EXTENT OF WOODY VEGETATION ON THE PRAIRIE IN EASTERN NEBRASKA, 1855-1857

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Abstract. Early surveyors' notes from five counties bordering the Platte River in eastern Nebraska were utilized to measure the extent of original woody vegetation in this region. These data were compared to field studies from the same area made from 1979-1983, were used to determine areas of prairie-forest transition, and were used to tabulate the extent of woody vegetation in the lower Platte River Valley at the time of European settlement (1855-1857). Using a modified importance value based on relative density and relative dominance of witness trees, the highest ranking presettlement tree species were cottonwood [*Populus eltoides* Marsh. spp. *monilifera* (Ait.) Eckenw.], bur oak (*Quercus macrocarpa* Michx.), elms (*Ulmus* spp.), willows (*Salix* spp.), and black oak (*Quercus velutina* Lam.). The original survey indicated the presence of single trees and tree clusters within the original prairie vegetation of eastern Nebraska. Trees are presently more widespread, and their composition differs from the original woody vegetation. Presently, cottonwood, bur oak, American linden (*Tilia americana* L.), and rough-leaved dogwood (*Cornus drummondii* Meyer) are more common than they were 130 years ago.

Key Words. presettlement vegetation, woody vegetation, prairie-forest transition, tallgrass prairie, succession, Nebraska

INTRODUCTION

The eastern one-third of Nebraska originally consisted of tallgrass prairie. It has generally been accepted that the small amount of woody vegetation present prior to 1855 existed only along or near rivers and streams. This would have provided a rather distinct prairie-forest ecotone restricted primarily to river floodplains, terraces, or other uplands bordering rivers and streams. However, evidence does suggest the existence of savanna-like stands of trees, some of which were located in areas formerly thought to be exclusively tallgrass prairie (Rozmajzl 1988).

Invasion of woody vegetation into grassland has often been attributed to decreased fire intensity and frequency (Buell and Facey 1960, Vogl 1974, Towne and Owensby 1984, Abrams 1986, Hulbert 1986). Weaver (1960) described the ecotone between grassland and bur oak forest occurring on the upper slope of the bluffs bordering the Platte River as a "chaparral or scrub community containing wolfberry, dogwood, and prickly ash". More recent studies indicate that dense thickets of eastern red cedar (*Juniperus virginiana* L.), wild plum (*Prunus americana* Marsh.), choke cherry (*Prunus virginiana* L.), smooth sumac (*Rhus glabra* L.), and hazelnut [*Corylus americana* (L.) Walt.] were quite common along the margins of bur oak/bitternut hickory associations (Stephens 1973, Rothenberger 1985). These shrub communities are a direct result of post settlement fire exclusion, and they sometimes encroach upon the few grassy openings that still exist in this heavily cultivated region. This study was designed to compare present woody vegetation of the area with the presettlement woody vegetation as indicated by the General Land Office (GLO) records.

METHODS

Study Site

The study site included Dodge, Saunders, Douglas, Sarpy, and Cass counties in eastern Nebraska, which border the lower 96 km of the Lower Platte River above its confluence with the Missouri River (Figure 1). This part of the river valley presents an extension of oak-hickory upland forest (Braun 1950) and cottonwood-willow-elm riparian forest into the prairie. During presettlement times, these woodlands were bordered exclusively by tallgrass or true prairie. The study area was located within the Drift Hills Region of the Central Lowland Province (Figure 1) and was within the western portion of the tallgrass prairie formation (Küchler 1964). Nebraska is a transitional plains state in which the drift hills in the east give way to loess hills, sandhills, and ultimately tablelands or high plains of the Great Plains Province in the western part of the state. The study area included elevations ranging from 290 to 427 m and precipitation ranging from 74 to 80 cm per year.

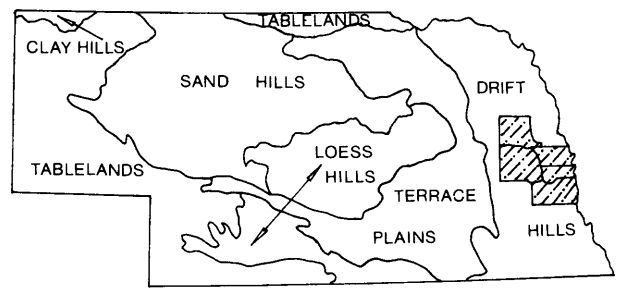

FIG 1. The physiography of Nebraska showing the five-county study site located in the Drift Hills region.

A wide variety of tills and post glacial deposits were present. Much of the five-county area was mantled with loess which is largely Medial Wisconsin in age, but Late Wisconsin loess mantled Late Wisconsin terrace deposits along many of the valley sites of the principal stream courses (Burchett and Reed 1967). The Platte River terraces and most of the adjacent uplands were capped by Peoria loess of Medial Wisconsin origin (Wayne 1985). Even though the underlying sediments and tills varied throughout the area, the overlying loess mantle formed the basis for the development of the original tallgrass prairie and adjacent woodlands along major streams and their tributaries.

Data Collection

Early GLO survey records were studied and compared to field data collected from 1979-1983 to determine the extent of original woody vegetation in a five-county study area of eastern Nebraska. The study area included Dodge, Saunders, Douglas, Sarpy, and Cass counties (Figure 1) and was selected because this area was originally composed of tallgrass prairie dissected by the Platte River (Küchler 1964). The Platte and its tributaries provided habitat conducive to the growth of woody plants in this area.

The original GLO survey occurred from 1855-1857 when significant settlement of Europeans first began in this area. Records were obtained at the county offices in Fremont, Papillion, Plattsmouth, Omaha, and Wahoo, Nebraska, and from the state surveyor's office in Lincoln. These records were in the form of original written descriptions, microfilm, and maps.

Some difficulties were encountered in interpreting certain writer's penmanship. Also, some inaccuracies due to species sampling errors and misuse of common names were probable. "Elm," "willow," and "hickory" were reported without designation as to species. "Spanish oak" (referring to *Quercus palustris* Muench.) and "white oak" (*Quercus alba* L.) were reported in the GLO

survey but were not found to occur in the area of the study of 1979-1983 (Rothenberger 1985). "Hickory" was inferred to mean bitternut hickory [*Carya cordinformis* (Wang.) K. Koch.], the most common hickory in the area, and "Lynn" referred to American linden (*Tilia americana* L.). Despite these problems, the use of witness tree data and written descriptions of vegetation provided a reasonably reliable source of information for this study. The witness tree data from the survey included the number of trees and their sizes (diameter) and was used to calculate importance value, a modified value equal to the sum of the relative density and the relative dominance for each species. Importance values were calculated for each of the five separate county surveys. Botanical nomenclature follows the Great Plains Flora Association (1986).

RESULTS AND DISCUSSION

The concentration of witness trees recorded in the study area in 1855-1857 were much higher within the Platte Valley and along the uplands bordering the river than on the open grassland (Figure 2). However, some groupings of witness trees occurred on both upland and lowland sites away from the river. These small tree groves and single isolated witness trees located away from major streams and their tributaries were of special interest, because they gave evidence to the existence of some woody vegetation within the tallgrass prairie. Similar results were reported in Douglas and Washington counties, Nebraska, in which presettlement savanna relics were identified on uplands (Rozmajzl 1988). The incidence of these trees and tree "patches" was probably dependent on fire, climate, substrate, and topography (Bell and Hulbert 1974).

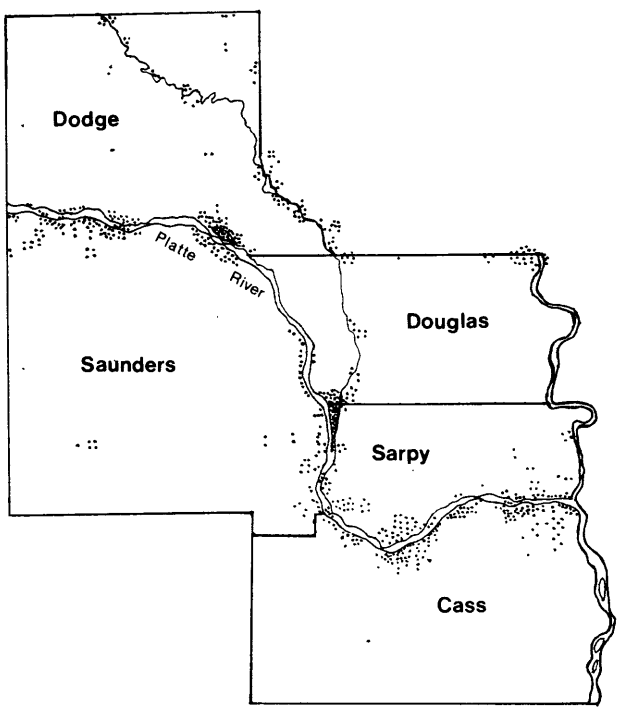

FIG 2. Witness trees recorded during the GLO survey of 1855-1857. Each dot represents one tree.

In the eastern Nebraska survey, bur oak savanna integraded sharply into tallgrass prairie on the uplands and gradually gave way to more established riparian forest types containing cottonwood [*Populus deltoides* Marsh. subsp. *monilifera* (Ait.) Eckenw.], green ash [*Fraxinus pennsylvanica* Marsh. var. *subintegerrima* (Vahl.) Fern.], willows (*Salix* spp.), and elms (*Ulmus* spp.) as the surveyors approached the Platte River. Fire-susceptible species, such as eastern red cedar, were seldom encountered. Solitary trees, most notably cottonwood, green ash, and elms are more difficult to explain but must have occurred along creeks, near wetlands, or on similar sites where they were afforded some measure of fire protection. At several locations, few witness trees were reported even though the survey notes indicated the presence of significant amounts of woody vegetation. Perhaps the survey team felt that these trees were too small to sample. Whatever the reason, the surveyors' notes did not always accurately reflect the presence of woody vegetation.

The exclusion of fire in the study area has resulted in successional changes in species composition and increases in the total amount of woody vegetation. Higher elevations on upland sites in eastern Nebraska were more open than they are now, with park-like bur oak stands interrupted by grassy areas (Lawson *et al.* 1980). In the Kansas Flint Hills, Bragg and Hulbert (1976) found prairies remaining unburned for 20 years or longer were replaced by forest on over one-half or more of their area.

During the 130-year period since the original survey, fluctuations in biotic and abiotic factors have caused inevitable changes in species composition. Table 1 compares the relative importance values of woody plants from the 1855-1857 GLO survey with those of the 1979-1983 study. Cottonwood and bur oak accounted for 73% of all witness trees reported. The high importance value for cottonwood also reflects the exceedingly large total basal area calculated for this species. Even though the GLO survey was not intended to be an ecological study, some interesting changes are noteworthy. These include:

1. Increases in fire-sensitive eastern red cedar probably because of fire suppression.
2. Increases in more mesic tree species, such as American linden, red mulberry (*Morus rubra* L.), green ash, hackberry (*Celtis occidentalis* L.), and red oak [*Quercus borealis* Michx. var. *maxima* (Marsh.) Ashe.].
3. A high incidence of rough-leaved dogwood (*Cornus drummondii* Meyer). It should be noted that rough-leaved dogwood is present in large numbers although it was only occasionally mentioned by the GLO surveyors.
4. A decrease in American elm (*Ulmus americana* L.), presumably because of Dutch elm disease (*Ceratocystis ulmi*).

A combination of factors have changed the species composition of woody vegetation in eastern Nebraska. This study indicates that, initially, trees were mostly limited to river valleys or to scattered trees or groves. Subsequent vegetative changes, resulting from fire exclusion, disease, grazing, human activities, and variable precipitation have combined to form a somewhat different woody vegetation type along the rivers and streams in the study area. These changes are likely to continue and may result in a woody plant composition even more different from that dominating the presettlement landscape.

Table 1. Total numbers and relative importance values for trees recorded during the original GLO survey compared to relative importance values of trees sampled in the study area from 1979-1983.

	1855-1857 Survey		*1979-1983 Field Study*
Species	*Total trees*	*Relative importance value*	*Relative importance value*
	--- no. ---	---------- % ----------	
Cottonwood [*Populus deltoides* Marsh subsp. *monilifera* (Ait.) Eckenw.]	345	55.6	12.9
Bur oak (*Quercus macrocarpa* Michx.)	177	21.3	12.0
Elm (*Ulmus americana* L.)	54	7.7	0.5
Willow (*Salix* spp.)	34	2.9	0
Black oak (*Quercus velutina* Lam.)	19	2.5	2.4
White oak (*Quercus alba* L.)	16	2.1	0
Green ash [*Fraxinus pennsylvanica* Marsh. var. *subintegerrima* (Vahl.) Fern.]	19	1.9	6.1
Pin oak (*Quercus palustris* Muench.)	4	1.0	0
American linden (*Tilia americana* L.)	4	1.0	9.9
Bitternut hickory [*Carya cordiformis* (Wang.) K. Koch]	10	0.9	2.6
Red oak [*Quercus borealis* Michx. var. *maxima* (March.) Ashe.]	6	0.7	5.0
Eastern red cedar (*Juniperus virginiana* L.)	6	0.6	5.4
Box elder (*Acer negundo* L.)	7	0.6	1.3
Silver maple (*Acer saccharinum* L.)	3	0.4	2.3
Hop hornbean [*Ostrya virginiana* (P. Mill.) K. Koch]	4	0.4	3.8
Red elm (*Ulmus rubra* Muhl.)	3	0.3	7.6
Hackberry (*Celtis occidentalis* L.)	1	0.1	5.2
Species not reported in the GLO Survey:			
Rough-leaved dogwood (*Cornus drummondii* Meyer)	0	0	9.0
Red mulberry (*Morus rubra* L.)	0	0	8.3
Black walnut (*Juglans nigra* L.)	0	0	1.4
Northern catalpa (*Catalpa speciosa* Warder)	0	0	0.8
Honey locust (*Gleditsia triacanthos* L.)	0	0	0.7
Common buckthorn (*Rhamnus cathartica* L.)	0	0	0.6
Peach-leaved willow (*Salix amygdaloides* Anderss.)	0	0	0.6
Kentucky coffee tree [*Gymnocladus dioica* (L.) K. Koch]	0	0	0.4
Black willow (*Salix nigra* Marsh.)	0	0	0.4
White mulberry (*Morus alba* L.)	0	0	0.3
Smooth sumac (*Rhus glabra* L.)	0	0	0.2
Juneberry (*Amelanchier arborea* (Michx. f.) Fern.]	0	0	0.1
Downy hawthorn [*Crataegus mollis* (T. & G.) Sheele]	0	0	0.1
Red osier dogwood (*Cornus stolonifera* Michx.)	0	0	0.1

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