Restoring American Prairie

Konrad Liegel

By the end of the 19th century the vast grasslands that once covered nearly two-fifths of the US land surface had almost disappeared, turned over to cultivation. Today some of the very few surviving remnants are being saved, but they are unlikely to be enough to support the full range of prairie species, and since the 1930s efforts have been made to create new prairies. Because prairie is prime habitat for cranes, many of which are endangered, the International Crane Foundation, as part of its Ecosystem Restoration Programme started in 1979, is planting a prairie in Wisconsin. The author, who is in charge of this, describes the methods and results so far.

In the mid 1800s Walt Whitman wrote, 'While I know the standard claim is that Yosemite, Niagara Falls, the upper Yellowstone and the like afford the greatest natural shows, I am not sure but the Prairies and Plains last longer, fill the esthetic sense fuller, precede all the rest and make North America's characteristic landscape'. Earlier, thousands of French and English explorers had written almost mystically of these vast grasslands, where wind-swept long-stemmed plants undulated like ocean waves, and trees were completely absent or occurred in widely separated clumps, much like islands in a sea of grass. They had no name for these grasslands. Eventually the word 'prairie', a French word meaning 'meadow', was used for the treeless area, and the name remains today. In the last hundred years millions of acres of prairie have been ploughed under or grazed out, and a civilisation nourished, and in part shaped, by their soils and climate has grown up in the region. What follows is a summary of our theories, methodology, successes and failures in restoring Wisconsin types of this unique and fascinating ecosystem.

The Prairie Ecosystem – A Forgotten Landscape

Described in a general way, prairie is a 'natural North American grassland, composed of native perennial grasses and other herbaceous plants, in which the grasses contribute much of the vegetative cover'.[1] Although dominated by grasses, over 150 species of forbs (pasture herbs) may be found to the square

Above *Avoca, largest surviving prairie in Wisconsin* Scott Weber

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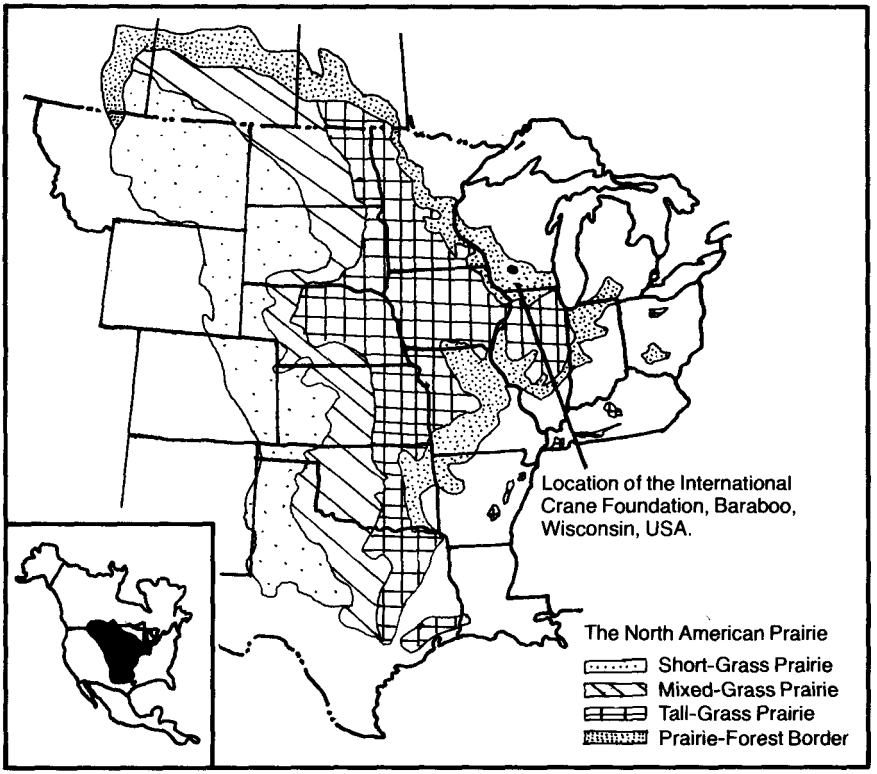

Adapted from Costello, D.F., 1969. *The Prairie World.* Crowell, New York.

kilometre on better drained prairies, with more than 45 families represented. The sunflower family Asteraceae (Compositae) contributes the largest number of species. The grass family Poaceae (Gramineae) and pea family Fabaceae (Leguminosae) are also well represented.

Ecologically the North American prairie is most like the steppes of Eurasia, but also shares common features with the veld of South Africa and the pampas of South America. An excess of potential evaporation over available precipitation characterises all these grasslands, creating periodic droughts that favour grasses over trees.[2] In the continental United States, the amount of precipitation increases from 25cm (10in) just east of the Rocky Mountains to 100cm (40in) near Lake Michigan. The grassland vegetation changes accordingly, dividing up the American midwest into three vegetational zones: short-grass, mixed-grass and tall-grass prairies. Wisconsin lies along the humid, eastern border of the prairie region, where climatic conditions may be tolerable for both grasslands and forests, but certain soils and topographies may favour one community over the other. On most sites, however, the presence or absence of grassland was determined by the presence or absence of burning.[3] Fires, ignited sporadically by lightning and regularly by native peoples, encouraged grass and suppressed trees. Large herds of grazing bison also favoured the prairie vegetation through browsing and rubbing of woody invaders.

One of the difficulties that faced the early prairie farmers was the breaking of

the tough prairie sod in preparation for planting their crops. However, with the invention of the steel mouldboard plough, most of the well-drained prairies were destroyed by the time of the American Civil War, 1861. Poorly drained prairies and prairie fens lasted a little longer, but the introduction of drainage tiles in the late 19th century presaged their doom.

Most Americans living in the continental United States have never seen a prairie untouched by ploughing or over-grazing, for within 150 years of settlement by Europeans the North American grassland, once extending from the highlands of central Mexico across the United States and into Canada, and covering over 38 per cent of the US land surface, had virtually disappeared. Most prairie plants are so rare today that field identification guides do not even mention them. Much of the prairie fauna, including the greater prairie chicken *Tympanuchus cupido pinnatus,* buffalo *Bison bison,* and the black-footed ferret *Mustela nigripes,* has been extirpated from most of its former range.

Today, some of the few remaining prairies are being destroyed through cultivation, overgrazing and continuous mowing. To counteract the intense pressure for developing land, a belated interest in the preservation of prairie has developed. Federal and State governments and the Nature Conservancy – a private conservation organisation whose objective is to preserve and protect ecologically and environmentally significant land – have preserved some of the finest prairie remnants remaining, but it is a miniscule fraction of what once existed. The question remains whether there is enough saved to preserve the diversity of life that prairie supports.

The Art of Restoration – Lessons from the Past

The first attempts to restore prairie on disturbed land grew out of the environmental and economic trials of the 1930s. The Great Drought and concurrent Great Depression left millions of acres of abused farmland literally choked in dust – the topsoil blown away and the landscape severely eroded. Ecologists, searching for approaches to the reclamation of abused land, noted the adaptations of prairie species to intermittent drought and the stability of the prairie sod in preventing soil erosion. John Weaver of the University of Nebraska-Lincoln, for example, studied the recovery of native grasslands from the Great Drought and the ecology of their component species over a 30-year period.[4] His research encouraged many range owners in the 1940s and 1950s to revegetate their pasture and cultivated land to native grasses. From these and similar studies budded the new science and art of land restoration. It constituted a new way of investigating nature: not by taking apart, but by learning how to put back together.

The first prairie restoration began in 1935 at the University of Wisconsin-Madison Arboretum. This arboretum, unlike any other of its day, was envisaged as a collection of biotic communities representing all the plant communities native to the state. The history of the arboretum's prairie, now called Curtis Prairie in memory of eminent ecologist John T. Curtis, encapsulates the early phase of the restoration movement.

It is agreed by most practitioners that the process of reproducing a plant community involves six basic steps:

1. *Site analysis,* including an understanding of the biotic and physical environment;

2. *Site preparation*, including the elimination of existing unwanted species or the formulation of a strategy for their suppression, and the creation of an environment favourable for the desired species;
3. *Species selection*, including desired numbers, sizes (ages), and proportions, both intially and over time;
4. *Species placement*, including distribution patterns and associations;
5. *Planting*, occurring as one step or a sequence; and
6. *Short and long term management*, including provisions for periodic review and evaluation.

In 1935 when work started on Curtis Prairie, little was known about prairie ecology and almost nothing about re-establishing it on disturbed ground. Through a series of experiments, ecologists at the University of Wisconsin-Madison (UWM) pioneered the strategies for most of these steps – see Table 1.[5] Today, planting stratified seed on disked ground with a cover crop and managing with fire is the most widely applied technique. Over a 30-year period, the plants of Curtis Prairie have gradually arranged themselves into habitat groupings corresponding to the moisture conditions.[6] When prairie plants only are considered, the prairie shows a degree of resemblance to native prairies approximately equal to the resemblance of the native prairies to each other.

In Greene Prairie, a second UWM Arboretum prairie developed by UW botanist Henry Greene in the 1940s and 1950s, special attention was given to placing the individual plants in their appropriate environment, and the 'migratory shifts' of species towards optimum sites have been slight.[7] To hasten the restoration process, therefore, it is important to understand the special requirements of each species within the community and to match them as closely as possible on the restoration site.

The results of this ground-breaking work at the Arboretum demonstrate that reasonable facsimiles of prairie can be attained on abused farmland. However, it is apparently easier to introduce prairie species than to remove non-prairie species.[6] The restored prairies are richer in species than almost any other plant community in Wisconsin.[8] Almost forty years after the first experiments with re-establishing prairie, the bluegrass *Poa pratensis* sod (turf) of the former pasture is gone, but the bluegrass remains abundant, and other non-native species continue to be problems.

The Science of Restoration – Continued Experiments

Reversing the loss of crane habitat, by restoring examples of the prairies and marshes where sandhill and whooping cranes once danced, is the aim of the International Crane Foundation's Ecosystem Restoration Program, and the ICF is carrying on experimental prairie restoration just 80 kilometres north-west of the UWM Arboretum. The ICF at Baraboo, Wisconsin, is the world centre for the preservation of cranes and their habitats. In 1979 the Foundation established the Ecosystem Restoration Program to further its goals of habitat preservation and education. Its primary task is to educate the public about native vegetation and the nature of crane habitat, which includes wetland and prairie environments. Over the next decade this habitat restoration programme will restore 26 hectares of abused farmland on ICF's 64-hectare property to native prairies, marshes, oak openings and oak forests. ICF's site will become a refuge for over 150 native wildflowers and grasses

Above Species beds for wet prairie at the Crane Foundation *Richard Fitter*
Right Prairie plants: shooting stars *Dodecatheon media* and wood lily *Lilium philadelphicum* *Kitty Kohout*

which are rapidly vanishing from midwestern America's cityscape and countryside.

A secondary purpose is to develop successful restoration techniques for a variety of natural plant communities. A series of long-term experiments is being undertaken in co-operation with the University's Department of Landscape Architecture. Unknown concepts we hope to address during the course of the restoration process include:

The relationship between the number of seeds planted and the number of plants attained for different species at various ages of a planting;
the relationship between the seeding rate and the success of different species;
the relationship between seeding patterns and ultimate plant distribution patterns;
the effect of environmental differences on these relationships; and
the effects of different intial management strategies and/or site preparation techniques on: (1) the composition of the restoration and (2) the competition of exotic weeds with native prairie species both initially and over time.

It is likely that we will never really understand these concepts well enough to predict accurately the results of a planting on a specific site, for many of the causes and effects hinge on unpredictable environmental or seasonal fluctuations and on stochastic events. But we can greatly increase our present level of knowledge.

1980 Prairie Planting

Federation Fields Prairie, named in honour of the Wisconsin Garden Club Federation's financial support for the restoration, is presently a 4-ha hayfield of easily eroded sandy soil. Our 1980 planting was designed to test the effect of different grass-to-forb ratios (calculated by seed number) on the subsequent composition of the prairie. The seed used in the planting was hand-collected during the previous fall from remnant prairies within a 200-km radius of the site; local seeds ensure the presence of appropriate ecotypes in the restoration. Some seed was also obtained from a prairie nursery established on the ICF site. The seed was stored cold and dry to enhance germination. Seeds of the family Fabaceae were inoculated with their associated *Rhizobia,* and we made laboratory germination tests to help determine the seed viability for each species, a factor which may be useful in composing seed mixes.

We planted 84 species – 10 grasses and 74 forbs – basing our selection on plant lists for local prairie remnants on similar soils. Somewhat arbitrarily, we chose a total seeding rate of 1500 seeds per sq metre. Using *Andropogon*

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Summary of Restoration Experiments on the University of Wisconsin-Madison Arboretum's Curtis Prairie 1935-1980[5]

Site Preparation

Experiment 1

Methods: Burning the existing bluegrass *Poa pratensis* sod, scalping and removing it, and ploughing it under.

Results: Ploughing under the bluegrass sod helped the most in reducing weed competition.

Experiment 2

Methods: Unprepared ground, ground that had been burned and raked, and ground that either had been burned or raked.

Results: The combination of burning and raking gave the best results for the establishment of the dominant prairie species.

Species Selection

Experiment 1

Methods: Sod transplants from nearby prairie remnants, seeding, seedlings and prairie hay.

Results: Though the sod technique appeared to have a slight edge, the success of each method was very similar.

Recommendation: Broadcast seeding after spring burns is the most economical method.

Experiment 2

Methods: Pure grasses, pure forbs and a mixture of grasses and forbs.

Results: The pure grass block was eventually invaded by forbs. The mixed block did not change much, though a few species entered by natural propagation. The forbs block, however, remained almost free of grass for many years, and is still distinguishable today.

Planting

Experiment 1

Methods: Seed casting after a burn, hand insertion of seeds, disking followed by seed casting with a cover crop and sod transplants.

Results: The use of stratified seed on disked ground under a cover crop was the most successful.

Management

Experiment 1

Methods: Burning every year or every other year and no burning.

Results: After six years the density of the bluegrass sod was reduced by 80 per cent on the burned plots, bare ground was greatly increased, and a number of prairie perennials also increased.

Recommendation: Establish a burning regime of about every three years.

scoparius as a model species, it being the grass of highest frequency on Wisconsin prairies of similar soil, our seeding rate translates into about 26.5 kg per ha. Amounts of seed for each of the 84 species planted approximated to the proportions of mature plants in prairies of similar type. Because the sandy soil erodes easily we added a fast-growing native grass, *Elymus canadensis,* to act as a cover crop.

In early spring, the planting site was treated with Roundup – an isopropylamine salt of glyphosate, to eliminate the existing non-native perennial vegetation. This herbicide is effective, yet relatively safe: it is active for only a short time after application, affects only actively growing tissue, and has little, if any, residual soil effect. Exotic perennials are a serious threat to the initial stages of a restoration, and are difficult to eliminate by mechanical means alone. Several weeks after the herbicide application the field was ploughed, disked and planted, and seed broadcast by hand, not raked in. In the summer we scythed the restoration twice to ensure that annual weeds would not crowd out the young prairie plants in the first year. This technique is effective because most of the prairie species spend their first growing season developing deep roots rather than tall shoots, and it is possible to mow the tops of the weedy species without damaging the young prairie seedlings.

At the end of the first growing season, the relative frequencies of the grasses and forbs, as determined by a quadrant sample, closely reflected the initial seeding rates. Non-planted species were dominant in the first year but are expected to decline in subsequent years. Of 84 planted species, 16 were found in the sample, but more of the native species are expected to appear in future years, as appropriate environmental conditions break seed dormancy.

Conclusion

Restoring abused, marginal and privately or publicly protected land into prairie complements the preservation of the few remaining tracts of this rapidly vanishing North American ecosystem. Together, they enhance the probability that adequate habitat will be provided for the diversity of life the prairie supports.

References

1. BETZ, R.F. 1977. What is a Prairie? *The Nature Conservancy News* **27**, 2: 9-13.
2. WALTER, H. 1979. Vegetation of the Earth, second edition. Springer-Verlag, New York. 274pp.
3. CURTIS, J.T. 1959. The Vegetation of Wisconsin. University of Wisconsin Press, Madison. 657pp.
4. WEAVER, J.E. 1968. Prairie Plants and Their Environment. University of Nebraska Press, Lincoln. 276pp.
5. BLEWETT, T. 1980. Curtis Prairie: a Look Backward. *The University of Wisconsin/Madison Arboretum News* **29**,4: 1-4.
6. COTTAM, G., and H.C. WILSON 1966. Community Dynamics on an Artificial Prairie. *Ecology* **47**,1: 88-96.
7. ALLSUP, M. 1978. Henry Greene's Prairie. *The University of Wisconsin/Madison Arboretum News* **27**,4: 1-4.
8. COTTAM, G. 1979. Our First 45 Years. *The University of Wisconsin/Madison Arboretum News* **28**,1: 1-4.

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