This section contains original research notes submitted to *Ecological Restoration* and abstracts derived from current restoration literature. To develop the abstracts, the editorial staff searches more than 100 scientific journals, professional and organizational newsletters, conference proceedings, and other resources for information relevant to ecological restoration practice and research. Each note and abstract is numbered in order to facilitate indexing. Please direct comments or suggestions for notes to mapels@wisc.edu and abstracts to cmreyes@wisc.edu.

Grasslands

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A Comparison of the Influence of Disturbance Regimes on Native Forbs (Kansas)

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Many tallgrass prairie restorations fail to achieve the diversity of remnant prairies and are instead often dominated by several species of native warm-season grasses with few forbs (Kindscher and Tieszen 1998, Polley et al. 2005). In addition, the more than 2.4 million hectares of warm-season grass plantings enrolled in the Conservation Reserve Program typically have little or no native forb component. These native prairie grass plantings are clear candidates for further restoration. However, once the dominant warm-season grasses are established, they can inhibit the colonization of conservative forbs. Restoration practitioners often employ disturbance techniques aimed at reducing the vigor of warm-season grasses and facilitating forb interseeding. We decided to formally compare the effects of multiple disturbance regimes on native forb establishment in mature warm-season grass plantings.

In 2005, we established research plots on upland native warm-season grass plantings at Prairie Fork Conservation Area in central Missouri and on two tracts of the University of Kansas Ecological Reserves in northeastern Kansas. The Missouri site was planted to native grasses in 1983, and the Kansas sites were planted in 1957 and 1987. All three sites are characterized by low forb cover and the almost complete absence of exotic species, and are dominated by big bluestem (*Andropogon gerardii*) and Indiangrass (*Sorghastrum nutans*), with switchgrass (*Panicum virgatum*) and little bluestem (*Schizachyrium scoparium*) also dominant in the 1957 Kansas planting. We added native forb seed to the plots and subjected them to the following treatments: 1) no disturbance, 2) prescribed burn, 3) prescribed burn and shallow disking, 4) prescribed burn and mowing, and 5) prescribed burn and broad-spectrum herbicide. In addition, control plots at each site were neither seeded nor disturbed. Each treatment was applied to five replicate 4-m^2 plots per site.

We conducted all burns in August 2005 because summer burns can favor forbs and suppress the dominance of warm-season grasses (Howe 1995, Copeland et al. 2002). For the herbicide treatment, we applied a 5 percent glyphosate solution prior to burns in early July. This treatment enabled us to compare interseeding and the seeding of bare ground as is found on sites formerly planted in row crops, while also allowing us to investigate the inhibitory role of dominant grasses by seeding plots in which they are absent. We disked at a depth of approximately 5 cm in November 2005 and mowed grass to a height of about 20 cm in early July 2006.

Seed of 37 conservative forbs was purchased in Missouri and broadcast at a rate of 1,550 pure live seeds per m^2 in early January 2006. Based on estimates of the number of seeds per gram, we weighed seed mixes to include an equal number of seeds of each species.

We sampled the plots in June 2005 prior to treatments and again in 2006, following treatments. We will continue to sample the plots each June through 2008. We recorded stem counts of herbaceous and woody species in a 1-m^2 quadrat located within each plot. Species richness was calculated separately for both the seeded target species and exotic species for each plot. ANOVA ($p < 0.05$) was used to compare target and exotic species richness between treatments across all sites. It should be noted that exotic species richness is a much smaller component of total species richness than target species richness (Figure 1). As anticipated, the burn-only and mowing treatments are statistically equal for all analyses because mowing occurred after the 2006 sampling. The undisturbed seeded treatment had significantly lower target species richness than all disturbed treatments, although it was higher than the control. The burn-only, mowing, and disking treatments were not significantly different from one another. The glyphosate treatment had significantly lower target species richness than all other disturbance treatments except for disking, which was slightly insignificant ($p = 0.089$).

Exotic species richness was not significantly different between undisturbed seeded plots and controls. Disturbed treatments had higher exotic richness than undisturbed plots but were not significantly different from one another. However, some interesting trends indicate an inverse relationship between target and exotic species richness among disturbed treatments. The glyphosate and disking treatments, which had the lowest and second lowest target species richness among disturbed treatments, respectively, had the highest and second highest exotic species richness, respectively. An ANOVA demonstrated that the glyphosate treatment resulted in a significantly ($p < 0.01$) higher mean stem count of combined exotic species than all other treatments, indicating that herbicide favors growth of exotics.

Although these analyses are based on the first year of post-treatment data, the effect of increased abundance of exotic species may endure. The most abundant exotic species in both the glyphosate and disking treatments are black medic (*Medicago lupulina)*, which is a persistent annual or short-lived perennial; red clover (*Trifolium pratense*), a perennial species; and yellow sweetclover (*Melilotus alba*), an annual species capable of persisting decades after establishment.

It is evident that some disturbance encourages the colonization of forbs in established warm-season grass plantings. However, our preliminary findings show that the use of glyphosate or disking promoted the occurrence of exotics and decreased colonization by conservative native species. Disking may have increased seed bank recruitment of species that compete for resources with target species, but soil disturbance cannot explain the more pronounced effects of glyphosate. Severe disturbance to resident vegetation resulted in uniform bare ground within glyphosate plots, which may have increased competitive interactions among colonist species and caused the exclusion of inferior competitors.

While subsequent years of data are needed to reveal the effects of mowing, our initial results suggest that the natural process of burning most effectively facilitates conservative forb colonization in prairie restorations.

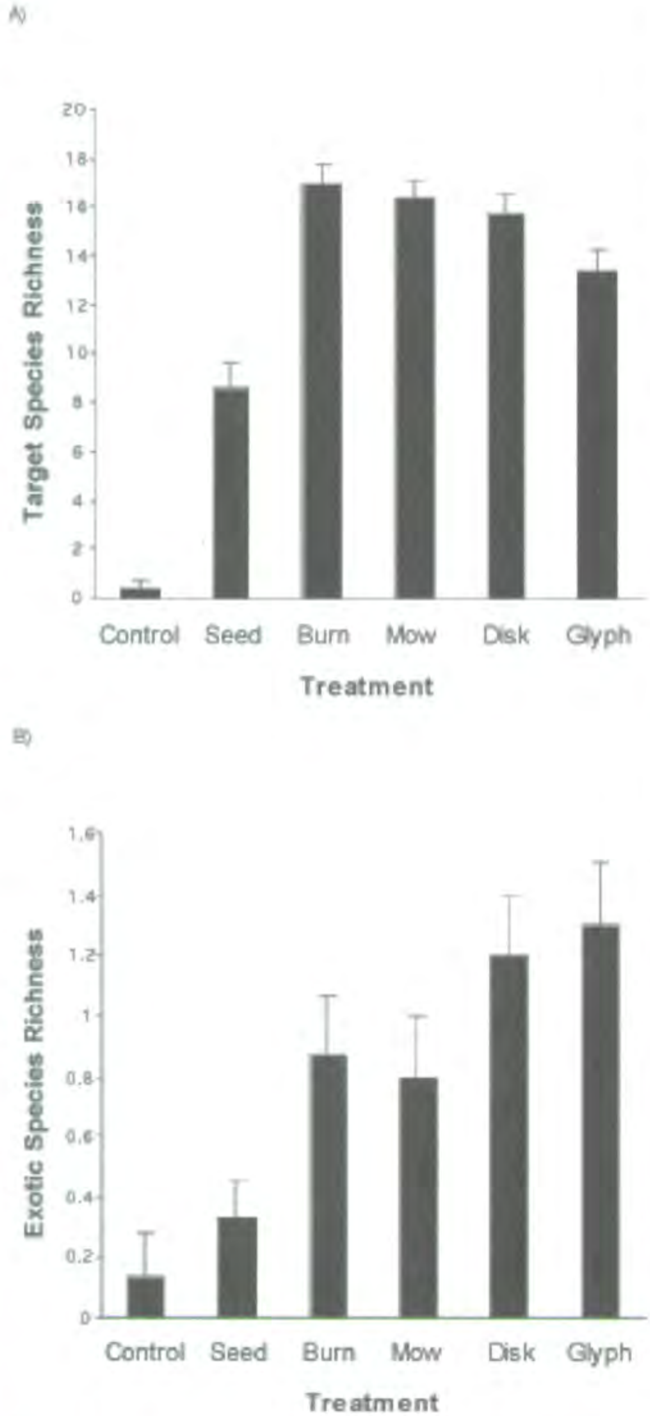

Figure 1. Mean target species richness A) and exotic species richness B) for all treatments. Seed = undisturbed + seed, Burn = burn + seed, Mow = mow + burn + seed, Disk = disk + burn + seed, Glyph = glyphosate + burn + seed. The y-axis is scaled to whole numbers in figure A and fractions in fig ure B, indicating that exotic species richness is lower than target species richness.

Acknowledgments

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