Woody Species Composition of Floodplain Forests of the Little River, McCurtain and LeFlore Counties, Oklahoma

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Species composition and structure of bottomland hardwood forests were studied in the coastal plain region of southeastern Oklahoma. The objectives of this study were to develop a quantitative vegetation classification and analysis of species diversity patterns in bottomland forests of the Little River. Fourteen bottomland sites were sampled with 10-m² circular plots. Data were compiled into a species-by-site matrix for analysis using detrended correspondence analysis and two-way indicator. The following plant communities types were identified: 1) *Quercus phellos*, 2) *Carpinus caroliniana* and 3) *Taxodium distichum*. Sites were separated in ordination space by the apparent flooding tolerance of dominant tree species. The diversity of woody species was higher in southeastern Oklahoma bottomland forests than in central Oklahoma bottomland forests.

INTRODUCTION

Bottomland hardwood forests are the characteristic vegetation of coastal plain and Piedmont rivers with broad floodplains (*1*,*2*). The vegetation of the Oklahoma coastal plain was mapped by Küchler (*1*) as Southern Floodplain Forest, primarily along the Little and Red Rivers (*3*-*5*). These forested wetlands are highly productive ecosystems with well documented ecological and economic values (*3*,*6*). Dominant woody genera include Quercus, Nyssa, and Taxodium (*2*,*4*,*6*,*7*). Vegetation surveys specific to Oklahoma list *Fraxinus pennsylvanica, Liquidambar styraciflua, Pinus taeda, Quercus phellos, Quercus nigra,* and *Quercus lyrata* as dominant species (*5*,*8*,*9*). Despite the ecological and economic importance of these natural communities, there is a paucity of information regarding bottomland hardwood forest composition and structure in Oklahoma. In addition, approximately 84% of bottomland hardwood forests in LeFlore and McCurtain counties have been destroyed (*9*). In this study, we attempt to broaden the knowledge of Oklahoma bottomland hardwood forest communities by developing a quantitative vegetation classification and analyzing patterns of species diversity.

STUDY AREA

Fourteen bottomland forest sites were sampled in the Little River drainage of McCurtain and LeFlore counties, Oklahoma. Eleven sites were located at the Little River National Wildlife Refuge (referred to as Refuge), one on Cypress Creek, and two on Cucumber Creek, a tributary of the Mountain Fork River (Figure 1).

The Refuge and Cypress Creek sites were situated on the dissected coastal plain physiographic province (*10*). Two geologic formations, both of Cretaceous age, flank the Little River floodplain: the Antlers sand to the north and Goodland limestone to the south (*11*). The floodplain is composed of deep Quaternary alluvial deposits with remnant, heavily eroded terrace deposits (*11*). The predominant soil association at the Refuge and on Cypress Creek is the Guyton silt loam (*12*). No sites were located on the Cahaba fine sand loam soils, which represent remnant terrace deposits (*12*). The two Cucumber Creek sites were located in the Ouachita Mountain physiographic province (*10*). Steep hills composed of Pennsylvanian sandstone and shale flank Cucumber Creek (*13*). The Ceda-Rubble Land complex, described as shallow with moderate to large stones just below the surface, was the predominant soil along Cucumber Creek (*14*).

Annual precipitation for southeast Oklahoma averages 107 cm, 62% of which falls

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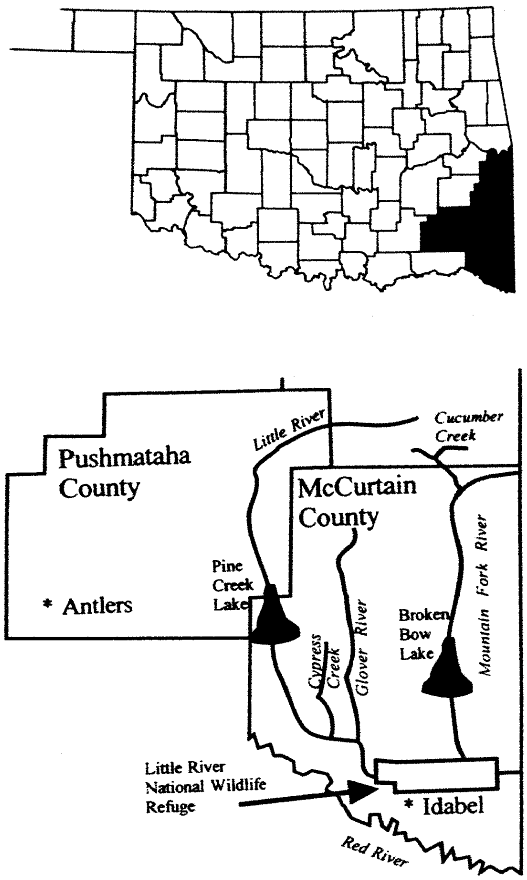

Figure 1. Location of the Little River and Cucumber Creek study sites.

during the growing season (*15*). Average relative humidity at mid-aftemoon is 50% (*14*). Mean annual temperature is 17.3 °C. The annual high temperature occurs in July (38.0 °C) and the low in January (27.5 °C). The growing season extends from April to September (*14*).

MATERIALS and METHODS

Data were collected during the summers of 1989 and 1990. Since the study area was located in a timber-producing region, sites which had been recently harvested, high-graded, or were current or abandoned pine plantations, were not sampled. Selected forest stands are referred to as sites and each site was quantitatively sampled using 25 randomly placed 10-m^2 2 circular plots. The diameter-at-breast-height (DBH) for all woody species greater than 2.5 cm was recorded within each plot. Relative frequency, relative density, and relative basal area were calculated and summed to derive an Importance Value (IV) for each species at a site (*16*). Importance values were compiled into a species-by-site matrix for analysis using Two-Way Indicator Species Analysis (TWINSPAN) and Detrended Correspondence Analysis (DCA, *17*). Rare species were downweighted for these analyses.

Species importance values were averaged for each TWINSPAN cluster in order to describe the vegetation types they represented. Species richness, evenness, and diversity were then calculated for each TWINSPAN cluster. Species richness was reported as the number of species encountered. Evenness, a measure of the distribution of individuals within a species among the community of species, was calculated according to Pielou (*18*). Evenness is maximal when there is the same number of individuals among all the species in a community. The Shannon-Weiner Index, a measure of species richness weighted by species evenness, was used to calculate species diversity (*19*). Woody species nomenclature follows Little (*20*).

RESULTS

A total of 47 woody species were encountered at the 14 sites sampled. The genus *Quercus* (nine species total) was commonly encountered during sampling. *Quercus phellos* and *Carpinus caroliniana* were the most prominent species in this study, though *C. caroliniana* was more broadly distributed (Table 1).

Classification. TWINSPAN analysis of the species-by-site matrix produced three clusters. These clusters were named as community types according to the species with the highest average IV. These community types were: *(1) Taxodium distichum, (2) Quercus phellos,* and (3) *Carpinus caroliniana.* Of the fourteen sites sampled, seven were assigned to the *Quercus phellos* community type, four to the *Carpinus caroliniana* community type, and three to the *Taxodium distichum* community type. In the first TWINSPAN division, the *Quercus phellos* community type was separated from the *Taxodium distichum* and *Carpinus caroliniana* community types by the presence of *Acer saccharum.* The *Taxodium distichum*

TABLE 1. Species importance values for 14 quantitatively sampled bottomland forest sites in southeastern Oklahoma. Sites are arranged by TWINSPAN cluster/community-type with the name of each community-type given above the sites.

	Taxodium distichum Comm.			*Carpinus caroliniana* Community				*Quercus phellos* Community						
	Cypress Creek	Crooked Creek	Forked Lake	Cucumber Creek 1	Cucumber Creek 2	Refuge East	Refuge West	Caney	Refuge North	H-shoe[a] Lake	Brick Slough	Grassy Lake	Buzzards Roost	Holly Creek
Acer negundo	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acer rubrum	0.0	9.5	8.2	28.4	6.5	48.7	38.2	19.0	0.0	1.5	0.0	0.0	1.3	6.1
Acer saccharum	25.5	46.4	37.2	14.7	11.4	10.7	23.2	4.9	0.0	0.0	0.0	0.0	0.0	0.0
Betula nigra	14.1	23.7	18.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bumelia lanuginosa	0.0	0.0	0.0	1.9	0.0	0.0	0.0	15.8	19.2	0.0	0.0	0.0	0.0	0.0
Carpinus caroliniana	13.6	41.6	41.4	59.5	64.4	41.9	68.3	0.0	0.0	26.5	46.3	9.4	60.3	16.1
Carya illinoensis	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carya ovata	0.0	0.0	0.0	7.6	0.0	0.0	0.0	8.0	2.6	8.5	5.9	3.6	1.9	3.8
Carya texana	4.2	7.6	3.6	0.0	0.0	0.0	0.0	38.8	3.4	0.0	0.0	0.0	0.0	0.0
Carya tomentosa	11.6	16.8	4.1	24.2	16.8	48.8	36.0	0.0	0.0	37.3	8.7	22.8	7.7	19.4
Celtis laevigata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0
Cephalanthus occidentalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0
Cercis canadensis	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cornus amomum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.8	0.0
Cornus florida	0.0	0.0	0.0	17.2	6.5	4.1	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crataegus marshallii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	2.9	1.7	0.0
Crataegus spp.	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crataegus viridus	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diospyros virginiana	0.0	0.0	0.0	0.0	0.0	1.6	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fraxinus pennsylvanica	0.0	0.0	0.0	4.6	15.2	0.0	0.0	0.0	0.0	3.7	0.0	1.8	0.0	3.6
Gleditsia triacanthos	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	4.4	0.0	0.0	0.0
Ilex decidua	0.0	4.4	25.4	0.0	0.0	0.0	0.0	13.9	0.0	21.2	1.6	6.1	1.7	1.7
Ilex opaca	0.0	21.7	29.6	1.9	26.2	22.7	19.2	0.0	0.0	0.0	29.6	0.0	2.3	34.9
Liquidambar styraciflua	0.0	17.9	4.8	36.2	0.0	6.6	4.6	38.1	62.5	13.9	34.5	4.0	44	21.2
Morus alba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0
Morus rubra	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nyssa sylvatica	4.3	7.8	17.8	0.0	82.7	4.5	23.5	0.0	4.9	2.7	18.3	0.0	8.6	11.0
Pinua taeda	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	23.3	0.0	0.0	6.0	0.0

TABLE 1 (continued)

	Taxodium distichum Comm.			*Carpinus caroliniana* Community				*Quercus phellos* Community						
	Cypress Creek	Crooked Creek	Forked Lake	Cucumber Creek 1	Cucumber Creek 2	Refuge East	Refuge West	Caney	Refuge North	H-shoe[a] Lake	Brick Slough	Grassy Lake	Buzzards Roost	Holly Creek
Planera aquatica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0
Platanus occidentalis	43.0	0.0	10.3	2.6	13.8	7.1	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prunus serotina	0.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quercus alba	0.0	11.0	0.0	35.9	24.8	8.8	24.4	54.1	44.9	0.0	0.0	4.5	0.0	21.4
Quercus falcata	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.8	0.0	0.0	30.3	18.7
Quercus lyrata	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	7.6	14.0	37.9	21.6	64.9
Quercus nigra	0.0	10.9	10.9	0.0	0.0	12.9	8.9	24.4	0.0	3.8	32.7	0.0	33.3	0.0
Quercus nuttalii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.6	127.9	0.0	0.0	28.6	5.2	1.9
Quercus phellos	0.0	7.3	12.7	0.0	0.0	38.1	3.6	0.0	4.5	83.7	75.0	125.0	35.4	45.9
Quercus rubra	0.0	0.0	0.0	15.5	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quercus stellata	0.0	0.0	0.0	0.0	0.0	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Quercus velutina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.3	0.0	0.0	7.1	0.0
Taxodium distichum	139.4	18.4	36.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tilia americana	0.0	5.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tilia caroliniana	1.9	0.0	16.4	0.0	0.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ulmus alata	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	1.6	0.0	1.7	0.0
Ulmus americana	4.2	0.0	0.0	50.0	21.0	13.6	13.3	1.5	0.0	0.0	0.0	0.0	0.0	3.5
Ulmus rubra	14.3	25.9	22.6	0.0	0.0	15.0	21.2	36.9	20.9	30.0	25.0	39.6	29.3	25.9
Zanthoxylum clava-herculis	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Horseshoe Lake

community type was then separated from the *Carpinus caroliniana* community types in the second TWINSPAN division by the *Betula nigra,* which was present only at the three *Taxodium distichum* sites.

Carpinus caroliniana and *Liquidambar styraciflua* were common overstory constituents in the *Quercus phellos* community type. Understory species with the highest total importance values were *Crataegus marshalii, C. viridis,* and *Cornus florida*. Canopy composition was most variable in the *Carpinus caroliniana* community type. Several tree species were important in this community type, including *Acer rubrum, Nyssa sylvatica,* and *Quercus alba. Crataegus marshallii* was a commonly encountered shrub. The *Taxodium distichum* community type was prevalent in sloughs and along stream margins. Common woody species in this community type included *Acer saccharum, Carpinus caroliniana,* and *Rex decidua.*

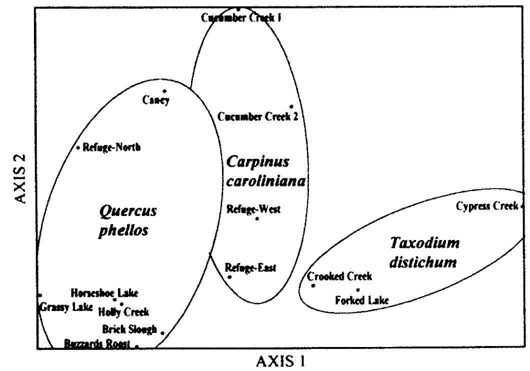

Figure 2. Detrended Correspondence Analysis ordination of 14 sites in the Little River Drainage basin of southeastern Oklahoma. Sites within one of the three community types produced by TWINSPAN analysis are bounded by ellipses. Species names within the ellipse indicate community type.

Ordination. Sites were separated in ordination space by the apparent flooding tolerance of dominant woody species (Fig. 2). Sites in the *Quercus phellos* community type had the highest proportion of flood-tolerant *Quercus* spp. (i.e., *Q. falcata, Q. lyrata, Q. nigra, Q phellos)* and the lowest first axis DCA scores. The high IV for *Liquidambar styraciflua* separated the Caney and Refuge-North sites from others in the *Quercus phellos* community type. Overall, importance values for water tolerant *Quercus* spp. were low in the *Carpinus caroliniana* community type. Second axis DCA scores were high for sites with *Quercus alba,* regardless of community type. The high axis 1 and low axis 2 scores for the *Taxodium distichum* community type are most likely due to the singular presence of *Taxodium distichum, Betula nigra,* and *Acer saccharum* at those sites.

Species Diversity. Species richness was greatest in the *Quercus phellos* community type, but species diversity and evenness were low (Table 2). Species diversity and evenness scores were highest for the *Taxodium distichum* community type, but this community type had the smallest number of species. Richness, evenness and diversity values were not significantly different between communities.

DISCUSSION

In this study, we identified three bottomland forest vegetation types in the Little River drainage. Previous vegetation surveys had listed *Liquidambar styraciflua, Quercus alba,* and *Acer rubrum* as bottomland hardwood forest dominant species in Oklahoma (*5,8,9,20*). These species were constituents of all three community types, *but- Carpinus caroliniana* and *Quercus phellos* were most abundant. The *Quercus phellos* community type reported here is closely allied with the SAF forest type 92, sweetgum. - willow oak (*21*). Although *Liquidambar styraciflua* was not a dominant species, it was a secondary species in the *Q. phellos* community type. *Liquidambar styraciflua* is an early successional species in bottomland hardwood forests and its abundance may be indicative of successional status at a site (*8,20,21*).

TABLE 2. Species richness, diversity, and evenness scores for the three bottomland forest community types produced by TWINSPAN analysis of fourteen bottomland forest stands in southeastern Oklahoma.

Community Type	Species Richness	Evenness	Species Diversity
Quercus phellos	30	0.76	2.6
Carpinus caroliniana	29	0.80	2.68
Taxodium distichum	27	0.82	2.72

The *Carpinus caroliniana* community type was distributed throughout the study area. Variation in canopy composition was most likely effected by the difference in elevation between the Refuge and Cucumber Creek sites. In general, the

Cucumber Creek stream gradient is greater and the floodplain more confined than the lower Little River. *Carpinus caroliniana* is a common tree on high elevations within floodplain sites (*2*). These differences were apparent in the ordination diagram. Many of the woody species at the Cucumber Creek sites had a lower flood tolerance than those at Refuge sites. For example, *Quercus* rubra is a weakly flood-tolerant species (*22*) that was encountered only on Cucumber Creek. *Quercus* spp. with greater flood tolerance (i.e., *Q. nigra, Q. nuttallii, Q. phellos, Q. lyrata; 22*) were prominent in Refuge *C. caroliniana* communities.

The *Taxodium distichum* community type (equivalent to SAF type 101; *21*) was of limited extent in this study. Nonetheless, we noted vigorous regeneration and several mature stands at the Refuge. *Taxodium distichum* was an important commercial tree throughout the coastal plain, including Oklahoma, at the turn of the century (*23*). *Taxodium distichum* is the only tree species present in Oklahoma deepwater habitats (*5,7*). Interestingly, *Acer saccharum* was found to be a prominent member of the *T. distichum* community type. Although *A. saccharum* is common on poorly drained flats (*24*), it is not typically considered an associate of *T. distichum.* Sampling with randomly placed quadrats may be responsible for this apparent anomaly. The sampling method could have obscured vegetation patterns produced by floodplain microtopography, an important factor in seedling regeneration and vegetation structure in bottomland hardwood forests (*25,26*).

At the continental scale, species diversity in bottomland forests has been shown to decrease from east to west (*27*). Bottomland forest composition also changes from eastwest in Oklahoma (*28,29,30*). In southcentral Oklahoma, species diversity (H'=2.99) was higher for a riparian forest than the community types reported here, although species richness (n=18) was considerably lower (*31*). Species diversity in north-central Oklahoma bottomland forest (H'=2.49) did not exceed those reported from the Little River (*30*). At the community level, though, species richness (n=29, x=21.2) was comparable to the *Carpinus caroliniana* community type (*30*). Interestingly, species diversity in bottomland forests of LeFlore county (H'=2.22; *32*) was lower than the community types on the Little River. Species diversity for the LeFlore county sites was comparable to that at Cucumber Creek sites.

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