

Assessment of the Iowa Arboretum Prairie Reconstruction

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I. Introduction

Prairie restoration and management are crucial for maintaining the existence of the tallgrass prairie, an endangered ecosystem. Most estimates place the amount of remaining native remnant prairie in Iowa at less than one-tenth of one percent of the approximate 30 million acres that was present in 1800 (Rosburg 2001). Prairie restoration has been a component of prairie conservation for several decades and has returned some of the Iowa landscape back to at least a facsimile of prairie. The Iowa Arboretum in central Iowa conducted a prairie reconstruction on 4 acres 15 years ago and has actively managed the site ever since. They planted 31 different species of prairie plants in an area that was previously cropland, and their management strategy has consisted of burning the area every other year in the spring. The goals of my research on the Arboretum prairie were:

- 1) Conduct a species inventory to determine its species composition.
- 2) Provide an assessment of the prairie, based on the seed mix used and its current composition.
- 3) Develop management options based upon my research.

II. Methods

The Iowa Arboretum is located in Boone County, near Madrid, Iowa. On 8 September 2010, the prairie was traversed, and specimens of each forb species observed were collected and identified using *Newcomb's Wildflower Guide*. These identifications were verified by Dr. Thomas Rosburg to insure accuracy. On 15 September 2010 the prairie was again traversed and specimens for each grass species observed were collected. The specimens were identified by Dr. Rosburg due to difficulties in identification from books. Finally on 29 September 2010 the prairie was again traversed and any species not previously observed were then collected. Also,

the abundance of each species present was recorded. These specimens were identified using *Newcomb's Wildflower Guide*, and were confirmed by Dr. Rosburg.

Nomenclature for all species follows Eilers and Roosa (1994). The species observed were compiled in an Excel worksheet along with the following categories: Common Name, Scientific Name, Planted Originally, Abundance, Coefficient of Conservatism, Native to IA, and Native to Boone Co. The sheet was titled FOUND (Table 1).

The list of species originally planted 15 years ago was obtained from Lesley Joplin (Iowa Arboretum Horticulture and Project Manager) and entered in an Excel worksheet. The categories included in this worksheet were: Common Name, Scientific Name, Found, Coefficient of Conservatism, Native to IA, and Native to Boone Co. The sheet was titled PLANTED (Table 2).

Christiansen and Müller (1999) and Eilers and Roosa (1994) were used to determine if species were native to Boone County and to Iowa. Drobney et al. (2000) was used to ascertain the Coefficient of Conservatism for each species. A species' Coefficient of Conservatism is a number from 0 to 10 assigned to a species to reflect its level of conservatism in habitat use. Plant species with low coefficients are generalists and adept at utilizing anthropogenic habitats, while species with high coefficients are confined to more pristine and natural habitats. These data were essential for an evaluation of reconstruction success and to distinguish planted species from resident or self-colonizing species. They were also necessary for developing commentary concerning the appropriateness of the seed mix design.

III. Results

Table 1. Species observed during the assessment.

This table shows the common and scientific name of each species collected during the field survey. The ‘X’ under Planted Originally, Possibly Planted, Native to IA, and Native to Boone Co. signifies a ‘yes.’ A ‘?’ signifies the potential for a ‘yes,’ and a ‘~’ signifies a ‘no’ for that category. The bolded terms and numbers represent significant talking points for the results.

FOUND							
Common Name	Scientific Name	Planted Originally	Abundance	Possibly planted	Coefficient of Conservatism	IA Native	Boone Co. Native
Great Blue Lobelia	<i>Lobelia siphilitica</i>		Frequent	X	3	X	X
Bottle Gentian	<i>Gentiana andrewsii</i>		Occasional	X	8	X	X
Compass Plant	<i>Silphium laciniatum</i>		Frequent	X	7	X	X
Purple Coneflower	<i>Echinacea purpurea</i>	X	Sparse		9	X	~
Skyblue Aster	<i>Aster azureus</i>	X	Sparse		7	X	X
Tall Coreopsis	<i>Coreopsis tripteris</i>		Frequent	X	4	X	~
New England Aster	<i>Aster novae-angliae</i>	X	Very Common		3	X	X
Saw-toothed Sunflower	<i>Helianthus grosseserratus</i>		Occasional		4	X	X
Partridge Pea	<i>Chamaecrista fasciculata</i>		Very Common	X	1	X	X
White Snakeroot	<i>Eupatorium rugosum</i>	X	Occasional		2	X	X
Hairy Aster	<i>Aster pilosus</i>		Occasional		0	X	X
Stiff (Rigid) Goldenrod	<i>Solidago rigida</i>	X	Very Common		4	X	X
Ontario Aster	<i>Aster ontarionis</i>		Occasional		3	X	X
Rosinweed	<i>Silphium integrifolium</i>		Very Common	X	4	X	X
Slender-leaved Mountain Mint	<i>Pycnanthemum tenuifolium</i>		Occasional	X	6	X	X?
Canada Goldenrod	<i>Solidago canadensis</i>		Frequent		0	X	X
Big Bluestem	<i>Andropogon gerardii</i>	X	Very Common		4	X	X
Switchgrass	<i>Panicum virgatum</i>		Occasional	X	5	X	X
Canada Wildrye	<i>Elymus canadensis</i>		Occasional	X	5	X	X
Indiangrass	<i>Sorghastrum nutans</i>	X	Very Common		4	X	X
Birds foot Trefoil	<i>Lotus corniculatus</i>		Sparse		*	~	~
Heath Aster	<i>Aster ericoides</i>		Sparse		3	X	X
Culver's Root	<i>Veronicastrum virginicum</i>	X	Occasional		5	X	X
Rattlesnake Master	<i>Eryngium yuccifolium</i>		Occasional	X	8	X	X
Reed Canary Grass	<i>Phalaris arundinacea</i>		Occasional		**	~	~
Winged Loosestrife	<i>Lythrum alatum</i>		Sparse		3	X	X

Table 2. Species originally planted in the reconstruction 15 years ago.

This table shows the common and scientific name of each species in the seed mix used in the Arboretum prairie. The 'X' under Found, Native to IA, and Native to Boone Co. signifies a 'yes.' A '?' signifies the potential for a 'yes,' and a '~' signifies a 'no' for that category. The bolded terms and numbers represent significant talking points for the results.

PLANTED					
Common Name	Scientific Name	Found	Coefficient of Conservatism	Native to IA	Native to Boone Co.
Lead Plant	<i>Amorpha canescens</i>		8	X	X
Canada Anemone	<i>Anemone canadensis</i>		2	X	X
Columbine	<i>Aquilegia canadensis</i>		6	X	X
Butterfly Milkweed	<i>Asclepias tuberosa</i>		6	X	X
Skyblue Aster	<i>Aster azureus</i>	X	7	X	X
New England Aster	<i>Aster novae-angliae</i>	X	3	X	X
Pale Purple Coneflower	<i>Echinacea pallida</i>		7	X	X
Purple Coneflower	<i>Echinacea purpurea</i>	X	9	X	~
Cream Gentian	<i>Gentiana alba</i>	X	4	X	X
Wild Licorice	<i>Glycyrrhiza lepidota</i>		4	X	X
Ox Eye Sunflower	<i>Heliopsis helianthoides</i>		4	X	X
Rough Blazingstar	<i>Liatris aspera</i>		8	X	X
Prairie Blazingstar	<i>Liatris pycnostachya</i>		6	X	X
Cardinal Flower	<i>Lobelia cardinalis</i>		5	X	X
Wild Bergamot	<i>Monarda fistulosa</i>		2	X	X
Purple Prairie Clover	<i>Dalea purpurea</i>		8	X	X
Yellow Coneflower	<i>Ratibida pinnata</i>		4	X	X
Sweet Black-eyed Susan	<i>Rudbeckia subtomentosa</i>		4	X	X?
Stiff Goldenrod	<i>Solidago rigida</i>	X	4	X	X
Ohio Spiderwort	<i>Tradescantia ohioensis</i>		4	X	X?
Culver's Root	<i>Veronicastrum virginicum</i>	X	5	X	X
Showy Tick Trefoil	<i>Desmodium canadense</i>		6	X	X
Joe Pye Weed	<i>Eupatorium purpureum</i>		6	X	X?
White Snakeroot	<i>Eupatorium rugosum</i>	X	2	X	X
Solomon's Seal	<i>Polygonatum biflorum</i>		4	X	X
Black-eyed Susan	<i>Rudbeckia hirta</i>		2	X	X
Prairie Coreopsis	<i>Coreopsis palmata</i>		7	X	X
Big Bluestem	<i>Andropogon gerardii</i>	X	4	X	X
Little Bluestem	<i>Schizachyrium scoparium</i>		5	X	X
Indian Grass	<i>Sorghastrum nutans</i>	X	4	X	X
Sideoats Gramma	<i>Bouteloua curtipendula</i>		6	X	X

IV. Discussion

Evaluation of Species Composition

There were 26 plant species observed on the Arboretum prairie in the fall of 2010 (Table 1) and 31 species in the seed mix that was planted (Table 2). The results of this assessment show that only 8 of the 31 planted species were found in the plant survey (26%). This is a very low success rate. But there are several possible reasons why so few of the planted species were observed after 15 years. The best explanation for this small percentage is that the survey was conducted during the fall season when many of the forbs were no longer in bloom. Thus an incomplete survey could be the reason for the low establishment ratio. A second reason is related to the dominance of warm-season grass species. The high abundance of native grasses could have eliminated or suppressed some of the planted forbs due to competition. A third reason is that the soil may not have been ideal for some of the planted prairie species. Certain species prefer wetter or drier soil moisture, or more upland or lowland landscape. If the Arboretum prairie characteristics do not correspond with the species' preferences then there is a lower potential for species survival. And a fourth reason for poor establishment may be that the seed densities of some of the forbs in the seed mix were too low for successful establishment. The information provided on the seed mix did not give data on the seeding density.

Of the species that were planted, four of them should not have been planted at this site. *Echinacea purpurea* is not native to Boone County and therefore is a problem due to location (it is native in Iowa in only the south-central and southeast counties). Its inclusion in the seed mix probably happened because it is a popular, easy-to-grow, and inexpensive species. The other three species are a problem due to habitat. *Eupatorium purpureum*, *Eupatorium rugosum*, and *Polygonatum biflorum* are all woodland species. Why they were included in the seed mix is

difficult to know; most likely this is due to the lack of prairie expertise in planning the reconstruction.

The results of this assessment also show that among the 26 species observed, 18 species (69%) were not originally planted. Of these 18 species, 16 are native to Iowa and two are not native. These 18 species can be separated into two groups based on the mechanism that best explains their presence. There are ten native species in a group that were most likely “accidentally” planted by the Arboretum (Table 1, probably planted). This claim is based on the fact that these species have either a coefficient of conservatism ≥ 5 (which means they tend to be late successional species), and/or they have an abundance of ‘frequent’ or ‘very common.’ High coefficients and abundances suggest that these plant species are not likely to have entered the prairie naturally and to such an extent.

The second group of eight species has either a low coefficient or a low abundance. Six native species and two non-native species are in this group (Table 1). Low coefficients of conservatism are characteristic of ruderal, early successional species that have the ability to naturally colonize disturbed areas. These eight species probably established in the prairie from either being present in the site’s seed bank or by dispersing seed into the area from a nearby population. Some of these species may have entered the prairie from the Iowa DNR-planted prairie in the ditch lining the west side of the prairie. Contamination from equipment can also aid in the establishment of non-native or invasive species.

In the first group, the term “accidental” is used to mean that seeds were actually in the seed mix even though they were not intended to be included. How might a species be accidental? One reason is that they were in the seed mix by error or accident. Seeds can easily be misidentified or could be added to the mix due to careless attention. Another reason could be

due to the machinery used during planting. Machinery such as seed drills can be “contaminated” with seed from previous seeding projects. Either way, having ten prairie species that were not supposed to be in the seed mix establish in a prairie reconstruction is very troubling, and indicative of a larger problem in prairie reconstruction – insuring that prairies are planted with the proper species.

Exotic Species

Bird’s Foot-Trefoil and Reed Canary Grass are the two non-native species found and are also invasive species. The Bird’s Foot-Trefoil most likely entered the prairie from the DNR-planted ditch because it was only found along the border of the two prairies. Reed Canary Grass prefers wet conditions and was located only near the adjacent stream and woodland. This grass may have entered the prairie through machinery, or it could have already been present in the woodland and then invaded the prairie. Both of these species need to be removed in order to improve the quality of the Arboretum prairie. Because the Trefoil is only a small patch it could easily be removed through hand pulling or spot spraying with herbicide. The Reed Canary is a large patch along the south walking path. Because it is a large area and the only species present in the patch, it will require more attention. Herbicide or burning the area would work as a treatment but then the site will need to be replanted (Missouri Dept. of Conservation).

The seeds for this replanting need to come from the species already present in the prairie or from a list of species native to Boone County. Seeds can be collected from the Arboretum prairie from appropriate species. When collecting the plants it is important to select seeds from around the prairie in order to ensure genetic diversity and to avoid over collecting from one area (Smith et al. 2010). One advantage of collecting from the Arboretum prairie is that there is less

possibility of more contamination from seed mixes. Additionally, it is important not to collect seeds from other invasive or non-native species in order to prevent their further spread.

Instead of collecting seeds from around the prairie, seeds can also be purchased. Despite the potential for unwanted species, seed mixes offer the opportunity to enhance the biodiversity in the prairie. The amount of individuals of the sparser species already present can be increased by purchasing those seeds specifically. Overall, the seeds being purchased need to be of a local ecotype, meaning they should be gathered from a site within 150 miles of the Arboretum prairie. This, too, ensures better adaptation to the local environment.

Management Options

Once the invasive species are removed and the areas are reseeded, overall management of the prairie can begin. Currently, the Arboretum burns the prairie every other year in the spring. This strategy is appropriate for a newly planted prairie, but for this already established prairie more infrequent burning is appropriate. Prairie burning should occur every 3-5 years, or whenever an ecological reason to burn can be expressed. Burning too frequently can favor species whose seeds grow better after a fire, and burning too infrequently will be less effective at controlling unwanted invasive species. In general, burning is necessary in prairie management because it is a natural feature of the environment, and therefore prairie species are well adapted to it (Smith et al. 2010). Burning also removes accumulated litter, which then promotes more sunlight reaching the ground that facilitates seed germination and new plants to establish. Increased sunlight at ground level also occurs with the removal of tall plants, such as grasses, which may shade out shorter plants.

Burning can occur either in the spring or the fall. Burning in either season provides various seasonal benefits. Late-spring burns favor warm-season grasses. Because the

Arboretum has historically burned in the spring, this may be a reason the grasses were so prominent during the survey. Burning too late in the spring season could harm those species with a spring phenology, which will cause less above-ground growth for that season and potentially lower species survival in the future due to less seed production. Burning earlier, such as in winter or early spring, will favor the dominance of grasses and limit the growth of other species due to competition for sunlight from the tall grass species. Finally, spring burns will allow regrowth within weeks, as well as standing vegetation all year. Having standing vegetation all year serves as habitat and protection for wildlife such as birds, especially in winter.

Fall burns have the potential to reduce grass growth by stressing individuals and weakening their root systems. This allows for more available sunlight in the spring when the new growth of the spring species is beginning. Unfortunately, fall burns have less potential for immediate regrowth of the site, and they also remove standing vegetation for wildlife during the winter. Overall, winter or early spring burns are most recommended because of the promotion of forb growth, especially in comparison to fall burns which reduce habitat and aesthetic values.

Other than burning, alternative management strategies include grazing, mowing, and haying. The benefits of these are that they can mimic the historic practice of burning by Native Americans and of grazing by large ungulates. Grazing specifically represents the presence of Bison that once roamed the tallgrass prairie; however, it is impractical on the Arboretum prairie because of implementation and control of the animals. Mowing is more practical. It should occur approximately twice a year to resemble fire or grazing patterns. When done the blade should remain around 6" above ground level so as not to remove all vegetation and expose the soil for weed growth. Mowing does not remove dead organic matter covering the soil, rather it adds to the amount of litter present. This can be good for birds, mammals and insects that need a

litter layer. It may also help increase forbs relative to grasses. Mowing parts of the prairie more or less at random could help create patchiness in the prairie and increase its overall diversity. Haying is another alternative management strategy that more closely mimics fire since the cut material is removed. Haying can also result in the collection of the seeds of the species present at the time, which can then be used later for reseeding—such as in the area once populated by Reed Canary Grass.

A good overall management strategy to follow is one that utilizes a variety of tools to accomplish tasks. Doing the same single thing repeatedly will potentially cause negative impacts on the same group of species. Mixing up the types of management activities, as well as both the timing and spatial location of those activities, minimizes the risk of causing excessive stress on species.

Economic Value

The quality of this prairie has the potential to offer several economic benefits to the Arboretum. These benefits can be categorized into either direct or indirect values. Direct economic values available from this prairie refer to obtaining actual dollars, and involve seed collection and sale. While it would be difficult for the Iowa Arboretum to compete with seed nurseries in terms of sales, the Arboretum could package and sell samples of prairie seed in the gift shop, potentially at a higher-than-market price. Based on abundance in the prairie and price on the Ion Exchange website, the most economically viable seeds are *Solidago canadensis* and *Chamaecrista fasciculata*. These have abundances of frequent and very common, respectively, and have an Ion Exchange price of \$15.00/ounce and \$3.00/ounce, respectively. Species' prices vary widely, from \$3.00/ounce to as much as \$100/ounce, depending on the difficulty in collecting and cleaning seed and in the amount of seed production (Ion Exchange, Inc.). Due to

higher abundances, collecting and selling any aster or grass species is most recommended. Species collected could also be determined based upon popularity or customer preferences.

Another source of direct income could be realized from hay that is sold. Since the Arboretum does not have the equipment to make hay, the hay would need to be sold in the field to buyers who would then cut and make the hay. Polk County Conservation does this on hundreds of acres every summer by taking bids from potential hay buyers. Hay prices generally range from \$20.00/ton to \$30.00/ton depending on the quality (the amount of weedy material). Cutting for hay could begin about August 1 for those that want to maximize quality, or run later into early September for those that want to maximize quantity. Typical prairie hay yields range from 1.5 tons to 2.75 tons per acre depending upon landscape position, seasonal variation, and timing. The direct economic value of the prairie reconstruction is limited by its small size. This is especially true for haying, since it may be difficult to find someone willing to incur the expense in moving equipment to the site for only 4 or less acres of hay. For this reason, the indirect values may be more important to consider.

Indirect economic values available from this prairie cannot be quantified into dollars but are probably the more important benefits provided. These include ecosystem services. Prairies maintain soil quality by attracting and storing nutrients underground in the root system. This is important for the extended viability of the soil. Another ecosystem service is reduced flooding by absorbing excess water runoff. This helps both the area around the Arboretum as well as areas and people farther downstream. Prairies are also efficient at carbon storage, which is a benefit to the entire ecosystem in terms of climate change. The prairie helps to maintain insect populations and the pollination services they provide. This is beneficial to the long-term success of the prairie due to many plants' reliance upon insect pollination, but it is also a benefit to the

entire surrounding area in terms of pollination for gardens and trees which enhances the quality of neighboring ecosystems. It also provides habitat for many small mammals and birds that serve important functions in the maintenance of food chains and control of herbivores.

Perhaps the best indirect economic value of the prairie is its educational value. Public education is an important purpose of the Arboretum, and having the opportunity to educate people about Iowa's most important ecosystem greatly adds to the mission of the Arboretum. Many people do not fully understand and appreciate prairies; rather they think of them as patches of weeds. The Arboretum should continue to develop opportunities that utilize the prairie reconstruction to help increase public knowledge of prairie.

V. Acknowledgements

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