

# Establishment of a Prairie on a Borrow-Pit Site at the Bergamo-Mt. St. John Nature Preserve in Greene County, Ohio<sup>1</sup>

DENIS G. CONOVER and DONALD R. GEIGER, Department of Biological Sciences, University of Cincinnati, Cincinnati, Ohio 45221-0001 (DGC) and Department of Biology, University of Dayton, Dayton, Ohio 45469-0001

**ABSTRACT.** During the spring of 1986, development of a prairie was begun on a site at the Bergamo-Mt. St. John Nature Preserve located in Greene County, Ohio. A major objective of the project was to reclaim a sand and gravel borrow-pit. Prairie was chosen for reclamation of this area because prairie vegetation was present in the immediate area and that type of community is well-suited to the extremes in moisture conditions on the site. The prairie is intended to provide a habitat for some species being displaced by human disturbance and to provide a specific plant community within the preserve. To establish grasses, seeds obtained from Western sources were planted in April of 1986 by hydroseeding on the graded site. Just prior to this, seeds of several forbs obtained from Western sources were broadcast over the area. Subsequently, seeds of grasses and forbs collected locally were broadcast. For species more difficult to establish, plants were propagated in soil-filled plastic-film cylinders. These, and other plants collected locally from disturbed sites, were transplanted into holes prepared with a soil auger. After three seasons of growth, approximately 36 species of Ohio prairie indicator plant species, along with a number of species of animals, have become established on the site despite the severe drought of 1988.

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## INTRODUCTION

At the time of white settlement, there were extensive areas of wet prairies and fens in Greene County, Ohio (Nolin and Runkle 1985). While most of these areas have since been disturbed, some sites remain, including Zimmerman Prairie State Nature Preserve in Section 2 of Beavercreek Township. Highways, interchanges, industrial sites and housing projects threaten many of the remaining prairie habitats. Some species displaced from these areas, such as *Napaea dioica*, *Filipendula rubra* and *Pycnanthemum virginianum*, are becoming threatened or endangered in Ohio and it is important to protect and expand their habitats.

An increasing number of groups are working to preserve and restore relict prairies and to establish new prairies on altered sites (Green et al. 1981), thereby helping to protect threatened plants and animals (Falk and McMahan 1988). Such areas also provide important islands of green space for enrichment and education, especially needed in areas of rapid development. Establishment of the prairie at Bergamo-Mt. St. John Nature Preserve is an example of the reclamation of a disturbed site for a natural area. The purpose of this paper is to describe the methods used to establish the prairie and to evaluate the success of this effort.

## MATERIALS AND METHODS

**SITE DESCRIPTION.** The 14-acre site occupied by the present prairie planting is located in Greene County (Township 2, Range 7MRS, Section 7), on glacial moraine and was described by surveyor Colonel Israel Ludlow in the early 1800's as forested. After settlement, the site was used for agriculture or pasture until 1985. The main soil type at the location of the prairie is Miamian-Casco complex, characterized by a thin topsoil horizon. In 1985, sand and gravel were excavated from this location for use in the construction of I-675 which borders the area on the east. Before excavation, some topsoil was salvaged for later replacement. Early in the spring of 1986 the area was graded, creating a flat basin bounded on the west and south by relatively steep slopes. An ephemeral pond of approxi-

mately 0.1 ha formed in the basin. A thin layer of the salvaged topsoil was spread over about a third of the area not included in the pond, leaving much of the surface with only the exposed sand and gravel. Various edaphic conditions exist, but much of the prairie is subjected to periodic extensive drying. Several small clay lenses, located on the slopes, are associated with seeps that persist except in the driest times.

**SEED AND PLANT SOURCES.** Seeds for eight prairie grasses and three forbs for the initial sowing of the site were obtained in March 1986 from the Bluestem Seed Company, Grant City, MO. In fall of the years 1985 through 1987, seeds for prairie grasses and forbs were collected locally and prepared according to methods described by Rock (1977). Collection locations included the Aullwood Audubon Center prairie, Dayton, OH; a railroad right-of-way location adjacent to Zimmerman Prairie State Nature Preserve, Greene County, OH; sites along the Great Miami and Stillwater Rivers near Dayton, OH; and sites in Adams County, OH. Prior to planting, seeds of *Cassia fasciculata* were placed in concentrated sulfuric acid for 2 min and rinsed in running water and dried. Plants were salvaged from some of the sites mentioned above that were being destroyed by human activities and were transplanted directly to the prairie.

**SEEDING GRASSES AND FORBS.** The area was prepared with a harrow and board drag prior to seeding. Forb seeds were broadcast by hand a few days before the grasses. On 20 April 1986, a mixture of eight prairie grasses was planted by hydroseeding. Seeds were covered to a depth of less than 1 cm by traversing the area with a simple board drag and the soil was covered with straw. Application rate for the mixture of grasses was approximately 22 kilograms per ha. The mixture consisted of *Andropogon scoparius*, *Bouteloua curtipendula*, *Agropyron smithii*, *Sorghastrum nutans*, *Panicum virgatum*, *Bouteloua gracilis*, *Elymus canadensis* and *Andropogon gerardi* in the ratio 5:4:3:2:2:1:1:1. Oats (*Avena sativa*) were included as a nurse crop at the rate of 1 m<sup>3</sup> per ha. Seeds of three forbs (*Echinacea purpurea*, *Asclepias tuberosa*, and *Rudbeckia hirta*) were broadcast just before sowing the grasses. Seeds of forbs and grasses, collected locally, were broadcast and raked into the soil at various times after the initial planting. A complete listing of species introduced to this site is provided and the method used for propagation is indicated (Table 1).

**SEEDLING CULTURE.** Because of the periodic drying of the site, direct seeding was not used when the supply of seed was limited. Instead, seedlings of some forbs (Table 1) were propagated elsewhere in plastic-film cylinders and transplanted to the prairie after they were well-established. Plastic tubing, 0.03 mm wall thickness and 5 cm in diameter (Packaging and Handling Supplies Co., Dayton, OH), was cut to a length of 30 cm, tied shut at one end and filled with top soil. Holes made with an ice pick provided drainage. Seeds were planted in the cylinders and covered to several times their diameter. Cylinders were placed outdoors in a 30-cm-deep pit in the

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TABLE 1

## Some Plant Species Found in Bergamo-Mt. St. John Prairie

Column on right gives the methods used to establish the species. B: seeds broadcast; C: seeds planted in plastic-film cylinders; H: seeded by hydro-seeding; T: plants transplanted in dormant state; V: volunteer colonized from local sites; W: Western species seeded along with grasses; X: species probably extirpated in Ohio; \*: flowered by fall of 1988. From Bare (1979); Cusick and Troutman (1978); Gleason and Cronquist (1963) and Weisaupt (1971).

## Prairie Indicator Grasses Native to Ohio:

|                 |                               |         |
|-----------------|-------------------------------|---------|
| Big bluestem    | <i>Andropogon gerardi</i>     | H, B, * |
| Little bluestem | <i>Andropogon scoparius</i>   | H, *    |
| Sideoats grama  | <i>Bouteloua curtipendula</i> | H, *    |
| Canada wild rye | <i>Elymus canadensis</i>      | H       |
| Switchgrass     | <i>Panicum virgatum</i>       | H, *    |
| Indiangrass     | <i>Sorghastrum nutans</i>     | H, B, * |
| Cord Grass      | <i>Spartina pectinata</i>     | T       |

## Prairie Indicator Forbs Native to Ohio:

|                        |                                  |         |
|------------------------|----------------------------------|---------|
| False Aloe             | <i>Agave virginica</i>           | C       |
| Nodding pink onion     | <i>Allium cernuum</i>            | C, *    |
| Thimble weed           | <i>Anemone cylindrica</i>        | C       |
| Butterfly weed         | <i>Asclepias tuberosa</i>        | C, *    |
| Asters                 | <i>Aster</i> spp                 | V, *    |
| White wildindigo       | <i>Baptisia leucantha</i>        | C       |
| Indigo                 | <i>Baptisia</i> sp               | C       |
| Partridge pea          | <i>Cassia fasciculata</i>        | C, *    |
| Tickseed coreopsis     | <i>Coreopsis lanceolata</i>      | C, X    |
| Tick-trefoil           | <i>Desmodium illinoense</i>      | B       |
| Purple coneflower      | <i>Echinacea purpurea</i>        | B, C, * |
| Rattlesnake master     | <i>Eryngium yuccifolium</i>      | C, *    |
| Queen-of-the-prairie   | <i>Filipendula rubra</i>         | T, *    |
| Bush clover            | <i>Lespedeza capitata</i>        | B, C, * |
| Blazing-stars          | <i>Liatris</i> spp               | C, *    |
| Scaly blazing-star     | <i>Liatris squarrosa</i>         | C       |
| Bergamot               | <i>Monarda fistulosa</i>         | C, B, * |
| Pricklypear cactus     | <i>Opuntia humifusa</i>          | C       |
| Mountain mint          | <i>Pycnanthemum virginianum</i>  | C, T, * |
| Grayheaded coneflower  | <i>Ratibida pinnata</i>          | T, *    |
| Upright coneflower     | <i>Ratibida columnifera</i>      | B, X, * |
| Black-eyed susan       | <i>Rudbeckia hirta</i>           | B, *    |
| Orange coneflower      | <i>Rudbeckia fulgida</i>         | C, B, * |
| Thin-leaved coneflower | <i>Rudbeckia triloba</i>         | B, *    |
| Royal catchfly         | <i>Silene regalis</i>            | C       |
| Compassplant           | <i>Silphium laciniatum</i>       | C, B    |
| Prairie dock           | <i>Silphium terebinthinaceum</i> | C, T, * |
| Stiff goldenrod        | <i>Solidago rigida</i>           | C, *    |
| Western Ironweed       | <i>Vernonia fasciculata</i>      | V, *    |

## Non-Prairie Plants Native to Ohio:

|                  |                               |            |
|------------------|-------------------------------|------------|
| Dogbane          | <i>Apocynum medium</i>        | V, *       |
| Swamp milkweed   | <i>Asclepias incarnata</i>    | C, *       |
| Sedges           | <i>Cyperus</i> spp            | V, T, *    |
| Barnyard grass   | <i>Echinochloa crus-galli</i> | V, *       |
| Joe-pye-weed     | <i>Eupatorium fistulosum</i>  | V          |
| Boneset          | <i>Eupatorium perfoliatum</i> | V, *       |
| Horsetail        | <i>Equisetum</i> sp           | V          |
| Purple gerardia  | <i>Gerardia paupercula</i>    | V, C, B, * |
| Great lobelia    | <i>Lobelia silphilitica</i>   | V, *       |
| Glade mallow     | <i>Nappa dioica</i>           | C          |
| Evening primrose | <i>Oenothera biennis</i>      | V, *       |
| Lady's-thumb     | <i>Polygonum persicaria</i>   | V, *       |
| Hairy ruellia    | <i>Ruellia carolinensis</i>   | V, *       |
| Bullrush         | <i>Scirpus</i> sp             | T, *       |
| Common cattail   | <i>Typha latifolia</i>        | V, *       |
| Blue vervain     | <i>Verbena hastata</i>        | V, *       |

fall and covered with soil on the sides to prevent repeated rapid freezing and thawing of the roots. In other cases, seeds were germinated in a plant growth room at the University of Dayton, following moist stratification for three months at 5°C in a refrigerator. In March, these seedlings were transplanted to cylinders and kept outdoors until well-developed root systems had formed. Most seedlings

TABLE 1, (continued)

## Prairie Grasses Found in Ohio But Not Native:

|                    |                           |      |
|--------------------|---------------------------|------|
| Western wheatgrass | <i>Agropyron smithii</i>  | H    |
| Blue grama         | <i>Bouteloua gracilis</i> | H, * |

## Trees and Shrubs:

|                    |                             |   |
|--------------------|-----------------------------|---|
| Red cedar          | <i>Juniperus virginiana</i> | T |
| Carolina buckthorn | <i>Rhamnus caroliniana</i>  | T |
| Bur oak            | <i>Quercus macrocarpa</i>   | T |

## Other Plants Found in Ohio But Not Native:

|                 |                              |      |
|-----------------|------------------------------|------|
| Western ragweed | <i>Ambrosia psilostachya</i> | W, * |
| Nodding thistle | <i>Carduus nutans</i>        | V, * |
| Bull thistle    | <i>Cirsium vulgare</i>       | V, * |
| Gumweed         | <i>Grindelia squarrosa</i>   | W, * |
| Moth mullein    | <i>Verbascum blattaria</i>   | V, * |
| Flannel mullein | <i>Verbascum thapsus</i>     | V, * |

## Introduced Western Species:

|                     |                                   |      |
|---------------------|-----------------------------------|------|
| Broomweed           | <i>Gutierrezia dracunculoides</i> | W, * |
| Broom snakeweed     | <i>Gutierrezia sarothrae</i>      | W, * |
| Blazing star        | <i>Mentzelia decapetala</i>       | W, * |
| Pitcher sage        | <i>Salvia pitcheri</i>            | W, * |
| Rosinweed           | <i>Silphium integrifolium</i>     | W, * |
| Stenosiphon         | <i>Stenosiphon linifolius</i>     | W, * |
| Rayless thelesperma | <i>Thelesperma megapotamicum</i>  | W, * |

had developed root systems that reached the bottom of the containers by May.

**TRANSPLANTING.** Dormant plants were transplanted in spring. The general soil and microhabitat conditions were noted at the locations where plants and seeds were collected. Care was taken to place the plants in a location similar to their original habitats. Plants raised in cylinders were removed by slitting the plastic film and placing the cylinder of soil into holes prepared with a soil auger. Planting was done when the soil was wet to ease coring and to lessen moisture stress. Establishment of plants by the above methods has been done regularly since the initial planting and is being continued.

**WEED CONTROL.** Sufficient seed could not be obtained locally to establish grasses before serious erosion occurred. Consequently, a number of Western prairie species were introduced unavoidably with the commercial seed (Table 1). A program for eradication of these introduced species is underway, along with efforts to control local weed species such as *Ambrosia* spp, *Cichorium intybus*, *Daucus carota*, *Melilotus officinalis*, *Setaria* sp and *Sorghum halapense*. Methods being used include uprooting plants before flowering, timely mowing, hand removal of flowers and selective spraying with the non-selective, post-emergence herbicide glyphosate (N-phosphonomethylglycine). Planned future management activities include annual spring burning of one third of the prairie on a 3-yr cycle to control weeds and unwanted trees and to maintain a balance between grasses and forbs (Kucera and Ehrenreich 1962).

## OBSERVATIONS AND DISCUSSION

As previously observed (Moeller 1973), above-ground growth of prairie plants was slow. During the first summer (1986) weeds were numerous and their growth was profuse, especially where topsoil was present. On the other hand, the prairie grasses and directly-seeded forbs were inconspicuous and their above-ground growth was slow. By the end of the first summer the individual plants of *Andropogon scoparius*, *Sorghastrum nutans*, *Panicum virgatum*, *Bouteloua gracilis* and *Andropogon gerardi* formed obvious tufts that dotted the soil.

During the second year (1987) the grasses on the areas with some topsoil formed tillers and some of the grasses and directly-seeded forbs, such as *Echinacea purpurea* and *Rudbeckia hirta*, flowered. Perennial forbs

started in plastic-film cylinders, such as *Asclepias tuberosa*, produced large flowering plants by this time. Plants in areas that lacked topsoil grew much slower and showed signs of poor mineral nutrition.

By fall of the third year (1988) it was obvious that the prairie community was well-established despite the severe drought. Most of the signs of marked mineral deficiency that were observed initially had disappeared by this time, probably because the root systems had become extensive enough to gather sufficient minerals. Nearly all of the grasses and forbs on the more fertile sites flowered by the third year (Table 1). On the dryer and less fertile sites the directly-seeded forbs flowered, but were quite small. The grasses on these sites were still small, discrete tufts, some of which were flowering. Flowering grasses on these sites consisted largely of *Andropogon scoparius* and *Bouteloua gracilis*.

Plant species established at the edge of the ephemeral pond were those that could survive alternate flooding and drying. The predominant species were barnyard grass (*Echinochloa crus-galli*) and lady's-thumb (*Polygonum persicaria*). Attempts to establish plant species such as water plantain (*Alisma triviale*), *Sagittaria* sp and *Bidens* sp have been unsuccessful to date. Sedges (*Cyperus* spp) and bullrushes (*Scirpus* sp) were established even though the pond dried completely on one occasion at the height of the 1988 drought.

Recolonization by animals is gradually occurring and is paced by the development of the plant communities. From the start, the pond attracted local and migrating water fowl and shore birds along with white-tailed deer (*Odocoileus virginianus*) and racoons (*Procyon lotor*). Toads, common aquatic insects and snails became established soon after grading was completed. Killdeers (*Charadrius vociferus*) soon took up residence on the surrounding areas of sand and gravel. By the third year, cotton-tail rabbits (*Sylvilagus floridanus*), red foxes (*Vulpes fulva*), red-tailed hawks (*Buteo jamaicensis*), broad-winged hawks (*Buteo platypterus*) and ring-necked pheasants (*Phasianus colchicus*) were present. Insects and spiders characteristically associated with the various grasses and forbs have become established.

### CONCLUSIONS AND FUTURE PLANS

The progress observed provides evidence that the methods presented here can be applied elsewhere to reclaim similar disturbed areas. The plants established in the plastic-film cylinders prior to their being transplanted in the prairie were particularly successful. With their well-established root systems and accompanying soil, these plants appeared to tolerate dry periods rather well, even in well-drained areas.

As the prairie develops, microhabitats are becoming better differentiated. Some areas have very thin topsoil, are well-drained and are very dry. In these places, the

main grasses are *Andropogon scoparius* and *Bouteloua gracilis*. Other areas have thin soil and are very poorly drained. These areas show an extreme range of moisture conditions, with the soil being saturated during wet seasons and powder dry during late summer and early fall. *Silphium terebinthinaceum* and *Echinacea purpurea* have become established here and it is expected that these and other wet prairie species that can tolerate the extreme wet and dry conditions will survive in these areas. Still other areas have thicker, well-drained topsoils with a number of seeps. Here *Andropogon gerardi*, *Sorghastrum nutans* and *Panicum virgatum* are thriving along with *Bouteloua gracilis*, *Bouteloua curtipendula* and *Andropogon scoparius*.

Observing the success of plants of various species within these microhabitats will enable us to become increasingly successful in establishing plants of rare species growing in Ohio prairies. In the future, we intend to expand the borrow-pit prairie to an additional 15 acres of adjacent old-field area. The enlarged prairie may provide sufficient area for animal species that require a larger prairie habitat.

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