what is happening to our California Grasslands and meet via Zoom for executive and committee meetings to ensure CNGA keeps moving forward and adapts to these new times. Although we surely miss seeing each other, it seems to be working quite well under the current situation. Hoping you all are safe and taking good care, we send you our heartfelt best wishes for the new year to come.

Please keep an eye out for the *Grasslands* Spring 2021 issue which will deservingly be dedicated to John Anderson. The Summer 20201 issue will focus on our 30th Anniversary. You don't want to miss out!

Finally, please don't forget to renew your membership for 2021. The CNGA depends on your support!

JP Marié

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

RECORDED TALKS & SUPPORTING MATERIALS NOW AVAILABLE ONLINE

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

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

Cobwebby thistle (*Cirsium occidentale*), a new item being produced at Hedgerow Farms, was featured at Field Day. *Photos courtesy Pat Reynolds*

CNGA'S 13th Annual Field Day at Hedgerow Farms Goes Virtual *by Pat Reynolds*[1]

The California Native Grassland Association's (CNGA) 13th Annual Field Day at Hedgerow Farms went virtual this year due to the coronavirus pandemic. It was the first virtual Field Day and the first virtual workshop in the history of CNGA. We had a few technical glitches at the start, but these were solved by CNGA president JP Marie who served as the Zoom Master for this event. There were 145 participants and per the generally positive responses in the workshop evaluations, it was very successful. The theme of fire and restoration ("From the Ashes: Fire and Restoration") was well covered by a variety of high-quality speakers. We filmed the "walking tour," "driving tour," and one of our featured speakers prior to the event to minimize any technical difficulties that we might have experienced trying to film live. The driving tour was hosted by local restoration professionals, Chris Rose of the Solano County Resource Conservation District (RCD), Bryan Young of the Sacramento County Sanitation District, and included special guests Jeff Quitter and Jim Mast from Hedgerow Farms. They provided participants with information about the history of Hedgerow Farms while sharing their in-depth knowledge of habitat restoration.

By filming the driving tour, we were able to offer new perspectives not generally covered in a live Field Day event. For example, we were able to take cameras inside a Hedgerow Farms combine harvester to better understand how these remarkable pieces of farm equipment do much of the initial heavy lifting during the seed cleaning process. We were also able to conduct a controlled burn during filming to demonstrate how controlled burns are implemented, and we used that opportunity to discuss how fire can improve grassland health. Our tour leaders explained how burns can prepare sites for seeding by reducing thatch and weed seed prior to seeding native grasses and forbs. The hosts articulated how Hedgerow Farms founder, John Anderson, pioneered work that helped move forward the practice of habitat restoration in Northern California and how the extensive habitat features, including hedgerows, tailwater ponds, bioswales, and sumps, are incorporated into the farm and serve as a model for other farmers who want to incorporate similar features into their operations. Tour leaders explained how Hedgerow Farms has evolved over the last 30+ years to include growing additional native forbs for seed production (Hedgerow Farms initially grew native grasses) and the modernization of the seed production process. Emily Allen (ecological consultant and CNGA board member) supplemented the information provided in both the walking tour and driving tour by adding commentary in the Zoom chat box feature.

continued next page

[1]Pat Reynolds is the General Manager at Hedgerow Farms and is a CNGA board member.

From left: Chris Rose and Bryan Young discussing establishment of native grasses along roadsides at Hedgerow Farms. | Contrasting treatments of irrigation canal banks with a native vegetation on the left bank and traditional complete vegetation control on the right bank. *Photos courtesy Pat Reynolds*

CNGA'S 13th Annual Field Day at Hedgerow Farms Goes Virtual *continued*

The walking tours were led by Pat Reynolds (Hedgerow Farms and CNGA board), Andrew Fulks (University of California, Davis (UCD)), Andrea Williams (California Native Plant Society, and immediate past president of CNGA), Michele Ranieri (Hedgerow Farms), Jim Mast (Hedgerow Farms), and Haven Kiers (UCD). The walking tours, which lasted approximately 1.5 hours, included a wide range of topics related to the production and effective use of native seed in habitat restoration. This included detailed discussions of several species grown out at Hedgerow Farms. A stop was made at a pollinator experiment looking at the diversity and abundance of pollinator species using 45 different native wildflower species. This experiment, which is being run out of Neal Williams lab at UCD, is now in its second year and will help to inform seed mix designs to maximize pollinator habitat.

In addition to the walking and driving tours, there were three presentations related to fire and restoration. Dr. Valerie Eviner, professor of plant science at UCD, provided an update on her research as it relates to the influence of fire on California grasslands. She talked about how the frequency, duration, and intensity of fires are increasing in California and how our grassland communities are particularly prone to fire. Her research showed that wildfires greatly decreased grass seed survival, with a more muted effect on forb survival, leading to a greater proportion of vegetation cover by wildflowers. Despite the

continued next page

From left: Chris Rose and Bryan Young discuss controlled burns as a restoration technique. | Jim Mast, Hedgerow Farms Production Manager, ignites the controlled burn featured at Field Day. *Photos courtesy Pat Reynolds*

CNGA'S 13th Annual Field Day at Hedgerow Farms Goes Virtual *continued*

decrease in surviving seeds, the above-ground biomass following fires was much greater in areas that had burned when compared to unburned areas. In addition, she found that grazing dampens the effects of wildfire on vegetation responses to fire. Her post-fire observations also show that native perennial grasses, native bulbs, and forb seedbanks are important "responders to fire".

Michelle Halbur, preserve ecologist for the Pepperwood Preserve in Sonoma County, described how two large-scale fires (Tubbs in 2017 and Kincade in 2019) influenced plant communities and preserve management while opening up many new questions. She described some of the practical lessons learned dealing with fire and how fire impacts on-going research when things like equipment are lost. Overall, ecologically, the Tubbs Fire seemed to have a significant positive impact on grasslands at the preserve by stimulating germination of native forb species, among others. However, it also created management issues with delayed mortality of native trees which required costly removal along roads and infrastructure to maintain safe conditions. The full effects of the 2019 Kincade fire are still being analyzed and it was unclear if the same positive ecological response observed with the 2017 Tubbs fire will occur with the 2019 Kincade fire given the two fires occurred just two years apart.

Dr. Don Hankins, of California State University-Chico, talked about ecocultural considerations in grassland stewardship and resilience. He described how indigenous people use fire extensively to maintain healthy grassland ecosystems as part of the long-term sustainable stewardship of their lands (see page 19). He shared some of his research on the effects of fire on native vegetation as well. Some of his more interesting findings include increased cover of native vegetation in the first 2–3 years following fires (Hankins 2015).

Despite some early technical difficulties and having to experience Hedgerow Farms from our computer screens, the first-ever virtual Field Day was a success. Hedgerow Farms and CNGA have begun planning for next year's Field Day and our hope is that we will be able to return to being physically present at Hedgerow Farms.

References

Hankins, D.L. 2015. "Restoring Indigenous Prescribed Fires to California Oak Woodlands". Proceedings of the seventh California Oak symposium: Managing oak woodlands in a dynamic world. General Technical Report PSW-GTR-251. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.

Inset: Crotch's bumblebee (*Bombus crotchii)* on coyote mint (*Monardella villosa*) within UCD pollinator experiment plots at Hedgerow Farms. *Photos courtesy Jaymee Marty*

MEET A GRASSLAND RESEARCHER **Roisin Deák** rmurphyd@calpoly.edu

Rajakaruna Lab, Biology Department, California Polytechnic State University, San Luis Obispo

What is your study system?

I work for the U.S. Forest Service (USFS) Range Meadow Monitoring Program that for the last 20 years has monitored the changes in vegetation, soils, and hydrology of over 800 montane meadows ranging from San Diego up to the Oregon border. In this capacity, I have observed several meadows that have burned and were transformed from meager strips of weedy meadows surrounded by encroaching forest into veritable wetlands complete with kingfisher and cattail. I focus on meadows that have burned in wildfires to help understand the effects of fire on meadow vegetation ecology.

What are your primary research goals?

I hope that by examining long-term data from burned meadows, I can discern under what circumstances fire promotes the growth of obligate wetland species. I am particularly interested in obligate wetland species because they are an important source of graminoid diversity in California, support the resilience of watersheds, and can play an important role in carbon sequestration.

Who is your audience?

It is my hope that the results of this research can be applied practically by land management agencies such as the USFS, Bureau of Land Management, and National Park Service to refine decisions surrounding wildfires and the maintenance of meadow systems while building on our understanding of the influence of fire in various plant communities in California.

Who has inspired you, including your mentors?

I would not be here today without the inspiration and encouragement of many amazing folks along the way. Much of my drive has come from the joy of spending time in the field with people whom I admired; the beautiful landscapes and fascinating plants were almost secondary. First and foremost, I would like to thank Dave Weixelman who started the USFS Range Meadow Monitoring project and hired me. Dave created the platform from which I have been able to travel all over the state and observe so many different and unique places, and my research project in its current scope and form would not be possible without his efforts to start and expand the Regional Range Monitoring Program. My work as a graduate student also would not be possible without the immeasurable support of my advisors Dr. Nishi Rajakaruna and Dr. Nicole Molinari.

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"?

At the USFS, we rate the health of meadows according to the proportion of species that fall into each wetland indicator category, as maintained by the Army Corps of Engineers. The healthiest meadows are host to a majority of obligate wetland species, mostly graminoids. I hope that my research reveals mechanisms or patterns that promote robust meadow systems and the maintenance and expansion of native grasslands. Meadows are habitat for a large fraction of the California graminoid flora, and by studying ways to promote their existence, I hope to protect the species that comprise California grasslands.

Why do you love grasslands?

Apart from their obvious beauty, I am inspired by new research showing the capacity of meadows to function as effective carbon sinks. Additionally, the restoration of wet meadow habitats has been one of the most successful efforts to support endangered wetland birds and meadows, supporting more wildlife than any other habitat in the Sierra Nevada. I know that I am not alone in dreaming about what California grasslands were like prior to European settlement, with the writings of early naturalists like John Muir fueling the imagination. While most of California grasslands are now dominated by European annual grasses, wet meadows appear to have mostly resisted similar invasions and maintain a majority of native and often endemic flora. Gazing into a wet meadow is for me a ticket to the past.

Photo courtesy Matt Berry.

Figure 1: A) Lichen-dominated biocrust from San Clemente Islands (SCI). B) Dried soil bryophyte from SCI. C) Moss biocrust underneath grasses on SCI. D) Patchy distribution of a diversity of lichen biocrusts on SCI. E) Active cyanobacteria after a rainstorm in the Mojave Desert.

More Questions than Answers: *The Recovery of Biological Soil Crust Communities After Prescribed Burns*

by Brianne Palmer[1,2] and David Lipson[1]

Background

Biological soil crusts (biocrusts) are complex communities of macroscopic and microscopic organisms found on every continent and in a variety of ecosystems, including grasslands. Generally, biocrusts can be categorized into three broad functional groups that are easily identifiable without a microscope: cyanobacteria, lichen, or bryophyte. Each of these functional groups provides different functions for the ecosystem (Belnap, Büdel, and Lange 2003). Cyanobacterial crusts are dominated by microbes such as Nostoc and Microcoleus (Büdel et al. 2016). These microbes form colonies on the soil surface that are visible with the naked eye, particularly when they are wet (Figure 1 E). They also excrete a sugar syrup, called exopolysaccharides, from their cells and the sugar binds soil particles together, forming a crust (Büdel et al. 2016). Lichen biocrusts are often more highly developed than cyanobacteria biocrusts and provide even more soil stability (Castillo-Monroy et al. 2015, Figure 1 A, D). The organisms in both cyanobacterial and lichen biocrusts fix atmospheric nitrogen and provide more available nutrients in the soil (Belnap 2002). Bryophyte biocrusts are composed of liverworts and mosses and are often difficult to see when they are dry (Figure 1 B, C). Bryophyte crusts hold more water than the other crust types and have been shown to increase the soil water content (Michel et al. 2013).

Previous studies have assessed how biocrusts respond to disturbance, although the responses vary depending on the biocrust composition and the severity of disturbance (Belnap and Eldridge 2001). For example, when biocrusts are trampled, they can take anywhere from one month to one century to recover to the pre-disturbance state (Zhao et al. 2016). Researchers have looked at biocrust disturbance by measuring the changes in biocrust cover, changes in the macroscopic composition, and changes in the microbial community. The primary disturbance of interest to us is fire. As fire is increasing in frequency and severity across the globe, it is important to think about how components of the ecosystem respond. Previous work in the Great Basin found some fire-resistant cyanobacteria in biocrusts (Bowker et al. 2004), although fire did reduce the overall diversity of biocrust lichens (Root et al. 2017). Compared to other ecological communities, the response of biocrusts has been understudied and primarily focused on deserts and cold shrublands with little emphasis on grasslands. In fact, biocrusts in grasslands have been largely overlooked.

Why does this matter?

Biocrusts provide a variety of different ecosystem functions. Previous work indicated that a decline in biocrust cover increased soil erosion and led to depleted nutrients in the soil (Belnap 2002; Eldridge and Leys 2003; Morillas and Gallardo 2015). Changes to or loss of biocrust cover can thus result in a loss of ecosystem function at larger scales (Barger et al. 2006; Chamizo et al. 2012). Therefore, it is critical that we not only understand how biocrusts respond to fire but also understand how to best protect them and the services they provide.

This has a variety of implications for grassland management. First, prescribed burns are often used in grasslands as a management practice. It is important to know how those prescribed burns are impacting biocrusts and weigh the potential loss of biocrust function with the potential benefits of the fire. Secondly, the presence of biocrusts after a fire may help with ecosystem recovery.

From 2018–2020, we attempted to understand how these complex biocrust communities respond to prescribed fire in a California coastal grassland.

Where did we do it?

The project took place on San Clemente Island (SCI), the southernmost island in the California Channel Islands. It is owned by the US Navy and home to a variety of ecological research projects through the United State Geological Survey (USGS) and the Soil and

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[1]San Diego State University, Department of Biology. [2]University of California, Davis, Department of Plant Science

The Recovery of Biological Soil Crust Communities After Prescribed Burns *continued*

Ecology Restoration Group (SERG) at San Diego State University. The plateaus of the island are dominated by a coastal perennial grassland while the canyons and mesic areas are characterized as coastal sage scrub. The interspaces between the grasses are filled with a diverse cover of biocrusts including cyanobacteria, lichens, and bryophytes (Figure 2). We used two sites that were burned using prescribed fire in 2012 and 2017. The sites are named Perennial Grassland East (PGE) and Perennial Grassland West (PGW). The goal of the prescribed burns was to promote the growth of the native bunchgrass, *Stipa pulchra*. Both prescribed burns occurred in the same ten $10m^2$ plots at all three sites with adjacent unburned plots. This created an opportunity for us to measure the effects of fire on the biocrusts of the island.

What we did

In the springs of 2018, 2019, and 2020, we surveyed the percent cover of biocrusts within each burned plot using $1m^2$ Daubenmire frames. We repeated this measurement four times in each plot for a total of forty burn measurements and forty control measurements in each site. Unfortunately, we did not measure the percent cover of biocrusts before the fire, although the control plots are adjacent to the burned plots and may be similar to the pre-fire community. We characterized the functional group of the dominant biocrust cover as cyanobacteria-, lichen-, or bryophyte-dominated. We hypothesized that in the year after the fire, cyanobacteria-dominated biocrusts would be the most common and would gradually increase in lichen and bryophyte cover. We expected greater biocrust cover in the control plots and more highly developed biocrusts in the control plots.

To understand how the microbial community changed with fire, we used shotgun metagenomics (Quince et al. 2017). This technique allows the sequencing of all the DNA present in a small biocrust sample. DNA was extracted from biocrusts collected in 2018. We sequenced four samples from each site-treatment combination for a total of 16 metagenomes. More extensive DNA sequencing will occur in the future. The sequences were uploaded to the MG-RAST database where we were able to extract taxonomic and functional profiles for each sample.

What we found

Contrary to our hypothesis, there was greater biocrust cover in the burned plots compared to the control plots across all three sampling years and there were significant differences between treatment and site. In general, the eastern sites (PGE) had more biocrust cover in the burn and control compared to the western sites (PGW). As the time since the fire progressed, the total biocrust cover in the burned plots decreased. But in the three years since the fire, it has not declined to the same coverage as the control plots (Figure 3).

Although cyanobacteria dominated crusts occupied more space throughout the years, there was a difference in the cover of the different biocrust types as the ecosystem recovered from the fire. In 2018, one year after the fire, PGE and PGW both had significant

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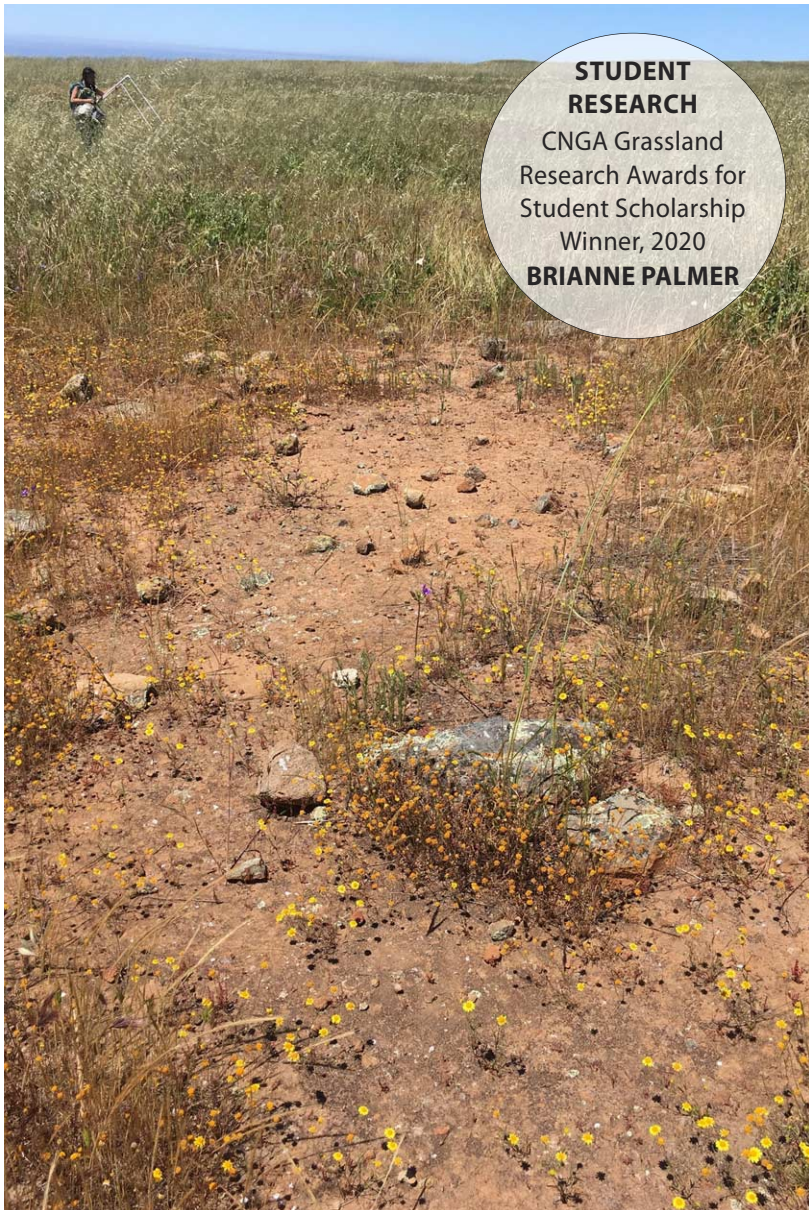

Figure 2: Typical plot on San Clemente Island. The vegetation is patchy with continuous swaths of grasses and forbs broken up by large patches of biocrust.

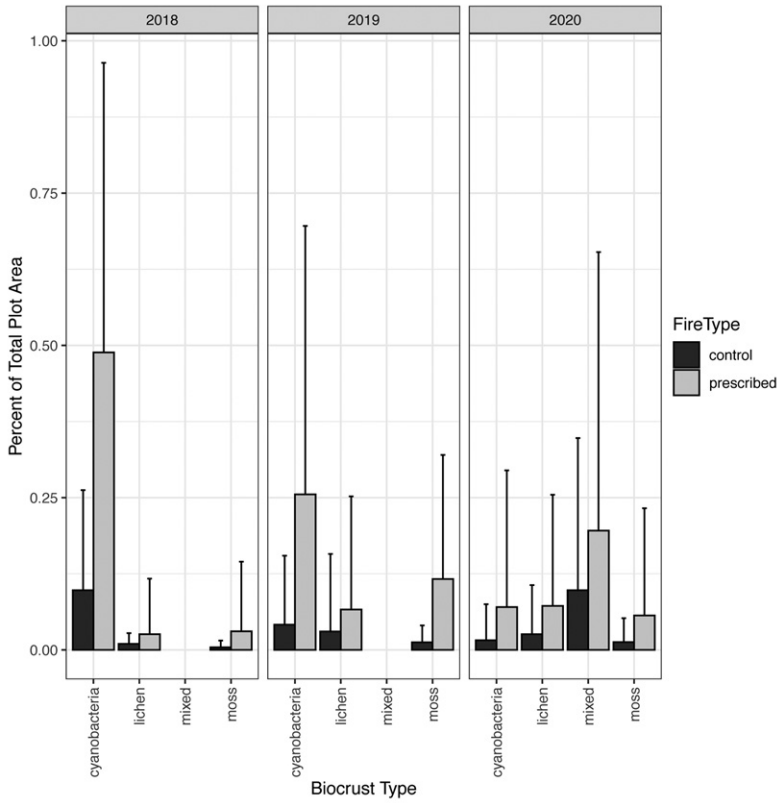

Figure 3: Proportion of the total plot area covered by each biocrust type for 2018, 2019, and 2020. Mixed biocrusts were recorded when the biocrust types were overlapping and we were unable to distinguish between the types.

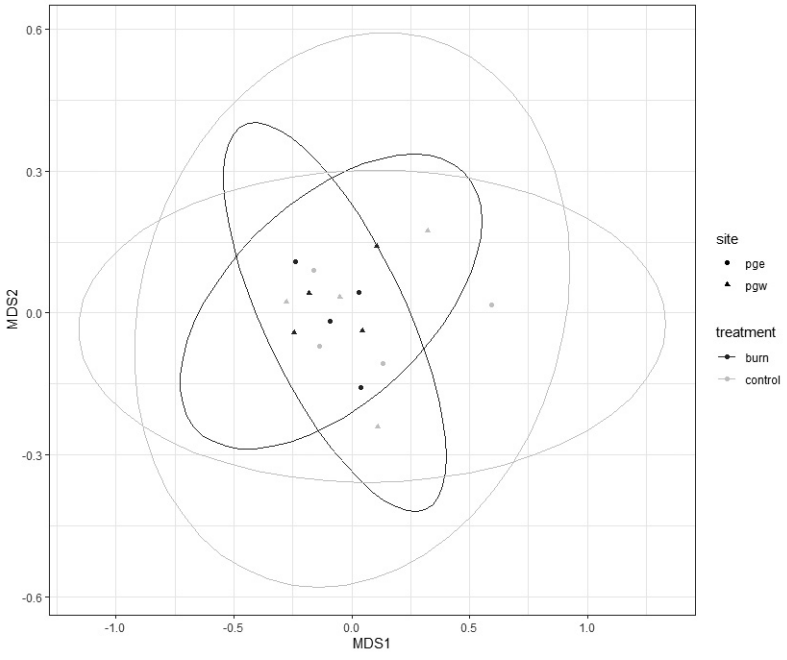

Figure 4: NMDS plot of the microbial community at each site (shapes) and treatment (colors). The closer the points are together and the more overlap there is between the ellipses, the more similar communities are to each other. There is no difference in community composition between treatment (P=0.4) or site (P=0.9).

The Recovery of Biological Soil Crust Communities After Prescribed Burns *continued*

cyanobacterial cover in the burned treatments. Cyanobacteria were still the most dominant biocrust type in the control plots but had less overall cover. In 2019, cyanobacterial biocrusts were still common at both sites, although there was an overall decline in biocrust cover and an increase in the percentage of lichen and moss biocrusts in the burned plots. Then in 2020, biocrust cover continued to decline but again, the proportion of lichen and moss biocrusts increased (Figure 3).

Based on the stark differences between the biocrust cover between the burned and control plots, we expected to see these differences reflected in the microbial community. We used the sequences at the genus level to look for differences in richness and diversity and found no difference between treatment or site. Then using Bray-Curtis distances, we analyzed the communities for each site and treatment and again, found no difference in the community composition between treatment or site (Figure 4).

What could this mean?

Contrary to other studies, in this grassland, there was greater biocrust cover in the burned plots one to three years after a prescribed burn. There are a variety of explanations to describe this result. The first is the product of the experimental design. Each plot was only burned in the $10m^2$ area leaving the grassland around the plot unburned. This undisturbed area may be an inoculum source of biocrust microbes that allowed for swift colonization of the plots immediately after the fire. It is unknown how biocrusts are colonized from adjacent areas, but it is a growing area of study. A possible hypothesis is that there are biocrust forming microbes, most likely cyanobacteria, that are aerosolized and blown into the burned area where they settle and can swiftly form a biocrust in the absence of competition from plants. Alternatively, there may be an inoculum source of biocrust forming microbes living deeper in the soil layers that can survive the fire. When conditions are right, these microbes may move to the surface and form the biocrust (Garcia-Pichel and Pringault 2001). The fires in grassland ecosystems are generally low severity and move quickly through the duff. San Clemente, in particular, has relatively sparse vegetation compared to other grasslands leading to less fuel and possibly cooler fires. This may be enough to allow the biocrust to remain intact and recover quickly after the fire.

There is likely greater biocrust in the burned plots because they colonized the soil surface before the vascular plants. Several

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cases document the prevalence of cyanobacterial crusts during secondary succession (Lan et al. 2014; Arróniz-Crespo et al. 2014; Pessi et al. 2019). In some cases, the biocrusts may provide a habitat that promotes plant growth and thus leads to a decline in the biocrust itself. Biocrusts can promote plant growth in a variety of ways including increasing the amount of available nitrogen in the soil, increasing water infiltration, and reducing erosion— all ecosystem functions that are useful after a fire (Eldridge, Zaady, and Shachak 2000; Belnap 2002; Breen and Lévesque 2006; Bowker et al. 2008; Godínez-Alvarez, Morín, and Rivera-Aguilar 2012). This may also explain the gradual decline in biocrust cover over time. As more plants establish, they outcompete the biocrust for space and light. This may be particularly true in the control plots where we see the little biocrust cover. These plots are dominated by exotic annual grasses such as *Avena barbata* and *Bromus madritensis* which create dense monocultures and thick thatch layers that may either inhibit biocrust growth or add an additional barrier for researchers surveying the percent cover of the biocrusts (Figure 5).

However, this study is not without its flaws. The microbial analysis was highly selective towards prokaryotic organisms and may have missed much of the eukaryotic diversity, particularly mosses and the fungi associated with lichens. Additionally, in the field, on dry days it was difficult to distinguish the different types of biocrust types. Therefore, the total biocrust cover is a better variable than the proportion of lichen, moss, and cyanobacteria. Most likely, most of the biocrust cover should have been characterized as mixed.

What are the implications for management?

There are a few takeaways from this experiment. The first is that there is still an incomplete understanding of how grassland biocrusts recover after a prescribed fire. There is a need to more fully understand the inoculum sources and how biocrusts are colonized. However, the swift recovery of biocrusts after fire would be beneficial for fire management, particularly due to their ability to reduce erosion, modulate water content, and influence nutrient regimes. Based on this research, prescribed fire in a coastal grassland should not reduce the cover of biocrust nor change the microbial community and may therefore leave some of the biocrust functions intact. Managers can take advantage of these biocrust functions when restoring a post-fire landscape. Either by utilizing the biocrust present or by transplanting other biocrust inoculum, biocrusts will readily colonize a landscape and provide more nutrients and soil stability. Rather than managing fire to promote and conserve biocrusts, biocrusts themselves may be used to passively improve the post-fire landscape overall.

California grasslands generally have high plant cover and low plant stature which presents a unique challenge for biocrusts. Without space to grow, the biocrust forming cyanobacteria may lurk in the soil, awaiting a patch of light to begin photosynthesizing and form a crust. When restoring grasslands, land managers should evaluate the type of grassland structure they are aiming for. Do they want endless fields of continuous plants or the patchy distribution of biocrusts? The decision will probably be based on evaluating the trade-offs of each community, restoration goals, and the disturbance history of the site. A continuous grassland may provide more forage and more carbon storage. Perhaps, a continuous grassland matches the reference community used by restorationists and provides ecosystem functions. But consider what this grassland may have looked like in an early successional state. As we learned from this study, there was greater cover of early successional biocrusts in plots that were burned. Perhaps restoring a grassland to a state where biocrusts can do what biocrusts do would be beneficial for the ecosystem and require less hands-on management. These are simply speculations and they require research. However, we urge land managers to consider, even briefly, the function of biocrust on their land and the potential benefits of a healthy biocrust community after a disturbance.

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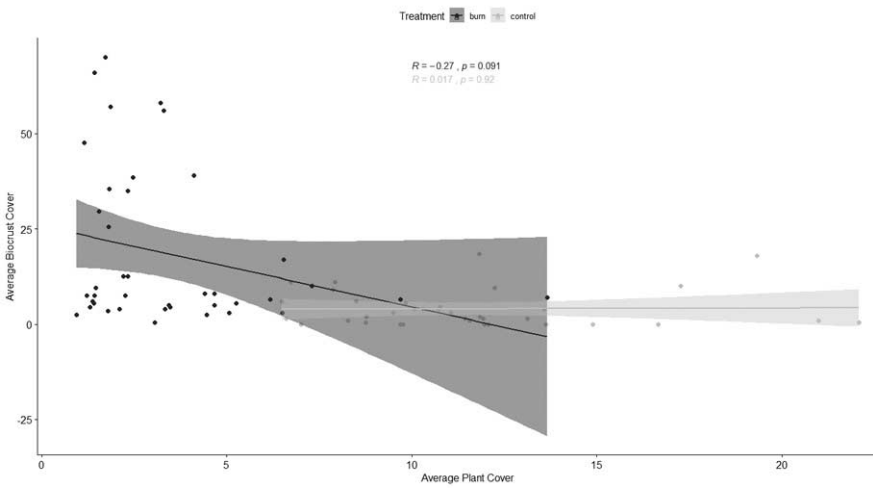

Figure 5: There is a significant negative correlation (Spearman's correlation coefficient) between biocrust cover and plant cover in the burned plots. There is no correlation between the cover of these two communities in the control plots.

We are kicking off our end-of-year donation drive on #Giving Tuesday, December 1st. We invite you to join us and millions around the world in showing how together we can be a force for good! *See page 21 for details*

The Recovery of Biological Soil Crust Communities After Prescribed Burns *continued*

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COASTAL PRAIRIE RESTORATION

Choosing Plants for Success

STUDENT RESEARCH
CNGA Grassland Research Awards for Student Scholarship Winner, 2019 & 2020
JUSTIN LUONG

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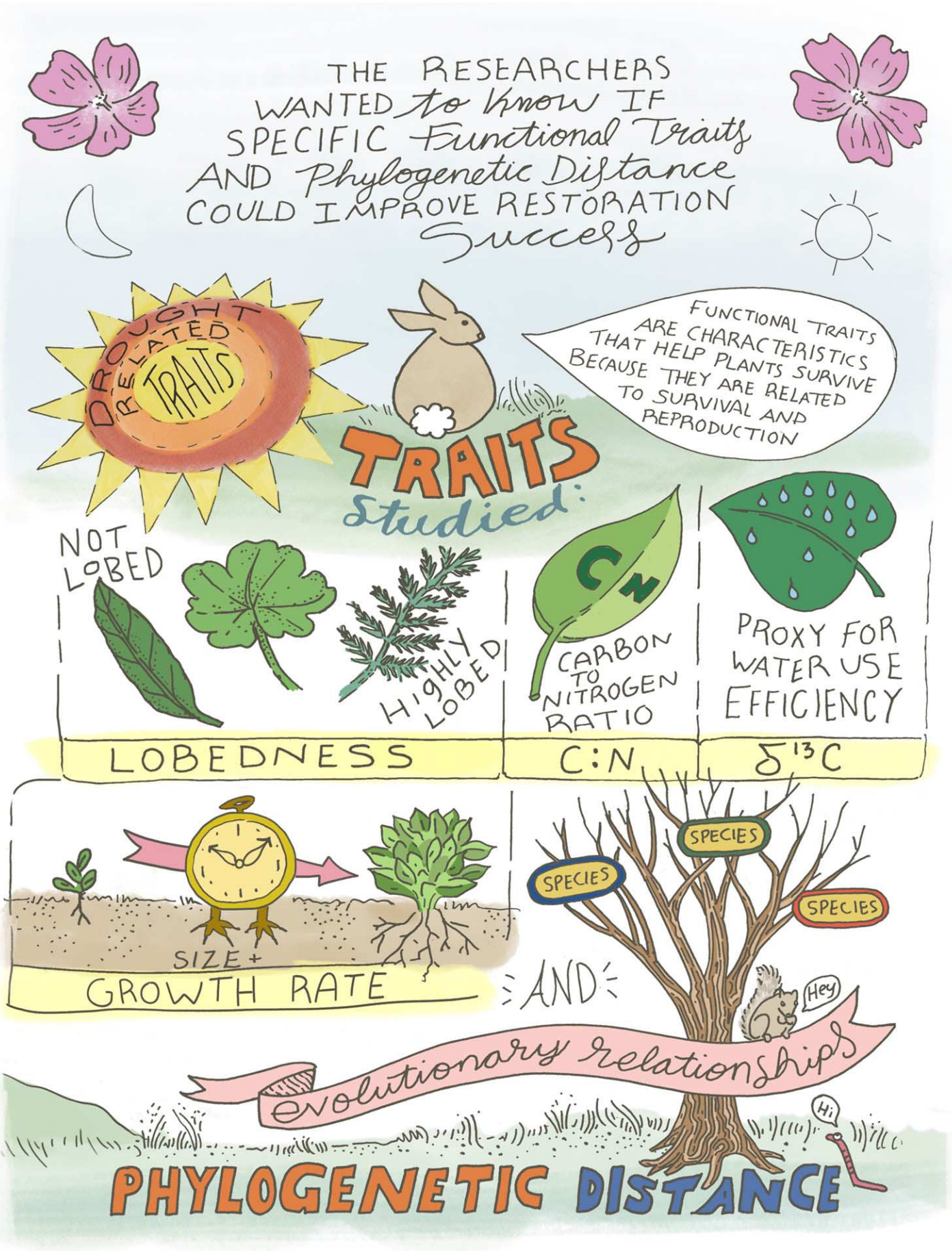
THE RESEARCHERS WANTED to know IF SPECIFIC Functional Traits AND Phylogenetic Distance COULD IMPROVE RESTORATION Success
DROUGHT RELATED TRAITS
FUNCTIONAL TRAITS ARE CHARACTERISTICS THAT HELP PLANTS SURVIVE BECAUSE THEY ARE RELATED TO SURVIVAL AND REPRODUCTION
TRAITS Studied:
NOT LOBED
HIGHLY LOBED
LOBEDNESS
C N
CARBON TO NITROGEN RATIO
C:N
PROXY FOR WATER USE EFFICIENCY
δ13C
SIZE+
GROWTH RATE
AND
SPECIES
SPECIES
SPECIES
Hey
evolutionary relationships
Hi
PHYLOGENETIC DISTANCE

**Mimulus* is now *Diplacus aurantiacus*

continued next page


2665 Leaf Samples Collected
DROUGHT RELATED TRAITS WERE measured FROM EACH LEAF SAMPLE. PLOTS were ASSESSED for PLANT COVER.
Ambient Rainfall
Drought Treatment
THE STUDY RESULTS SUGGEST THAT THE SELECTED NATIVE SPECIES ARE BETTER Adapted TO DROUGHT THAN THE Invasives IN THE PLOTS.
GREATER ABUNDANCE OF INVASIVE NONNATIVE GRASSES
GREATER ABUNDANCE OF NATIVE GRASSES AND FORBS
PLANTS WITH THESE TRAITS WERE MORE SUCCESSFUL:
MORE LOBED OVERALL
SLOWER GROWTH RATE OVERALL
HIGHER CARBON TO NITROGEN RATIO IN AMBIENT WATER PLOTS
C:N
δ13C
HIGHER DELTA CARBON-13 IN DROUGHT PLOTS
Pd
SPECIES more CLOSELY RELATED to NEIGHBORS
were LESS LIKELY to DIE
AS the CLIMATE CHANGES PERIODS OF DROUGHT MAY INCREASE. UNDERSTANDING Functional Traits + Phylogenetic Distance CAN HELP INCREASE Native COVER in FUTURE Restoration PROJECTS.

Coastal Prairie Restoration: *Choosing Plants for Success*

by Justin Luong[1] and illustrated by Lesley Goren[2]

[1]Justin Luong is a PhD student at UC Santa Cruz studying restoration ecology and how to better incorporate practitioner input and restoration responses to a changing climate. Justin's website is **justinluong.com**, his twitter is **@JustinCLuong**, and he also runs the **@Stipapulchra** instagram page. [2]Lesley Goren is an illustrator specializing in California's plants and places. She works with many environmental organizations and non-profits. Her work can be seen at **www.LesleyGoren.com**. Citations for Lesley Goren's Illustration of Justin Luong's Restoration Drought Grassland Research follow below.

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An area of Drakesbad Meadow dominated by California false hellebore (*Veratrum californicum*).

VISIT A NATIVE GRASSLAND: *by Kendra Moseley[1] and Marchel Munnecke[2]* *Photos courtesy of the author*

Drakesbad Meadow, Lassen Volcanic National Park

Nestled at the base of a rugged glacier-carved landscape, Drakesbad Meadow can be found within the Warner Valley near Chester on the eastern side of the southern portion of the Cascade Mountains, surrounded by majestic cedar trees (*Thuja plicata*), white fir (*Abies concolor*), and lodgepole pine (*Pinus contorta*) trees. This National Park Service-managed meadow is part of Lassen Volcanic National Park and also serves as a historic "check-in" point for the Pacific Crest Trail (PCT).

Drakesbad Meadow is the largest meadow in Lassen Volcanic National Park and one of its especially unique features is the complex mosaic of plant communities interconnected by a spectrum of hydrologic conditions from wet to dry, including a small portion at the base of a spring, which qualifies as a fen. Fens build up thick amounts of organic matter (over 40 cm within the upper 80 cm of soil), support hydrophytic vegetation, and are generally saturated to the soil surface for a least one month each year. Land uses over the past 100 years have impacted this meadow, primarily from the incised ditches that concentrate water flows and dry out the surrounding soils, and the removal of Lemmon's willow (*Salix lemmonii*) and other shrubs that have altered the vegetation dynamics. Despite these alterations and previous livestock grazing, there are still many unique native grasses, grass-like plants, and forbs present.

The hydrology, soil development, and history of this meadow, in particular, play important roles in the unique distribution and composition of these plant communities. The presence and distribution of the plant communities are related to water table depth and duration of soil saturation. The wettest portions of this meadow have developed with a constant, steady flow of water from the springs upslope fed by groundwater seeping out at a bedrock

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Drakesbad Meadow, Lassen Volcanic National Park *continued*

contact and seasonal snowmelt. Presently, only the wettest areas of the meadow have these deep, organic, peat soils that comprise the fen, while the drier areas of the meadow have mineral soils and support a larger composition of upland plant species.

While the wettest portions are almost entirely dominated by peat-forming sedges, including short-beaked sedge (*Carex simulata*), beaked sedge (*C. utriculata*), and Nebraska sedge (*C. nebrascensis*); you can also find native grasses interspersed within the sedges such as Bolander's bluegrass (*Poa bolanderi*) and California brome (*Bromus carinatus*), and native forbs including Scouler's St. John's wort (*Hypericum scouleri*) and Douglas' thistle (*Cirsium douglasii*). The rest of the meadow is a patchwork of wet meadow and dry meadow species that vary based on the elevation of the soil and the depth to the water table which is influenced by snowmelt each spring and into the summer. At a slightly higher elevation, surrounding the fen, you will find a community that is almost entirely dominated by Nebraska sedge, which provides soil stabilization as well as peat accumulation from its vast and deep network of roots.

A mixed sedge and grassland community is found throughout the meadow, wet near the surface in late spring/early summer, and drying out as the summer progresses. Some of the most dominant plants in this part of the meadow include narrow-leaved sedge (*Carex angustata*), tufted hairgrass (*Deschampsia cespitosa*), and meadow barley (*Hordeum brachyantherum*). Scattered among these many native grasses and grass-like plants are a variety of forbs, including Chamisso arnica (*Arnica chamissonis*), long-stalked clover (*Trifolium longipe*s), slender phlox (*Microsteris gracilis*), rose thistle (*Cirsium andersonii*), California false hellebore (*Veratrum californicum* var. *californicum*), fringed willowherb (*Epilobium ciliatum*), and Rydberg's penstemon (*Penstemon rydbergii*).

The remaining portions of the fen in Drakesbad Meadow can be found at the base of this bedrock-contact alder-dominated seep on the toeslope.

As you continue to move to the driest portions of the meadow where you can keep your feet dry, you will find species that are associated with the topographically higher floodplain stream deposits within the meadow, which were a result of past flood dynamics. This area is presently dominated by mixed sedges (*Carex* spp.), mountain rush (*Juncus balticus*), Columbia needlegrass (*Stipa nelsonii*), and a host of different forbs, such as spreading groundsmoke (*Gayophytum diffusum*), slender cinquefoil (*Potentilla gracilis*), and several asters.

To visit Drakesbad meadow and access the hiking trails open to all visitors, take Highway 36 towards Chester and take a left on Warner Valley Road. You can then park at the trailhead located 1/4 mile before Drakesbad Guest Ranch. Come anytime from early summer to early fall and enjoy picturesque views, open space for wildlife viewing, songbird viewing, photographic opportunities, historical features, access to hot springs, and easy and level nature trails to access hours of botanizing. For more information, visit **https://www.nps.gov/lavo/planyourvisit/drakesbad.htm**.

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From left: Deniss Martinez and Dr. Beth Rose Middleton and a student help Diana Almendariz (elder; Maidu/Wintun/Hupa/Yurok heritage) plant Native plants after the cultural burn workshop at the Tending and Gathering Garden. Deergrass burning. *Photos: Melinda Adams*

Hands on the Land, Heart in Community: *Returning Cultural Fires*

by Deniss J. Martinez[1] Originally published at EHN.org. Permission by the author.

Fire is a necessary part of California ecosystems; we should follow Indigenous cultural fire practices for healthier, abundant forests, and to reverse more than a century of damage.

It was a California Summer. I was working in a plant nursery tucked into the Cascade Mountain Range—blue mountains in the distance and rivers and creeks to splash in. But I couldn't clearly see my hand outstretched in front of me. It's the smoke. Like almost every summer of my childhood, a wildfire raged in a nearby forest.

Looking back, what was most disturbing was not the smoke or the thick layer of ash on my car after work, it was how normal this was. Evacuations and high severity forest fires are an almost annual occurrence. California's forest fire problem now routinely makes international news as entire cities are destroyed.

Now more than ever, California forest fires have become synonymous with death, destruction, and long-term economic depression.

But it wasn't always so: Native people once were able to steward all of the lands that settlers came to call "wilderness." Instead of excluding fire as United States' land management policy has dictated for more than one hundred years, Indigenous people in California knew the land needed fire.

Instead of depriving the land of fire by suppressing it, Indigenous communities across California used controlled fire consistently to meet the land's needs while increasing the productivity of key food and fiber resources. This constant caretaking resulted in abundant landscapes less prone to catastrophic wildfire.

However, since the federal government began a fire suppression policy starting in the early 20th century, Native people in California have had to fight an uphill battle to tend to their homelands. While fire suppression is now widely regarded as a faulty policy, it is difficult to turn around a hundred years of damage.

My research focuses on understanding the political and economic strategies Native communities are taking to revitalize their cultural fire

continued next page

[1]Deniss is a PhD Candidate in Ecology at UC Davis and a Health Policy Research Scholar, Robert Wood Johnson Foundation. Her work seeks to understand how California Native Nations navigate power differentials in varying natural resource stewardship collaborations with western institutions. She is passionate about increasing Indigenous representation in environmental stewardship in order to support environmental justice, health equity, sovereignty, and cultural vitality.

practices. California Native cultures, like the Karuk, Yurok, Wintun, and North Fork Mono, have a different worldview when it comes to fire. Fire in these communities is a means for rejuvenation, abundance, and creativity.

Fire is sometimes referred to as a relative or a living entity. This view of fire stands in stark contrast to fearing fire as an agent of death and destruction. As an ecologist passionate about social justice, I've realized that this ecological process is also a deeply cultural one. Fire is a necessary part of California ecosystems; we should follow Native cultural fire practitioners' lead in changing the way we relate to it.

How homelands become wilderness

The general public mourns for the "wilderness" burnt in large wildfires, but the wilderness is a social construct.

Wilderness is actually a stolen, once carefully tended, homeland. The beautiful and conveniently bountiful landscapes that colonizers encountered on their first journeys to California were not a coincidence. The concept of wilderness was created by settlers who made themselves innocent of murder and theft by claiming the land was empty, wild, unused, or improperly used by Native people.

As a descendent of Tutunaku and Mexica people, I know too well that our homelands were innovatively crafted to support our communities and were places that nourished us and our cultures in every sense of the word. However, the abundance that we created using science, sustainable economic practices, culture, and labor became the stolen wealth of settler nations across the Americas. When settlers stole the land, the wealth they stole included our relatives: the land, water, and wildlife.

Now, as I live as a guest on California Native lands, it is even more clear to me that Native people are brilliant land stewards. California Native people work meticulously to manage forests, shrublands, fisheries, and other wildlife (Baldy 2013; Norgaard 2019; Anderson 2013). The land that colonizers encountered was abundant because Native people looked to the future and built an environment that was sustaining and life-giving.

Fire is a prime example of this ingenuity. While the diverse California Native cultures use fire for different purposes, cultural fire practitioners around the state have used low intensity, controlled fire to reduce pests in acorns (a key traditional food staple), stimulate regeneration of native plants, reduce invasive species, increase water use efficiency, create habitat for wildlife, and improve the quality of basketry material.

These benefits of cultural fire stewardship have been documented by Native people as well as researchers. In the midst of catastrophic uncontrolled fires, climate change, and traditional food shortages, cultural fire has the potential to increase the health of Native communities by protecting healthy traditional foods such as acorn, salmon, and huckleberries. Access to traditional foods is crucial in communities that are food deserts and where rates of diabetes and heart disease can be three times the national average (Norgaard 2005).

Many people still depend on the land to provide their daily meals. Fire is considered a spiritual obligation and a responsibility to retain culture in the form of foods, ceremony, and environment. Fire stewardship is a gift of health to future generations.

A century of warnings

It is increasingly urgent that Native people should have a voice in California fire stewardship as large catastrophic fires are already wreaking havoc on our lives. The climate crisis will worsen an already difficult situation by extending hot and dry seasons and increasing tree mortality via extended drought (Cart and Lin 2019).

The challenge that wildfire and climate change pose collectively seems insurmountable at times. However, one benefit of Native people's constant caretaking is a reduction of the dead and dry material that litters our forest floors.

This material, coupled with overcrowded forests, increases wildfire hazards. The federal and state government's fire suppression policies

continued on page 22

Ron Goode (Chairman, North Fork Mono Tribe) and author Deniss Martinez laugh about a good joke on a cultural burn of redbud and sourberry. *Photo: Zack Emerson*

Deniss Martinez helps clean up a burn area. *Photo: Zack Emerson*

Hands on the Land, Heart in Community: *Returning Cultural Fires* *continued from page 20*

instituted a command and control mentality that outlawed the necessary low-intensity fires required to reduce the amounts of dead plant material that could become fuel for the large wildfires of today.

Native people in California knew this and were outspoken about it from the beginning. Klamath River Jack, a Native man living in the Klamath basin, tried to educate settlers as early as 1916 in a letter written to the California Fish and Game Commission and published in the local paper in Requa, California, which is a part of traditional Yurok homelands (Norgaard 2019). In it, he implores them to recognize that Native fire management practices reduced fuels for large wildfires, reduced pests on acorns, and increased the food available for deer and elk by increasing new sprouts and keeping grasslands desirable.

His plea was ignored and mocked by a local forest ranger. Since Klamath River Jack's letter, many Native people in the Klamath basin have been arrested for arson for continuing this and other necessary practices.

Native people all over California have kept telling decision-makers, scientists, and the public that cultural burning has many more benefits including increasing water use efficiency in forests, helping salmon survive hot water temperatures, and keeping food and fiber abundant for Native communities.

Now, as our environment is in crisis, people are finally beginning to listen.

Redefining fire

In order to return fire to California landscapes, Native communities have had to collaborate with state and federal agencies. A large part of my research looks at how effective these collaborations are at creating more just futures for Native people.

I am fortunate to spend time with Indigenous activists, scientists, and policymakers redefining what the response to climate change and environmental destruction should be. Native people all over California are mounting a cultural fire revolution and, in talking to them, I have learned how important it is to understand power and decision-making over public lands.

They have built large collaboratives that bring former foes together, successfully lobbied for consulting power, and are changing the way that California's non-Native residents understand fire by building broad outreach and education efforts. All this is an effort to bring Indigenous leadership and cultural fire back to landscapes that sorely need it.

These Native change-makers are reminding all of us of our responsibilities to the land and teaching us how to have a better

continued on page 24

California Grassland Research Awards for Student Scholarship (GRASS)

STUDENTS! *Call for Applications Begins November 1, 2020*

We are proud of all our GRASS recipients from 2019 and 2020. Sarah Gaffney (2019 recipient) is a Director on the CNGA Board and Research & Science Committee Chair. Justin Luong (2019, 2020) is running for the 2021–2022 CNGA Board of Directors. Three scholarship recipients are featured in this issue: Brianne Palmer's (2020) article on biocrusts, co-authored with David Lipson; Justin Luong's (2019, 2020) coastal prairie research creatively illustrated by Lesley Goren; and Roisin Deák (2020) is the featured grassland researcher in this issue. All ten of our GRASS recipients have published articles or were featured in previous Grasslands issues.

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

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

Awards: CNGA will fund four or more $500 awards per year. These awards are designed to support basic undergraduate and graduate research in native grassland ecosystems. Funds can be used for fieldwork, small equipment purchases, visits to herbaria, materials and/or books. Students may re-apply and receive a scholarship award for a maximum of two years.

How to Apply: Visit https://cnga.org/GRASSgrants for application information for 2020 Grants. Application deadline is January 31, 2021. .

Support the Next Generation of Grassland Researchers: Would you like to fund a student scholarship to encourage a new generation of grassland conservationists? For more information or to make a donation visit https://cnga.org/GRASSgrants

relationship with fire. They remind us to ask ourselves: how am I nourishing the landscapes that nourish me? What are my responsibilities to this place?

For Indigenous communities there is no hand wringing about what to do in the face of climate change; there is action, love, and hope. Native nations know their responsibilities to place. Do you?

Indigenous fire workshops: Creating social resilience to climate change

Fire creeps through the blades of grass. I squat and put more dry blades in its path. The fire grows and consumes the deergrass. I look around at our gathering of Indigenous elders, children, community members, and students. People are laughing and there's this deep sense of love for the land we are burning.

The fire is slow today, we have to coax it onto the deergrass. The plants we burn will allow the local Native community to have basketry material. Without fire and other careful caretaking, basketry plants are unusable. They can become scarce, crooked, or inflexible. Burning shrubs such as redbud, sourberry, and hazelnut make for long, straight, and flexible sprouts perfect for weaving. Deergrass produces more of its desirable flower stalks.

The three Wintun/Patwin basket weavers that dictate our movement in the Tending and Gathering Garden at Cache Creek Nature Conservancy are alight and laughing. They answer a myriad of questions from curious newcomers.

This is one of the recent Indigenous Fire Workshops that our team at UC Davis has organized with cultural practitioners to bring policymakers, land managers, and academics together under the guidance of elders. These workshops create social resilience to climate change by building relationships and respectful collaboration.

Our most recent trip to visit Ron Goode in Mariposa County brought out more than 100 people to burn five acres of sourberry and redbud, as well as a meadow.

These important basketry materials have been put to use by basket weavers and other community members. We camped for three days alongside members of CAL FIRE, the U.S. Forest Service, scientists, neighbors, elders, and Native youth.

We told stories and jokes around the campfire. We made connections not only to each other but also to the land.

I wish this was what people thought of when they imagined fire in California, but unfortunately, a couple of hundred years of violent settler colonialism has left its mark. The criminalization and suppression of California Native cultural stewardship have led to forests that are a true wilderness. Wilderness because they are not cared for. Wilderness because they are thick, full of fuel, and disease.

But here, with fire creeping through deergrass, I remember that Indigenous people all over the Americas—including my own ancestors—have already survived an end of the world. We saw our people die in epidemics, taken as slaves, killed en masse. We saw the mass killings of our relatives: stacks of buffalo bodies, antlers, and salmon dead on the sides of rivers. We've been mourning for centuries.

But amidst all of that death, destruction, and heartbreak we have been resilient, joyful, and creative.

We know the best way to counteract the destruction of land is to love the land. Love it radically and fiercely. After all, we are the land.

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Front cover: *Grindelia camporum*, gumweed, a wonderful late-season prolific blooming perennial forb. It is attractive to various pollinators including bees and butterflies and is also used by many beneficial insects. It produces abundant seeds each year. This photo was taken in The Wild Gardens at the Grace Hudson Museum in Ukiah, Mendocino County. *Photo by Emily Allen, botanical and restoration consultant and CNGA board member* (November 2019).

Back cover: A selection of low growing coastal California native plants for a small space, an entryway, in a microclimate of filtered sun. The plant list includes from front to back: *Erigeron glaucus* (Seaside daisy), *Arctostaphylos cruzensis* (Arroyo de la Cruz manzanita), *Festuca rubra* 'Patrick's Point' (Patrick's Point red fescue), and *Achillea millefolium* (Yarrow). Planted in San Clemente, SoCal. Photo, design, and install by Colin Dunleavy, Live Forever Landscape LLC (October 2019).