

IS THERE STILL NATIVE DIVERSITY IN CALIFORNIA GRASSLANDS?

by Megan E. Lulow and Truman P. Young

Our understanding of the native flora of California's Central Valley is undergoing a sea change. Although this community has traditionally been described as a grassland once dominated by native perennial bunchgrasses (Burcham 1957, Heady 1988, Schiffman 2007, Stromberg et al. 2007), there have been many over the decades who have suggested that the emphasis on grasses was misplaced, and that native wildflowers (non-grass herbs) were a significant component as well (John Muir 1894; Hamilton 1997).

Recently these voices have risen again, spearheaded by Glen Holstein of the CNPS and Richard Minnich in his book, *California's Fading Wildflowers*. Our own survey work has revealed a wonderfully rich flora of



A post-fire wildflower display representing species frequently found across areas with native remnants in grassland and grassland scrub. Photograph by Jutta Burger.

wildflowers in remnant grasslands throughout the state, and the pages of *Fremontia* are often filled with fields of magnificent wildflowers. In addition to their aesthetic appeal, wildflowers contribute to ecosystem function, including nitrogen fixation, pollinator resources, habitat structure, and forage quality.

A LOST LEGACY

The Central Valley and adjacent hills of California have been so heavily invaded by non-native species, particularly annual grasses (e.g., bromes and wild oats) and herbs (e.g., mustards and starthistle), that few clues remain of the original vegetation. Hiking through most former rangelands in the Central Valley or within the California Coast Range, one finds only a scattering of native plant species, or perhaps rare pockets where natives truly dominate (Noss et al. 1995). The majority of areas, particularly those recently released from grazing, have accumulated high levels of thatch and decadent growth of non-native species.

There is very little record of the composition of California grassland flora prior to the invasions of non-native species, cattle ranching, and large-scale cultivation (but see Muir sidebar, page 9). The invasion by exotic plants has been so extensive that formal classifications of California flora recognize the grassland dominated by non-native annuals as its own distinctive subtype, or alliance (Sawyer et al. 2009). In fact, there are few plant communities on the planet for which we have so little confidence about their original composition.

We have observed, as have others (e.g., Ayzik Solomeshch, Glen Holstein, Peter Hopkinson, pers. comm.; see also Tables 14.3 and 14.4 in Bartolome et al. 2007) that in both "remnant" sites and sites converted to dominance by exotic annual grasses, many native wildflower species persist. It is clear that calling these communities "grasslands" may be misleading (although we will use the term here, for form's sake).

We have been involved in surveying grasslands in two regions of California, both of which Keeler-Wolf et al. (2007) refer to as the "Valley and south coastal" type in their classification of the state's major grasslands. Large-scale grassland restorations were being planned and implemented throughout the two regions we surveyed: the foothills of the Santa Ana Mountains within the Irvine Ranch National Natural Landmark in Orange County, and the Coast Range foothills on the western edge of the Sacramento Valley in Yolo County. For both regions we sought to document the occurrence and general abundance of upland native "grassland" species, and to generate a reference list to facilitate the enhancement of species diversity in grassland restoration projects. Both regions consisted of sites within a larger, often degraded landscape of grassland, as well as smaller grasslands that were part of an oak woodland or scrub mosaic.

IRVINE RANCH NATURAL LANDMARK

A map of native grasslands and the extent of their degradation was developed for management planning within the Lomas Ridge and Limestone Canyon regions of the Irvine Ranch National Natural Landmark. National Natural Landmarks are designated by the U.S. Secretary of Interior for natural areas in both public and private ownership. They are recognized as outstanding examples of the natural heritage of the country, alongside national parks, recreation areas, and monuments.

After a fire in October 2007, our



A mosaic of grassland (background, left), scrub (foreground), and ecotone (center), plant communities common to the Irvine Ranch Natural Landmark survey region. Photograph by Jutta Burger.

team of scientists visited all but the least accessible grasslands in these hills. Grasslands were defined as having less than 20% cover of woody species, including both coast live oak (*Quercus agrifolia*) and coastal sage scrub species. At each of 475 sites across the hills, we developed a list of all native species, and estimated the percent cover of each life form (grass, wildflower, shrub, and tree). Based on floristic composition, these sites were divided into six community types, or alliances (Figure 1).

Across all surveyed grasslands in the Irvine Ranch Natural Landmark, there were a total of 140 native species: 99 wildflowers, 12 grasses, 1 rush, 26 shrubs, and 2 trees. Most species were observed at low frequencies, with only two

species occurring at more than half of all sites, and only 15 occurring at more than one-fifth of all sites. The number of native wildflower species ranged from 5–61 across sites, and always far exceeded the number of native grass species (Figure 1), and also often exceeded the native grasses in cover.

Some of the most frequent wildflowers included: fascicled tarweed (*Deinandra fasciculata*), blue dicks (*Dichelostemma capitatum*), miniature lupine (*Lupinus bicolor*), coastal goldenbush (*Isocoma menziesii*), and common goldenstars (*Bloomeria crocea*). Across all surveyed grasslands, the overall abundance and species richness of native wildflowers was greater than that of woody species or geophytes (wildflowers growing from underground bulbs

and corms). However, the woody and geophyte species were more common and consistently found across multiple grasslands.

There were substantially more native species in ecotone grasslands—a transition area between two plant community types, such as native grassland and woodland, or native grassland and scrub. However, at Irvine Ranch Natural Landmark, ecotones contained half the cover of the most common native grass, purple needlegrass (*Stipa pulchra*), than the more open grassland. While these ecotone areas are species rich, they likely serve a different function to the ecosystem because the relative abundance (or cover) of species is so different from that in the core area of each plant community type.

WESTERN SACRAMENTO VALLEY FOOTHILLS

We had also carried out a survey of grassland remnants in the western Sacramento Valley foothills, limited to grasslands known to have either a native wildflower or grass component to the flora, even if comprising only 10–15% of the total plant cover at some sites (Lulow and Young 2009). Seven areas were chosen, with a total of 58 sites surveyed during the spring and summer of 2002–2004 (Figure 2). Grasslands were defined as having less than 20% cover of woody species,

dominated by blue oak (*Quercus douglasii*) in this region. At these Northern California sites, only presence or absence of native species was recorded. Four of the seven sites had cattle or sheep grazing occurring at low levels of intensity. In general, ecotones, rocky ridge tops, and north facing slopes were better places to find the remnant patches than flatter, open grassland. Nonetheless, all sites had at least 50% of their cover represented by exotic annual plant species.

Again, wildflowers dominated the native species lists. Across the seven sites, at least 79 native spe-

cies were found in the remnant grassland flora (10 grasses, 67 wildflowers, 1 shrub, and 1 tree). The number of native wildflower species in each area ranged from 20 to 36 (Figure 2). Many of these species were widespread; 25 species were observed in more than half the sites surveyed. Geophytes accounted for 20% of wildflower species that occurred in at least one-half of all sites surveyed. Some of the more frequent wildflowers included California yarrow (*Achillea millefolium*), miniature lupine (*Lupinus bicolor*), brodiaea (*Brodiaea* spp.), valley tassels (*Castilleja attenuata*), tree clo-

Degraded grassland dominated by non-native annual grasses at Limestone Meadow in the Irvine Ranch Natural Landmark. Photograph by David Olson.



TABLE 1. COMMON SPECIES SHARED BETWEEN SURVEY REGIONS.

Common Name	Species
Fascicled tarweed, hayfield tarweed	<i>Deinandra fasciculata</i> or <i>Hemizonia congesta luzulifolia</i>
Miniature lupine	<i>Lupinus bicolor</i>
Blue dicks	<i>Dichelostemma capitatum</i>
Arroyo lupine	<i>Lupinus succulentus</i>
Mariposa lily: splendid, Catalina, or yellow	<i>Calochortus splendens</i> , <i>C. catalinae</i> , or <i>C. luteus</i>
Gum plant	<i>Grindelia camporum</i>
Short-podded lotus, strigose lotus	<i>Acemispion</i> (formerly <i>Lotus</i>) <i>brachycarpus</i> or <i>A. strigosus</i>
California plantain	<i>Plantago erecta</i>

Note: Tarweeds, mariposa lilies, and annual lotuses did not share the exact same species between regions, but had similar taxa.

Source: Lulow and Young, 2009.

ver (*Trifolium ciliolatum*), and hayfield tarweed (*Hemizonia congesta*).

NORTHERN VS. SOUTHERN SURVEYS

While the survey within the Irvine Ranch Natural Landmark found that most species occur at low frequencies across a variety of sites, the two survey areas shared 8 of their 25 most common native wildflowers (see Table 1). While geophytic species represent a small fraction of the total richness, in both

surveys they were among the more frequent species across sites. This group of species are often not included in grassland restoration species lists and can be cryptic in remnant native communities, appearing aboveground primarily only after fires or wet years. These results suggest this group may be an overlooked, yet significant component of native grassland composition across the state.

There were conspicuous differences between the two areas. In particular, native clover species were found more frequently in the west-

ern foothills of the Sacramento Valley, whereas more shrubs were found in the grasslands on the Irvine Ranch Natural Landmark. Greater total species richness was recorded on the Irvine Ranch Natural Landmark, but this may be because a far greater number of sites were surveyed there.

GRASSLAND? FORBLAND? PRAIRIE!

In summary, throughout the surveyed remnant sites, the number of native wildflower species was far

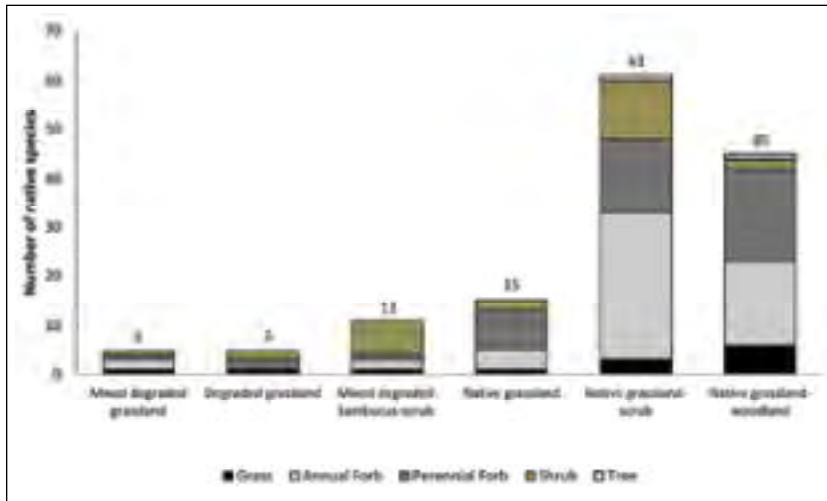
AN EARLY ACCOUNT OF THE CENTRAL VALLEY PRAIRIE

There are several accounts of the flower-rich flora of the Central Valley in the era before large-scale agriculture, but perhaps none as eloquent as this, from John Muir:

The Great Central Plain of California, during the months of March, April, and May, was one smooth, continuous bed of honey-bloom, so marvelously rich that, in walking from one end of it to the other, a distance of more than 400 miles, your foot would press about a hundred flowers at every step. Mints, gilies, nemophilas, castilleias, and innumerable compositæ were so crowded together that, had ninety-nine per cent of them been taken away, the plain would still have seemed to any but Californians extravagantly flowery. The radiant, honey-ful corollas, touching and overlapping, and rising above one another, glowed in the living light like a sunset sky—one sheet of purple and gold, with the bright Sacramento pouring through the midst of it from the north, the San Joaquin from the south, and their many tributaries sweeping in at right angles from the mountains, dividing the plain into sections fringed with trees.

— from *The Mountains of California* by John Muir, 1894

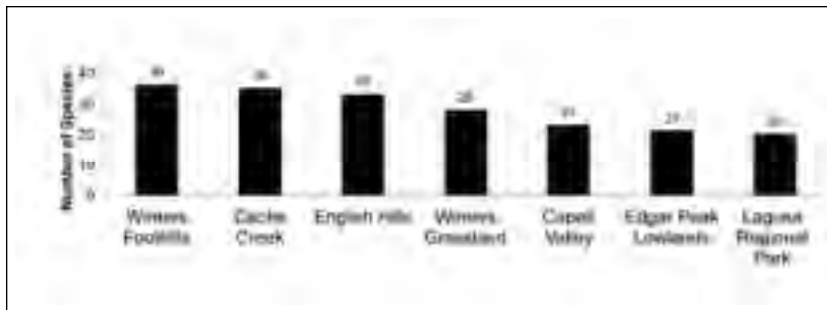
FIGURE 1. SPECIES RICHNESS OF NATIVE PLANTS AT IRVINE RANCH NATIONAL NATURAL LANDMARK.



Note: Based on floristic composition cluster and similarity analyses, six plant communities were identified. All sites had a minimum of 50% relative cover of non-native species.

Source: Lulow and Young, 2009.

FIGURE 2. SPECIES RICHNESS OF WILDFLOWERS IN WESTERN SACRAMENTO VALLEY FOOTHILLS.



Note: Each site had a maximum of three native grass species, and had a minimum of 50% relative cover of non-native species.

Source: Lulow and Young, 2009.

greater than the number of native grass species, particularly in grasslands with less non-native cover or ecotone grasslands. *Individual* native grass species often occurred at higher abundance (cover) than wildflowers, but as a class were rarely dominant.

The persistence of native wildflowers may offer a tool for reconstructing the original composition of California's grasslands—an essential step in restoration. By comparing remnant wildflower species in

more highly invaded sites to the wildflower components of grassland communities that are more intact, it may be possible generally to reconstruct their lost components, including perennial grasses.

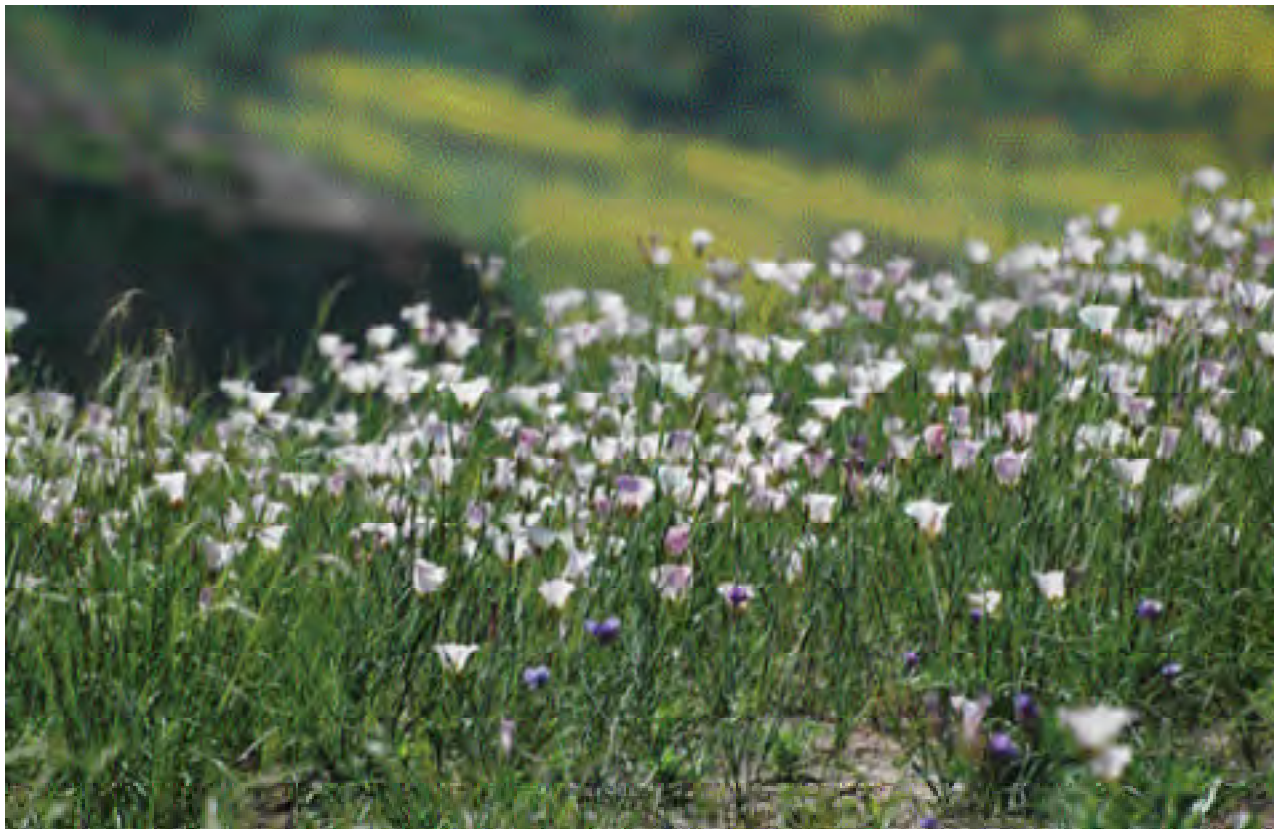
Disturbed areas may also have surprisingly resilient seed banks or corm banks. In grasslands disturbed for over a century and with virtually no native cover, any of the following processes—clearing built up thatch, a fire, or after responsibly

applying herbicide—can stimulate native wildflower species to germinate that were not evident prior to the clearing (personal observation, M. Lulow).

When putting together a species list for restoration, identifying those species that are able to coexist with non-native annual species can be as important as determining which species are most appropriate for a given site. This is particularly true for California grasslands, where it is virtually impossible to completely eradicate non-native annuals due to the extent of their invasion throughout the state and their prolific seed production.

Collaborative research between researchers and practitioners can greatly inform which methods and species are most effective for restoring components of California's native wildflowers to our grasslands. While there will be some species or species groups shared among regions, given the diversity of species and physical characteristics of the state, restoration approaches and species used should be honed for a given region and environment. The large number of wildflower species included in these rather coarse surveys, their functional diversity, and their aesthetic variety suggest a rich palette for ecological restoration.

These surveys also remind us of an essential question that warrants our revisiting, namely what should we call these plant communities that are (were!) a mixture of native grasses together with herbaceous non-grasses that vastly outnumber the former in species richness, and often dominate in cover. "Grasslands" seems clearly misleading. "Forblands" is dismissive of the grasses. While some feel that "prairie" evokes images on the tall-grass and short-grass regions of the Midwest, we believe that it is the most neutral and therefore most descriptive term, and we are increasingly using it to describe the original vegetation of open habitats in the Central Valley.



Catalina mariposa lily (*Calochortus catalinae*), a native grassland geophyte, found in fine soils. Geophytes were found frequently with remnant native species in both survey regions across grassland sites. Both photographs by Fred Roberts.

REFERENCES

Burcham, L.T. 1957. California range land: An historico-ecological study of the range resource of California. Division of Forestry, Department of Natural Resources, Sacramento, CA.

Hamilton, J.G. 1997. Changing perceptions of pre-European grasslands in California. *Madroño* 44:311–333.

Heady, H.F. 1988. Valley grassland. In *Terrestrial Vegetation of California*, ed. M.G. Barbour and J. Major. California Native Plant Society, Sacramento, CA.

Keeler-Wolf, T. et al. 2007. Community classification and nomenclature. In *California Grasslands: Ecology and Management*, ed. M. R. Stromberg, J.D. Corbin, and C.M. D'Antonio. University of California Press, Berkeley, CA.

Lulow, M.E., and T.P. Young. 2009. High native wildflower richness in Central Valley “grassland” sites in the western Sacramento Valley and adjacent foothills. *Grasslands* 14(3):7-11.

Minnich, R.A. 2008. California's fading

ing wildflowers: Lost legacy and biological invasions. University of California Press, Berkeley, CA.

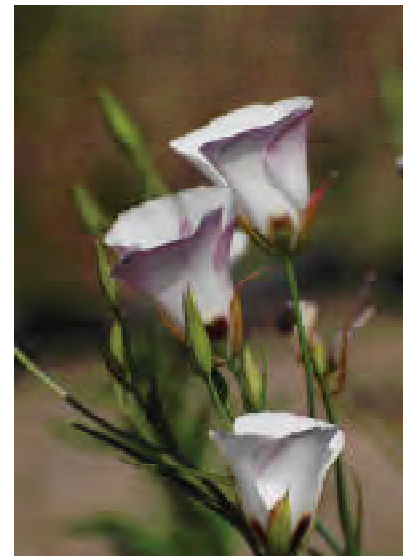
Muir, J. 1894. *The Mountains of California*. The Century Company, New York, NY.

Noss, R.F., E.T. LaRoe III, and J.M. Scott. 1995. *Endangered ecosystems of the United States: A preliminary assessment of loss and degradation*. National Biological Service, Washington, DC.

Sawyer, John O., T. Keeler-Wolf, and J. Evens. 2009. *A Manual of California Vegetation*, 2d ed. California Native Plant Society Press, Sacramento, CA.

Schiffman, P.A. 2007. Species composition at the time of first European settlement. In *California Grasslands: Ecology and Management*, ed. M.R. Stromberg, J.D. Corbin, and C.M. D'Antonio. University of California Press, Berkeley, CA.

Stromberg, M.R., J.D. Corbin, and C.M. D'Antonio, eds. 2007. *California Grasslands: Ecology and Management*. University of California Press, Berkeley, CA.



Megan Lulow, Irvine Ranch Conservancy, 4727 Portola Parkway, Irvine, CA 92620, mlulow@irconservancy.org; Truman Young, Department of Plant Sciences, University of California, Davis, CA 95616, tpyoung@ucdavis.edu