Arboretum Leaflets
Restoration Discovery Research
LEAFLET 16
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Curtis Prairie: 75-year-old restoration research site

Curtis Prairie is the world's oldest ecologically-restored prairie—an effort that returned a horse pasture to native vegetation while setting the stage for Restoration Ecology to emerge as both a science and a practice. The eastern third of the prairie had apparently been too wet to plow, but the western two-thirds of the prairie were cultivated beginning in 1836, then allowed to go fallow from about 1920 – 27, and later used to pasture horses. In 1933, the University of Wisconsin bought the land for research and education (Blewett and Cottam 1984).

It was Norman Fassett, a member of the first Arboretum Committee, who proposed that a prairie be restored, and he engaged his student, John Thomson, to begin experimenting with methods to accomplish this (Blewett and Cottam 1984). From the beginning, Curtis Prairie was a key research site. Fassett and Thomson compared methods of establishing native plants by removing surface soil, plowing, seeding, transplanting sod, and mulching with prairie hay to replace the bluegrass-dominated pasture. Sod transplantation was judged most effective, but Curtis recommended seeding as a more cost-effective approach (ibid.). Experimentation with more prairie species expanded from 1935–1941, when Theodore Sperry led ~200 men from the Civilian Conservation Corps in adding 42 species in single-species blocks and comparing seeds, seedlings and blocks of sod under the technical direction of Aldo Leopold and William Longenecker (Blewett and Cottam 1984). According to Cottam and Wilson (1966), "the initial result was a mosaic of single species in a field of bluegrass." Introductions resumed in 1950, when Grant Cottam and David Archbald used mixtures of seeds of 154 species and varying planting methods, including burning before seeding, discing after seeding, and mulching with prairie hay (ibid.; Blewett and Cottam 1984). These were complemented by fire experiments to test how prescribed burning might favor native species over weeds and herbaceous plants over woody species (Curtis and Partch 1948, 1950; Blewett and Cottam 1984).

John Curtis's research interest in the prairie dates to 1934, when he was a new graduate student at UW (Blewett and Cottam 1984). Later, as a faculty member and advisor to the Arboretum, he wrote a master plan for the prairie and directed much of the early research. One important decision Curtis made was to monitor the progress of the restoration, and he supervised the first three vegetation surveys in 1946, 1951 and 1956 (Cottam and Wilson 1966). In related work, Greene and Curtis (1950) tested seeds of 91 prairie species and found that scarification and stratification both increased germination rates. At 30 years of age, the prairie resembled native prairie remnants except for the "large quantity of non-prairie species" including both weeds and native plants (ibid.). With such a strong scientific legacy, it was fitting that the prairie was posthumously named for a scientist, J. T. Curtis, in 1962 (Sachse 1974). A 1985–86 restoration expanded the prairie northward, for a total of 29 ha (71 acres). Of this area, about 3.4 ha (8.3 acres) appear to be unplowed (but not undisturbed), based on early aerial photos (data of Wegener, unpubl).

As the Arboretum approaches its 75th birthday, it is time to celebrate what many decades of restoration research have achieved. Here, we highlight results of recent ecological studies and outline plans for future restoration research.

Long-term assessment of restoration progress

In 1966, Cottam and Wilson wrote, "Apparently it is easier to introduce the prairie species than to remove the non-prairie species" and "there is no indication that anything short of hand-weeding will eliminate the non-prairie species in the immediate future." Curtis Prairie is still species-rich, yet threatened by weed and non-prairie native species, as shown by continued vegetation sampling.

While not visible except for metal stakes that are obvious after fire, Curtis Prairie's "grid" has over over a thousand points at 16.8-m (50-ft) intervals. Using a global positioning system (GPS), researchers can re-sample and track what grows where. Before GPS technology, sample-point relocation was less precise, but sampling has been consistent in using one-square-meter plots. Data from 1951, 1961, 1966, 1971, 1976, 1991 and 2002 are thus comparable over time. Paul and Joy Zedler collected the 1966 data while in graduate school, never anticipating a return to guide resampling in 2002 and 2008. Under Paul's supervision, Ted Snyder spent the summer of 2002 recording plant species in most of Curtis Prairie, and he added the recently-restored area in 2003 for a total of 1,011 plots. The Arboretum gained a much-needed update of our oldest restoration project, and Ted gained an MS degree in Land Resources.

The 2002 resample of Curtis Prairie (Snyder 2004) yielded key indicators of how well native prairie vegetation has been restored. We learned that:

- Curtis prairie had 265 species in total, of which 230 were native.
- The species that occurred most frequently were *Poa pratensis* (in 78.2% of the plots), *Solidago canadensis* (69.2%), *Andropogon gerardii* (61.6%), *Monarda fistulosa* (56.9%), and *Cornus racemosa* (52.8%).
- On average, a square-meter plot supported ~11 native species and ~2 nonnative species.
- The most species-rich plot supported 34 native species.
- Some plots had no native species.
- Eleven species had increased in frequency since 1951, including native prairie plants. Two of these were native invasives, *C. racemosa* and *S. canadensis,* and two were exotic invasives, *Euphorbia esula,* and *Phalaris arundinacea* (probably not the native strain) (Figure 1).
- Five species decreased in frequency since 1951 (Figure 2).
- Native species richness and exotic species richness were weakly correlated ($r = 0.15$, $p < 0.01$).

Is Curtis Prairie uniformly rich in species?

Maps compiled by Mark Wegener, Arboretum Database Administrator, show that diversity varies spatially (Figure 3) even though the shape of the species sequence curve (Figure 4) indicates a highly diverse plant community overall. Wegener's spatial analysis of richness shows that:

- The largest concentration of species-rich plots is in the unplowed prairie.
- Areas with low species richness are wetland dominated by *Carex stricta* (tussock sedge), even though this species does not limit diversity (Peach and Zedler 2006, Frieswyk et al. 2008). Other low-diversity areas are dominated by *P. arundinacea* (reed canary grass) or woody plants *(Cornus racemosa, Salix interior).*

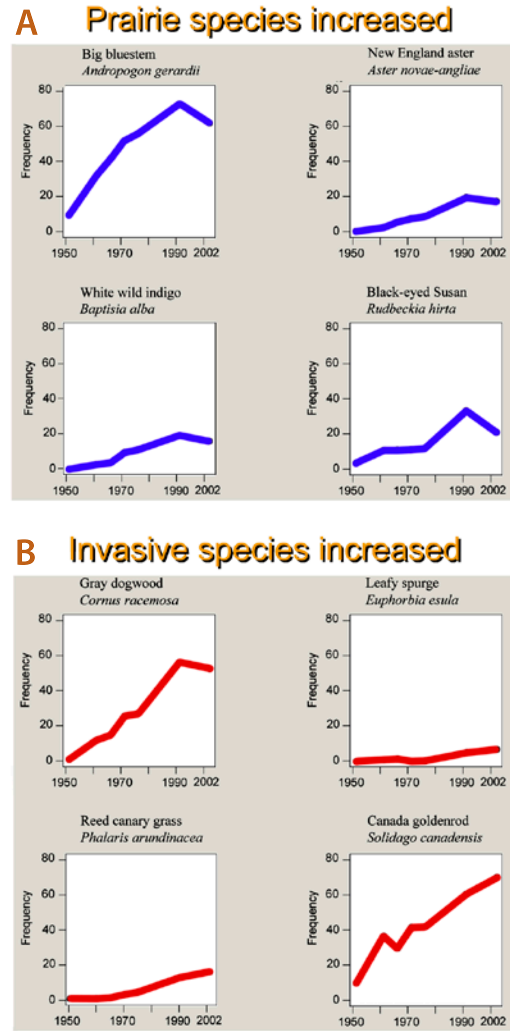

Figure 1. Species that increased in historical censuses of Curtis Prairie. Graphs of Ted Snyder, used with permission.

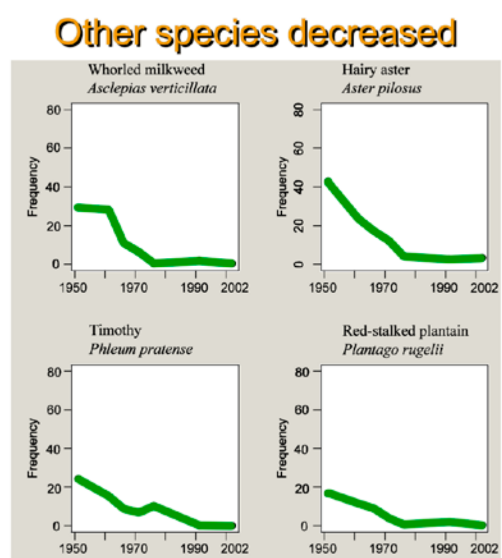

Figure 2. Species that decreased. Graphs of Ted Snyder, used with permission.

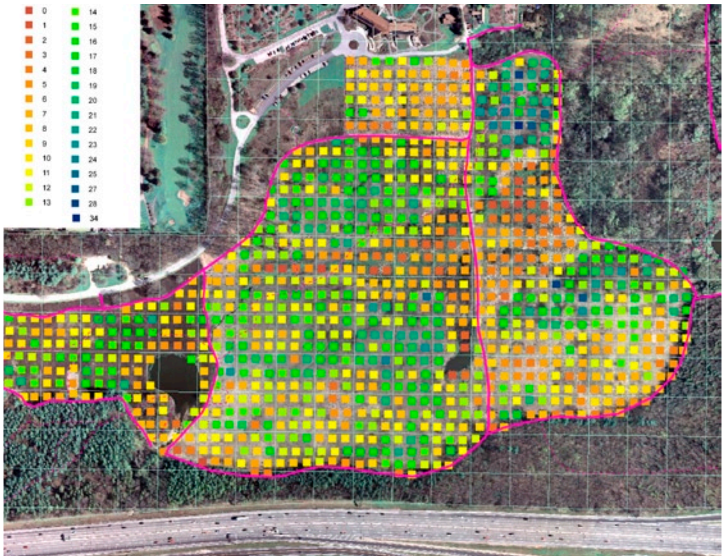

Figure 3. Number of species per m^2 plot (2002–3 census data, mapped by M. Wegener).

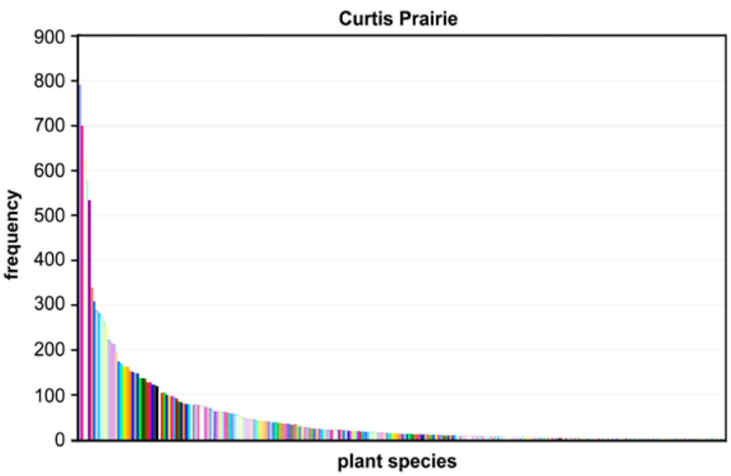

Figure 4. The array of species from most to least frequent in the 2002–3 census.

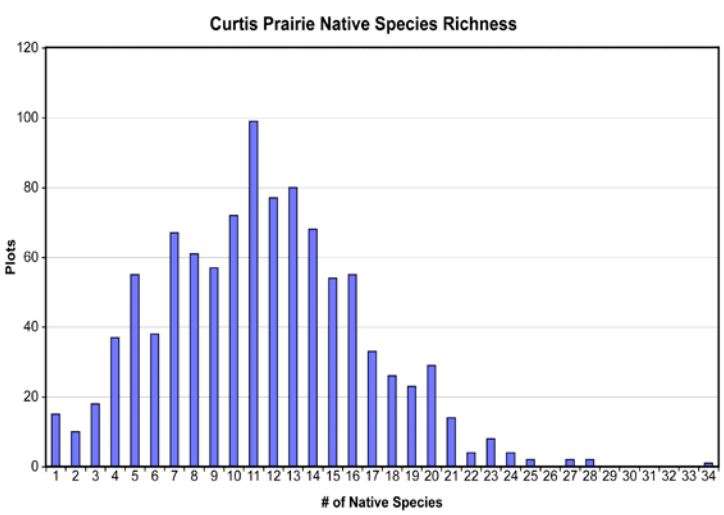

Figure 5. The number of m^2 plots that had 1, 2, 3…34 species in the 2002–3 census.

A histogram of plots with low to high richness of native species (Figure 5) shows that only 135 plots had 5 or fewer species, while 839 plots had 6 to 20 species, and just 37 plots had more than 20 species, with the richest plot having 34 native species (Snyder data summarized by Wegener).

Is Curtis Prairie "restored"?

The term "restored" implies that efforts are complete, but restoration is rarely finished. The increasing abundances of exotic and woody plants (Figure 1) and the paucity of native animals suggests that there is much yet to be done. At the same time, there is much to celebrate:

- Burning continues the restoration process, under the guidance of Steve Glass, Mike Hansen and the Field Crew.
- Diversity is high overall.
- Curtis Prairie continues to serve as a model for restoration in the region.
- Research has helped advance science on carbon storage (Kucharik et al. 2006) and stormwater effects on soils (Stiles et al. 2008).

Does Curtis Prairie match natural prairies in species richness?

Comparisons are difficult to make, because we have so few remnants with comparable soil and topographic conditions, and few data to describe them. The unplowed part of Curtis Prairie (~4.9 ha; 12.1 acres) was sampled with 174 plots, which had above-average diversity in 2002.

Faville Prairie, in Jefferson County along the Crawfish River, is the Arboretum's largest prairie remnant. In 1962, Max Partch reported results from sampling ~16.2 ha (40 ac) using 180 4-m^2 plots that were ~33 m (100 ft) apart. He listed 86 species that occurred in 5 or more plots but did not say how many species were rare. The June 2008 flood threatened many of those species, and we have yet to determine which were tolerant of days of inundation by the overflowing Crawfish River—likely the first time ever that this prairie experienced prolonged inundation. In the late 1980s, Leach and Givnish (1996) looked for 266 prairie species in 54 remnant prairies (sites of 6 ha or less), but found only 228. Small remnants tend to lose short-statured, small-seeded and nitrogen-fixing species, in part because such prairies are not burned as they were historically.

Persistent restoration issues

- Shrubs are increasingly widespread and dominant (Snyder 2004, McCaw 2002).
- Cover of exotics is positively related to the cover of *C. racemosa,* and the floristic quality and richness of native prairie species is negatively correlated. This suggests that increasing cover of shrubs can negatively affect species diversity (McCaw 2002).
- Stormwater inflows (estimated at 64,141 cubic meters or 52 acre-feet per year) contaminate the soil and cause dominance by *P. arundinacea* in central Curtis Prairie (Stiles et al. 2008).

- Exotic forbs are not yet fully controlled. One weed that increased in frequency of occurrence *(E. escula)* thrives on the berm of the stormwater basin and is in patches along the edge of the southern firelane.
- Control fires cannot always be as hot as nature fires were historically, due to safety concerns.
- Tall pines on the southern boundary shade a significant area of the prairie.
- The attempt to establish a dry prairie by importing limestone gravel and drought-tolerant species did not achieve its target. Deep, rich soil favored dominance by tall grasses.
- At 70+ years of age, Curtis Prairie is still in need of restoration and restoration research.

Continuing restoration and research in Curtis Prairie

- The Arboretum's Adaptive Restoration Task Force links land care and research by designing restoration as experiments, testing alternative treatments, and implementing the approaches that work best. The Task Force includes Steve Glass (Land Care Manager), Michael Hansen (Restorationist), students, authors of this leaflet, and Kevin McSweeney (Arboretum Director).
- Juli Speck (MS thesis in progress) is comparing shrub regrowth with various burning times. Her preliminary results indicate that small fires cannot control shrubs. However, observations in the paths between her experimental plots suggested that shrubs could be reduced by mowing .
- We began a pilot test of shrub cutting (in addition to the burning regime) in May 2008 by cutting four 3x3-m plots cut at the base. The aim is to deplete belowground reserves of *Cornus racemosa* with repeated cutting. This pilot study will suggest if cutting can reduce resprouting beyond the effect of fire and if 3x3-m plots are large enough to prevent rhizome subsidies from neighboring shrubs. If results are promising, a more ambitious experiment will be developed for 2009.
- We are testing the prediction that diversity and ecosystem functioning are positively correlated in prairie restorations. To do so, we engaged Jim Doherty (MS thesis in progress) to sample species richness and aboveground net primary productivity in 60 plots. It is likely that theory developed in controlled experiments with random assemblages of species simply does not apply to restoration sites where variations in diversity are not random.
- Stormwater management plans call for diverting inflows around Curtis Prairie. By moving the retention pond closer to the beltline, there might be opportunity to turn the existing pond into a covered infiltration system (with rock and gravel fill) so that the surface could be covered with soil. If the soil layer were thin, the site would support experimentation to establish a dry prairie.
- Long-term monitoring protocols are being designed by Brad Herrick and Mark Wegener so that citizen scientists can help the Arboretum track changes in both Curtis and Greene Prairies. Some of the plots sampled by Doherty will be selected for annual assessment. The aim is to locate representative plots that are easily accessible.

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This leaflet was compiled by Mark Wegener, Paul Zedler, Brad Herrick and Joy Zedler. Layout by Kandis Elliot. This and other leaflets can be found at:

www.botany.wisc.edu/zedler/leaflets.html

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