

DESIGNING NATURAL LANDSCAPES WITH NATIVE PRAIRIE PLANTS

Neil Diboll
Prairie Nursery
Westfield, WI. 53964
800-476-94543
www.prairienursery.com

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I. Ecological Structure of the North American Prairie Grassland

The North American Prairie is a grassland ecosystem. It is composed of hundreds of different flowers and grasses, but is dominated by a few vigorous and adaptable grasses:

<u>Latin Name</u>	<u>English Name</u>	<u>Prairie Habitat</u>
<i>Andropogon gerardii</i>	Big Bluestem	Dry to Wet Prairies
<i>Bouteloua curtipendula</i>	Side Oats Grama	Dry Prairies
<i>Elymus canadensis</i>	Canada Wild Rye	Dry to Wet Prairies
<i>Panicum virgatum</i>	Switchgrass	Dry to Wet Prairies
<i>Schizachyrium scoparium</i>	Little Bluestem	Dry to Medium Prairies
<i>Sorghastrum nutans</i>	Indiangrass	Dry to Medium Prairies
<i>Sporobolus heterolepis</i>	Prairie Dropseed	Dry to Medium Prairies
<i>Spartina pectinata</i>	Prairie Cordgrass	Wet Prairies

Although dozens of other grasses, sedges (*Carex*), and rushes (*Scirpus*) can be found on the American Prairie, the grasses listed above are the most commonly occurring and widespread across the entire prairie region. These grasses are most commonly used in prairie landscape design due to their adaptability and visual appeal.

Dozens of species of forbs (wildflowers) and a few small shrubs are interspersed among the prairie grasses in a natural prairie. The grasses typically dominate the flowers in remnant prairies, with the average ratio being approximately 80% grasses to 20% flowers in terms of stem density, although this ratio can vary widely from prairie to prairie.

The average Wisconsin prairie contains approximately 65 different species of higher plants, including flowers, grasses, sedges, and shrubs. Typically, five to fifteen different grasses and sedges are present in any given prairie, with the balance composed of flowers and small shrubs. Thus, the ratio of the number of flower species to graminoid species is approximately 80% flowers to 20% grasses, the reverse of the stem density for each of these two components.

The North American Prairie is recognized as being a tightly-knit, stable ecosystem that resists invasion by weeds. This is due to two primary factors:

1. The root systems of the prairie grasses are deep and densely fibrous, and nearly completely occupy the upper three feet of the soil rooting zone. Combined with the many deep-rooted flowers (some with roots up to twenty feet deep), the prairie forms a dense sod that resists invasion by other plants.
2. Most prairie plants are long-lived perennials that tend to persist for many years, often decades. Plant turnover and replacement in a mature prairie is very low, often with little or no change from year to year.

Once established, the prairie becomes a low maintenance, natural perennial garden or meadow. By applying the principles of plant ecology in the prairie garden design process, the plants are selected and associated together to create a stable, functional ecosystem. This is the secret to creating successful low maintenance prairie gardens and meadows.

II. Garden Design Principles Using Prairie Plants

The basic principles of garden design and installation apply to prairie gardens. With a knowledge and understanding of the characteristics and behavior of each species, beautiful gardens can be designed, installed, and maintained with a minimum of maintenance and cost.

General Garden Design Principles

1. Select only those plants that are adapted to growing in the soil type, moisture conditions, and light intensities on the planting site.
2. Choose plants to match the scale of the site. In small gardens, shorter plants (less than three feet) are the best choice, as they will fit the space well. Taller flowers and grasses can be used along walls, fences, and woodland edges to good effect.
3. Repeat some of the same plants in selected areas of the garden to provide a sense of unity and harmony throughout the planting.
4. Position plants so they will show off best at their particular time of the year. Place shorter, early blooming plants toward the front, not in back behind taller plants. Plants with small flowers should be in the foreground; those with big, bold flowers can be located in the background.
5. Use larger, specimen plants to draw the eye to specific focal centers of interest.
6. Combine textures so that they complement and play off one other. The fine leaves of the grasses are a perfect foil for the bold foliage of large-leaved prairie flowers such as *Silphiums*, *Baptisias*, and *Eupatoriums*.
7. Combine flower colors to create a pleasing effect. For instance, white flowers mix well with pastel blues, purples, reds, and pinks. Strong yellow flowers generally mix best with colors opposite them on the color wheel, such as bright blues and purples.
8. Prepare the site thoroughly prior to planting so that all weeds and other plant growth have been eliminated. No perennial weeds should be present on the planting site, as they can rapidly colonize the new garden jeopardize success. Proper site preparation greatly reduces post-planting maintenance by preventing weed problems in advance.

9. Consider the longevity of each species. Plant primarily long-lived perennials (5 years or more), as opposed to shorter-lived perennials (3-5 years) and biennials (2 years). This reduces future plant replacements and results in a stable, low maintenance garden.
10. Use a diversity of species, with complementary bloom times for interest throughout the seasons. The prairie flowers provide spring, summer and early fall color. The prairie grasses, with their red and gold fall colors, become the focal point in autumn and well into the winter.

Specific Design Principles for Prairie Gardens

1. Use at least 33% to 50% grasses in the garden design. The grasses help to squeeze out the weeds, lend support to the prairie flowers (eliminating the need for staking), and provide late season interest with their fall colors. A 100% prairie flower garden can be created, but will require more maintenance than a garden that includes grasses to help control weedy invasion.
2. Use low-growing, showy, clump-forming prairie grasses (up to three feet tall) to allow the flowers to show off. The best grasses for prairie gardens are Little Bluestem (*Schizachyrium scoparium*), Prairie Dropseed (*Sporobolus heterolepis*), Side Oats Grama (*Bouteloua curtipendula*) and Junegrass (*Koeleria macrantha*).
3. Beware of planting the taller prairie grasses with shorter species, as they can spread aggressively by seed and take over the garden. Sod-forming tall grasses such as Big Bluestem (*Andropogon gerardii*) and Switchgrass (*Panicum virgatum*) should be used sparingly, if at all, in gardens that are to have a strong flower component.
4. Tall prairie grasses are best used in large sweeps and masses in background areas, mixed with other robust, tall prairie flowers. Plant tall species at a distance from short flowers and grasses to prevent invasion of the short prairie garden by taller neighbors.
5. Plant flowers with bulbs, corms, and taproots in close association with grasses to provide complementary fibrous roots to reduce weeds. These include Onions (*Allium spp.*), Leadplant (*Amorpha canescens*), Butterflyweed (*Asclepias tuberosa*), Canada Milkvetch (*Astragalus canadensis*), Wild Indigos (*Baptisia spp.*), Poppy Mallows (*Callirhoe spp.*), Wild Hyacinth (*Camassia scilloides*), New Jersey Tea (*Ceanothus americanus*), Prairie Clovers *Dalea spp.*, Larkspurs (*Delphinium spp.*), Coneflowers (*Echinacea spp.*), Blazingstars (*Liatris spp.*), Lupine (*Lupinus perennis*), Wild Petunia (*Ruellia humilis*), Catchflies (*Silene spp.*), Compassplant (*Silphium laciniatum*), Prairie Dock (*Silphium terebinthinaceum*), and Spiderworts (*Tradescantia spp.*).
6. When massing flowers, intersperse them with short prairie grasses. Most prairie flowers, even those with fibrous roots, benefit from having grasses adjacent to them to help provide support and control weeds. Side Oats Grama grass is a good companion for flowers, as it is low-growing (2-3 ft.), and covers the surface soil without competing heavily with the flowers.
7. Prairie grasses that stand up best over winter for architectural interest are Switchgrass and Little Bluestem. Indiangrass stands up well if not knocked down by ice or snow. Other prairie grasses such as Big Bluestem and Canada Wild Rye tend to fall over by late autumn or early winter and do not provide good winter interest.
8. Place plants an average of one foot on center. This spacing will fill in the garden completely, leaving little room between plants for weeds to grow. Some plants with an upright growth habit require less room and can be planted more closely together. These

include the Blazingstars, Wild Onions, Prairie Smoke (*Geum triflorum*), Prairie Clovers, Wild Petunia, and Spiderworts. Larger plants require more room and should be planted 1.5 to 2 feet apart. These include Prairie Dropseed grass, Leadplant, the Wild Indigos, New Jersey Tea, Queen of the Prairie (*Filipendula rubra*), Rose Mallow (*Hibiscus moscheutos*), and the various members of the genus *Silphium*.

9. Beware of planting aggressive rhizomatous species in the prairie garden. Although most prairie plants are well behaved, a few can spread aggressively by rhizomes. These include Canada Anemone (*Anemone canadensis*), Common Milkweed (*Asclepias syriaca*), Frost Aster (*Aster pilosus*), Prairie Coreopsis (*Coreopsis palmata*), Flowering Spurge (*Euphorbia corollata*), Sunflowers (*Helianthus spp.*), Bergamot (*Monarda fistulosa*), Obedient Plant (*Physostegia virginiana*), Western Spiderwort (*Tradescantia occidentalis*), and Prairie Cordgrass (*Spartina pectinata*).
10. Be careful when planting species that tend to seed aggressively, as they may take over sections of the garden. This includes the prairie grasses Big Bluestem, Switchgrass, and Indiangrass. Flowers that are known to self-sow readily include Common Milkweed, Pale Indian Plantain (*Cacalia atriplicifolia*), Purple Coneflower (*Echinacea purpurea*), Ox Eye Sunflower (*Heliopsis helianthoides*), Yellow Coneflower (*Ratibida pinnata*), Brown Eyed Susan (*Rudbeckia triloba*), Rosinweed (*Silphium integrifolium*), Cupplant (*Silphium perfoliatum*) Stiff Goldenrod (*Solidago rigida*), and the Vervains (*Verbena spp.*)

Integrating the Prairie Garden into the Landscape

The prairie garden can be either structured or “wild.” The structured prairie garden is designed so that it appears and functions like a typical perennial garden, using prairie plants. It can be an island garden within a lawn, a border along a wall, fence, or building, or as a “theme garden” with specific textures or colors, such as whites, pastels, etc. An all grass garden can also be created, taking advantage of the various heights, forms, leaf textures, and fall colors of the various prairie grasses.

The transition from the formal landscape into the prairie garden should be seamless. Prairie gardens that border a lawn should be designed with shorter-growing flowers and grasses in the foreground. An excellent plant for a transitional border between lawn and prairie is the highly ornamental grass, Prairie Dropseed. This fine-textured, emerald green grass can be planted at the forward edge of the prairie garden, one or more “rows” deep, to gradually introduce larger, bolder plants behind it. Placed 20 to 24 inches apart, in rows or curvilinear sweeps, it serves as an excellent border between formal and “wild.” Prairie Dropseed is a slow-growing, long-lived, well-behaved clump-forming grass. The foliage grows about one foot tall, with seedheads that reach to three feet in August and September. The deep green foliage takes on a golden color with the first frosts of fall.

Weed Control in the Prairie Garden

The easiest method of weed control in the prairie garden is to design it so that the “plants do the work for you” by completely occupying the soil rooting zone and aboveground foliar zone. However, two to three years is required for the prairie garden to reach maturity. In the interim, weed control is essential to both the early success and long-term performance of the garden.

If permissible, the use of pre-emergent herbicides at the time of planting is invaluable in preventing germination of weed seeds lurking in the soil. Pre-emergent herbicides are required only at the time of installation of the plants, and should be applied immediately after planting. Do not apply pre-emergent herbicides prior to installing plants, as the herbicide can find its way into the planting hole and cause “clubroot” in the transplants which can severely stunt and even kill them.

The use of mulches to prevent weeds is a great organic approach to weed control, and can be used in conjunction with pre-emergent herbicides. Apply mulch about three inches deep around new transplants. This prevents weed seed germination by depriving them of light at the soil surface, and also helps retain soil moisture. This greatly reduces weeding and watering.

Mulches composed of clean straw, grass clippings, and composted leaves are best. Cocoa bean hulls and rice hulls are also excellent mulches, and are easy to apply. However, cocoa bean hulls are toxic to some pets. Bark chips and other tree-derived mulches are not recommended. Prairie plants do not respond well to most woody mulches, as they often rob the soil of nitrogen, retain excess moisture at the soil surface, and may exude chemicals that are toxic to some plants. A light layer of shredded hardwood bark mulch can be used if no other mulches are available, but this is not generally recommended. Pine bark nuggets have been shown to severely retard the growth of many prairie plants. Never use field hay as mulch. It invariably contains high concentrations of weed seeds that can thoroughly infest your new garden.

In the second year some re-mulching may be necessary between plants in order to keep weeds down. The need for on-going mulching depends upon the plants used and their spacing. Gardens with low percentages of prairie grasses usually have more weed problems and require more mulching. If the plants were installed more than an average of one foot apart, there will likely be areas of open soil where weeds can become established. The only way to prevent weed invasion in these open areas is to re-apply pre-emergent herbicides or add a new layer of mulch every spring, or to hand-weed the garden.

In a properly designed prairie garden, the plants should be in full control of both the soil and foliar zones by the third growing season, leaving few openings for weeds to become established.

Annual Maintenance of the Prairie Garden

The prairie garden can be allowed to stand over winter to highlight the prairie grasses. This provides winter habitat and food sources for songbirds. In mid-spring, the prairie garden can either be burned off, or mowed closely to the ground and the cut material raked off to expose the soil to the warming rays of the sun. Removing the previous year’s dead growth in spring tidies up the garden and promotes new plant growth.

Most prairie flowers and grasses are “warm season” plants and grow best in warm soil. To provide maximum advantage to these plants, the soil should be exposed in mid-spring to

foster their growth. Cool season weeds often become established and can present competitive problems if the previous year's plant growth is left standing. The old growth shields the soil from the sun and delays its warming up in spring, slowing the emergence and growth of the prairie plants. Burning the prairie garden in mid-spring after the cool season weeds have grown about six inches tall (usually in mid to late April) is the best management choice for prairie gardens and meadows. Where burning is not an option, as in urban environments, the garden can be mowed to the ground in mid-spring and the cut material raked off to expose the soil to the sun.

Plant Usage Listings for the Prairie Garden

Selected Specimen Plants for the Prairie Garden

Leadplant	<i>Amorpha canescens</i> (small shrub)
Butterflyweed	<i>Asclepias tuberosa</i>
New England Aster	<i>Aster novae-angliae</i>
Blue False Indigo	<i>Baptisia australis</i>
White False Indigo	<i>Baptisia lactea</i>
Wild Senna	<i>Cassia hebecarpa</i>
New Jersey Tea	<i>Ceanothus americanus</i> (small shrub)
Rattlesnake Master	<i>Eryngium yuccifolium</i>
Tall Joe Pye Weed	<i>Eupatorium fistulosum</i>
Joe Pye Weed	<i>Eupatorium maculatum</i>
Sweet Joe Pye Weed	<i>Eupatorium purpureum</i>
Queen of the Prairie	<i>Filipendula rubra</i>
Turks Cap Lily	<i>Lilium superbum</i>
Orange Coneflower	<i>Rudbeckia fulgida</i>
Sweet Black Eyed Susan	<i>Rudbeckia subtomentosa</i>
Compassplant	<i>Silphium laciniatum</i>
Cupplant	<i>Silphium perfoliatum</i>
Prairie Dock	<i>Silphium terebinthinaceum</i>
Ohio Goldenrod	<i>Solidago ohioensis</i>
Tall Ironweed	<i>Vernonia altissima</i>
Culvers Root	<i>Veronicastrum virginicum</i>

Prairie Flowers for Massing

		<u>Root System Type</u>
Nodding Pink Onion	<i>Allium cernuum</i>	Bulb
Shootingstar	<i>Dodecatheon meadia</i>	Fibrous; goes dormant early
Purple Prairie Clover	<i>Dalea purpurea</i>	Taproot
Pale Purple Coneflower	<i>Echinacea pallida</i>	Taproot
Purple Coneflower	<i>Echinacea purpurea</i>	Fibrous
Wild Iris	<i>Iris shrevei</i>	Corm (bulb-like)
Blue Flag	<i>Iris versicolor</i>	Corm (bulb-like)
Blazingstars	<i>Liatris spp.</i>	Corm (bulb-like)
Wild Quinine	<i>Parthenium integrifolium</i>	Tap root
Penstemons	<i>Penstemon spp.</i>	Fibrous
Orange Coneflower	<i>Rudbeckia fulgida</i>	Fibrous

Stiff Goldenrod	<i>Solidago rigida</i>	Fibrous
Ohio Goldenrod	<i>Solidago ohioensis</i>	Fibrous
Spiderworts	<i>Tradescantia spp.</i>	Fibrous

Note: Always combine bulbs, corms, and taproots with short prairie grasses when massing.

Groundcover Plants: Plants That Creep by Rhizomes

Canada Anemone	<i>Anemone canadensis</i>	Forms an aggressive mat
Heath Aster	<i>Aster ericoides</i>	Creeps slowly, forms "bush"
Stiff Coreopsis	<i>Coreopsis palmata</i>	Creeps slowly to forms a mat
Wild Geranium	<i>Geranium maculatum</i>	Prefers shade; creeps slowly
Prairie Smoke	<i>Geum triflorum</i>	Dry soils: creeps slowly
False Dragonhead	<i>Physostegia virginiana</i>	Creeps slowly but inexorably

Border Edge Plants

Prairie Dropseed Grass	<i>Sporobolus heterolepis</i>
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Big Bold Plants

New England Aster	<i>Aster novae-angliae</i>
Blue False Indigo	<i>Baptisia australis</i>
White False Indigo	<i>Baptisia lactea</i>
Pale Indian Plantain	<i>Cacalia atriplicifolia</i>
Wild Senna	<i>Cassia hebecarpa</i>
Tall Coreopsis	<i>Coreopsis tripteris</i>
Tall Joe Pye Weed	<i>Eupatorium fistulosum</i>
Joe Pye Weed	<i>Eupatorium maculatum</i>
Sweet Joe Pye Weed	<i>Eupatorium purpureum</i>
Compassplant	<i>Silphium laciniatum</i>
Cupplplant	<i>Silphium perfoliatum</i>
Prairie Dock	<i>Silphium terebinthinaceum</i>

Prairie Flowers for Dry Sandy or Gravelly Soils

Leadplant	<i>Amorpha canescens</i>
Butterflyweed	<i>Asclepias tuberosa</i>
Sky Blue Aster	<i>Aster oolentangiensis</i>
Heath Aster	<i>Aster ericoides</i>
Smooth Aster	<i>Aster laevis</i>
Cream False Indigo	<i>Baptisia bracteata</i>
Poppy Mallow	<i>Callirhoe triangulata</i>
Harebell	<i>Campanula rotundifolia</i>
New Jersey Tea	<i>Ceanothus americanus</i>
Lanceleaf Coreopsis	<i>Coreopsis lanceolata</i>
Purple Prairie Clover	<i>Dalea purpurea</i>
Pale Purple Coneflower	<i>Echinacea pallida</i>
Prairie Smoke	<i>Geum triflorum</i>

Western Sunflower	<i>Helianthus occidentalis</i>
Rough Blazingstar	<i>Liatris aspera</i>
Lupine	<i>Lupinus perennis</i>
Wild Petunia	<i>Ruellia humilis</i>
Stiff Goldenrod	<i>Solidago rigida</i>
Showy Goldenrod	<i>Solidago speciosa</i>
Spiderworts	<i>Tradescantia spp.</i>

Prairie Grasses for Dry Sandy or Gravelly Soils

Side Oats Grama	<i>Bouteloua curtipendula</i>
Little Bluestem	<i>Schizachyrium scoparium</i>
Prairie Dropseed	<i>Sporobolus heterolepis</i>

Prairie Flowers for Clay Soils

Nodding Pink Onion	<i>Allium cernuum</i>
New England Aster	<i>Aster novae angliae</i>
Blue False Indigo	<i>Baptisia australis</i>
White False Indigo	<i>Baptisia lactea</i>
Wild Senna	<i>Cassia hebecarpa</i>
Shootingstar	<i>Dodecatheon meadia</i>
Pale Purple Coneflower	<i>Echinacea pallida</i>
Purple Coneflower	<i>Echinacea purpurea</i>
Rattlesnake Master	<i>Eryngium yuccifolium</i>
Prairie Blazingstar	<i>Liatris pycnostachya</i>
Wild Quinine	<i>Parthenium integrifolium</i>
Smooth Penstemon	<i>Penstemon digitalis</i>
Yellow Coneflower	<i>Ratibida pinnata</i>
Orange Coneflower	<i>Rudbeckia fulgida</i>
Sweet Black Eyed Susan	<i>Rudbeckia subtomentosa</i>
Royal Catchfly	<i>Silene regia</i>
Compass Plant	<i>Silphium laciniatum</i>
Prairie Dock	<i>Silphium terebinthinaceum</i>
Ohio Goldenrod	<i>Silphium ohioensis</i>
Stiff Goldenrod	<i>Solidago rigida</i>
Culvers Root	<i>Veronicastrum virginicum</i>

Prairie Grasses for Clay

Big Bluestem	<i>Andropogon gerardi</i> (sod-forming and aggressive by seed)
Switchgrass	<i>Panicum virgatum</i> (sod-forming and aggressive by seed)
Indiangrass	<i>Sorghastrum nutans</i> (can be aggressive by seed)

Prairie Flowers for Moist Soils

Nodding Pink Onion	<i>Allium cernuum</i>
Red Milkweed	<i>Asclepias incarnata</i>
White Turtlehead	<i>Chelone glabra</i>
Tall Joe Pye Weed	<i>Eupatorium fistulosum</i>

Joe Pye Weed	<i>Eupatorium maculatum</i>
Queen of the Prairie	<i>Filipendula rubra</i>
Bottle Gentian	<i>Gentiana andrewsii</i>
Dogtooth Daisy	<i>Helenium autumnale</i>
Wild Iris	<i>Iris shrevei</i>
Blue Flag Iris	<i>Iris versicolor</i>
Prairie Blazingstar	<i>Liatris pycnostachya</i>
Dense Blazingstar	<i>Liatris spicata</i>
Turks Cap Lily	<i>Lilium superbum</i>
Cardinal Flower	<i>Lobelia cardinalis</i>
Great Blue Lobelia	<i>Lobelia siphilitica</i>
False Dragonhead	<i>Physostegia virginiana</i>
Sweet Black Eyed Susan	<i>Rudbeckia subtomentosa</i>
Prairie Dock	<i>Silphium terebinthinaceum</i>
Cupplant	<i>Silphium perfoliatum</i>
Ohio Goldenrod	<i>Solidago ohioensis</i>
Steeplebush	<i>Spiraea tomentosa</i> (small shrub)
Tall Ironweed	<i>Vernonia altissima</i>
Ironweed	<i>Vernonia fasciculata</i>
Culvers Root	<i>Veronicastrum virginicum</i>

Prairie Grasses for Moist Soils

Vanilla Sweetgrass	<i>Hierochloe odorata</i>
Switchgrass	<i>Panicum virgatum</i> (sod-forming and aggressive by seed)
Prairie Cordgrass	<i>Spartina pectinata</i> (aggressive by rhizomes)

III. Meadow Design Principles and Prairie Seed Mixes

When designing a prairie seed mix, experience has shown that “*What you plant is what you get.*” The composition of the original seed mix will strongly determine what species are present five, ten, and twenty-five years later. Seed mix composition is the primary factor in determining the long-term structure of the prairie, both in terms of the species composition and the relative quantities of each species.

Because the composition of the initial seed mix is such a strong determinant in what the prairie will look like, all the desired species should usually be planted in the initial installation. This is the most cost-effective method, for two reasons. First, only a single installation is required rather than two or more. Secondly, the seed will have the best chance of germination and survival in the initial seeding. There will be less competition compared to seeding in later years after the plants in the first seeding have matured. Although it might seem prudent to split the costs of a prairie seeding into two phases, this typically ends up costing more and yielding poorer results in the long run.

If the goal is a prairie rich in flowers, it is best to plant seed in fall as a “dormant seeding.” Fall plantings yield higher germination rates for prairie flowers. Many flower species have seed dormancies that are broken by exposure to cold, moist conditions, such as those

experienced in the soil over-winter. Numerous studies have shown that fall-seeded prairies have a higher diversity and density of flowers, compared to spring or early summer seedings. When investing in a diversity of different flower species, it pays to schedule the planting for fall so as to maximize the results.

If the main goal of the prairie seeding is the establishment of warm season prairie grasses, and flowers are of secondary importance, seeding should take place in mid spring to early summer. The optimal time to seed most prairie grasses is when spring soil temperatures reach 75-80 degrees F., roughly the same as the spring planting date for corn (*Zea mays*). Dormant fall seedings typically exhibit decreased germination of warm season grasses the following spring. An exception is Prairie Dropseed, which does best when seeded in fall or early spring when soil temperatures are cool. Prairie Dropseed should not be seeded after mid-spring (May 15), as it typically does not germinate well after this date.

Although many prairie flowers germinate best when seeded in fall, many do fine when seeded in spring or early summer. Many species that require exposure to cool, moist conditions to break seed dormancy will remain viable in the soil over the summer and winter after a spring seeding, and then germinate the following spring.

Overseeding

A common misconception is that one can seed prairie grasses at the outset, and then overseed with flowers a few years later. Although it is true that this strategy can be employed successfully in some instances, it is rather inefficient. After three years of growth, the prairie grasses will have matured and established a thick sod. It becomes increasingly difficult for the prairie flowers to become established by scattering seed into an established prairie sod. The dense roots of the grasses that help to squeeze out weeds also prevent colonization by newly scattered prairie flowers.

If overseeding of flowers or grasses to enhance an existing planting is to be done successfully, it should be done in the first or second year after the initial seeding, before the prairie sod becomes fully developed. Overseeding in spring or fall using a no-till drill can be very effective. Broadcasting seed onto the soil in fall or winter also works well. The frost action of the soil during winter and early spring opens up small fissures in the soil into which the seed drops prior to spring germination.

Overseeding of flower seeds should be done in the autumn of the first or second growing season using a no-till drill or by broadcasting the seed. Overseeding can also be done in the spring of the second growing season using a no-till drill. Broadcasting seed onto the soil in spring is much less effective, as the seed does not have the benefit of winter frost action to work its way down into the soil.

Shortgrass prairies can be more successfully overseeded than tallgrass prairies. This is because the short prairie grasses, especially Little Bluestem and Side Oats Grama, are clump-forming, rather than sod-forming grasses. There is often sufficient space between the individual clumps for an over-seeding of flowers to become established. Tall prairie grasses such as Big Bluestem and Switchgrass –form a thick sod that lock up the soil

rooting zone and effectively keep out all but the most aggressive plants. Indiangrass is a clump-forming tall grass that does not form a tight sod, thus leaving some room between the clumps for successful over-seeding of flowers.

An effective two-stage method of seeding prairies involves planting only the prairie grasses in the spring of the first year. The planting is treated with a broadleaf herbicide in mid to late summer to kill all non-grassy weeds, leaving the prairie grasses unaffected. The prairie flowers are then over-seeding in the first fall, and will germinate the next spring with only moderate competition from the still-small one year old prairie grasses.. This is a very effective strategy for sites that have a history of serious weed problems, such as old fields, barnyards, and waste areas. It will not, however, control weedy grasses, and these are best eliminated prior to seeding.

Seed Mix Design Considerations

1) Tall, Short, and Mixed Height Prairies

The original American Tallgrass Prairie was composed of a wide variety of flowers and grasses of varying heights. Prairie plants are typically grouped into categories of tall (5-10+ feet) and short (6 inches to 5 feet). If the American Prairie of the Midwest were to be restored as it occurred two hundred years ago, it would be dominated by tall grasses and flowers. However, tall prairie plants are not acceptable in some landscape settings. To address this concern short prairie seed mixes were first developed by Prairie Nursery in the early 1980's to better fit smaller spaces and landscapes where tall plants are not desirable.

The context in which the prairie is to be planted will determine the height of the plants to be used. For instance, a tall prairie is not a good choice for a small front yard. A good choice for this situation would be low-growing grasses such as Prairie Dropseed and Little Bluestem mixed with short flowers. In a large back yard or open field a tall prairie meadow can be a good choice, perhaps in conjunction with a short prairie meadow in the foreground.

The combination of tall and short prairies yields many advantages. First, it allows for the use of a wider diversity of plant species, which will attract more variety of butterflies and other invertebrates. Secondly, the two different prairies provide different plant cover types, each of which provides nesting opportunities for specific grassland birds. Finally, the landscape interest is increased with the wider variety of flowers and grasses that are provided when these two different prairie communities are planted adjacent to one another.

A word of caution: Tall prairie species tend to invade short prairie plantings, especially on rich, silt loam and clay loam soils. When working in a limited space of a few thousand square feet, it is recommended that only a short prairie be planted. This will preserve the integrity of the short prairie, and it will not eventually become a tall prairie by incursion from its taller neighbors. If it is acceptable for the tall prairie to gradually invade the short prairie, both can be planted in close quarters. The invasion process typically occurs over a period of many years, but it is almost a certainty.

The rate of invasion of tall prairie species into short prairies can be reduced by careful placement of the two prairie types. Most prairie seeds ripen in late summer and autumn. In North America, the prevailing winds at that time of year are generally from the west and northwest. Ripe seeds are most commonly blown by the wind from the northwest to southeast. The seeds from a tall prairie located to the west and north of a short prairie will primarily blow into the short prairie to the south and east. If possible, a tall prairie meadow should be planted east and south of a short prairie meadow to reduce the rate of invasion.

Seeds are also transported by animals, and the winds do not always come from the west and north. However, attention to planting location can make a significant difference in the long-term composition of short prairie meadows that are planted adjacent to tall prairies.

One way to enjoy the diversity of both short and tall prairie plants is to seed a Diverse Prairie meadow, consisting of a wide variety of tall and short flowers and grasses. This approach maximizes biodiversity, landscape interest, and wildlife habitat opportunities.

2) Ratio of Flowers to Grasses

A crucial decision that will determine the long-term appearance of a prairie is the ratio of flower seeds to grass seeds in the mix. As noted earlier, the composition of the original seed mix is the single most important factor in determining the eventual structure and appearance of the prairie for years to come.

Most people prefer a prairie meadow with a strong complement of flowers, and more than the average of 20% flowers presently found in a typical prairie remnant. Others prefer broad sweeps of prairie grasses, with few flowers to interrupt the uniform effect of the grasses. Some people want only certain flower colors in their prairie. Prairie seed mixes can be designed to accommodate almost any design preference.

Under no circumstances should a mix of pure prairie flowers with no grasses be planted. Such a mix will not have the dense grass roots that help control weeds. When flowers are planted to the exclusion of grasses, weeds inevitably become a problem and flourish in the areas of open soil between the flowers. Although it is possible to design mixes with a high percentage of fibrous-rooted flowers that occupy much of the surface soil and are competitive with most weeds, it is extremely difficult to achieve a truly low maintenance prairie landscape without including the prairie grasses.

If the prairie is to be managed using fire, the lack of grasses will render it virtually non-flammable, further complicating management and weed control. It is the grasses that supply the fine fuels to carry a prairie fire. The flower stems do not provide sufficiently dense and readily flammable material to support a prairie burn. In the absence of grasses, it is nearly impossible to conduct a burn to control weeds and favor the prairie species..

For a flower-rich prairie, use primarily low-growing, clump-forming prairie grasses such as Side Oats Grama, Little Bluestem and Prairie Dropseed. To maximize the flower component in a tall prairie seed mix, avoid the sod-forming Big Bluestem and Switchgrass.

Two excellent grasses for seeding with medium height and taller flowers are Indiangrass and Little Bluestem. These two clump-forming grasses allow room for growth of the prairie flowers while also helping to keep weeds to a minimum. They provide a fabulous fall color display, with the crimson of the Little Bluestem complementing the gold of the Indiangrass.

3) Seeding Rates

Seeding rates can be measured in two different ways:

Pounds per Acre	(Kilograms per Hectare)
Seeds per Square Foot	(Seeds per Square Meter)

Most prairie seed mixes are applied at a rate of 5 to 15 PLS pounds per acre, depending upon the components of the mix and the intended goal of the planting. Most of Prairie Nursery's prairie seed mixes contain 10 PLS pounds per acre, consisting of 6 PLS pounds of prairie grass and 4 PLS pounds of prairie flowers. This ratio of grasses to flowers has been shown over a period of 25 years to consistently yield prairie meadows with a good balance of these two components.

The most accurate way to determine seeding rates is to use the Seeds per Square Foot method. This indicates exactly how many seeds are being planted of each species per amount of area, and is an accurate way to measure the relative quantities of each species in the mix. The total weight of seed per acre (or per 1000 square feet) serves as a general guide when designing prairie seed mixes. However, the seeds per square foot method provides a true measure of the actual number of seeds being planted per area for each species, and as a percentage of the total mix.

Many of the major prairie grasses have surprisingly similar seed sizes, usually around 8,000 seeds per ounce. Flower seeds, on the other hand, tend to vary widely. For instance, there are approximately 650 seeds per ounce of Compassplant (*Silphium laciniatum*). In comparison, one ounce of Culver's Root (*Veronicastrum virginicum*) contains over 750,000 seeds. Thus, Culver's Root contains 18,000 times as many seeds per ounce as does Compassplant.

Some General Rules of Thumb for Designing Prairie Seed Mixes

- 1) A prairie seed mix should contain a minimum of 40 seeds per square foot of perennial prairie species (excluding biennials such as Black Eyed Susan). Rates of 50 to 80 seeds per square meter are even better, and will typically provide excellent results.
- 2) Grasses should not exceed 20 seeds per square foot if a strong component of flowers is desired. When seeding tall prairie grasses, rates as low as 10 to 15 seeds per square foot will yield a better floral display.
- 3) Subtract out the seeding rates for any annuals or biennials (such as Partridge Pea (*Cassia fasciculata*), Dotted Mint (*Monarda punctata*), Black Eyed Susan, and Brown Eyed Susan) from the total seed mix to determine the "Perennial Seeding Rate." It is the perennial plants in the mix that will determine the long-term structure of prairie

plant community. Annuals and biennials will fade out after the first few years, and will not be long-term members of the mature prairie plant community.

- 4) For a good display of flowers, at least 50% of the total seeding rate should be composed of perennial flowers, with 25 to 50 seeds of perennial flowers per square foot.
- 5) The biennial, Black Eyed Susan, can be planted at a rate of 4-10 seeds per square foot (1.5 to 4 ounces per acre) to create a floral display in the second year while the slower-growing perennial flowers and grasses are still developing.
- 6) Smaller-seeded species tend to “get lost in the shuffle” and need to be seeded at significantly higher rates per square foot than larger seeded species. Species containing more than 50,000 seeds per ounce should be seeded at two to three times the rate of larger seeded species (500 to 50,000 seeds per ounce) to account for this effect. Species that contain more than 200,000 seeds per ounce can be seeded at three to five times the rate as for larger seeds in terms of seeds per square foot.
- 7) Seeding rates should be increased for species that are to be more prominent in the planting. For instance, certain showy plants such as the Blazingstars (*Liatris spp.*), Pale Purple Coneflowers (*Echinacea pallida.*), Purple Prairie Clovers (*Dalea purpurea.*), Asters (*Aster spp.*), Spiderworts (*Tradescantia spp.*), Butterflyweed (*Asclepias tuberosa*), and Shootingstar (*Dodecatheon meadia*) can be safely seeded at high rates without jeopardizing the development of other species in the planting.
- 8) With the exception of extremely small-seed species, no single flower should be seeded at a rate of more than 5 seeds per square foot in a diverse prairie mix that contains at least a dozen flowers. Most flowers should be seeded at a rate of 0.50 to 3 seeds per square foot in a mix that contains 12 to 40 different flower species.

Exceptions to this rule include aggressive plants that spread rapidly by seed or by rhizomes, such as Ox Eye Sunflower (*Heliopsis helianthoides*), Common Milkweed (*Asclepias syriaca*), and the genus *Helianthus*. These species should be seeded at very low rates, between 0.10 to 0.25 seeds per square foot.

Large specimen plants that provide a lot of show per plant, such as members of the genera *Baptisia* and *Silphium* should also be seeded at lower rates of 0.25 to 0.50 seeds per square foot. Another approach is to spot-seed patches or drifts of specimen plants in designated areas to create the desired effect.

- 9) When seeding solid stands of prairie grasses, use a rate of 25 to 50 seeds per square foot. Some recommended seeding rates for solid stands of grasses are listed below:

<u>Tall Prairie Grasses</u>	<u>Seed Weight per Acre</u>	<u>Seeds per Square Foot</u>
<i>Andropogon gerardi</i>	10 PLS lbs. per acre	30 seeds per square foot
<i>Panicum virgatum</i>	5 PLS lbs. per acre	33 seeds per square foot
<i>Sorghastrum nutans</i>	10 PLS lbs. per acre	30 seeds per square foot

Short Prairie Grasses

<i>Bouteloua curtipendula</i>	10 PLS lbs. per are	29 seeds per square foot
<i>Schizachyrium scoparium</i>	10 PLS lbs. per acre	32 seeds per square foot
<i>Sporobolus heterolepis</i>	10 PLS lbs. per acre	51 seeds per square foot

10) Certain aggressive species should be planted at rates that should never be exceeded. If planted at too high a rate, these plants may be “too successful,” and out-compete other desirable species. It is critical that the proper balance between species be maintained. Maximum seeding rates for selected aggressive species are listed below. These rates apply to seed mixes that are designed to be balanced between a wide variety of species, with no individual species dominant over the others.

<u>Grasses</u>	<u>Latin Name</u>	<u>Wt. per Acre</u>	<u>Seeds/Sq. Foot</u>
Big Bluestem	<i>Andropogon gerardi</i>	1.0 PLS lb./acre	3 seeds/sq. ft.
Switchgrass	<i>Panicum virgatum</i>	0.5 PLS lb./acre	3 seeds/sq. ft.

<u>Flowers</u>	<u>Latin Name</u>	<u>Wt. per Acre</u>	<u>Seeds/Sq. Foot</u>
Lavender Hyssop	<i>Agastache foeniculum</i>	2.0 PLS oz./acre	3 seeds/sq. ft.
Common Milkweed	<i>Asclepias syriaca</i>	5.0 PLS oz./acre	0.50 seed/sq. ft.
Frost Aster	<i>Aster pilosus</i>	0.5 PLS oz./acre	2 seeds/ sq. ft.
Lanceleaf Coreopsis	<i>Coreopsis lanceolata</i>	3.5 PLS oz./acre	1 seed/sq. ft.
Purple Coneflower	<i>Echinacea purpurea</i>	6.5 PLS oz./ acre	1 seed/sq. ft.
Showy Sunflower	<i>Helianthus laetiflorus</i>	2.0 PLS oz./acre	0.20 seed/sq. ft.
Downy Sunflower	<i>Helianthus mollis</i>	1.5 PLS oz./acre	0.25 seed/sq. ft.
Bergamot	<i>Monarda fistulosa</i>	1.0 PLS oz./ acre	2 seeds/sq. ft.
Yellow Coneflower	<i>Ratibida pinnata</i>	4.0 PLS oz./ acre	2.5 seed/sq. ft.
Black Eyed Susan	<i>Rudbeckia hirta</i>	4.0 PLS oz./ acre	9 seeds/sq. ft.
Sweet Bl. Eyed Susan	<i>Rudbeckia subtomentosa</i>	2.0.PLS oz./ acre	2 seeds/sq. ft.
Brown Eyed Susan	<i>Rudbeckia triloba</i>	4.0 PLS oz./ acre	3 seeds/sq. ft.

General Relationship Between Pounds per Acre and Seeds per Square Foot

As noted previously, most prairie seed mixes are seeded at rates between 5 and 15 PLS pounds per acre. The prairie grasses will typically be seeded at a rate of 4 to 10 PLS lbs. per acre, and the flowers at a rate of 1 to 5 PLS lbs. per acre. These seeding rates typically translate into grass seeding rates of 15 to 30 seeds per square foot, and flower seeding rates of 20 to 100 seeds per square foot or more, depending upon the exact seeding rate and species composition.

Seed Costs and Techniques to Stretch Your Budget

Most species of prairie grass seed are much cheaper than most prairie flower seeds. The cost to produce seed of most prairie grasses is significantly lower than the cost to produce most flower seeds. In situations where the seed budget is an issue, the ratio of flowers to grasses can be reduced. A similar amount of area will be covered, albeit it with fewer flowers and more grasses. As the flower seeding rate is reduced, the grass seeding rate is increased, in order to ensure proper coverage. The final total weight of the seed mix may decrease slightly, but not significantly.

Another technique is to calculate the “Seeds per Dollar” for each species. Just as there is a wide range in the number of seeds per ounce for individual species, there can also be a big difference in the number of “Seeds per Dollar.” The prairie seed budget can be stretched by selecting those species that provide the most seeds per dollar, as calculated below for some popular species:

Flowers

<u>Common Name</u>	<u>Latin Name</u>	<u>Cost/Ounce</u>	<u>Seeds/Ounce</u>	<u>Seeds/ Dollar</u>
Butterflyweed	<i>Asclepias tuberosa</i>	\$ 25.00	3,500	140
New England Aster	<i>Aster novae-angliae</i>	\$ 30.00	70,000	2333
White False Indigo	<i>Baptisia lactea</i>	\$ 8.00	1,600	200
Purple Prairie Clover	<i>Dalea purpurea</i>	\$ 5.00	20,000	4000
Shootingstar	<i>Dodecatheon meadia</i>	\$100.00	75,000	750
Pale Purple Coneflwr.	<i>Echinacea pallida</i>	\$ 12.00	5,000	417
Purple Coneflower	<i>Echinacea pallida</i>	\$ 5.00	6,600	1320
Prairie Blazingstar	<i>Liatris pycnostachya</i>	\$ 20.00	12,000	600
Lupine	<i>Lupinus perennis</i>	\$ 20.00	1,000	50
Bergamot	<i>Monarda fistulosa</i>	\$ 15.00	78,000	5200
Smooth Penstemon	<i>Penstemon digitalis</i>	\$ 10.00	100,000	10,000
Yellow Coneflower	<i>Ratibida pinnata</i>	\$ 5.00	27,000	5400
Black Eyed Susan	<i>Rudbeckia hirta</i>	\$ 5.00	100,000	20,000
Compassplant	<i>Silphium laciniatum</i>	\$ 20.00	650	33
Stiff Goldenrod	<i>Solidago rigida</i>	\$ 15.00	46,000	3067
Showy Goldenrod	<i>Solidago speciosa</i>	\$ 25.00	105,000	4200
Culvers Root	<i>Veronicastrum virginicum</i>	\$ 40.00	750,000	18,750

Grasses

<u>Common Name</u>	<u>Latin Name</u>	<u>Cost/Ounce</u>	<u>Seeds/Ounce</u>	<u>Seeds/ Dollar</u>
Big Bluestem	<i>Andropogon gerardii</i>	\$ 3.50	8,200	2343
Side Oats Grama	<i>Bouteloua curtipendula</i>	\$ 4.00	8,000	2000
Canada Wild Rye	<i>Elymus canadensis</i>	\$ 3.00	4,200	1400
Switchgrass	<i>Panicum virgatum</i>	\$ 3.00	18,000	6000
Little Bluestem	<i>Schizachyrium scoparium</i>	\$ 4.00	8,800	2200
Indiangrass	<i>Sorghastrum nutans</i>	\$ 3.00	8,300	2777
Prairie Dropseed	<i>Sporobolus heterolepis</i>	\$25.00	14,000	560

CAUTION: Do not select *only* those species that offer the most seeds per dollar. You may create an unbalanced mix that will not function properly. Be sure to include plenty of long-lived perennial flowers and grasses to ensure long-term success.

High and Low Visibility Areas

To stretch the seed budget and still attain the desired results in larger prairie planting, the site can be divided into “High Visibility” and “Low Visibility” areas. A more costly diverse prairie mix can be planted in the High Visibility areas. A second “budget mix” that contains fewer of the more costly flower seeds and more grasses can be planted in the Low

Visibility areas. Mixes such as Prairie Nursery's Land Restoration Mix are an excellent value for creating an attractive "budget prairie" in background areas. These mixes contain 25% less flower seed and 25% more grass seed than the standard prairie mixes (3 PLS pounds flower seed per acre versus 4 PLS pounds flower seed per acre in standard mixes). A few of the more expensive seeds have also been reduced or eliminated, but these mixes provide reasonable diversity and good color throughout the growing season.

Using the Prairie Meadow

Paths can be designed into the prairie meadow to provide access to enjoy the flowers and grasses. Pathways should be part of the original design. An effective technique is to seed the paths to a slow-growing turf grass, such as Prairie Nursery's "No Mow" Lawn Mix. Composed of fine fescue grasses (*Festuca rubra* and *Festuca ovina*), it makes an excellent walking path on loose, well-drained soils, and require only occasional mowing. It is not recommended for clay soils or low, wet areas. A standard Kentucky Bluegrass and Perennial Ryegrass turf mix is a good choice for heavy clay soils and moist areas.

Another effective design concept is to create "meadow islands" of a few hundred or thousand square feet within a lawn. This provides ready access to the meadow. Another option is to create a twenty to thirty foot wide "River of Prairie" that extends for a distance through a large lawn.

Beware of planting thin, narrow strips of prairie, as they are readily invaded from the edges by unwanted grasses and weeds. Prairie meadows function best when seeded in large areas, with a minimum of external perimeter per internal area (such as a circle or large teardrop shape). To minimize the opportunity for unwanted plants to creep into the prairie from the edges, it is best to plant meadows in large open areas, rather than in long, narrow spaces.

IV. Conclusion

The American Prairie is a dynamic, yet stable ecosystem that serves as an excellent natural model for creating attractive, ecologically sustainable urban landscapes. By selecting the species that are best adapted to your soil and growing conditions, and combining the plants or seeds in the proper proportions, a variety of different landscape effects can be created.

With careful attention to design, establishment, and management, these adaptable plants can be used to one can create beautiful low maintenance prairie gardens and meadows that create an abundance of habitat for birds, butterflies, and other wildlife. Coupled with their minimal requirements for irrigation, pesticides, and maintenance, prairies are a low maintenance and cost effective way to enhances the our living spaces while saving money and valuable resources.