A Preliminary Report on the Establishment and Implementation of a Long-Term Inventory and Vegetation Monitoring Regime in the Litzsinger Road Ecology Center Prairie Habitat

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INTRODUCTION

Tallgrass prairie habitat is one of the most endangered ecosystems in North America (Samson and Knopf, 1996). Once covering 60 million hectares and ranging from southern Texas to southern Manitoba, only about 4% of presettlement tallgrass prairie habitat remains, being distributed in scattered fragments throughout its former range (Steinauer and Collins, 1996). Therefore, prairie habitats are obviously of great conservation concern and have been the focus of much study, with a considerable amount of this research focusing on monitoring and evaluating the ecological status of both relictual and restored prairies (e.g., Foster and Kettle, 1999; Smith et al., 1998). Having a repeatable monitoring regime and baseline data on the vegetation occurring within relictual and restored prairies is crucial to these monitoring and evaluation efforts.

Litzsinger Road Ecology Center (LREC) contains approximately 10 acres of restored tallgrass prairie habitat. In his ecological survey of LREC, Ochs (1993) classified this prairie habitat (sensu Nelson 1987) as mesic prairie. The prairies were first established in 1989 by sowing seed and by planting seedlings, and supplemental plantings have occurred periodically to the present time. Also during the time period since their restoration, the prairies have been subjected to various management practices including mowing and annual spring or fall burning.

The prairies at the Litzsinger Road Ecology Center are part of the extant prairie habitat and thus are important to the conservation and preservation of this once widespread ecosystem. On a more local scale, Ochs (1993) noted that the prairie habitat contained the most ecologically specialized plant species at LREC. Furthermore, these prairies serve as a natural classroom for St. Louis area students to learn about the natural world and about prairies in particular. Despite the global and local ecological importance of prairie habitat and despite the effort devoted to the establishment of the prairie habitat at LREC, no objective, long-term monitoring program has been implemented since their formation. The goal of this project is to implement a long-term vegetation monitoring program for the LREC Prairie in order to gauge the success of the restoration and to track the effect of different management practices on the Prairie over time. Our specific goals were to:

1) Develop an objective vegetation sampling and monitoring protocol (referred to as *Vegetation Monitoring*) for use in the LREC Prairie. The methods of the protocol should be repeatable for future surveys and the results should be comparable to other surveys conducted in similar habitats.

2) Use said protocol to implement a vegetation monitoring program at the LREC Tallgrass Prairie during the 2001 growing season.

3) Thoroughly inventory the Prairie throughout the 2001 growing season to compile a complete list of the species growing in the prairies (referred to as *Inventory*).

4) Use GPS technologies to obtain the coordinates for the Prairie boundaries and to obtain the coordinates for the 15-meter grid-intercept points previously established within the prairies; and, provide GIS coverage for the Prairie boundaries and pins that incorporate the vegetation data for each quadrat.

In this report we present the results of an inventory conducted during the growing season of 2001. We also present the results of our efforts to establish and initiate a long-

term vegetation monitoring regime of the LREC prairie habitat using a systematic sampling design with permanent 0.25 m^2 sampling quadrats.

METHODOLOGY

The tallgrass prairie habitat at LREC is divided into northern and southern areas by a (roughly) east-west band of mowed grass and trees. Because these areas are spatially separate and managed differently, we treat the prairie habitat at LREC as two entities referred to hereafter as the "North Prairie" and the "South Prairie." The Inventory was conducted in the North and South Prairies during 2001. Sampling was restricted to the North Prairie for the Vegetation Monitoring because of difficulty in placing the permanent quadrat frames in the South Prairie.

Inventory

We documented the vascular plant species occurring within the prairies by conducting several random walk-through surveys. The North Prairie was searched for new species approximately every two weeks between April 15 and August 26, 2001. The South Prairie was only sampled sporadically during this period. All species observed were recorded to compile a comprehensive list of observed taxa in both prairies.

Vegetation Monitoring

To monitor changes in vegetation, a systematic sampling design was implemented by establishing permanent 0.25 m^2 sampling quadrats. These quadrats were placed systematically throughout both prairies. The LREC permanent grid system, which has pins placed in 15-meter intervals along roughly East/West and North/South transects, was used as a basis for placing the quadrats. Steel quadrat frames were placed to the southwest of each grid pin using a compass, so that the frame edges are aligned with the cardinal directions (and gridlines) and the corner of the frame was placed in contact with the pin. A numbered metal tag was placed at each grid pin to indicate the identification of the quadrat. For example, quadrat O27 corresponds to the quadrat at the intersection of Row 27 and Column O. A quadrat frame was placed at 68 grid pins in the North Prairie. The adequacy of this number of quadrats was determined by conversations with Doug Ladd and by plotting the cumulative number of species found against the number of sampled quadrats. These data are presented in Figure 1.

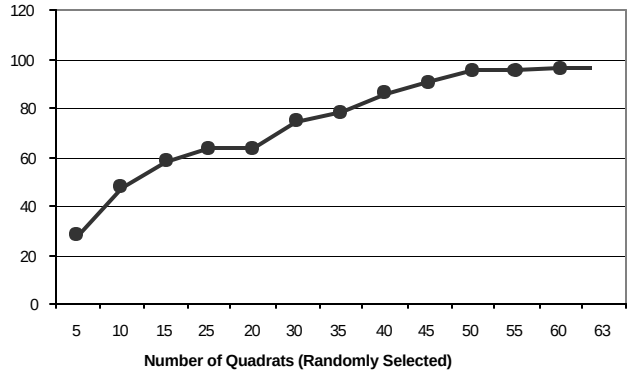

Figure 1. Number of species detected versus number of randomly selected quadrats

Sampling was conducted once per month during the latter portion of June, July, and August. All vascular plant species that were rooted within each quadrat were recorded for each month. Percent aerial coverage of each species was estimated separately, as if it were the only species present in the quadrat. The percent coverage was estimated as the complete horizontal extent of coverage within the quadrat, regardless of height of the plants. Percent coverage was divided into classes of percent coverage (see Table 1) as developed in part by Doug Ladd (e.g., Ladd and Heumann, 1995; but see Braun-Blanquet, 1965).

Table 1. Cover estimation classes used in this study.

Cover estimation class	Description
1	<1% cover, and not commonly distributed in all quadrants of the quadrat
2	1 - <5% cover, or, for small plants with less than 1% cover, numerous individuals present in each quadrant of the quadrat
3	5 - <25% cover, or, for species with less than 5% cover, pervasive throughout the quadrat, forming the most frequent plant species in all quadrants of the quadrat, and generally present in any given square decimeter
4	25 – 50% cover
5	>50% cover

Specimens that were unidentifiable in the field to the researchers were collected from outside of the quadrats, pressed, and dried for later identification. To identify the specimens we used Steyermark's Flora of Missouri Volume I (Yatskievych, 1999) for monocotyledons and Flora of Missouri (Steyermark, 1981) for dicotyledons. Specimens were compared to herbarium specimens at Missouri Botanical Garden herbarium for further verification. Nomenclature follows Yatskievych and Turner (1990) and authors for all taxa can be found there.

Floristic Quality Assessment

We used the floristic quality index (FQI) of Swink and Wilhelm (1994) as a measure to assess the current condition of the prairie flora and its restoration potential. By comparing our values to those of other projects employing the FQI (e.g., Ladd and Heumann 1995) and to values obtained from future surveys of LREC, we can obtain a dispassionate, repeatable gauge of the structure and composition of the LREC prairies. The FQI is calculated as the product of the mean of coefficient of conservatism (*CofC*) values for a given area and the square root of the number of native taxa (*NT*) within the area.

$$\overline{CofC} \times \sqrt{NT}$$

The C of C value, ranging from 0 to 10, represents the degree to which a species, in Missouri, is either able to opportunistically occupy a variety of habitats (i.e., native weeds) or displays a high level of fidelity for particular habitats in pre-settlement condition. Non-native taxa have no C of C value, since they were not represented in pre-settlement habitats. For a more complete explanation of the C of C and FQI as it has been used in Missouri prairies, see Ladd and Heumann (1995).

Geographic Information Systems

Using an Ashtech Reliance "submeter" GPS unit provided by LREC, the boundary of the Prairies and the location of each grid intercept point were recorded. The coordinates for the boundaries of the prairie were obtained by slowly walking the border of each prairie while recording our position every 30 seconds. For the grid intercept points, readings were taken every 30 seconds. All resulting coordinates were corrected ("post-processed") using data from the USGS Geoditic Survey (see http://www.ngs.noaa.gov/CORS/Data.html) and were incorporated into an ArcView GIS project for later display and analysis. The attribute tables for each grid-intercept point coverage include the survey data for its associated quadrat.

RESULTS

Inventory

In our inventory of the vascular flora of the LREC North Prairie, we recorded 167 taxa, 145 of which are native to Missouri. A list of these species is provided in Appendix A. For each observed taxon, the scientific and common names, family, Coefficient of Conservatism (C of C) value, Wetland Indicator value (WI), and a five- to seven-letter acronym are listed. Twenty-one species were exotic (listed in all capital letters) and have no C of C value; these are given an asterisk (*) in the 'C of C' column. Species not previously documented for the prairie are indicated in the list by two asterisks (**). An explanation of the Wetland Indicator Status is given in Appendix B. Species and family-level taxonomy follows that of Yatskievych and Turner (1990) and authorities for names are provided there. The acronym was assigned to each species following documentation used by the Nature Conservancy and is used in lieu of the scientific name in some subsequent appendices. There were 43 species recorded in previous inventories but not found during our survey. These are listed in Appendix C. Taxa in this list with an asterisk (*) may have been seen during our survey; however, we were unable to determine these specimens unequivocally.

Vegetation Monitoring

For the Vegetation Monitoring portion of the project, a total of sixty-three quadrats were surveyed in June and sixty-eight in July and August. A map of the North Prairie showing the locations of the 15 meter grid-intercept points where each quadrat was placed is given in Figure 2. The results of the vegetation monitoring for each month are given in Appendix D. For each quadrat, the scientific name, the cover estimation class, and the C of C value are given for each species are given. We then pooled the data for each quadrat from all three months into a composite list, given in Appendix E, and used the pooled data to obtain the total number of taxa (TT), total native taxa (NT), mean C of C, and FQI for each quadrat. These values are presented in Appendix F.

We then summarized data for the total prairie flora by calculating mean C of C and FQI for the North Prairie as a whole; this data presented in Appendix G. These values were calculated using all of the taxa in the Inventory list. The native flora of the LREC North Prairie has a mean C of C of 3.80, and a Floristic Quality Index of 45.75.

GIS

Using GPS technologies, geographic coordinates for the boundaries of the North and South Prairies were obtained. These boundaries, over-lain on an aerial photo of the surrounding area taken in December of 1996, are shown in Figure 2. We also obtained coordinates for each of the 15-meter grid intercept points that had an associated quadrat.

The locations of the grid intercept points within the prairies are shown in Figure 3. The boundary and grid intercept point coordinate data are recorded in the form of ArcView GIS 3.2a shapefiles and are provided on an accompanying compact disk. For each month, coverages of the grid intercept points with attribute tables containing the vegetation monitoring data for each grid intercept point's associated quadrat are provided. Also provided on the accompanying compact disk are GIS coverages of 20-meter interval topographic contour lines, FEMA 100 year flood limits, hydrology, and roads.

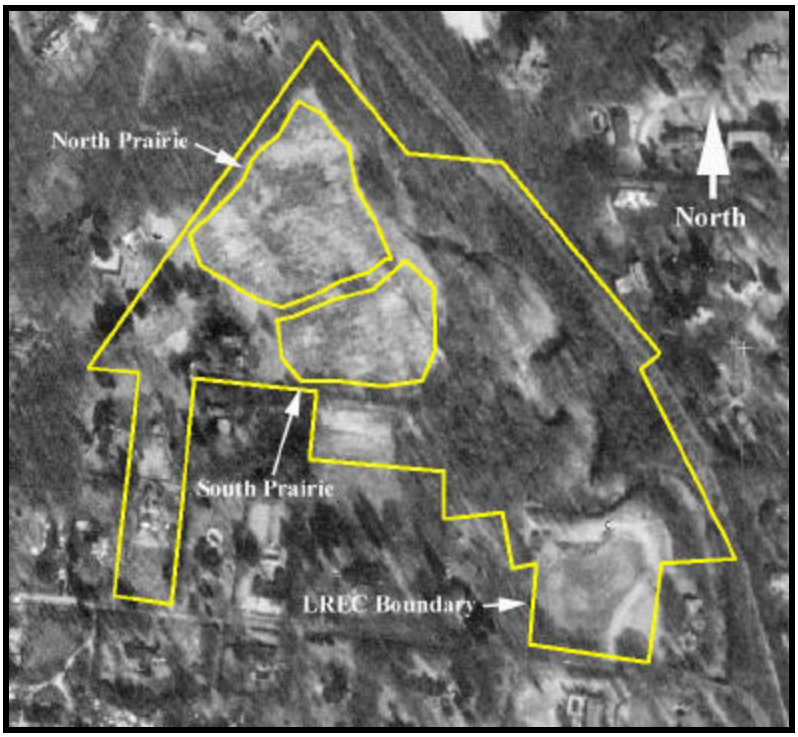

Figure 2. Aerial photo taken in December of 1996. North and South Prairie and LREC boundaries are over-lain.

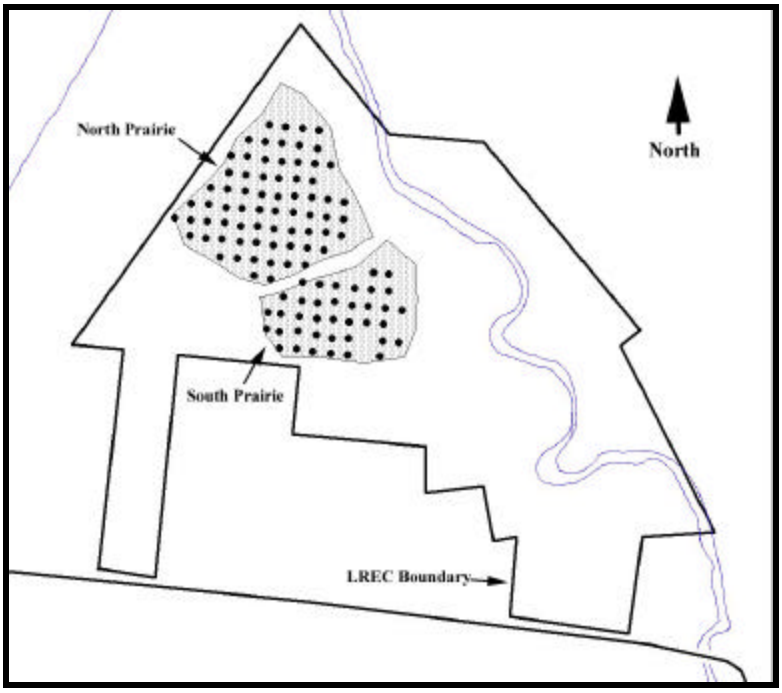

Figure 3. North and South Prairies (shaded areas) with locations of grid-intercept pins (black dots). The LREC property boundary is also shown (polygon with thick black lines).

DISCUSSION

Floristic Inventory

During our random walk-through surveys, we found twenty-six species not previously listed for the prairies, and did not find forty-three that were present in previous inventories. Some of the species that we missed may be present only in the South Prairie, which we did not survey thoroughly. Still others may be biennial or may have been extirpated as a result of the normal prairie dynamic. Considering these factors, we may have missed a few species flowering in the North Prairie in 2001.

Only three of the species new to the North Prairie are exotics, none of which is very common, with their distribution being mostly limited to the interior path and the edge of the prairie. This is encouraging in that it suggests that the prairie has been restored to a state that seems to be robust against invasive species, several of which are present within the LREC borders (e.g., *Allaria petiolata*). Also encouraging is that several new species are of high C of C value, and appear to have arrived on their own (e.g., *Agalinis viridis*, C of C = 10; *Eupatorium fistulosum*, C of C = 8; *Scirpus cyperinus*, C of C = 7) along with a majority of new arrivals with mid-range C of C values.

Exotic plant species comprise 13.2% of the number of species present in the North Prairie. This is in line with values reported from relict prairies. For example, Ladd and Churchwell (1999) reported as exotic 14% of the total flora documented in Missouri Prairie Foundation lands they surveyed in 1997 and 1998. It is our impression that many of these exotics in the LREC prairie are confined to disturbed areas within the prairie such as paths and the prairie margin. Plants common in surrounding areas, such as the mowed border of the prairie and the nearby forest edge are not, in general, invading the prairie to a significant extent. We believe that this observation, combined with the fact

that the prairie plantings were established 5 years prior to the survey, may indicate that the North Prairie is a stable environment, with regard to exotics, under the current management practices. However, it should be noted that this could only be verified after data is accumulated over time.

It is notable that there were many wetland species detected in the prairie. Appendix B lists wetland plant species found in the North Prairie and their corresponding wetland indicator values. The large number of wetland plant species present most certainly reflects the history of the prairie. The presence of these species contributes to the diversity of the prairie and should not be discouraged.

Vegetation Monitoring Regime

The major goal of this project was to collect baseline data that will be of future use in evaluating the status and success of the restoration of the LREC Prairie. We feel that we have established a user-friendly and repeatable monitoring system that will be amenable to statistical analyses developed later. Below we discuss a few of the more pertinent issues associated with the monitoring protocol and some general observations made from the first year's monitoring.

A number of vegetation surveys of prairies have been conducted, and some of these surveys report on the overall condition of the studied prairie using a Floristic Quality Assessment or FQA (see Taft et al., 1997 and www.moprairie.org/eco/intro.htm). The FQA provides a way to measure a site's "overall natural potential and recoverability from a restoration perspective," as well as a means to conduct spatial and chronological comparisons (Taft et al., 1997). The monitoring protocol established in this study will allow the LREC prairies to be evaluated using the FQA methodology. In Appendices A, D, E, F and G we report two of the vegetation parameters commonly used in FQA. It also should be possible with the implemented sampling regime to statistically evaluate the prairie using methodologies other than FQA.

We sampled the North Prairie at three different time periods in the growing season (i.e., June, July, and August). Multiple sampling periods ensures that plants growing at different times throughout the growing season are detected and that differences in percent cover values can be compared. One assessment that may be of value to future management may be to monitor how species that seem overly abundant affect the ability of other species to grow in close proximity. For example, *Solidago altissima*, which occupies the highest percentage of quadrats (83.8), and has a relatively high average cover value (3.6), represents one species that should be closely monitored for potential aggressiveness.

Quadrat data can also be used to obtain an estimate of total percent cover, by species, for the prairie, by multiplying the average percent cover by the total area of all 68 quadrats. For example, the estimated average cover value for *Solidago altissima* is 3.6, which corresponds to coverage of about 15-25% of the quadrats. We can extrapolate this to the whole prairie and estimate the total cover of S. altissima at, say 20%, or approximately one acre of the five-acre prairie. A more precise method for this estimate made for more species would be helpful in describing the floristic structure of the prairie. Evaluating the variation between quadrats of values such as TT, NT, C of C, and FQI may also be helpful in describing structure. Species of high conservation value should be monitored more carefully, which begins with knowing their position in the prairie. Perhaps the position of species of high C of C and others of particular interest and low abundance should be plotted in future GIS work.

A few species dominate the North Prairie, namely *Andropogon gerardii, Rudbeckia subtomentosa*, and *Solidago altissima*. The percentage of quadrats in which each of these species was found and the average percent cover of each are given in Table 2. It is not clear to us if this level of dominance is normal for a mesic tallgrass prairie. However, the North Prairie is relatively small when compared to other prairies that have been surveyed and to the once extensive pre-settlement prairies of the past. It may be that it is not uncommon or unnatural to have areas as large as the North Prairie or larger dominated by a few species, which would effectively be small patches in larger prairies. Statistical comparison to currently existing prairies can verify whether this scenario is unusual. Conversely, there are many species that seem to be very rare. This is indicated by the failure to detect several species in the quadrats. As indicated in Fig. 1, increasing the number of quadrats is not an effective way (from a cost/benefit standpoint) of monitoring rare species. It may be that a second monitoring regime for rare plants is needed.

Table 2

Taxon	Percent of quadrats occupied	Average cover class value for occupied quadrats
Andropogon gerardii	32%	3.5
Rudbeckia subtomentosa	67.6%	2.9
Solidago altissima	83.8%	3.6

While much variation exists in the North Prairie, the northern half of the North Prairie is relatively homogenous and is dominated by *Andropogon gerardii* and *Rudbeckia subtomentosa*, while *Solidago altissima* is common in the southwestern portion of the prairie. Nevertheless, the southwestern portion of the prairie seems to be the most diverse, containing many species not detected in other parts. Furthermore, many of these species are characteristic prairie species (e.g., *Asclepias sullivantii, Liatris pycnostachya, Solidago speciosa, Sporobolus heterolepis*). The southeastern portion of the North Prairie is also diverse, but seems to be slightly more disturbed than the southwestern portion. Notable species present in this area are: *Gentiana andrewsii, Hibiscus militaris, Physostegia virginiana*, and *Spartina pectinata*.

Again it is clear that the number of quadrats is sufficient to capture much of the species diversity present in the North Prairie (Fig. 1). As the number of quadrats is increased from 50 to 64, one new species is gained. This suggests that very few new species will be detected if more quadrats are used. Since the South Prairie was not sampled during this survey, it is not possible to comment on the number of quadrats needed to capture most of the diversity present there. If one assumes, perhaps simplistically, that the species diversity in the South Prairie is comparable to that in the North, then by extrapolation a roughly similar number of quadrats per unit area are needed there. A sampling system distributing quadrats identical to that used in the North Prairie has been established in the South Prairie. A preliminary survey of these quadrats during the 2002 growing season will provide data that can be used to evaluate if the current number of quadrats (ca. 35) in the South Prairie is appropriate.

While it is clear that the number of quadrats in the North Prairie is sufficient, it is not altogether clear if the distribution of the quadrats and their placement captures the

heterogeneity present in the prairie. It is our general impression that the prairie is somewhat heterogeneous, with variation present at various scales. It may be that the current system needs to be modified to capture this variation, perhaps placing a denser concentration of quadrats in some areas that become of particular interest to monitoring needs.

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