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Black Oak Savannas and Pin Oak Flatwoods in Iroquois County, Illinois

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BLACK OAK SAVANNAS AND PIN OAK FLATWOODS IN IROQUOIS COUNTY, ILLINOIS

(TITLE)

BY

Kenneth Johnson

THESIS

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ABSTRACT

A vegetation survey was undertaken at the Iroquois County Conservation Area and the Hooper Branch Nature Preserve in Iroquois County, Illinois. Dry sand savanna, dry-mesic sand savanna, and Pin Oak flatwoods were the three communities under study at the Iroquois County Conservation Area. *Carex pensylvanica* had the highest relative frequency of any ground layer species present at both the dry and the dry-mesic sand savannas. In both of these sand savanna communities the dominant overstory tree was *Quercus velutina*. These two communities differed mainly in the composition of their woody ground layer species. *Rubus hispidus obovalis* had the highest relative frequency of any ground layer species at the Pin Oak flatwoods. The understory vegetation was much less diverse in this community than in either of the sand savannas. The dominant overstory tree was *Quercus palustris*, which formed a much denser canopy layer than did *Q. velutina* at the dry and dry-mesic sand savannas.

A ground layer vegetation survey, and a woody overstory and understory vegetation survey also was undertaken at the Hooper Branch Nature Preserve. Sampling from a site that had been burned every spring over the past three years was compared to a site that had received only one burn over this same three year period. *Carex pensylvanica* had the highest relative frequency of any ground layer species at both sites.

No differences existed in the overstory vegetation between the two sites, both of which had as the dominant tree *Quercus velutina*. The site that had been under the three year prescribed burning management showed fewer woody seedlings present in the understory than the site that had not been burned as often. More years would have to elapse before any significant differences in vegetational composition would become apparent between these two sites.

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INTRODUCTION

Oak savannas occurred across much of North America at the time of presettlement. According to Nuzzo (1986) these were communities of open-grown trees growing in small groves or as scattered individuals, having a herbaceous (primarily grassy) understory. Although these oak savannas vary in definition, depending upon where they are located and who has studied them, two broad concepts can be used to define their physiognomy: the open savanna is a park-like community with widely spaced trees, virtually no shrub layer, and a herbaceous ground layer; the scrub savanna, on the other hand, is composed of dense thickets of oak sprouts within a prairie-like matrix, with a few dwarfed open-grown trees (Curtis 1959; Nuzzo 1986).

Oak savannas occurred scattered throughout most of Illinois at presettlement times, forming either broad ecotones separating forest from prairie, or appearing as isolated communities upon the open prairie (Madany 1981). Today in the state of Illinois these remaining oak savannas have been defined by the Illinois Natural Areas Inventory (White and Madany 1978) as communities with a grassy ground cover and an average tree canopy cover of less than 80 percent but greater than 10 percent. These Illinois oak savannas are separated into the three following subclasses: savanna "proper" on fine-textured soils on till plains; sand

savanna on sandy, acidic soils; and barrens on excessively drained, acidic soils (Madany 1981). These three subclasses are further divided according to moisture levels.

The savanna areas in this study are located on soils which are classified as a Gilford-Chelsea-Watseka Association, within the major soil order Entisol (Hedborn 1984). These are light-colored sandy soils that are derived from wind-blown deposits, referred to as Parkland Sand (Glass 1985; McDowell *et.al.* 1983).

Flatwood communities occur as depressions in the topography and typically have poorly-drained, acidic soils over a thin hardpan of silt or clay. Originally, many of these flatwoods were true savannas, although most are structurally forests today (Madany 1981).

The present study was undertaken at the Iroquois County Conservation Area (T29N, R11W, Sec.22,23,24), and the Hooper Branch Nature Preserve (T29N, R11W, Sec.13), in the northeast corner of Iroquois County, Illinois. Both areas lie within the Kankakee Sand Area Section of the Grand Prairie Division (Schwegman 1973) (Figs. 1 and 2). The Iroquois County Conservation Area is a 777 hectare tract of forest, savanna, prairie, and marsh communities located 4 miles northeast of Beaverville, Iroquois County, Illinois (Fig. 3). The land originally was acquired by the state in 1944, and is managed by the Bureau of Land and Historic Sites

principally as a permit hunting area. The Hooper Branch Nature Preserve is a 230 hectare tract of forest, savanna, prairie, and sucessional field communities located north and adjacent to the Iroquois County Conservation Area (Fig. 3). The land was acquired by the state in 1984, and 195 hectares were dedicated as the Hooper Branch Nature Preserve in 1985.

These two areas are situated at the edge of former Glacial Lake Watseka (Fig. 4). Glacial Lake Watseka and other glacial lakes in this region were formed approximately 14,000 years ago during the Kankakee Torrent. With the incising of the Illinois River Valley these glacial lakes were eventually drained, leaving sandy beach and nearshore deposits (White and Glass 1985). Wind action created the sandy dunes and swales, followed by the establishment of characteristic sand savanna and sand prairie vegetation. According to Hedborn (1984) prairie vegetation covered 92 percent of Iroquois County at the time of presettlement. The regular fires that swept across the prairies restricted the encroachment of woodlands onto the open prairie, and was a major factor in the development and maintenance of savanna communities. The fires were either started by the native inhabitants of this region or initiated by lightning strikes. Fire exclusion and agricultural practices changed the appearance of many oak savanna communities into closed forest with a dense understory as noted by Beckwith (1880), Gleason

(1912; 1913), and Transeau (1935). See Vogl (1974) for more information on fire and prairie communities. According to Nuzzo (1986) of the approximately 12 million hectares of oak savannas scattered across the prairie peninsula in 1840, only 2600 hectares remain as high-quality oak savannas (0.02 percent of the presettlement extent). For a more complete study on the soils and the flora of this region see Glass (1985), and Hedborn (1984).

DESCRIPTION OF THE STUDY AREAS

All plant communities that are located within the Iroquois County Conservation Area and the Hooper Branch Nature Preserve have been defined and mapped by the Illinois Natural Areas Inventory (White and Madany 1978). Each community has been assigned a particular grade depending upon the quality of vegetation that exists there. Communities with the highest ranking (those with a high frequency of natural vegetation) were designated as "grade A". A total of five levels exist, with "grade D" designated as the poorest level of natural vegetation composition. Plant communities that are composed of artificial plantings (tree plantations) were classified as "grade E". For more information concerning the Illinois Natural Areas Inventory see White and Madany (1978).

Area 1. Dry sand savanna at the Iroquois County Conservation Area: The two locations chosen for study are designated as grade B dry sand savannas by the Illinois Natural Areas Inventory. The first of these two dry sand savannas is located in the NW1/4 of the NE1/4, Sec.24, T29N, R11W; and the second dry sand savanna is located in the E1/2 of the NW1/4, Sec.24.

Area 2. Dry-mesic sand savanna at the Iroquois County Conservation Area: The two locations chosen for study are designated as grade B dry-mesic sand savanna by the Illinois Natural Areas Inventory. The first of these two dry-mesic sand savannas is located in the NE1/4 of Sec.24, T29N, R11W; and the second dry-mesic sand savanna is located in the NW1/4 of Sec.24.

Area 3. Pin Oak flatwoods at the Iroquois County Conservation Area: The two locations chosen for study are designated as grade C Pin Oak flatwoods by the Illinois Natural Areas Inventory. The first of these two flatwoods is located in the center of Sec.24, T29N, R11W; and the second flatwoods is located in the NE1/4 of Sec.24. Other plant communities that are present in the surrounding areas are sedge meadow, marsh, shrub prairie, and dry-mesic sand prairie. Various grades of all of these communities border and intergrade with one another throughout this region of the Iroquois County Conservation Area. All areas north of an

east-west access road were burned in the spring of 1986. This prescribed burn included study areas 1 and 2 above (Glass, personal comm.).

Area 4. Dry sand savanna at the Hooper Branch Nature Preserve: This study area located at the Hooper Branch Nature Preserve is recognized as grade B dry sand savanna by the Illinois Natural Areas Inventory, and is located in the NW1/4 of Sec.13, T29N, R11W. Dry-mesic sand savanna and scrub prairie/mesic sand prairie communities border and intergrade with this dry sand savanna. An east-west access road transverses this part of the NW1/4 of Sec.13. Land management south of this access road has included an annual prescribed burn over the last 3 years (spring '87, '88,'89), while the savanna north of the access road has only been burned once (spring '87) (Glass, personal comm.). The Site A study area is located about 100 meters south of the access road and about 150 meters east of the north-south country road that forms the western boundary of the nature preserve. The Site B study area is located about 200 meters north of the access road and about 150 meters east of the same north-south country road.

MATERIALS AND METHODS

The herbaceous and woody ground layer species of two dry

sand savannas, two dry-mesic sand savannas, and two Pin Oak flatwoods were sampled at the Iroquois County Conservation Area. In the middle of September 1989, north/south transects 20 meters long were located randomly in each vegetation type. Transect locations were selected arbitrarily based upon earlier studies of theses communities by Madany (1981), McDowell *et.al.*(1983), and White and Madany (1978). A total of five transects were located in each of the sand savannas, and a total of three were located in each of the flatwoods. Along each transect, 0.25m^2 quadrats were placed randomly at 1 meter intervals. A random numbers chart was used to determine the number of meters the plots were placed to the east (odd numbered plots) or to the west (even numbered plots) of the transect.

The data collected from the two study locations for each vegetation type were combined, resulting in a total of 200 samples for the dry sand savanna, 200 samples for the dry-mesic sand savanna, and 120 samples for the Pin Oak flatwoods. It was presumed that sampling from two distinct locations gave a more accurate reflection of the community types under study. Sorensen's Index of Similarity (Curtis 1959) was used to verify that both locations were similar to one another and that combining their data would accurately reflect the community type. The Sorensen Index of Similarity was determined as follows:

$$\text{Index of Similarity} = \frac{2w}{a + b}$$

w = total no. of species in common
a = total no. of species sampled from area a
b = total no. of species sampled from area b

The relative frequencies for all species sampled were determined as follows:

$$\text{Relative Frequency} = \frac{\text{plots of occurrence of a species}}{\text{total plots of occurrence of all spp.}} \times 100$$

To determine if the relative frequencies were significantly different between species found at the dry and dry-mesic sand savannas a chi-square statistical procedure was used (2 x 2 contingency table, $X^2_{0.05,1}=3.841$, with 95% confidence limits) (Zar 1984).

All woody species were counted (number of stems) at the dry and dry-mesic sand savannas and their relative frequencies, relative densities, and importance values (IV) determined. Relative frequencies were calculated as above. Relative densities, importance values (IV), and the average number/m^2 of woody stems were calculated as follows:

$$\text{Relative Density} = \frac{\text{total individuals of a species}}{\text{total individuals of all species}} \times 100$$

$$\text{Importance Value (IV)} = \text{Relative Frequency} + \text{Relative Density}$$

$$\text{Average Number Stems/m}^2 = \frac{\text{no. stems of a species}}{\text{no. plots examined}} \times 4$$

The importance values were analyzed for significance of

difference (chi-square test, alpha=0.05, with equal expected frequencies) (Zar 1984).

Only relative frequency data were recorded and calculated for the species sampled at the Pin Oak flatwoods.

The herbaceous and woody ground layer species of a dry sand savanna located at the Hooper Branch Nature Preserve were sampled in a similar manner as described above. Sampling was done in the middle of September, with the area south of the access road (regularly burned) designated as Site A, and the area north of the access road (burned once) as Site B. Five north/south transects 20 meters long were located randomly in each site. Along each transect, 0.25m^2 quadrats were placed randomly, yielding a total of 100 samples from each site. As in the Iroquois County Conservation Area sampling, all herbaceous and woody species were identified and recorded and from this data relative frequencies of each species were determined. As before, a chi-square statistical proceedure was used (2 x 2 contingency table, $X^2_{0.05,1}=3.841$, with 95% confidence limits) to determine if the relative frequencies were significanty different between species found at the two sites.

Relative frequencies, relative densities, importance values, and the average number/m^2 of woody stems were calculated as before for all woody species sampled. Importance values were compared for significance of

difference using chi-square as described above.

In late October, the woody overstory and understory vegetation at the Hooper Branch Nature Preserve were surveyed. A 3.0 hectare section in each of the two sites was divided into quadrats 25 meters on a side, and the number, size, and species of all living and dead-standing trees above 10 cm diameter breast height (dbh) were recorded for each of the resulting 48 total quadrats. From this data the average number of individuals/hectare in five diameter classes (10-20 cm, 20-30 cm, 30-40 cm, 40-50 cm, 50+ cm) were calculated. The average tree densities of each site (total individuals/hectare) were determined by combining the data from all five diameter classes. Basal areas of each species (m^2/hectare) were determined by converting the above dbh results to m^2 of basal area. Relative densities were calculated as before. Relative dominance and importance values (IV) were also calculated for each species sampled as follows:

$$\text{Relative Dominance} = \frac{\text{total basal area of a species}}{\text{total basal area of all species}} \times 100$$

Importance Value (IV) = Relative Density + Relative Dominance

Nested circular plots of 0.001 and 0.01 hectares in size then were located randomly in each of the quadrats. In the 0.001 hectare plot, seedlings more than 40 cm in height and

less than 2.5 cm dbh were recorded. In the 0.01 hectare plot, saplings of 2.5 - 10.0 cm dbh were recorded. The average seedling and sapling densities (total individuals/hectare) were determined as follows:

$$\text{Seedling Density} = \frac{\text{total seedlings of a species}}{\text{total number of quadrats}} \times 1000$$

$$\text{Sapling Density} = \frac{\text{total saplings of a species}}{\text{total number of quadrats}} \times 100$$

The soils from Site A and Site B at the Hooper Branch Nature Preserve were sampled in late October from 5 randomly chosen spots within each site. The A-horizon depth was determined, and soil from both the A and B horizons were collected. Using an "Ionalyzer" pH meter (model 470 A/L), pH was measured that same evening for both soil horizons. Soil texture was later determined using the Bouyoucos hydrometer method (Bouyoucos 1962).

Nomenclature of all plant species discussed follows Swink and Wilhelm (1979). An alphabetical listing of all plants, with their common names, is found in the Appendix.

RESULTS AND DISCUSSION

Ground Layer Vegetation of Dry and Dry-mesic Sand Savannas at the Iroquois County Conservation Area:

The dry and dry-mesic sand savannas at the Iroquois County Conservation Area were similar to each other in their

general appearance and overall vegetation associations. *Carex pensylvanica* makes up the dominant ground layer species in both savanna types, often being the only species sampled in the quadrats. The dry sand savannas generally occupy the upper slopes and ridges of the sand dunes, and have as their dominant (often exclusive) canopy tree *Quercus velutina*. McDowell *et.al.* (1983) defines the dry-mesic sand savannas as occupying primarily the lower dune slopes, and having a tree canopy consisting of both *Q. velutina* and *Quercus alba*.

The field data that was collected from the two sampling locations for the dry and also for the dry-mesic sand savannas were combinded. A total of 31 species were sampled at the first dry sand savanna location, and a total of 34 species were sampled at the second location. Twenty three species were common to both locations, resulting in a Sorensen Index of Similarity of 0.71 for the dry sand savanna locations. A total of 35 species were sampled at the first dry-mesic sand savanna location, and a total of 36 species were sampled at the second location. Twenty six species were common to both locations, resulting in a Sorensen Index of Similarity of 0.73 for the dry-mesic sand savannas.

All species encountered along with their relative frequencies from the dry and dry-mesic sand savannas at the Iroquois County Conservation Area are listed in Table 1. Those species that were seen and recorded as part of the

total sight inventory but did not occur in any of the quadrats are listed in the table with an asterisk (*). Ten species from Table 1 were "dominant" in that each of these species had a combined relative frequency of 5.0 or greater between the two sand savanna communities. Of these 10 species only one, *Cassia fasciculata* (X^2=0.58), showed no significant difference in relative frequency between the dry and the dry-mesic sand savannas. The nine species that did show a significant difference in their relative frequencies between the two areas were *Carex pensylvanica* (X^2=28.20), *Panicum oligosanthes scribnerianum* (X^2=34.86), *Quercus velutina* (X^2=4.26), *Rosa carolina* (X^2=4.68), *Koeleria cristata* (X^2=9.69), *Smilacina stellata* (X^2=6.31), *Andropogon scoparius* (X^2=5.66), *Rhus copallina latifolia* (X^2=34.86), and *Rubus flagellaris* (X^2=12.89).

The differences in the woody ground layer species were more apparent between the two savannas than their differences in herbaceous composition. All woody species sampled in the dry and the dry-mesic sand savannas are listed in Table 2. A total of 10 species were sampled in the dry sand savanna, with an average of 5.38 stems/m^2. In comparison, there were a total of 15 species found at the dry-mesic site, with an average of 9.42 stems/m^2. Seven species from Table 2 were "dominant" in that each of these species had a combined relative frequency of 5.0 or greater between the two sand

savanna communities. The importance values of those 7 species were analyzed for significance of difference using chi-square. Three of the 7 species, *Rubus pensylvanicus* (X^2=0.04), *Rubus flagellaris* (X^2=2.60), and *Prunus serotina* (X^2=0.30) showed no significant difference in relative frequencies between the two areas. The 4 species that did show a significant differerence in relative frequencies were *Rosa carolina* (X^2=53.60), *Quercus velutina* (X^2=18.40), *Rhus copallina latifolia* (X^2=20.90), and *Ceanothus americanus* (X^2=8.60). The 8 remaining woody species from Table 2 were not found in both areas or if they were, then not with high enough importance values to make comparisons with any accuracy. Six of these 8 species (*Amorpha canescens, Quercus alba, Vaccinium angustifolium laevifolium, Salix humilis, Gaylussacia baccata, and Populus tremuloides*) showed higher importance values in the dry-mesic savanna. Generally, the dry-mesic sand savanna has a denser woody understory than the dry sand savanna. Also, there is a general increase in the appearance and relative frequencies of mesophytic species and a higher number/m^2 of woody stems sampled at the dry-mesic sand savanna than at the dry sand savanna.

Ground Layer Vegetation of the Pin Oak Flatwoods at the Iroquois County Conservation Area:

The Pin Oak flatwoods sampled at the Iroquois County

Conservation Area had a much denser canopy layer than either of the sand savannas, with *Quercus palustris* as the dominant canopy tree. These flatwoods appear in the low depressions between the dunes, and McDowell *et.al.* (1983) notes also that their understory vegetation is much less diverse than that of the open sand savannas.

The field data that were collected from the two sampling locations for the Pin Oak flatwoods were combined. A total of 11 species were sampled at the first location, and a total of 12 species sampled at the second location. Nine species were sampled that were common to both locations, resulting in a Sorensen Index of Similarity of 0.78.

The relative frequencies of the species encountered in the Pin Oak flatwoods are shown in Table 3. Ten of the 15 species sampled were woody, and three species that were seen and recorded as part of the total sight inventory but did not occur in any of the quadrats are listed in the table with an asterisk (*). The dominant ground layer species was *Rubus hispidus obovalis*, with a relative frequency of 26.4%. As in both of the sand savannas, *Carex pensylvanica* was the dominant herbaceous species present, but its relative frequency was lower in the flatwoods (16.8%) than in the dry (26.6%) and in the dry-mesic (19.6%) sand savannas.

Delineation of these two sand savannas communities and the Pin Oak flatwoods generally concurs with the findings of

Madany (1981); McDowell *et.al.* (1983); and Nuzzo (1986).

Ground Layer Vegetation of the Dry Sand Savanna (Sites A & B) at the Hooper Branch Nature Preserve:

The dry sand savanna sampled at the Hooper Branch Nature Preserve was similar to those studied at the Iroquois County Conservation Area. The dominant species in the ground layer was *Carex pensylvanica*, forming a dense cover under the open canopy of *Quercus velutina*. This was the case for both Site A (prescribed controlled burn over the last 3 years, and located south of the access road) and Site B (burned only one time in this same 3 year period, and located north of the access road).

The relative frequencies of each species encountered from Sites A and B at the Hooper Branch Nature Preserve are listed in Table 4. As before, those species that were seen and recorded in the total sight inventory but did not occur in any of the quadrats are listed in the table with an asterisk (*).

Ten species from Table 4 were found to be "dominant" in that each species had a combined relative frequency of 5.0 or greater between the two sites. The following 4 species showed no significant difference in relative frequencies: *Rosa carolina* (X^2=1.25), *Euphorbia corollata* (X^2=0.60), *Panicum villosissimum pseudopubescens* (X^2=0.39), and

Eragrostis spectabilis (X^2=0.39). The following 6 species all showed a significant difference in relative frequencies between the two sites: *Carex pensylvanica* (X^2= 16.25), *Rhus copallina latifolia* (X^2=12.03), *Koeleria cristata* (X^2=4.17), *Andropogon scoparius* (X^2=11.53), *Cassia fasciculata* (X^2=11.48), and *Quercus velutina* (X^2=4.60).

The woody ground layer species encountered at Sites A and B at the Hooper Branch Nature Preserve are listed in Table 5. A total of 4 species were sampled in Site A, with an average of 3.58 stems/m^2. There were a total of 9 species sampled at Site B, with an average of 2.64 stems/m^2. The importance values of the 4 species found at both sites were analyzed for significance of difference using chi-square. One species, *Rosa carolina* (X^2=1.40) showed no significant difference in importance value between the two sites, while *Rhus copallina latifolia* (X^2=49.10), *Quercus velutina* (X^2=19.00), and *Rhus glabra* (X^2=7.20) all showed significant differences. At Site B there was the presence of an additional 5 woody species sampled that were not found at Site A, ranging in importance values from 8.5 to 3.5.

The decrease in the relative frequencies in 8 of the 9 woody species sampled at Site A in comparison to Site B (Table 4) may be the result of the more frequent prescribed burning which has occurred south of the access road over the last 3 years. The fewer number of woody species sampled from

Site A than from Site B (Table 5) may also be explained by the different burning programs between the two sites. The idea that regular burning may actually enhance the growth of certain woody species may explain in part the higher number/m^2 of woody stems sampled at Site A than at Site B. In a study of a Northern Illinois prairie, Kraege (1978) concluded that the growth of *Rubus flagellaris* was shown to be stimulated by regular burning, probably due to litter removal and enhanced seed germination. No direct correlation exists between the results of Kraege's study and the results at the dry sand savanna. Still, it is possible that regular burning may actually stimulate certain woody species, resulting in a higher number of stems to developing at the ground layer.

Overstory and Understory Vegetation Survey of the Dry Sand Savanna (Sites A & B) at the Hooper Branch Nature Preserve:

The results from the woody overstory and understory vegetation survey at the Hooper Branch Nature Preserve are found in Table 6. The canopy layer densities were similar, with an average of 142 trees/hectare at Site A, and an average of 130 trees/hectare at Site B. A total of 453 trees were measured at Site A, 26 of which were dead (5.7% of the total). At Site B, a total of 428 trees were measured, 28 of which were dead (6.5% of the total). The dominant tree by

far was *Quercus velutina* with an IV of 199.5 at Site A, and an IV of 198.4 at Site B. *Quercus alba* was sampled once at Site A and twice at Site B, while *Prunus serotina* was sampled just once at each of the two sites. The distribution of trees in all 5 diameter classes varied somewhat between the two sites, but more important was the similarity that both sites had the majority of trees in the 3 smallest classes (87% in Site A; 80% in Site B). From the distribution of these even-aged stands it can be assumed that both sites (which lie approximately 250 meters apart from one another) recently have experienced similar disturbances. The primary disturbance in this savanna region has been grazing (Glass 1985), and to a lesser extent clearing and occasional fires.

Practically all of the saplings present (as determined from the 0.01 hectare nested circular plots) were *Quercus velutina*. At Site A, 24% of these saplings were resprouted from dead (killed by fire) clumps, while 13% of these at Site B were resprouted from dead clumps. In a study of Black Oak woodlands in Northwestern Indiana, Henderson (1982) found basal sprouting to be more vigorous in areas where fires were less frequent than in areas where fire disturbance had been more regular. Less frequent fires were more intense and therefore more destructive to the canopy trees, which resulted in a greater amount of basal sprouting. Certainly not enough time has elapsed for any conclusions to be drawn

concerning this phenomenon at the two sites in this study.

Seedling density (as determined from the 0.001 hectare nested circular plots) showed the most dramatic differences between the two sites. These values for the 5 species sampled were analyzed for significance of difference using chi-square. All 5 species showed significant differences in seedling densities between Sites A and B: *Quercus velutina* (X^2= 40.60), *Quercus alba* (X^2=22.00), *Prunus serotina* (X^2=140.60), *Rhus copallina latifolia* (X^2=1,316.00), and *Rubus allegheniensis* (X^2=488.00). Only *P. serotina* showed a higher seedling density at Site A than at Site B. The other 4 species all showed lower seedling densities at Site A, in particular *R. copallina latifolia* (a seven-fold decrease) and *R. allegheniensis* (a three-fold decrease). The regular burning which has occurred at Site A over the past 3 years has probably decreased or eliminated the fire intolerant understory vegetation, much of which still exists at Site B. In time it can be expected that seedling densities of fire intolerant species will continue to decrease at Site A if the same fire management is continued. Similar results were found by Henderson (1982) in the Black Oak woodlands in Northwestern Indiana.

Not enough time has elapsed since these two areas were placed under different prescribed burning programs for any significant changes in the canopy layer to have occurred. In

a 13 year study by White (1983) on an oak savanna in Minnesota, annual burning had only a gradual effect on the canopy layer. The large canopy trees (*Quercus ellipsoidalis*) were stressed but not killed by the fires and so the canopy density showed little change over this time period. At the Hooper Branch Nature Preserve it can be assumed that, in time, annual burning will result in an increase in the smaller diameter class trees in the canopy and a decrease in the woody understory density.

The results of the soil analysis at Sites A and B at the Hooper Branch Nature Preserve are given in Table 7. The A-horizon soils from both sites can be considered as sandy to loamy-sands in texture. Also, the average depth of the A-horizon showed no difference between the 2 sites. There was little to no variation in the pH of the soils, which were quite acidic in both soil horizons at both sites.

SUMMARY

The dry and dry-mesic sand savannas at the Iroquois County Conservation Area were similar to one another in general appearance, but the dry-mesic sand savanna had a denser, more woody understory than the dry sand savanna, and occupies the more mesic lower slopes of the dunes. The most frequent ground layer species in both savanna communities was

Carex pensylvanica. *Quercus velutina* was the dominant tree throughout these savannas, although *Quercus alba* was also a common tree at the dry-mesic sand savannas.

The Pin Oak flatwoods were a much less diverse community than either of the sand savannas and consisted of a mostly woody ground layer under a dense canopy of *Quercus palustris*.

No significant differences were noted between the two sites at the dry sand savanna from the Hooper Branch Nature Preserve. There were, however, far fewer woody seedling sampled in the understory at the regularly burned site than at the site that had been burned just once. More years would have to elapse before any significant differences in their vegetation composition could be noted.

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APPENDIX

List of plants, sampled or in total sight inventory, from the September and October '89 field data at the Iroquois County Conservation Area and the Hooper Branch Nature Preserve, Iroquois County, Illinois. Nomenclature follows Swink and Wilhelm (1979).

Achillea millefolium L. - COMMON YARROW.

Ambrosia artemisiifolia elatior (L.)Descourtils - COMMON RAGWEED.

Amorpha canescens Pursh - LEAD PLANT.

Andropogon gerardii Vitman - BIG BLUESTEM GRASS.

Andropogon scoparius Michx. - LITTLE BLUESTEM GRASS.

Anemone cylindrica Gray - THIMBLEWEED.

Antennaria neglecta Greene - CAT'S FOOT.

Aristida purpurascens Poir. - ARROW FEATHER.

Asclepias amplexicaulis Sm. - SAND MILKWEED.

Asclepias tuberosa L. - BUTTERFLY WEED.

Asclepias verticillata L.- WHORLED MILKWEED.

Aster azureus Lindl. - SKY-BLUE ASTER.

Aster linariifolius L. - FLAX-LEAVED ASTER.

Aster simplex Willd. - PANICLED ASTER.

Baptisia leucantha T. & G. - WILD WHITE INDIGO.

Carex bicknellii Britt. - PRAIRIE SEDGE.

Carex muhlenbergii Schkuhr. - SAND SEDGE.

Carex pensylvanica Lam. - PENNSYLVANIA SEDGE.

Carex swanii (Fern.)Mackenz. - SAVANNA SEDGE.

Cassia fasciculata Michx. - PARTRIDGE PEA.

Cassia nictitans L. - WILD SENSITIVE PLANT.

Ceanothus americanus L. - NEW JERSEY TEA.

Chenopodium leptophyllum Nutt. - NARROW-LEAVED GOOSEFOOT.

Commelina erecta deamiana Fern. - NARROW-LEAVED DAY FLOWER.

Coreopsis tripteris L. - TALL COREOPSIS.

Corylus americana Walt. - AMERICAN HAZELNUT.

Cyperus filiculmis Vahl.

Desmodium canadense (L.)DC. - SHOWY TICK TREFOIL.

Desmodium illinoense Gray - ILLINOIS TICK TREFOIL.

Eragrostis hypnoides (Lam.) BSP. - CREEPING LOVE GRASS.

Eragrostis spectabilis (Pursh)Steud. - PURPLE LOVE GRASS.

Erigeron canadensis L. - HORSEWEED.

Eupatorium rugosum Houtt. - WHITE SNAKEROOT.

Euphorbia corollata L. - FLOWERING SPURGE.

Froelichia gracilis (Hook.)Moq. - SMALL COTTON WEED.

Galium pilosum Ait. - HAIRY BEDSTRAW.

Gaylussacia baccata (Wang.)K.Koch - HUCKLEBERRY.

Gentiana saponaria L. - SOAPWORT GENTIAN.

Gerardia pedicularia ambigens Fern. - CLAMMY FALSE FOXGLOVE.

Gnaphalium obtusifolium L. - OLD FIELD BALSAM.

Helianthemum canadense (L.)Michx. - COMMON ROCKROSE.

Helianthus divaricatus L. - WOODLAND SUNFLOWER.

Hieracium gronovii L. - HAIRY HAWKWEED.

Hypericum gentianoides (L.)BSP. - ORANGE GRASS.

Ilex verticillata (L.)Gray - WINTERBERRY.

Juncus greenei Oakes & Tuckerm. - GREENE'S RUSH.

Koeleria cristata (L.)Pers. - JUNE GRASS.

Lactuca canadensis L. - WILD LETTUCE.

Lactuca scariola L. - PRICKLY LETTUCE.

Lepidium virginicum L. - COMMON PEPPERCRESS.

Lespedeza capitata Michx. - ROUND-HEADED BUSH CLOVER.

Lespedeza virginica (L.)Britt. - SLENDER BUSH CLOVER.

Liatris aspera Michx. - ROUGH BLAZING STAR.

Lithospermum canescens (Michx.)Lehm. - HOARY PUCCOON.

Monarda fistulosa L. - WILD BERGAMOT.

Monarda punctata villicaulis Pennell - HORSE MINT.

Nyssa sylvatica Marsh. - BLACK GUM.

Oenothera rhombipetala Nutt. - SAND PRIMROSE.

Osmunda cinnamomea L. - CINNAMON FERN.

Panicum oligosanthes scribnerianum (Nash)Fern.-SCRIBNER'S PANIC GRASS

Panicum villosissimum Nash - WHITE-HAIRED PANIC GRASS.

Panicum villosissimum pseudopubescens (Nash)Fern.

Panicum virgatum L. - SWITCH GRASS.

Paspalum ciliatifolium Michx. - HAIRY LENS GRASS.

Poa compressa L. - CANADA BLUE GRASS.

Polygala polygama obtusata Chodat - PURPLE MILKWORT.

Polygonum coccineum Muhl. - WATER HEARTSEASE.

Polygonum tenue Michx. - SLENDER KNOTWEED.

Populus grandidentata Michx. - LARGE-TOOTHED ASPEN.

Populus tremuloides Michx. - QUAKING ASPEN.

Potentilla simplex Michx. - COMMON CINQUEFOIL.

Prunus serotina Ehrh. - WILD BLACK CHERRY.

Pyrus melanocarpa (Michx.)Willd. - BLACK CHOKEBERRY.

Quercus alba L. - WHITE OAK.

Quercus palustris Muenchh. - PIN OAK.

Quercus velutina Lam. - BLACK OAK.

Rhus copallina latifolia Engler - SHINING SUMAC.

Rhus glabra L. - SMOOTH SUMAC.

Rosa carolina L. - PASTURE ROSE.

Rubus allegheniensis Porter - COMMON BLACKBERRY.

Rubus flagellaris Willd. - COMMON DEWBERRY.

Rubus hispidus obovalis (Michx.)Fern. - SWAMP DEWBERRY.

Rubus pensylvanicus Poir. - YANKEE BLACKBERRY.

Rumex acetocella L. - FIELD SORREL.

Salix humilis Marsh. - PRAIRIE WILLOW.

Sassafras albidum (Nutt.)Nees - SASSAFRAS.

Scrophularia lanceolata Pursh - EARLY FIG WORT.

Scutellaria parvula leonardi (Epling)Fern. - SMALL SKULLCAP.

Smilacina racemosa (L.)Desf. - FEATHERY FALSE SOLOMON'S SEAL.

Smilacina stellata (L.)Desf. - STARRY FALSE SOLOMON'S SEAL.

Solidago gymnospermoides (Greene)Fern.

Solidago nemoralis Ait. - OLD-FIELD GOLDENROD.

Sorgastrum nutans (L.)Nash - INDIAN GRASS.

Spiraea tomentosa rosea (Raf.)Fern. - HARDHACK.

Spiranthes cernua (L.)Richard - NODDING LADIES' TRESSES.

Sporobolus cryptandrus (Torr.)Gray - SAND DROPSEED.

Stipa spartea Trin. - PORCUPINE GRASS.

Tephrosia virginiana (L.)Pers. - HOARY PEA.

Tradescantia ohiensis Raf. - COMMON SPIDERWORT.

Vaccinium angustifolium laevifolium House - EARLY LOW BLUEBERRY.

Viola pedata lineariloba DC. - BIRD'S FOOT VIOLET.

Viola sagittata Ait. - ARROW-LEAVED VIOLET.

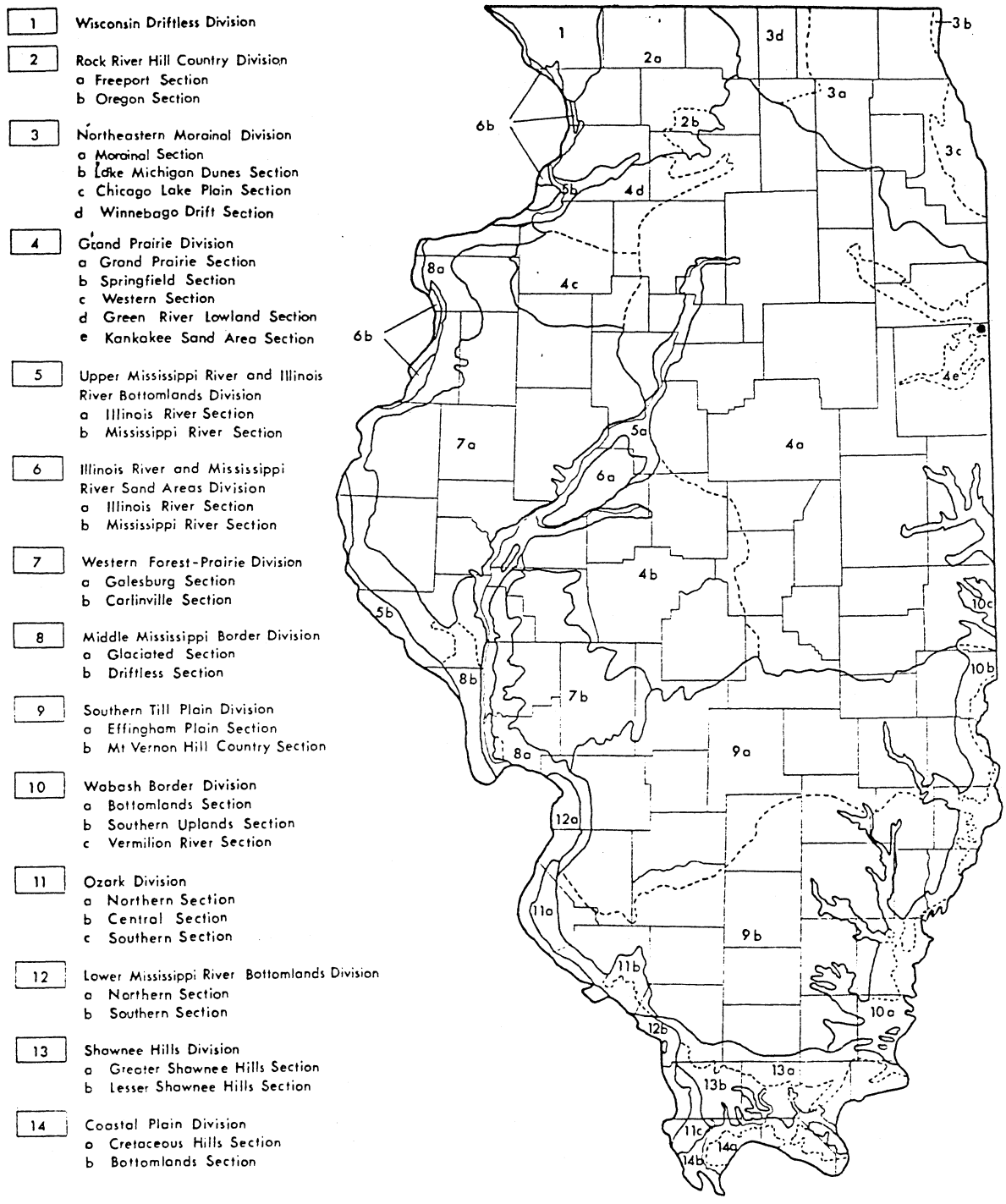

Figure 1. Natural divisions of Illinois showing the Kankakee Sand Area Section (4e) of the Grand Prairie Division. The Iroquois County Conservation Area and the Hooper Branch Nature Preserve are located in the northeast corner of Irquois County, Illinois (●). (Schwegman 1973).

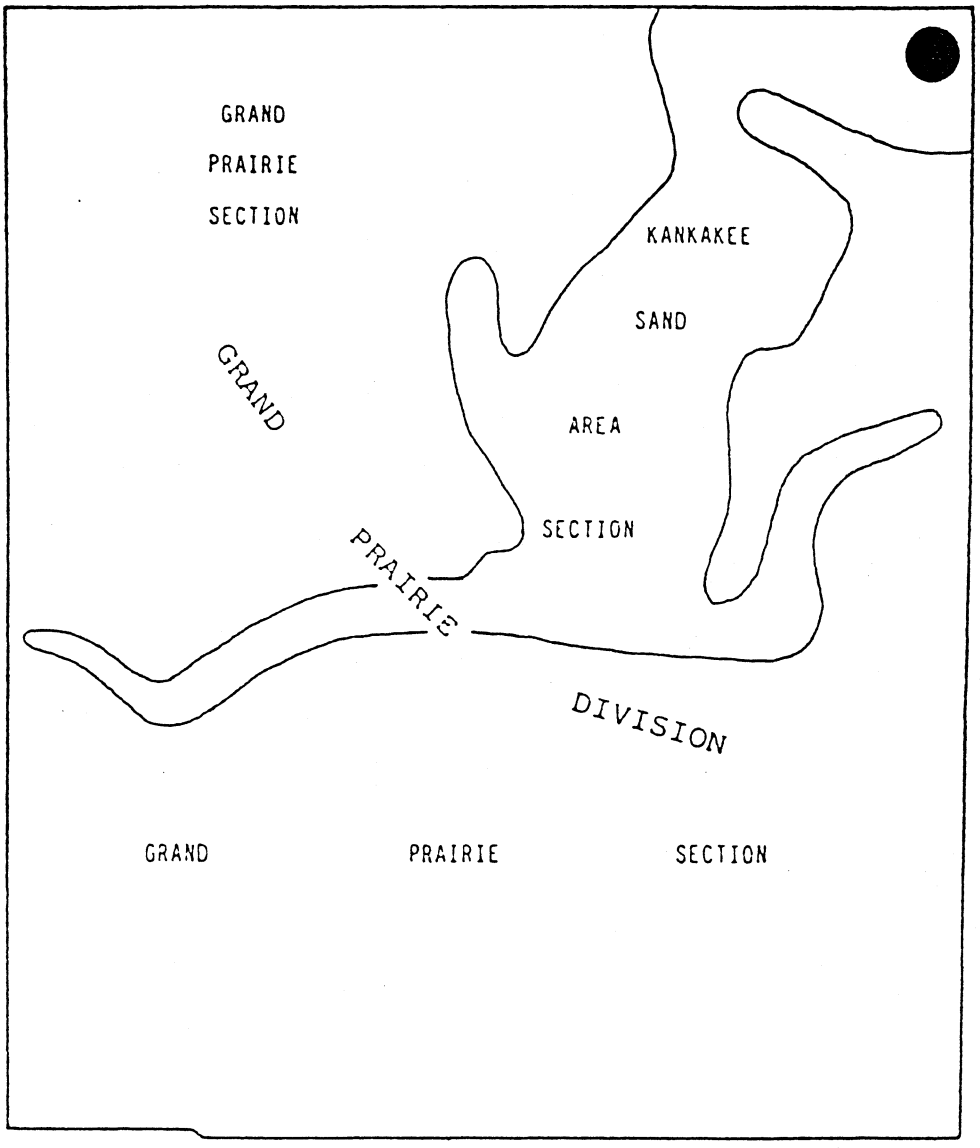

Figure 2. Location of the Iroquois County Conservation Area and the Hooper Branch Nature Preserve in Iroquois County, Illinois (●). (Hedborn 1984).

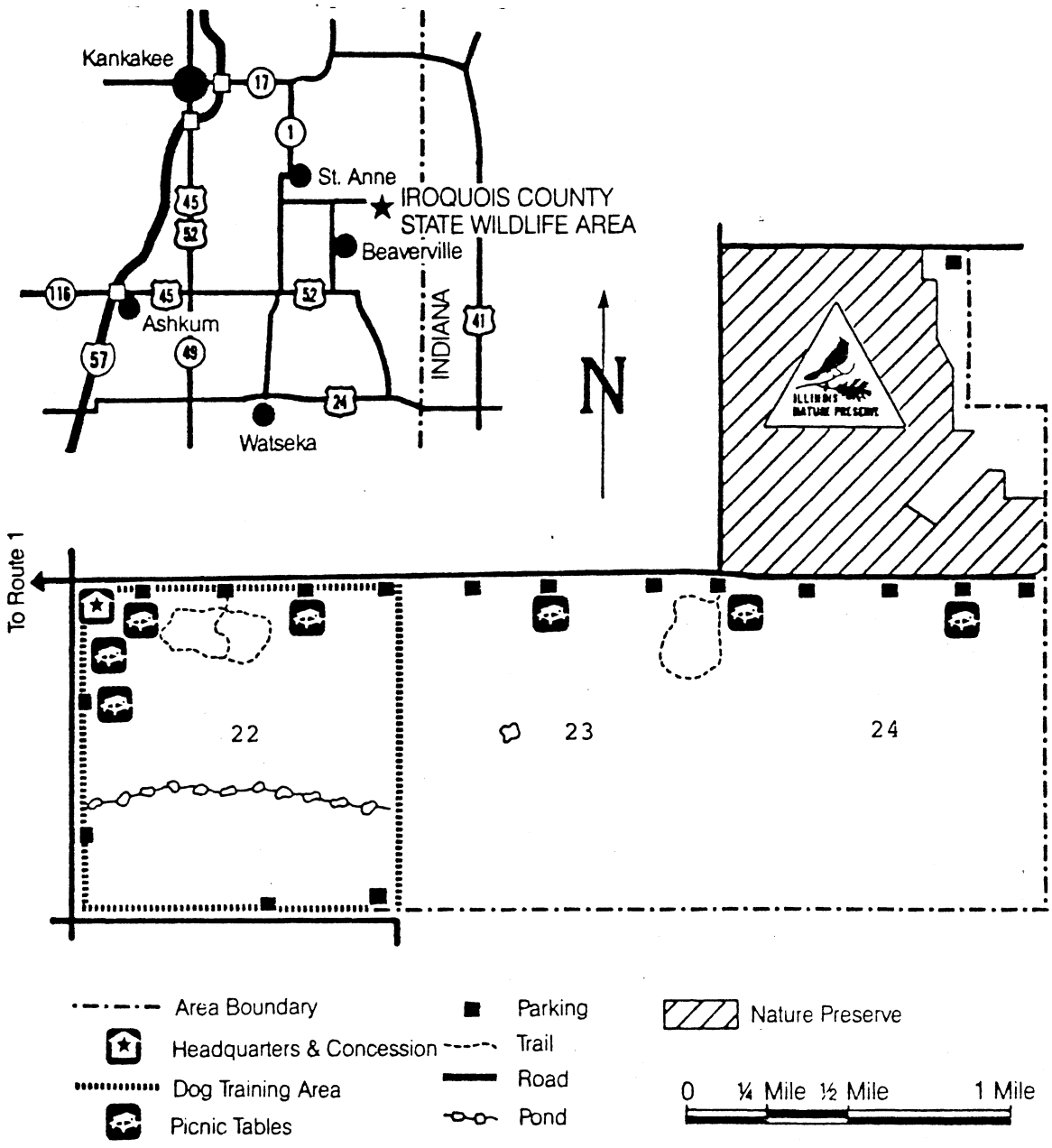

Figure 3. Map of the Iroquois County Conservation Area (T29N, R11W, Sec.22,23,24) and the Hooper Branch Nature Preserve (T29N, R11W, Sec.13). (Ill. Dept. Conservation n.d.)

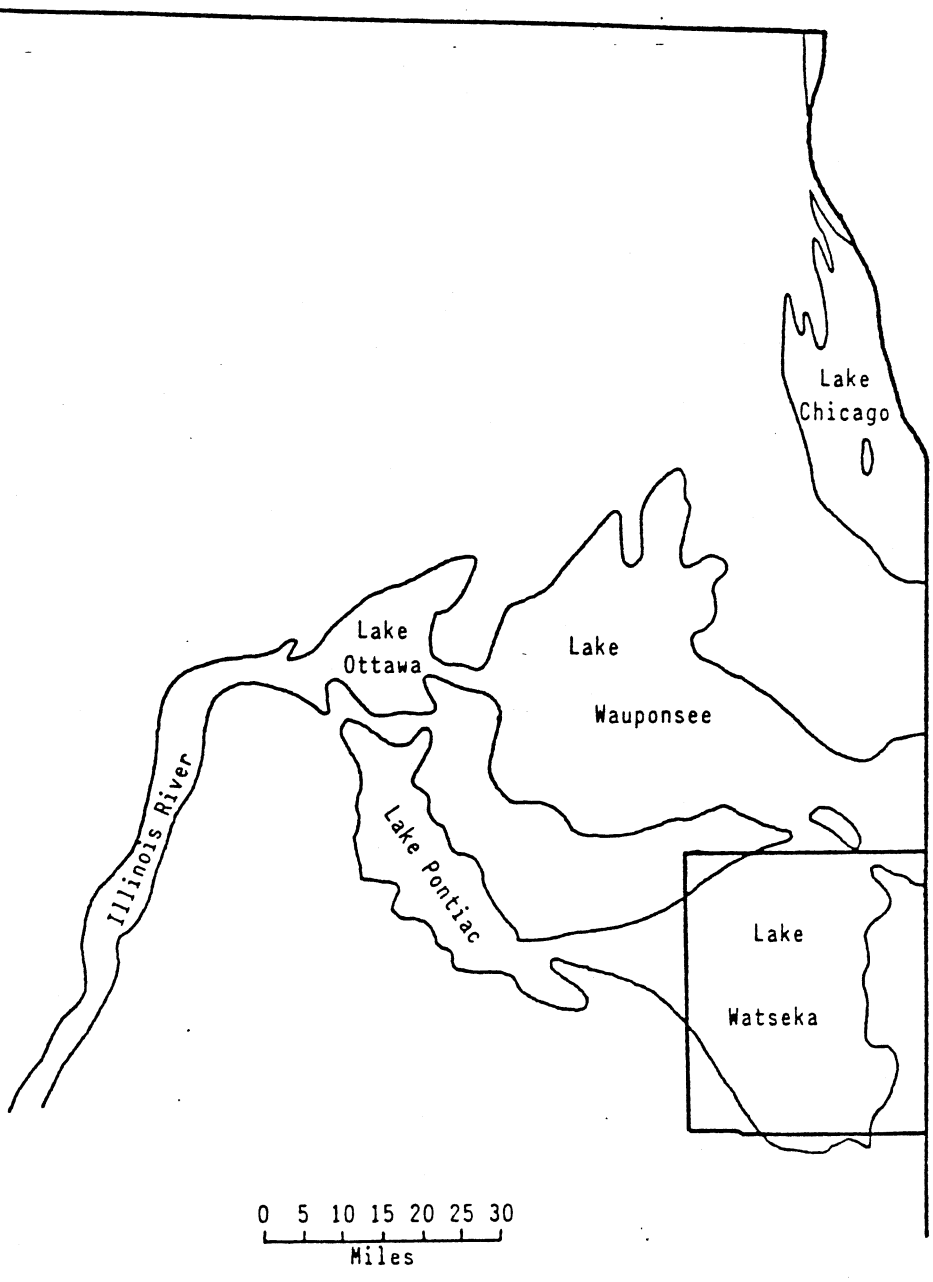

Figure 4. Glacial Lake Watseka and other glacial lakes formed by the Kankakee Torrent. (Hedborn 1984).

Table 1. Relative frequencies of all species sampled from the dry and dry-mesic sand savannas at the Iroquois County Conservation Area, Iroquois County, Illinois. September, 1989.

Species	Dry	Dry-mesic
Carex pensylvanica	26.6	19.6
Panicum oligosanthes scribnerianum	9.9	2.5
Quercus velutina	8.2	5.6
Rosa carolina	7.8	5.3
Koeleria cristata	6.0	2.7
Smilacina stellata	3.8	1.6
Helianthemum canadense	3.8	0.8
Cassia fasciculata	3.6	4.5
Stipa spartea	2.8	0.6
Asclepias verticillata	2.7	0.3
Andropogon scoparius	2.4	4.8
Sporobolus cryptandrus	1.9	-
Rhus copallina latifolia	1.6	12.3
Euphorbia corollata	1.6	1.4
Viola pedata linariloba	1.3	-
Rubus flagellaris	1.1	4.3
Lithospermum canescens	1.1	0.2
Lespedeza virginica	1.1	-
Rubus pensylvanicus	0.9	3.3
Eragrostis spectabilis	0.9	0.2
Prunus serotina	0.8	1.9
Helianthus divaricatus	0.8	0.8
Aster azureus	0.8	0.3
Rumex acetocella	0.8	*
Cyperis filiculmis	0.8	-
Rubus allegneniensis	0.6	0.5
Lespedeza capitata	0.6	0.2
Monarda punctata villicaulis	0.6	0.2
Panicum virgatum	0.5	1.3
Desmodium canadense	0.5	0.5
Commelina erecta deamiana	0.5	0.2
Rhus glabra	0.5	0.2
Polygonum tenue	0.5	-
Amorpha canescens	0.3	1.7
Aristida purpurascens	0.3	-
Gerardia pedicularia ambigens	0.3	-
Scrophularia lanceolata	0.3	-
Ceanothus americanus	0.2	1.1
Panicum villosissimum pseudopubescens	0.2	0.8
Viola sagittata	0.2	0.2
Asclepias amplexicaulis	0.2	-
Juncus greenii	0.2	-
Poa compressa	0.2	-

Scutellaria parvula leonardii	0.2	-
Quercus alba	-	6.1
Vaccinium angustifolium laevifolium	-	2.6
Salix humilis	-	1.7
Potentilla simplex	-	1.6
Andropogon gerardii	*	1.4
Sorgastrum nutans	-	1.3
Galium pilosum	-	0.8
Aster linariifolius	-	0.6
Coreopsis tripteris	-	0.5
Gaylussacia baccata	-	0.5
Populus tremuloides	-	0.5
Solidago gymnospermoides	-	0.5
Antennaria neglecta	*	0.3
Tephrosia virginiana	*	0.3
Achillea millefolium	-	0.3
Monarda fistulosa	-	0.3
Aster simplex	-	0.2
Hieracium gronovii	-	0.2
Polygonum coccineum	-	0.2
Smilacina racemosa	-	0.2
Ambrosia artemisiifolia elatior	*	-
Anemone cylindrica	*	-
Carex muhlenbergii	*	-
Chenopodium leptophyllum	*	-
Erigeron canadensis	*	-
Liatris aspera	*	-
Panicum villosissimum	*	-
Paspalum ciliatifolium	*	-
Solidago nemoralis	*	-
Asclepias tuberosa	-	*
Carex swanii	-	*
Hypericum gentianoides	-	*
Populus grandidentata	-	*
Sassafras albidum	-	*
Spiranthes cernua	-	*
Total	100	100

* = Recorded in the total sight inventory of the area, but not sampled within any of the quadrats.

- = Not recorded in the total sight inventory nor sampled within any of the quadrats.

Table 2. Woody species sampled from the dry and dry-mesic sand savannas at the Iroquois County Conservation Area, Iroquois County, Illinois. September, 1989.

Dry sand savanna: Species	no./m²	Rel. freq.	Rel. den.	IV
Rosa carolina	2.80	35.4	52.2	87.6
Quercus velutina	1.50	36.1	27.5	63.6
Rhus copallina latifolia	0.30	7.1	5.7	12.8
Rubus pensylvanicus	0.24	5.7	4.5	10.2
Rubus flagellaris	0.22	5.0	4.1	9.1
Prunus serotina	0.10	3.6	1.9	5.5
Rubus allegheniensis	0.10	2.9	1.9	4.8
Rhus glabra	0.06	2.1	1.1	3.2
Amorpha canescens	0.04	1.4	0.7	2.1
Ceanothus americanus	0.02	0.7	0.4	1.1
Total (10 spp.)	5.38	100.0	100.0	200.0
Dry-mesic sand savanna: Species				
Rhus copallina latifolia	2.20	25.5	23.2	48.7
Quercus alba	1.28	11.8	13.9	25.7
Quercus velutina	1.10	11.6	12.0	23.6
Rosa carolina	0.82	10.9	8.6	19.5
Rubus flagellaris	0.92	8.9	9.7	18.6
Ceanothus americanus	0.78	3.3	8.2	11.5
Vaccinium angustifolium laevifolium	0.54	5.6	5.7	11.3
Rubus pensylvanicus	0.44	6.6	4.6	11.2
Salix humilis	0.34	3.6	3.6	7.2
Prunus serotina	0.30	4.0	3.2	7.2
Amorpha canescens	0.26	3.6	2.7	6.3
Gaylussacia baccata	0.28	2.0	3.0	5.0
Rubus allegheniensis	0.08	1.3	0.8	2.1
Populus tremuloides	0.06	1.0	0.6	1.6
Rhus glabra	0.02	0.3	0.2	0.5
Total (15 spp.)	9.42	100.0	100.0	200.0

Table 3. Relative frequencies of all species sampled from the Pin Oak flatwoods at the Iroquois County Conservartion Area, Iroquois County, Illinois. September, 1989.

Species	Rel. freq.
Rubus hispidus obovalis	26.4
Carex pensylvanica	16.8
Pyrus melanocarpa	12.3
Gaylussacia baccata	12.0
Vaccinium angustifolium laevifolium	9.5
Spiraea tomentosa rosea	8.4
Quercus palustris	4.9
Panicum villosissimum	3.2
Panicum villosissimum pseudopubescens	2.8
Nyssa sylvatica	1.8
Prunus serotina	0.7
Baptisia leucantha	0.4
Ilex verticillata	0.4
Salix humilis	0.4
Eragrostis hypnoides	*
Gentiana saponaria	*
Osmunda cinnamomea	*
Total (17 spp.)	100.0

* = Recorded in the total sight inventory of the area, but not sampled within any of the quadrats.

Table 4. Relative frequencies of all species sampled from the dry sand savanna at the Hooper Branch Nature Preserve, Iroquois County, Illinois. September, 1989.

Species	Site A	Site B
Carex pensylvanica	35.1	23.7
Rosa carolina	6.9	8.0
Euphorbia corollata	6.9	4.9
Rhus copallina latifolia	6.2	0.7
Panicum villosissimum pseudopubescens	5.8	4.2
Eragrostis spectabilis	4.6	5.2
Rumex acetocella	4.6	-
Koeleria cristata	3.9	7.8
Panicum virgatum	3.9	*
Cassia nictitans	3.1	0.3
Andropogon scoparius	2.6	9.1
Tephrosia virginiana	2.6	1.0
Sporobolus cryptandrus	2.3	-
Liatris aspera	1.5	*
Cassia fasciculata	1.2	6.6
Quercus velutina	1.2	4.2
Asclepias verticillata	1.2	2.8
Lithospermum canescens	1.2	0.8
Commelina erecta deamiana	1.2	0.4
Cyperus filiculmis	0.8	2.8
Erigeron canadensis	0.8	0.3
Monarda punctata villicaulis	0.8	*
Helianthemum canadense	0.4	1.8
Rhus glabra	0.4	1.4
Polygonum tenue	0.4	-
Viola pedata linariloba	0.4	-
Panicum oligosanthes scribnerianum	-	5.6
Andropogon gerardii	-	1.4
Corylus americana	*	1.0
Achillea millefolium	-	1.0
Prunus serotina	*	0.7
Smilacina stellata	*	0.7
Lespedeza capitata	-	0.7
Rubus allegheniensis	-	0.7
Rubus flagellaris	-	0.7
Ambrosia artemisiifolia elatior	*	0.3
Sorgastrum nutans	*	0.3
Amorpha canescens	-	0.3
Juncus greenii	-	0.3
Lepidium virginicum	-	0.3
Aster linariifolius	*	*
Oenothera rhombipetala	*	*
Stipa spartea	*	*

Asclepias amplexicaulis	*	-
Asclepias tuberosa	*	-
Carex bicknellii	*	-
Carex muhlenbergii	*	-
Froelichia gracilis	*	-
Lactuca canadensis	*	-
Paspalum ciliatifolium	*	-
Polygala polygama obtusata	*	-
Sassafras albidum	*	-
Antennaria neglecta	-	*
Chenopodium leptophyllum	-	*
Desmodium illinoense	-	*
Eupatorium rugosum	-	*
Gerardia pedicularia ambigens	-	*
Gnaphalium obtusifolium	-	*
Hieracium gronovii	-	*
Lactuca scariola	-	*
Scrophularia lanceolata	-	*
Solidago gymnospermoides	-	*
Solidago nemoralis	-	*
Tradescantia ohiensis	-	*
Total	100.0	100.0

* = Recorded in the total sight inventory of the area, but not sampled within any of the quadrats.

- = Not recorded in the total sight inventory nor sampled within any of the quadrats.

Table 5. Woody species sampled from the dry sand savanna at the Hooper Branch Nature Preserve, Iroquois County, Illinois. September, 1989.

Site A: Species	no./m²	Rel. freq.	Rel. den.	IV
Rosa carolina	2.52	47.4	70.0	117.4
Rhus copallina latifolia	0.92	42.1	25.6	67.7
Quercus velutina	0.12	7.9	3.3	11.2
Rhus glabra	0.02	2.6	1.1	3.7
Total (4 spp.)	3.58	100.0	100.0	200.0

Site B: Species				
Rosa carolina	1.44	46.0	53.7	99.7
Quercus velutina	0.52	24.0	19.4	43.4
Rhus glabra	0.20	8.0	7.5	15.5
Corylus americana	0.12	4.0	4.5	8.5
Prunus serotina	0.12	4.0	4.5	8.5
Rhus copallina latifolia	0.08	4.0	3.0	7.0
Rubus allegheniensis	0.08	4.0	3.0	7.0
Rubus flagellaris	0.04	4.0	2.9	6.9
Amorpha canescens	0.04	2.0	1.5	3.5
Total (9 spp.)	2.64	100.0	100.0	200.0

Table 6. Woody overstory and understory vegetation survey from the dry sand savanna at the Hooper Branch Nature Preserve, Iroquois County, Illinois. October, 1989.

Site A:

	Seedlings	Saplings	Diameter classes (no./ha)						B.A.	Rel.	Rel.	IV	Av. Diam.
Species	no./ha	no./ha	10-20cm	20-30cm	30-40cm	40-50cm	50+cm	total	m^2/ha	den.	dom.		cm
Quercus velutina	1208	323	42.0	58.7	23.3	12.7	5.0	141.7	8.81	99.6	99.9	199.5	25.8
Quercus alba	-	4	0.3	-	-	-	-	0.3	-	0.2	-	0.2	19.8
Prunus serotina	250	2	0.3	-	-	-	-	0.3	0.01	0.2	0.1	0.3	10.4
Rhus copallina	271	-											
Rubus allegheniensis	521	-											
Totals	2250	329	42.6	58.7	23.3	12.7	5.0	142.3	8.82	100.0	100.0	200.0	

Site B:

Species													
Quercus velutina	1542	390	53.7	21.7	26.3	22.3	4.7	128.7	8.91	99.3	99.1	198.4	26.2
Quercus alba	21	2	-	-	0.3	0.3	-	0.6	0.07	0.5	0.8	1.3	37.6
Prunus serotina	146	2	0.3	-	-	-	-	0.3	0.01	0.2	0.1	0.3	11.1
Rhus copallina	2000	-											
Rubus allegheniensis	1521	-											
Totals	5230	394	54.0	21.7	26.6	22.6	4.7	129.6	8.99	100.0	100.0	200.0	

Table 7. Soil analysis from the dry sand savanna at the Hooper Branch Nature Preserve, Iroquois County, Illinois. October, 1989.

	% Sand	% Silt	% Clay	Av. pH	Av. depth (cm)
Site A:					
A horizon	84.8	6.2	9.0	3.9	13.4
B horizon	92.8	4.8	2.4	3.9	-
Site B:					
A horizon	87.0	5.8	7.2	4.0	13.0
B horizon	98.2	1.6	0.2	3.8	-