

# Vegetation of Forest Communities at the Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois

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## ABSTRACT

Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois, is a 590 ha preserve that contains extensive sand-prairie and sand forest communities. *Quercus velutina* (black oak) dominates the forests with importance values of 148 to 196 (200 possible), and 260 to 468 stem/ha. Other overstory species included *Q. marilandica* (blackjack oak), *Carya ovata* (black hickory), and *C. tomentosa* (mockernut hickory). Many oaks were multiple-stemmed with 2-5 stems from near the base. The ground-layer vegetation was dominated by *Eupatorium rugosum* (white snakeroot), *Carex pensylvanica* (Pennsylvania sedge), *Tradescantia ohiensis* (smooth spiderwort), *Parthenocissus quinquefolia* (Virginia creeper), and *Rubus pensylvanicus* (Pennsylvania blackberry). The woody understory species were more common in areas that had not been subjected to recent burns.

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## INTRODUCTION

The Illinois River Sand Area of Mason and Cass Counties was the last extensive area in the state converted to agriculture. In the early 1900s thousands of acres of natural sand communities were still present (Gleason 1910, Sampson 1921). With the advent of center pivot irrigation in the 1940s, most of these lands were cultivated, but a few scattered remnants provide indications of past species diversity and plant community composition.

These sand communities were intensively studied in the early 1900s (Hart and Gleason 1907, Gleason 1910, Vestal 1913, Sampson 1921). Later studies include presettlement vegetation of the Illinois River Sand Area using Government Land Office survey records (Rodgers and Anderson 1979), and the response of sand forest species to a moisture gra-

dient (Adams and Anderson 1980). Recently, Jenkins et al. (1991) and Coates et al. (1992) studied the overstory of closed canopy sand forests in Mason County. The response of these sand forests to fire has been examined by Anderson and Brown (1983, 1986), while Nuzzo et al. (1996) reported on the impact of fire on the ground-layer flora. The present study was undertaken to determine the structure and composition of the forest communities at Sand Prairie-Scrub Oak Nature Preserve (SPSONP), and the apparent changes in these communities during the last century.

### DESCRIPTION OF THE STUDY AREA

The 590 ha SPSONP is located between the towns of Bath and Kilborne (T20N R9W S14, S23, N1/2 S26) in Mason County. It is situated in the Illinois River Section of the Illinois River and Mississippi River Sand Areas Natural Division (Schwegman 1973). The soils of this region, which includes most of Cass and Mason Counties, resulted from the Kankakee Torrent between 14,000 to 15,000 years ago (Willman and Frye 1970). After the floodwaters subsided, wind action created large sand dunes known as the Parkland Formation. Dunes and areas of actively moving sand characterize much of the SPSONP. These soils consist of about 95% sand, 4% silt, and 1% clay; pH ranges from 5.1 to 5.3; and organic matter and nitrogen are very low (Benjamin et al. 1989).

The preserve was purchased by the Illinois Department of Conservation in 1969, and dedicated as an Illinois Nature Preserve in 1970. At the time of purchase, the site was a mixture of remnant sand communities and abandoned agricultural land. Past management practices consisted mainly of protecting the site from off-road vehicles, occasional burns, and the removal of exotic and invasive species, particularly *Robinia pseudoacacia* L. (black locust), and all pine plantations.

All four study areas are located on ancient stabilized dunes characterized by a flat to gently rolling topography. Each study area was selected based on their different fire regimes, and all are located sufficiently far from the forest edge or other disturbances to eliminate edge effect.

- Area 1-Near the northeast corner of the preserve. Burned in the spring or fall seven times in the past ten years, the last fire in the fall of 1994.
- Area 2-About 200 m west of the parking lot, and 100 m north of an east/west fire line, this site was burned in the fall of 1992.
- Area 3-About 100 m west of the parking lot, and 100 m south of an east/west fire line, this site was burned in the fall of 1994.
- Area 4-Near the southwest corner of the preserve, this site has not been burned for the past 30 years.

### MATERIALS AND METHODS

During the summer of 1995 the overstory of four study areas was surveyed. Each area, 1 ha in size, was divided into quadrats 25 m on a side (16 quadrats in each study area), and the number, size and species of all live and dead-standing stems  $\leq 10$ cm dbh were recorded for each quadrat. The average diameter (cm), density (stems/ha), basal area ( $m^2/ha$ ), relative density, relative dominance and importance value (IV) were calculated for each species (McIntosh 1957). The percent cover was determined by photographing

the canopy from below (16 points) and calculating the percent of the area covered using a 100 point dot matrix.

The woody understory was sampled using 32 nested circular plots located randomly along line transects throughout each area. Woody seedlings ( $\leq 40$  cm tall) and shrubs were tallied on 0.0001 ha plots. Small saplings ( $>40$  cm tall,  $\leq 2.5$  cm dbh) were recorded in 0.001 ha plots, while large saplings (2.5-9.9 cm dbh) were recorded in 0.01 ha plots. Densities (stems/ha) were determined for each size class in each study area.

In each of the four study areas, four transects 25 m long were located randomly in a north-south orientation. Along each transect,  $1/4$  m<sup>2</sup> quadrats were located at 1 m intervals to the east (odd numbers) or to the west (even numbers) of the transect. A random numbers table was used to determine the number of m (0-9) the quadrats were located from the transect. The percent cover of each species was determined using the Daubenmire (1959) cover classes as modified by Bailey and Poulton (1968): class 1 = 0-1%; class 2 = 2-5%; class 3 = 6-25%; class 4 = 26-50%; class 5 = 51-75%; class 6 = 76-95%; class 7 = 96-100%. From these data the percent cover, frequency, relative cover, relative frequency and importance value of each species was determined. The Sorenson Index of Similarity (IS) (Mueller-Dombois and Ellenberg 1974) was used to determine the degree of similarity between the study sites [ $IS = 2C/(A+B) \times 100$ ]. Nomenclature follows Mohlenbrock (1986).

## RESULTS

### Overstory

*Quercus velutina* Lam. (black oak) dominated the overstory. It ranked highest in relative density, relative dominance and IV (148-196 out of 200), and averaged between 260 and 468 stems/ha (Table 1). *Quercus mariulandica* Muenchh. (blackjack oak) ranked second with an IV of 2.7 to 50.2, with no individuals exceeding 27 cm dbh. *Carya texana* Buckl. (black hickory) was present in all study areas, but never exceeded an IV of 4.3. The only other species that entered the canopy were *Carya tomentosa* (Poir) Nutt. (mockernut hickory) and *Prunus serotina* Ehrh. (black cherry). All study areas had 83-88% canopy cover.

Multiple-stemmed trees were common, ranging from 70 to 96 trees/ha in the study areas, 15-25% of the stands (Table 2). The basal area of coppice stems averaged 5.9 to 11.4 m<sup>2</sup>/ha, 25-55% of the stands. Coppice individuals averaged about two living stems per tree, although some had as many as five living stems along with some dead-standing stems. Most coppice individuals were oak species, and were extensively fire scared near the base. Tree mortality was high, 47-95 stems/ha, with black oaks accounting for most of this number (Table 3).

### Woody understory

The understories in the study areas were open with few understory trees or saplings (Table 1). Large saplings were uncommon, none being found in area 1, with up to 35 stems/ha in the other study areas. Small saplings averaged from 62-999 stems/ha, although most were less than 100 cm tall. Common saplings were black hickory, followed by a few black oak and almost no blackjack oak (Table 1).

Woody seedlings were common in all study areas, 7,502-12,501 stems/ha (Table 1). Black oak seedlings accounted for more than 75% of the individuals present, the remaining overstory taxa being poorly represented. Two of the four study areas (3 & 4) had higher plant species richness, black cherry being fairly common, with the vine *Celastrus scandens* L. (bittersweet) and the shrub *Ceanothus americanus* L. (New Jersey tea) present.

### Ground-layer vegetation

The ground-layer vegetation of the four study areas contained 74 species, 18 tree seedlings, shrubs or woody vines, five grasses and sedges, four alien taxa, and 47 forbs (Table 4). Woody species were common in the ground-layer vegetation of the four study areas, their total IV's ranging from 38-106 (Table 4). Black oak seedlings were common in all areas (IV of 4.5-16.2), while members of the genus *Rubus* spp. (blackberries and raspberries) and *Parthenocissus quinquefolia* (L.) Planch. (Virginia creeper) were common in areas 3 and 4, which had not been subjected to recent fires. Other woody species with high cover in one or more study areas included black cherry and *Toxicodendron radicans* (L.) Kuntze (poison ivy).

Grasses and sedges were not abundant (Table 4). *Carex pensylvanica* Lam. (Pennsylvania sedge) occurred in all areas, while *C. festucacea* Willd. (sedge) and *Dichanthelium villosissimum* (Nash) Freckm. (hairy panic grass) were less frequently encountered. The only common exotic grass was *Poa pratensis* L. (Kentucky bluegrass).

Forbs usually accounted for the majority of the ground-layer cover in the study areas, but only four taxa were common to all areas: *Eupatorium rugosum* Houtt. (white snakeroot) with an IV of 37.5-52.9, followed by *Tradescantia ohioensis* Raf. (spiderwort), *Solidago nemoralis* Ait. (field goldenrod), and *Fragaria virginiana* Duchesne (common strawberry) (Table 4). Other forbs with high IV's in most areas included *Helianthus divaricatus* L. (woodland sunflower), and the herbaceous vine *Amphicarpa bracteata* (L.) Fern. (hog peanut). The remaining forbs were only common in one of the study areas, or had very low IV's. Based on Sorenson's Similarity Index, the ground-layer vegetation of the four study areas was fairly similar, ranging from 48.1 to 62.5 (Table 5).

## DISCUSSION

In presettlement times, the wooded areas of the SPSONP were mostly open woodlands and savannas, particularly in areas with some relief (Rodgers and Anderson 1979). Due to extensive fires (McClain and Elzinga 1994), these forests were undoubtedly more open in the past, the ground-layer being composed of shrubs and herbaceous species that were common sand prairie components (Hart and Gleason 1907). Aerial photographs from 1938 show a very open woods with scattered blowouts.

Since settlement by Europeans, the natural vegetation of Illinois has been affected by fire suppression (Ebinger and McClain 1991). According to Gleason (1910) and Vestal (1913), the open forests and savannas of the sand areas of Mason County were becoming closed forests by the early 1900s. Blackjack oak accounted for about 50% of the overstory in these forests, black oak about 35%, and black hickory the remainder (Hart and

Gleason 1907). Trees rarely exceeded 12 inches dbh, were very crooked, gnarled, and full of dead branches. Our data indicate that, over time, the forest canopy closed and black oak became the dominant species with blackjack oak and few hickory species being of minor importance.

Other closed canopy forests communities in Mason County, have a similar composition and structure. Both Bishop's Woods (Jenkins et al. 1991), and Barkhausen Woods (Coates et al. 1992) are presently closed canopy forests with black oak the dominant overstory species along with scattered individuals of blackjack oak and black hickory. In both woods, the mesic species *Sassafras albidum* (Nutt.) Nees (sassafras), *Ulmus americana* L. (American elm), and *Celtis occidentalis* L. (hackberry) are entering the canopy. The closed canopy, and past fire suppression has probably encouraged the growth of these mesophytes.

Past burns are probably responsible for the high mortality, and multiple-stemmed individuals in the forests of the SPSONP. Most trees contain fire scars at the base, and many of the multiple-stemmed trees have one or more dead trunks. In Area 1, which has been burned seven times between 1984 and 1994, dead-standing individuals accounted for more than 16% of the stand. In the remaining study areas, which burned less frequently, dead-standing stems account for about 10% of the stands. Based on the numerous multiple-stemmed individuals, and the numerous fire scars, it is very likely that fires were common before the area was dedicated as a nature preserve.

Most of the prescribed burns in the study areas have been low intensity fires. These fires have not had much effect on the large sapling layer which is relatively open, and have not resulted in extensive canopy openings. Similar results were obtained by Nuzzo et al. (1996) where annual fires resulted in a minor decrease in the woody cover at the Sand Ridge State Forest, Mason County, Illinois. During the present study, a decrease in fire frequency resulted in an increase in Virginia creeper and blackberries.

The ground-layer of all four study areas was very similar (Table 4 and 5). The woodland forb *Eupatorium rugosum* dominated with IV's ranging from 37.7 to 52.9. This taxon increases in sand forests after ground fires, sometimes increasing fourfold in importance (Nuzzo et al. 1996). Many of the remaining forbs were also species of shaded habitats, though some prairie forbs with low IV's were encountered. Also, many of the woody species encountered in the study areas were common woodland taxa. Sand prairie species were mostly absent from these habitats although early observations by Hart and Gleason (1907), Gleason 1910, and Sampson (1921) indicated an open woods with sand prairie species common in the ground-layer. With forest canopy closure due to fire suppression, most of these prairie species have been eliminated from the forest interior.

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Table 1. Densities (#/ha), diameter classes, basal areas (m<sup>2</sup>/ha), relative values, importance values and average diameters (cm) of the woody species at four study sites at the Sand Prairie Scrub Oak Nature Preserve, Mason County, Illinois.

|                            | Seedlings | Saplings      |               | Diameter |       |     | Total<br>#/ha | Basal Area<br>m <sup>2</sup> /ha | Rel.Den | Rel.Dom | IV    | Av.Diam.<br>m |
|----------------------------|-----------|---------------|---------------|----------|-------|-----|---------------|----------------------------------|---------|---------|-------|---------------|
|                            | #/ha      | Small<br>#/ha | Large<br>#/ha | 10-19    | 20-29 | 30+ |               |                                  |         |         |       |               |
| <u>AREA # 1</u>            |           |               |               |          |       |     |               |                                  |         |         |       |               |
| <i>Quercus velutina</i>    | 6562      | 31            | --            | 177      | 236   | 55  | 468           | 21.17                            | 97.7    | 98.6    | 196.3 | 22.9          |
| <i>Quercus marilandica</i> | --        | --            | --            | 4        | 3     | --  | 7             | .26                              | 1.5     | 1.2     | 2.7   | 21.3          |
| <i>Carya tomentosa</i>     | 938       | --            | --            | 3        | --    | --  | 3             | .04                              | 0.6     | 0.1     | 0.7   | 13.4          |
| <i>Carya texana</i>        | 625       | 438           | --            | 1        | --    | --  | 1             | .01                              | 0.2     | 0.1     | 0.3   | 11.0          |
| Totals                     | 8125      | 469           | --            | 185      | 239   | 55  | 479           | 21.48                            | 100.0   | 100.0   | 200.0 |               |
| <u>AREA # 2</u>            |           |               |               |          |       |     |               |                                  |         |         |       |               |
| <i>Quercus velutina</i>    | 10000     | 31            | 13            | 62       | 127   | 71  | 260           | 14.31                            | 67.9    | 80.6    | 148.5 | 25.5          |
| <i>Quercus marilandica</i> | 625       | --            | 13            | 71       | 48    | --  | 119           | 3.39                             | 31.1    | 19.1    | 50.2  | 18.7          |
| <i>Carya texana</i>        | 938       | 31            | 9             | 4        | --    | --  | 4             | .05                              | 1.0     | 0.3     | 1.3   | 12.8          |
| Totals                     | 11563     | 62            | 35            | 137      | 175   | 71  | 383           | 17.75                            | 100.0   | 100.0   | 200.0 |               |
| <u>AREA # 3</u>            |           |               |               |          |       |     |               |                                  |         |         |       |               |
| <i>Quercus velutina</i>    | 2813      | --            | 3             | 52       | 207   | 91  | 350           | 19.67                            | 86.8    | 95.1    | 181.9 | 26.0          |
| <i>Quercus marilandica</i> | --        | --            | --            | 30       | 7     | --  | 37            | .83                              | 9.2     | 4.0     | 13.2  | 16.6          |
| <i>Carya texana</i>        | 313       | 250           | 16            | 14       | --    | --  | 14            | .17                              | 3.5     | 0.8     | 4.3   | 11.7          |
| <i>Prunus serotina</i>     | 1875      | 219           | 6             | 2        | --    | --  | 2             | .02                              | 0.5     | 0.1     | 0.6   | 10.7          |
| <i>Celastrus scandens</i>  | 2188      | --            | --            | --       | --    | --  | --            | --                               | --      | --      | --    | --            |
| Others (4 species)         | 313       | 281           | --            | --       | --    | --  | --            | --                               | --      | --      | --    | --            |
| Totals                     | 7502      | 750           | 25            | 98       | 214   | 91  | 403           | 20.69                            | 100.0   | 100.0   | 200.0 |               |
| <u>AREA # 4</u>            |           |               |               |          |       |     |               |                                  |         |         |       |               |
| <i>Quercus velutina</i>    | 10625     | 63            | 3             | 65       | 181   | 88  | 334           | 18.11                            | 80.7    | 89.5    | 170.2 | 25.4          |
| <i>Quercus marilandica</i> | --        | --            | --            | 45       | 24    | --  | 69            | 1.93                             | 16.7    | 9.6     | 26.3  | 18.3          |
| <i>Carya texana</i>        | --        | 375           | 13            | 10       | 1     | --  | 11            | .20                              | 2.6     | 0.9     | 3.5   | 14.5          |
| <i>Celastrus scandens</i>  | 625       | --            | --            | --       | --    | --  | --            | --                               | --      | --      | --    | --            |
| <i>Ceanothus americana</i> | 625       | --            | --            | --       | --    | --  | --            | --                               | --      | --      | --    | --            |
| <i>Prunus serotina</i>     | 313       | 406           | --            | --       | --    | --  | --            | --                               | --      | --      | --    | --            |
| Others (5 species)         | 313       | 155           | --            | --       | --    | --  | --            | --                               | --      | --      | --    | --            |
| Totals                     | 12501     | 999           | 16            | 120      | 206   | 88  | 414           | 20.24                            | 100.0   | 100.0   | 200.0 |               |

Table 2. Densities (stems/ha), basal areas (m<sup>2</sup>/ha), and average diameters of live coppice stems at the Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois.

|                            | Coppice<br>Trees<br>Stems/ha | Average<br>Number of<br>Stems/tree | Basal Area<br>(m <sup>2</sup> /ha) | Average<br>Diameter<br>(cm) |
|----------------------------|------------------------------|------------------------------------|------------------------------------|-----------------------------|
| AREA # 1                   |                              |                                    |                                    |                             |
| <i>Quercus velutina</i>    | 76                           | 1.84                               | 5.936                              | 22.6                        |
| Totals                     | 76                           |                                    | 5.936                              |                             |
| AREA # 2                   |                              |                                    |                                    |                             |
| <i>Quercus velutina</i>    | 55                           | 2.25                               | 6.903                              | 25.7                        |
| <i>Quercus marilandica</i> | 15                           | 2.27                               | 1.026                              | 19.3                        |
| Totals                     | 70                           |                                    | 7.929                              |                             |
| AREA # 3                   |                              |                                    |                                    |                             |
| <i>Quercus velutina</i>    | 88                           | 2.17                               | 11.026                             | 26.6                        |
| <i>Quercus marilandica</i> | 6                            | 2.17                               | .354                               | 18.2                        |
| <i>Carya texana</i>        | 1                            | 2.00                               | .018                               | 10.6                        |
| <i>Prunus serotina</i>     | 1                            | 2.00                               | .018                               | 10.7                        |
| Totals                     | 96                           |                                    | 11.416                             |                             |
| AREA # 4                   |                              |                                    |                                    |                             |
| <i>Quercus velutina</i>    | 58                           | 2.05                               | 6.537                              | 25.9                        |
| <i>Quercus marilandica</i> | 12                           | 2.00                               | .894                               | 21.3                        |
| Totals                     | 70                           |                                    | 7.431                              |                             |

Table 3. Densities (#/ha), basal areas (m<sup>2</sup>/ha), and average diameters (cm) of dead-standing stems at Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois.

|                            | Trees, #/ha | Basal Area | Av. Diam. |
|----------------------------|-------------|------------|-----------|
| AREA # 1                   |             |            |           |
| <i>Quercus velutina</i>    | 85          | 1.771      | 15.1      |
| <i>Quercus marilandica</i> | 10          | .295       | 19.0      |
| Totals                     | 95          | 2.066      |           |
| AREA # 2                   |             |            |           |
| <i>Quercus velutina</i>    | 27          | .983       | 20.1      |
| <i>Quercus marilandica</i> | 24          | .386       | 14.2      |
| Totals                     | 51          | 1.369      |           |
| AREA # 3                   |             |            |           |
| <i>Quercus velutina</i>    | 50          | 1.303      | 17.3      |
| <i>Quercus marilandica</i> | 3           | .063       | 16.4      |
| Totals                     | 53          | 1.366      |           |
| AREA # 4                   |             |            |           |
| <i>Quercus velutina</i>    | 34          | .905       | 17.5      |
| <i>Quercus marilandica</i> | 13          | .227       | 14.5      |
| Totals                     | 47          | 1.132      |           |



Table 4. Importance Values (IV) of ground-layer vegetation life-form groups and for species (IV >1.5) encountered in the four study areas at the Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois.

|                                    | Area 1 | Area 2 | Area 3 | Area 4 |
|------------------------------------|--------|--------|--------|--------|
| <u>Life-forms IV</u>               |        |        |        |        |
| Total species in each area         | 33     | 49     | 30     | 47     |
| Woody                              | 53.6   | 38.2   | 106.1  | 62.6   |
| Graminoid                          | 36.4   | 18.1   | 6.8    | 10.1   |
| Forbs                              | 109.1  | 136.6  | 86.4   | 123.3  |
| Aliens                             | 0.9    | 7.1    | 0.7    | 4.0    |
| <u>Species IV</u>                  |        |        |        |        |
| <i>Euatorium rugosum</i>           | 52.9   | 37.5   | 51.4   | 49.1   |
| <i>Carex pensylvanica</i>          | 30.7   | 10.0   | 4.5    | 3.9    |
| <i>Tradescantia ohiensis</i>       | 16.8   | 9.5    | 7.9    | 6.9    |
| <i>Quercus velutina</i>            | 16.2   | 5.6    | 8.6    | 4.5    |
| <i>Solidago nemoralis</i>          | 10.5   | 3.7    | 3.6    | 15.1   |
| <i>Helianthus divaricatus</i>      | 10.1   | 29.4   | --     | 5.0    |
| <i>Parthenocissus quinquefolia</i> | 8.7    | 7.3    | 49.4   | 19.1   |
| <i>Rosa carolina</i>               | 8.4    | --     | --     | 0.7    |
| <i>Prunus serotina</i>             | 7.9    | 0.4    | 0.4    | 2.5    |
| <i>Amphicarpa bracteata</i>        | 4.1    | 19.4   | 1.4    | --     |
| <i>Rubus occidentalis</i>          | 3.9    | 2.2    | 15.7   | 3.6    |
| <i>Fragaria virginiana</i>         | 3.9    | 3.5    | 0.4    | 7.3    |
| <i>Cassia nictitans</i>            | 3.0    | 1.6    | --     | 1.0    |
| <i>Carex festucacea</i>            | 2.7    | 3.3    | --     | 0.6    |
| <i>Lespedeza capitata</i>          | 2.2    | 1.3    | --     | 3.8    |
| <i>Dichanthelium villosissimum</i> | 2.0    | 3.7    | 2.3    | 5.6    |
| <i>Celastrus scandens</i>          | 2.0    | 0.4    | --     | 0.7    |
| <i>Rudbeckia hirta</i>             | 1.9    | --     | --     | 2.7    |
| <i>Rhus glabra</i>                 | 1.7    | --     | --     | 2.0    |
| <i>Toxicodendron radicans</i>      | 1.5    | 9.5    | --     | --     |
| <i>Lithospermum carolinense</i>    | 0.5    | 1.5    | --     | 0.4    |
| <i>Penstemon pallidus</i>          | 0.5    | 1.1    | --     | 1.6    |
| <i>Rubus pensylvanicus</i>         | --     | 9.3    | 23.8   | 23.1   |
| <i>Scrophularia lanceolata</i>     | --     | 7.8    | 0.7    | 0.4    |
| <i>Poa pratensis</i>               | --     | 4.6    | --     | 3.7    |
| <i>Rubus flagellaris</i>           | --     | 3.1    | --     | --     |
| <i>Galium pilosum</i>              | --     | 3.0    | 0.4    | --     |
| <i>Polygonum convolvulus</i>       | --     | 2.5    | 0.7    | 0.3    |
| <i>Euthamia graminifolia</i>       | --     | 2.5    | --     | --     |
| <i>Apocynum cannabinum</i>         | --     | 1.6    | --     | --     |
| <i>Carya texana</i>                | --     | 0.4    | 2.0    | 1.2    |
| <i>Teucrium canadense</i>          | --     | --     | 8.4    | --     |
| <i>Potentilla simplex</i>          | --     | --     | 5.5    | 14.8   |
| <i>Ceanothus americanus</i>        | --     | --     | 2.5    | 2.6    |
| <i>Ribes missouriense</i>          | --     | --     | 2.2    | --     |
| <i>Vitis riparia</i>               | --     | --     | 1.5    | 0.9    |
| <i>Eupatorium serotinum</i>        | --     | --     | 0.8    | 3.4    |
| <i>Hackelia virginiana</i>         | --     | --     | --     | 1.6    |
| <i>Smilacina racemosa</i>          | --     | --     | --     | 1.5    |
| Others                             | 7.9    | 14.3   | 5.9    | 10.4   |

Table 5. A comparison of the ground layer vegetation of the four study areas using the Sorensen's Similarity Index.

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|        | Area 1 | Area 2 | Area 3 | Area 4 |
|--------|--------|--------|--------|--------|
| Area 2 | 56.1   |        |        |        |
| Area 3 | 48.1   | 50.6   |        |        |
| Area 4 | 62.5   | 62.5   | 57.1   |        |

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