Restoration Notes

Restoration Notes have been a distinguishing feature of *Ecological Restoration* for more than 25 years. This section is geared towards introducing innovative research, tools, technologies, programs, and ideas, as well as providing short-term research results and updates on ongoing efforts. Please direct submissions and inquiries to the editorial staff (mingram@wisc.edu and cmreyes@wisc.edu).

Differences in the Effects of Drought upon Restored and Remnant Prairies (Illinois)

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This study was motivated by two observations. First, I noted distinctly visible differences in vegetation, and more particularly amount of bare space, between restored and remnant tallgrass prairies when I sampled these sites during a severe drought as part of a long-term monitoring protocol. Restoration at the prairies I study began in 1955 (Allison 2002) and I expected such well-established restored prairies to respond like remnant prairies to climatic events, such as drought. Second, I found no relevant studies as I checked the literature for information on drought effects on restored prairies. Grassland ecosystems, such as North American prairies, regularly experience drought; global climate change models predict more frequent and severe droughts in these communities in the not too distant future (Stewart 1986). Considerable effort has been expended to restore prairie ecosystems across North America since ecological restoration began with tallgrass prairie in the 1930s (Howell and Jordan 1991). Despite the fact that interest in prairie restoration has increased since the 1980s, as has public awareness of the potential effects of global climate change, there has been little study of the effects of drought on prairie restorations. I was surprised by the qualitative differences that I observed in vegetation and decided to statistically analyze the data and document my observations as a starting point for future research.

My research was conducted at six sites in northern Illinois, all relatively flat and located on black mesic silty loam soils. The three restored prairies are located at the Green Oaks Field Research Center in Knox County: East (2.8 ha), South (4.8 ha), and West (7.7 ha). The three remnant prairies are Lost Meadow (0.4 ha), also located at Green Oaks, Brownlee Cemetery Prairie Nature Preserve (0.6 ha) in Mercer County, and Spring Grove Cemetery Prairie Nature Preserve (0.5 ha) in Warren County. All six sites are typical tallgrass prairies in terms of species composition: dominated by C_4 grasses and complex mixtures of forbs (Table 1). The prairies are described in more detail by Allison (2002). All of the sites are managed by prescribed burning, although the regimes differ, ranging from annual fires at two remnant prairies (Brownlee and Spring Grove) to three-year fire return intervals for all of the prairies located at Green Oaks.

I sampled the restored and remnant prairies late in the summer (mid-August to early September) during 2000, 2001, 2002, 2004, and 2005. Sampling consisted of randomly placing 25-m belt transects within the prairies according to their size to avoid oversampling smaller sites, and then identifying all plant species that occurred within 1 m of the central transect line. West and South Prairies contained five transects, East contained four, and the remnants each had three. I used five 0.10-m^2 quadrats per transect, spaced 5 m apart, to collect data on plant abundance and live plant cover and identifying the plants occurring at 25 points on the 0.10-m^2 grid.

I compared the restored and remnant prairies by examining the percentage of bare space, the species richness, and the percent cover of the 10 most abundant species as determined by percent cover and the number of quadrats containing the species in each prairie. The top ten species constitute more than 80% of the plant cover and thus can reasonably act as a proxy for the entire plant community.

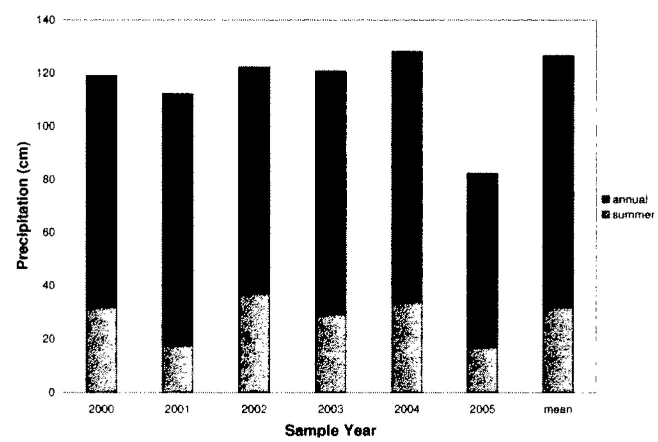

Figure 1. Summer and annual precipitation (cm) as recorded at the weather station at Galesburg, Illinois (ISCO 2006). Mean precipitation is normalized climatic data collected from 1971 to 2000.

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Table 1. Mean percent cover (averaged for all years) and change in cover (owing to drought) for the most abundant species sampled during the summers of 2000–2002 and 2004–2005 in Illinois prairies. Mean percent cover values and changes in cover are given for the ten most abundant species in each prairie (eleven in Lost Meadow owing to a tie). Numbers in bold indicate a decline in mean percent cover during drought years; n.c. means no change.

	Restorations						Remnants					
	East		South		West		Brownlee		Lost Meadow		Spring Grove	
Species	Mean	Change	Mean	Change	Mean	Change	Mean	Change	Mean	Change	Mean	Change
Grasses												
Andropogon gerardii	35.40	-24.0	30.11	+2.13	22.46	+0.34	31.73	-1.74	26.03	-7.50	15.63	+1.16
Schizachyrium scoparium	26.96	+17.44	14.94	+6.10	35.64	+9.32	9.86	-0.80	11.09	+2.90	9.17	-0.38
Sorghastrum nutans	2.40	-1.10	11.17	-8.69	5.15	-4.35	7.15	-7.15			14.40	-9.87
Forbs												
Astragalus canadensis							12.00	+7.60				
Ceanothus americanus							2.61	-1.01				
Desmodium canadense			1.02	-0.38					2.77	-0.11		
D. canescens									1.76	+2.10		
Equisetum arvense							0.85	-0.31				
Eryngium yuccifolium	2.86	+2.44	2.27	-0.19								
Euphorbia corollata							3.20	+0.26	2.45	+1.28	6.29	+2.64
Helianthus divaricatus									8.16	+3.30		
H. giganteus	0.32	-0.02			0.64	n.c.	4.96	-3.63			10.18	+2.75
H. hirsutus							8.64	+7.49			2.45	-0.99
H. mollis	2.44	-1.60			17.98	-5.74						
Lespedeza capitata					2.08	-1.04						
Melilotus alba											4.53	-3.87
Monarda fistulosa							5.12	-1.13				
Rhus glabra									2.19	-1.13		
Rubus allegheniensis									3.36	-0.97		
Silphium lacinatum			1.98	+0.90	1.63	-1.07					14.02	-1.09
S. terebinthinaceum	2.24	-0.94	2.21	+0.19								
Solidago altissima	6.28	+3.52	3.97	-1.69	1.15	+0.29			12.69	+4.11	3.04	+2.55
S. gigantea	11.56	+0.34	20.45	-2.29	2.72	-0.64			16.48	-7.42		
S. juncea									1.76	+2.64		
S. rigida			1.25	+0.91	2.34	+0.46						
Veronia gigantea	2.28	-1.48										

Bare space and species richness were compared by repeated measures ANOVA, followed by a posteriori pairwise comparisons of sample years if the repeated measures ANOVA revealed significant differences among sample years. All statistical tests were performed using Systat, version 5.03 (Systat Software, Inc.).

In 2001 and 2005 summer precipitation was only slightly greater than half of the approximately 32-cm mean summer precipitation for this area (Figure 1). The total precipitation in 2005 was far below the mean (94.5 cm), and so 2005 was considered to be a drought year. However, 2001 received almost exactly mean annual precipitation owing to wet periods in the spring and fall.

Summer drought conditions significantly increased the amount of bare space in restored prairies to more than double the amount in non-drought years ($F = 15.5$, df = 4,452, $p < 0.001$). Although assessing plant growth by measuring a negative—bare space due to lack of plant growth—is not the ideal way to examine drought effects, it does illustrate the fact that remnant prairies may be more resistant to short-term climatic events than restored prairies—even well-established ones.

Species richness was significantly higher in remnant than in restored prairies ($F = 100.513$, df = 1,113, $p < 0.001$), except in 2000. This general pattern was contrary to the expectation that old, well-established prairie restorations would be very similar functionally to remnants. I suggest that even 50 years is insufficient for prairie restorations to converge with remnants.

Three grasses were the most abundant species (Table 1): big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and Indiangrass (*Sorghastrum nutans*). The other abundant species consisted of several composites (Asteraceae, mostly goldenrods (*Solidago* spp.), rosinweeds (*Silphium* spp.), and sunflowers (*Helianthus* spp.)) and a few legumes (Fabaceae: milkvetches (*Astragalus* spp.), ticktrefoils (*Desmodium* spp.), lespedezas (*Lespedeza* spp.), and the invasive sweetclover (*Melilotus* spp.)). The ten most abundant species make up 89–96% of the live plant cover in the restored prairies but only 83–89% of live plant cover in the remnants. Most striking is that in the restored prairies the dominant grasses account for 56–65% of the cover but only 37–49% of the live plant cover in the remnant prairies.

The changes in cover for the most abundant species during summer drought show no overall pattern. There was no clear difference between restored and remnant prairies in this respect. Most of the observed species increased in some sites while decreasing in others. The only exception was Indiangrass, which declined in every prairie where it was a dominant species.

A key question raised by my study is why the increase in bare space (or decrease in plant growth) between restored and remnant prairies, such that restored prairies are more negatively affected than remnant prairies? It is possible that there were genetic differences between plants in the remnant and restored prairies, such that remnant prairie plants were better adapted to resist drought than their conspecifics in restored prairies. However, the original restorationists at Green Oaks were careful to harvest local seed, mainly from prairie remnants in cemeteries (much seed came from Brownlee Cemetery Prairie) and along railroads (Schramm 1992, Allison 2002). Thus, it is likely that plants in both remnant and restored prairies were similarly adapted to local conditions.

Several potential mechanisms may be at work, all of which require differences in development or establishment of the plant communities between restored and remnant prairies. It is possible that differences in species composition and species richness may account for differential resistance to drought conditions between remnant and restored prairies (Knapp 1985, Martin et al. 1991). However, the changes among the ten most abundant species are not consistent from prairie to prairie, making it difficult to perceive patterns caused by compositional differences. It is also possible that differences in belowground processes, such as development of roots and/or mycorrhizal associations lead to distinct drought responses (Daniels-Hetrick et al. 1986, Hayes and Seastedt 1987).

In the end, I have found an interesting pattern: drought had a greater negative impact on restored prairies than on remnant prairies, as revealed by significantly more bare space (and thus less plant growth) in the restored prairies and changes in the abundance of the 10 most common species in each prairie. The causal mechanisms are unknown at this time and will have to be determined through future research. Because drought severity and frequency are expected to increase in prairies owing to global climate change, restoration ecologists will have to figure out these relationships to help plan for long-lasting grassland restorations in North America and the rest of the world.

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Restoration in a Failed State: Community-Based Agroforestry in Haiti

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As the poorest country in the Western Hemisphere (Sletten and Egset 2004), the small Caribbean nation of Haiti is often characterized as an environmental and