High Native Forb Richness in Central Valley "Grassland" Sites in the Western Sacramento Valley and Adjacent Foothills

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Determining an appropriate species list for ecological restoration at a given site can be challenging. It not only entails an attempt to determine the composition of the undisturbed target state, but also the degree to which these species may tolerate disturbed abiotic conditions and what is feasible economically.

When determining reference species for a restoration site, practitioners often look for remnant populations of natives at the site itself, and if native populations are too few, they turn to nearby areas with similar environmental variables where the native flora is more intact.

Upland prairies in California have been heavily invaded by non-native annuals; native species are sparse or have been entirely replaced (Noss et al. 1995). Furthermore, there is very little record of the composition of native California prairie flora prior to its destruction. Because of this lack of information, surveys of remaining pockets of native flora are essential to the attempt to piece together a list of species appropriate for restoration in a given region.

Both native grasses and forbs have an extensive range throughout California grasslands, and the relative abundances of different grassland guilds and species vary significantly across the landscape (Beetle 1947, Heady 1988, Stromberg et al. 2001). Large-scale variation appears to be due to climatic influences (Burcham 1957, Heady et al. 1991), but there is also significant regional variation, the cause of which becomes more difficult to interpret.

Potentially confounding influences include soil conditions, topographical variation, competition among species, and current and historic land use (especially with respect to prior tilling and grazing). For example, in a study in Monterey County, land cultivation was determined to be the overriding factor in describing the distribution of native grassland species compared to gopher abundance, grazing, and slope, but this factor could not be separated from soil type, as all loams had been cultivated (Stromberg and Griffin 1996).

More fundamentally, there is still no agreement on the historic community structure of sites in the Central Valley and adjacent foothills. The traditional view has been that native plant communities were dominated by perennial bunchgrasses (Heady 1988, Schiffman 2007).

However, there is increasing realization that a strong forb component also existed (Hamilton 1997, Minnich 2008). At the very least, perennial and annual forbs filled the interstitial spaces between bunchgrasses (Heady 1988). Less conservatively, these communities may have been dominated by forbs, with only minor grass components. This position has been forcefully argued in Richard Minnich's new book, *California's Fading Wildflowers* (Minnich 2008, and references therein).

The latest edition of *Terrestrial Vegetation of California* (Barbour et al. 2007), although still emphasizing the traditional view of Central Valley grasslands dominated by perennial bunchgrasses, does mention the alternative possibility of forb dominance (p. 371).

Curiously, both species lists in their "Valley Grassland" chapter show strong forb components. One (Table 14-3) is for a (non-native) annual grassland site that lists no native grasses but six native forb species. The other (Table 14-4) is for a "relict bunchgrass" site that lists three native grass species and fifteen native forb species.

Paula Schiffman (2007) in *California Grasslands* also discusses the possibility of a much more forb-dominated Central Valley prairie. We have observed, as have others (e.g., Ayzik Solomeshch, Glen Holstein, Peter Hopkinson, pers. comm.) that in both "remnant" sites and sites converted to dominance by exotic annual grasses, many native forb species persist. We prefer the use of the word "prairie" for these communities, because it allows for either interpretation of species dominance.

Prairie restoration in California has historically emphasized restoring perennial bunchgrasses, often to the detriment of forb species (Stromberg et al. 2007). Increasingly, restorationists are realizing that the restoration of other ecosystem components (forbs) is a vital part of good ecological restoration. Even if not dominant, these forbs may contribute significantly to ecosystem function (including nitrogen fixation) and forage quality.

We conducted a coarse level survey to document the occurrence and general abundance of upland native forb species in prairies in the lower foothills adjacent to the western edge of the Sacramento Valley, and to generate a reference list of these species to facilitate the enhancement of species diversity in restoration projects in the region.

Methods

Site Selection

Based primarily on interviews with local experts in grassland ecology, seven sites in the western Sacramento Valley and adjacent foothills were chosen that were known to contain an abundant and species-rich native flora of upland prairie species (Fig. 1). These sites were: Laguna

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Regional Park (N38°18′ W121°59′), Capell Valley (N38°27′ W122°13′), Winters Grassland (N38°31′ W121°59′), Winters Foothills (N38°32′ W122°03′), English Hills (N38°26′ W121°01′), Cache Creek (N38°58′ W121°30′), and Edgar Peak Lowlands (N38°37′ W121°04′).

One of us (Lulow) surveyed known locations of remnant patches that remain in the region but also looked to adjacent areas with similar environmental

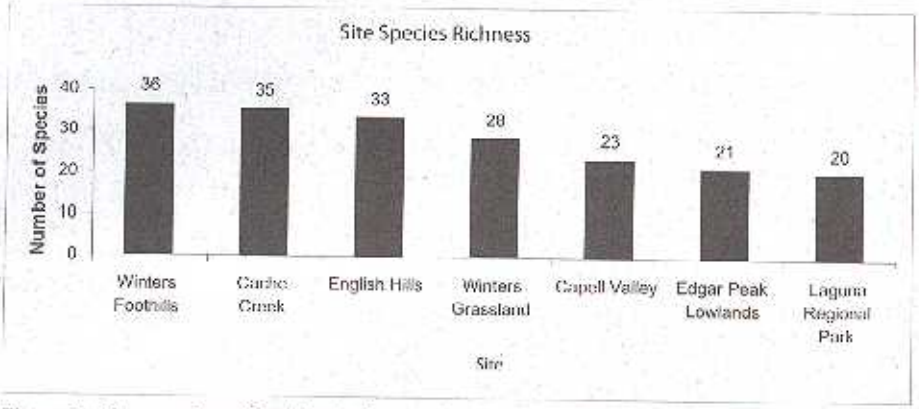

Figure 1. The number of native forb species found at each of the seven sites.

Table 1. Native forb species found in the seven survey sites.

	Species	Frequency	# of sites (of 7) in top 10 most abundant (Spring)	# of sites (of 4) in top 8 most abundant (Summer)	Annual / Perennial	Geophyte	Nitrogen Fixer	Commercially Available
1.	*Lupinus bicolor*	7	6		A		X	X
2.	*Achillea millefolium*	6	2		P			X
3.	*Achyrachaena mollis*	6	6		A			X
4.	*Brodiaea* sp.	6	1		P	X		
5.	*Castilleja attenuata*	6	2		A			
6.	*Chlorogalum* sp.	6	3		P			
7.	*Hemizonia congesta luzulifolia*	6		4	A			X
8.	*Lotus humistratus*	6	3		A		X	
9.	*Micropus californicus*	6	4		A			
10.	*Trifolium bifidum*	6	5		A		X	X
11.	*Trifolium ciliolatum*	6	2		A		X	X
12.	*Dichelostemma capitatum capitatum*	5	3		P	X		X
13.	*Eremocarpus setigerus*	5		4	A			X
14.	*Grindelia camporum*	5	1	2	P			X
15.	*Trifolium willdenovii*	5	3		A		X	X
16.	*Calochortus luteus*	4			P	X		X
17.	*Delphinium variegatum variegatum*	4			P	X		
18.	*Eschscholzia californica*	4	1		A			X
19.	*Lupinus succulentus*	4		1	A		X	X
20.	*Plantago erecta*	4	1		A			X
21.	*Ranunculus* sp.	4	1		A			
22.	*Sisyrinchium bellum*	4	1		P			X
23.	*Trifolium albopurpureum*	4	2		A		X	X
24.	*Triphysaria eriantha*	4			A			
25.	*Triteleia laxa*	4	3		P	X		X
26.	*Castilleja exserta*	3	1		A			X
27.	*Clarkia* sp.	3	2		A			
28.	*Tricostema lanceolatum*	3		3	A			X
29.	*Wyethia angustifolia*	3	1	1	P			X
30.	*Allium membranaceum*	2	1		P	X		X
31.	*Asclepias cordifolia*	2			P			X

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conditions. Ecotones, rocky ridge tops, and north-facing slopes are good places to find remnant patches, but there were always surprises.

These surveys were not exhaustive. We report species encountered while surveying along transects in the spring and summer over a span of 1 to 2 days per site.

Sampling

Surveys at a given site consisted of several belt transects, with surveyors recording species encountered while slowly walking in a zigzag pattern. Survey transect

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Table 1. Contin ued

Species	Frequency	# of sites (of 7) in top 10 most abundant (Spring)	# of sites (of 4) in top 8 most abundant (Summer)	Annual / Perennial	Geophyte	Nitrogen Fixer	Commercially Available
32. *Castilleja* sp.	2	1		A			
33. *Chorizanthe membranacea*	2			A			X
34. *Clarkia affinis*	2			A			
35. *Collinsia heterophylla*	2			A			X
36. *Gilia tricolor*	2			A			X
37. *Hemizonia fitchii*	2		2	A			
38. *Linanthus ciliatus*	2	1		A			
39. *Linanthus parviflorus*	2			A			
40. *Linanthus* sp.	2			A			
41. *Lotus purshianus*	2		2	A		X	X
42. *Lupinus densiflorus*	2	1		A		X	X
43. *Lupinus formosus*	2	1	1	P		X	X
44. *Plagiobothrys* spp.	2	1		A			
45. *Plectritis ciliosa*	2		1	A			X
46. *Saxifragaceae*	2	1		A			
47. *Wyethia helenioides*	2	1		P			X
48. *Allium* sp.	1			P	X		
49. *Amsinckia menziesii*	1	1		A			X
50. *Amsinckia* sp.	1			A			
51. *Apiaceae*	1	1		A			
52. *Asclepias eriocarpa*	1		1	P			X
53. *Asclepias fascicularis*	1		2	P			X
54. *Calandrinia ciliata*	1			A			X
55. *Chamaesyce ocellata*	1		1	A			
56. *Eriogonum* sp.	1			P			
57. *Eriophylum lanatum*	1		1	P			X
58. *Gnaphalium* sp.	1			A			
59. *Lasthenia californica*	1	1		A			X
60. *Lupinus albifrons*	1			A		X	X
61. *Lupinus nanus*	1			A		X	X
62. *Malvaceae*	1			A			
63. *Nemophila menziesii*	1			A			X
64. *Perideridia kelloggii*	1		1	A			X
65. *Trifolium depauperatum truncatum*	1			A		X	
66. *Trifolium variegatum*	1	1		A		X	
67. *Viola pedunculata*	1	1		A			X

Availability information from the California Native Plant Link Exchange: HTTP://WWW.CNPLX.INFO/INDEX.HTML

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locations within each site were selected when species on the preliminary list or other native species were observed. The number and length of transects conducted at a given site increased with the overall site area and the area and frequency of native forb populations encountered within sites.

Species abundance was characterized as dominant (5), abundant (4), frequent (3), occasional (2) and rare (1) (Kent and Coker 1992). Abundance values reported for species at a given site represent the average abundance value for transects surveyed at the site. Because transects within sites were selected based on the occurrence of native species, abundance values are inflated relative to their representation throughout the entire site. These surveys were conducted in the spring (all seven sites) and summer (four sites) of 2002–2004, targeting months that would overlap flowering periods for the majority of species active in a given season. Multiple visits were made to determine the optimal timing for surveying each year. Cattle or sheep grazed four of the seven sites at low levels of intensity.

Results

Across the seven sites, at least 67 native forb species were found in the remnant prairie flora (Table 1). The number of native prairie forb species in each site ranged from 20 to 36, with a mean of 28 (Fig. 1). Many of these species were widespread; 25 species were observed in more than half the sites surveyed. There were 14 leguminous species on the list, which presumably are nitrogen fixers. Some abundant genera (*Lotus* and *Trifolium*) are characterized as desirable forage plants. A majority (41) of the forb species found are commercially available, although not necessarily as local ecotypes. None are listed species, either on state or federal threatened or endangered lists.

There was great variation among sites in species composition. There were also several species that occurred repeatedly as relatively dominant. These include *Lupinus bicolor* (six lists, most abundant in four), *Achyrachaena mollis* (six lists, most abundant in one), *Trifolium willdenovii* (five lists, most abundant in one), *Lotus humistratus* (four lists, second most abundant in two), *Brodiaea* spp. (five lists), *Trifolium bifidum* (five lists), and *Micropus californicus* (five lists).

Table 2. Native grass species found among native forbs in the seven sites.

Elymus glaucus	*Nassella cernua*
E. multisetus	*N. lepida*
Hordeum sp.	*N. pulchra*
Leymus triticoides	*Poa secunda secunda*
Melica californica	*Vulpia microstachys*

Summer surveys found fewer native forb species, and at lower abundances, than spring surveys (Table 1). These summer floras were dominated by *Hemizonia congesta luzulifolia* (or *H. fitchii*), *Eremocarpus setigerus*, and *Trichostema lanceolatum*.

Across all seven sites, a total of ten native perennial grass species were found (Table 2). These grasses were not recorded by site, but the local native grass species richness was usually far lower than this, sometimes as few as one or two species.

Discussion

The number of native forb species was far greater than the number of native grass species in these relict prairies. We have also noted that even in more highly invaded prairies without any relict stands of native grasses, a few native forb species still persist (see also Table 14.3 in Barbour et al. 2007). It appears that, as a whole, native forbs have been more resistant to local extinction than the native perennial bunchgrasses. We do not know why this is true, but possibilities include differences in seed dormancy (a persistent seed bank), differences in the competitive nature of invasive species (especially exotic grasses), or differences in the relative proportions and diversity of these guilds in the original communities.

This greater persistence may offer a tool for reconstructing the original composition of Central Valley prairies, an essential step in restoration. By comparing remnant forb communities in more highly invaded sites to the forb components of prairie communities that are more intact, it may be possible to "back-transform" their lost components, including perennial grasses (Solomeshch and Barbour, pers. comm.).

It is not surprising that fewer forbs were found in the summer survey in this Mediterranean climate, but some species were only found in summer surveys; others may be restricted to even later in the year. Further research on how native forb groups with different seasonality competitively interact with exotic annuals and native grasses would be helpful for determining how one might best incorporate them into the restoration process.

The large number of forb species present in this rather coarse survey, their functional diversity, their variety of economic uses, and their aesthetic variety suggest a rich palette for ecological restoration. Regardless of your position on the appropriate relative dominance of grasses and forbs in the Central Valley sites, we encourage greater use of these forbs in prairie and rangeland restoration.

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