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PRESENCE OR FREQUENCY OF WOODY PLANTS IN VEGETATION SAMPLES IN THE COASTAL PLAIN AND INTERIOR LOW PLATEAU OF TENNESSEE

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ABSTRACT. **Records of the woody flora, based on nearly 1500 plots/stands of mainly forest vegetation of West and Middle Tennessee, have been compiled. The data are from 1155 transects (data collected 1993-1995) and 343 0.1 ha plots (data collected 1985-1986). Taxa total 246 species and lesser forms. The dominant woody plants sort into many community types occupying the small remaining areas of natural landscape. Results are reported as percent presence or frequency of stands seen. Some taxa are common–in ca. 85% of the stands; others are rare. Some taxa occur only on the Coastal Plain, others only on the Plateaus, and some occupy both areas. The range of some species centers in the Central Basin and that of other species exclude the Basin.**

INTRODUCTION

Field botanists, ecologists, foresters, and wildlife personnel often need to know the vegetation matrix in which a certain species or biological phenomenon under study lives. The absolute range of many woody taxa has been mapped by Little (1971, 1977) and in Tennessee, all of them are mapped by Chester *et al.* (1993) and Chester *et al.* (1997). The expected frequency of occurrence, however, cannot be determined by such range maps or "dot" maps; frequencies are needed. It is the purpose of this paper to provide those presences/frequencies of the woody taxa from nearly 1500 sample stands or plots. The samples may substantiate known distributions but also show relative abundance in parts of the range (as in timber volume mapped by county, Beltz *et al.* 1992, and detailed ranges mapped by May (1991).

THE STUDY AREA

The study area is the Gulf Coastal Plain of West Tennessee and the Interior Low Plateau of Middle Tennessee (Fenneman 1938). The Plateau area is herein referred to as Middle Tennessee (Fig. 1).

Climate

Middle and West Tennessee have a humid temperate climate which characterize land areas of this latitude and proximity to the Gulf of Mexico. Precipitation varies from 122-142 cm annually, decreasing irregularly northward and westward. Precipitation is well distributed

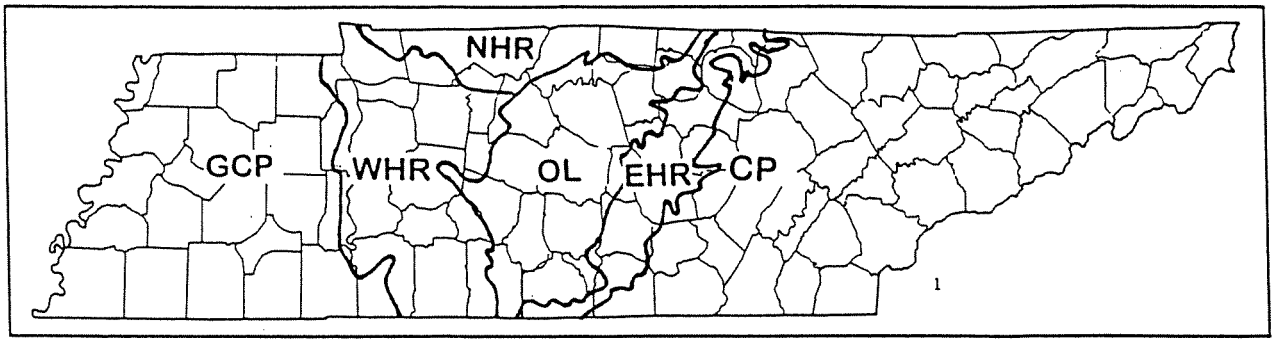

Figure 1. Tennessee showing physiographic divisions in West and Middle Tennessee. GCP = Gulf Coastal Plain (largely West Tennessee), Interior Low Plateaus: WHR = Western Highland Rim, NHR = Northern Highland Rim, EHR = Eastern Highland Rim, OL = approximate extent of Ordovician limestones enclosing the Central Basin and most of the dissected Highland Rim (DeSelm 1959). Some of these limestones also occur elsewhere in the Highland Rim. CP = Cumberland Plateau.

through the year though summer and/or autumn droughts are common (Dickson 1960). During one 38-year period, 38% of the months had slight to severe or extreme drought (Vaiksonoras and Palmer 1973). Seven-day growing season droughts have a 13-33% chance of occurrence (Safley and Parks 1974). Tornado force winds are occasional (Vaiksonoras 1971); winds, drought and snow (and especially ice storms) may open forest canopies and change vegetation structure (Hursh and Haasis 1931). The winds may also be important propagule carriers (Ridley 1930). Temperatures are also variable. Mean July maxima average 31-33°C and mean July minima of 19-22°C occur. In the winter mean January maxima of 10-11°C and mean January minima of -2°C occur (Dickson 1960).

Topography, Geology, Soils

Middle and West Tennessee are characterized by a generally undulating to rolling landscape but the landscape also exhibits such landforms as narrow to broad valley bottom, ridges, steeply sloping hills, bluffs and cliffs. Elevation varies from about 220-450 m on the Highland Rim (higher on Cumberland Plateau outliers and lower on the Cumberland River) to 200-250 m in the Central Basin. Uplands in eastern West Tennessee vary around 200 m but fall to about 110 m on the Tennessee River; these uplands descend westward to about 120 m above major flood plains and may fall to about 100 m on the flood plain of the Mississippi River.

Western West Tennessee is underlain by soft sands and clays of Tertiary age which overlay Cretaceous beds exposed to the east; the latter generally terminate near the Tennessee River though they also appear in parts of Hardin and Wayne counties. Topography westward is undulating to rolling; eastward toward the Tennessee River, sharp ridges and slopes occur. Much of the land is overlain by loess which thickens westward forming high loess bluffs or loess hills on the east side of the Mississippi River flood plain (Hardeman 1966, Miller 1974, Safford 1869).

Middle Tennessee is underlain by more or less horizontally disposed beds of Mississippian limestone in most areas, but Ordovician limestone is exposed in the Central Basin and in valleys around the Basin, and the Devonian Chattanooga Shale encircles the Basin in a narrow band.

Devonian and Silurian limestones, shales and clays are exposed widely in the southwestern Tennessee River valley and to a lesser extent in the dissected parts of the western and northern Rim (Hardeman 1966, Miller 1974, Safford 1969).

The soils of the study area are mapped in hundreds of series and generalized by Elder and Springer (1978) and Edwards *et al.* (1974) into 38 soil associations containing Alfisols, Ultisols, Inceptisols, Mollisols and Entisols. The series (and types) vary greatly in their depth, rockiness, pH, nutrient availabilities, water storage capacity/water content and aeration (Brady 1974, Black 1968). These factors combine with such site factors as stand aspect, slope position, slope shape, and slope protection which, along with history, account for the varied floras (Patterson 1989, Braun 1950, Heineke 1987, DeSelm and Murdock 1993).

Land Use

Middle and West Tennessee were the living and/or hunting areas of a sequence of Native American cultures that populated eastern North America late in the Pleistocene. Evidence of Paleoindians, Archaic settlements, Woodland mounds and Mississippian cultural mounds abound (Lewis and Kneberg 1958, Swanton 1946).

Native American populations were low when found by French and English/American explorers and early settlers. Pressure from the Cherokee Nation, living in East Tennessee, caused the Shawnee to leave Middle Tennessee by 1514 and probably the Euchee left earlier (Williams 1937). West Tennessee was controlled by the Chickasaw Nation. Effects of the cultures on vegetation are unknown for certain but villages and fields were cleared and the people hunted for food and medicinal plants (as well as animals). The setting of surface fires to clear underbrush to facilitate large animal sighting and hunting were to be expected (Williams 1989). An increase in oak, chestnut, and pine pollen occurred in peat and pond sediments (as Cliff Palace Pond, Cumberland Plateau, southeastern Kentucky) after 3000 YBP after the beginning of intensive use here by Archaic people. The authors, Delcourt and Delcourt (1998), attribute these increases to spread of oak-chestnut and oak-pine vegetation following increased use of fire by the local Archaic and Woodland populations.

In the 1760s, the Long Hunters came from the eastern Appalachians to hunt big game in eastern and Middle Tennessee and Kentucky and they may also have hunted in West Tennessee (Haywood 1823, Williams 1930, Goodspeed 1887). Middle Tennessee was opened to settlement in 1780 and was settled gradually thereafter and West Tennessee was opened in 1818. Settlement involved land clearing, extensive crop cultivation of uplands, and draining and cultivation of lowlands. Forests were cut and burned, or cut for board use and some wood products were shipped outside the area. Forests not cut were usually grazed and the understory burned periodically (Williams 1930, Killebrew *et al.* 1874).

Flora and Vegetation

The early explorers, such as the Long Hunters, spoke of only a few plants seen (in Tennessee and Kentucky) but they were impressed by the extensive and luxuriant forest, barrens and cane, *Arundinaria gigantea* (Haywood 1823, Filson 1784, Boon 1784). Late in the eighteenth century, the

settlers at Nashville spoke of the large cedar (*Juniperus virginiana*) (Donaldson party in Williams 1928). Michaux (1793-1796) traveled through Middle Tennessee and collected and wrote of some plants. The land survey of southern Middle Tennessee mentioned 35 problematic taxa (DeSelm 1994). Taxa mentioned in West Tennessee at the time of settlement are the oaks (*Quercus* spp.), tulip tree (*Liriodendron*), cane (*Arundinaria gigantea*), peavine (*Amphicarpa*) and cypress (*Taxodium distichum*) (Williams 1930, DeSelm 1989). Modern studies by scientifically trained persons living in Tennessee began with Safford (1869) and Killebrew *et al.* (1874), who noted forest species and forest types by regional or county location. Gattinger listed the flora first of the Nashville area (Gattinger 1887), and then of all of Tennessee (Gattinger 1901) with short notations on collection or occurrence locations. Other species lists appeared subsequently but the maps in Chester *et al.* (1993) and Chester *et al.* (1997) are of particular use here. The species live in the vegetation matrix described by Braun (1950), Heineke 1987), Skeen *et al.* (1993), Quarterman *et al.* (1993), DeSelm and Murdock (1993) and Bryant *et al.* (1993). The modern vegetation pattern based on sampling, especially of older forests, is under study (DeSelm 1995).

Elements of the Flora

The varied climate, climatic history such as Pleistocene coolings and warmings, a mild Holocene Hypsithermal warm or dry period (DeSelm 1989, 1994), land use by Native Americans and past and present Tennesseans have stimulated creation of a large and varied flora (Wofford and Kral 1993). Plant introductions, extinctions and virtual elimination of some landforms and natural vegetation of many types, disease and insect pests and weed competitor introductions have further influenced the composition of the flora. From these positive and negative historical impacts, some of which continue, several species range types (floristic elements) are now known. Lamson-Scribner (1892, 1894), and Gattinger (1901) commented on the range of many species of which they knew in the late nineteenth century. Modern studies of floristic regions/elements are those of Underwood (1945), Shanks (1958), Wofford (1989), and DeSelm *et al.* (1994).

Shanks mapped the collective county distributions of woody species characteristic of the state's floristic regions. Among these are the Appalachian taxa of which a few taxa have an occasional specimen extending westward into Middle and West Tennessee. Some Cumberland Plateau species behave similarly. Species characteristic of the Central Basin may have individuals found also on the Highland Rim and in the Loess Bluffs of West Tennessee. Species of the Mississippi Embayment region (Gulf Coastal Plain), of which some extend occasionally eastward, occur. Southern taxa were mapped. Underwood (1945) using sedges, DeSelm (1994) using grasses, and Shaver (1954) using ferns all found species ranges with many similarities to those shown for woody plants by Shanks (1958).

METHODS

During the field season (May-September or October) 1993-1995, in West and Middle Tennessee to the west edge of the Cumberland Plateau, the landscape was reconnaissanced for vegetation to sample for the study of the terrestrial vegetation of Tennessee. Suitable forests, marshes and woody borders of cedar glades and of barrens were sampled. In 1993, 301 useable samples were obtained in West Tennessee; in 1994, 418 samples were obtained on the Western Highland Rim and Central Basin; in 1995, 436 samples were obtained from the Northern and Eastern

Highland Rims. Forest stands with trees ≥24 inches d.b.h. were sought. The procedure was to walk a transect across uniform topography and geology in the forest, obtaining d.b.h. measurements of about 80 trees (≥ 5 inches) by species. On the transect, the names of seedlings, saplings, shrubs, woody vines and herbs were recorded. Samples were generally well distributed among and within counties. All 57 counties or parts of counties, except Lake, were included. Since a study of the bottomland forests of West Tennessee had already been made, the 1993-5 study sampled mainly uplands. Unknown plants were collected and determined each autumn using facilities at TENN. Some specimens were given to TENN or EKU.

During the summers of 1985 and 1986, Vernon Bates, under contract with the Ecological Services Division, Tennessee Department of Environment and Conservation, sampled West Tennessee bottomland forests using 351 0.1 ha plots (Durham *et al.* 1988, Durham *et al.* 1988). These were well distributed in the bottoms of the Mississippi River and its tributaries, the Forked Deer, Hatchie, Loosahatchie, Obion and Wolfe rivers, as well as the Tennessee River. Relative basal areas, relative density and relative frequency were summed forming an Importance Value 300 for each tree species in each plot. A set of 343 plots were used in the hierarchical, agglomerative, centroid linkage cluster analysis using CLUSTER (SAS Institute, Inc. 1985). Forest communities were classified and described (Patterson 1989). In addition to the above, subcanopy species frequency, mean and relative density was calculated. Shrub and herb frequency and mean cover were calculated by community (Patterson 1989).

The data obtained by DeSelm (1993-1995) and those reported by Patterson (1989) total 1498 plots/stands and constitute the data from which Table 1 was constructed. Here the writer did not apply a species number cut off as was applied for the sake of brevity in the list of characteristic barrens plants (DeSelm 1995). Nomenclature essentially follows Chester *et al.* (1993) and Chester *et al.* (1997), and Gleason and Cronquist (1991). Nomenclatural authorities should be sought in the above publications.

RESULTS

Woody taxa seen total 246 species, including varieties, subspecies and four oak hybrids (Table 1, appended). There also were 18 generic categories such as *Carya* spp. or *Wisteria* spp. (Table 1). The total taxa constitute about 59% of the Tennessee woody flora (Shanks 1952). The percentage of native taxa is 91.5.

The taxa occupy many landforms, geologic beds (Hardeman 1966) and soil series (Elder and Springer 1978), and sort into many plant communities. There are 16 bottomland types (using IV-300 of the more important taxa) (Patterson 1989) and many upland types (using relative tree density) (DeSelm 1995).

A primary objective of this study is to provide the field botanist in West and Middle Tennessee with a list of woody species likely to be seen (especially in forests) and the frequency with which they are to be expected. Thus, *Quercus alba* is to be expected in 73-84 of the stands (but not in the bottoms). *Parthenocissus* may be expected with 55-79 percent frequency and *Toxicodendron radicans* in 78-84% of the stands. Most taxa occur in the study area with a percent presence/frequency of 3-4 to 30-40%.

Some taxa occur across the study area but are uncommonly seen as *Calycocarpum lyoni*, *Ceanothus americanus*, *Hypericum prolificum* and *Lonicera sempervirens*. Eight rare taxa (Nordman 1997) were found in the studies (see maps in Chester 1997 and Table 1). Many taxa occur chiefly in (sometimes East and) Middle Tennessee but not West Tennessee such as *Aesculus glabra*, *A. flava* (*A. octandra*), *Forestiera ligustrina* and *Fraxinus quadrangulata* (maps in Chester *et al.* 1997 and Table 1). Some taxa (especially from the bottoms) occur in West Tennessee but do not occur, or scarcely occur eastward in the State (as *Gleditsia aquatica*). Other West Tennessee taxa have a few counties represented eastward (as *Carya aquatica*). Of the 13 southern taxa reaching Tennessee along the southern border mapped by Shanks (1958), seven still fit that description; one is *Decumaria barbata* found in this study (Table 1). A few woody taxa occur in Middle Tennessee are disjunct in the loess bluffs or swamps of West Tennessee (see *e.g.*, *Cladrastis lutea*) (Shanks 1958, Chester *et al.* 1997).

Currently recognized floristic elements are mapped in Chester *et al.* (1993) and Chester *et al.* (1997). What such "dot" maps do not illustrate is the relative abundance or rarity of a species in a region. Species' ranges in and around the Central Basin are of particular interest. Here, number of stands sampled per county averaged 13 (range 4-38). Illustrated are the concentration of occurrence of *Quercus shumardii* (Fig. 2) and *Ulmus serotina* (Fig. 3) in the Basin and their relative minor importance in the surrounding Rim. In the case of the *Quercus*, presence on the Rim averages 2.7 per county, in the Basin it averages 12.1 per county. In the case of *Ulmus*, presence where seen on the Rim averages 1.0 per county, whereas in the Basin counties it averages 13.1 per county. *Vitis rotundifolia* behaves another way; it seems to encircle the Basin (Shanks 1952, Chester *et al.* 1997). The average presence in the Basin is <1 per county; in the Rim it is 8.8% presence in the adjoining or nearby 25 counties (Fig. 4).

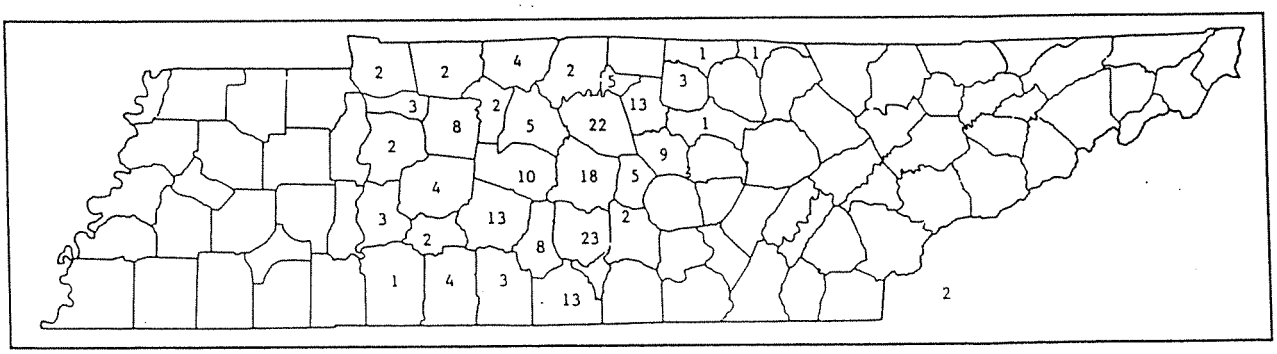

Figure 2. Tennessee showing presence of *Quercus shumardii* in stands per county on and off the Ordovician limestone area in Middle Tennessee.

DISCUSSION

The determination of the pre-Columbian ranges of the species of our flora is difficult at best. Our best records, those in herbaria, are historical accumulations of specimens collected from the beginning of the period of occupation by European peoples to the present. Determination errors in herbarium specimens of woody plants are doubtless few, but species concepts change (compare *Tilia* in Shanks, 1952, with that in Chester *et al.* 1997). Range maps may be produced from exsiccate

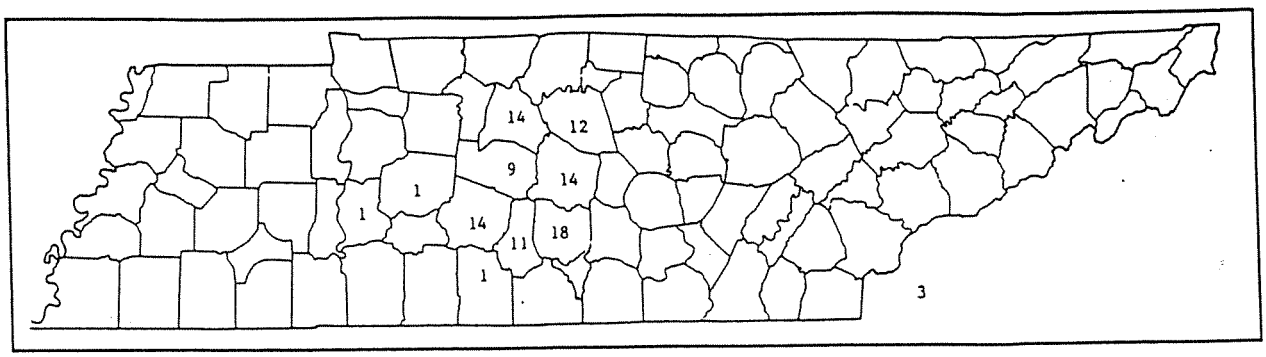

Figure 3. Tennessee showing presence of *Ulmus serotina* in stands per county on and off the Ordovician limestone area in Middle Tennessee.

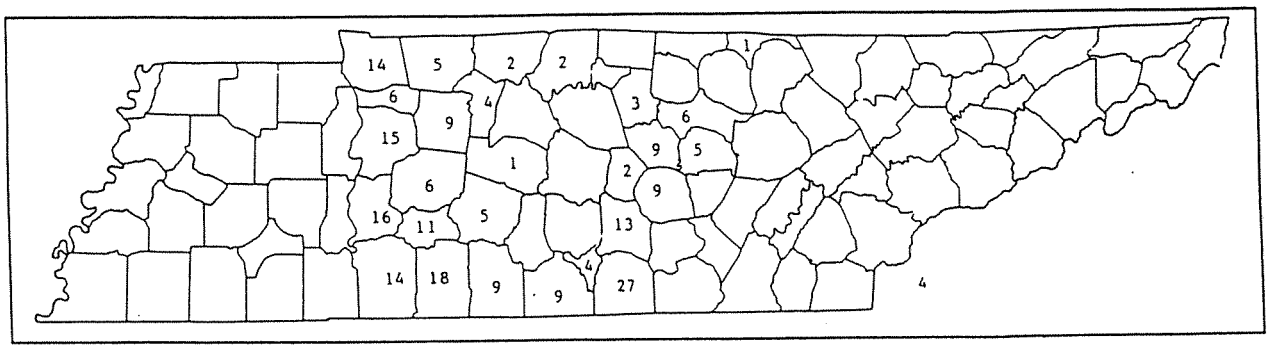

Figure 4. Tennessee showing presence of *Vitis rotundifolia* in stands per county on and off the Ordovician limestone area in Middle Tennessee.

from fewer than all relevant collections. Range maps (as Little 1971, 1977) are made from a variety of sources of which some are "dot" maps with necessary interpolations between dots. Some parts of some maps are based upon sight records (Little 1971).

Elimination of natural vegetation by logging, draining lowlands, grazing/browsing stock and by fire are well known. Local elimination of *Fagus* by hogs stripping the bark from the trees occurs. Fire may eliminate fire-sensitive forest mesophytic herbs (DeSelm and Clebsch 1991). Unfortunately for our study of the ranges of our native species and determination of their relative abundance, logging of the forests continue–indeed clearcutting is now very common with serious changes in dominants and drastic changes in understory composition species resulting (Duffy and Meier 1992, Elliott and Swank 1994). The loss of forest to agricultural use continues. The rate of insertion of primary and secondary homes into forest lands seems to increase. Though forests are seldom burned intentionally now, the species which require the open canopy or understory that fire produces are in peril (White 1982). In large areas of forest land formerly grazed/browsed by low density stock, understory herbs and woody plants survived in patches. Increased use of fencing today results in the concentration of few to many, *e.g.*, cattle, in the forest understory and may result in its virtual elimination. In areas not fenced, the herds of white-tailed deer have grown to the extent that their grazing/browsing pressure results in some forest stands with sparse to no herbs, shrubs or tree seedlings and saplings smaller than 10 cm diameter. Hunting of individual species for food use

(Fernald and Kinsey 1958), medicinal use (Foster and Duke 1990) and for use as landscape/garden plants continues (Phillips 1985). The discontinuous range of many species of our flora (Chester *et al.* 1993, Chester *et al.* 1997) may be the result of this habitat modification/elimination since settlement.

Most native species have numerous bacterial (and viral) and fungal disease to which they are subject which may cause temporary or long-term population declines (Hepting 1971). *Fagus grandifolia* was eliminated at Beech Grove Church (Williamson County) by such attack in the past. Diseases transported by accident from other continental deciduous forests, to which our native taxa are not immune, may be catastrophic (cf. *Castanea dentata, Ulmus americana*). *Juglans cinerea* is currently at risk (Campbell and Schlarbaum 1994).

Similarly native insects may cause local population declines (Baker 1972, Solomon 1995); an example is the current losses in yellow pines from the southern pine beetle (Kowal 1960). Imported insect pests, such as the gypsy moth, cause tree decline or death and forest composition changes (Gottschalk 1993).

Many native trees, shrubs and vines which are planted for such various uses as fiber, ornamentals, shade, or fruit may spread from plantings as competitors into native vegetation. *Pinus strobus*, very rare as a native in Middle Tennessee (Chester and Scott 1980), is commonly planted and may escape. *Pinus taeda*, native on the southern border of the state and in the western Tennessee River Valley, is now planted widely and escapes. *Magnolia grandiflora*, native on the Gulf Coastal Plain, is planted and escapes here (Shanks 1952).

In addition to facilitating the spread of native competitors, we have introduced competitors from other continents (McKnight 1993, Mooney and Drake 1986, Natural Areas Association 1992, Tennessee Exotic Plant Pest Council 1996). Seen in this study were *Broussonetia papyrifera, Albizia julibrissin, Prunus calleryanum, Celastrus orbiculatus,* and *Vinca major*; even more commonly seen were *Ailanthus altissima, Paulownia tomentosa, Ligustrum vulgare, Rosa multiflora, Lonicera japonica* and *Vinca minor* among others. Many other woody cultivars are in use and may be potential escapes.

In spite of the problems cited above, Tennessee state and county records continue to be collected. State records of native and naturalized taxa net (in Wofford and Kral 1993) a little more than 100 more taxa than those of Sharp *et al.* (1956) and Sharp *et al.* (1960). County records of woody plants (Chester *et al.* 1993, 1997) now deviate from previous range descriptions (Shanks 1952, 1953, 1954, Sharp *et al.* 1956, Sharp *et al.* 1960). With these collections, we continue to add to our knowledge of the ranges of our native and introduced taxa and of the probable migrations of some of them.

CONCLUSIONS

A relatively large effort has been expended to sample vegetation in West and Middle Tennessee–about 59% of the state's woody flora has been found. Collateral data collected will also contribute to our understanding of the plant communities–the units of landscape management. Species distribution types (floristic elements) approximate those known from previous studies.

Abundance on the Rim and in the Basin of certain limestone intolerant and tolerant taxa amplifies simple county-level distribution records.

Destruction of our natural landscape and natural vegetation has made our "old" records of species occurrence and range of increased importance. In spite of habitat fragmentation and depredation of native flora and introduced pests into the native flora, new County and State records continue to be made (records at TENN).

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APPENDIX: TABLE 1

Table 1. Percent presence or frequency of woody plants in West and Middle Tennessee

Taxa	West Tennessee					Basin	N.E. Rim W. Rim
	P all a	Overst F b	Subcanopy No types:F range c	Shrub layer No types:F range d	Herb layer No types:F range e	P all f	P all g
*Abelia floribunda**							0.2
Acer floridanum	x					0.2	
A. negundo	18.6	33.0	14:0 - 76.3	7:0 - 50.0	4:0 - 7.1	13.6	20.9
A. nigrum	0.3					1.0	3.2
A. rubrum	57.8	39.6	15:0 - 70.0	16:5.1 - 72.4	10:0 - 41.4	30.4	62.4
A. saccharum	47.2	0.6	1:6.7			73.9	75.7
A. saccharinum	0.6	16.0	14:0 - 66.7	8:0 - 44.4	6:0 - 14.3	1.9	2.8
Aesculus glabra	x					7.2	29.6
A. octandra						0.2	2.3
*Ailanthus altissima**	1.7					9.8	20.6
*Albizia julibrissin**	4.7					0.2	3.7
Alnus serrulata	1.0	0.3	2:0 - 6.7	6:0 - 34.6	1:11.5	1.7	2.3
Amelanchier arborea	19.3					15.6	11.7
Amorpha fruticosa						0.2	0.5
Ampelopsis arborea	1.3			3:0 - 3.4	9:0 - 28.6		0.2
A. cordata	2.7				3:0 - 55.6	3.1	3.4
Aralia spinosa	50.5					30.6	21.3
Aristolochia tomentosa	x			1:1.1		0.5	0.7
Arundinaria gigantea	10.6			9:0 - 62.5	10:0 - 85.7	8.1	11.5
A. tecta	x					0.2	
Asimina triloba	25.2		9:0 - 71.4	7:0 - 66.7	8:0 - 33.3	18.9	27.3
Berchemia scandens	10.0			1:1.7	3:0 - 14.3	4.5	0.9
Betula nigra	4.7	8.5	5:0 - 24.1	3:0 - 16.7	1:3.4	1.2	1.4
Bignonia capreolata	14.0			2:0 - 6.8	12:0 - 85.7	47.1	25.7
*Broussonetia papyrifera**	1.0					0.2	
Brunnichia cirrhosa	x			10:0 - 40.0	13:0 - 44.4	x	
Bumelia lycioides	x			3:0 - 25.0		1.4	0.2
Callicarpa americana	0.7					0.2	0.7
Calycanthus floridus						x	0.2
Calycocarpum lyoni	0.3					0.7	0.9
Campsis radicans	33.9			5:0 - 16.7	16:9.1 - 100.0	27.3	26.4
Carpinus caroliniana	23.3	29.9	15:0 - 83.9	9:0 - 50.6	4:0 - 25.0	22.5	28.2
Carya aquatica	0.3	6.8	7:0 - 55.6	1:22.2	2:0 - 11.1	x	x
C. carolinae-septentrionalis	2.0					14.4	3.0
C. cordiformis	7.0	8.0	5:0 - 37.5	1:1.1		14.8	15.8
C. glabra	81.4					68.2	60.8
C. illinoensis	1.0	7.4	2:0 - 13.6	1:1.7	1:1.7	x	x
C. laciniosa	4.3	25.1	9:0 - 83.3	6:0 - 50.0	8:0 - 50.0	1.4	x
C. ovata	52.2	0.6				52.4	60.6
C. ovalis	1.7					8.9	4.9

Taxa	West Tennessee					Basin	N.E. Rim W. Rim
	P all a	Overst F b	Subcanopy No types:F range c	Shrub layer No types:F range d	Herb layer No types:F range e	P all f	P all g
C. pallida	1.3					0.2	0.5
C. tomentosa	28.9					29.7	40.8
C. spp.	2.7		1:1.7	4:0 - 33.3	3:0 - 12.5		0.9
Castanea dentata	2.0					1.7	1.4
Catalpa speciosa	2.3				1:12.5	1.2	0.5
Ceanothus americanus	1.3					0.5	0.7
*Celastrus orbiculatus**							0.5
C. scandens	4.0					x	x
Celtis laevigatus	2.7	29.9	13:0 - 100.0	14:0 - 83.3	9:0 - 32.3	1.9	3.0
C. occidentalis	1.4		1:1.1	1:34.5		42.1	43.6
C. tenuifolia	0.6					2.4	3.0
Cephalanthus occidentalis	0.7		11:0 - 100.0	10:0 - 81.8	8:0 - 27.3	0.7	2.1
Cercis canadensis	29.6	0.3	3:0 - 6.7	1:1.1		57.9	52.5
Chionanthus virginicus						0.2	0.2
Cladastris kentukea	1.0					1.0	x
Clethra acuminata							0.2
C. alnifolia (PE)							0.2
Cocculus carolina				2:0 - 7.1	4:0 - 16.9	x	x
Cornus alternifolia						x	0.2
C. amomum	x					3.3	0.2
C. drummondii	0.1					1.7	1.8
C. florida	68.8			1:6.7		58.4	66.7
C. foemina			11:0 - 63.3	14:0 - 59.1	8:0 - 27.3	0.5	2.8
C. spp.						0.2	
Corylus americana	15.6			1:12.5		14.1	x
C. cornuta							0.2
Crataegus crusgalli	1.0		1:3.8		1:3.8	0.5	x
C. marshallii			1:12.5	1:16.7		0.2	
C. viridus		2.8	8:0 - 25.0	4:0 - 13.8	1:3.4	x	x
C. spp.	4.0					4.5	2.1
Decodon verticillatus				03:0 - 27.3		x	x
Decumaria barbata	1.3					0.7	x
*Deutsia scabra**							0.2
Dioclea multiflora					2:0 - 12.5	x	
Diospyros virginiana	16.6	18.2	10:0 - 44.4	4:0 - 20.0	2:0 - 11.1	35.9	12.8
Dirca palustris						x	0.2
*Eleagnus umbellata**						0.2	0.7
Euonymus americana	18.6			4:0 - 14.3	4:0 - 14.3	34.9	34.4
E. atropurpurea.	0.7					3.1	1.4
*E. fortunei**	0.7					1.4	1.8
E. spp.						0.2	
Fagus grandifolia	59.1	0.6	1:1.1			46.4	60.6

Taxa	West Tennessee					Basin	N.E. Rim W. Rim
	P all a	Overst F b	Subcanopy No types:F range c	Shrub layer No types:F range d	Herb layer No types:F range e	P all f	P all g
Forestiera acuminata		3.7	12:0 - 45.5	9:0 - 44.4	3:0 - 11.1	x	x
F. ligustrina						12.2	2.1
Fraxinus americana	55.8	2.0	2:0 - 4.5	1:2.3	1:1.1	77.7	72.2
F. pensylvanica	2.7	68.4	16:11.1 - 86.2	13:0 - 30.0	11:0 - 20.1	2.2	3.2
F. quadrangulata						8.9	4.4
F. spp.			2:0 - 7.1	4:0 - 25.0	2:0 - 16.7		
Gaultheria procumbens							0.2
Gaylusaccia baccata						x	2.3
G. dumosa (T)							0.5
Gelsemium sempervirens (S)						0.2	
Gleditsia aquatica	0.3						
G. triacanthos	5.0	9.4	7:0 - 30.0	1:1.7	4:0 - 22.2	11.5	5.5
Gymnocladus dioicus	1.0	1.4	2:0 - 8.5	2:0 - 16.7		x	0.5
Hamamelis virginiana						3.3	2.8
*Hedera helix**	0.7					0.5	0.2
Hibiscus laevis				6:0 - 40.0	1:11.1	x	x
H. moscheutos						x	0.7
*H. syriaca**						0.5	0.2
Hydrangea arborescens	12.6					23.9	26.8
H. discolor	x					0.2	0.5
H. quercifolia	1.3					0.7	x
H. radiata						1.0	
Hypericum densiflorum						0.7	
H. frondosum	x					4.5	0.9
H. hypericoides	31.6					6.9	6.4
H. prolificum	0.7					3.1	3.2
H. stans						0.5	1.1
H. sphaerocarpon	x					0.7	x
H. stragalum	x					9.3	17.2
H. spp.	0.3						
Ilex decidua	19.6		14:0 - 75.0	15:0 - 66.7	8:0 - 14.3	5.2	0.9
I. opaca	26.2		3:0 - 14.3	5:0 - 14.3	1:16.7	0.5	2.1
I. verticillata	1.0					0.2	x
I. spp.							0.2
Itea virginica				9:0 - 63.6	6:0 - 27.3	0	2.3
Juglans cinerea (T)	x					1.9	1.6
J. nigra	21.6	1.7				3.9	50.0
Juniperus virginiana	40.9					60.9	61.5
Kalmia latifolia	x					2.2	8.5
Ligustrum vulgare/sinense**	11.3		5:0 - 12.5	11:0 - 33.3	7:0 - 33.0	11.2	13.5
Lindera benzoin	7.6		7:0 - 42.9	7:0 - 50.0	4:0 - 50.0	15.6	23.6

Taxa	West Tennessee					Basin	N.E. Rim W. Rim
	P all a	Overst F b	Subcanopy No types:F range c	Shrub layer No types:F range d	Herb layer No types:F range e	P all f	P all g
Liquidambar styraciflua	72.1	48.4	14:0 - 83.3	7:0 - 33.3	1:3.4	26.3	36.5
Liriodendron tulipifera	65.8	2.6	2:0 - 14.3	2:0 - 1.7		55.7	72.5
*Lonicera fragrantissima**						0.2	
*L. japonica**	56.8				9:0 - 66.7	53.6	56.7
*L. mackii**						4.3	0.5
L. sempervirens	1.0					1.2	0.5
L. spp.						0.2	
Lyonia ligustrina	x						0.4
Maclura pomifera	1.7		2:0 - 1.7			4.8	4.8
Magnolia acuminata	4.0					x	8.3
M. grandiflora	0.3						
M. macrophylla	x					0.5	
M. tripetala						x	5.7
M. virginiana (T)	0.7					0.2	
Menispermum canadense	0.7			1:1.7	1:3.4	0.5	5.7
Morus rubra		14.0	10:0 - 100.0	7:0 - 16.7	3:0 - 12.5	35.9	40.8
Nyssa aquatica	0.7	20.2	11:0 - 100.0	9:0 - 54.5	9:0 - 50.0		x
N. biflora	x					0.2	0.5
N. sylvatica	78.1	14.5	9:0 - 50.0	2:0 - 14.3	5:0 - 25.0	55.3	66.1
Ostrya virginiana	47.5	0.9	2:0 - 12.5	1:12.5		55.7	33.7
Oxydendron arboreum	13.0					28.7	38.5
Pachysandra procumbens						0.2	x
Parthenocissus quinquefolia	81.1			1:2.3	7:0 - 42.9	84.7	78.7
*Paulonia tomentosa**	1.7					1.7	1.8
Philadelphus hirsutus						x	0.7
P. inodorus	1.3					x	0.5
Pinus echinata	4.7					2.2	0.7
P. strobus						0.2	0.5
P. taeda	8.0					5.3	6.0
P. virginiana	0.7					3.3	5.1
Planera aquatica		12.8	11:0 - 54.5	7:0 - 45.5	9:0 - 33.3		
Platanus occidentalis	18.9	14.5	9:0 - 33.3	3:0 - 16.7	1:3.8	22.2	25.9
Populus deltoides	2.7	4.6	3:0 - 16.7	2:0 - 16.7		1.4	1.4
P. grandidentata (S)						x	0.2
P. heterophylla	x						0.2
Prunus americana	x					0.2	0.9
P. angustifolia	x					x	0.2
*P. mahalob**	0.3					0.2	
P. serotina	73.4	0.3	3:0 - 14.3	1:1.1		42.3	61.0
P. spp.	0.3						0.7
*Pyrus alleryana**							0.2
P. angustifolia	x					1.0	x

Taxa	West Tennessee					Basin	N.E. Rim W. Rim
	P all a	Overst F b	Subcanopy No types:F range c	Shrub layer No types:F range d	Herb layer No types:F range e	P all f	P all g
P. primulifolia	x					x	2.1
P. spp.						0.2	1.2
Ptelea trifoliata	0.7					0.5	x
*Pueraria lobata**	1.0						
Quercus alba	89.4					77.3	72.9
Q. albaxmuhlenbergii							0.2
Q. bicolor	x					0.7	0.9
Q. x capesii						0.5	
Q. coccinea	43.5					29.9	29.8
Q. falcata	64.5					37.8	41.1
Q. x fontana							0.2
Q. imbricaria	1.7					5.7	2.8
Q. lyrata	1.7	33.0	14:0 - 77.8	7:0 - 20.0	10:0 - 28.6	1.2	1.8
Q. macrocarpa	x					0.5	
Q. marilandica	8.3					5.3	4.4
Q. michauxii	6.0	20.8	9:0 - 50.0	6:0 - 16.7	5:0 - 16.7	2.6	0.9
Q. muhlenbergii	20.6					47.8	37.6
Q. nigra	7.0	11.0	5:0 - 33.3	6:0 - 16.7		0.2	6.9
Q. nuttallii	0.3		2:0 - 3.9	1:14.3			
Q. pagoda	20.6	29.3	8:0 - 21.8	2:0 - 14.3	1:3.4	1.4	0.2
Q. palustris	2.7	4.6	4:0 - 16.7			1.4	3.7
Q. phellos	14.0	21.9	9:0 - 66.7	6:0 - 12.5	3:0 - 6.9	3.6	19.3
Q. prinus	4.0					19.1	12.2
Q. rubra	34.6					59.3	56.0
Q. x saulii						0.2	
Q. schumardii	3.7	0.9				31.6	15.1
Q. stellata	60.5					40.0	31.4
Q. velutina	84.4					62.7	52.5
Rhamnus caroliniana	6.0					33.7	39.7
R. lanceolata						0.2	
Rhododendron canescens	0.7					0.2	0.2
R. spp.	5.6					0.6	10.6
Rhus aromatica	1.7					11.7	1.8
R. copallina	19.6					16.5	13.3
R. glabra	8.0					2.9	4.4
Ribes odoratum						1.7	
R. cynosbati							0.2
Robinia pseudoacacia	15.9					14.6	15.8
Rosa carolina	4.7					7.9	3.0
*R. mutiflora**	10.3					11.2	21.3
R. palustris	1.7			4:0 - 23.1	1:3.4	0.5	1.4
R. setigera	2.3					3.1	2.5
R. spp.	3.3					0.7	

Taxa	West Tennessee					Basin	N.E. Rim W. Rim
	P all a	Overst F b	Subcanopy No types:F range c	Shrub layer No types:F range d	Herb layer No types:F range e	P all f	P all g
Rubus hispidus							0.9
R. spp.	40.9			8:0 - 16.7	6:0 - 42.3	40.4	38.7
Salix caroliniana	x				2:0 - 7.1	x	x
S. humilis	x					x	0.2
S. nigra	0.7	20.2	11:0 - 100.0	8:0 - 77.8	6:0 - 33.3	0.7	1.4
S. tristis						0.5	0.2
Sambucus canadensis	23.9			7:0 - 16.7	7:0 - 28.6	22.7	21.3
Sassafras albidum	15.9	0.3	2:0 - 7.1		2:0 - 14.3	55.3	48.2
Schisandra glabra (T)	0.7					0.2	
Smilax bona nox	8.0					23.9	14.9
S. glauca	51.9					37.3	41.7
S. hispida	0.3					0.5	2.8
S. rotundifolia	58.5					66.7	68.3
S. spp.	0.3			11:0 - 40.2	10:0 - 57.1	0.7	
*Spirea japonica**						x	0.5
S. tomentosa						x	0.2
Staphylea trifolia	3.3					7.9	5.5
Styrax americana	0.7			8:0 - 36.4	4:0 - 33.3	1.9	0.5
S. grandiflora	2.0					4.7	x
Symphoricarpos orbiculatus	19.3					63.2	35.6
Taxodium disticum	1.0	36.8	9:0 - 86.2	8:0 - 30.0	9:0 - 54.5		0.5
Tilia americana	2.7					9.8	16.7
T. heterophylla	x					1.4	0.2
Toxicodendron radicans	84.1			5:0 - 27.1	13:0 - 86.4	81.3	78.2
Trachelospermum difforme	1.3				2:0 - 9.1		x
Tsuga canadensis							4.1
Ulmus alata	71.4		3:0 - 7.1	1:12.5	1:1.1	55.5	44.0
U. americana	3.7	4.3	10:0 - 42.9	4:0 - 42.4	1:14.3	1.9	2.3
U. crassifolia (S)		1.7	2:0 - 10.2				
U. rubra	52.2	56.7	16:9.1 - 85.1	12:0 - 39.1	6:0 - 12.5	52.3	60.3
U. serotina	x					22.2	x
U. thomasii	0.3					x	2.3
Vaccinium arboreum	34.6					16.7	15.1
V. attrococcum	1.0					x	2.8
V. corymbosm	x			1:7.7		x	1.1
V. pallidum						x	1.2
V. stamineum	6.3					18.2	17.7
V. vacillans	2.3					16.5	17.9
V. spp.	2.3					2.4	1.6
Viburnum acerifolium						x	16.1
V. cassinoides	0.3						0.7

Taxa	West Tennessee					Basin	N.E. Rim W. Rim
	P all a	Overst F b	Subcanopy No types:F range c	Shrub layer No types:F range d	Herb layer No types:F range e	P all f	P all g
V. dentatum						x	0.7
V. nudum	x		2:0 - 11.5	3:0 - 23.1	1:14.3		0.5
V. prunifolium	0.7						10.3
V. rufidulum	7.6					1.4	3.4
V. spp.						0.2	0.5
*Vinca major**	0.7						
*V. minor**	0.7					2.9	1.6
Vitis cinerea and its var. *baileyana*	x					x	0.5
V. labrusca							0.2
V. rotundifolia	61.1				1:1.1	30.6	22.1
V. spp.	59.8			3:0 - 7.1	6:0 - 28.8	70.6	70.2
Wisteria frutescens	x			4:0 - 20.0	2:0 - 6.7	0.5	0.2
W. sp.	0.3					1.0	
Xanthorhiza simplicissima	x					x	0.2
Yucca filamentosa	0.3					x	0.2

Columns a, f, g - percent presence, all layers, uplands and bottoms
Columns (bottom samples only) b, F - in overstory in all samples.
Columns (bottom samples only) c in subcanopy, d in shrub layer, e in herb layer, number of vegetation types (of 16): F range among those types.
x = known to occur but not sampled in this study.
Levels of endangerment, State: T, Threatened; S, Special Concern.; PE, Proposed Endangered (Nordman 1997)
*Species with asterisk are introduced.