
METHODS OF PRAIRIE DEVELOPMENT USED AT THE AULLWOOD AUDUBON CENTER, DAYTON, OHIO¹

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ABSTRACT

The Aullwood Audubon Center in Dayton, Ohio, in order to expand its educational offerings, began the development of a tall-grass prairie in the fall of 1959. Seeds were gathered in the fall from natural prairies in Adams County, Ohio, and were stratified in soil and buried in an outdoor pit. In April 1960 the seeds were broadcast by hand with a cover crop of oats on Miamiian Silt Loam soil that had been plowed and disked the preceding fall. In the fall of 1960 the site was mowed and raked. In April 1961 straw was spread over the site and burned. In 1963 biennial spring burning was begun, and annual extensions of the prairie in quarter-acre increments were instigated, using the same procedure as for the original site.

As a result of evaluation in 1968 the procedure was changed and the project increased to include 10 acres, to be finished by 1974. At this time the seeds were stratified in an equal volume of damp sand and stored in a refrigerator from early February until planting time in mid-May. The variety of seeds was increased from 35 species to 60 species or more in each seeding. The soil at this time was plowed in the fall and disked at two-week intervals in the spring until mid-May; fall mowing and raking were eliminated. Biennial burning was continued. The revised procedure produced a dense stand of prairie plants more quickly than did the original method, though both methods produced a tall-grass prairie.

INTRODUCTION

The Aullwood Audubon Center was opened in 1957 as a result of the donation by Mrs. John Aull of 70 acres of her farm near Dayton, Ohio, to the National Audubon Society. This new outdoor education facility was to be a model for the development of nature centers across the country. The land-management policies have been aimed toward enhancing the educational potential of the site. In keeping with this it was decided to establish, if possible, a tall-grass prairie, a type of plant community that had once been present in parts of southwestern Ohio, but that had been almost completely eliminated by the activities of modern man (Transeau, 1935; Sears, 1926; Gordon, 1966, 1969).

EARLY HISTORY OF THE PRAIRIE

Tom McElroy, Managing Director from 1957 to 1961, sought guidance on how to develop such a prairie from Dr. Paul Sears of Yale University, Mr. Frank

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Preston of Butler, Pennsylvania, and Dr. J. T. Curtis of the University of Wisconsin. Valuable help was received from all these men on site selection and procedure.

The site that was selected, as a result of the guidance, was a gently sloping 2½-acre field containing well-drained Miamian Silt Loam soil (personal communication, Richard Watkins of the Soil Conservation Service). Following earlier cropping, the field had been seeded to a brome grass; very little other vegetation was evident.

The procedure used at that time (fall of 1959 and spring of 1960) was as follows: The land was plowed and disked in the fall. At about the same time seeds were gathered from roadsides in Adams County, Ohio, in areas that contained prairie vegetation (Braun, 1928). These seeds, together with some provided by Dr. J. T. Curtis, were stratified, or mixed with an equal volume of soil, and the seed-soil mixture was buried in a screen-lined pit 1 foot deep. In April 1960 the field was disked again, and the seed-soil mixture was then dug up and hand broadcast, together with a cover crop of oats; the field then was disked lightly.

In the fall of 1960 the site was mowed and then raked to remove excess stalks. In April 1961 50 bales of straw were spread over the site and burned in an attempt to control annual weeds. Fall mowing and raking and spring burning were continued through the spring of 1963.

The species introduced into the prairie included: *Sorghastrum nutans*, *Andropogon scoparius*, *A. gerardi*, *Panicum virgatum*, *Uniola latifolia*, *Echinacea purpurea*, *Liatris squarrosa*, *L. aspera*, *L. spicata*, *Silphium terrebinthinaceum*, *S. integrifolium*, *Ratibida pinnata*, *Monarda fistulosa*, *Coreopsis tripteris*, *Solidago rigida*, *Sabalina angularis*, and *Pycnanthemum tenuifolium*.

The original plot contained only 1 acre of the 2½ acres set aside for the prairie. Therefore annual expansion of the prairie in quarter-acre increments was begun in 1963. At that time it was decided also to burn the site every other year.

The apparent growth of the prairie species was very slow. In the 1960 plot, for example, no prairie species were seen during the first year. In the second year, 1961, only one specimen of *Liatris* (of unknown species), perhaps 40 stems of *Andropogon gerardi* and *Sorghastrum nutans*, and 4 individuals of *Echinacea purpurea* were found. Each year, however, more prairie plants became evident, and the clumps of grasses grew larger. By 1968 there was not only a dense stand of *Andropogon gerardi* 8 to 11½ feet tall and of *Sorghastrum nutans* 7 to 8 feet tall, but also a fair sprinkling of the forbs that had been introduced.

PRESENT PRAIRIE MANAGEMENT

Re-evaluation of the prairie project seemed necessary in 1968. The 1960 plot had been moderately successful, though only a limited number of prairie species were represented. Those species that had been introduced had done well, but it was felt that a better, more varied, example of prairie could be established. The quarter-acre expansion of 1963 had a solid stand of Indian Grass on the northern half, but few prairie plants were evident on the southern half. The 1964 plot contained a solid stand of Indian Grass with virtually nothing else in it. The 1965 and 1966 plots were failures because the seed had begun to sprout (because of premature spring warmth in the soil in which the seed had been buried) before it was broadcast, as a result there was no real growth of prairie plants. It was too soon to judge the 1967 plot.

Careful study revealed that there were several critical unsolved problems in the method of development of the prairie. Stratifying the seed in the soil had proved to be somewhat risky. In 1965 and 1966 when very warm weather early in April had caused the seeds to sprout prematurely, very few matured; clearly, a better method of holding the seeds over the winter was needed. In addition there was some question as to whether the species used in the earlier prairie indeed represented the species characteristic of the prehistoric prairie of southwestern

Ohio; this problem did not appear to have an easy answer. We needed also a source of seeds other than our own existing prairie. Finally, the next plot of land to be included in the prairie was more poorly drained than were the other plots. Additional land appeared to be necessary, however, because by the time of this re-evaluation (1968) the prairie had become a much-used plant community in the educational program at Aullwood; it was observed increasingly by guided groups, paralleling an expanded interest in prairies elsewhere throughout the state. The additional land was at that time a field of brome grass growing in Brookston Silty Clay Loam, a very poorly drained soil. Because of the poor drainage it was recognized that some prairie species characteristic of more poorly drained sites should be obtained if possible; both identity and source of appropriate species needed to be determined.

A symposium on prairies and prairie restoration held in Galesburg, Illinois, in September 1968 provided much help on methods of prairie restoration and answers to many questions, including that of stratification. Our present methods are a direct result of the report presented by Ray Schulenberg on the experiences and procedures at Morton Arboretum in Lisle, Illinois. Two new seed-source sites were also found. One was along a railroad-highway right-of-way near the Indiana-Illinois state line in the vicinity of Kentland, Indiana. The other site was along a railroad-highway right-of-way near Selma, Ohio, in the southwestern part of the state. This second site provided not only seeds, but also some information on prairie species native to Ohio. Both sources had areas of poorly drained soils.

Soil Preparation

Each fall the land to be planted in the spring is plowed. In the spring, disking begins as soon as soil conditions permit, usually in late March or early April. Disking is then repeated approximately every two weeks until planting time in mid-May. This frequent disking and late planting have eliminated much of the competition with the old field weeds which normally appear earlier in the spring. The soil is disked lightly immediately before and immediately after the seed is broadcast.

Seed Gathering and Preparation

When the seeds are ripe in late October or early November they are gathered both from our own prairie and from the two newly discovered railroad prairies. The seeds of some prairie species are not available this late in the season, but a large number remain. Seeds from at least 74 species were gathered in October and November of 1970. Approximately one-half by volume of the seeds gathered are of grass, the other half forbs. Entire inflorescences are picked, transported in large open containers, then spread out on tables and in large open boxes to promote drying. Legume seeds are kept separate at this time, as they require a somewhat different treatment than do the other seeds.

Once dry, the inflorescences are broken apart by hand, separating the individual seeds from each other as much as possible. The result is a mass of seeds and much chaffy material, *i.e.*, dried flower parts and stems. Because it may contain minute animal life characteristic of the prairie community from which these seed heads were obtained, the stems and removed chaff are kept and applied to the prairie plot of the preceding year in the hope of adding some invertebrates. At the end of January the seeds (totaling approximately 1½ bushels for each acre) are mixed with an equal volume of moist sand, placed in large plastic bags, and stored in a refrigerator until the middle of May.

The seeds of the legumes are broken apart also. Most of these seeds, however, need both scarification to weaken or scratch the seed covering and inoculation with nitrogen-fixing bacteria. Seed can be scarified with chemicals or with abrasives; at Aullwood, an orbital sander is used for this purpose. The legume seeds are then mixed with an equal volume of moist sand, put in plastic bags, and stored

in a refrigerator. Inoculation is done in mid-May, using any commercial source of nitrogen-fixing bacteria (at Aullwood, inoculant from the Nitrogen Company, Inc., of Milwaukee, Wisconsin, is used).

Sowing the Seed

Seed is generally sown during the third week of May, following disking of the soil. The seed-sand mixtures are removed from the refrigerator and, after the legume seeds have been inoculated with nitrogen-fixing bacteria, are combined with twice their volume of horticultural perlite (making 9 bushels of mixture per acre—1½ bushels of seeds, 1½ bushels of sand, and 6 bushels of perlite). Perlite is added to make broadcasting easier and to permit ready identification of areas already seeded. The seed-sand-perlite mixture is then taken immediately to the plot and broadcast by hand. When this is finished, the soil is disked lightly.

TABLE 1

Prairie species introduced into the Aullwood prairie. Species are in the order in which they appear in Gray's Manual of Botany.

<i>Uniola latifolia</i>	<i>M. fistulosa</i>
<i>Elymus canadensis</i>	<i>Blephilia ciliata</i>
<i>Spartina pectinata</i>	<i>Pycnanthemum tenuifolium</i>
<i>Panicum virgatum</i>	<i>P. virginianum</i>
<i>Panicum</i> sp.	<i>Penstemon digitalis</i>
<i>Andropogon scoparius</i>	<i>Veronicastrum virginicum</i>
<i>A. gerardi</i>	<i>Triosteum</i> sp.
<i>Sorghastrum nutans</i>	<i>Lobelia cardinalis</i>
<i>Tradescantia ohioensis</i>	<i>L. spicata</i>
<i>Agave virginica</i>	<i>Vernonia missurica</i>
<i>Spiranthes cernua</i>	<i>Eupatorium altissimum</i>
<i>Mirabilis nyctaginea</i>	<i>Liatris spicata</i>
<i>Anemone canadensis</i>	<i>L. pycnostachya</i>
<i>A. cylindrica</i>	<i>L. aspera</i>
<i>Potentilla arguta</i>	<i>L. squarrosa</i>
<i>Geum laciniatum</i>	<i>L. cylindracea</i>
<i>Geum</i> sp.	<i>Solidago nemoralis</i>
<i>Rosa</i> sp.	<i>S. rigida</i>
<i>Desmanthus illinoensis</i>	<i>S. graminifolia</i>
<i>Cassia fasciculata</i>	<i>S. speciosa</i>
<i>C. nictitans</i>	<i>Aster azureus</i>
<i>Psoralea onobrychis</i>	<i>A. shortii</i>
<i>Amorpha canescens</i>	<i>A. sagittifolius</i>
<i>Petalostemum purpureum</i>	<i>A. laevis</i>
<i>P. candidum</i>	<i>A. sericeus</i>
<i>Astragalus canadensis</i>	<i>A. ericoides</i>
<i>Desmodium canescens</i>	<i>A. dumosus</i>
<i>D. illinoense</i>	<i>Silphium terebinthinaceum</i>
<i>Lespedeza capitata</i>	<i>S. terebinthinaceum</i> var. <i>pinnatifidum</i>
<i>Euphorbia corollata</i>	<i>S. laciniatum</i>
<i>Hypericum</i> sp.	<i>S. trifoliatum</i>
<i>Gaura biennis</i>	<i>S. integrifolium</i>
<i>Eryngium yuccifolium</i>	<i>Parthenium integrifolium</i>
<i>Sium suave</i>	<i>Rudbeckia hirta</i>
<i>Dodecatheon meadia</i>	<i>R. triloba</i>
<i>Sabatia angularis</i>	<i>Echinacea purpurea</i>
<i>Gentiana puberula</i>	<i>E. pallida</i>
<i>G. andrewsii</i>	<i>Ratibida pinnata</i>
<i>Asclepias viridiflora</i>	<i>Helianthus occidentalis</i>
<i>A. tuberosa</i>	<i>H. laetiflorus</i>
<i>A. verticillata</i>	<i>H. grosseserratus</i>
<i>A. sullivantii</i>	<i>H. mollis</i>
<i>Lithospermum canescens</i>	<i>H. hirsutus</i>
<i>Verbena stricta</i>	<i>H. annuus</i>
<i>Verbena</i> sp.	<i>Coreopsis palmata</i>
<i>Teucrium occidentale</i>	<i>C. tripteris</i>
<i>Physostegia virginiana</i>	<i>Prenanthes</i> sp.
<i>Monarda punctata</i> var. <i>villicaulis</i>	

Watching it Grow

The 1969, 1970, 1971, and 1972 plots, each of which was planted according to the revised methods, all appeared at first to be failures. By the end of June in each newly established plot, Jimson Weed (*Datura stramonium*), Velvetleaf (*Abutilon theophrasti*), and Bindweeds (*Convolvulus* sp.) were everywhere. Fox-tail grasses (*Setaria* sp.) also were profuse. However, by September of each year, *Andropogon gerardi*, *Sorghastrum nutans*, *Elymus canadensis*, and *Asclepias tuberosa* were in bloom (for a total list of introduced species see Table 1). The second summers for the 1969, 1970, and 1971 plots were spectacular, and a similar result is expected for the 1972 plot in the summer of 1973. What had looked like weed patches early in the first year of each plot were obviously young prairies. The assemblage became established without the aid of weeding or fertilizing. The only continuing maintenance is spring burning in mid-April every other year to maintain a balance between grasses and forbs (Kucera and Ehrenreich, 1962). This burning is done with the aid and cooperation of the local fire department and by permit from the local air pollution control board.

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