Prairie enhancement of non-native cool-season grass stands

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Key Findings

- Most prairie species established poorly when seeded into established stands of non-native grasses
- Milkweed seedlings emerged at sufficient densities to create monarch habitat (> 0.6 plants/m^2) with minimal site preparation (duff removal only) and no follow-up management
- First year mowing does not reduce competition enough for sufficient native seedling establishment- initial herbicide is likely necessary
- **Follow-up monitoring is needed to confirm initial findings**

Introduction

Over the course of Iowa's 29 year old IRVM program, thousands of acres of roadside right-of-ways have been diversified using native prairie plants. The value of diverse native vegetation in roadsides is significant, with clear economic, social, and environmental benefits. For example, increasing plant diversity in stands of vegetation also increases resistance to weed invasion (Hector et al. 2001), ultimately saving time and money otherwise spent on controlling weeds. With the decline of monarch butterflies, diverse roadside prairie plantings that include milkweeds and nectar sources are also becoming a tool of interest for conservationists. Still, species poor non-native grass stands overwhelmingly dominate Iowa's 700,000 acres of roadside right-of-way (Brandt et al. 2011), creating a significant opportunity for roadsides to be enhanced with prairie species.

Roadside managers have multiple options for converting cool-season grass stands into diverse native prairie plantings. In bare-soil situations such as ditch clean-outs, native grass and forb seeds are planted using techniques similar to prairie reconstruction in crop fields. When directly converting non-native roadsides to native vegetation, established non-native vegetation is killed with herbicides, then prairie species are no-till drilled into dead sod. However, these methods can be costly and equipment intensive, as both techniques require either broadcast herbicide application or soil tillage to kill the established vegetation.

Prairie species can be successfully seeded into grass stands without killing the established vegetation. Christiansen (1994) showed that using prescribed spring fire during the first two years after planting prairie seeds into cool-season grasses was an effective way of increasing sown species establishment an Iowa roadside. In a similar experiment, Williams and others (2007) sowed prairie forbs into established warm-season grasses. The authors found that frequent mowing in the first year reliably increased forb establishment and vigor compared to unmowed controls. Taken together, these studies suggest that cool-season grass stands can be enhanced with prairie species without destroying the established vegetation, and that frequent first year mowing may be a means to promote seedling establishment. However, the effectiveness of diversifying cool-season grass stands using only establishment mowing remains unstudied.

Diversifying non-native grass stands by seeding and mowing may be a simple and cost-effective practice that roadside managers can add to their existing portfolio of native vegetation management tools. To assess whether prairie species can be successfully seeded into stands of non-native cool season grasses using only establishment mowing, we conducted a field experiment in three Iowa roadsides. Our objectives in this study were to 1) quantify native seedling emergence in cool-season grass stands seeded with prairie species, and 2) evaluate the effect of mowing on native seedling establishment and established roadside vegetation.

Materials and Methods

Site description and experimental design

In 2017, we established an experiment that used a randomized complete block design with six replicates, with blocks as roadside sites in three separate Iowa counties (Fig. 1). We selected counties based on proximity to the Tallgrass Prairie Center (< 100 km), IRVM program staffing (active roadside manager with seasonal staff), and latitudinal difference (counties north and south of Cedar Falls). In each block, we established a 5 x 191 m study area in the ditch bottom (avoiding foreslopes and backslopes), each consisting of twelve 5 x 15 m plots (n = 36). In each plot, we randomly assigned mowing treatments at two levels: 1) unmowed or 2) mowed.

To locate roadside study areas for this experiment, we interviewed roadside managers, developed selection parameters, and ground-truthed candidate sites. We created a pool of candidate sites (n = 9) based on land-use history (no previous native plantings, no planned roadwork) from discussions with county roadside mangers. To further minimize variation unrelated to mowing, we chose site selection parameters that prioritized similarity in soils, vegetation, adjacent land-use, slope, and right-of-way width. We ensured sites were: 1) on Mollisol soils that were moderately well drained to poorly drained, 2) dominated by cool-season non-native grasses (excluding reed canary grass, *Phalaris arundinacea*), 3) adjacent to corn or soybean fields, 4) on slopes < 5%, and 5) in right-of-ways at least 10m wide. After applying site selection criteria, we chose the three sites that were the most easily accessed (e.g. near pull-offs, had the most gradual foreslopes).

We also seeded demonstration sites adjacent to each experiment study area using identical seed mixes and planting methods. These demonstration sites (5 x 300 m in Benton and Linn Counties, 5 x 150 m in Fayette County) contrast the differences in mowed and unmowed cool-season enhancements at a scale large enough to easily visualize (half of each site is mowed, half is unmowed). These sites serve as an educational companion to the experiment.

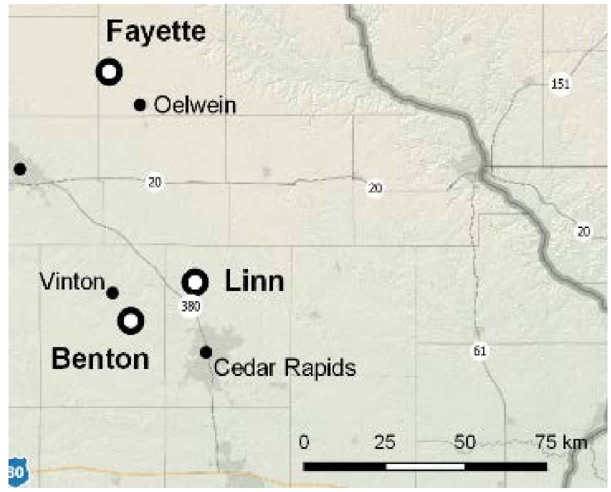

Fig. 1. Study site map. Locations of each experiment site (block) are shown as black and white circles and labeled with

Fig. 2. Plot ground cover before (top) and after (bottom) site-prep mowing. Note the thick duff mat before mowing and the exposure of soil after mowing.

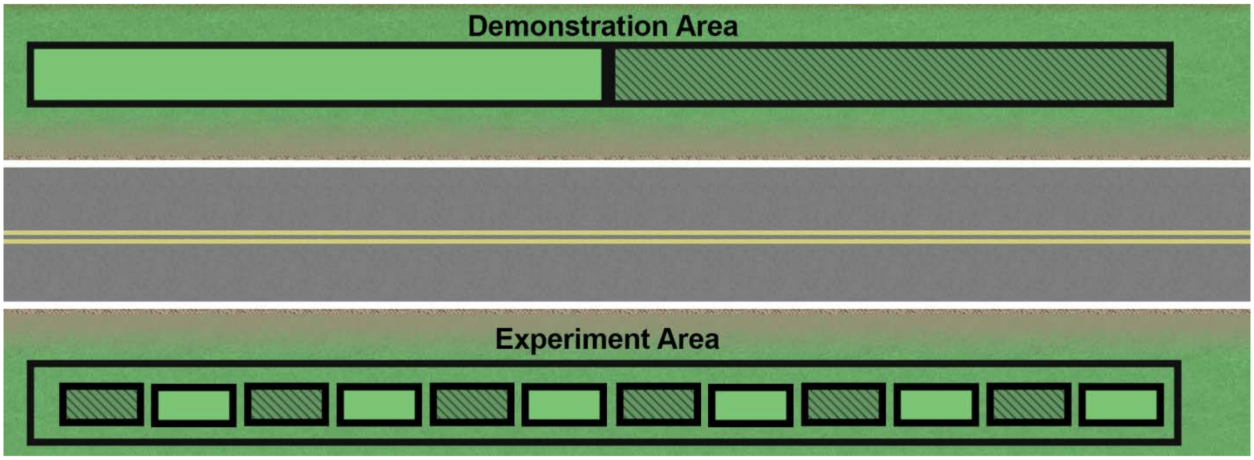

Fig. 3. Experimental layout in each block. Unmowed treatments are shown as un-hatched rectangles and mowed treatments are shown as hatched rectangles. Each experiment site has six replicates of mowed and unmowed plots, and an associated demonstration area nearby.

Site preparation, seeding, and establishment management

Our approach to site preparation used mowing in order to help create a viable planting surface. We found initial site conditions to be characterized by an extremely thick duff layer (100% canopy cover) which was not conducive to seeding, even with a no-till drill. We used a Toro Titan HD Commercial 60" deck mower to mow vegetation to 13 cm, followed by a second cutting to 5 cm that also moved cut biomass out of plots. After mowing, the resulting ground cover was ~50% bare ground and provided a suitable seed bed for no-till drilling (Fig. 2).

In each experimental plot, we planted a seed mix similar to the diverse seed mixes distributed to IRVM programs (Appendix A). This mix included 71 species adapted to the mesic to wet-mesic soil conditions at each site, and included grasses and forbs in approximately equal seeding ratios (1:1). Due to interest in monarch habitat restoration in roadsides, we also increased and standardized the seeding rate for four milkweed species. We purchased seed from native seed nurseries in Iowa and adjacent states in January 2017 and stored the seed in a temperature and humidity controlled (4˚C, 45% RH) cooler until planting. We weighed, bagged, and mixed the seed for each plot separately. The amount of seed for each plot was small (~70 g), so we added 700 g cracked corn in each mix to increase flowability during planting. We seeded at an overall rate of 459 pure live seeds/m^2 using a Truax FLX-86U no-till drill and John Deere JD-5325 tractor in the spring of 2017. Because plot size was small, we used tube modifications connected to the seed cups to accommodate the small amounts of seed. We seeded the Benton County study area April 21, the Linn County study area April 24, and the Fayette County study area May 9.

We conducted establishment mowing frequently throughout the 2017 growing season (Fig. 3). Beginning May 11, we used a Toro Titan HD Commercial 60" deck mower to mow designated treatment plots to 10 cm height. We mowed sites six times (approximately every three weeks) until September (May 11, June 1, June 23, July 12, August 4, August 23). Vegetation height typically did not reach over ~15 cm in the interval between mowings, so cut thatch did not accumulate. Thus we did not attempt to remove or manage mower thatch. In order to make plant identification easier during end-of-season vegetation surveys, we did not mow in September.

Data collection and analysis

We collected vegetation data in early September 2017. To sample native seedling emergence and roadside vegetation cover, we established a 15 m transect running parallel to the road in each plot. We established each transect randomly along the plot baseline (the area within 1 m of plot edges was excluded) and at a random start distance on each transect, assessed four 0.25 m^2 quadrats spaced every 1 m. In each quadrat, we identified all species, counted planted prairie seedlings, and recorded canopy cover values for non-planted species.

To analyze the effects of mowing on native plant emergence and vegetation composition in cool-season grass stands, we used R to conduct analysis of variance (ANOVA) on linear fixed effect models. We included mowing and block as additive factors in our models, and used a threshold of $p < 0.05$ when testing whether differences in mowing treatments were significant. To meet parametric assumptions for testing, we square-root-transformed seedling emergence and vegetation cover values. We were also interested in the effect of mowing on milkweed species establishment when seeded into cool-season grass stands, so we pooled seedling emergence data on all *Asclepias* species and conducted a separate, additional analysis using an ANOVA model.

Results and Discussion

Native seedling emergence

When attempting to seed prairie species into stands of non-native cool season grasses using only establishment mowing, native seedling emergence was low, and mowing did not influence seedling density. Averaged across all treatments, planted seedling density was 3.28 seedlings / m^2 (Table 1, Figure 4), which is an overall establishment rate of 0.07%. While mowing did not have an effect on seedling emergence, we found variation in emergence between roadside sites ($F_{2,32} = 3.74$, $p < 0.05$). Of 71 species planted, we found only 17 in sampled quadrats. Mean species richness was 2.39 / m^2, and was not influenced by mowing.

The emerging native seedling community was very different from the seed mix planted. *Ratibida pinnata* and *Rudbeckia hirta* were the most common native seedlings, which made up 28% and 13% of all seedlings encountered, respectively. These two species combined only made up 4% of the planted seed mix. Grasses were very poorly represented in the native seedling community (5% of seedlings encountered) even though they were important in the seed mix (47% of seeds sown). Native legume seedling composition (8.5% of seedlings encountered) was similar to planting density (7% of seeds sowed).

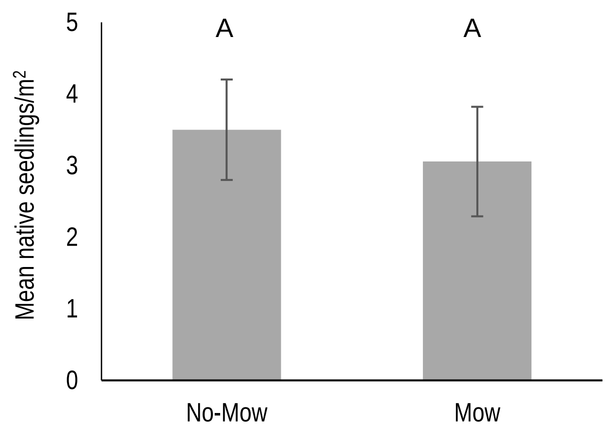

Fig. 4. Density of planted seedlings in cool-season roadsides that were unmowed and mowed during the first growing season. Significant differences between mowing treatments (ANOVA, p < 0.05) are distinguished by different letters (i.e. "A" is different from "B"). Error bars represent standard error.

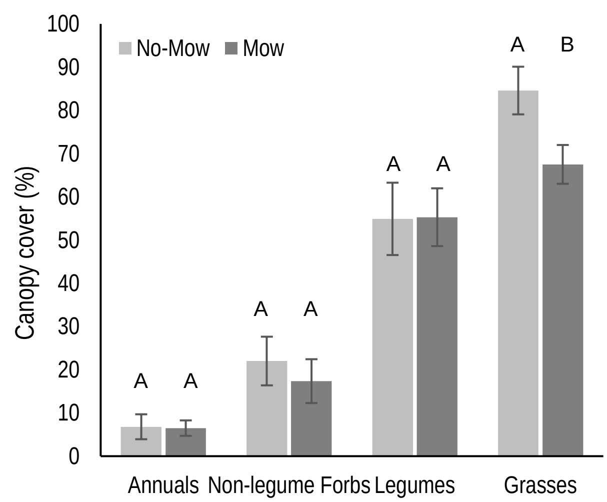

Fig. 5. Percent canopy cover for four functional groups found in cool-season roadsides (not including planted native species) that were unmowed and mowed during the first growing season. Cover percentages presented are converted from Daubenmire classes. Significant differences between mowing treatments (ANOVA, p < 0.05) are distinguished by different letters (i.e. "A" is different from "B").

Milkweed species generally established more readily than other species. Averaged across all treatments, planted milkweed seedling density was 0.83 seedlings /m^2. Milkweed seedlings made up a disproportionate percentage of the emerging native plants (25% of seedlings encountered) even though they were not a large component of the seed mix (5% of seeds sown). Of the four *Asclepias* species we planted, common milkweed (*Asclepias syriaca*) (0.36 seedlings m^2) and butterfly milkweed (*Asclepias tuberosa*) (0.31 seedlings m^2) were the most abundant. We found whorled milkweed (*Asclepias verticillata*) in lower abundance (0.17 seedlings m^2), and did not observe swamp milkweed (*Asclepias incarnata*) at all.

Roadside vegetation cover

Cool-season grasses and legumes dominated roadside vegetation in our study areas. Smooth brome (*Bromus inermis*), hybrid clover (*Trifolium hybridum*), and sweetclover (*Melilotus* spp.) had the highest canopy cover among all species we found (Table 2). Annual species and non-legume forbs were relatively common, but did not make up a significant portion of the plant community on their own. Though we did not include a seeding treatment where the thatch layer was left intact, we observed that parts of the ditches where we did not mow during site preparation had more grass cover and much less legume cover than areas we did mow.

Establishment mowing did little to change vegetation composition in cool-season grass stands seeded with prairie species. We found some evidence to suggest total vegetative cover was reduced with mowing ($F_{1,32} = 3.47$, $p < 0.07$), but the absolute difference in canopy cover was only 12.9% (168.3% without mowing and 146.6% with mowing). Canopy cover of most functional groups was not affected by mowing (Table 2, Figure 5), with the exception of grasses which decreased with mowing ($F_{1,32} = 8.90$, $p < 0.01$).

Prairie species can not be effectively seeded into stands of non-native cool season grasses using only establishment mowing. Mowing was ineffective at

Table 1. Density of planted seedlings observed and establishment success in cool-season roadsides that were unmowed and mowed during the first growing season. Values in parentheses are ± SE. Percent establishment is calculated using mean seedlings/ m^2 averaged over all mowing treatment levels and number of live seeds planted/ m^2.

		Mean seedlings/ m^2		
Species	*Functional group*	*No-Mow*	*Mow*	*Establishment (%)*
Andropogon gerardii	Grass	0.11 (0.06)	0.06 (0.06)	0.39
Bouteloua curtipendula	Grass	0.11 (0.08)	0	0.17
Schizachyrium scoparium	Grass	0.06 (0.06)	0	0.13
Asclepias incarnata	Forb	0	0	0
Asclepias syriaca	Forb	0.33 (0.11)	0.39 (0.14)	6.71
Asclepias tuberosa	Forb	0.28 (0.14)	0.33 (0.18)	5.68
Asclepias verticillata	Forb	0.17 (0.09)	0.17 (0.12)	3.10
Artemesia ludoviciana	Forb	0	0.06 (0.06)	0.26
Astragalus canadensis	Forb	0.06 (0.06)	0.06 (0.06)	0.52
Chamaecrista fasciculata	Forb	0.06 (0.06)	0.11 (0.08)	2.58
Dalea purpurea	Forb	0.17 (0.09)	0.17 (0.09)	1.55
Desmodium canadense	Forb	0.17 (0.12)	0.11 (0.08)	8.61
Echinacea pallida	Forb	0.17 (0.12)	0.17 (0.09)	7.74
Monarda fistulosa	Forb	0.06 (0.06)	0.06 (0.06)	0.69
Parthenium integrifolium	Forb	0.22 (0.13)	0.17 (0.09)	18.07
Ratibida pinnata	Forb	1.06 (0.35)	0.78 (0.26)	8.52
Rudbeckia hirta	Forb	0.56 (0.25)	0.28 (0.14)	5.16
Symphyotrichum laeve	Forb	0.06 (0.06)	0.06 (0.06)	1.03
Total		3.50 (0.70)	3.06 (0.76)	0.71

Table 2. Percent canopy cover for important species found in cool-season roadsides (not including planted native species) that were unmowed and mowed during the first growing season. Only species with average canopy cover >1% are included. Values in parentheses are ± SE. Cover percentages presented are converted from Daubenmire classes.

		Canopy cover (%)	
Species	*Functional group*	*No-Mow*	*Mow*
Ambrosia artemesifolia	Annual	3.44 (1.73)	0.52 (0.26)
Setaria spp.	Annual	3.23 (1.47)	5.10 (1.71)
Daucus carota	Non-legume forb	3.13 (0.89)	6.67 (3.03)
Cirsium arvense	Non-legume forb	0.87 (0.54)	3.02 (2.11)
Pastinaca sativa	Non-legume forb	1.88 (0.96)	1.18 (0.45)
Solidago canadensis	Non-legume forb	2.50 (2.25)	0.38 (0.32)
Solidago gigantea	Non-legume forb	2.05 (1.26)	0.35 (0.28)
Symphyotrichum lanceolatum	Non-legume forb	4.03 (3.10)	0.10 (0.06)
Symphyotrichum pilosum	Non-legume forb	2.47 (1.37)	3.54 (2.05)
Lotus corniculatus	Legume	2.57 (2.57)	3.40 (1.95)
Medicago lupelina	Legume	2.36 (0.76)	4.86 (1.98)
Melilotus spp.	Legume	29.27 (8.53)	18.09 (6.16)
Trifolium hybridum	Legume	20.69 (3.27)	28.92 (5.37)
Bromus inermis	Grass	48.16 (6.88)	36.67 (6.97)
Carex spp.	Grass	3.40 (1.39)	1.32 (0.77)
Equisetum arvense	Grass	6.98 (2.09)	1.70 (0.82)
Festuca arundinacea	Grass	12.95 (4.69)	21.25 (6.95)
Poa pratensis	Grass	8.44 (1.94)	6.35 (1.20)

controlling non-grass weed cover, and seedling establishment was far too low to be considered successful. Morgan (1995) suggests a successful prairie planting must have a minimum of 10.76 prairie plants / m^2— seedling density in our study was more than three times less than that. A potential cause for such low emergence may be that short statured legumes formed a canopy at the mowing height, reducing light and competing with germinating seedlings. It is possible that removing the duff layer during site-preparation may have resulted in the observed flush of non-native legume seedlings. Further, the smooth brome that dominated the vegetation in out roadsides may actually have temporarily benefited from the frequent establishment mowing regime. Otfinowski and others (2007) showed that cutting can accelerate vegetative growth in smooth brome but frequent cutting decreases root mass and available carbohydrates, resulting in increased winter injury. Thus, several years of mowing may be necessary to create a less competitive environment where germinating native seedlings can survive.

Seeding prairie species into stands of non-native cool season grasses using only establishment mowing is not a cost-effective practice. One of the reasons that "mow-only" stand enhancement is attractive is because it removes the cost of herbicide application during site preparation. The cost of seed for this study was $1235/ha while the savings from using no herbicide treatment is estimated at $148/ha (Phillips-Mao et al. 2015). At these costs and compared to revegetation using herbicides, decreases in native plant emergence of more than 12% are not cost effective, since the savings from not using herbicides is outweighed by the cost of "lost" seed. When compared with experiments done by Williams and Smith (2007a,b) our results suggest that removing herbicides from site-preparation results in 80% less native seedling establishment. If prairie enhancement of cool-season grass stands without herbicide is to be cost-effective, either the price of a diversity seed mix must drop to $185/ha (assuming $148/ha herbicide treatment), or the price of herbicide treatment must rise to $988/ac (assuming $1235/ha seed prices).

Though a diverse prairie enhancement cannot be achieved with mowing, simply planting a subset of prairie species into non-native cool season grass stands may still be a useful practice in limited circumstances. In particular, if seed nearing the end of its shelf-life cannot be efficiently used in a traditional roadside planting where it would readily establish, it could still provide a modicum of diversity if planted into a cool-season grass stand. Since mowing has little effect when seedlings are competing with vigorously tillering perennial sod and low-growing legumes, no follow-up establishment mowing would be necessary after seeding. Several of the species identified by Brandt and others (2011) as easy to establish in roadsides also established in this study, and these may be candidate species for cool-season roadside enhancements. Because most prairie species not identified in Brandt's list did not establish at all, we do not recommend planting other species in cool-season grass stands unless herbicide is applied during site preparation.

Our results suggest that milkweed species may be well suited to enhancing non-native grass stands for monarch habitat. When planting a mixture of milkweeds at 21.52 seeds/ m^2, we found 0.83 seedlings/ m^2 established, regardless of mowing. Kasten and others (2016) showed that the minimum milkweed density for high monarch value was 0.6 plants/ m^2, which suggests simply seeding milkweed into cool-season grass stands may improve their value as monarch habitat. However, it is likely that winter seedling mortality in the planted milkweeds will be significant (~20%, Williams and Smith 2007), and it remains unclear whether sufficient milkweed densities will remain in the future.

Conclusion

Based on our results after one growing season, we do not recommend seeding prairie species into stands of non-native cool season grasses using only establishment mowing. Mowing by itself does not appear to reduce competition with existing vegetation enough for planted native seedlings to establish successfully at sufficient densities. However, follow up monitoring is needed to confirm our initial analysis. Additional site-preparation is likely necessary to foster seedling survival in the first year. Prescribed fire as a means to decrease the competitive ability of non-native cool-season grass stands before seeding may be a promising avenue of future research.

Acknowledgements

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Literature Cited

Brandt, J., K Henderson, and J. Uthe. 2011. Integrated roadside vegetation management technical manual. Tallgrass Prairie Center, University of Northern Iowa, Cedar Falls, Iowa.

Christiansen, P.A. 1994. Establishment of prairie species by overseeding into burned roadside vegetation. In Hartnett, D.C. (ed.), *Proceedings of the 14th North American Prairie Conference: prairie biodiversity*, pp. 167–169. Kansas State University, Manhattan, KS.

Hector, A., K. Dobson, A. Minns, E. Bazeley-White, and J. Lawton. 2001. Community diversity and invasion resistance: An experimental test in a grassland ecosystem and a review of comparable studies. Ecological Research 16:819-831.

Kasten, K., Stenoien, C., Caldwell, W., & Oberhauser, K.S. 2016. Can roadside habitat lead monarchs on a route to recovery? *Journal of Insect Conservation* 20: 1047–1057.

Otfinowski, R., Kenkel, N.C., & Catling, P.M. 2007. The biology of Canadian weeds. 134. Bromus inermis Leyss. *Canadian Journal of Plant Science* 87: 183–198.

Phillips-Mao, L., Refsland, J.M., & Galatowitsch, S.M. 2015. Cost-Estimation for landscape-scale restoration planning in the Upper Midwest, U.S. *Ecological Restoration* 33: 135–146.

Reis, L., D. Debinski, and M. Wieland. 2001. Conservation value of roadside prairie restoration to butterfly communities. Conservation Biology 15(2):401-411.

Williams, D., L. Jackson, and D. Smith. 2007. Effects of frequent mowing on survival and persistence of forbs seeded into a species-poor grassland. Restoration Ecology 15:24-33.

Williams, D. and D. Smith. 2007a. The effects of seeding time on native plant establishment in a prairie reconstruction. Iowa Department of Transportation Technical Report.

Williams, D. and D. Smith. 2007b. The effects of varying seeding rates of prairie grasses and forbs on native plant establishment in a prairie reconstruction. Iowa Department of Transportation Technical Report.

Appendix A. Seed mix planted in each experimental plot.

Common Name	*Scientific Name*	*Functional group*	*Seeds/ft²*	*% mix*
big bluestem	*Andropogon gerardii*	Grass	2.000	4.69%
side-oats grama	*Bouteloua curtipendula*	Grass	3.000	7.03%
prairie brome	*Bromus kalmii*	Grass	0.250	0.59%
Canada wildrye	*Elymus canadensis*	Grass	1.000	2.34%
fowl mannagrass	*Glyceria striata*	Grass	1.000	2.34%
switchgrass	*Panicum virgatum*	Grass	2.000	4.69%
little bluestem	*Schizachyrium scoparius*	Grass	2.000	4.69%
Indiangrass	*Sorghastrum nutans*	Grass	2.000	4.69%
tall dropseed	*Sporobolus compositus*	Grass	5.000	11.72%
prairie dropseed	*Sporobolus heterolepis*	Grass	0.250	0.59%
yellow fox sedge	*Carex annectens*	Sedge	1.000	2.34%
copper-shoulder oval sedge	*Carex bicknellii*	Sedge	0.100	0.23%
plains oval sedge	*Carex brevior*	Sedge	0.250	0.59%
heavy sedge	*Carex gravida*	Sedge	0.020	0.05%
troublesome sedge	*Carex molesta*	Sedge	0.250	0.59%
leadplant	*Amorpha canescens*	Legume	0.200	0.47%
Canada milkvetch	*Astragalus canadensis*	Legume	1.000	2.34%
white wild indigo	*Baptisia alba*	Legume	0.020	0.05%
partridge pea	*Chamaecrista fasiculata*	Legume	0.300	0.70%
purple prairie clover	*Dalea purpurea*	Legume	1.000	2.34%
showy tick trefoil	*Desmodium canadense*	Legume	0.150	0.35%
Illinois tick trefoil	*Desmodium illinoense*	Legume	0.250	0.59%
round-headed bushclover	*Lespedeza capitata*	Legume	0.050	0.12%
wild garlic	*Allium canadense*	Forb	0.100	0.23%
Canada anemone	*Anemone canadensis*	Forb	0.020	0.05%
thimbleweed	*Anemone cylindrica*	Forb	0.050	0.12%
prairie sage	*Artemisia ludoviciana*	Forb	1.000	2.34%
swamp milkweed	*Asclepias incarnata*	Forb	0.500	1.17%
common milkweed	*Asclepias syriaca*	Forb	0.500	1.17%
butterfly milkweed	*Asclepias tuberosa*	Forb	0.500	1.17%
whorled milkweed	*Asclepias verticillata*	Forb	0.500	1.17%
New Jersey tea	*Ceanothus americanus*	Forb	0.050	0.12%
prairie coreopsis	*Coreopsis palmata*	Forb	0.040	0.09%
shootingstar	*Dodecatheon media*	Forb	0.100	0.23%
pale purple coneflower	*Echinacea pallida*	Forb	0.200	0.47%
rattlesnake master	*Erynigium yuccifolium*	Forb	0.200	0.47%
tall boneset	*Eupatorium altissimum*	Forb	0.250	0.59%
flowering spurge	*Euphorbia corollata*	Forb	0.100	0.23%
grass-leaved goldenrod	*Euthamia graminifolia*	Forb	1.000	2.34%
northern bedstraw	*Galium boreale*	Forb	0.100	0.23%
bottle gentian	*Gentiana andrewsii*	Forb	0.500	1.17%
bigtooth sunflower	*Helianthus grosseserratus*	Forb	0.150	0.35%

prairie sunflower	*Helianthus laetiflorus*	Forb	0.020	0.05%
ox-eye sunflower	*Heliopsis helianthoides*	Forb	0.500	1.17%
prairie blazingstar	*Liatris pycnostachya*	Forb	0.100	0.23%
Michigan lily	*Lilium michiganense*	Forb	0.010	0.02%
great blue lobelia	*Lobelia siphilitica*	Forb	1.000	2.34%
wild bergamot	*Monarda fistulosa*	Forb	0.750	1.76%
stiff goldenrod	*Oligoneuron rigidum*	Forb	0.750	1.76%
wild quinine	*Parthenium integrifolium*	Forb	0.100	0.23%
foxglove beardtongue	*Penstemon digitalis*	Forb	1.000	2.34%
prairie phlox	*Phlox pilosa*	Forb	0.020	0.05%
prairie cinquefoil	*Potentilla arguta*	Forb	1.000	2.34%
hairy mountain mint	*Pycnanthemum pilosum*	Forb	0.750	1.76%
slender mountain mint	*Pycnanthemum tenuifolium*	Forb	1.000	2.34%
common mountain mint	*Pycnanthemum virginianum*	Forb	1.000	2.34%
yellow coneflower	*Ratibida pinnata*	Forb	1.000	2.34%
black-eyed susan	*Rudbeckia hirta*	Forb	0.750	1.76%
sweet coneflower	*Rudbeckia subtomentosa*	Forb	0.750	1.76%
rosinweed	*Silphium integrifolium*	Forb	0.020	0.05%
compass plant	*Silphium laciniatum*	Forb	0.010	0.02%
showy goldenrod	*Solidago speciosa*	Forb	0.750	1.76%
smooth blue aster	*Symphyotrichum laeve*	Forb	0.500	1.17%
New England aster	*Symphyotrichum novae-angliae*	Forb	0.500	1.17%
sky-blue aster	*Symphyotrichum oolentangiense*	Forb	0.250	0.59%
purple meadow rue	*Thalictrum dasycarpum*	Forb	0.050	0.12%
prairie spiderwort	*Tradescantia bracteata*	Forb	0.050	0.12%
Ohio spiderwort	*Tradescantia ohiensis*	Forb	0.100	0.23%
ironweed	*Vernonia fasciculata*	Forb	0.250	0.59%
Culver's root	*Veronicastrum virginicum*	Forb	0.500	1.17%
golden alexander	*Zizia aurea*	Forb	0.250	0.59%
	Overall Total:		42.68	