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A REGIONAL PERSPECTIVE OF THE PHYSIOGRAPHIC PROVINCES OF THE SOUTHEASTERN UNITED STATES[1]

J.H. Miller and K.S. Robinson[2]

Abstract-A landscape classification system using defined units for physiography. landform, and soils is needed to organize ecological information and to serve as an aid for landscape management. To assist this effort a composite physiographic map is presented for 12 southeastern states. The physiographic classification system and maps for five states were devised by a committee formed in the early 1970's through the Society of American Foresters, directed by Earl Hodgkins, Auburn University. Maps were prepared by state teams delineating physiographic provinces, regions, and subregions-forest habitat regions. The five state maps were combined and the province delineations extended to the surrounding states using information from topographic. geologic, and soil maps for states and counties. The system is a refinement of the traditional physiographic provinces that have been recognized in the Southeast for sometime.

INTRODUCTION

Southeastern forests grow on a repeating spatial mosaic of soils across landform patterns unique to physiographic provinces. The patterns. are created through the perpetual dynamics of climate moving across varying geology to create landforms and soils that support an evolving vegetation. Within human life spans, vegetation and weather change while geology, landform, and soil are more permanent as dassiliers. By using a classification system that recognizes different landscape units, ecological information can be placed and viewed in scales of interest to aid in landscape management.

Thii paper introduces a complete-coverage, concise physiographic map for 12 southeastern states. The map is based upon a system of landscape classification that can be used to organize ecological and silvicultural research findings.. The map and system may be useful for introducing visitors and students to the Southeastern Forest Region.

The physiographic (or geomorphic) regions of the United States have been long recognized, but an accurate depiction in a regional map has been only possible with the advent of aerial photography and satellite imagery (Miller and Golden 1991). Physiographic provinces of the Southeastern United' States were recognized as early as 1705 (White 1953). with preliminary maps as early as 1895 by Major Joseph W. Powell (shown in Thornbury 1965). A comprehensive: map&h approximate boundaries was produced by a committee of the Association of American Geographers, chaired by N.M. Fenneman, and reported at the 1916 annual meeting. Fenneman (1938) went on to write the widely recognized book. *Physiography of Eastern United States,* describing the provinces. The subject was revisited and the information updated in comprehensive detail by Thornbury (1965), although without a map. These works mainly focused on the wealth of geological data amassed early in thii century. However, little information was available that hnked surficial geology to soils and vegetation. One notable exception was the publication in 1911 of *Forest Physiography* by Isaiah Bowman, who devoted considerable space to discussing the interaction of climate and soils with vegetation.

SOURCES OF MAP INFORMATION

The natural ties between forest communities and physiography-geomorphology stimulated foresters to undertake defining the physiography of the Southeastern region. An organized effort was conceived in the 1960's by Earl Hodgkins. Auburn University Department of Forestry. and coordinated with the assistance of W.F. Miller, Mississippi State University Department of Forestry. A committee of researchers from the southern states was formed under the Southern Forest Environment Research Council through the Society of American Foresters.

The classification system was developed by Hodgkins (1965) and initially summarized in *Southeastern forest habitat regions based on physiography.* The classification system is based on physiography that delineates uniformities that result from the interaction of geomorphology (i.e., geology and landform) and climate (e.g.. increased rainfall and cooling with increases in elevation. lengthened growing seasons

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with decreased latitudes, etc.). The major classification units are province (e.g., Piedmont Province), habitat region (e.g., Piedmont Foothills Region), and habitat subregion (e.g., Upper Foothills). Regions and subregions represent finer subdiions primarily of geomorphology.

Maps showing "forest habitat regions" were prepared for five cooperating states and overlaid on Landsat multi-spectral scanner imagery at a scale of 1:1,000,000. States with published maps and unit descriptions are Alabama and Miissippi (Hodgkins and other 1976.1979). Louisiana (Evans and others 1983), Georgia (Pehl and others 1985). and South Carolina (Myers and others 1986). Further, physiographic provinces were identified for North Carolina and discussed relative to this system (Cheshire 1982). In addition, the provinces of Florida and the Sandhills of Georgia were presented by Hodgkins (1965) and have been incorporated with verification and details from USDA Soil Conservation Service (SCS) county soil maps

To complete the province delineations for the 12 southeastern states, other sources of information were used. The Blue Ridge Mountain Province of Virginia was delineated from the Virginia base map (U.S. Geological Survey 1973) with the Piedmont and Coastal Plain boundaries taken from Virginia geological maps (Miion and others 1989). The provinces of Arkansas were derived from the Geologic Map of Arkansas (Haley and others 1976) and county soil surveys. Provinces within the eastern forested areas of Oklahoma were defined from the Geologic *Map of Oklahoma* (Miser 1954) and A forest At/as of *the* South (Nelson and Zillgitt 1969). The province delineations of Tennessee came from Smalley (1986). State soil mapsformed the base for eastern Texas (Godfrey and others 1973). Final details came from available SCS county soil surveys.

Province names mostly correspond to conventional physiographic provinces (Nelson and Zillgitt 1969) with more divisions of the coastal plain and some changes in nomenclature.
The provinces and selected habitat regions shown on the comprehensive physiographic map of the Southeastern United States, figure 1, are as follows:

Lower Coastal Plain Province (LCP)
- Everglades and Prairie Marsh Region

Middle Coastal Plain Province (MCP)
- Florida Sandhills Region

Hilly Coastal Plain Province (HCP)
- Sandhills Region
- Black Belt Region

Piedmont Province
Blue Ridge-Taltadega Mountain Province
Ridge and Valley Province
Cumberland Plateau-Mountain Province
Limestone Plateau Province
Silt Bluff Province
Mississippi Alluvial Floodplain and Terrace Province
- Mississippi Terrace Region (shaded)
- Mississippi Alluvial Floodplain Region (non: shaded).

Coastal Prairie (Marsh) Province (Texas and Louisiana)
Ouachii Mountain Province
Ozark Plateau Province

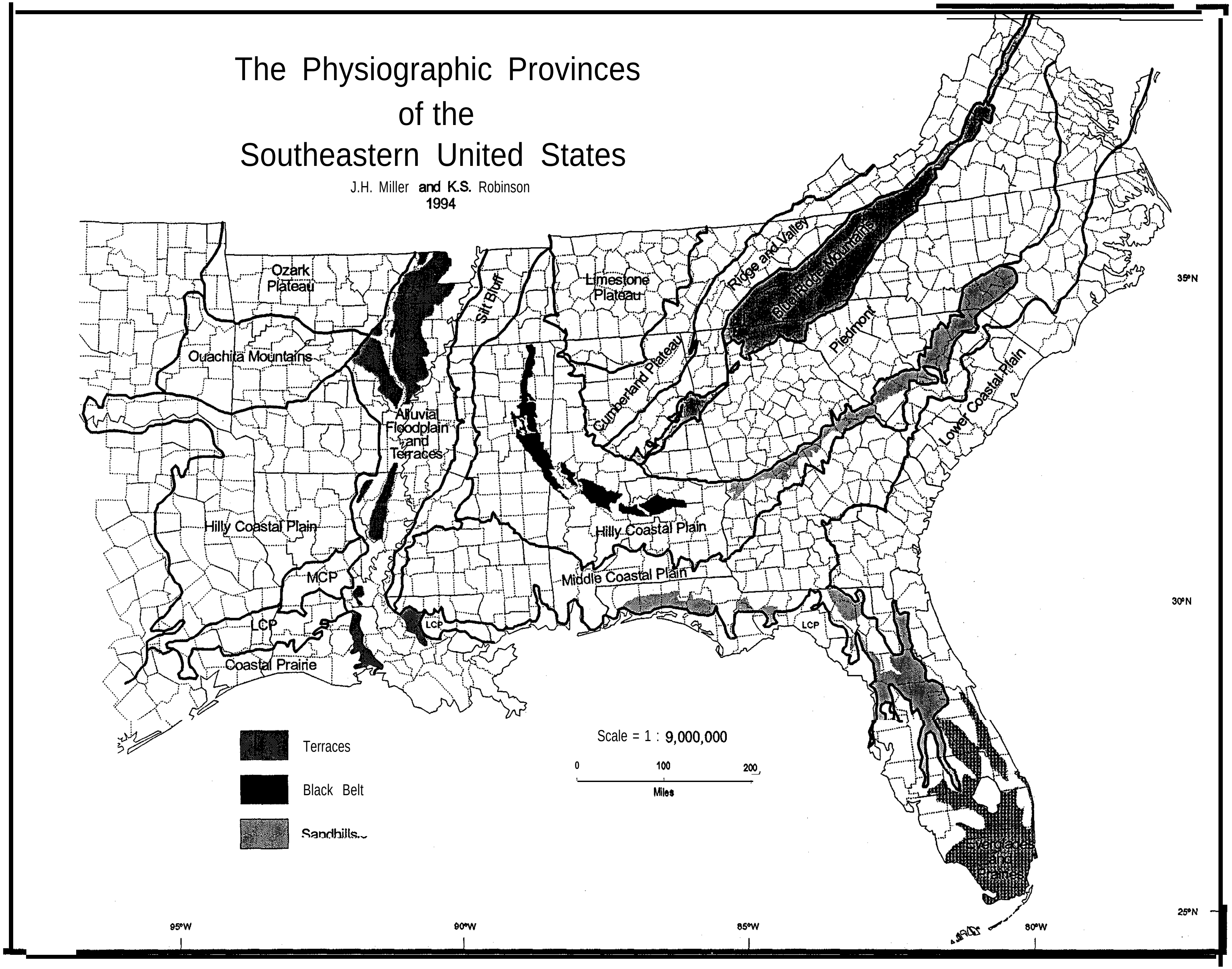
The county delineations have been incorporated to aid in locating areas of interest

Province names recommended by Hodgkins (1965) have been slightly modified according to what is perceived as traditional usage. Hodgkins' Flatlands Coastal Plain Province has been changed to Lower Coastal Plain Province, which k ako commonly referred to as the Flatwoods Coastal Plain. (The "flatwoods" name k reserved to denote habitat regions and subregions in both the Lower and Middle Coastal Plain Provinces.) His Great Appalachian Valley Province has been changed to the Ridge and Valley Province. Deep Loess Province has been changed to Silt Bluff Province. Usage of these terms may evoke, but consistency should be sought. Provinces that are not directly shown on the map, but should be recognized are the extensive Alluvial Rood Plain and Terrace Province(s) (shown only for the Miippi Riier) and the Coastal Marsh and Island Province(s) (shown only for Texas and Florida).

Soil series represent a finer logical unit for site characterization and research reporting, derived from available SCS county soil surveys. It is recognized that finer descriptors for taxonomic soil series are required to delineate differences in forest site quality, engineering considerations, and habitat (Van Lear 1991). Other mid-units, above soil series, have been developed or are proposed within thii classification system, i.e., land type, land subtype, and habitat type (Hodgkins and others 1979, Miller and Golden 1991). Maps have not yet been prepared for these. Other finer delineations using landform (drainage) have been defined for the Limestone Plateau and Cumberland Plateau Provinces (Smalley 1982, 1984, 1986, 1991), the Blue Ridge Province (McNab 1992). the Lower Coastal Plain Province of Florida (Fisher 1981), and the state of South Carolina (Jones 1991).

LANDFORM

As a third-dimensional supplement to figure 1, the relative progression of elevational changes and general landform shapes within provinces are shown in figure 3 for transects indicated in figure 2. These cross sections were drawn using topographic maps of individual states having 200-ft contour intervals, with the exception of Louisiana, which had 50-ft intervals. The greater detail afforded by the 50-ft contours is evident for the extensive coastal plains of Louisiana. These cross-sections show that the Lower Coastal Plain in Louisiana has more elevational relief than in Florida and


The Physiographic Provinces
of the
Southeastern United States
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1994
Ozark Plateau
Ouachita Mountains
Alluvial Floodplain and Terraces
Silt Bluff
Limestone Plateau
Cumberland Plateau
Ridge and Valley
Blue Ridge Mountains
Piedmont
Lower Coastal Plain
Hilly Coastal Plain
Hilly Coastal Plain
MCP
Middle Coastal Plain
LCP
LCP
LCP
Coastal Prairie
35°N
30°N
25°N
95°W
90°W
85°W
80°W
Terraces
Black Belt
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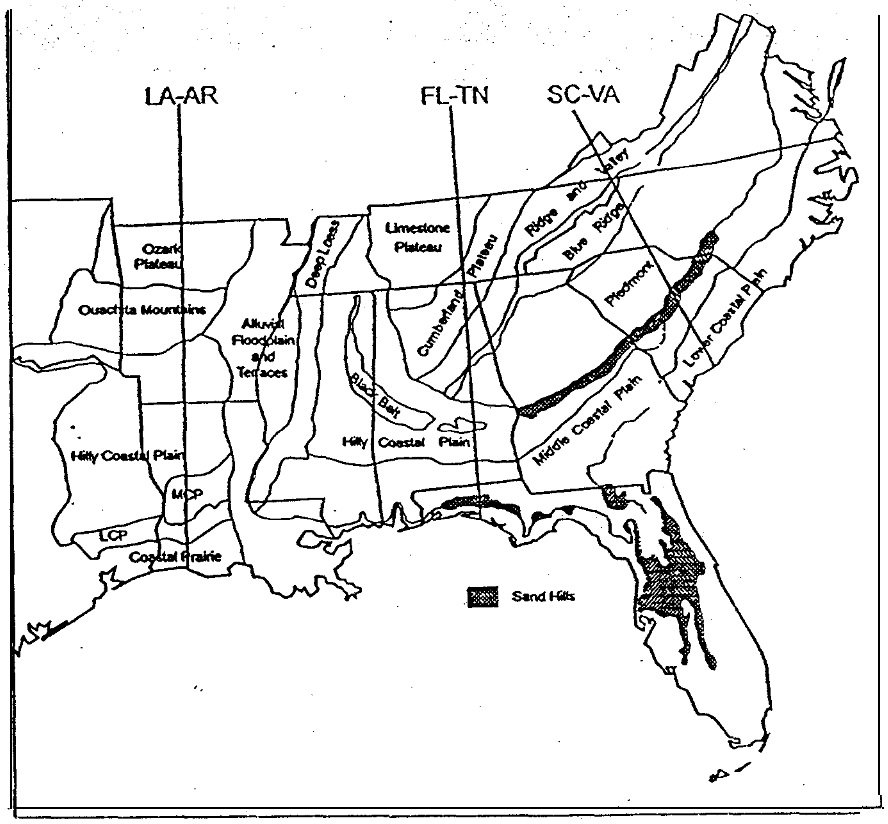

Figure Z.-Cross-sectional relief transects shown in figure 3.

Table 1—Physiographic provinces, their range in elevation, age of soil-forming parent materials, and predominate type of rocks

Province	Elevation range	Age of parent material	Type of rocks
	(ft)	(million yrs)	
Lower Coastal Plain	< 100	< 2	Unconsolidated water-, ocean-, and wind-deposited sediments.
Middle Coastal Plain	75-600	2-5.5	Same as above.
Hilly Coastal Plain	100-800	5.5-22	Same as above.
Piedmont	200-1,200	200-600+	Varying zones of deeply weathered metamorphic rocks with lesser areas of sedimentary and igneous rocks.
Blue Ridge and Talladega Mountains	1,200-6,684	500+	Upliied metamorphic and igneous rocks (and sedimentary along western edge) with wide aprons of colluvium.
Ridge and Valley	ridges 1,000-4,500 valleys 400-1,400	500+	Folded and tilted sedimentary rocks with sandstone ridges and limestone valleys with wide aprons of colluvium.
Cumblerland Plateau	800-3.200	270-320	Horizontal layers of sandstone, shale, and limestone sedimentary.
Limestone Plateau	500-1,100 (2,100 exception)	320340	Consolidated sedimentary.
Sift Bluff	100-400	0.01-0.125	Wind blown silt from glacial outwash plains.
Mississippi Alluvial Floodplain and Terraces	floodplain <400 terraces 100-400	recent 0.01-0.125	Sand, silt, and clay alluvium; and wind-blown silt terraces.
Ouachita Mountains	200-2.700	500+	Folded and tilted sedimentary rocks with sandstone ridges and limestone valleys with wide aprons of colluvium.
Ozark Plateau	800-2,200	500+	Horizontal layers of sandstone, shale. and limestone sedimentary

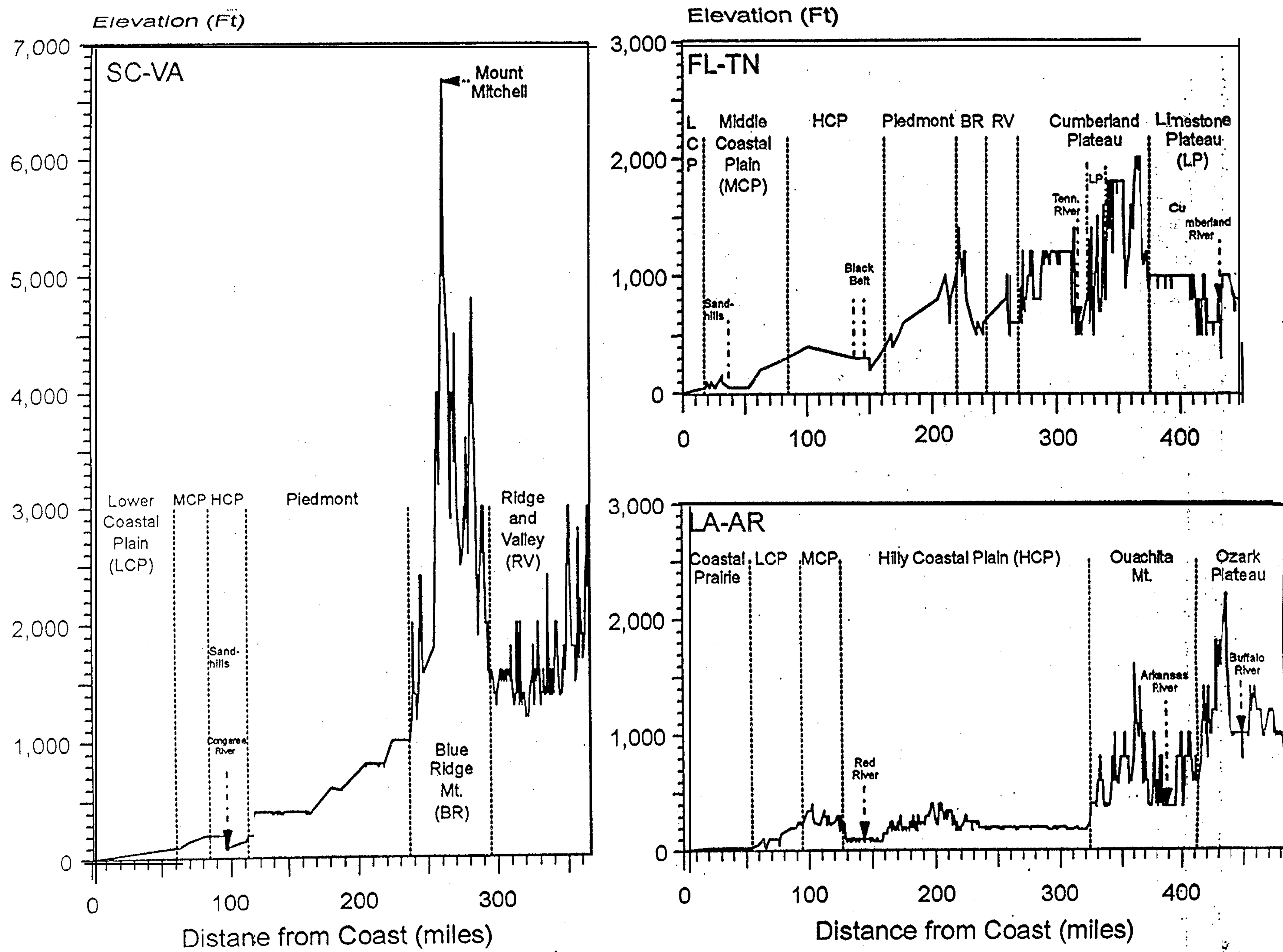

Figure 3.--Cross-sectional ref of the following transects: SC-VA, from the coast of South Carolina, through North Carolina, Tennessee, and Virginia; FL-VA, from Florida coast through Alabaa and Tennessee; and LA-AR, from the Louisiana coast through Arkansas.

South Carolina Elevational ranges within provinces and the geologic parent material for soil formation and its age are summarized in table 1.

The greatest range in elevation within the Southeast is shown in figure 3 SC-VA with the cross-section through South Carolina, North Carolina, and Virginia. Elevations range from zero at the coast up to 6,684 ft at Mount Mitchell, the highest point in the United States east of the Miippi River. Some of the highest yearly precipitation with the coolest temperatures and shortest growing seasons are associated with the Blue Ridge Mountain Province, due to the orographic effect

It is evident that the landforms found in the Ridge and Valley Province have comparable traits to the Ouachii Mountain Province, and may have similar geologic origins (Thornbury 1965). One interesting feature shown in figure 3 (FL-TN) is an inclusion of Limestone Plateau (LP) as a narrow band within a portion of the Cumberland Plateau (i.e., the Sequatchie Valley). This is an example of an area that was too small to delineate in figure 1.

SOILS

Previous reports have presented maps and discussions of the soils in the Southeastern United States (Nelson and Zillgitt 1969, Buol 1973) and generalities will be discussed here relative to physiography. Each physiographic province has a suite of soils. Some are unique to a province. while some are shared with other provinces as is the case with the coastal plain provinces. Many of the soil forming forces-climate, geologic material, biotic organisms, relief, and time—are similar between adjacent provinces.

The influence of time has varied by province and habitat regions within provinces (table 1). Erosional processes have been working on the mountains and uplands induding parts of the Piedmont for over 500 million years. About 250 million years ago the Blue Ridge Mountains were comparable in elevation to the Rocky Mountains. While only 54 million years ago, the warm sea that eventually formed the coastal plains was at the "Fall tine" at the base of the Piedmont and at the lower slopes of the Cuachiia Mountains and Ozark Plateau. With the fluctuating subsidence of the sea and rise of the unburdened land, the coastal plains were successively formed through upland erosion and coastal deposition starting about 22 million years ago.

Over the last 2 million years, during earths latest ice age, sea level has fluctuated during the 40+ advances and retreats of glaciers, alternately exposing and inundating expanses of the Lower Coastal Plain and continental shelf. During this period, windblown glacial outwash was deposited to form the Silt Bluff and River Terraces of the Mississippi River, which are some of the youngest inland geology. Presently, the Coastal Marsh and Island Province(s) is gradually being flooded during the current interglacial age (the last 20,000 years), white coastal deposition continues or has been accelerated due to human disturbance (Pielou 1991). For the most part, the climate of&Southeast has fluctuated between temperate to tropical over the last 200 million years: remarkably remaining within similar latitudes as today, even as the mega-continent, Pangaea, broke-up and drifted apart (Conkle *1992).* Presently, the Southeast is in the subtropical climatic domain except for the southern tip of Florida, which is tropical (Bailey 1983).

Because of the warm humid &mate, lengthy weathering period, and minerals in the parent rock, the dominant soils of the region are *Ultisols* (Nelson and Zillgitt 1969, Buol 1973)—well-developed, highly weathered soils with distinct horizons. Exceptions are:

a. Alluvial Floodplain Province, mostly *Inceptisols* and *Entisols*, i.e., relatively young soils with no or weakly differentiated horizons.
b. Silt Bluff Province and Miiissippi Terrace Region, mostly *Alfisols*, i.e., soils that are medium or high in bases with gray to brown surface horizons and subsurface horizons of day accumulation.
c. Lower Coastal Plain of Florida. mainly *Entisols, Histosols.* i.e., wet organic peat and muck soils, and *Spodosols, i.e., sods low* in bases that have a subsurface horizon of accumdated organic matter and compounds of aluminum and iron.

The extensively-formed *Ultisols* have red-to-brown clayey subsoils below sandy or loamy surface soils. These soils are acid and relatively infertile, because the days are the type that retain few nutrients. Eastern coastal plain soils from Virginia to Alabama have days that are dominantly kaolinite and vermiculite, while those from Mississippi, Arkansas, and Texas consist of montmorillonite, chlorite, and illiie in addiion to the kaolinite and vermiculite (Fiikell and Perkins 1970). Kaolinite and vermiculite retain less nutrients than montmorillonite, chlorite, and illiie. In general, soil nutrient retention is by the accumulated organic matter fraction in the surface and subsurface horizons (Wallace 1994). Coastal plain soils increase in nutrient holding capacity as pH increases. This pH-dependent, nutrient- holding capacity arises from soil organic matter and presumably from the highly weathered clays.

Soils in the mountainous Blue Ridge, Ouachita Mountain, and Ozark Plateau Provinces have formed over 500 million years (Thornbury 1965). Few, if any, have formed in place on level surfaces, because of erosive forces. The pattern of soils depend upon landform and whether they are derived from residual or transported parent material. Residual soils occur more towards ridge summits. while colluvial soils increase down slopes. grading into alluvial soils near water courses. But even on broad mountain tops in the Blue

Ridge Province, streams with flood plains end **terraces.** can be found with **alluvial** soils as **also occur** in the **well-**formed valleys between 'mountain ridges. 'The cooler, wetter climate of mountains result in typically more **fine-**loamy textured **soils** compared to the dayey textured soils that dominant provinces et lower **elevations.**

Soils of upland Piedmont sites are primarily ***Ultisols,*** with ***Alfisols*** in **localized** areas Most are residual soils, having weathered in place for greater than 600 million years from underlying materials. In general, in thii province; forest site **productivity** increases **with** increasing depth to a clay-textured horizon (Hodgkins 1965).

The marine sediments of gravel, sand, silt, day, and chalk that **underlie** the Hilly Coastal Plain Province were deposited at a time when the shoreline was located along the Fall tine **(table** 1). Along the eastern-part of the Fall Line, soils of the Sandhills Region were formed **in thick beds of marine sands and have minimal profile development.** In the Black Belt Region (also called the Black Prairie), that extends across **northeastern Mississippi** and central Alabama, **dark-colored soils with** about **neutral pH** are formed in chalk deposits.

The Middle Coastal Plain Province is a transition zone between the Hilly Coastal Plain and the Lower Coastal Plain Provinces. Soils developed from marine deposits of gravel, sand, and day, that are geologically younger that those in the Hilly Coastal Plain Province and older than those of the Lower Coastal Plain Province (table 1). The Middle Coastal Plain Province is characterized by flat to **rolling** topography and generally **coarse-**textured soils. Regions within this Province reflect the composition of the original sediments and are delineated by parallel bands of low-lying ridges. A predominant ridge system is the Southern Loam Hills Region, which extends as a belt from Virginia to Louisiana. Because the marine terrace sediments of the Middle Coastal Plain Province have been exposed for a relatively long *time, the* land surface is moderately well dissected by a dendritic drainage pattern. The **moderately** dense drainage pattern is better developed than in the Lower Coastal Plain Province, but loss dense than in the Hilly Coastal Plain Province.

The Lower Coastal Plain Province (often referred to as the **flatwoods** coastal plain) is characterized by flat to undulating topography, high water tables, and generally coarse sandy **soils,** except where broken by areas of extensive swamp lands containing mostly organic soils. Soils were developed from marine deposits over the last 2 million years. All of the province was **intermittently** covered by shallow coastal waters **during** the receding periods of northern glaciation that ended only 20,000 years ago. Regional delineations are a **result** of the **differences in the ages** and elevations of old **shoreline-related landforms. One of the most** unique regions **is the Everglades and** Prairie Marsh Region in southern Florida that contains the Everglades, Big Cypress Swamp, and Lake Okeechobee **(Thornbury** 1965). This is a region of recently formed organic **soils.** Trees only grow on hammocks or **"tree-islands",** which are separated from each other by water areas and are oriented according to the **direction** of drainage.

The extensive flood **plains.** river and stream terraces, **bogs,** marshes, and'the margins of fakes and ponds have generally younger and **different** soils than in the surrounding uplands, and also present unique habitat features vital to spedafied **life-forms** such as neotropical birds (Hunter and others 1992).

PLANTS

Some plant species tend to be associated with **specific** provinces. white many are not **confined** owing to the uniform **climate** that characterizes much **of the** Southeastern Forest Region (Nelson and **Zillgitt** 1969). The **high** elevations of the Blue Ridge Mountain Province harbor the most unique assemblage of plants and animals as does the deep valleys of the Cumberiand Plateau. Commonly shared spedes characterize much of the flora in the Piedmont, **Hilly** and Middle Coastal Plain Provinces, while more constrained species are found in the Lower Coastal Plain

Examples of tree species not constrained and constrained by physiographic province boundaries are as follows **(Harlow** and Harrar 1958, Brown and **Kirkman** 1990):

Not Constrained

Occur across all provinces except along the lower Mississippi **River** and South Florida:

Acer rubrum L.	red maple
Fagus grandifolia Ehrh.	Americanbeech
Carya cordiformis (Wang.) K. Kock	bitternut hickory
C. glabra (Miller) Sweet	pignut hickory
Comus florida L.	flowering dogwood
Ilex opaca Aiton	American holly
Moms rubra L.	red mulberry
Nyssa sylvatica Marshall	blackgum
Pinus taeda L.	loblolly pine
Quercus alba L.	white oak
Q. falcata Michaux	southern red oak
Q. marilandica Muenchh.	blackjack oak
Q. stellata Wangenh.	post oak

Constrained		
Occur within limits of physiographic provinces:		
Abies fraseri Miller	Fraser fir	Only in Blue Ridge Mountains.
Picea rubens (Du Roi) Link	red spruce	Only in Blue Ridge Mountains.
Tsuga caroliniana Engelm.	Carolina hemlock	Only in Blue Ridge Mountains.
Pinus pungens Lamb.	table mountain pine	Only in Blue Ridge and scattered monadnocks.
P. rigida Miller	pitch pine	Only as far south as Blue Ridge of GA and SC.
P. strobus L	eastern white pine	Only as far south as Blue Ridge of GA and SC.
P. virginiana Miller	virginia pine	Occurs as far SW and W as Talladega Range, Ridge-Valley, Cumbedand Plateau, and Limestone Plateau.
Quercus prinus L.	chestnut oak	Not in coastal plains (CP).
C?. nigra L.	water oak	Everywhere except in Blue Ridge.
Q. shumardii Buckley	shumard oak	Everywhere except in Blue Ridge.
Celtis laevigata Willd.	sugarbeny	Everywhere except in Blue Ridge.
Pinus palustris Miller	longleaf pine	South of upper boundary of Hilly CP in NC.
P. serotina Michaux	pond pine	South of upper boundary of Hilly CP in GA SC, NC, and VA
Taxodium ascendens Brongn.	pondcypress	South of upper boundary of Hilly CP in GA, SC, and NC.
Pinus elliottii Engelm.	slash pine	South of upper boundary of Middle CP.
Quercus laurifolia Michx	laurel oak	Only in CP.
C?. incana Bartram	bluejack oak	Only in CP.
Q. laevis Wafter	turkey oak	Only in eastern CP.
Nyssa *sylvatica* Marsh.	black tupelo	Only in CP.
Pinus echinata Miller	shortleaf pine	Everywhere except in Lower CP in MS, AL, and GA.
Juniperus virginiana L.	eastern redcedar	Everywhere except in Lower CP.
Carya ovata (Miller) K. Koch	shagbark hickory	Not in Lower CP except in LA and TX.
Taxodium disfichum (L.) Rich	baldcypress	Only in CP, Silt Bluff, and Alluvial Floodplains of major rivers that flow from the Ouachiia Mountains and Limestone Plateau.

Less information has been published regarding the physiographic range of the 500+ species of shrubs and 3,000+ species of herbaceous plants growing within the Southeastern United States.

MAP AND SYSTEM USES

Hodgkins (1965) envisioned using the physiographic classification system as: (a) a guide for selecting sampling strata whenever site or habitat are experimental variables, (b) a framework for local site classification, and (c) a logical context for reporting research results. The last use appears to be extremely pertinent now as ecological (and management) information gathering increases. Research sites could be categorized by province, region, subregion, landform position, and soil series to define a scope of inference for research results. This is now possible for the five states-South Carolina, Georgia, Alabama, Mississippi, and Louisiana-with maps delineated to the subregion level. Copies of these maps and unit descriptions are available from the Agriculture Cooperative Extension Service of each state. Figure 1 will permit province delineation for the remaining seven southeastern states and can be used in conjunction with available county soil surveys and/or other land classification systems (e.g., Smalley 1986) to classify sites. The map was constructed in Lotus Freelance Graphics version 2.0 for Windows and a diskette copy of the map is available from the authors-

An example of site specification would be as follows:

State: Alabama
Province: Hilly Coastal Plain Province
Region: The Upper Loam Hills Region
Subregion: The Loam Hills Border Terraces
Landform: upper slopes and ridge tops
Soil **series: Cowarts** loamy sand, 6 to 10 percent slope fine-loamy. siliceous, Thermic Typic Hapludults

The further division of coastal plain provinces into Atlantic, East Gulf, or West Guf can be used, because it is evident that climate and soils do vary by these subdivisions (Nelson and Zillgitt 1969). The reporting of the past land-use practices also characterizes site quality and determines ecological response (Van Lear 1991).

Further refinements are needed to delineate and define units to the subregional level in the seven states not Yet completed and further refinements to this system will continually be warranted. As ecological land classification develops (Bailey 1983). physiographic units should naturally comprise a middle tier of categorization and still will remain useful. As researchers and managers continue to obtain and utilize more information pertaining to southeastern ecosystems, it becomes more critical that common terminology be used in order to improve understanding and decrease confusion. Adoption and use of common physiographic landscape nomenclature would benefit us all as we begin to manage ecosystems and restore landscapes-

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