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Effects of Prescribed Burns on the Woody Vegetation of a Dry Sand Savanna, Hooper Branch Nature Preserve, Iroquois County, Illinois

Kenneth C. Johnson and John E. Ebinger
Botany Department
Eastern Illinois University
Charleston, IL 61920

ABSTRACT

Two areas of a dry sand savanna remnant at the Hooper Branch Nature Preserve have been subjected to different fire regimes with one site burned every spring from 1987 through 1989, while the other site was burned only in the spring of 1987. The overstory at both sites was similar, varying from 129 to 142 stems/ha and a basal area of 8.82 to 8.99 m^2/ha with *Quercus velutina* Lam. (black oak) accounting for 99% of the individuals. In the seedling and small shrub layer, annual burning enhanced the growth of some shrub species (*Rosa carolina* L.), while less frequent burns enabled the establishment and continued success of others, particular seedlings of black oak. Overall, annual burns appear to decrease tree seedling and shrub densities. Sapling densities are similar at both burn sites, but more damaged and top-killed individuals were present at the site which was burned annually.

INTRODUCTION

Oak savannas occurred across much of North America at the time of European settlement in the early 1800's. According to Nuzzo (1986) these were communities of open-grown trees occurring in small groves or as scattered individuals, having a herbaceous (primarily grass) understory. Savannas occurred throughout much of Illinois at this time, forming either broad ecotones separating forest from prairie, or as isolated communities surrounded by prairie. Illinois oak savannas are separated into three subclasses: black soil savannas which occur on fine-textured soils of glacial till plains; sand savanna which occur on sandy, acidic soils; and barrens which are present on excessively drained, acidic soils (Madany 1981, Packard 1991).

The present study was undertaken at the Hooper Branch Nature Preserve, Iroquois County, Illinois, located in the Kankakee Sand Area Section of the Grand Prairie Division (Schwegman 1973). This 230 ha tract of forest, savanna, prairie, and successional field communities, is located north and adjacent to the Iroquois County Conservation Area. The land was acquired by the Illinois Department of Conservation in

1984, and 195 ha were dedicated as an Illinois Nature Preserve in 1985. This area is situated at the edge of former Glacial Lake Watseka which was formed approximately 14,000 years ago during the Kankakee Flood (Willman and Frye 1970). Due to the incising of the Illinois River Valley, this glacial lake was eventually drained, leaving sandy beach and near shore deposits. Wind action created the sand dunes and swales which was followed by establishment of characteristic sand savanna and sand prairie vegetation during the Hypsithermal period (King 1981). According to Hedborn (1984) prairie vegetation covered 92% of Iroquois County at the time of European settlement. The regular fires that swept across the open prairies restricted the encroachment of woodlands onto the open prairie, and was a major factor in the development and maintenance of savanna communities. Fire exclusion has allowed many oak savanna communities to become closed forests with dense understories (Gleason 1912, 1913, Transeau 1935, Curtis 1959, Vogl 1974, Ebinger and McClain 1991). The present study was undertaken to determine the structure and composition of the dry sand savanna community at Hooper Branch Nature Preserve, and to examine the effects of fire on this community.

STUDY AREA

The study area, located about 6 miles NE of Beaverville, Iroquois County, Illinois, was recognized as good quality dry sand savanna by the Illinois Natural Areas Inventory (White and Madany 1978). This dry sand savanna remnant is about 30 ha in size, and occurs on elevated dunes in the Hooper Branch Nature Preserve (NW1/4, Sec 13 T29N R11W) at an elevation of about 206 m above sea level. The savanna is located on Plainfield fine sand, a light-colored, acidic, sandy soil derived from wind-blown deposits (Wascher et al. 1951). Dry-mesic sand savanna and scrub prairie/mesic sand prairie communities border and intergrade into this dry sand savanna. An east-west access road transverses the study area dividing it into two nearly equal parts. Land management practices south of the access road included prescribed burns in the spring of 1987, 1988 and 1989 (Site A), while the savanna north of the access road had been burned only during the spring of 1987 (Site B) (Glass, personal communication).

MATERIALS AND METHODS

In late October of 1989, a woody vegetation survey was undertaken on two sections (each 3 ha in size) of the dry sand savanna at the Hooper Branch Nature Preserve. A total of 96 quadrats, 25 m on a side, were established within the savanna, 48 in the section that had been burned for three consecutive years from 1987-89 (Site A), and 48 in the section that had been burned only in 1987 (Site B). In each quadrat the number, size, and species of all trees above 10 cm dbh were recorded. Relative density, relative dominance, and importance value (IV) of each species encountered were then calculated for the two sites. The determination of the importance values follows McIntosh (1957) and Boggess (1964) and is the sum of the relative density and the relative dominance. The average diameter, density (stems/ha) in broad diameter classes, and basal area (m^2/ha) were also calculated for each species.

Woody seedlings and small shrubs (less than 40 cm tall) were surveyed using 1/4 m^2 quadrats. Five north/south transects 20 m long were located randomly in both sites A and B. Along each transect the quadrats were placed at 1 m intervals along lines perpendicular to the transect lines. A random numbers table was used to determine the number of meters the quadrats were placed to the east (odd numbered quadrats) or to the west (even numbered quadrats) of the transect. All individuals were identified, counted, and their densities (stems/m^2) relative values, and importance values determined.

Larger seedlings, saplings and shrubs were surveyed using nested circular plots 0.001 and 0.01 ha in size located randomly in each of the 96 quadrats. In the 0.001 hectare plot seedlings and shrubs (more than 40 cm in height and less than 2.5 cm dbh) were tabulated, and in the 0.01 hectare plot saplings (2.5 - 10.0 cm dbh) were tabulated and their frequencies and densities (stems/ha) determined. Nomenclature follows Swink and Wilhelm (1979).

RESULTS AND DISCUSSION

Woody Overstory

The canopy layer densities were similar at both sites, with an average of 142.3 stems/ha at Site A, and 129.6 stems/ha at Site B (Table 1). The dominant species was *Quercus velutina* Lam. (black oak) with an IV of 199.5 at Site A, and 198.4 at Site B. White oak (*Quercus alba* L.) and black cherry (*Prunus serotina* Ehrh.) were the only other tree species encountered, both represented by a few, scattered individuals. Size class distribution (Table 1) of black oak varied somewhat between the two sites, but at both sites the majority of the trees were less than 40 cm dbh (87% at Site A; 80% at Site B) indicating that both sites have a similar developmental history. Before dedication as a nature preserve, both areas, which are within 200 m of each other, had been grazed, lightly logged, and occasionally burned (Glass 1985). After dedication, the different burning regimes were implemented.

Dead-standing individuals are not a common feature of these savannas, with only 8.7 stems/ha and an average diameter of 24.2 cm dbh at Site A, and 9.3 stems/ha with an average diameter of 31.3 cm dbh at Site B. With continued burning, tree mortality will probably increase since numerous fire-scars were observed, particularly in Site A where management burns have occurred for the past three years.

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. White (1983) in a study of an oak savanna in Minnesota, found that annual burning has had only a minimal effect on the canopy layer. The large canopy trees were stressed but not killed by fires, and canopy density showed little change over a 13 year period. Annual burning at the Hooper Branch Nature Preserve will probably, over time, result in a gradual decrease in the density of canopy individuals. Less frequent burns, however, may result in greater destruction, since increased fuel loads will result in hotter fires.

Woody Understory

Small shrub and seedling (less than 40 cm tall) densities varied from 3.58 stems/m^2 on site A to 2.64 stems/m^2 on site B (Table 2). Four species were identified on site A with *Rosa carolina* L. (multiflora rose) accounting for the majority of the individuals present (IV of 117.4 out of 200), followed by *Rhus copallina* L. (dwarf sumac) and black oak seedlings. Site B had greater diversity with 9 species encountered. Again *Rosa carolina* was the most important shrub (IV of 99.7), followed by black oak, *Rhus glabra* L. (smooth sumac), *Corylus americana* Walt. (hazelnut) and black cherry (Table 2). Regular burns probably enhance the growth of some shrub species (*Rosa carolina*), while less frequent burning may be important for establishment and continued success of others, particular seedlings of black oak and some of the shrubby species encountered only at site B.

Large shrub and seedling (greater than 40 cm tall) densities varied from 2250 stems/ha at Site A to 5230 stems/ha at Site B (Table 1). Only black cherry showed a higher seedling density at Site A, with the remaining species showing a dramatic increase in density at Site B, particularly *Rhus copallina* and *Rubus allegheniensis*. The regular burns at Site A over the past three years are probably responsible for this dramatic decrease in seedling densities. Seedling densities will probably continue to decrease at Site A if burning is continued on an annual basis. Similar results were obtained by Henderson and Long (1984) for seedling densities in the black oak woodlands in northwestern Indiana.

Sapling densities are similar at both sites, varying from 329 stems/ha to 394 stems/ha from Sites A and B, respectively (Table 1). Black oak saplings dominated, accounting for nearly all of the individuals encountered. At Site A, 24% of the saplings were sprouting from damaged or top-killed individuals, while 13% of those at Site B were sprouts from top- killed individuals. In oak woodlands of northwestern Indiana, Henderson and Long (1984) 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, which resulted in a greater amount of basal sprouting. At Hooper Branch, however, fewer black oak saplings were present, and more of them had been damaged or top-killed at the site which had been burned for the past three years (site A). Not enough time has elapsed for any definite conclusions to be drawn concerning this phenomenon, but increased fuel loading should be a major factor considered in determining the frequency of future management oriented prescribed burns.

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Table 1. Densities (#/ha), diameter classes, basal areas (m^2/ha), relative values, importance values and average diameters of the woody species at two dry sand savanna sites in Hooper Branch Nature Preserve, Iroquois County, Illinois.

Species	Seedlings #/ha	Saplings #/ha	Diameter Classes (cm) 1-2	2-3	3-4	4-5	5+	Total #/ha	Basal Area m^2/ha	Rel. Den.	Rel. Dom.	I.V.	Av. Diam. (cm)
Site A: Dry sand savanna burned for three consecutive years from 1987-89.													
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: Dry sand savanna burned only in 1987.													
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 2. Densities (stems/ha), relative values, and importance values of the seedlings (less than 40 cm tall) and small shrubs encountered at two sites in the Hooper Branch Nature Preserve.

Species	Density (m^2/ha)	Rel. Freq.	Rel. Den.	I.V.
Site A: Dry sand savanna burned for three consecutive years from 1987-89.				
Rosa carolina L.	2.52	47.4	70.0	117.4
Rhus copallina L.	0.92	42.1	25.6	67.7
Quercus velutina Lam.	0.12	7.9	3.3	11.2
Rhus glabra L.	0.02	2.6	1.1	3.7
Totals	3.58	100.0	100.0	200.0
Site B: Dry sand savanna burned only in 1987.				
Rosa carolina L.	1.44	46.0	53.7	99.7
Quercus velutina Lam.	0.52	24.0	19.4	43.4
Rhus glabra L.	0.20	8.0	7.5	15.5
Corylus americana Walt.	0.12	4.0	4.5	8.5
Prunus serotina Ehrh.	0.12	4.0	4.5	8.5
Rhus copallina L.	0.08	4.0	3.0	7.0
Rubus allegheniensis Porter.	0.08	4.0	3.0	7.0
Rubus flagellaris Willd.	0.04	4.0	2.9	6.9
Amorpha canescens Pursh.	0.04	2.0	1.5	3.5
Totals	2.64	100.0	100.0	200.0