Publications of the Oklahoma Biological Survey
2nd Series
Volume 7: 34-39, 2006

WOODY PLANT SPECIES COMPOSITION OF A *FAGUS GRANDIFOLIA* EHRH. (AMERICAN BEECH) FOREST ALONG BEECH CREEK, LEFLORE COUNTY, OKLAHOMA

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ABSTRACT.—*Fagus grandifolia* Ehrh. reaches the northwestern extent of its range in LeFlore and McCurtain counties, Oklahoma. Woody species such as *Castanea pumila* var. *ozarkensis*, *Halesia carolina*, and *Magnolia tripetala* also occur in the area and may co-occur with *F. grandifolia*. A review of the literature failed to uncover published accounts of the species composition and structure of these forests. To characterize the beech forests of Oklahoma, 17 plots measuring 20m x 20m were established in the beech forest along Beech Creek in the Ouachita National Forest. The DBH of all stems greater than 2.54cm was recorded for each woody species present. Basal area, density, and frequency were then calculated to determine stand dominance. Thirty-five woody plant species were encountered during the sampling. The highest dominance values for overstory trees was scored by *F. grandifolia, Quercus alba*, and *Pinus echinata*, respectively.

INTRODUCTION

Fagus grandifolia Ehrh. is a common tree of the deciduous forests of eastern North America. Its range extends from Missouri, Illinois, and Wisconsin, to Ontario and Quebec, south along the Atlantic and Gulf Coast states, and west to eastern Texas and Oklahoma (Figure 1). The western edge of this range has two distinct lobes extending into southeast Texas and southeast Oklahoma. *Fagus grandifolia* is known only from McCurtain and LeFlore counties in Oklahoma (Hoagland et al. 2006). Little (1996) notes the occurrence of *F. grandifolia* along Big Creek and on Rich Mountain in LeFlore County and along Beech Creek and the Mountain Fork River in McCurtain County. A population of *F. grandifolia* was recently documented from Cucumber Creek in LeFlore County (Hoagland and Buthod unpublished data) Given the limited geographic distribution in the state, *F. grandifolia* is considered a rare tree in Oklahoma (Bruner 1931; Little and Olmstead 1935). Populations of *F. grandifolia* are tracked by the Oklahoma Natural Heritage Inventory (ONHI), which has given it a conservation rank of S1. Species conservation ranks are assigned according to the level of imperilment at the state (S) and global (G) levels on a scale of 1 - 5, with 1 representing a species that is imperiled and 5 a species that it is secure (Groves et al. 1995). For example, a common species such as *Quercus stellata* has a conservation rank of G5S5, but the rare endemic *Lesquerella angustifolia* is ranked as a G1S1. *Fagus grandifolia* forests in Oklahoma have been ranked as S1, but at the global level, both *F. grandifolia* forest communities and *F. grandifolia* are ranked as G5 (ONHI 2006).

The composition and dynamics of *Fagus grandifolia* forests have been the subject of intense study for several decades (e.g., Shanks 1953; Ward 1956; Williamson 1975; Nesom and Treiber 1977; Abrell and Jackson 1978; Nixon et al. 1980; Glitzenstein et al. 1986; White 1987, Palik and Murphy 1990; Brisson et al. 1994; Foster 1998 and others). Braun (1950) included forests of the Ouachita Mountains in the Southern Division of the Oak-Hickory Forest, Interior Highlands. Occurrences of *F. grandifolia* in the Ouachita Mountains of Arkansas have been characterized as sporadic (Braun 1950; Moore 1972), a pattern verified by Mayo and Raines (1986). Vegetation classifications of Arkansas recognize multiple *Fagus*- dominated associations. For example, Pell (1981) reported a *Fagus*-mixed-hardwoods cover class, with subclasses consisting of *F. grandifolia-Liriodendron tulipifera-Quercus* spp., *F. grandifolia-Quercus* spp.- *Magnolia tripetala*, and *F. grandifolia*-terrace hardwoods. Foti et al. (1994) recognized a modified form of these three associations; *F. grandifolia-Acer (rubrum, saccharum)-Liriodendron tulipifera*, *F. grandifolia - Magnolia tripetala*, and *F. grandifolia-Acer saccharum-Quercus* (*alba, muehlenbergii, rubra*).

Mayo and Raines' (1986) study of forest vegetation in the central Ouachita Mountains of Arkansas, found *F. grandifolia* at a limited number of sites. It occurred on north-facing slopes and was a co-dominant species with *Carya cordiformis* along streams. On Crowley's Ridge in eastern Arkansas, *F. grandifolia* share canopy dominance with *Pinus echinata* and *Quercus alba* (Clark 1977). Common co-occurring species in both studies included *Acer rubrum, A. saccharum, Liquidambar styraciflua, Nyssa sylvatica, Q. muehlenbergii,* and *Q. rubra*.

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Quantitative studies of *F. grandifolia* forests in Oklahoma are limited. Little and Olmstead (1935) sampled forest communities of the Ouachita Mountains in LeFlore County, Oklahoma. These data were used to developed a classification of forest types, which placed occurrences of *F. grandifolia* into the *Liquidambar-Nyssa* Forest Association. Little and Olmstead (1935) noted that *F. grandifolia* was an uncommon species and was not a canopy dominant. Johnson (1986), as part of a study of Wilderness Areas in the Ouachita National Forest, sampled three stands in the Beech Creek drainage area. He concluded that none of the 24 woody species encountered, including *F. grandifolia*, were canopy dominants. In a description of Oklahoma vegetation types, Hoagland (2000) recognized a *Fagus grandifolia - Quercus alba/Ilex opaca* forest association that was placed in a *Fagus grandifolia* Forest Alliance. The habitat was described as mesic slopes and streamsides. Associated species included *Acer saccharum, Arisaema triphyllum, Cornus florida, Magnolia acuminata, Prunus serotina, Quercus rubra*, and *Tilia americana*.

The objective of this study was to document the composition and structure of *F. grandifolia* forests in Oklahoma. Beech Creek was chosen as a study site based upon a review of records in the Oklahoma Vascular Plants Database (Hoagland et al. 2006). This analysis was undertaken to resolve ambiguities in the composition of *F. grandifolia* forests and to clarify their position within the Vegetation Classification maintained by the ONHI (2006) and the National Vegetation Classification (Grossman et al. 1998).

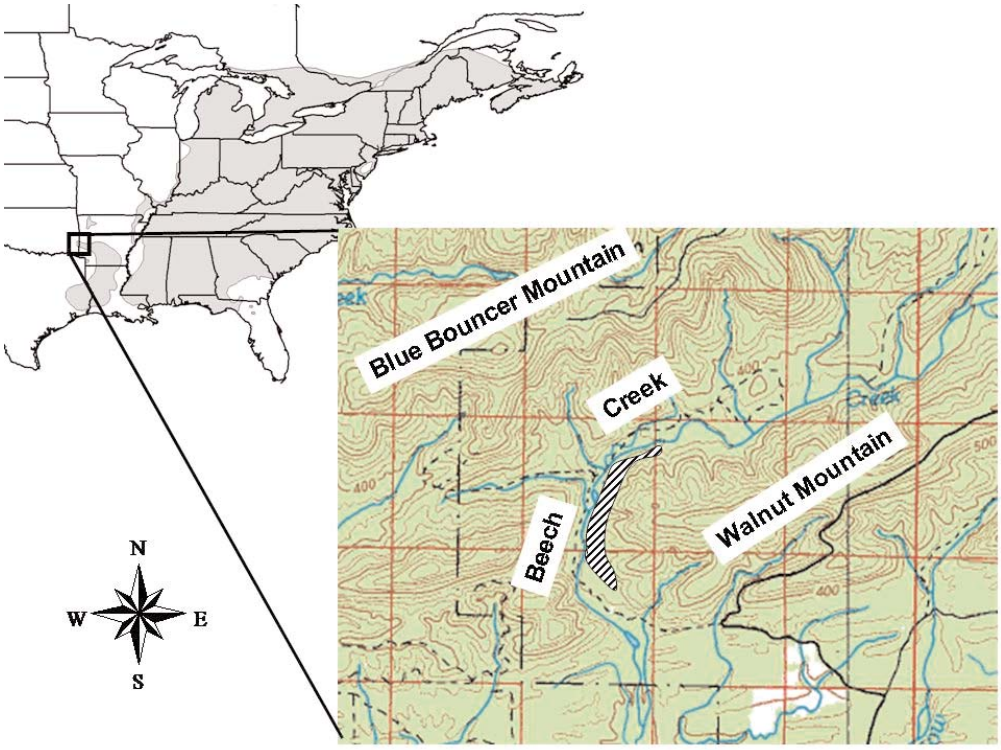

Figure 1: The range of *Fagus grandifolia* in North America and the Beech Creek study area (hatched) in LeFlore County, Oklahoma.

STUDY AREA

The Beech Creek site encompasses over 100 hectares (34.5544°N, 94.5603°W) in LeFlore County, Oklahoma (Fig. 1). The study area is located within the Subtropical Humid (Cf) climate zone (Trewartha 1968). Summers are warm (mean July temperature = 27.7°C) and humid, and winters are relatively short and mild (mean January temperature = 3.9°C). Mean annual precipitation is 121.7 cm, with periodic severe droughts (Oklahoma Climatological Survey 2006). The study area is located in the Ouachita province (Hunt 1974) and within the Ridge and Valley Belt in Oklahoma (Curtis and Ham 1979). Elevation is 312 m above sea level. The surface geology consists of Mississippian and Pennsylvanian sandstones with recent sedimentary deposits along the streams (Branson and Johnson 1979). Two soil associations occur at the site; the Kenn-Ceda Complex, which is occasionally flooded, and the

Bengal-Octavia-Tuskahoma Complex (Abernathy et al. 1983).

METHODS

Seventeen 20mX20m plots were established within the Beech Creek forest site. All species present in the plot were recorded and stems in excess of 2.54 cm DBH were measured. Basal area (BA) was calculated for each species in each plot using the formula Area=Πr^2, where r = the radius of the trunk, and Π = pi. Relative Basal Area (RBA) was calculated as:

$$\frac{\Sigma \text{ BA}_{\text{species I}}}{\Sigma \text{ BA}_{\text{all species}}} \text{ X } 100 = \text{RBA}$$

Density (D) was defined as the number of stems for each species occurring in a plot. Relative Density (RD) was calculated as:

$$\frac{\Sigma \text{ D}_{\text{species I}}}{\Sigma \text{ D}_{\text{all species}}} \text{ X } 100 = \text{RD}$$

Frequency was defined as the number plots in which a species occurred. Relative Frequency (RF) as calculated as:

$$\frac{\Sigma \text{ FREQ}_{\text{species I}}}{\Sigma \text{ FREQ}_{\text{all species}}} \text{ X } 100 = \text{RF}$$

An importance value (IV) was calculated for each species in order to determine which trees were stand dominants.

$$\text{IV} = \text{RBA} + \text{RD} + \text{RF}$$

In order to determine regenerative ability of the stand, stems were assigned to five size class categories first for all species at the site and then for *F. grandifolia*. Nomenclature follows the US Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS 2006).

RESULTS AND DISCUSSION

Thirty-five species of woody plant species were encountered during sampling (Table 1), 11 more than reported by Johnson (1986) from Beech Creek. Among all species, three are tracked by the ONHI: *Castanea pumila* var. *ozarkensis* (G5T3S2), *Halesia tetraptera* (G5G4S2), and *Magnolia tripetala* (G5S1). There were more stems of *Halesia carolina* and *Magnolia tripetala* present than reported here, but they were less than 2.54 cm DBH. In the case of *M. tripetala*, many stems were suckers, a characteristic trait of the species. Mayo and Raines (1986) reported 28 species from the central Ouachitas and 23 species from Crowley's Ridge (Clark 1977).

The highest Importance Values were scored by *F. grandifolia* (10.5) and *Q. alba* (10.3). *Ilex opaca* and *Ostrya caroliniana*, both understory tree species, scored IVs of 9.5. There are several differences between this study and those from the Arkansas Ouachitas. For example, Derwood and Raines (1986) reported that *Carya cordiformis* and *F. grandifolia* had the highest IVs, with *Q. alba* occurring only in the understory. The most important understory species in the Derwood and Raines (1986) study were *Carpinus caroliniana* and *F. grandifolia* saplings. *Ilex opaca* occurred in the shrub layer. On Crowley's Ridge, *Q. alba, Pinus echinata*, and *F. grandifolia* scored the highest IVs. Although both studies have several species in common, several species from dry habitats also were present, such as *Carya texana, Quercus stellata, Q. falcata,* and *Q. velutina.*

A total of 1,101 stems were measured in 17 plots. *Fagus grandifolia* (206) had the greatest number of stems, followed by *Quercus alba* (168). *Ilex opaca* (137) and *Ostrya virginiana* (106) had the greatest number of stems in the subcanopy. Total basal area, for all stems sampled, was 272,488cm^2. The highest basal area recorded was for *F. grandifolia* (88,678 cm^2), *Q. alba,* (63,816 cm^2), and *P. echinata* (51,275 cm^2). The stem class plot indicated a regenerating forest (Figure 2). A total of 441 stems occupied the lowest size class, 94 of which were *F. grandifolia*. Two stems, both *F. grandifolia*, measuring 76.2 and 77.8, were in the largest size class. Little and Olmstead (1935) encountered several individuals in their study and reported the largest as 58.4 cm in diameter. They also reported a hollow tree, possibly implying that it was dead, of 91.4 cm. Of the dominant trees, the largest *P. echinata* measured 51.2 cm in diameter and the largest *Q. alba* 63.7 cm.

In regards to vegetation classification, this study clarifies the composition of the *F. grandifolia* forest type in Oklahoma. Unlike stands sampled by Little and Olmstead (1935), a distinct *F. grandifolia* Forest Association is recognizable in southeast Oklahoma. In these forests, *Fagus* constitutes the dominant species in terms of basal area and importance value.

Table 1: Total basal area (BA), mean basal area/plot (MPlot), relative basal area (RBA), total number of stems for all plots sampled (Stems), average density per plot (Mstems), relative density (RD), frequency (FREQ), relative frequency (RF) , and importance value (IV) for a forest site along Beech Creek, McCurtain County, Oklahoma.

Species	BA	MPlot	RBA	Stems	Mstems	RD	FREQ	RF	IV
Fagus grandifolia	88677.8	5216.3	0.325	206	12.1	0.187	17	9.94	10.5
Quercus alba	63815.9	3753.9	0.234	168	9.9	0.153	17	9.94	10.3
Pinus echinata	51275.4	3016.2	0.188	74	4.4	0.067	8	4.68	4.9
Liquidambar stryraciflua	14400.4	847.1	0.053	64	3.8	0.058	14	8.19	8.3
Quercus velutina	13476.3	792.7	0.049	29	1.7	0.026	2	1.17	1.2
Ilex opaca	6037.7	355.2	0.022	137	8.1	0.124	16	9.36	9.5
Quercus rubra	5911.7	347.7	0.022	4	0.2	0.004	2	1.17	1.2
Acer rubrum	5902.3	347.2	0.022	65	3.8	0.059	12	7.02	7.1
Nyssa sylvatica	5655.3	332.7	0.021	38	2.2	0.035	11	6.43	6.5
Ostrya virginiana	4132.0	243.1	0.015	106	6.2	0.096	16	9.36	9.5
Tilia carolina	2881.1	169.5	0.011	5	0.3	0.005	3	1.75	1.8
Carya alba	2649.7	155.9	0.010	67	3.9	0.061	7	4.09	4.2
Carya spp.	1927.6	113.4	0.007	7	0.4	0.006	3	1.75	1.8
Cornus florida	1599.5	94.1	0.006	50	2.9	0.045	13	7.60	7.7
Quercus falcata	1519.5	89.4	0.006	5	0.3	0.005	2	1.17	1.2
Amelancher arborea	743.2	43.7	0.003	15	0.9	0.014	2	1.17	1.2
Castanea pumila	260.8	15.3	0.001	7	0.4	0.006	2	1.17	1.2
Quercus stellata	229.7	13.5	0.001	1	0.1	0.001	1	0.58	0.6
Magnolia tripetala	211.7	12.5	0.001	6	0.4	0.005	1	0.58	0.6
Sassafrass albidum	210.9	12.4	0.001	6	0.4	0.005	2	1.17	1.2
Halesa teraptera	170.8	10.0	0.001	9	0.5	0.008	2	1.17	1.2
Carpinus caroliniana	168.4	9.9	0.001	4	0.2	0.004	1	0.58	0.6
Carya cordiformis	161.0	9.5	0.001	2	0.1	0.002	2	1.17	1.2
Morus rubra	128.7	7.6	<0.001	1	0.1	0.001	1	0.58	0.6
Juniperus virginiana	96.8	5.7	<0.001	2	0.1	0.002	2	1.17	1.2
Hamamelis virginiana	47.6	2.8	<0.001	6	0.4	0.005	2	1.17	1.2
Carya ovalis	46.4	2.7	<0.001	2	0.1	0.002	2	1.17	1.2

Table 1. Continued

Species	BA	MPlot	RBA	Stems	Mstems	RD	FREQ	RF	IV
Chionanthus virginicus	38.6	2.3	<0.001	2	0.1	0.002	1	0.58	0.6
Acer saccharum	35.0	2.1	<0.001	5	0.3	0.005	1	0.58	0.6
Vaccinium arboreum	18.7	1.1	<0.001	3	0.2	0.003	1	0.58	0.6
Prunus serotina	14.5	0.9	<0.001	1	0.1	0.001	1	0.58	0.6
Ulmus alata	13.9	0.8	<0.001	1	0.1	0.001	1	0.58	0.6
Sideroxylon lanuginosum	13.2	0.8	<0.001	1	0.1	0.001	1	0.58	0.6
Viburnum rufidulum	9.1	0.5	<0.001	1	0.1	0.001	1	0.58	0.6
Robinia pseudoacacia	7.1	0.4	<0.001	1	0.1	0.001	1	0.58	0.6

ACKNOWLEDGMENTS

I thank Lacy Brookshire, Jessica Brumley, Lacy Burgess, Amy Buthod, Priscilla Crawford, Tyler Haas, Shannon Hall, Raquel Orzoco, James Shipman, and Jill Wise for field data collection assistance.

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