Rev 15 April 2011

THE NATURAL TERRESTRIAL VEGETATION OF TENNESSEE

In Progress

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CHAPTER 5, METHODS

General

The well-defined physiographic provinces of Tennessee (Fenneman 1938) with well-known distinctive geology and geologic history (Safford 1869, Hardeman 1966)—the provinces also defined as physiographic floristic units (Shanks 1958)—make these units obvious focal points for vegetation study based upon reconnaissance and sampling.

During the period 1954 through about 1989, in provinces west of the Blue Ridge, barrens were found and examined and 1968-1989 a few cedar-pine glades were studied. Methods are detailed in papers such as De Selm (1993). Burned forest understory methods are described in De Selm and Clebsch (1991).

Field Methods

From about 1973 through 2002 (most intensively 1993-2002) other vegetation was sampled over the State. Sample sites used were located by previous reconnaissance or field study (as De Selm 1984), from contacts with federal and state land managers, The Tennessee Natural Heritage Program, the Tennessee Chapter of the Nature Conservancy and certain college and university biologists. In each county, the county agent, and the Natural Resources Conservation Service agent was contacted by mail and often later in person. Regional foresters, loggers and landowners were interviewed. Most sample sites were found, however, by personal reconnaissance (in 1998-2002 winter-spring reconnaissance was carried out in counties planned as summer study areas). During the field season of 1993-1998, one county, chiefly four-day

sampling weeks were used (at first May through September, 1996 and thereafter May through October). During 1996-2002 chiefly one-day sampling trips were made. Work in each county extended over a 3-5 week period. West Tennessee was sampled in 1993, the western Rim and Central Basin in 1994, the eastern and northern Rims in 1995, the Cumberland Plateau and Mountains 1996-1998, the Ridge and Valley 1998-2002, and the Blue Ridge 1998-2001.

Counties, or other study regions, where possible, were stratified geologically, by county-level soil association, and topographically. Sampling areas were also sought on multiple slope positions/forms and aspects.

Previous studies coupled with classifications such as those of Daubenmire (1968) and Shafale and Weakley (1990) indicated the probable presence of marsh, fen, barrens, glade, outcrop, scrub, savannah woodland and forest. Wetlands as "bog," ponds, swamps, and seeps were sought (Weakley et al. 1998). Vegetation considered seral (as old field or recent change) (Smith 1968, Quarterman 1957, Shankman 1990, 1991, Miller and Holyfield 1986) was bypassed. Seral forests stands included especially some of those dominated by mixed hardwoods, tulip poplar, pine or eastern redcedar. Forest stands with trees ≥24 inches (61 cm) d.b.h. were sought. About 80 percent of stands used had trees of this diameter class or larger although pine, eastern redcedar and wetland stands were difficult to find with trees in this class and stands with smaller trees have been used.

The geographically wide sampling scheme resulted in most stands sampled from private land; it was hoped that occasional residual, old-growth stands would be found, such as seen by John Potzger in Indiana in the 1940s and 1950s (cf. Lindsey et al. 1969) or in Illinois (Weaver and Ashby 1971). However, no old-growth stands were seen on private land, but are known in

the Great Smoky Mountains. Those stands sampled were residual stand with some mid-size/age trees or "second" growth.

Stand sizes varied from a few to many hectares. The sampling area used was homogeneous topographically, geologically and with respect to soil parent material. Stands were chosen with no stumps or only occasional old stumps and none or only slight Japanese honeysuckle infestations. Stands with small trees (as woodlands, Daubenmire 1968) usually proved to be recently disturbed, as usually were those with low tree density. Understory density and cover varied widely and may have exhibited effects of open range grazing/browsing by stock (until about 1945, Ploskonka 1993) and current deer browse.

In selected stands, transects of 100-200 meters were extended through more or less uniform site and vegetation, the presence of all vascular plant species was recorded. Diameters of about 80 trees ≥5 inches (12.5 cm) obtained in one inch (2.5 cm) diameter classes.

The 80 tree sample corresponds to about 0.5 to 0.66 acre (0.25 to ca. 0.5 hectare) (Martin 1966, Martin 1971, Hinkle 1978, Golden 1974). Samples without areas, as the transect, has been previously used in geographically wide studies such as those by Braun (1935) and Whittaker (1956). Canopy was classed as deciduous, needle leaf, or mixed, and tree height was estimated as low (about 10 m), intermediate (11-35 m), or tall >35 m. One to four basal area estimates were made of canopy trees using the slope corrected English BAF 10 Cruiser's Crutch. Canopy coverage was estimated to the nearest 10 percent as was understory coverage (≤1 meter tall).

Understory types were classed as woody, herbaceous, or mixed. Woody types were tree reproduction, shrubs, woody vines, or mixed. Herbaceous types were graminoid, forb, ferns, bryophytes-lichens, or mixed. Mixed understory incorporated various woody, herbaceous, or bryo-lichen elements.

Topography was noted in position classes, upland flat, ridge, side slope (shape: ridge, flat or draw; position: upper, middle, lower, toe-slope). Bottoms were characterized as flood plains or terraces. Position of prevailing water level was noted. Terrace dissection intensity and depth was noted. Slope angle and aspect were determined (nearest 2 degrees or percent). General bedrock type, soil rockiness was noted, surface rock cover was estimated in 20 percent units. Photographs were made at some stands.

Plant Determinations

Unknown plant specimens were collected and returned to the laboratory for determination. Facilities and personnel at the herbarium of the University of Tennessee have been helpful for species identification—several curators and many assistants and associates have helped. In the past about two decades V. E. McNeilus and B. E. Wofford have determined unknowns (McNeilus determined all Cyperaceae through about 2004). Some specimens are at TENN or EKU. Reference specimens of each taxon at each stand have not been collected because of herbaria housing problem (as noted by Curtis 1959) and the massive time required for collecting, and processing specimens.

Studies of vegetation such as those to be described here necessitate use of lists and manuals of the local taxa which enable determination of specimens to species, proper nomenclature and knowledge of species range. In a study lasting nearly 50 years, some were used in the early years now out-of-date but were nonetheless useful for decades. Lists of the Tennessee vascular flora were prepared by Gattinger (1901), Sharp et al. (1956), Sharp et al. (1960), Wofford and Kral (1993), Chester et al. (1993), Chester et al. (1997, 2009); the regional lists Kartesz (1994, 1994) and the checklists of Little (1953, 1979), have all been used. The most

useful manual has been Gleason (1952) and subsequently Gleason and Cronquist (1991) with Holmgren (1998 and Flora of North America, Editorial Committee 1993 et seq.).

The field sampling procedure has advantages and disadvantages—one method cannot answer all of the kinds of questions raised by vegetation ecologists. The 80-tree sample is larger than the 0.1 or 0.2 acre (0:04, 0:08 hectare) samples used in other Tennessee studies (including Cain 1935) but smaller than that in use now in the North Carolina survey ( ). The non-area sample is quicker than installing plots and appropriate for a low budget single-field-investigator regional survey. Small stands or odd-shaped stands has resulted in sampling near the edge of the stand since there was often no large interior; this has resulted in some edge or opening understory species present in many samples. All specimens seen on each transect were not determined to species, some were determined to genus only, and some vegetative plants—which I thought I had no hope of determining—were left to grow and their presence as unknowns not recorded. Also *Rubus* taxa recorded only to genus, and only *Vitis rotundifolia* was recorded to species, the others as *Vitis* sp.

The field season of five or six months (May through September or October) and the single sampling period per stand means that each sample was seen only once/rarely repeated. The irregularity of year-to-year and week-to-week flowering of some taxa contributes to degree of richness—as does the line-of-sight visibility of plants on or near the transect. On some transects, the return trip followed the same track and new taxa were observed indicating the fallibility of simple observation. For these reasons each transect yielded a partial flora. Between-year observation of the same plots have yielded about 13 percent species misses one of three years (Grabner et al. 1997). However, many community types are widespread in the various graphic regions, years. This wide, long-term sampling alleviates the single transect compilations

of a probable incomplete vascular flora. But, in some rare vegetation types, richness is a function of only a few samples—plus available literature relating to this type.

Preliminary Data Manipulation

From the appropriate U.S. Geological Survey 7.5 minete quadrangle map, site elevation range, and latitude and longitude of each stand were determined. Using the best geological map (scales varied from 1/24000 to 1/25000) bedrock type was determined and county soil surveys were used to characterize the soil.

Stand species richness is represented by counts among tree, shrub-woody vine or herb taxa. Tree-form trees (reaching 12.4 cm d.b.h.) were also totaled. The shrub species *Aralia spinosa, Alnus serrulata* and *Rhamnus caroliniana* (listed as trees by Little 1979) were considered shrubs here. *Asimina* was usually seen as a shrub, rarely to tree size and when so, included among tree species. Similarly, species of *Crataegus, Ilex* and *Rhododendron* were generally listed among shrubs unless a rarely seen individual reached 12.4 cm d.b.h. when that species was listed as a tree.

Tree species relative (percent) density was calculated by summing the number of stems of a species and dividing by the total number of tree stems. Tree species relative (percent) basal area was calculated by converting each tree inch mid-range diameter to circular area, summing these by species and dividing for each species the percent of its area by that of the total tree sample basal area [NOT YET DONE]. Importance value for each tree species is the sum of relative density plus relative basal area (Importance Value – 200).

Site aspect was converted to a scale according to Beers et al. (1966) [NOT YET DONE]. Measured site aspect—slope angle was converted to direct solar radiation, at 40 degrees latitude (Buffo et al. 1972). Slope position and shape was converted to a number series 1-12 (dry to wet;

Hinkle 1978) from field notes and topographic map. Also using the map, the direction angle to the ridge top across valley from the stand was measured or calculated.

Geology

The location of each stand known on the 7.5 minete quadrangle map is relocated on the most appropriated geologic map at the largest scale possible. Of particular importance were the geologic reports and maps 7.5 minete quadrangle base issued by both the state and federal government. In West Tennessee Cushing et al. (1964) and Saucier (1974) were used. Maps for the entire Cumberland area are available (Wilson et al. 1956, Wilson 1956). Middle Tennessee geology was determined from quadrangle geology maps and those of Wilson (1945, 1949). In East Tennessee, the Rodgers (1953) atlas and report were used. Parts of the Blue Ridge have been mapped in more detail (as King 1964, King et al. 1960, 1968). The fallback map at 1:250,000 scale has been that of Hardeman (1966).

Soil

Sample area soil moisture was estimated from soil type name determined from county soil survey map and inches of water per inch of soil profile with profile thickness given in same soil surveys [NOT YET DONE]. In some counties water availability was calculated from soil texture and typical profile depth. Fertility was approached through soil pH or relative acidity in county soil survey reports.

Further Comments on Plant Determination and Other Biota

Beginning in the 1950s the northern manual of Fernald (1950) was used as was Small (1933) for the southeast in addition to those already mentioned. Most useful in East Tennessee have been the manuals of Wofford (1989) and Radford et al. (1968). Special treatments have been used, as Asteraceae (Cronquist 1980), Brassicaceae (Rollins 19--), Fabaceae (Isley 1990),

Magnoliidae and Hamamelidae and Pteridophytes & Gymnosperms (Flora of North America Editorial Committee (1993, 1997 et seq.), grasses (Underwood et al. 1973, Hitchcock and Chase 1950, *Trillium* (Case and Case 1997), *Lesquerella* (Rollins and Shaw 1973), orchids (Luer 1975) and Scrophulariaceae (Pennell 1935).

A study of the ferns of Tennessee was prepared by Anderson (1929) and about 1936 Jesse Shaver began his study of the ferns of Tennessee which resulted in several papers and a book (Shaver 1954). The book has been used in conjunction with Sharp (1955) and Wherry (1942). Later the treatments of Lellinger and Evans (1985) the list by Evans of Tennessee ferns (Evans 1989), and the illustrated flora of Georgia ferns (Snyder and Bruce 1986) have been used.

A vegetation region of mostly forest, woody plant manuals have been necessary. Of much long-continued use is the key of Shanks and sharp (1963), Sargent (1933), Blackburn (1952), Petrides (1958) and the maps by Little (1971, 1977). Later the keys by Swanson (1994), Little (1980), Wofford and Chester (2002), and Cope (2001) were used. For many years the checklist with supplements (Shanks 1952, 1953, 1954) were used with the Shanks and Sharp key.

Climbing plant determination has been aided by use of the papers of Duncan (1967), Moore (1991) and De Selm (1957).

Winter plant determinations have been aided by the use of Core and Ammons (1958), and Beatley (1956), and later, Swanson (1994), and Lance (2004).

The escape of cultivars into native communities has made the use of cultivated plant manuals/lists necessary. Continuous use has been made of Bailey (1951), Rehder (1927), and Blackburn (1952), and more recent use has been made of Cope (2001), Dirr (1998) and the southeastern list by Meyer et al. (1994).

National Parks/Recreation Areas have received special attention by writers. In the Great Smoky Mountains, White has produced an annotated flora (White 1982) and Stupka (1964) a study, with keys, to the woody plants. At Land Between the Lakes, Chester et al. (1987) and Ellis and Chester (1980) have prepared studies of trees and shrubs, and Chester (1992) a catalogue of vascular plants.

In the early days of the Tennessee Valley Authority, Isley (1946) prepared keys to the woody plants in the herbaceous plants of the Tennessee Valley reservoirs. Hall (1945) prepared keys to the woody plants in the Alabama sections of the Tennessee Valley and in 1940 and 1941, G. S. Perry of the Division of Forestry Relations at Norris, prepared keys to the species of nine tree genera in the Valley. These were available to the writer when he initiated fieldwork in Tennessee in the 1950s.

During the period from the middle 1950s through the 1990s, I collected and used many other scientific papers which were used as sources of information, floristic and systematic, in many families, to aid in species determination. Some examples of genera are *Fraxinus* (Miller 1955), *Gerardia* (Robinson 1960), *Helianthus* (Beatley 1963), *Houstonia* (Terrell 1959), *Juncus* (Shanks 1941), *Leavenworthia* (Rollins 1963), *Pycnanthemum* (Grant and Epling 1943), and *Viola* (McKinney 1992, Russell 1965). Here also the reprint collections of A. J. Sharp and B. E. Wofford have been used. The barrens sampling brought the writer in contact with over one-third of the State's flora (De Selm 1989)—the 1990s and later decades of sampling has increased that percentage.

Other (non-vascular) plant groups occur in the stands included here though they have been little included in the community descriptions. Early studies of bryophytes were made by Sharp (1939) and Ammons (19--) in West Virginia. More recent are Smith's list of Tennessee

species (Smith 1989) the list from Land Between the Lakes (Clebsch 1974), and manuals by Crum and Anderson (1981), Hicks (1992) and Shuster (1966-1980). For a person just beginning to learn the details of moss morphology, the illustrated glossary of Malcolm and Malcolm (2000) is available.

For the study of lichens are the books by Hale (1961, 1979) and the recent illustrated Lichen of North America (Brodo et al. 2001). There are also the lists of Tennessee lichens (Skorepa 1972) and those of the high Southern Appalachian mountains lichens (Dey 1978).

For the study of the algae, see Smith (1950), Dillard (1999), and Whitford and Schumacher (1969). Studies carried out at Western Kentucky University have resulted in publications on much of the southeastern algal flora (as Dillard 2000).

Early interest in the fungus flora of the Great Smokies was expressed by Hesler (1960 and earlier). Other applicable mushroom books are by McKnight (1987) and Bessette et al. (1997). An introduction of the slime molds has been prepared by Stephenson and Stempen (1994). A manual of shade tree diseases is that of Hepting (1971).

The influence of animals of all types is well known on plant communities and has given rise to the concept of biotic communities and, with environment, the ecosystem (Barbour et al. 1987). Animals are only occasionally considered in the pages which follow but to interested reader will find abundant help in the lists and guides as for mammals (Burt and Grossenheider 196; Linzey and Linzey 1971), and bats (Harvey et al. 1999). Birds have been of interest to many people and the Peterson field guide (Peterson 1980) has gone through several editions; local studies have produced the Atlas of Tennessee Birds (Nicholson 1997), birds of the Tennessee Valley (Welborn 1974), birds of Land Between the Lakes (Snyder and Alsup 1991), birds of Shady Valley (Coffey and Shumate 1999), and birds of the Great Smokies (Stupka 1963).

For those interested in Tennessee fish there is the excellent scientific treatment by Etnier and Starnes (1993). There are regional studies of reptiles and amphibians by Wright and Wright (snakes 1957, frogs and toads 1949), and Conant (1975); for Tennessee, see Sinclair et al. (1970). Redman et al. (1990), and Redman and Scott (1996), and for the Smokies, see Huheey and Stupka (1967).

Comprehensive studies of invertebrate groups are far fewer. However, the upper Tennessee River is a center of diversity for mussels studied by Parmalee and Bogan (1998). Land snails, crayfish ___

Insects are of particular importance because of their pollination and predation actions. General entomology is approached by Borror and White (1970) and Arnett and Jacques (1981). Insects attacking trees are described in Baker (1972) and Solomon (1995). Field manuals are available for beetles (White 1983, dragonflies (Dunkle 2000), and butterflies (Glassberg 1999, Scott 1986, and Opler and Malikut 1998). A list of Tennessee mayflies has been prepared by Long and Kondratieff (1996).

In this study hundreds of papers and books have been used—the above lists only the most comprehensive and general. This regional or appropriate biological literature is enormous. In the Great Smoky Mountains National Park, the bibliography of biological, historical and environmental literature is 101 pages in length (Nodvin et al. 1993).

However, in the use of botanical nomenclature, Chester et al. (2009) has been used—this is where species authorities may be found.

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