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Woody Vegetation of a Disjunct Oak Woodland in East-Central Nebraska.

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Woody Vegetation of a Disjunct Oak Woodland in East-Central Nebraska.

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by

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THESIS ACCEPTANCE

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ABSTRACT

The woody vegetative composition of the Oak Glen Wildlife Management Area, a disjunct oak woodland in Seward County, Nebraska, was assessed using the Point-Quarter method. Based on data from three size categories, the presettlement composition of the woodland appears to have been a bur oak (*Quercus macrocarpa*) dominated community which, based on spacing and growth form, may have been savanna-like. Under present management, this community is succeeding to one consisting primarily of elm (*Ulmus* spp.), and hackberry (*Celtis occidentalis*).

INTRODUCTION

Upland forest stands, dominated by bur oak (Quercus macrocarpa) appear to have occurred naturally within the tallgrass prairie region of eastern Nebraska (Weaver, 1960). Quantitative evaluations of the vegetation of these stands, however, have not been published nor has the presettlement composition been compared with the extant stands. The principal purpose of this study was to provide a quantitative description of one such forested area with a secondary objective being to assess, to the extent possible, the presettlement vegetative composition of the stand using both historical records and the current vegetative composition.

METHODS

The study was conducted at the Oak Glen Wildlife Management Area (WMA) located 2.6 km North of Garland in Seward County, Nebraska. The site is situated on a large moraine left from the glacial retreat following the Kansan glaciation of the Pleistocene Epoch (Reed and Dreeszen, 1965). Runoff flows toward the North and is part of the Middle and Oak Creek drainages. The soils of the tract developed in glacial till underlain with a deposit of Cretaceous Greenhorn Limestone (Quandt, 1974). The site, which includes approximately 73 ha of trees situated along generally east and west-facing slopes, was acquired by the Nebraska Game and Parks Commission in March of 1983.

Hilltops have been disturbed but still contain some patches of native prairie. At the time of settlement, the area was divided among several owners. Old fence lines, terracing on some slopes but not others, and the disturbance of some hilltops provide evidence that different parts of the tract were managed differently over the years.

Sampling of tree and shrub species was conducted on one east-facing slope (east-slope) and one west-facing slope (west-slope) in each of the two principal ravines of the area (Fig. 1); sampling was limited to approximately the same elevation within each ravine. Data were collected using the Point-Quarter Method (Cottam and Curtis, 1956). Thirty points were evaluated along all except the west-facing transect of the South Ravine (Transect 1). This transect started at the ecotone between an eastern red cedar (Juniperus virginiana) dominated successional area and a grassland habitat, and ended as the habitat merged into a marsh; only 27 points were evaluated. Evaluation points along all transects were approximately 20 m apart.

At each point, 12 trees were recorded, three in each quarter, with one in each of the following dbh size classes: Small, < 10 cm; Medium, 10 - 30 cm; Large, > 30 cm. The three size classes were analyzed separately and used to assess potential changes in vegetative composition. A correction factor to compensate for missing data was used

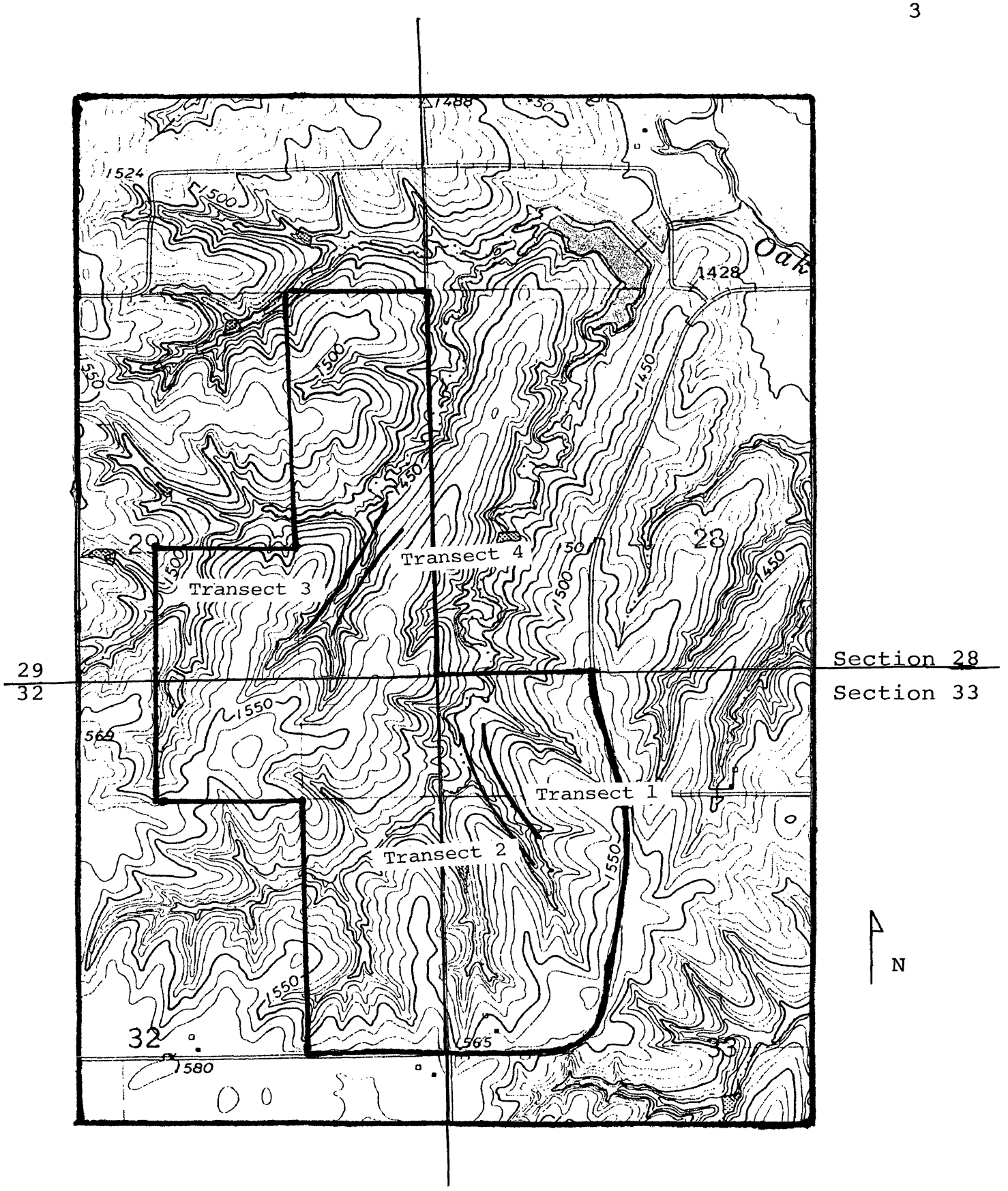

Fig. 1. Site and Transect location. Sections are within T12N and R4E. Perimeter dark lines = boundry of Oak Glen WMA; Interior dark lines = transect (T).

when necessary (Warde and Petranka, 1981). A number of trees had multiple stems but only the stem closest to the center point was measured. Some trees had large scars at the base of the bole. These features were noted when such trees were included in the sample.

Coring trees to determine age was discouraged at the site, hence dbh alone was used as a rough approximation of relative tree age. This approximation was considered adequate to assess successional trends.

Beta diversity, used to make comparison between transects, was calculated using Percent Similarity (Whittaker, 1975). Importance Values (IV) were used in comparing transects. These values are the sum of relative density, relative dominance, and relative frequency.

The 1857 General Land Office Survey records of the site, which include some observations on vegetation, were reviewed to assess potential presettlement vegetation. Since the county was first settled ca. 1864, the descriptions given are considered to represent pristine conditions. The study area includes parts of four section lines, thus providing a reasonable amount of information on which to base site-specific presettlement vegetation.

RESULTS

Presettlement Vegetation

In 1864 the area that includes the present study site was known as Oak Groves (Olney, 1887). Timber found in the ravines of the area was cut for firewood for the salt works in Lancaster County, thus woodlands of the study site were subject to disturbance. The general description of the township, as written in the 1857 General Land Office Survey, indicates that timbered streams occurred both along the section lines that cross the study area and along nearby streams. Tree species mentioned included bur oak, cottonwood (*Populus deltoides*), hickory (*Carya* spp.), and ash (*Fraxinus* spp.). The presence of large bur oaks at that time is indicated by the notation of one individual with a dbh of 60 cm recorded near the study area.

Extant Vegetation

Based on Importance Values (IV), the medium and large-sized trees of the study site are dominated by bur oak (average IV = 203) with elm (*Ulmus* spp.), hackberry (*Celtis occidentalis*), ash, and black walnut (*Juglans nigra*) (average IV = 50, 18, 12, and 9 respectively) of considerably lesser importance (Table 1). These results are also reflected by density values (Table 2, Appendix Table 1). Woody plant composition of these size categories did not differ between the East and West slopes.

TABLE 1. Average Importance Value for all sites ± 1 S.E. by size category

Species	Size Category		
	Small	Medium	Large
Quercus macrocarpa	9± 3.0	148± 38.5	258± 19.3
Celtis occidentalis	27± 8.9	24± 10.9	12± 6.8
Fraxinus spp.	7± 1.3	15± 7.5	10± 4.0
Ulmus spp.1	114± 20.1	91± 24.6	10± 6.0
Juglans nigra	2± 1.2	9± 5.6	9± 5.0
Juniperus virginiana	13± 4.6	12± 6.6	0
Morus spp.	0	2± 1.6	0.8± 0.83
*Prunus virginiana*2	2± 1.3	0	0
*Cornus drummondii*2	93± 20.4	0	0
*Zanthoxylum americanum*2	34± 9.4	0	0

1 *Ulmus* spp. sampled were primarily red elm (*Ulmus rubra*) although some individuals may have been american elm (*Ulmus americana*).
2 Shrub species

TABLE 2. Average Absolute Density ± 1 S.E. (No/ha) of major species by size category.

Species	Size Category		
	Small	Medium	Large
Quercus macrocarpa	19± 7.5	77± 8.1	152± 184.4
Ulmus spp.	330± 17.7	81± 35.1	4± 2.4
Celtis occidentalis	85± 37.6	22± 10.1	6± 4.3
Fraxinus spp.	22± 1.4	11± 7.3	4± 1.0

In the medium size class, the importance of elm is highest in Transects 1 and 2 and that of bur oak in Transects 3 and 4.

Hackberry shows a higher Importance Value along Transect 2 for the medium and large size classes than along other transects. This value is influenced by a group of hackberry trees growing in a more level and more mesic habitat through which the transect passed. Of the 12 hackberry sampled in the large size class along Transect 2, ten were recorded from this group.

In the small size class (dbh < 10 cm), elm had the highest Importance Value of all the tree species for all transects. The importance of the understory shrubs prickly ash (Zanthoxylum americanum) and rough-leaved dogwood (Cornus drummondii) along Transects 3 and 4 are influenced by a number of large clearings allowing sunlight to reach the forest floor. In such open areas, these species grew in dense, tall stands giving inflated Importance Values. Aikman (1929) also describes this type of understory growth in a bur oak forest.

Beta diversity values for each size class show a greater similarity between Transects 1 and 2 and Transects 3 and 4 than between other transect pairs (Table 3). Beta diversity of Transects 1-2 and 3-4 are most similar to other transect pairs for the large size category, less similar for

TABLE 3. Beta diversity (Percent Similarity) between forest stands by size category. High value equals high degree of similarity.

Transect Comparison	Size Category		
	Small	Medium	Large
1 vs 2	.9395	.8047	.8904
1 vs 3	.6941	.6607	.8153
1 vs 4	.5925	.4851	.8278
2 vs 3	.6526	.5474	.7244
2 vs 4	.5452	.3718	.7590
3 vs 4	.8523	.7619	.9643

the medium, and least similar for the smallest size category.

DISCUSSION

Woodland Dynamics

Historical accounts provided by the early settlers, as well as records of the General Land Office surveyors, indicate that trees were present in the area prior to settlement although the physiognomy of such woodlands is not known. The very largest trees presently in the study area are primarily bur oak that are sufficiently widely-spaced so that the canopies do not overlap, and that have branching patterns typical of a more open community than exists today. The few small oaks observed were found in well-lit areas such as in clearings or near the edge of the woodlands. These observations suggest that these presettlement woodlands may have resembled a savanna-type community dominated by bur oak. The increasing importance of elm, hackberry, ash, and other species appears to be a consequence of environmental changes, such as changes in the fire or grazing regime, that have not maintained an open understory.

The dynamic status of the extant woodlands is reflected specifically in the difference in Importance Values of bur oak and elm. While bur oak is the dominant large species in the present woodlands, its importance lessens in each successively smaller size category. This trend, also shown

by absolute density values, indicates that current oak establishment is not adequate to replace the existing population, thus this species is on the decline. Elm, hackberry, and to a lesser extent, ash, however, appear to be increasing in importance as shown by the increasingly greater Importance Value from large to small trees (Table 1). These species may ultimately dominate this region assuming first, that Dutch elm disease does not significantly affect the elm population and second, that the current management continues. Elm, for example, was not mentioned in the historical accounts provided by the General Land Office surveyors and may, therefore, be a recent addition to the woodland composition.

Vegetative Composition

In general, beta diversity values for all size classes consistently show that east and west transects of a single ravine are more similar than are transects of the same aspect from different ravines. These results suggest that either the two ravines have always differed in composition, or that they have been managed differently since settlement. A more detailed consideration of inter-ravine comparisons, however, provide evidence that the presettlement composition of both ravines may have been similar. Percent Similarity values for the large tree comparisons are all greater than the small and medium size trees, with the exception of those

in the same ravine (Table 3). More generally stated, this means that the composition of the community of old trees occupying the entire site is more similar than the younger tree community. The large trees are less likely to have been affected by any type of management except cutting, which may have occurred uniformly through both ravines. The smaller trees, however, are more susceptible to management effects such as burning or grazing, which are the kinds of treatments that are likely to differ between owners. The results of such different kinds of management are likely to result in 1) different species composition than that characterized by the original woodland and 2) different composition in each ravine. The beta diversity values obtained in this study describe this kind of compositional difference, thus further suggesting the importance of management as the cause of these observed differences.

Additional observations further implicate management. Historical records and the presence of multiple stemmed trees, tree stumps, and trees showing scarred boles all indicate that disturbances have occurred at the site (Appendix Table 2). Stumps observed in the South but not the North ravine infer that the disturbances may not have uniformly occurred in both areas although this is not conclusive evidence.

The overall conclusion from this study is that the study site was wooded prior to settlement and that the

character of the mid-nineteenth century woodlands may have been more open and savanna-like. This is in contrast to the extant woodland which is more fully canopied and is undergoing secondary succession. Further, under present management, it seems likely that this succession will continue with the ultimate replacement of bur oak by other, more shade tolerant, species, such as elm, hackberry, or ash. Further study is needed to assess management practices that could retain bur oak as a dominant species.

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APPENDIX TABLE 1. Importance Value parameters for all species by size category and by transect.

Transect, Size Class and Species	Absolute Values: Density (No/100m2)	Frequency (%)	Dominance (dbh in cm2)	Importance Value
TRANSECT 1				
DBH ≤ 10 cm				
Bur oak	.25	7.4	12	11.85
Elm	3.12	77.8	168	147.01
Hackberry	1.44	37.0	11	37.44
Ash	.25	7.4	6	9.05
Black walnut	.08	3.7	3	4.17
Red cedar	.25	11.1	2	8.6
Dogwood	3.04	59.3	7	63.28
Prickly ash	.59	22.2	5	18.61
DBH 10- 30 cm				
Bur oak	.75	77.8	252	105.64
Elm	1.22	96.3	263	134.84
Hackberry	.13	18.5	61	18.98
Ash	.11	18.5	26	16.74
Black walnut	.16	22.2	48	23.76
DBH >30 cm				
Bur oak	1.06	96.3	1723	239.92
Elm	.06	18.5	61	20.94
Hackberry	.01	3.7	10	4.09
Ash	.05	14.8	71	17.91
Black walnut	.07	11.1	68	17.14

APPENDIX TABLE 1, CONT.

Transect, Size Class and Species	Absolute Values: Density (No/100m2)	Frequency (%)	Dominance (dbh in cm2)	Importance Value
TRANSECT 2				
DBH ≤ 10 cm				
Bur oak	.15	6.7	10	11.34
Elm	3.42	70.0	113	148.41
Hackberry	1.56	46.7	11	45.77
Ash	.22	10.0	2	8.41
Black walnut	.07	3.3	3	4.3
Red cedar	.07	0	0	2.35
Choke cherry	.3	.7	1	5.47
Dogwood	2.3	56.7	2	52.53
Prickly ash	.82	26.7	1	21.43
DBH 10-30 cm				
Bur oak	.63	46.7	238	69.05
Elm	1.58	90.0	299	125.64
Hackberry	.5	46.7	161	55.73
Ash	.32	30.0	107	36.03
Black walnut	.08	10.0	34	10.94
Red cedar	.03	3.3	2	2.61
DBH ≥ 30 cm				
Bur oak	1.41	80.8	2101	212.67
Elm	.1	20.0	95	20.32
Hackberry	.19	26.7	193	33.07
Ash	.06	10.0	96	12.84
Black walnut	.08	16.7	100	17.73
Mulberry	.02	3.3	14	3.33

APPENDIX TABLE 1, CONT.

Transect, Size Class and Species	Absolute Values: Density (No/100m2)	Frequency (%)	Dominance (dbh in cm2)	Importance Value
TRANSECT 3				
DBH ≤ 10 cm				
Bur oak	.35	13.3	6	12.75
Elm	2.92	70.0	50	88.6
Hackberry	.18	6.7	7	9.15
Ash	.18	6.7	6	8.15
Red cedar	.17	23.3	11	23.4
Choke cherry	.09	3.3	0	2.24
Dogwood	4.42	83.3	68	120.63
Prickly ash	1.77	43.3	2	35.7
DBH 10-30 cm				
Bur oak	.69	76.7	284	73.9
Elm	.35	53.3	61	73.9
Hackberry	.06	13.3	10	14.55
Ash	.01	3.3	5	4.11
Red cedar	.1	26.7	21	28.45
Mulberry	.02	6.7	4	6.53
DBH ≥ 30 cm				
Bur oak	1.7	100	2255	295.35
Hackberry	.01	3.3	13	4.65
TRANSECT 4				
DBH ≤ 10 cm				
Elm	3.73	33.3	12	70.08
Hackberry	.22	3.3	4	13.82
Ash	.22	3.3	0	3.35
Red cedar	.88	10.0	3	17.4
Dogwood	15.81	90.0	9	135.45
Prickly ash	5.49	50.0	4	59.89
DBH 10-30 cm				
Bur oak	1	93.3	470	243.71
Elm	.1	23.3	19	28.99
Hackberry	.03	3.3	7	6.6
Ash	.01	3.3	5	4.29
Red cedar	.05	13.3	11	16.41
DBH ≥ 30 cm				
Bur oak	1.91	100	2532	284.95
Hackberry	.05	6.7	55	10.7
Ash	.02	3.3	12	4.34

APPENDIX TABLE 2. Number of individuals sampled having multiple stems by dbh size category by transect.

Transect	Size Category	
	Medium	Large
1	14	18
2	9	23
3	4	6
4	16	13