

Title: A Rare Mixed-Oak Sand Flatwoods Community, Iroquois County Conservation

Area, Illinois

Running Head: Rare Mixed-Oak Sand Flatwoods

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Paul B. Marcum, Loy R. Phillippe, John E. Ebinger*

Illinois Natural History Survey, Prairie Research Institute, The University of Illinois,
1816 South Oak Street, Champaign, Illinois 61820.

*corresponding author (jeebinger@eiu.edu)

ABSTRACT

Sand flatwoods communities dominated by *Quercus palustris* (pin oak) are occasionally encountered in the Kankakee Sands Region of the Grand Prairie Natural Division in northeastern Illinois. These communities are typically found in depressions subject to ponding from a seasonally high water table. Recently, a rare mixed-oak sand flatwoods community was encountered. This previously undescribed community type is slightly elevated above the typical sand flatwoods and therefore elevated above and influenced less by groundwater. The area is still largely flat but with slight depressions that collect rainwater. Here, *Q. ellipsoidalis* (Hill's oak) dominates with an Importance Value (IV200) of 116.1, (200 possible), *Q. palustris* is also common (IV200 of 72.0), while *Q. alba* (white oak) is occasional (IV200 of 10.6). This community has a well-developed woody understory; seedlings and saplings of *Q. ellipsoidalis* and *Q. palustris* are very common along with the shrubs *Vaccinium angustifolium* (low-bush blueberry) and *Aronia melanocarpa* (black chokeberry). Mean cover of ground layer vegetation

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averages 80%. The dominant herbaceous species is *Carex pensylvanica* (Pennsylvania sedge). Overall, this unique community type had low species diversity, especially in the canopy and ground layer.

Key words: Hill's oak/pin oak/white oak sand flatwood, Importance Value, Kankakee sand deposits, mixed-oak sand flatwoods, northeastern Illinois.

INTRODUCTION

Sand deposits account for nearly 5% of the land surface of Illinois, one of the largest being the Kankakee Sand Area Section of the Grand Prairie Natural Division located in parts of Grundy, Iroquois, Kankakee, and Will counties, Illinois, and adjacent Newton County, Indiana (Schwegman et al. 1973). Occurring on glacial outwash plains associated with erosion events of Wisconsin glaciation, this sand deposit remained after glacial lakes were drained about 14,500 years ago during the Kankakee Torrent (King 1981; Willman and Frye 1970).

Sand flatwoods are relatively rare communities, only a few being found in the Kankakee sand deposits, and are very rare or non-existent from the other sand areas of Illinois. This community type where dominated by *Quercus palustris* (pin oak) has been studied (McDowell et al. 1983; Phillippe et al 2009, 2010), but a sand flatwoods community dominated by *Q. ellipsoidalis* (Hill's oak), *Q. palustris*, and *Q. alba* (white oak) has not previously been described in Illinois. The present study was undertaken to determine woody species composition and structure, and the floristic composition of the ground layer vegetation in a mixed-oak sand flatwoods community at the Iroquois County Conservation Area (ICCA).

DESCRIPTION OF THE STUDY AREA

The ICCA is situated at the edge of former glacial Lake Watseka, drained during the Kankakee Torrent, leaving sandy beaches and near-shore sand deposits (Willman and Frye 1970; Willman 1973; Curry et al. 2014). These sands were reworked by wind creating the present-day dune and swale topography of the region. The characteristic sand savanna, sand prairie, and sedge meadow vegetation became established during the Hypsithermal period about 8,000 years ago (King 1981).

The ICCA, which encompasses 7.8 km², is located in extreme northeastern Iroquois County about 6 km northeast of the town of Beaverville. The flatwoods studied is located in the southeast part of the ICCA (SE1/4 SE1/4 Sec 24 T29N R11W; 40.98262°N/87.54307°W). Purchased by the Illinois Department of Conservation in 1944 as a prairie chicken sanctuary, the ICCA is now used principally as a hunting area. Based on historical aerial photography interpretation, when purchased most of the area had been heavily grazed and attempts had been made to drain the extensive sedge meadow and marsh communities in the southwest part of the preserve (Illinois State Geological Survey 2008). Hedborn (1984) studied the vascular flora of Iroquois County through thorough literature search and field studies and includes information on presettlement vegetation, soils, settlement history, and vegetation types. McDowell et al. (1983) described the composition and structure of the savanna communities of the ICCA, and more recently, Phillippe et al. (2002) and Phillippe et al. (2009) reported on the vascular flora of ICCA. Management of the site has included prescribed burns, efforts to remove invasive species (e.g., *Phalaris arundinacea* [reed canary grass]) and aggressive species (e.g., *Populus tremuloides* [quaking aspen], and *Salix* spp. [willow]), and levee repair (Eric Smith, IDNR Natural Heritage, personal communication).

The sand flatwoods, found in depressions between the dunes, are on Watseka loamy sands and Morocco fine sands (Wascher et al. 1951; Keifer 1982). These soils, derived from sandy outwash sediments, consist of 1-meter or more of acid, peaty sand over clay with a black surface horizon, and are poorly drained. Furthermore, Morocco fine sands are said to have a minor component (3%) of Maumee soils, for which the USDA Web Soil Survey gives an ecological site description of wet sandy flatwoods (F097XA008MI) (Soil Survey Staff, NRCS, USDA 2020). Climate at the ICCA is continental with warm summers and cold winters. Mean annual precipitation is 98.0 cm, with May having the highest rainfall (11.5 cm). Mean annual temperature is 9.9°C with the hottest month being July (average of 23.6°C), the coldest January (average of -5.7°C). Frost free days range from 141 to 206, with an average of 174 days per year (Midwestern Regional Climate Center 2009, Kankakee, Illinois).

METHODS

On October 9-10 and 19, 2007, the vegetation of the mixed-oak sand flatwoods was studied using a 100 m x 100 m (1-ha) area divided into contiguous quadrats 25 m on a side (16 quadrats). This 1-ha plot was placed near the center of the flatwoods, all sides at least 10 m from the community boundary. In each quadrat all living woody stems ≥ 10.0 cm dbh were identified and their diameters recorded. From these data, density (stems/ha), basal area (m^2/ha), relative density, relative dominance, importance value (IV), and average diameter (cm) were calculated for each species. Determination of the IV follows the procedure used by McIntosh (1957) and is the sum of the relative density and relative dominance (basal area) or IV200. Botanical nomenclature for most species follows Mohlenbrock (2002); nomenclature for endangered and threatened species follows the Illinois Endangered Species Protection Board (2020).

During the field work, some oak individuals not typical of *Quercus ellipsoidalis* were encountered. Representative specimens were sent to Dr. Andrew Hipp, an oak specialist at The Morton Arboretum, who verified that some of the specimens represented introgression with *Q. velutina* (black oak) (e-mail, 16 October 2014), a conclusion verified by Dr. Gerould Wilhelm (e-mail, 16 October 2014). These specimens are included under *Q. ellipsoidalis* in this study.

Woody understory composition and density (stems/ha) were determined using nested circular plots 0.0001, 0.001, and 0.01 ha in size. The nested plots were located at about 25 m intervals along four transects through the study area (20 sets of circular plots). Four additional 0.0001 ha circular plots were located 6 m from the center points along cardinal compass directions. Woody seedlings (≤ 50 cm tall) were recorded in the 0.0001 ha plots; small saplings (> 50 cm tall and < 2.5 cm dbh) in the 0.001 ha circular plots; and large saplings (2.5-9.9 cm dbh) in the 0.01 ha circular plots.

The ground layer vegetation was sampled along two 25-m long transects. Along each transect, 1.0 m² plots were located at 1-m intervals ($n=25/\text{transect}$) and offset a random distance (0-9 m) from the transect, with odd-numbered quadrats positioned to the right, even-numbered to the left. A random numbers table was used to determine the offset distance each quadrat was placed from the transect line. Cover of each species was determined using the Daubenmire cover class system (Daubenmire 1959) as modified by Bailey and Poulton (1968). Importance value (IV200) was determined by summing relative cover and relative frequency.

RESULTS

The mixed-oak sand flatwoods at the ICCA, like most other Illinois examples of sand flatwoods communities, is small, being less than 3 ha in size. The flatwoods had few species, as

only 22 species were recorded in all sampling plots (Tables 1, 2, and 3). All species observed in the sampling plots were native. Four species were recorded in the tree plots, seven in the large sapling plots, sixteen in small sapling plots, thirteen in seedling plots, and fourteen in the ground layer plots. Despite having low species diversity, this portion of ICCA is home to seven Illinois endangered plant species (*Carex cumulata* [clustered oval sedge], *Carex straminea* [eastern straw sedge], *Hypericum adpressum* [shore St. John's wort], *Persicaria careyi* [Carey's smartweed], *Scleria pauciflora* [few-flowered nut rush], *Sisyrinchium atlanticum* [eastern blue-eyed grass], and *Vaccinium corymbosum* [high-bush blueberry]) and one Illinois threatened plant species *Drosera intermedia* (narrow-leaved sundew) (Illinois Natural Heritage Database, Jeannie Barnes personal communication; Illinois Endangered Species Protection Board 2020). Only *Vaccinium corymbosum* was observed in our sampling plots for the current study.

The woody overstory of the flatwoods averaged 232 stems/ha with a basal area of 13.7 m²/ha (Table 1). Only four tree species were recorded in the tree plots and only two (*Quercus ellipsoidalis* and *Q. palustris*) were common and represented in the larger tree size classes. *Q. ellipsoidalis* dominated and accounted for nearly 58% of the canopy (IV200 of 116.1), *Q. palustris* ranked second in importance (IV200 of 72.0) followed by *Q. alba* (IV200 of 10.6); there also were a few individuals of *Nyssa sylvatica* (black gum) (Table 1). Both *Q. ellipsoidalis* and *Q. palustris* were common and evenly distributed throughout the mixed-oak sand flatwoods. *Q. ellipsoidalis* was most abundant in the larger size classes (20-29, 30-39, and 40-49 cm) while *Q. palustris* was abundant in the smaller size classes (10-19 and 20-29 cm).

Sassafras albidum (sassafras) and *Populus grandidentata* (big-tooth aspen) were the most abundant large saplings with 215 and 140 stems/ha respectively. Relatively few oaks were recorded in the stratum with 20 stems/ha of *Quercus ellipsoidalis* and *Q. alba* (Table 2). Small

saplings (51,500/ha) and seedlings (140,600/ha) were abundant. Woody shrub species *Aronia melanocarpa* (black chokeberry) (21,150 small saplings/ha and 3,500 seedlings/ha) and *Vaccinium angustifolium* (low-bush blueberry) (9,150 small saplings/ha and 121,500 seedlings/ha), both colonial spreading shrubs, were the most important. Oaks were also well represented with 5,950 small saplings and 4,900 seedlings of *Q. ellipsoidalis* and 950 small saplings/ha and 4,400 seedlings/ha of *Q. palustris*.

The ground layer vegetation (herbaceous species and woody plants ≤ 50 cm tall) was patchy but mostly dense with bare ground and litter averaging only 22.9% (Table 3). Fourteen species were recorded in the ground layer sampling plots. *Carex pensylvanica* (Pennsylvania sedge) with an IV200 of 29.5) was the only non-woody species important in this stratum (Table 3). The most important species in this stratum were shrub species. *Vaccinium angustifolium* had an IV200 of 69.5 and *Rubus hispidus* (bristly dewberry) had an IV200 of 56.1. Oak species were also present in the ground layer.

DISCUSSION

Sand flatwoods dominated by pin oak are rare in Illinois (White 1978), primarily restricted to a few small sites in Iroquois, Kankakee, and Cook counties. Most notably, sand flatwoods are known from ICCA (McDowell et al. 1983) and adjacent Hooper Branch Nature Preserve, both in Iroquois County (Phillippe et al. 2009, 2010), as well as Zander Woods (Thornton-Lansing Road Nature Preserve) and Jurgensen Woods (Jurgensen Woods North Nature Preserve) in Cook County. Only 21 acres of high-quality (Grade B) sand flatwoods occur in Illinois, all at Zander Woods (White 1978). Taft et al. (1995) documented additional flatwoods in Washington County (Chip-O-Will and Recker Woods), Illinois that have $>50\%$ sand in the A

horizon and could also be classified as sand flatwoods. Faber-Langendoen (2001) states there are probably fewer than 100 occurrences throughout the range and only 18 occurrences documented in Illinois, Indiana, and Michigan. Most are small, a few hectares in size; pin oak dominates most sites with occasional white oak. *Quercus stellata* (post oak) is the dominant species at Washington County sites.

Mixed-oak sand flatwoods dominated by *Quercus ellipsoidalis*, *Q. palustris*, and *Q. alba* are very rare. We only know of the example described in this article. Throughout the ICCA the water table is near the ground surface, causing ponding of lowland areas during the spring and sometimes early summer. Since the mixed-oak sand flatwoods community is at a slightly higher elevation, ponding is for a shorter duration than in the pin oak sand flatwoods. The ground layer of sand flatwoods communities rarely exceeds 25% cover, while bare sand and litter account for over 75% (Phillippe et al. 2009, 2010). The mixed-oak sand flatwoods studied in this article had over 80% cover and bare ground and litter was 23%. The shorter duration of ponding in this mixed-oak sand flatwoods is likely a reason for the more extensive ground layer, particularly the shrubby species. This increased shrub cover is likely a primary reason for low species diversity in the herbaceous layer.

Long-term fire suppression followed by infrequent prescribed burns is also a likely reason for high cover of colonial shrub species. As with other natural communities in the Kankakee Sands, the natural communities at ICCA are part of a fire-adapted system (Nuzzo 1986; Consadine 2009; Consadine et al. 2013). The sand savannas and flatwoods of this area; however, are different today compared to pre-settlement time in the early 1800's (Phillippe et al. 2011). Originally, natural fires and those set by early aborigines decreased woody invasion. Likewise, early settlers used fire to maintain open pasture (McClain and Elzinga 1994). Until

management resumed in the Midwest in recent decades there was a long period of reduced fire frequency followed by a total absence of fire. This absence of fire, even for just a few decades, has resulted in dramatic loss of oak savanna habitat in the Midwest (Taft 1997).

Historical aerial photography from 1940 shows this area to be very open (Illinois State Geological Survey 2008). Only scattered trees were present, likely a result of past grazing and fire. This area is thought to have been a wet sand flatwoods community based on the current composition and its landscape setting, as similar sites exist elsewhere at ICCA (Phillippe et al. 2002) and adjacent Hooper Branch (Phillippe et al. 2010). Historically this area might also have been wet shrub prairie or wet to wet-mesic sand prairie. White (1978) points out that without fire these communities can succeed to sand flatwoods. In recent decades this part of ICCA has been burned in 1999, 2003, and 2012 (Eric Smith, IDNR, personal communication). Increased fire management should promote the more fire-tolerant *Quercus ellipsoidalis* while an intermediate or infrequent fire management regime could favor pin oak. Currently, this site appears to have sufficient recruitment of both *Q. ellipsoidalis* and *Q. palustris* to have sustainable canopy composition.

A major problem facing the ICCA is the loss of ground water due to ditching efforts on the surrounding farmland and the increased use of center-pivot irrigation systems in the area. This de-watering has resulted in the loss of the marsh communities along the east edge of the ICCA, while the extensive sedge meadow in the southwestern part of the preserve has become drier. The sand flatwoods are also dependent on this high water table. The lowering of the water table will undoubtedly result in successional changes and may have contributed to the mixing and apparent hybridization of multiple species in the red oak group, including *Quercus ellipsoidalis*, *Q. velutina*, and *Q. palustris*.

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Accepted article

Table 1. Density by diameter class (stems/ha), basal area (m²/ha), relative density, relative dominance, importance value (IV200), and average diameter for the woody species recorded for a mixed-oak sand flatwoods community, Iroquois County Conservation Area, Iroquois County, Illinois.

Species	Diameter Classes (cm)					Total #/ha	Basal Area m ² /ha	Rel. Den.	Rel. Dom.	IV200	Avg. Diam. (cm)
	10-19	20-29	30-39	40-49	50+						
<i>Quercus ellipsoidalis</i>	12.0	59.0	40.0	11.0	1.0	123.0	8.665	53.0	63.1	116.1	28.9
<i>Quercus palustris</i>	32.0	40.0	19.0	1.0	--	92.0	4.441	39.7	32.3	72.0	23.6
<i>Quercus alba</i>	10.0	4.0	--	--	1.0	15.0	0.568	6.5	4.1	10.6	19.9
<i>Nyssa sylvatica</i>	1.0	1.0	--	--	--	2.0	0.058	0.8	0.5	1.3	18.9
Totals	55.0	104.0	59.0	12.0	2.0	232.0	13.732	100.0	100.0	200.0	

Accepted article

Table 2. Density (stems/ha) of seedlings, small saplings and large saplings encountered in a mixed-oak sand flatwoods community, Iroquois County Conservation Area, Iroquois County, Illinois. Seedlings = woody stems < 0.5 m; small saplings = stems > 50-cm tall and < 2.5 cm dbh (diameter at breast height); large saplings = stems > 2.5 cm dbh and < 10 cm dbh.

Species	Seedlings	Small Saplings	Large Saplings
<i>Vaccinium angustifolium</i>	121,500	9,150	--
<i>Quercus ellipsoidal</i>	4,900	5,950	20
<i>Quercus palustris</i>	4,400	950	--
<i>Aronia melanocarpa</i>	3,500	21,150	--
<i>Spiraea tomentosa</i>	2,200	2,700	--
<i>Gaylussacia baccata</i>	1,300	2,500	--
<i>Quercus alba</i>	900	550	20
<i>Rubus flagellaris</i>	600	--	--
<i>Sassafras albidum</i>	500	4,000	215
<i>Salix humilis</i>	300	--	--
<i>Prunus serotina</i>	200	600	40
<i>Rhus copallina</i>	200	1,500	5
<i>Nyssa sylvatica</i>	100	50	5
<i>Populus grandidentata</i>	--	1,100	140
<i>Rubus allegheniensis</i>	--	300	--
<i>Populus tremuloides</i>	--	300	--
<i>Vaccinium corymbosum</i>	--	200	--
<i>Spiraea alba</i>	--	150	--
Totals	140,600	51,150	445

Table 3. Frequency (%), mean cover (% of total cover), and importance value (IV) of the species encountered in the ground layer of a mixed-oak sand flatwoods community, Iroquois County Conservation Area, Iroquois County, Illinois. IV = relative frequency (frequency/sum frequency) + relative cover (mean cover/sum cover).

Species	% Freq.	Mean Cover	IV200
<i>Vaccinium angustifolium</i>	70	39.27	69.5
<i>Rubus hispidus</i>	98	21.67	56.1
<i>Carex pensylvanica</i>	76	5.54	29.5
<i>Quercus ellipsoidalis</i>	26	5.24	14.2
<i>Gaylussacia baccata</i>	12	5.10	9.9
<i>Quercus palustris</i>	18	1.97	7.7
<i>Spiraea tomentosa</i>	12	0.21	3.9
<i>Sassafras albidum</i>	6	0.18	2.0
<i>Aronia melanocarpa</i>	4	0.60	1.9
<i>Rubus flagellaris</i>	4	0.12	1.3
<i>Prunus serotina</i>	4	0.02	1.3
<i>Dichanthelium acuminatum</i>	2	0.30	1.0
<i>Rhus copallina</i>	2	0.30	1.0
<i>Solidago canadensis</i>	2	0.06	0.7
Totals		80.58	200.0
Bare Ground/Litter		22.92	

Accepted article