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Classification and Evaluation of Forest Sites in the Cumberland Mountains

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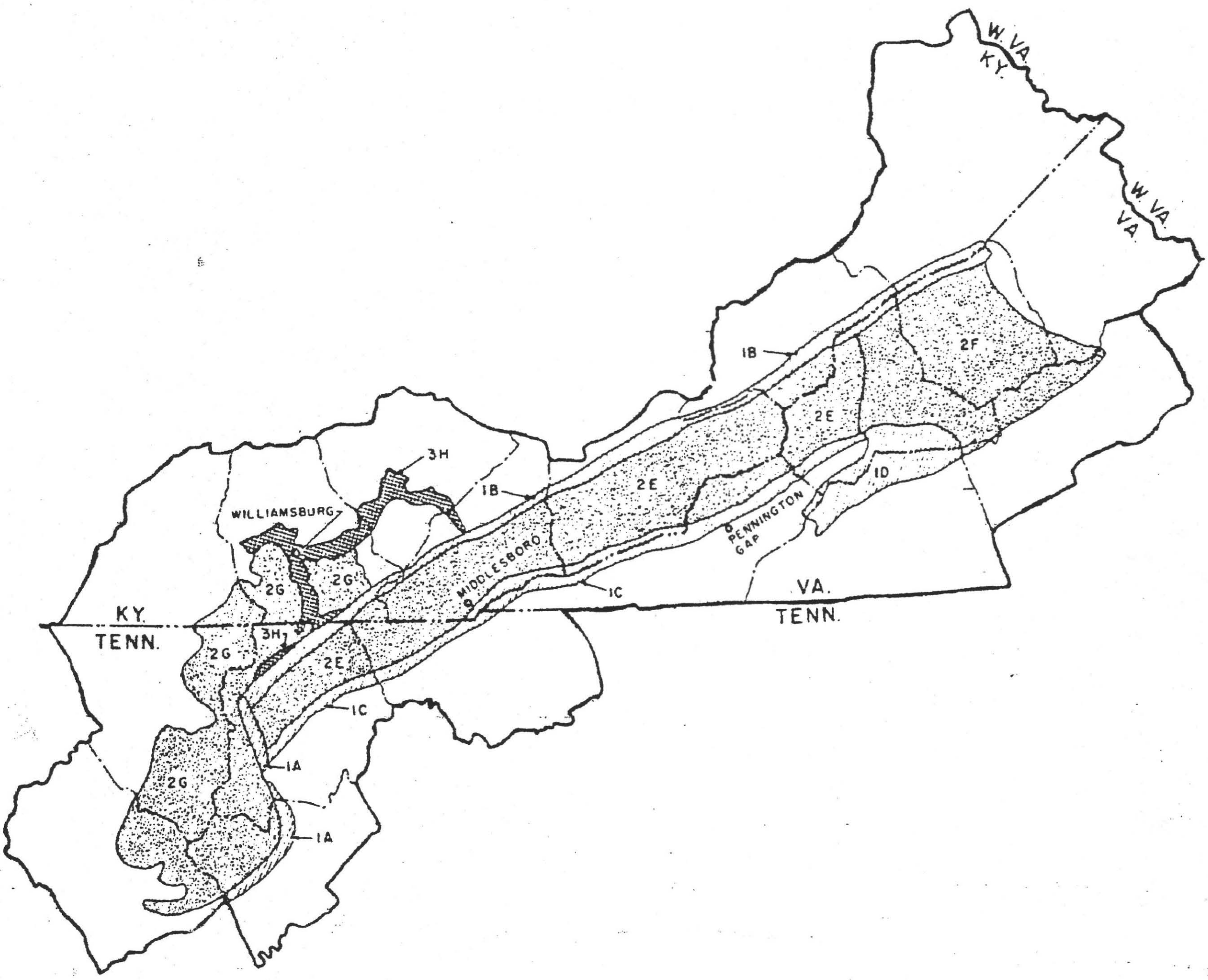

SUMMARY

This paper presents a comprehensive forest site classification system for the Cumberland Mountains in north central Tennessee, southeastern Kentucky, and southwestern Virginia. The system is based on physiography, geology, soils, topography, and vegetation. Thirty landtypes are described and evaluated in terms of productivity and desirability of selected pines and hardwoods for timber production. Also, each landtype is rated for five soil-related problems that can affect forest management operations.

ACKNOWLEDGMENTS

I am indebted to my colleagues, past and present, for their scientific input, reviews, and stimulating discussions. I am also grateful to the soil scientists, silviculturists, plant ecologists, and practicing foresters who have reviewed this guide.

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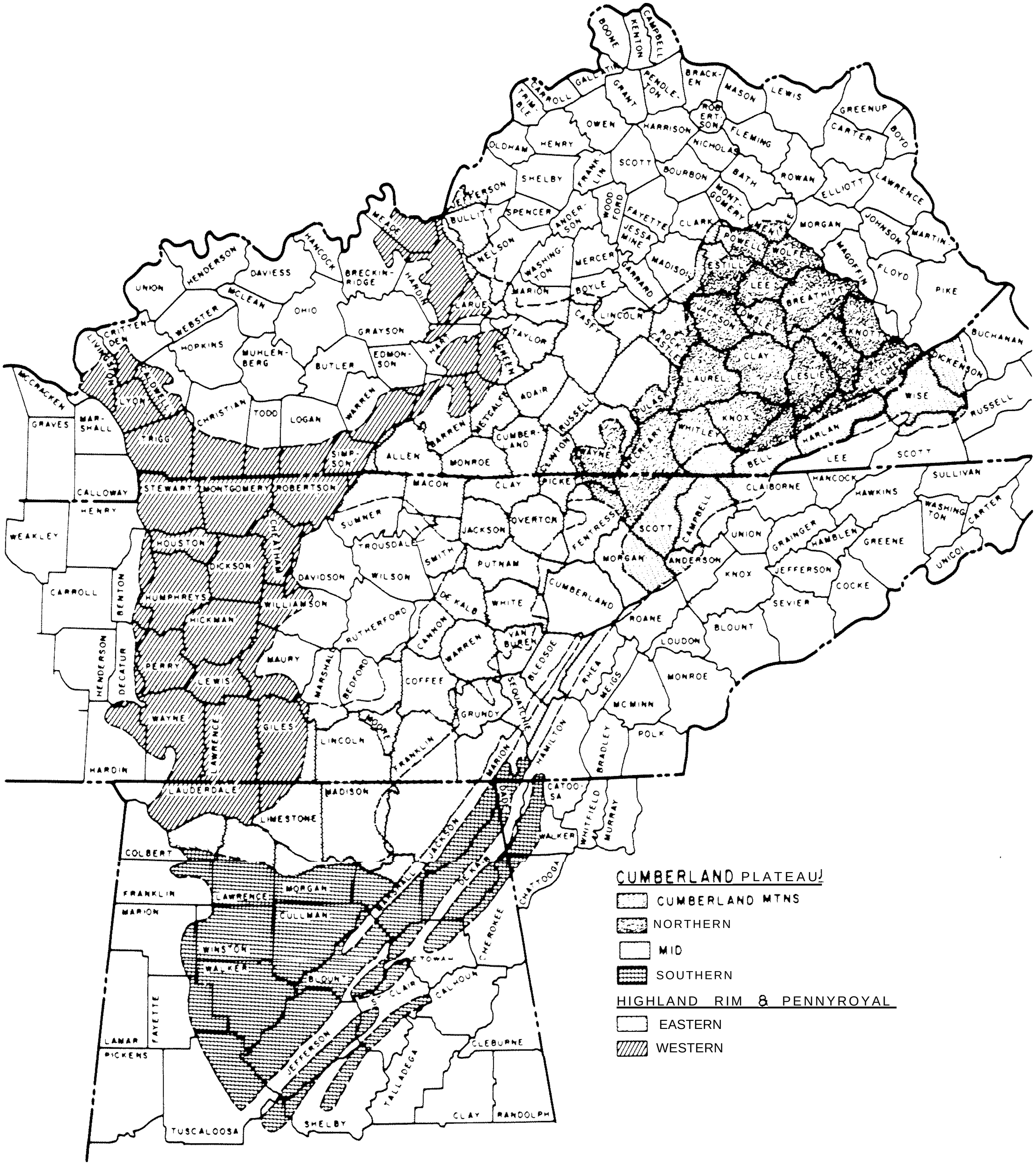

Figure 1.—*Physiographic provinces and regions of the Interior Uplands.*

Classification and Evaluation of Forest Sites in The Cumberland Mountains

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INTRODUCTION

This report classifies and evaluates forest sites in the Cumberland Mountains (fig. 1) for the management of several commercially valuable tree species. It provides forest managers with a land classification system that will enable them to subdivide forest land into logical segments (landtypes), allow them to rate productivity, and alert them to any limitations and hazards that the landtypes impose on forest management activities. Though soils information is an integral part of this system, users will not need to identify and classify soils or to make laboratory determinations. This report is oriented to timber production because timber is usually a major management objective. However, landtypes can also be the basis for the management and interpretation of other forest resources.

I have drawn freely on much published information on geology, physiography, soils, sites, and yields. In many cases, data specific to this area were not available, so information was extrapolated from adjacent regions. Extrapolation was particularly necessary with productivity data. All sources of data are documented, so the user can gage the accuracy and reliability of the information.

Productivity and management problem information is presented in a format that follows the outline used by the Soil Conservation Service (SCSI in the Woodland Suitability sections of county soil surveys. The similarity should facilitate the integration of information contained in county soil surveys' with this classification system.

This guide represents the best information and collective judgment now available. Nevertheless, it is still incomplete. I trust that forest managers, after applying this site classification system, will share their experience with me and make me aware of any shortcomings or needed revisions.

The rationale and methodology for the development of a site classification system for the Interior Uplands appeared in the proceedings of the Second Central Hardwood Forest Conference (Smalley 1978) and the Forest Soils and Site Quality Workshop (Smalley 1979a). Site classification guides for the Southern Cumberland Plateau, the Western Highland Rim and Pennyroyal, the Mid-Cumberland Plateau, and the Eastern Highland Rim and Pennyroyal Regions have been published (Smalley 1979b. 1980. 1982, 1983).

'See Appendix for available soil surveys.

CUMBERLAND MOUNTAINS REGION

The Cumberland Mountains region covers about 2,900 mi' in all or part of five counties in Tennessee. six in Kentucky, and six in Virginia. The region extends south to north from about north latitude 36°5′ to 37°20′ and east to west from about west longitude 81°55′ to 84°40′. It extends from near the Emory River in Morgan County, Tennessee. northward to the Russell Fork River in Dickenson County. Virginia, a distance of about 154 mi (fig. 2).

The Cumberland Mountains consist of the Cumberland overthrust block and the Wartburg Basin (Fenneman 1938, Luther 1977). The region is distinguished by elevation and relief, being everywhere higher than the adjacent Cumberland Plateau and the Powell Valley section of the Ridge and Valley physiographic province.

The Cumberland overthrust block is more accurately called the Pine Mountain thrust plate. reflecting current thought that the thrust plate is the result of thin-skinned tectonics (Harris 1970). The Pine Mountain thrust plate straddles the Tennessee. Kentucky, and Virginia boundaries. This quadrilateral thrust plate is bounded on the northwest by Pine Mountain; on the southeast by Cumberland, Stone, and Powell Mountains; on the northeast by the Russell Fork River; and on the southwest by Cove Creek. Geologically, the northwest and southeast boundaries are the Pine Mountain and Cumberland Mountain thrust faults, and the southwest and northeast boundaries are the Jacksboro and Russell Fork transverse faults.

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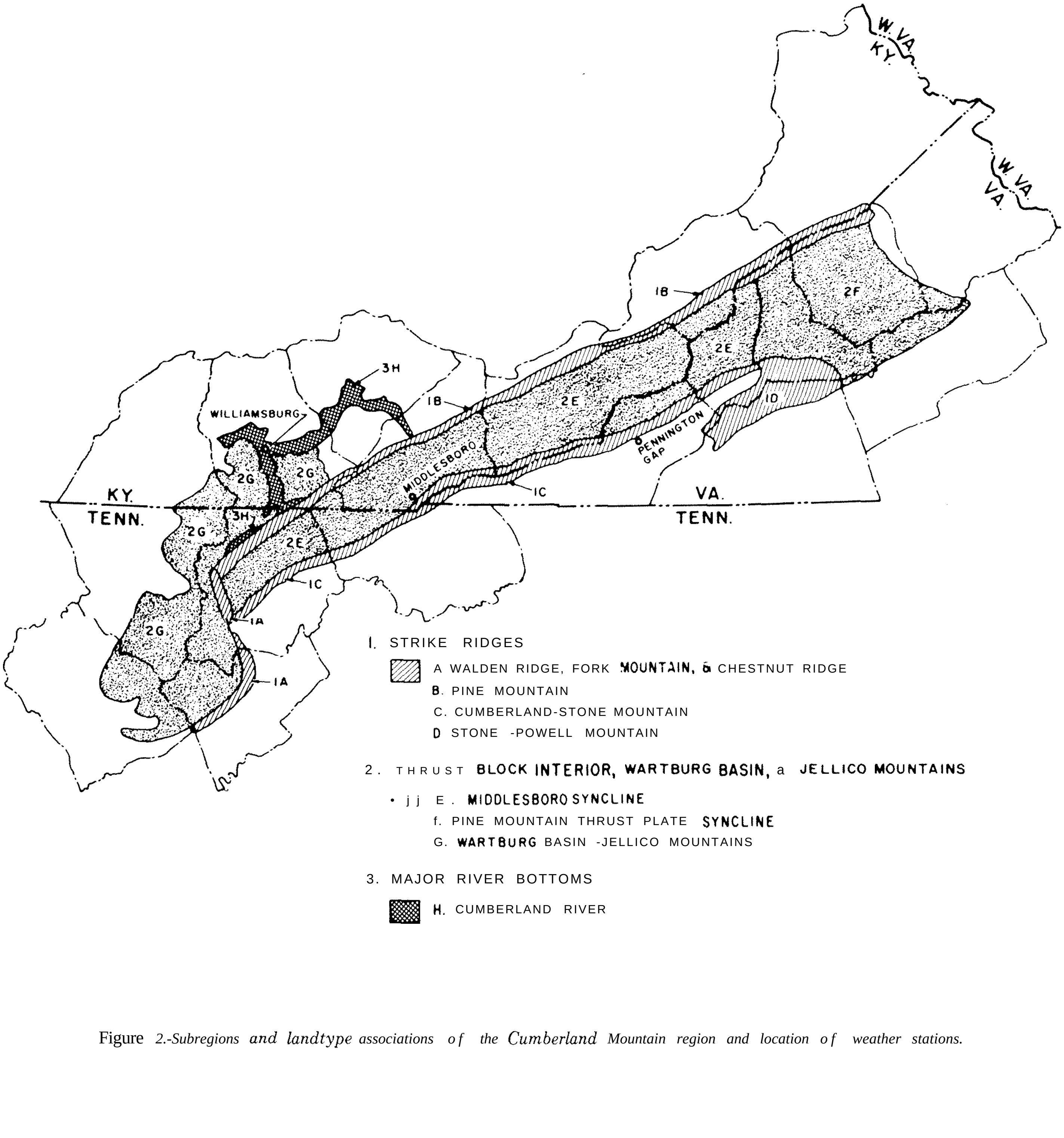

Figure 2.-Subregions and landtype associations of the Cumberland Mountain region and location of weather stations.

The Wartburg Basin, adjacent to the southwest end of the Pine Mountain thrust plate, is included in the Cumberland Mountain region because it is similar geologically to the interior of the thrust plate (Middlesboro Basin). The Wartburg Basin is bounded on the northeast by the Jacksboro fault, on the southeast by Walden Ridge, and on the southwest by the Emory River and Whetstone Mountain faults. It is limited geologically on the northwest, where it merges with the Cumberland Plateau.

Climate

The region has a temperate climate characterized by long, moderately hot summers and short, mild to moderately cold winters. According to Thornthwaite's (1948) classification of climate, it is humid mesothermal, with adequate precipitation at all seasons. Daily and seasonal weather is controlled largely by alternating cold, dry continental air masses from Canada and warm, moist air from the Gulf of Mexico. During the summer, complete exchanges of air masses are few and tropical maritime air masses persist for extended periods. Long periods of mild, sunny weather typically occur in the fall. Tables 1 and 2 show average monthly and annual precipitation and temperature values, average frost-free periods, and elevation above mean sea level for two stations in Kentucky and one in Virginia (fig. 2). No station was located in the Tennessee portion of the region.

Mean temperature for the region is about 55°F. The date of last freeze is mid-April, and the date of first freeze is mid- to late October. The frost-free period ranges from 180 to 190 days but may be 10 to 20 days shorter at the highest elevations. The temperature often falls below freezing at night in December, January, and February. The ground freezes to a depth of 2 to 8 in several times during the average winter season and commonly remains frozen for 3 to 14 days. Though air temperature does not appear to vary much across the region, local temperatures vary considerably because of elevation, aspect, and cloud cover. In summer, the valleys are very warm and occasionally hot, and the mountains are warm during the day but are cool at night. In winter, the valleys are very cool with occasional cold and warm spells, while upper slopes and mountaintops are generally cold.

Southerly winds prevail from May to September and northerly ones from November to March; average velocity ranges from 5 to 10 mph but probably exceeds 10 mph on the mountaintops. Infrequent, severe winds are usually associated with late spring and summer thundershowers.

Annual precipitation, averaging about 49 in, is ordinarily well-distributed throughout the year. Precipitation is greatest from December through March and least from August through November. Short periods of very wet or very dry weather are common. Thunderstorms that commonly occur from March

Table 1.-*Average monthly and annual precipitation in inches and elevation above mean sea level for three weather stations in the Cumberland Mountains*[1]

Station and county	Years of record	Elevation (ft)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Middlesboro Bell, KY	85	1,175	4.84	4.47	5.20	4.04	3.71	4.53	4.95	3.96	2.87	2.64	3.83	4.83	49.87
Williamsburg Whitley, KY	89	1,000	4.36	4.28	4.79	4.01	3.95	4.14	5.09	3.62	2.89	2.59	3.76	4.05	47.53
Pennington Gap Lee, VA	44	1,510	4.87	4.76	5.48	3.93	3.69	4.09	5.46	4.09	3.20	2.45	3.71	4.56	50.29

[1]U.S. Department of Commerce (1976a, 1976b).

Table 2.-*Average monthly and annual temperature (°F) and length of warm period for three weather stations in the Cumberland Mountains*[1]

Station and county	Years of record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Warm period days[2]
Middlesboro Bell, KY[3]	80	31	43	50	54	59	71	72	71	65	51	38	32	53	181
Williamsburg Whitley, KY	80	38	40	47	58	66	73	76	75	69	59	47	39	57	188
Pennington Gap Lee. VA	44	34	36	44	54	63	70	73	72	66	56	44	36	54	[4]185

[1]U.S. Department of Commerce (1976a, 1976b).

[2]Mean period from last 32°F to first 32°F (U.S. Department of Agriculture 1941).

[3]Data for 1976; no normal values available.

[4]Value for Elk Knob, Lee County, VA.

through August are of short duration. Steady rainfalls lasting several days sometimes occur in winter and late spring. Those storms are likely to cause local flooding in the mountains because soils are saturated, frozen, or snow-covered. In the winter, precipitation is chiefly rain in the valleys and snow, sleet, or freezing rain on the mountaintops. Average annual snowfall is 10 to 14 in, but snow persists for periods longer than a few days only at the highest elevations. Soils are wettest from December through April and driest from July to October. On the average, tree growth is probably retarded for periods of a few days less than six times each growing season. More severe droughts are common on upper mountain slopes facing south and west.

Soil dryness during the growing season can also be shown by "frequency of drought days" data (Knetsch and Smallshaw 1958). A drought day occurs when precipitation and evapotranspiration data indicate that soil moisture content is below the wilting point. At Dante in Russell County, Va. (about 15 mi east of Wise, Va.), drought days are most likely to occur in September when the probability of 10 drought days per month is 9 percent and least likely in June, July, **August,** and October when the probability is 3 percent or less. During the April to October growing season, there is a 24 percent probability of 10 drought days. These low probabilities indicate that precipitation in the Cumberland Mountains is well-distributed throughout the growing season in most years. These data were collected for soils having 4 in of available water storage. The probability of drought will be greater on soils with less storage capacity and vice versa.

Geology, Topography, and Soils

The Cumberland Mountains region consists of the Pine Mountain thrust plate and the Wartburg Basin-Jellico Mountains and is underlain by Pennsylvanian shales, siltstones, sandstones, and coal. The thrust plate is delineated by prominent strike ridges-Pine Mountain on the northwest and Cumberland-Stone Mountain on the southeast (Wilson and others 1956, Wilson and Stearns 1958, McFarlan 1943, Dietrick 1970). The Pine Mountain thrust fault is a complex system that initially formed at different stratigraphic levels along, as well as across, strike.

Along Pine Mountain, the leading edge of the thrust plate, strata dip 10" to 35" to the southeast. Strata along Cumberland-Stone Mountain, the trailing edge of the thrust plate, dip even more steeply to the northwest and are locally vertical. The dip flattens quickly to merge into the floor of the thrust plate.

At the trace of the Pine Mountain fault, strata as old as Silurian have been thrust over Pennsylvanian-aged rocks (Englund 1968, Smith and others 1967, Tennessee Division of Geology 1981). The southeast flank of Pine Mountain and the northwest flank of Cumberland-Stone Mountain are capped with lower Pennsylvanian strata belonging to the sandstone-dominated Gizzard and Crab Orchard Mountain groups in Tennessee (Wilson and others 1956) and the Pennington and Lee formations in Kentucky and Virginia (Englund 1968, McDowell and others 1981, Milici and others 1963). In places, the inclination of these mountain slopes is parallel or nearly so to the dip of the strata.

Northwest of the Pine Mountain thrust in Tennessee and Kentucky are subsidiary fault slices, which consist of intensely deformed strata of the Gizzard and Crab Orchard Mountain groups or Lee Formation (Wilson and Stearns 1958, Englund 1968). Southwest of the Pine Mountain thrust on the northeast side of the Jacksboro fault is a prominent anticlinal ridge—Fork Mountain and Chestnut Ridge-where deformed strata of the Gizzard and Crab Orchard Mountain groups are faulted against younger, nearly horizontal rocks of the Slatestone group. Titus Creek flows through Sharp Gap, which separates Fork Mountain and Chestnut Ridge. Along the Jacksboro fault, strata were moved northwestward about 11 mi and raised about 500 ft above their normal level on the adjacent Cumberland Plateau. On the northeast end of Pine Mountain, thrust movement along the Russell Fork fault was about 4 mi.

Alluvial deposits of Quaternary age occur along the Cumberland River, Russell Fork, Clear Fork in Elk Valley, and in the vicinity of Middlesboro, Ky. (Swingle and others 1966, Englund 1968, McDowell and others 1981).

The interior of the Pine Mountain thrust plate is divided into the Middlesboro syncline and the Pine Mountain thrust plate syncline (Harris 1970). These two basins are separated by the Buck Knob anticline, which extends from the head of Powell Valley near Norton, Va., northward to near Pound Gap. The Middlesboro Basin contains high, rugged mountains underlain by Slatestone to Cross Mountain formations in Tennessee (Wilson and others 1956), members of the lower and middle Breathitt formation in Kentucky (McDowell and others 1981), and Wise and Harlan formations in Virginia (Milici and others 1963). Pine Mountain syncline is less rugged and underlain by older Pennsylvanian rocks belonging to the Gladeville and Norton formations (Milici and others 1963).

The Wartburg Basin and Jellico Mountains are underlain with similar, nearly horizontal beds of shale, sandstone, and coal. In Tennessee, these beds have been divided into the Slatestone, Indian Bluff, Groves Gap, Kedoak Mountain, Vowell Mountain, and Cross Mountain groups (Wilson and others 1956). The Cross Mountain group includes the youngest Pennsylvanian strata in Tennessee and is preserved only on the highest ridges in the Wartburg Basin.

In Tennessee, Wartburg sandstone, the upper member of the Crooked Fork group, serves as the approximate boundary between the Cumberland Plateau and the Wartburg Basin portion of the Cumberland Mountains. Wartburg sandstone forms the broad topographic bench surrounding the Wartburg Basin on the south, west, and northwest. This sandstone marks the top of the lower sandy division of Pennsylvanian rocks. The corresponding stratum in Kentucky is the Corbin sandstone. Strata above the Wartburg and Corbin sandstones belong to the upper shaly division of Pennsylvanian rocks.

Study of the geology of the Cumberland Mountains region is difficult because different stratigraphic nomenclatures were developed in each of the three States. Some strata, including coal seams, have been assigned the same names, and, in some places, contacts between units coincide; but, in most cases, names are different and units do not coincide. Several correlations have been attempted, although no recent regional correlation is available (Wilson and others 1956, Stearns and Mitchum 1962, Englund 1968, Colton 1970).

An attempt at such a correlation may be futile since contacts are arbitrarily defined in a repetitious sequence of sandstone, siltstone, shale, coal, underclay, and argillaceous limestone. Also, the characteristics of the strata change from place to place so that a bed that is thick and readily mappable at one place may be thin and obscure at another. Consequently, the advantages and disadvantages of each nomenclature are dependent on the local character of the strata (Englund 1968).

Topography of the region ranges from gentle to rugged and complex, and is characterized by steep slopes, narrow crests, and narrow winding valleys. Slopes vary from nearly level to very steep, but most are 20 to 60 percent. Elevation ranges from 1,200 to 3,000 ft above mean sea level, with a few peaks exceeding 4,000 ft. Some smooth land occurs on broader mountaintops, footslopes, and benches and along larger mountain streams, particularly in the Pine Mountain thrust plate basin.

Elevation of the Pine Mountain varies from 2,100 to 2,300 ft at the southern end and rises gradually to 2,600 to 2,800 ft, and locally to 3,000 ft, at the northern end. Everywhere, it is 600 to 800 ft higher than the adjacent Cumberland Plateau. Elevation of Cumberland-Stone Mountain varies from 2,500 to 3,000 ft over much of its extent and occasionally exceeds 3,000 ft. High Knob on Powell Mountain south of Norton, Va., rises to 4,162 ft.

A series of steep, rugged mountains, carved into nearly horizontal beds of shale, siltstone, sandstone, and coal, characterize the Wartburg Basin, Jellico Mountains, and Middlesboro syncline. Some of the more prominent mountains are Bird, Massengale, Frozen Head, Cross, Jellico, Short, Walnut, Brushy, Rich, Log, Little Black, and Black. Cross Mountain in Tennessee has an elevation of 3,534 ft, and "The Double" on Black and Log Mountains in Kentucky rises to 4,150 ft and 3,200 ft, respectively. Local relief ranges from 1,000 to 1,400 ft and may be as much as 2,500 ft in the vicinity of the highest peaks. Conspicuous free faces and benches have developed on the more resistant strata of sandstone.

Topography of the Pine Mountain thrust plate syncline is not as high or as dissected as other parts of the Cumberland Mountains-ridgetops are broader, smoother land is more prevalent. and the landscape is more nearly like the Mid- and Northern Cumberland Plateau than the Cumberland Mountains.

The majority of the Cumberland Mountain region drains into the Cumberland River and its tributaries, while a small portion drains into the Emory. Powell, and Clinch Rivers, major tributaries of the Tennessee River. The northeast end of the Pine Mountain thrust plate is drained by the Russell Fork River, a tributary of the Big Sandy River. The Russell Fork River passes the north end of Pine Mountain in a gorge nearly 5 mi long and almost 1,000 ft deep known as the "Breaks of the Cumberland." Situated within the Breaks Interstate Park, the gorge contains many remarkable erosional features (Dietrich 1970).

The Cumberland River breaches Pine Mountain at Pineville in a narrow water gap at an elevation of about 1,000 ft, then turns northeastward and follows the back slope of Pine Mountain for nearly 60 mi. Clear Fork cuts through Pine Mountain near Jellico, and U.S. Highway 23 passes through a gap near Pound, Ky.

Cumberland Gap is the well-known pass in Cumberland Mountain through which Daniel Boone and other early explorers and settlers travelled. Stone Mountain is breached by the North Fork of the Powell River at Pennington Gap and the main Powell River at Big Stone Gap, Va.

Soils are mostly pale, loamy, and friable and vary in content of sandstone and shale fragments. Soils with dark surface horizons occur at high elevations, in coves, and on cool slopes. The more extensive soils are classified as loamy, mixed or siliceous, mesic Dystrochrepts and Hapludults. Soils forming in spoil material from surface mining of coal are classified as Udorthents.

On upper mountain slopes, soils formed from shale or sandstone, depending on elevation. Probably two-thirds or more of the region consists of soils formed in colluvium. On some slopes the colluvium extends three-fourths or more of the way to the top and, in places, goes through gaps and down the other side. On some steep mountain slopes, a series of narrow benches and short cliffs forms a stairstep pattern. Soils on ridge crests are 2 to 4 ft deep, soils on upper slopes are mainly 1 to 3 ft deep, and soils on colluvial slopes are 5 to 15 ft deep. In the upper reaches of mountain streams, discontinuous flood plains are typically long and narrow and rimmed with steep rocky ledges. Downstream along the larger creeks and rivers, flood plains and terraces are more extensive (Springer and Elder 1980, Lietzke and Porter 1978, Franzmeier and others 1969, Bailey and Winsor 1964).

Common upland soils are Lily, Ramsey, Muskingum, Gilpin, Latham, Petros, Alticrest, Berks, and DeKalb. Common colluvial soils are Grimsley, Jefferson, Shelocta, Bouldin, Rigley, and Zenith. Common alluvial soils are Sewanee, Ealy, Cuba, Stendal, Bonnie, Pope, Philo, Stokly, Clifty, and Atkins.

There is little smooth land- in the Cumberland Mountains region, and most of it is used for agriculture or building sites. Hardwood and pine forests occupy 57 to 90 percent of Cumberland Mountains counties (Hedlund and Earles 197 1, Knight and McClure 1978, Kingsley and Powell 1978). Counties with the lowest percentages of forest land reflect the fact that part of the area lies in the Ridge and Valley physiographic province. Large tracts are owned by lumber and coal companies. Part of the Clinch Ranger District of the Jefferson National Forest lies in the Cumberland Mountains.

Much land has been disturbed by surface mining for coal, and regulations now require rehabilitation. Some reclaimed land is being used for shopping centers, schools, athletic fields, subdivisions, and improved pasture. Most land disturbed before passage of reclamation laws is gradually reverting to forest. Soil erosion, stream sedimentation, and surface- and ground-water pollution are serious problems.

Gradient, aspect, slope length, and soil moisture are important factors in the delineation of landtypes described later. Slope steepness, soil thickness, and topographic position affect the rate and amount of both surface runoff and subsurface movement of soil water. Soil loss by erosion increases as gradient and length of slope increase. Although surface runoff and soil erosion are rare under forested conditions, they are important factors during road construction, logging, and other forest management operations. Slumping of the soil mass is fairly common on undisturbed steep slopes. Soils on short steep slopes are often shallower than soils on more nearly level terrain, while those on long steep slopes are often very deep. Deposition of sediments on gentle terrain by surface runoff is greatest below the longer and steeper slopes.

Generally, the steeper the gradient and the longer the slope, the greater the subsurface flow of soil water downslope. As a consequence, plants on lower slopes grow for longer periods without moisture stress. Subsurface flow may result in excessively wet soils with poor aeration at the base of slopes, especially those underlain by shale.

Aspect affects air and soil temperatures. Generally, soil temperatures are lower on north-facing than on south-facing slopes. Because soils on north-facing slopes tend to retain moisture for longer periods during the growing season, rate of tree growth is faster and species composition is richer.

Franzmeier and others (1969) in a study of soil properties on steep north- and south-facing slopes of the Cumberland Mountains in Morgan County, Tenn. found that, at a depth of 20 in, lower slopes were cooler than mid- and upper slopes. Lower slopes were shaded in the morning and evening by adjacent mountains in this steep, highly dissected landscape and also tended to be more moist than higher slope positions because of internal moisture flow. These moister soils warm more slowly because of the relatively high specific heat of water and the shorter periods of time they are exposed to direct sunlight.

Lee and Sypolt (1974), however, suggested that in areas of high summer precipitation, such as the Cumberland Mountains, marked differences in tree growth are not associated with soil moisture differences. During midday on south-facing slopes, it appears that (1) super-optimum temperatures for net assimilation frequently occur in forest canopies, (2) lower soil temperatures limit the absorption of available water, and (3) higher canopy temperatures increase the transpiration demand, create leaf water deficits earlier in the day, and magnify the midday depression of net assimilation.

Shading by an adjacent landmass is an important site factor in highly dissected landscapes. Attempts have been made to quantify the effects of shading on the growth of black cherry in the Allegheny Mountains of Pennsylvania (Davis 1966) and of chestnut oak, white oak, and yellow-poplar in the Cumberland Mountains of Tennessee (Rodriguez 1973) using the angle to the top of the shading Iandmass situated to the south. However, very little of the total variation in tree growth was attributed to this angular measurement. The effect of shading is complex and, evidently, a simple angular measurement does not explain this complexity. A thorough study is needed to quantify both the areal and temporal effects of shading on tree growth in steep, highly dissected landscapes.

In Soil Taxonomy, temperature regime is one of several differentiae used to group soils within a subgroup having similar physical and chemical properties (Soil Survey Staff 1975). In the Cumberland Mountains, nearly all soils are classed as mesic, but a few are thermic. Temperature regime of mesic soils ranges from 8°C to 15°C (47°F to 59°F), and the regime of thermic soils ranges from 15°C to 22°C (59°F to 72°F). Both classes also have a difference of 5°C (9°F) or more between mean summer and mean winter soil temperature. All temperature measurements are made at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower. In the description of landtypes that follows, both mesic and thermic soils are listed as occurring on a few landtypes to conform to current SCS classification. Soils differing only in temperature regime seem to have similar tree growth potential and management problem interpretations. However, average annual soil temperature does not reflect the daily and seasonal fluctuations, particularly in the top few inches. These fluctuations probably influence tree growth more than average temperature.

It is commonly thought that soils on steep mountain slopes have thin, weakly developed sola over bedrock. Soils developed from acid siltstones and shales in the Cumberland Mountains of Tennessee and the northern Cumberland Plateau of south central Kentucky have deep, well-developed sola and appear relatively stable despite fairly steep slopes (Franzmeier and others 1969). Soils on midslopes have greater contents of rock fragments than those on upper or lower slopes. Soils on lower slopes have higher base status. Most soils on south slopes have argillic horizons while most soils on north slopes have cambic horizons. Soils on north slopes have almost 2°C lower mean annual temperature, contain more organic matter, are darker in color, and hold more water during periods of water stress than soils on south slcpss.

Vegetation

The late Dr. E. Lucy Braun conducted extensive vegetation studies of the Cumberland Plateau and Cumberland Mountains in the 1930's and 1940's. This research formed the basis for her concepts of deciduous forest development and succession, which were synthesized in her book *Deciduous Forests of Eastern North America* (Braun 1950). This volume remains the only authoritative description of the eastern deciduous forest.

Braun's Cumberland Mountain section of the Mixed Mesophytic Forest region is coextensive with Fenneman's (1938) physiographic region of the same name. She included the mountainous Wartburg Basin lying west and south of the Cumberland Plateau thrust plate in the Cumberland Mountains section and referred to it as "the outlying area."

According to Braun, the mixed mesophytic forest reaches its best development in the Cumberland Mountains. The dominant climax species of American beech, yellow-poplar, white basswood, sugar maple, American chestnut, yellow buckeye, northern red oak, white oak, and eastern hemlock are not universally present. Physiographic climaxes are numerous and add to the diversity of the region. Other locally important species are yellow birch, river birch, black cherry, cucumbertree, white ash, red maple, blackgum, black walnut, shagbark hickory, and bitternut hickory. Composition and relative abundance vary greatly from place to place because of the large number of dominants in the climax. A dozen or more additional tree species seldom or never attain canopy position. The shrub and herbaceous vegetation is rich and varied.

The primary forest is a mosaic of climax and subclimax communities. Diversity in topography, soils, and microclimate is largely responsible for the complexity of the mixed mesophytic forest. American beech and white oak dominate southerly slopes at elevations below 2,000 ft. Beech seldom occurs above 2,000 ft, but white oak occurs at higher elevations and on cool aspects. Sugar maple-basswood-buckeye or sugar maple—basswood—buckeye—yellow-poplar communities are prominent at middle elevations. Shortleaf, pitch, and Virginia pines are common on the shallow sandstone-derived soils of the back slopes of Pine, Cumberland, Stone, and Powell Mountains. The mixed mesophytic forest prevails throughout the Wartburg Basin except on sandstone-derived soils and ridge crests where subclimax oak-hickory stands occur.

Current forests bear little or no resemblance to those that Braun described *40* to 50 years ago. American chestnut is gone, and extensive logging, coal mining, and wildfire have all caused drastic changes in tree size and composition of Cumberland Mountain forests. Selectively logged stands have similar composition but lack the large trees seen in photos illustrating Braun's book (1950, chapter *4)*. A few scattered old-growth remnants of the mixed mesophytic forest remain (Hinkle 1975). Recent studies characterize the existing forests.

DeSelm and others (1978) studied the forest vegetation of Wilson Mountain, the west end of Little Brushy Mountain in Morgan County, Tenn. Wilson Mountain, located at the southern end of the Wartburg Basin, rises to an elevation of 2,260 ft, which is 800 to 900 ft above the adjacent valleys. Sporadic timber harvesting occurred from early 1800 to 1948 by various owners; three seams of coal were mined between 1953 – 1957; and evidence of fires was found on lower slopes. Five communities were recognized: shortleaf pine on southern spur ridges, yellow-poplar in most north drainages, northern red oak on upper north slopes, white oak on most lower slopes (but also dominating some upper slopes), and chestnut oak on most mid-north and upper south slopes.

Composition (frequency of occurrence) and density (number of stems per acre) of tree reproduction on Wilson Mountain were related to soil and site characteristics as well as overstory species (Thor and others 1969). Some species were restricted to north or south exposures, but chestnut oak and red maple occurred on nearly all sites. Sweetgum, bitternut hickory, and American beech reproduce abundantly from root suckers, and their density of reproduction was significantly correlated with overstory density for each species. Neither yellowpoplar nor red maple showed any significant relationship between densities of overstory and understory. One or more of five soil and site variables was significantly correlated with understory density of twelve species, but only a small proportion of the total variation was explained by regression.

Cabrera (1969) described an old-growth deciduous forest on Ash Log Mountain about 20 mi northeast of Wilson Mountain. Ash Log Mountain rises to 3,240 ft, with local relief of about 1,400 ft. Slopes ranged from 10 to 140 percent, but most were 40 to 60 percent. North slopes typically had mull types of humus while west and southwest slopes had mor types. Three communities were recognized: sugar maple—yellow-poplar-basswood-buckeye in north coves, sugar maple-northern red oak—yellow-poplar—black locust on north and west spur ridges and on west and northwest slopes and coves, and chestnut oak-black locust on west and southwest spur ridges and coves. American beech occurred only below 2,000 ft elevation, where most sampled slopes had west and southwest exposures. The low density of seedlings and saplings of black locust suggested a temporary dominance of this species.

In a study of the relationship of soils and vegetation to topography and elevation in the Cumberland Mountains near Caryville in Campbell County, Tenn., Knight (1979) observed that mixed oak forests dominated warm slopes and ridges, and mesophytic forests dominated cool slopes. Chestnut oak and black oak occurred most frequently on soils developed from residuum, and American beech and hickories occurred on colluvial soils. It can be inferred that chestnut oak and black oak were common on upper slopes and ridges, and that American beech and hickories were common on mid and lower positions of long, steep slopes. Stands on cool aspects were denser than those on warm aspects, and, as expected, fire damage was greatest on warm aspects.

These studies have sought to identify and classify existing forest communities; i.e., typical descriptive botanical studies. Some investigators used correlation and/or multiple regression techniques to predict the importance of overstory and understory species to soil and topographic factors.

Rodriguez (1973) evaluated site quality of chestnut oak, white oak, and yellow-poplar at the Cumberland Forest Station, owned by the University of Tennessee, Scott County, Tenn. Elevation ranged from 1,400 to 2,850 ft. Site index (base age 50 years) was related to slope position, light, basal area growth, and closeness of neighboring land masses to the south. Best multiple regressions explained 50, 45, and 35 percent of the total variation in site index for the respective species.

The effort by SCS to determine mean site indices of selected tree species by soil series and the single site study mentioned above are the only attempts to determine relative or absolute productivity of Cumberland Mountain forest sites other than on a regional basis (Birdsey 1983, Kingsley and Powell 1978, Knight and McClure 1978).

SUBREGIONS AND LANDTYPE ASSOCIATIONS

I have divided the Cumberland Mountain Region into three subregions: (1) strike ridges, (2) thrust block interior, Wartburg Basin, and Jellico Mountains, and (3) major river bottoms (fig. 2). These divisions are based on easily recognized topographic features as well as strong geologic differences. Subregions 1 and 2 were divided into four and three landtype associations (LTA's), respectively. Subregion 3 has only one landtype association. Landtype associations correspond closely to soil associations shown on general soil maps for Tennessee and Kentucky (Soil Conservation Service 1975, Springer and Elder 1980). Landtype associations in Virginia are based on a study of old county soil surveys, Lietzke and Porter's (1978) interpretive guide, and personal knowledge of the area because the Cumberland Mountains are not differentiated from the Ridge and Valley physiographic province on the Virginia general soil map (Soil Conservation Service 1979) (table 3). A description of these landtype associations follows.

Subregion 1: Strike Ridges

Landtype Association-A: Walden Ridge, Fork Mountain, and Chestnut Ridge.-This LTA corresponds to a portion of soil association H21 (Bouldin-Rock outcrop-Ramsey) in Tennessee and soil association 7 (Grimsley-Jefferson-Ramsey) in the Anderson

Table 3.-*Subregions and landtype associations of the Cumberland Mountain region*

Subregion	Landtype Association
1. Strike ridges	A. Walden Ridge, Fork Mountain, and Chestnut Ridge
	B. Pine Mountain
	C. Cumberland-Stone Mountain
	D. Stone-Powell Mountain
2. Thrust block interior, Wartburg Basin, and Jellico Mountains	E. Middlesboro syncline
	F. Pine Mountain thrust plate syncline
	G. Wartburg Basin-Jellico Mountains
3. Major river bottoms	H. Cumberland River and major tributaries

County, Tenn. soil survey (Moneymaker 1981). The LTA includes: (1) the narrow, monoclinal Walden Ridge extending northeast from Oliver Springs to Lake City, then northwest to Vasper, south of Caryville in Campbell County, and (2) the two prominent anticlinal ridges-Fork Mountain and Chestnut Ridge-that extend from Caryville to near Elk Gap and form the southwest side of the Pine Mountain thrust plate. Walden Ridge is the northern end of the much wider land mass of the same name designated as Subregion 2 of the Mid-Cumberland Plateau region (Smalley 1982). The south end of Fork Mountain is separated from Cumberland Mountain by Bruce Gap, through which Interstate Highway 75 passes. The north end of Chestnut Ridge merges with Pine Mountain near Hackle Knob.

Landtype Association-A represents the narrow ridge crests, the intermittent sandstone free face, and the steep colluvial slopes below the crest and free face. On the west side of Walden Ridge and both sides of Fork Mountain and Chestnut Ridge, rocks of the Gizzard and Crab Orchard formations rest against younger sandstones and shales of the Crooked Fork and Slatestone groups. On the east side of Walden Ridge, the escarpment cuts across Pennsylvanian sandstones and shales and Mississippian limestones.

The narrow, undulating ridge crests have steep, convex slopes which, in places, end abruptly at the intermittent sandstone free face or merge into long, linear to concave side slopes. The loamy, shallow to moderately deep, well-drained to somewhat excessively drained soils formed in residuum and surficial colluvium from acid sandstone and, in places, from shale and siltstones. The surface is usually strewn with sandstone fragments, and rock outcrops are common.

The escarpment consists of steep, linear to concave slopes with numerous rock ledges, boulders, and benches. These slopes extend from the sandstone free face or convex upper slopes to the adjacent valleys.

Soils on the west slopes of Walden Ridge and both sides of Fork Mountain and Chestnut Ridge are shallow to deep, loamy, well-drained, and contain varying amounts of rock fragments. The surface is strewn with sandstone cobbles and boulders. Soils formed in colluvium from the ridge crests and upper slopes. On east-facing lower slopes of Walden Ridge, the silty and clayey, flaggy soils are well-drained and derived from clayey residuum from limestone. Limestone rockland is extensive.

Nearly all of LTA-A is forested. Some benches have been cleared, but most have reverted to woodland. Nine landtypes are recognized: 1 – 9.

Landtype Association-B: Pine Mountain.-This LTA corresponds to a portion of soil associations H21 (Bouldin-Rock outcrop-Ramsey) in Tennessee, and G4 (Jefferson-DeKalb) in Kentucky. Landtype Association-B is included in soil association 1 (DeKalb-Berks-Weikert) in Virginia.

Landtype Association-B represents the nearly straight, narrow ridge crest; the weakly dissected northwest-facing scarp slope; and the strongly dissected southeast-facing back slope. The ridge crest is mostly narrow and very rocky, but discontinuous broader areas occur. The back slope is dissected by intermittent streams, resulting in a complex pattern of V-hollows, steep stony side slopes, and fairly wide, sloping spur ridges. Although the dominant exposure is southeast, there are distinct cool and warm slopes, and some lower slopes are shaded by adjacent ridges. Nearly vertical pinnacles of resistant sandstone occur in places, mostly in Kentucky and Virginia; however, they are not as common as on the back slope of Cumberland-Stone Mountain (LTA-C).

The loamy, well-drained to somewhat excessively drained soils on main and spur ridges are generally less than 40 in to bedrock and formed mostly in residuum from tilted strata of sandstone and some siltstone and shale. The steep back slope is covered with well-drained colluvial soils containing varying amounts of rock fragments. Stream channels are strewn with rocks.

The weakly dissected scarp slope is very steep. A sandstone free face occurs in places, but it is not continuous or as tall as the one surrounding the Cumberland Plateau (LTA-A) because the bedrock is tilted. Minor free faces occur intermittently downslope on resistant, thin strata of sandstone between thick layers of limestone and shale. The very steep upper one-half to two-thirds of the outslope is straight or slightly convex, and the sloping to moderately steep lower one-third to one-half is concave. Benches are narrow and extend only for short distances.

The deep, loamy soils on the scarp slope are well-drained and derived from limestone colluvium and residuum. The soil mass contains considerable rock fragments and limestone outcrops in places.

Nearly all of LTA-B is forested. Some of the Pine Mountain back slope between Pound Gap and the Breaks Interstate Park is in the Clinch District of the Jefferson National Forest. Some benches and broader main and spur ridges have been cleared in times past, but most have reverted to woodland. A few areas on toe slopes are cleared and used for pasture and hay. Seven landtypes are recognized: 2 and 9 – 14.

Landtype Association-C: Cumberland-Stone Mountain.-This LTA corresponds to parts of soil association H21 (Bouldin-Rock outcrop-Ramsey) in Tennessee, soil association G4 (Jefferson-DeKalb) in Kentucky, and soil association 1 (DeKalb-Berks-Weikert) in Virginia. The arbitrary northern end of Stone Mountain is Little Stone Gap, west of Norton. through which State Highway 610 passes. The remainder of Stone Mountain is included with the broader, higher Powell Mountain ringing the head of Powell Valley to the south (LTA-D).

Landtype Association-C represents the mostly narrow, undulating ridge crest; the weakly dissected southeast-facing scarp slope; and the strongly dissected northwest-facing back slope consisting of narrow to broad spur ridges, steep side slopes, and narrow V-shaped coves.

The ridge crest is mostly narrow and very rocky, but discontinuous broader areas are common. The back slope is well-dissected by intermittent streams, resulting in a complex pattern of V-hollows, steep side slopes, and fairly wide, sloping spur ridges. Nearly vertical pinnacles of resistant sandstone are common, more so than on the back slope of Pine Mountain (LTA-B). The loamy soils on the main and spur ridges are well-drained to somewhat excessively drained, are generally less than 40 in to bedrock, and are formed in residuum and local colluvium from tilted strata of sandstone and some siltstone and shale.

Hollows incised into the back slope of Cumberland-Stone Mountain are flanked with steep, stony side slopes. Although the dominant exposure is northwest, there are distinct cool and warm slopes, and some lower slopes are shaded by adjacent ridges. These steep slopes are covered with deep, well-drained, colluvial soils containing varying amounts of rock fragments. Stream channels are strewn with rocks.

The scarp slope is very steep and weakly dissected. A sandstone free face is prominent along nearly the entire length of Cumberland-Stone Mountain. However, this free face is not as continuous or as tall as the one ringing the Cumberland Plateau (LTA-A) because of the tilt of the bedrock. Minor free faces occur intermittently downslope on resistant, thin strata of sandstone between the thicker layers of limestone and shale. The very steep upper one-half to two-thirds of the scarp slope is straight or slightly convex, and the sloping to moderately steep lower one-third to one-half is concave. Benches are narrow and extend only for short distances.

The deep, well-drained loamy soils formed in sandstone colluvium and limestone residuum and colluvium. The soil mass contains considerable rock fragments, and outcrops of limestone occur in places. Nearly all of LTA-C is forested. Some benches and broader spur ridges were cleared, but most have reverted to woodland. Seven landtypes are recognized: 2, 9 – 10, and 15 – 18.

Landtype Association-D: Stone-Powell Mountain. -This LTA is included in soil association 1 (DeKalb-Berks-Weikert) on the Virginia General Soil Map. Landtype Association-D represents the widened northern end of Cumberland-Stone Mountain (LTA-C) that curves around the northeast end of Powell Valley. The arbitrary boundary between LTA-D and the Pine Mountain thrust plate (LTA-F) is the Guest River from Norton to Coeburn, thence southeast to its confluence with the Clinch River near Bangor, Va.

Topography of LTA-D ranges from high mountains consisting of narrow ridges, steep rocky side slopes, and narrow V-valleys with 500 to 1,200 ft of local relief to lower mountains consisting of narrow to broad undulating ridges, hilly to rolling side slopes, and broad V-valleys with 100 to 350 ft of local relief. Streams drain into the Powell, Clinch, and Guest Rivers.

On the upper northwest-facing slope overlooking Powell Valley, the loamy soils are shallow to moderately deep, excessively drained, and quite stony. Further downslope, deep, well-drained, loamy soils have developed in colluvium. In places, limestone outcrops are interspersed with pockets of shallow to moderately deep clayey soils.

On narrow main and spur ridges, soils are loamy, well-drained to somewhat excessively drained, and generally less than 40 in to bedrock. On broader ridges and gently sloping to hilly side slopes, soils are loamy, well-drained, and moderately deep to deep.

Hollows are flanked with hilly to steep, stony side slopes oriented in all directions. Local relief is enough to cause shading by adjacent land masses. Side slopes are covered with deep, well-drained colluvial soils containing varying amounts of rock fragments. In places, sandstone rubble occurs along the base of these steep slopes.

Upper reaches of mountain streams are V-shaped, but further downstream narrow bottoms occur. These deep alluvial soils vary from loamy and well-drained to clayey and poorly-drained. The better-drained portions support gardens and subsistent farms of local residents. Sporadic rapid, high-volume flows transport gravel, cobbles, and boulders downstream.

Area surface mining of coal is common in LTA-D. Minespoil is composed of a mixture of partially weathered fine earth and fragments of acid shale, siltstone, coal, and sandstone. The young, loamy soils, developing in minespoil are 35 to 80 percent rock and strongly to extremely acid unless limed. Soils are well-drained to excessively drained with moderately slow permeability; runoff is very rapid.

Nearly all of LTA-D is forested; some is in the Clinch District of the Jefferson National Forest. Some benches and smooth ridges were cleared, but most have reverted to woodland. Thirteen landtypes are recognized: 1 – 4, 9, 13 – 14, and 21 – 26.

Subregion 2: Thrust Block Interior, Wartburg Basin, and Jellico Mountains

Landtype Association-E: Middlesboro Syncline.—This LTA corresponds to a portion of soil association H23 (Muskingum-Gilpin-Jefferson) in Tennessee, soil association G8 (Shelocta-Gilpin) in Kentucky, and soil association 1 (DeKalb-Berks-Weikert) in Virginia. The boundary between LTA's E and F is the Buck Knob anticline.

Landtype Association-E is characterized by high, rugged mountains such as Log, Black, and Little Black. Elevation ranges from 1,200 to nearly 4,200 ft, and relief ranges from 1,000 to 1,400 ft but approaches 2,500 ft near the highest peaks. Terrain consists of long, steep mountain slopes with gradients of 20 to 60 percent, narrow crests, and narrow winding valleys. Small areas of smooth land occur on mountain tops, footslopes, benches, and streambottoms. Middlesboro, Ky. is situated *in* a broad valley, and an area northeast of Middlesboro consists of low mountains of more gentle relief than most of the syncline.

The dominant bedrock is shale, but ledges of sandstone are common. Soils on ridge crests and convex upper slopes formed in residuum from shale and sandstone. One-third or more of LTA-E consists of soils formed in colluvium. On some mountain slopes, colluvium extends three-fourths of the way to the top, and in places, goes through gaps *and* down the other slope.

A series of narrow benches and short sandstone cliffs occurs on some of the steepest slopes. Soils on mountain crests average 2 to 4 ft to rock; those on upper slopes average 1 to 3 ft; and those on colluvial slopes average 5 to 15 ft. These soils are mostly pale, loamy, and friable, with varying amounts of rock fragments. Soils with dark surface layers occur in places at higher elevations and in coves.

The narrow, winding valleys represent the majority of smooth land in LTA-E, and most of the sparse population live in these valleys. The alluvial soils are mostly deeper than 5 ft, pale, loamy, and friable. Rock fragments are common on the surface and throughout the profile of these valley soils.

Large tracts are owned by timber and coal companies. Contour and area surface mining of the extensive coal deposits has disturbed thousands of acres and resulted in the acidification and siltation of streams. Soils developing in minespoil contain 35 to 80 percent rock and coal fragments. These young soils are well-drained with moderately slow permeability; run-off is very rapid. Reaction ranges from neutral to extremely acid.

Nearly all of LTA-E is forested with a mixture of hardwoods and conifers. Species composition and stand density vary greatly with aspect, slope position, and degree of shading from adjacent land masses. Thirteen landtypes are recognized: 2 – 4 and *19 – 28.*

Landtype Association-F: Pine Mountain Thrust Plate Syncline.—The Pine Mountain thrust plate syncline is included in Virginia soil association 1 (DeKalb-Berks-Weikert). Three patches of soil association 2 (Clymer-DeKalb) occur within LTA-F. The boundary between LTA-E and LTA-F is the Buck Knob anticline. Landtype Association-E is separated from Landtype Association-D by the Guest River.

Landtype Association-F is characterized by loner, less rugged mountains than those in LTA-E. The exception is Big A Mountain in the northeast corner of the LTA, which rises abruptly above the surrounding mountains to 3,735 ft. -Elevation ranges from 1,500 to 3,200 ft, but most land lies below 2,600 ft. Local relief ranges from 100 to 600 ft. Terrain consists of winding, narrow to broad, rounded mountain crests; undulating to steep, moderately long slopes with gradients of 8 to 60 percent; and narrow winding valleys.

Bedrock is shale, sandstone, and numerous coal seams. Soils on ridge crests and convex upper slopes formed in residuum from sandstone and shale. Since, on the average, slopes are shorter than those in LTA-E, colluvial soils seldom extend more than two-thirds of the way to the ridge tops. Upwards of 10 percent of LTA-F consists of nearly level to sloping broad ridges that supported a moderately extensive farm economy consisting of apples, potatoes, berries, and other truck crops. Farming as a livelihood has declined considerably in the last decade or so.

A series of narrow benches and short sandstone cliffs occurs on some of the steepest slopes. Soils on mountain crests average 2 to 4 ft deep, those on upper slopes average 1 to 3 ft, and those on colluvial slopes are 5 to 15 ft. Soils are mostly pale. loamy, and friable, with varying amounts of rock fragments. Soils with dark surface layers occur at higher elevations on north aspects and in coves.

Alluvial soils in the narrcw winding valleys are pale, loamy, friable, and mostly deeper than 5 ft. Rock fragments are common on the surface and throughout the profile of these valley soils.

Large tracts are owned by lumber and coal companies. Surface mining of coal has disturbed considerable acreage and resulted in the acidification and siltation of streams. Soils developing in minespoil contain 35 to 80 percent rock and coal fragments. These young soils are well-drained to excessively drained with moderately slow permeability: runoff is rapid. Reaction ranges from neutral to extremely acid.

Nearly all of LTA-F is forested with a mixture of hardwoods and conifers. Species composition and stand density vary greatly with aspect, slope position, and degree of shading from adjacent land masses. Thirteen landtypes are recognized 2 – 4 and *19 – 28.*

Landtype Association-G: Wartburg Basin and Jellico Mountains. -Landtype Association-G is a highly dissected mountainous area, similar both geologically and topographically to LTA-E. The area lies northwest and southwest of the Cumberland Mountains thrust plate (LTA's A-F).

This LTA corresponds to a portion of soil association H23 (Muskingum-Gilpin-Jefferson) in Tennessee and soil association G2 (Latham-Shelocta) in Kentucky. In the soil survey of the Whitley-McCreary area, Ky. (Byrne and others 1970), the Jellico Mountains were assigned to the Muse-Shelocta soil association. In the soil survey of Anderson County, Tenn. (Moneymaker 1981), most of the Wartburg Basin was assigned to the Muskingum-Jefferson-Gilpin-Udorthents soil association. The highest peaks, corresponding approximately to the Red Oak Mountain, Vowell Mountain, and Cross Mountain geologic formations, were assigned to the Muskingum-Udorthents-Petros soil association.

The highest peaks in LTA-G are in the eastern part of the Wartburg Basin, and elevation decreases gradually to the west where the Basin merges with the Mid-Cumberland Plateau (Smalley 1982). Elevation of the Jellico Mountains decreases to the north and east until these mountains merge with the Northern Cumberland Plateau. The northern boundary of LTA-G east of Williamsburg follows the Cumberland River, then turns south along Poplar Creek to the scarp slope of Pine Mountain (LTA-B).

Landtype Association-G is characterized by high, rugged mountains consisting of narrow crests and long steep slopes often broken with narrow benches and short sandstone cliffs. Relief averages 1,800 ft in the Wartburg Basin, exceeds 2,000 ft near the highest peaks, and diminishes to 1,200 ft and less in the Jellico Mountains. Intermountain valleys are narrow and winding. Mountain slopes vary from 20 to 60 percent. Small areas of smooth land occur on mountain tops, benches, footslopes, and in streambottoms.

Bedrock is mostly shale and siltstone interspersed with relatively thin strata of sandstone. Soils on ridge crests and convex upper mountain slopes formed in residuum from sandstone and shale. Usually, ridges underlain by shale are more rounded than those underlain by sandstone. One-third or more of LTA-G consists of soils formed in colluvium. In places, colluvium extends three-fourths of the way to the top, and may fill gaps between high peaks.

Soils on mountain crests average 2 to 4 ft to rock, those on upper slopes average 1 to 3 ft, and those on colluvial slopes are 5 to 15 ft. Soils are mostly pale, loamy, and friable with varying amounts of shale and sandstone fragments. Soils with dark surface layers occur at higher elevations on north aspects and in coves.

The narrow, winding valleys represent the majority of smooth land in LTA-G, and most of the sparse population live in these valleys. Alluvial soils in the valleys are mostly deeper than 5 ft, pale, loamy, and friable. Rock fragments are common on the surface and throughout the profile.

Large tracts are owned by timber and coal companies. Contour surface mining of the extensive coal deposits has disturbed thousands of acres and resulted in the acidification and siltation of streams. Soils forming in minespoils contain 35 to 80 percent rock and coal fragments. These young soils are well-drained to excessively drained with moderately slow permeability; runoff is very rapid. Reaction ranges from neutral to extremely acid.

Nearly all of LTA-G is forested with a mixture of hardwoods and conifers. Species composition and stand density vary greatly with aspect, slope position, and degree of shading from adjacent land masses. Eleven landtypes are recognized: 2 and 19 – 28.

Subregion 3: Major River Bottoms

Landtype Association-H: Cumberland River and Major Tributaries.-This LTA corresponds to soil association A8 (Pope-Bonnie-Allegheny) and A9 (Morehead-Whitley-Cuba) on the Kentucky General Soil Map. Soil association A8 occurs along the Cumberland River from the Whitley-McCreary County line east to Williamsburg and south along Clear Creek. Soil association A9 occurs along the Cumberland River upstream from Williamsburg nearly to Pineville. Landtype Association-H also corresponds to the Atkins-Pope-Tate soil association in the McCreary-Whitley area soil survey (Byrne and others 1970). A soil survey in progress assigns the Cumberland River bottom in the eastern half of Whitley County and Knox County, Ky. to an Allegheny-Huntington-Newark soil association.[2] Another survey in progress assigns Elk Valley and the lower reaches of Elk Creek in Tennessee to an Atkins-Whitley-Ealy soil association, an extension of Kentucky general soil association A8.[3]

Landtype Association-H is a continuation of LTA-M in the Eastern Highland Rim and Pennyroyal Region (Smalley 1983) and LTA-L in the Western Highland Rim and Pennyroyal Region (Smalley 1980).

Landtype Association-H consists of well-drained to somewhat poorly drained, loamy and silty soils formed in old mixed alluvium on terraces, and well-drained to poorly drained silty soils formed in more recent mixed alluvium on flood plains.

These bottoms vary from broad extensive areas nearly a mile wide to narrow discontinuous strips less than 1,000 ft wide. Flood plains are nearly level or very gently sloping with 5 to 30 ft of relief. Terraces

[2] Personal communication with Paul M. Love, Chief of Survey Party, Whitley-Knox Area, Soil Conservation Service, Barbourville, Ky. 1982.

[3] Personal communication with Clarence T. Conner, Chief of Survey Party; Campbell County, Soil Conservation Service, Jacksboro. Tenn. 1982.

and footslopes are steeper and relief may exceed 100 ft.

Fluctuating water tables and occasional flooding limit the use of this LTA and affect the management of it. Most of the bottoms of the Cumberland River and its major tributaries have been cleared for agriculture, but woodlands, some extensive, are scattered all along these rivers. Some land has been tile-drained to make it suitable for cultivation. Corn, small grains, soybeans, and legumes and tall grasses for hay and pasture are major crops.

Two landtypes are recognized: 29 and 30. Bottoms of smaller rivers, creeks, and streams in the Cumberland Mountains are assigned to Landtypes 19 and 20.

LANDTYPES

I have divided each landtype association into landtypes, which are the smallest unit of the landscape recognized in this classification system. Wertz and Arnold (1975) describe landtypes as visually identifiable areas that have similar soils and productivity and that have resulted from similar climatic and geological processes.

The Cumberland Mountains region has 30 landtypes distributed among three subregions and eight landtype associations (table 4). Many are common to two or more associations, while others are characteristic of only one landtype association. Figures 3 to 5

Table 4.—*Summary of landtypes and their occurrence by subregions and landtype associations*

Landtype number and name by subregion	Landtype association[1]
1. Strike ridges	
1. Narrow sandstone ridges and convex upper slopes	A, D
2. Shallow soils and sandstone outcrops	A, 13, C, D
3. Broad sandstone ridges-north aspect	A, D
4. Broad sandstone ridges-south aspect	A, D
5. Upper sandstone talus slopes and benches-north aspect	A
6. Upper sandstone talus slopes and benches-south aspect	A
7. Lower limestone slopes, benches, and spur ridges-north aspect	A
8. Lower limestone slopes, benches, and spur ridges-south aspect	A
9. Shallow soils and limestone outcrops	4, B, C, D
IO. Overthrust ridge crests and spur ridges on back slopes	B, c
11. Upper back slope (southeast) of Pine Mountain	B
12. Lower back slope (southeast.) of Pine Mountain	B
13. Upper scarp slope (northwest) of Pine and Stone-Powell Mountains	13. D
14. Lower scarp slope (northwest) of Pine and Stone-Powell Mountains	B, D
15. Upper back slope (northwest) of Cumberland-Stone Mountain	C
16. Lower back slope (northwest) of Cumberland-Stone Mountain	C
17. Upper scarp slope (southeast) of Cumberland-Stone Mountain	C
18. Upper scarp slope (southeast) of Cumberland-Stone Mountain	C
21. Undulating sandstone mountain uplands	D
22. Upper mountain slopes-north aspect	D
23. Upper mountain slopes-south aspect	D
24. Colluvial mountain slopes, benches, and coves-north aspect	D
25. Colluvial mountain slopes, benches, and coves-south aspect	D
26. Surface mines	D
2. Thrust block interior, Wartburg Basin, and Jellico Mountains	
2. Shallow soils and sandstone outcrops	E, F, G
3. Broad sandstone ridges-north aspect	E, F
4. Broad sandstone ridges-south aspect	E, F
19. Mountain footslopes, fans, terraces, and streambottoms with good drainage	E, F, G
20. Mountain terraces and streambottoms with poor drainage	E, F, G
21. Undulating sandstone mountain uplands	E, F, G
22. Upper mountain slopes-north aspect	E, F, G
23. Upper mountain slopes-south aspect	E, F, G
24. Colluvial mountain slopes, benches, and coves-north aspect	E, F, G
25. Colluvial mountain slopes, benches, and coves-south aspect	E, F, G
26. Surface mines	E, F, G
27. Narrow shale ridges, points, and convex upper slopes	E, F, G
28. Broad shale ridges and convex upper slopes	E, F, G
3. Major river bottoms	
29. Footslopes, terraces, and flood plains with good drainage	II
30. Terraces and flood plains with poor drainage	H

[1]See table 3.

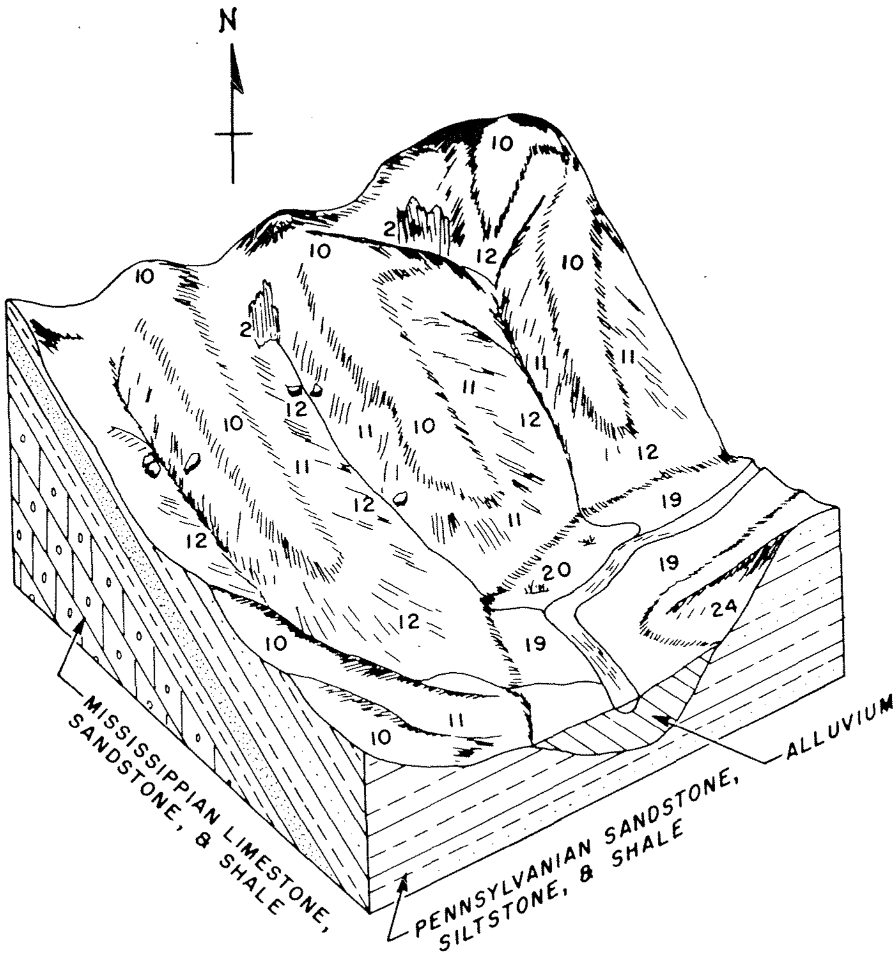

Figure 3.—*Landtypes characteristic of Landtype Association B (Pine Mountain) in Subregion 1 and the junction with Landtype Associations E (Middlesboro syncline) and F (Pine Mountain thrust plate syncline) in Subregion 2. The mirror image of figure 3 would represent Landtype Association C(Cumberland-Stone Mountain). Landtypes 15, 16, and25 would correspond respectively to Landtypes 11, 12, and 24.*

LEGEND

2. Shallow soils and sandstone outcrops.
10. Overthrust ridge crests and spur ridges on back slopes.
11. Upper back slope (southeast) of Pine Mountain.
12. Lower back slope (southeast) of Pine Mountain.
15. Upper back slope (northwest) of Cumberland-Stone Mountain.
16. Lower back slope (northwest) of Cumberland-Stone Mountain.
19. Mountain footslopes, fans, terraces, and streambottoms with good drainage.
20. Mountain terraces and streambottoms with poor drainage.
24. Colluvial mountain slopes, benches, and coves-north aspect.
25. Colluvial mountain slopes, benches, and coves-south aspect.

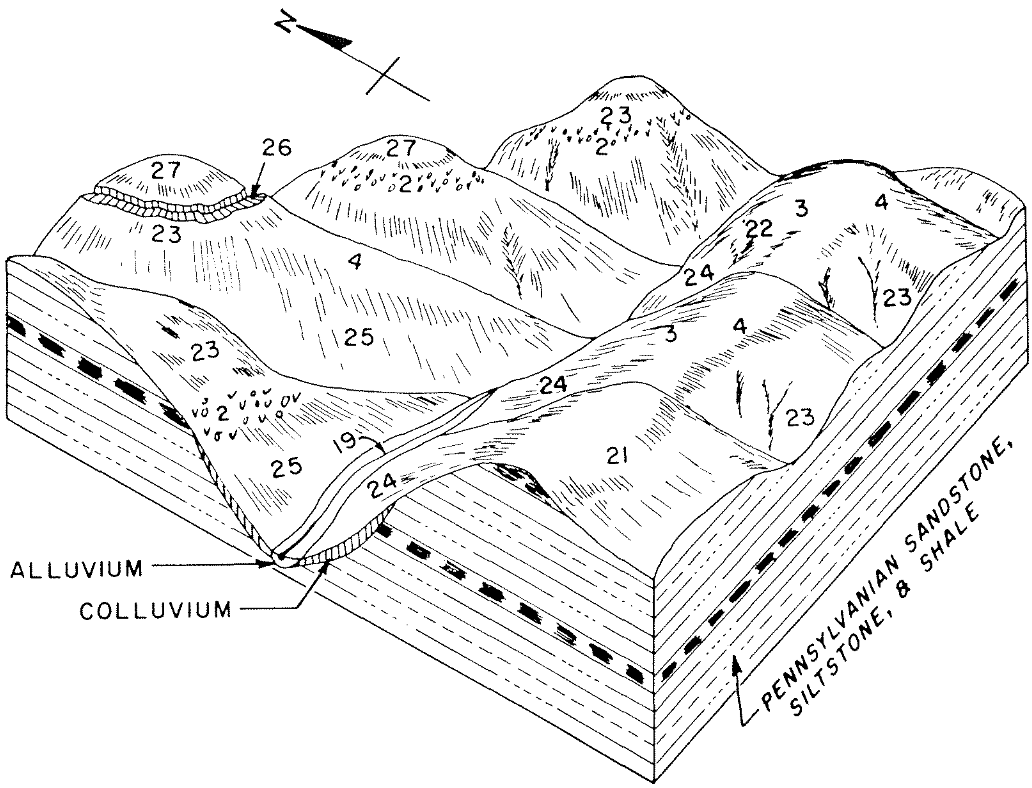

Figure 4.—*Landtypes characteristic of Landtype Association F (Pine Mountain thrust plate syncline) in Subregion 2. Adapted from figures 3 and 4 in McDonald and Blevins (1965).*

LEGEND

2. Shallow soils and sandstone outcrops.
3. Broad sandstone ridges-north aspect.
4. Broad sandstone ridges-south aspect.
19. Mountain footslopes, fans, terraces, and streambottoms with good drainage.
21. Undulating sandstone mountain uplands.
22. Upper mountain slopes-north aspect.
23. Upper mountain slopes-south aspect.
24. Colluvial mountain slopes, benches, and coves-north aspect.
25. Colluvial mountain slopes, benches, and coves-south aspect.
26. Surface mines.
27. Narrow shale ridges, points, and convex upper slopes.

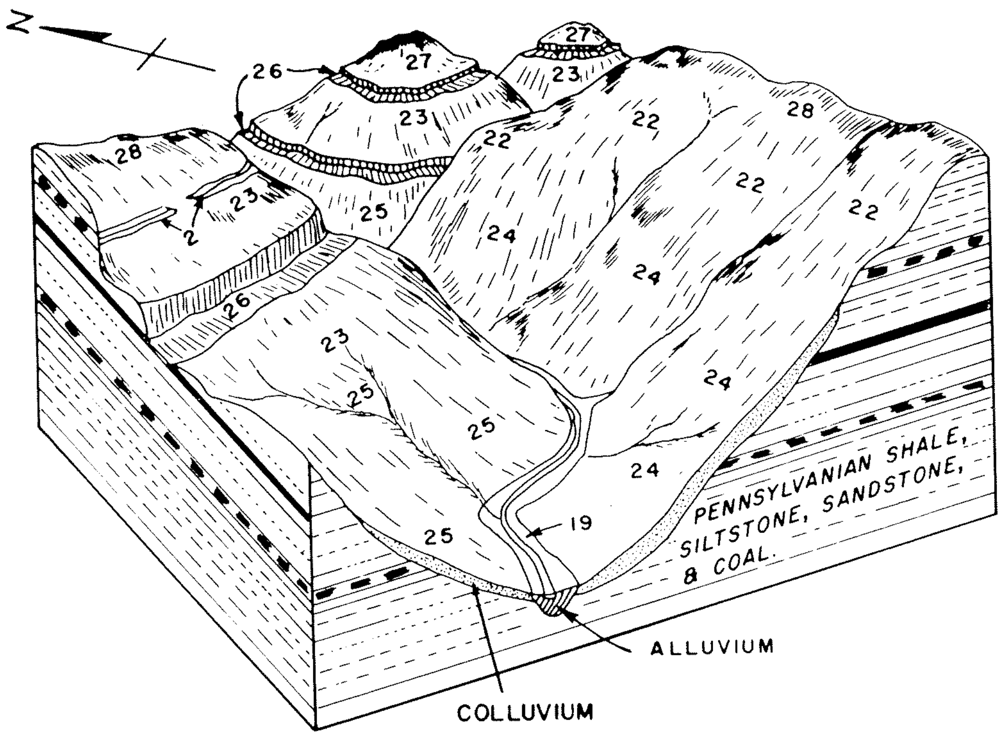

Figure 5.—*Landtypes characteristic of Landtype Association E (Middlesboro syncline) and G (Wartburg Basin-Jellico Mountains) in Subregion 2. Adapted from figure 1 in Knight (1979).*

LEGEND

2. Shallow soils and sandstone outcrops.
19. Mountain footslopes, fans, terraces, and streambottoms with good drainage.
22. Upper mountain slopes-north aspect.
23. Upper mountain slopes-south aspect.
24. Colluvial mountain slopes, benches, and coves-north aspect.
25. Colluvial mountain slopes, benches, and coves-south aspect.
26. Surface mines.
27. Narrow shale ridges, points, and convex upper slopes.
28. Broad shale ridges and convex upper slopes.

depict how these landtypes occur on the landscape in LTA's-B, E, F, and G.

Letters in the upper right corner of each landtype description (See "Landtype Descriptions and Forest Management Interpretations") identify the landtype association(s) in which each landtype occurs. Aspect distinguishes some landtypes and is recorded as either north or south. North aspects include all azimuths from 315" (northwest) to 135" (southeast). The remainder of the azimuth circle represents south aspects.

Each landtype is described in terms of nine elements in "Landtype Descriptions and Forest Management Interpretations." The **Geographic Setting** provides an overall description of the landtype, specifying both where it occurs on the landscape and its relation to other landtypes. Slope was classified in accordance with SCS standards (Soil Survey Staff 1951).

Slope Classes and Corresponding Percent of Slope

Slope percent	Class
o - 2	Level or nearly level
2 - 6	Gently sloping
6 - 10	Sloping
10 – 15	Strongly sloping
15-25	Moderately steep
25-45	Steep
45 +	Very steep

The most prevalent soil series are listed under **Dominant Soils.** The series link this site classification system with county soil surveys published by SCS. Users who wish more detailed information can refer to the published surveys or to soil series descriptions issued by SCS.

The kind of **Bedrock** or **Soil Parent Material** and **Depth to Bedrock** are listed next. **Soil Texture** is described in terms of the 12 conventional classes, which are based on percentages of sand, silt, and clay (Soil Survey Staff 1951).

The conventional seven **Soil Drainage** classes are: *very poorly drained, poorly drained somewhat poorly drained, moderately well-drained well-drained, somewhat excessively drained* and *excessively drained* (Soil Survey Staff 1951). **Relative Soil Water Supply** of each landtype is rated in five classes: very *low, low, medium, high,* and *very high.* This qualitative rating is based on the available water-holding capacity of the dominant soils (a function of soil texture and thickness), but allowances are made for the influence of soil drainage, topographic position, and aspect.

Soil Fertility is described as: *very low, low, moderately low, moderate, moderately high, high,* or very *high.* Most soils are fairly acid and formed in parent material with few weatherable minerals. Consequently, the most fertile soils of the Cumberland Mountain region are rated only moderate, except those along mountain streams and the Cumberland River, which are rated moderately high to high.

The most common woody species in the overstory are listed under **Vegetation** in approximate order of abundance. Important understory species are listed also, including some distinctive herbaceous groups. Although not listed, reproduction of overstory species is usually present in the understory. Loblolly pine is native only in northern Alabama and southern Tennessee but has been planted north of its range on converted sites and abandoned fields. Species nomenclature follows Little (1979) and Fernald (1950).

FOREST MANAGEMENT INTERPRETATIONS

Each landtype is evaluated in terms of productivity for selected species of trees and species desirability for timber production (tables 5 – 34). Also, each landtype is rated for five soil-related problems that may affect forest management operations.

Productivity

Productivity of commercially valuable species is expressed as site index and as average annual growth in cubic feet per acre. Site index is the total height attained by dominant and codominant trees at some specified age.

For all naturally occurring species, site indices are the means of values from soil survey interpretations for dominant soils in each landtype. Interpretations are issued by SCS as part of each soil series description. SCS personnel obtained height and age measurements in well-stocked, even-aged, essentially unmanaged stands that had not been damaged excessively by fire, insects, disease, or grazing. These stands were located on soils representing, as nearly as possible. the modal concept of each soil series. SCS personnel then used published site index curves (Beck 1962. Broadfoot and Krinard 1959, Curtis and Post 1962. Defler 1937, Nelson and others 1961, Schnur 1937. Tennessee Valley Authority 1948[4], and U.S. Forest Service 1929) to convert height and age data to site indices. Curves for all species were based on age 50 years. Sometimes, when site indices were available for one species, estimates for other species were made by using Doolittle's (1958) site index comparisons. When necessary, I adjusted these SCS site index values for aspect and slope position based on experience and soil-site research (Carmean 1975).

[4] Site index curves for eastern redcedar based on data from 271 plots throughout the Tennessee River Valley.

In a few cases when no values were available, site indices of important species were estimated; where they occur in tables 5 – 34, these estimated values are enclosed in parentheses.

Average annual growth expressed in cubic feet per acre was calculated from available yield tables (McCarthy 1933, Nelson and others 1961, Schnur 1937, U.S. Forest Service 1929, and Winters and Osborne 1935). The yield tables represent either normal or fully stocked conditions. Annual growth rates for all naturally occurring species or forest types were averaged over 50 years.

Though our productivity data are the best available, all site curves and yield tables were developed either for geographic areas larger than but including the Cumberland Mountains or for areas that do not include the Cumberland Mountains.

Yields are not expressed in a common merchantability standard, so care should be exercised in comparing average annual yields of species both within and between landtypes. Footnotes to table 5, which apply to subsequent tables, specify the merchantability standards used.

Management Problems

Plant Competition rates the invasion of unwanted plants after openings are made in the canopy. Plant competition is *slight* if unwanted plants do not prevent adequate natural regeneration, interfere with early growth, or restrict normal development of planted or seeded seedlings. Competition is *moderate* if unwanted plants delay establishment and hinder the growth of regenerated seedlings or if they retard the eventual development of a fully stocked stand. Competition is *severe* if unwanted plants prevent adequate restocking without extensive site preparation or special maintenance practices. Competition ratings in tables 5 – 34 represent regional averages, and competition on a given landtype may vary as a result of past land use.

Seedling Mortality is the loss of artificially established tree seedlings as influenced by soils and topographic conditions, assuming that planting is done properly and plant competition is insignificant. Rating is *slight* if expected mortality is zero to 25 percent, *moderate* if expected mortality is 26 to 50 percent, and *severe* if mortality is more than 50 percent. If the rating is moderate or severe, special preparation of the seedbed and special planting techniques are often necessary to insure a fully stocked stand.

Equipment Limitations are restrictions on the use of conventional wheeled or tracked equipment. Soil and topographic characteristics such as slope, drainage, texture, and rockiness influence equipment limitations, sometimes necessitating the use of different kinds of equipment and methods of operation or restricting the season when equipment is used. Generally, limitation is *slight* if slope is 20 percent or less and farm machinery can operate efficiently during all seasons. The rating is *moderate* if slope 20 to 30 percent, limiting the use of ordinary farm machinery and requiring track-type equipment, or if soil wetness prevents the use of logging vehicles for 2 to 6 months in a year. The rating *severe* if slope exceeds 30 percent, making track-type equipment inadequate and requiring power vehicles and other special equipment, or if wetness prevents use of vehicles for 6 months or more in a year.

Erosion Hazard is the degree of potential soil erosion that can occur during and after forest management operations that expose soil along roads, skid trails, fire lanes, and landing areas. The ratings assume that the forest is well-managed and protected from fire and grazing. Soil and topographic characteristics considered in rating hazard of erosion include slope, infiltration, permeability, water-holding capacity, and resistance to detachment of soil particles by rainfall and runoff. *Slight* indicates that no special measures are needed, *moderate* indicates that some attention needs to be given to erosion control, and *severe* indicates that intensive erosion-control measures are needed.

Windthrow Hazard measures how soils affect root development and how firmly soils hold trees. The hazard is *slight* if rooting depth is more than 20 in and trees withstand most winds, *moderate* if effective rooting depth is 10 to 20 in and some trees are blown down during excessive soil wetness and strong winds, and *severe* if effective rooting depth is 10 in or less and trees will not stand alone in strong winds.

Species Desirability

Three categories are used for rating **Species Desirability** of species that commonly occur on each landtype. *Most Desirable* species are those with potential for fast growth, high value, or both. *Acceptable* species are those with moderate growth rate or value. *Least Desirable* species are those with slow growth, poor quality, or both. These ratings represent the average situation for the region. The presence or absence of local markets could result in a species being assigned to another category.

USING THE SYSTEM

This guide will allow professional, foresters, forest landowners, landuse specialists, forest researchers, and other resource professionals to make on-site determinations of site productivity and will provide a site-dependent framework for forest management planning and forest research.

To make on-site determinations of productivity on a particular tract of land, the user must first determine the subregion and landtype association in which the particular tract of land occurs by referring to table 3 and fig. 2. Landtypes common to each landtype association are shown in table 4. Landtype descriptions and landscape drawings (figs. 3 – 5) will enable the user to identify specific landtypes. Information about productivity, severity of management problems, and species desirability are shown on pages facing the landtype descriptions (tables 5 – 34).

This site classification system provides a sound biological basis for forest management planning because it recognizes inherent site differences and soil-related hazards. When the system is adopted, landtypes become the basic unit of management. Continuous Forest Inventory or other forest inventory systems can easily be incorporated into this site classification system to obtain information on acreage, stocking, composition, and growth of forests by landtypes. Once productivity data are available for landtypes on a specific tract, they should be substituted for the regional values in the appropriate tables.

Users should be aware that productivity will vary within a landtype. This variation should be handled as a sampling problem dependent on the desired precision of the productivity information. To adequately sample some landtypes, users with existing inventory systems may be required to install new plots or points. Excessive variation in productivity within a landtype may indicate the need to divide that landtype into more homogeneous units.

A logical vehicle to transfer this site classification system into a valuable forest management tool is a landtype map (fig. 6), which can be used in all phases of management, from day-to-day activities to long-range planning. The number and scale of maps will depend on size of ownership and how intensively one wishes to manage. Landtypes can be mapped at scales of 1:10,000 to 1:60,000 and, at these scales, areas as small as 2 acres can be recognized on the larger scale maps. Smoothness of the terrain will determine maximum size. So the U.S. Geological Survey 7% minute quadrangle sheets (1:24,000) make excellent base maps on which to delineate landtypes. Black and white or color aerial photos, particularly stereo pairs, can also serve as base maps. A reasonable amount of ground checking should be part of the mapping process. Owners or managers of large tracts should explore the advantages of computer-generated mapping of landtypes and other physical and biological features of the landscape (Beeman 1978).

For forest researchers, this site classification system provides a basis for stratifying study areas. The system also aids in identifying and isolating problems that need to be researched. For example, it became apparent in compiling site index and growth information that little mensuration data specific to the region are available. Finally, the system provides researchers with a vehicle for quick transfer of research results to the practitioner. Study results can be reported on the basis of their applicability to specific landtypes.

An insight into multiple-use evaluations can be found in a paper by Trimble and others (1974) for the Central Appalachians, the northern extension of the Cumberland Plateau and Mountains. McComb (1982) has summarized the knowledge on integrating forestry and wildlife management in the central hardwood region. Vogel (1981) has provided comprehensive guidelines for revegetating minesoils.

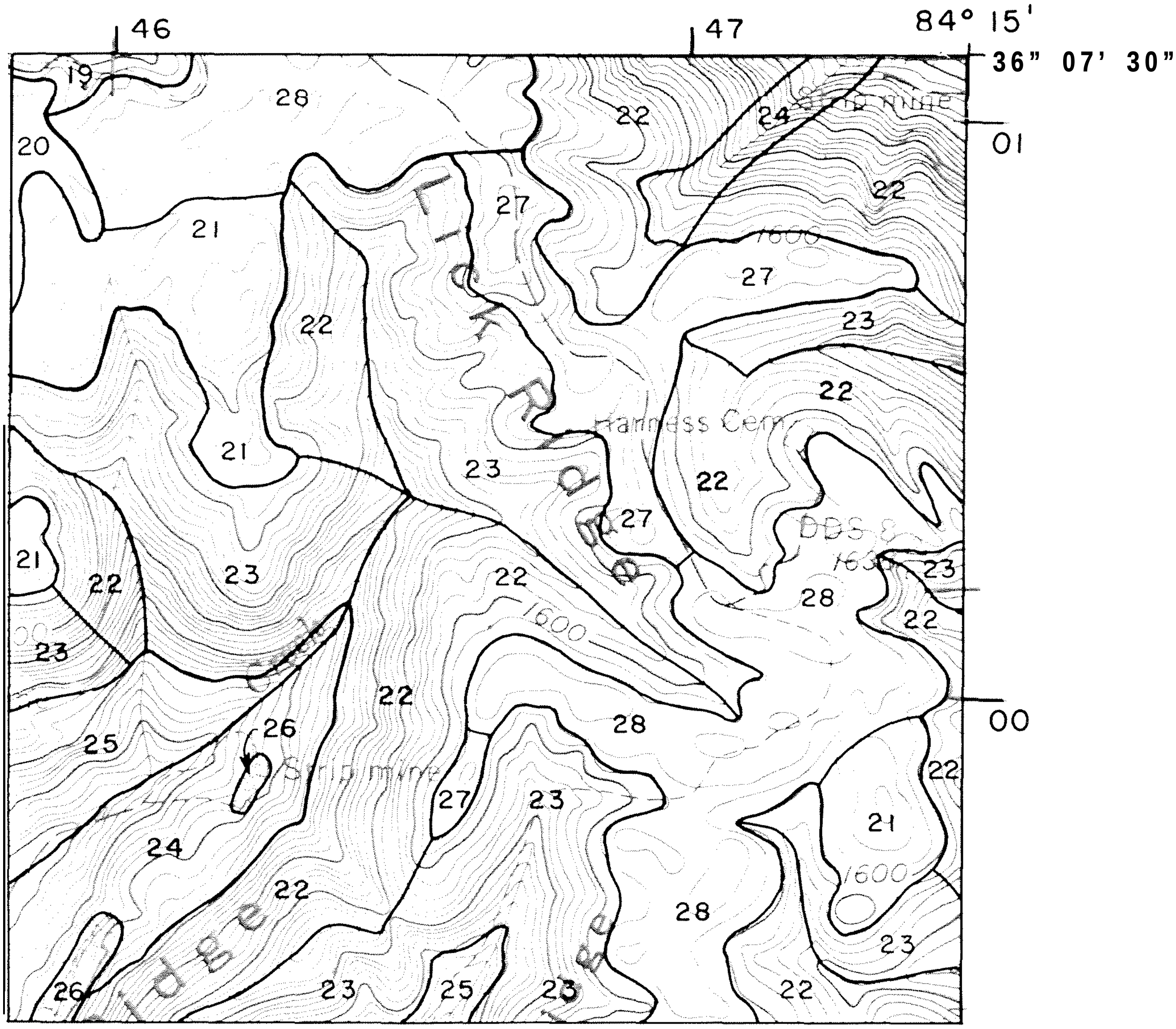

Figure 6.-A sample landtype map showing Landtype Association G (Wartburg Basin end Jellico Mountains) in Subregion 2. Map covers a tract of about 700 acres in the northeast corner of the northwest quarter of the Windrock Quadrangle, Anderson County, Tenn. Scale is 1:12,000. See table 4 for names of landtypes. Compare with Map 27, Anderson County Soil Survey (Moneymaker 1981)

LANDTYPE DESCRIPTIONS AND FOREST MANAGEMENT INTERPRETATIONS

Description of Landtype 1:
Narrow Sandstone Ridges and Convex Upper Slopes

Geographic Setting—Shallow to moderately deep soils on gently sloping to steep, straight to winding, narrow ridgetops and adjoining convex upper slopes in Subregions 1 and 2. Slope ranges from 5 to 40 percent. Typically, these ridgetops are less than 300 ft wide. Soils formed mostly in loamy residuum from horizontally bedded sandstone. Outcrops of sandstone and rock fragments on the surface are common and, in places, extensive enough to recognize Landtype 2 (shallow soils and sandstone outcrops). In LTA-A, Landtype 1 occupies the crests of the Walden Ridge, Fork Mountain, and Chestnut Ridge in association with Landtypes 3 and 4. Landtypes 5 and 6 occur below Landtype 1. In LTA-D, Landtype 1 occupies the main and spur ridges of Powell Mountain in association with Landtypes 3, 4, and 21. Landtypes 22 and 23 usually occupy the steep upper slopes below Landtype 1.

Dominant Soils-Ramsey, Alticrest, Wallen, and Steinsburg; possibly Lily, Muskingum, and Dekalb.

Bedrock-Nearly horizontal acid sandstone, conglomerate, and quartzite with thin strata of siltstone and shale in places.

Depth to Bedrock-7 to 40 in.

Texture-Loam, sandy loam, fine sandy loam; occasionally silty loam. Often gravelly, stony, or channery. Rock fragment content usually does not exceed 35 percent in the solum, except Wallen soils may have up to 70 percent rock fragments in the B horizon.

Soil Drainage- Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Low.

Soil Fertility-Low.

Vegetation-Chestnut oak, scarlet oak, post oak, hickories, black oak, white oak, red maple, Virginia pine, and southern red oak; occasional shortleaf pine, blackjack oak, eastern white pine, eastern redcedar, and blackgum. Sassafras, sourwood, flowering dogwood, vacciniums, sumac, persimmon, Carolina buckthorn, mountain-laurel, and American holly are common understory species.

Table 5.—*Forest* ***management interpretations*** *for Landtype* ***1: Narrow sandstone*** *ridges* ***and*** *convex* ***upper slopes***

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
E. white pine	70	115
Shortleaf pine	60	102
Virginia pine	65	70
White oak	60	43

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight to moderate	Moderate to severe	Moderate to severe	Slight to severe	Moderate to severe

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
E. white pine	Hickories	E. redcedar
Shortleaf pine	Post oak	Blackjack oak
Virginia pine	Chestnut oak	Sassafras
Black oak	Scarlet oak	American holly
White oak		Red maple
S. red oak		Blackgum
		Flowering dogwood
		Sourwood
		Persimmon

[1] Site indices in tables 5 – 34 for each naturally occurring species, except those enclosed in parentheses, are the means of values from soil survey interpretations issued by SCS for the dominant soils in each landtype, but sometimes adjusted for aspect and slope position (Beck 1962, Broadfoot and Krinard 1959, Curtis and Post 1962, Defler 1937, Nelson and others 1961, Schnur 1937, and U.S. Forest Service 1929). Estimated site indices are enclosed in parentheses. Base age is 50 years for all naturally grown species.

[2] Annual growth of natural stands calculated from published yields at 50 years: Shortleaf pine (U.S. Forest Service 1929, table 108), total volume outside-bark, trees > 3.5-in d.b.h.; Virginia pine (Nelson and others 1961, table 4), outside-bark volume to a 4.0-in o.b. top, trees >3.5-in d.b.h.; Upland oaks (Schnur 1937, table 2, column 12), outside-bark volume 4.0-in o.b. top, trees >4.5-in d.b.h.; Yellow-poplar (McCarthy 1933, table 17), inside-bark volume to 3.0-in i.b. top, trees > 4.5in d.b.h.; Sweetgum (Winters and Osborne 1935, table 13), inside-bark volume to a 4.0-in i.b. top, trees > 4.5in d.b.h.

Description of Landtype 2: Shallow Soils and Sandstone Outcrops

Geographic Setting-Small to moderately large areas of exposed sandstone, conglomerate, and quartzite and shallow to moderately deep, loamy soils formed in residuum from these same rocks in Subregions 1 and 2. Slope ranges from 8 to 70 percent,. The area of exposed rock varies from a few square feet to several acres mostly in narrow strips. Slope of the rock is nearly level in LTA's A, D, E, F, and G, but is tilted, sometimes near vertical, in LTA's B and C. Landtype 2 occurs on nearly level to moderately steep ridgetops, slopes, and edges of Walden Ridge, Fork Mountain, and Chestnut Ridge (LTA-A) above the nearly vertical sandstone free face in association with Landtypes 1, 3, and 4. Landtype 2 occurs on hilly to very steep crests and spur ridges of Pine, Cumberland, Stone, and Powell Mountains (LTA's B, C, and D) in association with Landtypes 1, 3, 4, 10, 11, 13, 15, and 17. Landtype 2 represents the thin to moderately thick sandstone free faces that occur intermittently on steep mountain slopes in LTA's E, F, and G in association with Landtypes 22-25, Landtype 2 also occurs extensively along deeply incised streams and creeks throughout Subregion 2.

Dominant Soils-Ramsey and sandstone outcrops; possibly Wallen, Alticrest, Dekalb, and Steinsburg.

Bedrock-Sandstone, conglomerate, and quartzite.

Depth to Bedrock—Usually less than 20 in, but occasionally ranges up to 40 in in places.

Texture-Loam, sandy loam, and fine sandy loam; often stony. Rock fragment content is usually less than 35 percent, but is more in places. Amount and size of fragments usually increase with depth.

Soil Drainage-Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Very low. Seepage above exposed rock is common in wet weather, but the soil dries quickly.

Soil Fertility-Very low.

Vegetation-Chestnut oak, white oak, post oak, blackjack oak, scarlet oak, southern red oak, and blackgum; occasional Virginia pine, shortleaf pine, pitch pine, hickories, red maple, and eastern redcedar. Sourwood, flowering dogwood, winged elm, mountain-laurel, vacciniums, lichens, mosses, grasses, and Carolina buckthorn are common understory species.

Table 6.-Forest management interpretations for Landtype 2: Shallow soils and sandstone outcrops

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf pine	50	79
Virginia pine	55	41
E. redcedar	30	
White oak	55	32

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight	Moderate to severe	Slight to severe	Slight to severe	Severe

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
Shortleaf pine	Pitch pine	Blackjack oak
Virginia pine	E. redcedar	Winged elm
	Hickories	Red maple
	White oak	Blackgum
	Post oak	Flowering dogwood
	Chestnut oak	Sourwood
	S. red oak	
	Scarlet oak	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 3: Broad Sandstone Ridges— North Aspect

Geographic Setting-Moderately deep, loamy soils on gently sloping to moderately steep north-facing portions of broad ridgetops and adjoining convex upper slopes in Subregions 1 and 2. This landtype extends from the ridge crest down to where the slope becomes linear or nearly so. At this point, gradient usually increases noticeably. Slope ranges from 6 to 20 percent and is dominantly greater than 10 percent. Soils formed in loamy residuum from sandstone or from interbedded sandstone, siltstone and shale. Rock fragments occur on the surface in places. Landtype 3 is associated with Landtype 1 in LTA's A, D, and F. In LTA-E, it occupies the ridgetops of lower mountains such as those northeast of Middlesboro, Ky. Landtype 3 also occurs in association with Landtype 21 in LTA's D, E, and F, and occasionally with Landtypes 27 and 28 in LTA's E and F. Landtype 3 lies above the sandstone free face in LTA-A and above Landtype 27 in LTA's D, E, and F. Landtype 3 may grade into Landtypes 19 or 20 in the heads of hollows in LTA's E and F.

Dominant Soils-Lily, Alticrest, Wallen, and Steinsburg; possibly Muskingum and Dekalb. Wallen soils are more common on south and west aspects.

Bedrock-Sandstone and conglomerate with thin strata of shale and siltstone in places.

Depth to Bedrock-20 to 40 in.

Texture-Loam, fine sandy loam, and sandy loam; occasionally silt loam and sometimes gravelly, stony, or flaggy. Volume of sandstone, and in places shale fragments, in the solum is usually less than 35 percent, but deeper horizons may contain more.

Soil Drainage- Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Medium.

Soil Fertility-Moderately low.

Vegetation-White oak, scarlet oak, southern red oak, chestnut oak, hickories, black oak, blackgum, red maple, shortleaf pine, Virginia pine, and eastern white pine; occasional yellow-poplar, northern red oak, black cherry, black locust, post oak, white ash, and eastern redcedar. Flowering dogwood, sassafras, serviceberry, sourwood, persimmon, sumac, viburnums, vacciniums, azaleas, smilax, and American holly are common understory species.

Table T.-Forest management interpretations for Landtype 3: Broad sandstone ridges-north aspect

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	75	126
Shortleaf pine	65	113
Virginia pine	65	120
N. red oak	70	52
Yellow-poplar	95	98

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate	Slight to moderate	Slight to moderate	Slight to moderate	Slight to moderate

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Hickories	E. redcedar
Shortleaf pine	White oak	Sassafras
Virginia pine	Post oak	Serviceberry
Yellow-poplar	Chestnut oak	Black locust
	N. red oak	American holly
	Black oak	Red maple
	S. red oak	Blackgum
	Scarlet oak	Flowering dogwood
	Black cherry	Sourwood
	White ash	Persimmon

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 4: Broad Sandstone Ridges— South Aspect

Geographic Setting-Moderately deep, loamy soils on gently sloping to moderately steep south-facing portions of broad ridgetops and adjoining convex upper slopes in Subregions 1 and 2. This landtype extends from the ridge crest down to where the slope becomes linear or nearly so. At this point, gradient usually increases noticeably. Slope ranges from 6 to 20 percent and is dominantly greater than 10 percent. Soils formed in loamy residuum from sandstone or from interbedded sandstone, siltstone, and shale. Rock fragments occur on the surface in places. Landtype 4 is associated with Landtype 1 in LTA's A, D, and F. In LTA-E, it occupies the ridgetops of lower mountains such as those northeast of Middlesboro, Ky. Landtype 4 also occurs in association with Landtype 21 in LTA's D, E, and F and occasionally with Landtypes 27 and 28 in LTA's E and F. Landtype 4 lies above the sandstone free face in LTA-A and above Landtype 23 in LTA's D, E, and F. Landtype 3 may grade into Landtype 19 or 20 in the heads of hollows in LTA's E and F.

Dominant Soils-Lily, Alticrest, Wallen, and Steinsburg; possibly Muskingum and Dekalb. Wallen soils are more common on south and west aspects.

Bedrock-Sandstone and conglomerate with thin strata of shale and siltstone in places.

Depth to Bedrock-20 to 40 in.

Texture-Loam, fine sandy loam, and sandy loam; occasionally silt loam and sometimes gravelly, stony, or flaggy. Volume of sandstone, and in places shale fragments, in the solum is usually less than 35 percent, but deeper horizons may contain more.

Soil Drainage- Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Medium to low.

Soil Fertility-Moderately low.

Vegetation-White oak, scarlet oak, chestnut oak, southern red oak, hickories, black oak, post oak, blackgum, red maple, Virginia pine, and shortleaf pine; occasional black locust, eastern redcedar, eastern white pine, and yellow-poplar. Dogwoods, sassafras, sourwood, persimmon, vacciniums, sumac, viburnums, serviceberry, mountain-laurel, and smilax are common understory species.

Table 8.—*Forest* ***management interpretations for*** *Landtype* ***4: Broad sandstone ridges-south*** *aspect*

PRODUCTIVITY		
Species	Site index'	Average annual growth* (ft³/acre)
E. white pine	70	115
Shortleaf pine	60	102
Virginia pine	60	53
N. red oak	65	48

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate	Slight to moderate	Slight to moderate	Slight	Slight to moderate

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
E. white pine	Hickories	E. redcedar
Shortleaf pine	White oak	Post oak
Virginia pine	Chestnut oak	Sassafras
	Black oak	Serviceberry
	S. red oak	Black locust
	Scarlet oak	Red maple
		Blackgum
		Dogwoods
		Sourwood
		Persimmon

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 5: Upper Sandstone Talus Slopes and Benches-North Aspect

Geographic Setting-Deep to very deep, loamy soils formed in colluvium from sandstone, siltstone, and shale and underlain by sandstone, siltstone, or shale in Subregion 1. Landtype 5 occupies the gently sloping to very steep upper one-third to one-half of the north-facing escarpment that extends from the free face to the adjacent valleys. Slope ranges from 5 to 70 percent, and much of the surface is covered with sandstone boulders and fragments. This landtype may be absent if the free face extends down to limestone. Landtype 5 is a mesic site and has high productivity.

Dominant Soils-Grimsley and Jefferson. Formerly mapped as sandstone rockland or bouldery colluvial land.

Bedrock-Sandstone, siltstone, and shale.

Depth to Bedrock-40 to 60 in or more.

Texture-Gravelly or cobbly loam, silt loam, sandy clay loam, or clay loam.

Soil Drainage-Well-drained.

Relative Soil Water Supply-Very high to high. Irrigated by subsurface flow and seepage.

Soil Fertility-Moderate to moderately low.

Vegetation-White oak, northern red oak, yellow-poplar, chestnut oak, sugar maple, hickories, American beech, black oak, white ash, white basswood, yellow buckeye, red maple, and black locust; occasional blackgum, elms, southern red oak, eastern hemlock, eastern white pine, chinkapin oak, black cherry, black walnut, and cucumbertree. Flowering dogwood, eastern redbud, bigleaf magnolia, spicebush, bladdernut, hydrangea, viburnums, azaleas, rhododendrons, sourwood, grape, and pawpaw are common understory species. This landtype also supports a rich herbaceous flora.

Table 9.—Forest management interpretations for Landtype 5: Upper sandstone talus slopes and benches-north aspect

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Black walnut	(90)	
White oak	75	57-62
N. red oak	80	
S. red oak	75	
Yellow-poplar	100	107
Black cherry	(90)	
White ash	(90)	

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate	Slight	Slight to severe	Slight to moderate	Slight

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
Black walnut	E. white pine	E. hemlock
White oak	Chinkapin oak	American beech
N. red oak	Black oak	E. redbud
Yellow-poplar	S. red oak	Black locust
Black cherry	Elms	Red maple
White ash	Cucumbertree	Blackgum
	Sugar maple	Flowering dogwood
	Yellow buckeye	Sourwood
	White basswood	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 6: Upper Sandstone Talus Slope and Benches-South Aspect

Geographic Setting-Deep to very deep, loamy soils formed in colluvium from sandstone, siltstone, and shale and underlain by sandstone, siltstone, or shale in Subregion 1. Landtype 6 occupies the gently sloping to very steep upper one-third to one-half of the south-facing escarpment that extends from the free face to the adjacent valleys. Slope ranges from 5 to 70 percent. Much of the surface is covered with sandstone boulders and fragments. This landtype may be absent if the free face extends down to limestone. Landtype 6 is not as productive as Landtype 5, and forests lack the preponderance of mesic species found on north aspects.

Dominant Soils-Grimsley and Jefferson. Formerly mapped as sandstone rockland or bouldery colluvial land.

Bedrock-Sandstone, siltstone, and shale.

Depth to Bedrock-40 to 60 in or more.

Texture-Gravelly or cobbly loam, silt loam, sandy clay loam, or clay loam.

Soil **Drainage-** Well-drained.

Relative Soil Water Supply-Medium to low. Irrigated by subsurface flow and seepage. This landtype is not as moist as Landtype 5.

Soil Fertility-Moderate to moderately low.

Vegetation-White oak, chestnut oak, northern red oak, hickories, black oak, red maple, yellow-poplar, and black locust; occasional blackgum, elms, eastern white pine, white ash, black cherry, black walnut, sugar maple, southern red oak, shortleaf pine, Virginia pine, and American beech. Flowering dogwood, viburnums, eastern redbud, sourwood, azaleas, and grape are common understory species.

Table 10.—*Forest* ***management interpretations for*** *Landtype* ***6: Upper sandstone talus slopes and benches-south aspect***

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf pine	65	113
Virginia pine	70	92
White oak	(65)	43-48 (White oak, N. red oak, S. red oak)
N. red oak	60	
S. red oak	(65)	

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment iimitations	Erosion hazard	Windthrow hazard
Slight	Moderate	Slight to severe	Slight to moderate	Slight

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
E. white pine	Black walnut	American beech
Shortleaf pine	Hickories	E. redbud
Virginia pine	Black locust	Red maple
White oak	N. red oak	Blackgum
Chestnut oak	Elms	Dogwood
Black oak	Yellow poplar	Sourwood
S. red oak	Black cherry	
	Sugar maple	
	White ash	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 7: Lower Limestone Slopes, Benches, and Spur Ridges-North Aspect

Geographic Setting-Moderately deep to very deep, loamy and clayey soils formed in colluvium from sandstone, siltstone, and shale and from limestone residuum and underlain by limestone in Subregion 1. Landtype 7 occupies the gently sloping to very steep lower one-half to two-thirds of the north-facing escarpment that extends from the free face to the adjacent valleys or the entire northern slopes of narrow spur ridges that extend into the adjacent valleys. Slope ranges from 2 to 75 percent. Sandstone boulders may be present, but up to 40 percent of the surface is covered with outcrops of limestone. Soil material between the rocks is compact, sticky, heavy clay. Coarse fragments in the soil vary from less than 10 percent to 65 percent. This landtype usually occurs downslope from Landtype 5 and is less productive than north upper talus slopes. Landtype 9 often occurs in association with Landtype 7 or below it on footslopes dominated by limestone outcrops. Where the free face has developed down to limestone, however, this landtype extends from the base of the escarpment down to the adjoining valleys.

Dominant Soils-Rouldin, Allen, Nella, and Talbott. Formerly mapped as limestone rockland or bouldery colluvial land.

Bedrock—Limestone.

Depth to Bedrock-Mostly 60 in or more but may be 20 to 40 in where Talbott soils occur.

Texture-Cobbly to stony loam, sandy loam, clay loam, and silt loam.

Soil Drainage- Well-drained.

Relative Soil Water Supply-Medium to low. Soil water percolates deep into the limestone.

Soil Fertility-Moderate to moderately low.

Vegetation-White oak, chestnut oak, northern red oak, black oak, hickories, eastern redcedar, scarlet oak, southern red oak, red maple, and yellow-poplar; occasional blackgum, sugar maple, eastern white pine, post oak, chinkapin oak, and elms. Flowering dogwood, eastern redbud, winged elm, viburnums, sumac, ironwood, and hawthorns common in the understory.

Table 11.-Forest management interpretations for Landtype 7: Lower limestone slopes, benches, and spur ridges-north aspect

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
White oak	70	43-52
N. red oak	70	
S. red oak	60	
Yellow-poplar	85	80

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight to moderate	Slight to moderate	Slight to severe	Slight to moderate	Slight to moderate

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
White oak	E. white pine	Ironwood
N. red oak	E. redcedar	Winged elm
Black oak	Hickories	E. redbud
S. red oak	Post oak	Red maple
Yellow-poplar	Chestnut oak	Blackgum
	Chinkapin oak	Flowering dogwood
	Scarlet oak	
	Elms	
	Sugar maple	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 8: Lower Limestone Slopes, Benches, and Spur Ridges-South Aspect

Geographic Setting-Moderately deep to very deep, loamy and clayey soils formed in colluvium from sandstone, siltstone, and shale and from limestone residuum and underlain by limestone in Subregion 1. Landtype 8 occupies the gently sloping to very steep lower one-half to two-thirds of the south-facing escarpment that extends from the free face to the adjacent valleys or the entire southern slopes of narrow spur ridges that extend into the adjacent valleys. Slope ranges from 2 to 75 percent. Sandstone boulders may be present, but up to 40 percent of the surface is covered with outcrops of limestone. Soil material between the rocks is compact, sticky, heavy clay. Coarse fragments in the soil vary from less than 10 percent to 65 percent. This landtype usually occurs downslope from Landtype 6. Landtype 9 often occurs in association with Landtype 8 or below it on footslopes dominated by limestone outcrops. Where the free face has developed down to limestone, however, this landtype may extend from the base of the escarpment down to the adjoining valleys.

Dominant Soils-Bouldin, Allen, Nella, and Talbott. Formerly mapped as limestone rockland or bouldery colluvial land.

Bedrock-Limestone.

Depth to Bedrock-Mostly 60 in or more but may be 20 to 40 in where Talbott soils occur.

Texture-Cobbly to stony loam, sandy loam, clay loam, and silt loam.

Soil Drainage-Well-drained.

Relative Soil Water Supply-Low to very low. Soil water percolates deep into the limestone.

Soil Fertility-Moderate to moderately low.

Vegetation-White oak, scarlet oak, chestnut oak, hickories, eastern redcedar, white ash, post oak, southern red oak, black oak, red maple, and elms; occasional blackgum, black locust, chinkapin oak, honeylocust, blue ash, American beech, Virginia pine, and shortleaf pine. Eastern redbud, flowering dogwood, winged elms, viburnums, ironwood, hawthorns, and sumac common in the understory.

Table 12.—*Forest* ***management interpretations for*** *Landtype* ***8: Lower limestone slopes, benches, and spur ridges-south aspect***

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
Shortleaf pine	55	90
Virginia pine	60	53
E. redcedar	45	
White oak	50	32-38
S. red oak	55	

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight	Moderate to severe	Moderate to severe	Slight to moderate	Slight to moderate

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
Shortleaf pine	E. redcedar	Ironwood
Virginia pine	Hickories	American beech
White oak	Post oak	Winged elm
S. red oak	Chestnut oak	E. redbud
White ash	Chinkapin oak	Honeylocust
	Black oak	Red maple
	Scarlet oak	Blackgum
	Elms	Flowering dogwood
	Black locust	
	Blue ash	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 9: Shallow Soils and Limestone Outcrops

Geographic Setting-Small to extensive areas of limestone outcrops interspersed with patches of shallow to moderately deep, clayey soils on gently sloping to steep slopes of strike ridges in Subregion 1. Slope ranges from 2 to 40 percent. The soil mass may contain up to 65 percent limestone slabs, and more than 50 percent of the surface may be exposed limestone. Where the exposed rock is extensive, it is often terraced, but the slope of each terrace is nearly horizontal. Eastern redcedar often dominates this landtype. In LTA-A, this intricate pattern of soil and rock outcrops occurs mostly between Landtypes 7 and 8 and the adjacent valleys, but it may occur intermingled with these landtypes. Also, Landtype 9 occurs intermittently, on the upper scarp slope (northwest) of Pine and Stone-Powell Mountains (Landtype 13) in LTA's B and D and on the lower scarp slope (southeast) of Cumberland-Stone Mountain (Landtype 18) in LTA-C.

Dominant Soils-Barfield, Gladeville, and limestone rockland. Pockets of moderately deep Talbott may occur in this landtype.

Bedrock-Limestone.

Depth to Bedrock-Mostly less than 20 in but ranges up to 40 in where Talbott soils occur.

Texture-Silty clay loam, silty clay, clay, and silt loam.

Soil Drainage- Well-drained to excessively drained.

Relative Soil Water Supply-Low seepage is common in wet weather, but the soil dries quickly.

Soil Fertility-Moderate.

Vegetation-Eastern redcedar, hickories, hackberry, white ash, and elms; occasional honeylocust, Virginia pine, blackjack oak, blue ash, black walnut, southern red oak, chinkapin oak, and osage-orange. Forbs, grasses, sumac, eastern redbud, winged elm, buckthorn, hawthorn, and pricklypear are common in the understory.

Table 13.—*Forest* ***management interpretations for*** *Landtype* ***9: Shallow soils and limestone outcrops***

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Virginia pine	(55)	41
E. redcedar	40	
Upland oaks	(55)	38

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight	Severe	Moderate to severe	Moderate-	Moderate to severe

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
Virginia pine	Hickories	Blackjack oak
E. redcedar	Chinkapin oak	Winged elm
Black walnut	Elms	Hackberry
S. red oak	White ash	Osage-orange
	Blue ash	E. redbud
		Honeylocust

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 10: Overthrust Ridge Crests and Spur Ridges on Back Slopes

Geographic Setting-Shallow to moderately deep, loamy soils on gently sloping to steep, narrow to moderately broad, nearly straight crests of Pine and Cumberland-Stone Mountains and spur ridges on backslopes (northwest side of Cumberland-Stone Mountain and southeast side of Pine Mountain) in Subregion 1. Slope ranges from 3 to 40 percent. Typically, these crests and spurs are less than 300 ft wide but may be wider in places. Soils formed in loamy residuum from tilted, sometimes nearly vertical, strata of sandstone, siltstone, and shale. Outcrops of sandstone and rock fragments on the surface are common and, in places, extensive enough to recognize Landtype 2. Landtype 10 is more extensive on Cumberland-Stone Mountain, where the crest is supported by fairly thick Pennsylvanian rocks. It is less common on Pine Mountain where Lower Pennsylvanian rocks are thin and the crest is supported mostly by Upper Mississippian strata. Landtype 10 occurs above Landtypes 11 and 15 on the back slopes of Pine and Cumberland-Stone Mountains, respectively, and above Landtypes 13 and 17 on the scarp slopes of Pine and Cumberland-Stone Mountains, respectively. Landtype 10 is a poor site because of topographic position, soil depth, and exposure to drying winds. No distinction is made at this time between cool and warm spur ridges.

Dominant Soils-Ramsey, Wallen, Alticrest, and Sieinsburg; possibly Lily, Muskingum and Dekalb.

Bedrock-Tilted sandstone and conglomerate with thin strata of siltstone and shale in places.

Depth to Bedrock-7 to 40 in.

Texture-Loam, sandy loam, fine sandy loam, and silt loam. Often gravelly or stony. Rock fragment content in the solum is usually less than 35 percent, but deeper horizons may contain as much as 70 percent.

Soil Drainage-Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Low.

Soil Fertility-Low.

Vegetation-Chestnut oak, white oak, scarlet oak, post oak, shortleaf pine, pitch pine, red maple, and hickories; occasional blackjack oak, blackgum, black oak, sourwood, Virginia pine, and eastern redcedar. Mountain-laurel, sumac, vacciniums, grasses, and forbs are common understory species.

Table 14.—*Forest management interpretations for Landtype 10: Overthrust ridge crests and spur ridges on back slopes*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
E. white pine	70	126
Shortleaf pine	60	102
Virginia pine	65	70
White oak	60	43

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight to moderate	Moderate to severe	Slight to severe	Slight to severe	Moderate to severe

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
Shortleaf pine	Pitch pine	Blackjack oak
Virginia pine	E. redcedar	Red maple
White oak	Hickories	Blackgum
	Chestnut oak	Sourwood
	Post oak	
	Scarlet oak	
	Black oak	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 11: Upper Back Slope (Southeast) of Pine Mountain

Geographic Setting-Shallow to moderately deep, loamy soils on the moderately steep to very steep, upper one-fourth to one-half of the back slope (southeast side) of Pine Mountain in Subregion 1. Pinnacles and outcrops of sandstone are common but not as common as on Cumberland-Stone Mountain (Landtype 15). The convex to linear slopes range from 15 to 70 percent. Soils formed in loamy residuum from tilted, in places nearly vertical, strata of sandstone, siltstone, and shale. In places, outcrops of sandstone and rock fragments on the surface may be extensive enough to recognize Landtype 2. Landtype 11 occurs below Landtype 10 and above Landtype 12. Landtype 11 is a relatively dry site because of topographic position, soil depth, and exposure.

Dominant Soils-Ramsey, Wallen, Alticrest, and Steinsburg; possibly Muskingum and Dekalb.

Bedrock-Tilted sandstone and conglomerate with thin strata of siltstone and shale.

Depth to Bedrock-7 to 40 in.

Texture-Loam, sandy loam, and fine sandy loam; often gravelly or stony. Rock fragment content in the solum is usually less than 35 percent, but deeper horizons contain more.

Soil Drainage-Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Low.

Soil Fertility-Low.

Vegetation-Chestnut oak, white oak, scarlet oak, post oak, shortleaf pine, Virginia pine, pitch pine, and hickories; occasional blackjack oak, blackgum, black oak, red maple, sourwood, eastern redcedar, and eastern white pine. Mountain-laurel, sumac, vacciniums, grasses, and forbs are common understory species.

Table 15.—*Forest management interpretations for Landtype* ***11: Upper back slope (southeast)*** *of* ***Pine Mountain***

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft³/acre)
E. white pine	70	126
Shortleaf pine	60	102
Virginia pine	65	70
White oak	60	43

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight	Moderate to severe	Moderate to severe	Moderate to severe	Moderate to severe

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Pitch pine	Blackjack oak
Shortleaf pine	E. redcedar	Red maple
Virginia pine	Hickories	Blackgum
White oak	Chestnut oak	Sourwood
	Post oak	
	Scarlet oak	
	Black oak	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 12: Lower Back Slope (Southeast) of Pine Mountain

Geographic Setting-Deep, loamy, cobbly soils on the sloping to steep, lower one-half to three-fourths of the back slope (southeast side) of Pine Mountain in Subregion 1. Outcrops and pinnacles of sandstone are common and often delineate the spur ridges from the slopes. The linear to concave slopes range from 10 to 60 percent. Soils formed in colluvium from acid sandstone, conglomerate, siltstone, and shale. Sandstone cobbles and boulders are common on the surface in lower slope concavities and in stream channels. Landtype 12 occurs below Landtypes 10 and 11. These colluvial slopes surround the coves incised in the back slope of Pine Mountain. Stream gradients are steep, and the slopes extend to the rock-strewn stream channels. These coves merge with mountain stream terraces and bottoms (Landtypes 19 and 20).

Dominant Soils-Jefferson, Grimsley, Shelocta, and Rigley. Formerly mapped as bouldery colluvial land.

Bedrock-Tilted sandstone and conglomerate with thin strata of siltstone and shale.

Depth to Bedrock-40 to 120 in.

Texture-Cobbly or gravelly loam, fine sandy loam, sandy loam, and possibly silt loam. Rock fragment content in the solum is usually less than 35 percent but may range to 80 percent in lower horizons.

Soil Drainage-Well-drained.

Relative Soil Water Supply-High to very high. Irrigated by subsurface flow and seepage.

Soil Fertility-Moderate to moderately low.

Vegetation-Eastern hemlock, American beech, yellow-poplar, red maple, and white oak; occasional white basswood, northern red oak, yellow birch, sweet birch, blackgum, cucumbertree, Fraser magnolia, hickories, and chestnut oak. Bigleaf magnolia, umbrella magnolia, sourwood, flowering dogwood, American holly, and rhododendron are common understory species.

Table 16.—*Forest* ***management interpretations for*** *Landtype* ***12: Lower back slope (southeast)*** *of Pine* ***Mountain***

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
E. white pine	80	172
Upland oaks	65-70	48-52
Yellow-poplar	90	90

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate	Slight to moderate	Moderate to severe	Moderate to severe	Slight

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
Hickories	E. hemlock	Magnolias
White oak	Yellow birch	American holly
Chestnut oak	Sweet birch	Red maple
N. red oak	American beech	Blackgum
Yellow-poplar	Cucumbertree	Flowering dogwood
	White basswood	Sourwood
		Rhododendron

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 13: Upper Scarp Slope (Northwest) of Pine and Stone-Powell Mountains

Geographic Setting-Shallow to moderately deep, clayey soils on moderately steep to very steep, upper one-fourth to one-half of the scarp slope (northwest side) of Pine and Stone-Powell Mountains in Subregion 1. Outcrops of limestone and sandstone ledges are common and, in places, may be extensive enough to recognize Landtype 9 or 2. The mostly linear slopes range from 30 to 65 percent. Soils formed in mostly clayey residuum from tilted limestone of the Mississippian Pennington Formation and, in places, tongues of sandstone of the Pennsylvanian Lee Formation. Landtype 13 occurs above Landtype 14 and below Landtype 10 or extends to the crest of Pine Mountain where the Lee Formation is thin or lacking and the Pennington Formation underlies the crest.

Dominant Soils-Talbott mesic variant and possibly Fairmount interspersed with limestone outcrops and sands tone ledges.

Bedrock-Tilted limestone with thin strata of shale and sandstone.

Depth to Bedrock-40 in or less.

Texture-Silt loam; occasional silty clay loam or silty clay. Rock fragment content is less than 35 percent in all horizons.

Soil Drainage- Well-drained.

Relative Soil Water Supply--Low to medium.

Soil Fertility-Moderate.

Vegetation-Sugar maple, white basswood, yellow-poplar, American beech, yellow buckeye, and white oak; occasional northern red oak, white ash, cucumbertree, hickories, red maple, black walnut, blackgum, chestnut oak, shortleaf pine, and Virginia pine. Flowering dogwood, sumac, viburnums, sassafras, eastern redbud, hydrangea, yellowwood, and eastern hophornbeam are common understory species.

Table 17.—*Forest management interpretations for Landtype 13: Upper scarp slope (northwest) of Pine and Stone-Powell Mountains*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf pine	65	113
Virginia pine	65	70
N. red oak	65	48
Yellow-poplar	90	90

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate	Moderate	Moderate to severe	Moderate to severe	Slight to moderate

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
Black walnut	Shortleaf pine	E. hophornbeam
White oak	Virginia pine	Sassafras
N. red oak	Hickories	E. redbud
Yellow-poplar	American beech	Yellowwood
Sugar maple	Chestnut oak	Sumac
White ash	Cucumbertree	Red maple
	Yellow buckeye	Blackgum
	White basswood	Flowering dogwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 14: Lower Scarp Slope (Northwest) of Pine and St&e-Powell Mountains

Geographic Setting-Moderately deep to deep, loamy and clayey soils on the gently sloping to steep, lower one-half to three-fourths of the scarp slope (northwest side) of Pine Mountain in Subregion 1. The linear to concave slopes range from 8 to 50 percent. Soils formed mostly in colluvium-some places in residuum-from tilted limestone and thin strata of siltstone, and sandstone. Landtype 14 occurs below Landtype 13 (upper scarp (northwest) slope of Pine Mountain). The boundary between these two Landtypes is usually a distinct reduction in slope gradient. Also included in Landtype 14 are minor spur ridges and benches. Drainages on the northwest side of Pine Mountain are poorly defined, and no landtype is recognized for these incipient coves. No distinction is made of the occasional warmer slopes flanking spur ridges. Landtype 14 is a cool, moist site because of topographic position, soil depth, and exposure.

Dominant Soils-Bouldin, Jefferson. and Grimsley; possibly Renox and Talbott. Formerly mapped as stony or bouldery colluvial land.

Bedrock-Tilted limestone with thin strata of shale and sandstone.

Depth to Bedrock-Mostly 60 in or more but 20 to 40 in where Talbott occurs.

Texture—Cobbly, stony, or gravelly loam and sandy loam; occasionally silt loam.

Soil Drainage- Well-drained.

Relative Soil Water Supply-Medium. Some soil water may percolate into fractures and bedding planes in the tilted bedrock.

Soil Fertility-Moderate to moderately low.

Vegetation-Sugar maple, white basswood, yellow buckeye, and yellow-poplar; occasional white ash, northern red oak, cucumbertree, American beech, hickories, white oak, black walnut, blackgum, red maple, and eastern hemlock. Sassafras, yellowwood, umbrella magnolia, rhododendron, flowering dogwood, and eastern hophornbeam are common understory species. Landtype supports a luxuriant herbaceous layer.

Table 18.—Forest management interpretations for Landtype 14: Lower scarp slope (northwest) of Pine and Stone-Powell Mountains

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
White oak	70	52
N. red oak	75	57
Yellow-poplar	100	107

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight to moderate	Slight to moderate	Moderate to severe	Slight to moderate	Slight

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
Black walnut	E. hemlock	E. hophornbeam
White oak	Hickories	Umbrella magnolia
N. red oak	American beech	Sassafras
Yellow-poplar	Cucumbertree	Yellowwood
Sugar maple	Yellow buckeye	Red maple
White ash	White basswood	Blackgum
		Flowering dogwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 15: Upper Back Slope (Northwest) of Cumberland-Stone Mountain

Geographic Setting-Shallow to moderately deep, loamy soils on the moderately steep to very steep, upper one-third to one-half of the back slope (northwest side) of Cumberland-Stone Mountain in Subregion 1. Pinnacles and outcrops of sandstone are common, more so than on Pine Mountain (Landtype 11). The convex to linear slopes range from 15 to 70 percent. Soils formed in loamy residuum from tilted, in places nearly vertical, strata of sandstone, siltstone, and shale. Outcrops of sandstone and rock fragments on the surface may be extensive enough to recognize Landtype 2. Landtype 15 occurs below Landtype 10 and above Landtype 16, and is a somewhat more mesic site than the comparable southeast-facing back slope on Pine Mountain (Landtype 11).

Dominant Soils-Ramsey, Wallen, Alticrest, and Steinsburg; possibly Muskingum and Dekalb.

Bedrock-Tilted sandstone and conglomerate with thin strata of siltstone and shale.

Depth to Bedrock-7 to 40 in.

Texture-Loam, sandy loam, and fine sandy loam; often gravelly or stony. Rock fragment content in the solum is usually less than 35 percent, but deeper horizons contain more.

Soil Drainage-Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Low.

Soil Fertility-Low.

Vegetation-Chestnut oak, white oak, scarlet oak, shortleaf pine, pitch pine, and hickories; occasional eastern white pine, black oak, post oak, Virginia pine, blackgum, northern red oak, red maple, yellow-poplar, and American beech. Flowering dogwood, sumac, vacciniums, sassafras, viburnums, grasses, and forbs are common understory species.

Table 19.—*Forest management interpretations for Landtype 15: Upper back slope (northwest) of Cumberland-Stone Mountain*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	(75)	126
Shortleaf pine	60	102
Virginia pine	65	70
Upland oaks	(60 - 65)	(43 - 48)
Yellow-poplar	(80)	71

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight to moderate	Moderate	Moderate to severe	Moderate to severe	Moderate to severe

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Pitch pine	Sassafras
Shortleaf pine	Hickories	Sumac
Virginia pine	American beech	Red maple
White oak	Post oak	Blackgum
N. red oak	Chestnut oak	Flowering dogwood
Yellow-poplar	Black oak	
	Scarlet oak	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 16:
Lower Back Slope (Northwest) of Cumberland-Stone Mountain

Geographic Setting-Deep, loamy, cobbly soils on the sloping to steep, lower one-half to two-thirds of the back slope (northwest side) of Cumberland-Stone Mountain in Subregion 1. Outcrops and pinnacles of sandstone are common and often delineate the spur ridges from the slopes. The linear to concave slopes range from 10 to 60 percent. Soils formed in colluvium from acid sandstone, conglomerate, siltstone, and shale. Sandstone cobbles and boulders are common on the surface, on lower slope concavities, and in stream channels. Landtype 16 occurs below Landtypes 10 and 15. These colluvial slopes surround the coves incised into the back slope of Cumberland-Stone Mountain. Stream gradients are steep, and the slopes extend to the rock-strewn stream channels. These coves merge with mountain stream terraces and bottoms (Landtypes 19 and 20). Landtype 16 is a cool, moist site; it is cooler and moister than its southeast-facing counterpart (Landtype 12) on Pine Mountain.

Dominant Soils-Jefferson, Grimsley, Shelocta, and Rigley. Formerly mapped as bouldery colluvial land.

Bedrock-Tilted sandstone and conglomerate with thin strata of siltstone and shale.

Depth to Bedrock-40 to 120 in.

Texture-Cobbly or gravelly loam, fine sandy loam, sandy loam, and possibly silt loam. Rock fragment content in the solum is usually less than 35 percent but may range to 80 percent in lower horizons.

Soil Drainage-Well-drained.

Relative Soil Water Supply-High to very high. Irrigated by subsurface flow and seepage.

Soil Fertility-Moderate to moderately low.

Vegetation-Eastern hemlock, American beech, yellow-poplar, red maple, and white oak; occasional white basswood, northern red oak, eastern white pine, yellow birch, sweet birch, blackgum, cucumbertree, Fraser magnolia, hickories, and chestnut oak. Bigleaf magnolia, umbrella magnolia, sourwood, flowering dogwood, American holly, and rhododendron are common understory species.

Table 20.—*Forest* ***management interpretations for*** *Landtype* ***16: Lower back slope (northwest)*** *of* ***Cumberland-Stone Mountain***

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	90	154
Upland oaks	70-75	52-57
Yellow-poplar	100	107

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate to severe	Slight	Moderate to severe	Moderate to severe	Slight

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
E. white pine	E. hemlock	Magnolias
Hickories	Yellow birch	American holly
White oak	Sweet birch	Red maple
N. red oak	American beech	Blackgum
Yellow-poplar	Chestnut oak	Flowering dogwood
	Cucumbertree	Sourwood
	White basswood	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 17: Upper Scarp Slope (Southeast) of Cumberland-Stone Mountain

Geographic Setting-Shallow to moderately deep, loamy soils on moderately steep to very steep, upper one-fourth to one-half of the scarp slope (southeast side) of Cumberland-Stone Mountain in Subregion 1. In places, prominent free faces have developed on resistant strata of sandstone and conglomerate. Boulders are common on the surface below the free faces. Outcrops may be extensive enough to recognize Landtype 2. The mostly linear slopes range from 30 to 65 percent. Soils formed in loamy residuum from tilted, in places nearly vertical, strata of sandstone, conglomerate, siltstone, and shale. Landtype 17 occurs below Landtype 10 and above Landtype 18.

Dominant Soils-Ramsey, Wallen, Alticrest, and. Steinsburg; possibly Muskingum and Dekalb.

Bedrock-Tilted sandstone and conglomerate with thin strata of siltstone and shale.

Depth to Bedrock-7 to 40 in.

Texture-Loam, sandy loam, and fine sandy loam; often gravelly or stony. Coarse fragment content in the solum is usually less than 35 percent, but deeper horizons contain more.

Soil Drainage-Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Low.

Soil Fertility-Low.

Vegetation-Chestnut oak, white oak, scarlet oak, post oak, shortleaf pine, pitch pine, and hickories; occasional blackjack oak, blackgum, black oak, red maple, sourwood, eastern redcedar, Virginia pine, and eastern white pine. Mountain-laurel, sumac, vacciniums, grasses, and forbs are common understory species.

Table 21.—*Forest management interpretations for Landtype 17: Upper scarp slope (southeast) of Cumberland-Stone Mountain*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	70	115
Shortleaf pine	60	102
Virginia pine	65	70
White oak	60	43

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight	Moderate to severe	Moderate to severe	Moderate to severe	Moderate to severe

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Pitch pine	Blackjack oak
Shortleaf pine	E. redcedar	Red maple
Virginia pine	Chestnut oak	Blackgum
White oak	Post oak	Sourwood
	Scarlet oak	
	Black oak	

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 18: Lower Scarp Slope (Southeast) of Cumberland-Stone Mountain

Geographic Setting-Moderately deep to deep, loamy and clayey soils on the gently sloping to steep, lower one-half to three-fourths of the scarp slope (southeast side) of Cumberland-Stone Mountain in Subregion 1. The linear to concave slopes range from 8 to 50 percent. Soils formed mostly in colluvium-in some places in residuum-from tilted limestone and thin strata of siltstone, and sandstone. Landtype **18** occurs below Landtype 17. The boundary between these two Landtypes is usually a distinct reduction in slope gradient. Also included in Landtype 18 are minor spur ridges and benches. Drainages on the southeast side of Cumberland-Stone Mountain are poorly defined, and no landtype is recognized for these incipient coves. Also, no distinction is made of the occasional cooler slopes flanking spur ridges. Landtype 18 is a much warmer site than its counterpart (Landtype 14) on Pine Mountain.

Dominant Soils-Bouldin, Jefferson, and Grimsley; possibly Allen, Nella, and Talbott. Formerly mapped as stony or bouldery colluvial land.

Bedrock-Tilted limestone with thin strata of shale and sandstone.

Depth to Bedrock-Mostly deeper than 4 ft but 20 to 40 in where Talbott occurs.

Texture-Cobbly, stony, or gravelly loam and sandy loam; occasionally silt loam.

Soil Drainage-Well-drained.

Relative Soil Water Supply-Medium. Some soil water may percolate into fractures and bedding planes in the tilted bedrock.

Soil Fertility-Moderate to moderately low.

Vegetation-Chestnut oak, black oak, white oak, hickories, shortleaf pine, and Virginia pine; occasional American beech, red maple, northern red oak, blackgum, eastern redcedar, black locust, southern red oak, yellow-poplar, eastern hemlock, black walnut, and sourwood. Flowering dogwood, sumac, Carolina buckthorn, American holly, and rhododendron are common understory species.

Table 22.-*Forest management interpretations for Landtype 18: Lower scarp slope (southeast) of Cumberland-Stone Mountain*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf pine	65	113
Virginia pine	70	92
E. redcedar	60	
White oak		
N. red oak	70	52
S. red oak		
Yellow-poplar	(85)	80

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate	Slight to moderate	Moderate to severe	Slight to moderate	Slight

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
Shortleaf pine	E. redcedar	Black locust
Virginia pine	E. hemlock	Sumac
Black walnut	Hickories	American holly
White oak	American beech	Red maple
N. red oak	Chestnut oak	Carolina buckthorn
Yellow-poplar	Black oak	Blackgum
	S. red oak	Flowering dogwood
		Sourwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 19: Mountain Footslopes, Fans, Terraces, and Streambottoms with Good Drainage

Geographic Setting-Deep, silty and loamy alluvial soils with good internal drainage on level to strongly sloping footslopes, fans, terraces, and streambottoms along mountain streams and creeks in Subregion 2. Slope ranges from 0 to 15 percent but is generally less than 6 percent. Landtypes 19 and 20 occur as long, narrow, winding, sometimes discontinuous strips of land bordering mountain drainages.

Dominant Soils-Whitley, Rowdy, Cotaco, Barbourville, and Combs on footslopes, fans, and terraces; Cuba, Steff, Clifty, Grigsby, Pope, Philo, Skidmore, Ealy, and Sewanee on streambottoms.

Parent Material-Alluvium, possibly colluvium, washed from soils formed in residuum from acid sandstone, siltstone, and shale.

Depth to Bedrock-40 in to 20 ft or more.

Texture-Loam, silt loam, fine sandy loam, and sandy loam; occasionally gravelly. Rock fragment content ranges from zero to 35 percent in the solum and to 60 percent in lower B and C horizons.

Relative Soil Water Supply-High. Irrigated by subsurface flow. Seeps occur on footslopes in winter and spring. Streambottoms have seasonal water tables at depths of 2 to 5 ft for 1 to 3 months. Landtype is subject to occasional flash floods following short, high intensitv and/or long, sustained rain storms.

Soil Fertility-Moderately high to high.

Vegetation-White oak, yellow-poplar, red maple, blackgum, sweetgum, and black oak; occasional northern red oak, American sycamore, scarlet oak, eastern white pine, eastern hemlock, shagbark hickory, shortleaf pine, Virginia pine, black willow, American elm, American beech, boxelder, black walnut, and river birch. Dogwoods, sassafras, sourwood, umbrella magnolia, American hornbeam, eastern hophornbeam, sumac, mountain-laurel, viburnums, azaleas, and cane are common understory species.

Table 23.—*Forest* ***management interpretations for*** *Landtype 19:* ***Mountain footslopes, fans, terraces, and streambottoms with good drainage***

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft³/acre)
E. white pine	90	154
Shortleaf pine	75	136
Virginia pine	75	120
White oak	75	57-62
N. red oak	80	
Yellow-poplar	100	107
Sweetgum	90	81
American sycamore	(90)	

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Severe	Slight	Slight to moderate	Slight	Slight

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Shagbark hickory	E. hemlock
Shortleaf pine	White oak	Black willow
Virginia pine	Black oak	River birch
Black walnut	Scarlet oak	American hornbeam
N. red oak	American elm	E. hophornbeam
Yellow-poplar		American beech
Sweetgum		Umbrella magnolia
American sycamore		Sassafras
		Red maple
		Boxelder
		Biackgum
		Dogwoods
		Sourwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 20: Mountain Terraces and Streambottoms with Poor Drainage

Geographic Setting-Deep, silty and loamy alluvial soils with poor internal drainage on level to gently sloping terraces and streambottoms along mountain streams and creeks in Subregion 2. Slope ranges from zero to 4 percent. Landtypes 19 and 20 occur as long, narrow, discontinuous strips of land bordering mountain streams.

Dominant Soils-Morehead on terraces; Stendal, Bonnie, Atkins, Stokly, and Bonair on streambottoms.

Parent Material-Alluvium washed from soils formed in residuum from acid sandstone, siltstone, and shale.

Depth to Bedrock-40 in to 10 ft or more.

Texture-Silt loam and silty clay loam; occasionally sandy loam, loam, and clay loam. Rock fragment content is 20 percent or less in the solum but ranges to 40 percent in lower B and C horizons.

Soil Drainage-Somewhat poorly drained to poorly drained.

Relative Soil Water Supply-High to very high. Water stands on the surface, or the water table is a foot or less below the surface for appreciable periods. This landtype is subject to occasional flash floods following short, high-intensity and/or long, sustained ram storms.

Soil Fertility-Moderately high to high.

Vegetation-Red maple, sweetgum, blackgum, yellow-poplar, white oak, American sycamore; occasional eastern cottonwood, pin oak, American elm, American beech, black willow, boxelder, and silver maple. Viburnums, azaleas, mountain-laurel, rhododendron, AMerican holly, cane, sphagnum moss, alder, dogwoods, grasses, and sedges are common in the understory.

Table ***24.-Forest management interpretations for Landtype 20: Mountain terraces and streambottoms with poor drainage***

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft³/acre)
E. cottonwood	105	
Pin oak	95	
Yellow-poplar	90	90
Sweetgum	90	81
American sycamore	(90)	

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate to severe	Moderate to severe	Severe	Slight	Slight

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. cottonwood	American elm	Black willow
White oak	Red maple	American beech
Pin oak	Boxelder	American holly
Yellow-poplar		Silver maple
Sweetgum		Blackgum
American sycamore		Dogwoods

See footnotes 1 and 2 to table 5, p. 23

Description of Landtype 21: Undulating Sandstone Mountain Uplands

Geographic Setting-Moderately deep to deep loamy and possibly silty soils on nearly level to rolling broad uplands that typically occupy the smother, but not necessarily the highest parts, of the landscape in Subregions 1 and 2. Landtype 21 is most common in LTA-F but occurs in LTA's D, E, and G on lower mountains or foothills rather than on high mountain crests. Slope does not exceed 15 percent, but the area with slope greater than 10 percent is small and aspect is not a dominant site factor. These broad ridges range up to 0.5 mi in width. Soils forrned in loamy residuum from acid sandstone, siltstone, and shale, and possibly in surficial deposits. Landtype 21 occurs in association with Landtypes 19, 20, 22, and 23.

Dominant Soils—Lily, Clarkrange, Lonewood, Crossville, 'I'ilsit, and Clymer.

Bedrock--Acid sandstone, conglomerate, siltstone, and shale.

Depth to Bedrock—20 to 90 in. Clarkrange and 'I'ilsit soils have fragipans at depths of 18 to 28 in.

Texture—Loam, fine sandy loam, sandy loam, and possibly silt loam. Rock fragment content is 10 percent or less in the solum, but deeper horizons may contain as much as 70 percent.

Soil Drainage—Well-drained except for Clarkrange and 'I'ilsit, which are moderately well-drained.

Relative Soil Water Supply—Medium.

Soil Fertility- Moderately low.

Vegetation---White oak, scarlet oak, chestnut oak, southern red oak, hickories, black oak, blackgum, red maple, shortlcaf pine, and Virginia pine; occasional yellow-poplar, eastern white pine, post oak, northern red oak, sweetgum, black locust, black cherry, and eastern redcedar. Flowering dogwood, sassafras, sourwood, serviceberry, persimmon, sumac, hawthorns, viburnums, azaleas, American holly, and stnilax are common understory species.

Table 25.—*Forest* ***management interpretations for*** *Landtype 21: Undulating* ***sandstone mountain uplands***

PRODUCTIVITY

Species	Site index	Average annual growth[a] (ft³/acre)
E. white pine	80	136
Shortleaf pine	65	113
Virginia pine	70	92
White oak	70	52 (White oak and N. red oak combined)
N. red oak	70	
Yellow-poplar	90	90

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight to moderate	Slight	Slight	Slight	Slight

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Hickories	E. redcedar
Shortleaf pine	Post oak	Sassafras
Virginia pine	Chestnut oak	Serviceberry
White oak	Black oak	Hawthorns
N. red oak	S. red oak	Black locust
Yellow-poplar	Scarlet oak	Sumac
Black cherry	Sweetgum	American holly
		Red maple
		Blackgum
		Flowering dogwood
		Sourwood
		Persimmon

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 22: Upper Mountain Slopes— North Aspect

Geographic Setting-Moderately deep, loamy and silty soils on the moderately steep to very steep upper one-fourth to one-third of north slopes in Subregions 1 and 2. Landtype 22 occurs over a wide range of elevations, from rugged high peaks, ridges, and foothills in LTA's D, E, and G to lower, less rugged mountains in LTA-F. These convex to linear slopes range from 16 to 75 percent in gradient. Soils formed in loamy residuum from acid siltstone, shale, and sandstone. Landtype 22 occurs below Landtypes 1, 3, and 21 in LTA-D and below Landtypes 21, 27, and 28 in LTA's E, F, and G. Landtype 22 occurs above Landtype 24, and the upper reaches of Landtype 19 may extend into Landtype 22. Areas of shallow soil and sandstone ledges may be extensive enough to recognize Landtype 2. Surface mines (Landtype 26) occur extensively in association with Landtype 22.

Dominant Soils-Muskingum, Gilpin, and Berks; possibly Dekalb and Steinsburg. Zenith and Cutshin occur at high elevation (above 2,500 ft) on slopes and in coves, particulariy in LTA's E and G. Often mapped as soil complexes.

Bedrock-Siltstone, shale, coal, and clay: possibly sandstone and conglomerate.

Depth to Bedrock-20 to 40 in. Zenith and Cutshin soils are 70 to 80 in to rock.

Texture-Silt loam, loam, fine sandy loam, and sandy loam; possibly sandy clay loam and clay loam. Rock fragment content is usually less than 35 percent in the solum but is more in Berks and Dekalb soils. Deeper horizons may contain as much as 75 percent rock fragments.

Soil Drainage-Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Medium to low.

Soil Fertility-Moderate to moderately low.

Vegetation-White oak, chestnut oak, yellow-poplar, northern red oak, black oak, red maple, and sugar maple; occasional black locust, white basswood, blackgum, Fraser magnolia, shortleaf pine, Virginia pine, hickories, eastern white pine, yellow buckeye, eastern hemlock, cucumbertree, black walnut, white ash, and sweet birch. Flowering dogwood, sassafras, sumac, eastern redbud, rhododendron, serviceberry, hydrangea, mountain-laurel, American holly, and grape are common understory species.

Table 26.-*Forest management interpretations for Landtype 22: Upper mountain slopes-north aspect*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	85	145
Shortleaf pine	80	148
Virginia pine	70	92
White oak	(75)	57
N. red oak	80	62
Black oak	70	52
Yellow-poplar	100	107

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate to severe	Slight to moderate	Moderate severe	Moderate to severe	Slight to moderate

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Hickories	E. hemlock
Shortleaf pine	Chestnut oak	Sweet birch
Virginia pine	Black oak	Fraser magnolia
Black walnut	Cucumbertree	Sassafras
White oak	Sugar maple	Serviceberry
N. red oak	Yellow buckeye	E. redbud
Yellow-poplar	White basswood	Black locust
White ash		Sumac
		American holly
		Red maple
		Flowering dogwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 23: Upper Mountain Slopes— South Aspect

Geographic Setting-Moderately deep, loamy and silty soils on the moderately steep to very steep upper one-third to one-half of south slopes in Subregions 1 and 2. Landtype 23 occurs over a wide range of elevations, from rugged high peaks, ridges, and foothills in LTA's D, E, and G to lower, less rugged mountains in LTA-F. These convex to linear slopes range from 16 to 75 percent in gradient. Soils formed in loamy residuum from acid siltstone, shale, and sandstone. Landtype 23 occurs below Landtypes 1, 4, and 21 in LTA-D and below Landtypes 21, 27, and 28 in LTA's E, F, and G. Landtype 23 occurs above Landtype 25, and the upper reaches of Landtype 19 may extend into Landtype 23. Areas of shallow soils and sandstone ledges may be extensive enough to recognize Landtype 2. Surface mines (Landtype 26) occur extensively in association with Landtype 23.

Dominant Soils-Muskingum, Gilpin, and Berks; possibly Dekalb and Steinsburg. Often mapped as soil complexes.

Bedrock-Siltstone, shale, coal, and clay; possibly sandstone and conglomerate.

Depth to Bedrock-20 to 40 in.

Texture-Silt loam, loam, fine sandy loam, and sandy loam. Rock fragment content is usually less than 35 percent in the solum but is more in Berks and Dekalb soils. Deeper horizons may contain as much as 75 percent rock fragments.

Soil Drainage-Well-drained to somewhat excessively drained.

Relative Soil Water Supply-Low.

Soil Fertility-Moderate to moderately low.

Vegetation-White oak, chestnut oak, scarlet oak, black oak, blackgum, red maple, shortleaf pine, and Virginia pine; occasional yellow-poplar, eastern white pine, northern red oak, hickories, black locust, sugar maple, white basswood, elms, yellow buckeye, cucumbertree, white ash, and magnolias. Flowering dogwood, sassafras, sourwood, serviceberry, sumac, hawthorns, viburnums, vacciniums, mountain-laurel, and grape are common understory species.

Table 27.—*Forest* ***management interpretations for*** *Landtype* ***23: Upper mountain slopes-south aspect***

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	75	126
Shortleaf pine	60	102
Virginia pine	60	53
N. red oak	65	48
Black oak	60	43
Yellow-poplar	(75)	63

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight	Moderate	Moderate to severe	Moderate to severe	Slight to moderate

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Hickories	Magnolias
Shortleaf pine	Chestnut oak	Sassafras
Virginia pine	Black oak	Serviceberry
White oak	Scarlet oak	Black locust
N. red oak	Elms	Sumac
Yellow-poplar	Cucumbertree	Red maple
White ash	Sugar maple	Blackgum
	Yellow buckeye	Flowering dogwood
	White basswood	Sourwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 24: Colluvial Mountain Slopes, Benches, and Coves-North Aspect

Geographic Setting-Deep, loamy, often gravelly, cobbly, or stony soils on the sloping to steep lower two-thirds to three-fourths of north slopes in Subregions 1 and 2. The linear to concave slopes range from 15 to 60 percent. Soils formed in loamy colluvium from acid siltstone, shale, and sandstone. Landtype 24 is more common in LTA's E and G than in LTA's D and F. Landtype 24 occurs below Landtype 22 and above Landtypes 19 and 20. Surface mines (Landtype 26) occur extensively in association with Landtype 24. In places, this landtype merges with major river bottoms (Landtypes 29 and 30).

Dominant Soils- Jefferson, Grimsley, Shelocta, and Rigley. Zenith and Cutshin occur at high elevations (above 2,500 ft) on slopes and in coves, particularly in LTA's E and G. Often mapped as soil complexes.

Bedrock-Siltstone, shale, coal, and clay; possibly sandstone and conglomerate.

Depth to Bedrock-40 to 120 in or more.

Texture-Loam, fine sandy loam, sandy loam, and silt loam; occasionally sandy clay loam and clay loam. Rock fragment content varies considerably with short distances. Boulders and cobbles are common on the surface, particularly in coves.

Soil Drainage-Well-drained.

Relative Soil Water Supply-Medium to high.

Soil Fertility-Moderate to moderately high.

Vegetation-Yellow-poplar, northern red oak, white oak, hickories, black oak, red maple, and American beech; occasional sugar maple, cucumbertree, yellow buckeye, eastern hemlock, eastern white pine, white ash, blackgum, white basswood, and black birch. Flowering dogwood, mountain-laurel, American hornbeam, vacciniums, grape, viburnums, hydrangea, alder, and smilax are common understory species.

Table 28.—*Forest* ***management interpretations for*** *Landtype* ***24:*** *Colluvial* ***mountain slopes, benches, and coves-north aspect***

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft³/acre)
E. white pine	85	145
Shortleaf pine	75	136
Virginia pine	75	120
White oak	75	57
N. red oak	80	62
Yellow-poplar	100	107

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate to severe	Slight to moderate	Moderate severe	Moderate to severe	Slight

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Hickories	E. hemlock
White oak	American beech	B. birch
N. red oak	Cucumbertree	American hornbeam
Black oak	Sugar maple	Serviceberry
Yellow-poplar	Yellow buckeye	Sumac
White ash	White basswood	Red maple
		Blackgum
		Flowering dogwood
		Sourwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 25: Colluvial Mountain Slopes, Benches, and Coves-South Aspect

Geographic Setting-Deep, loamy, often gravelly, cobbly, or stony soils on the sloping to steep lower one-half to two-thirds of south slopes in Subregions 1 and 2. The linear to concave slopes range from 15 to 60 percent. Soils formed in loamy colluvium from acid siltstone, shale, and sandstone. Lower parts of these slopes, particularly the coves, may be shaded by adjacent landmasses. Landtype 25 is more common in LTA's E and G than in LTA's D and F, and occurs below Landtype 23 and above Landtypes 19 and 20. Surface mines (Landtype 26) occur extensively in association with Landtype 25. In places, this landtype merges with major river bottoms (Landtypes 29 and 30).

Dominant Soils-Jefferson, Grimsley, Shelocta, and Rigley. Often mapped as complexes.

Bedrock-Siltstone, shale, coal, and clay; possibly sandstone and conglomerate.

Depth-to Bedrock-40 to 120 in or more.

Texture-Loam, fine sandy loam, sandy loam, and silt loam; occasionally sandy clay loam and clay loam. Rock fragment content varies considerably within short distances. Boulders and cobbles are common on the surface, particularly in coves.

Soil Drainage- Well-drained.

Relative Soil Water Supply-Medium.

Soil Fertility-Moderate to moderately high.

Vegetation-White oak, chestnut oak, scarlet oak, hickories, black oak, red maple, Virginia pine, and shortleaf pine; occasional northern red oak, yellow-poplar, sugar maple, black locust, eastern hemlock, American beech, blackgum, and white ash. Flowering dogwood, American hornbeam, sassafras, eastern redbud, grape, hydrangea, sumac, and American holly are common understory species.

Table 29.—*Forest management interpretations for Landtype 25: Colluvial mountain slopes, benches, and coves-south aspect*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
Shortleaf pine	65	113
Virginia pine	70	92
White oak, N. red oak	70	52
Yellow-poplar	(85)	80

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate	Moderate	Moderate to severe	Moderate to severe	Slight

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
Shortleaf pine	Hickories	E. hemlock
Virginia pine	American beech	American hornbeam
White oak	Chestnut oak	Sassafras
N. red oak	Black oak	E. redbud
Yellow-poplar	Scarlet oak	Black locust
White ash	Sugar maple	Sumac
		American holly
		Red maple
		Blackgum
		Flowering dogwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 26: Surface Mines

Geographic Setting-Nearly vertical high walls and young, loamy, rocky soils forming in heterogenous spoil resulting from area, contour, and auger types of surface mining for coal in Subregions 1 and 2. No distinction is made between unreclaimed (orphan) and reclaimed surface mines.

In contour mining (more common in LTA's E and G), the spoil is smoothed to form benches with steep to very steep outer slopes and to partially cover the high wall. Benches range from 70 to 150 ft or more in width, and the high walls are 60 ft or more in height. Contour mines occur at all elevations on mountain sides and tops. Nearly on the contour, they extend around the mountains in strips that range from a few hundred yards to several miles and encompass areas as large as 250 acres. Slopes are dominantly 12 to 20 percent on benches and 25 to 80 percent on outslopes. Ponds between the high wall and the spoil bank are common on orphan mines.

In area mining (more common in LTA's D and F), reclamation standards require restoration to approximate pre-mining topography. Area mining operations may cover several hundreds of acres. Slopes are usually less than 15 percent except in the vicinity of the final trench and in the heads of hollows at the margins of operations. Siltation ponds are now required on area mines.

Dominant Soils-F&point and Bethesda. Formerly mapped as minespoils and surface mines. Reaction of Fairpoint soils is neutral to medium acid; that of Bethesda soils is strongly acid to extremely acid.

Parent Material-**Formed in acid** to neutral regolith from surface mining and occasionally in refuse from deep mining. Rock fragments consist of siltstone, shale, coal, and fine- and medium-grained sandstone. Fine-earth material is partially weathered rock fragments.

Depth to Bedrock-50 in to 50 ft or more.

Texture-The A horizon of unreclaimed areas is shaly, channery, or gravelly clay loam, silty clay loam, or silt loam. Reclaimed areas have 4- to 12-in-thick A horizons from natural soil material with textures of silt loam, loam, silty clay loam, or clay loam. From 35 to 80 percent of C horizons are composed of rock fragments.

Soil Drainage-Well-drained.

Relative Soil Water Supply-Low to medium.

Soil Fertility-Low. Soil reaction ranges from neutral to extremely acid except for surface layers that have been limed. Toxicities and deficiencies of plant nutrients are common in strongly and extremely acid soils. Shrink-swell potential is moderate.

Vegetation-Reclaimed areas have been seeded to grasses and/or legumes. Plantings of black locust, shortleaf pine, Virginia pine, and eastern white pine are common on all sites, while yellow-poplar, green ash, American sycamore, and sweetgum have been planted on cool and/or moist to wet sites. Unreclaimed mine soils have slowly revegetated naturally, and species occurrence depends on age of the spoil. Common woody species are eastern redcedar, black locust, Virginia pine, shortleaf pine, winged elm, hickories, white oak, scarlet oak, blackgum, post oak, blackjack oak, chestnut oak, black oak, sweetgum, red maple, American sycamore, black willow, sumac, and sassafras. Consult Vogel's (1981) guide for specific recommendations for revegetating mine soils.

Table 30.-*Forest management interpretations for Landtype26: Surface mines*[1]

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight	Severe	Slight to severe	Severe	Slight

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
E. white pine	E. redcedar	Black willow
Shortleaf pine	Hickories	Blackjack oak
Virginia pine	White oak	Winged elm
Yellow-poplar	Post oak	Sassafras
Sweetgum	Chestnut oak	Sumac
American sycamore	Black oak	Blackgum
	Scarlet oak	
	Black locust	
	Red maple	
	Green ash	

[1] Data not available on productivity (species, site index, and average annual growth).

Description of Landtype 27: Narrow Shale Ridges, Points, and Convex Upper Slopes

Geographic Setting-Shallow to moderately deep, loamy and silty soils on sloping to very steep ridgetops, points of ridges, and adjoining convex upper slopes in Subregion 2. Typically, these shale ridges are less than 350 ft wide. Slope ranges from 6 to 80 percent and is usually more than 15 percent. Soils formed in loamy and silty residuum frorn shale, siltstone, and, in places, fine-g-rained sandstone, and shale fragments are common on the surface. Landtype 27 occurs extensively on mountain crests at varying elevations in association with Landtypes 22, 23, 26, and 28. Often Landtype 27 is disturbed or entirely removed during surface mining of coal if seam(s) are at relatively shallow depths.

Dominant Soils-Petros, Muskingum, Weikert, and Berks.

Bedrock-Shale, siltstone, coal, clay, and fine-g-rained sandstone.

Depth to Bedrock-10 to 40 in.

Texture-Silt loam, loam, and fine sandy loam; often shaly or channery. Rock fragment content exceeds 35 percent in the solum and may be as much as 85 percent in C horizons.

Soil Drainage-Excessively well-drained to well-drained.

Relative Soil Water Supply-Very low to low.

Soil Fertility-Low.

Vegetation-Chestnut oak, scarlet oak, black cak. shortleaf pine, and Virginia pine; occasional red maple, blackgum, black locust, southern red oak, northern red oak, pitch pine, blackjack oak, post oak, white oak, and hickories. Flowering dogwood, vacciniums, sumac, sassafras, sourwood, and mountain-laurel are common understory species.

Table 31.—*Forest management interpretations for Landtype 27: Narrow shale ridges, points, and convex upper slopes*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
Shortleaf pine	(55)	90
Virginia pine	55	41
Chestnut oak, Black oak, S. red oak	55	38
N. red oak	60	43

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight	Severe	Moderate to severe	Slight to moderate	Moderate to severe

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
Shortleaf pine	Pitch pine	Blackjack oak
Virginia pine	Hickories	Sassafras
White oak	Post oak	Black locust
Chestnut oak	S. red oak	Sumac
N. red oak	Scarlet oak	Red maple
Black oak		Blackgum
		Flowering dogwood
		Sourwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 28:
Broad Shale Ridges and Convex Upper Slopes

Geographic Setting-Moderately deep, silty and clayey soils on gently sloping to moderately steep rounded ridges and adjoining convex upper slopes in Subregion 2. Typically, these broad ridges are 1,000 ft or more wide. Slope ranges from 5 to 15 percent and aspect is not a dominant site factor. Soils formed in silty and clayey residuum from shale, siltstone and, in places, fine-grained sandstone. Landtype 28 occurs extensively on mountain crests at varying elevations in association with Landtypes 22, 23, 26, and 27 and is often disturbed by surface mining.

Dominant, Soils-Gilpin, Wernock, Sequoia, and Latham.

Bedrock-Shale, siltstone, coal, clay, and fine-grained sandstone.

Depth to Bedrock-20 to 40 in.

Texture-Silt loam, loamy, and silty clay loam; occasionally shaly or channery. Rock fragment content usually is less than 35 percent in the solum but may exceed 35 percent in the C horizon.

Soil Drainage-Well-drained to moderately well-drained.

Relative Soil Water Supply-Low to medium.

Soil Fertility-Moderately low.

Vegetation-Chestnut oak, scarlet **oak, black oak,** hickories, shortleaf pine, Virginia pine, white oak, and red maple; occasional northern red oak, sugar maple, yellow-poplar, eastern white pine, black locust, blackgum, elms, and Fraser magnolia. Vacciniums, flowering dogwood, sumac, sassafras, sourwood, and smilax are common understory species.

Table 32.—*Forest management interpretations for Landtype 28: Broad shale ridges and convex upper slopes*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf pine	65	113
Virginia pine	70	92
N. red oak	70	52
Yellow-poplar	75	63

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Slight to moderate	Slight	Slight to moderate	Slight	Slight

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Hickories	Fraser magnolia
Shortleaf pine	Chestnut oak	Sassafras
Virginia pine	Black oak	Black locust
White oak	Scarlet oak	Sumac
N. red oak	Elms	Red maple
Yellow-poplar	Sugar maple	Blackgum
		Flowering dogwood
		Sourwood

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 29: Footslopes, Terraces, and Flood Plains with Good Drainage

Geographic Setting-Deep, loamy and silty alluvial soils with good internal drainage on level to strongly sloping footslopes, terraces, and flood plains along the Cumberland River and its major tributaries-Clear Fork, Elk Creek, and Elk Valley -in Subregion 3. Slope ranges from zero to **15** percent but is dominantly less than 10 percent. This landtype occurs in association with Landtype 30, which has poor internal drainage.

Dominant Soils-Allegheny, Monongahela, Cotaco, Whitley, and Rowdy on terraces; Cuba, Steff, Clifty, Pope, Philo, Huntington, and Combs on flood plains.

Parent Material-On terraces, soils formed in old silty alluvium or loess underlain by old alluvium, while on flood plains, soils formed in more recent alluvium. Alluvium washed from soils formed in residuum weathered from acid sandstones, siltstones, shales, and perhaps loess.

Depth to Bedrock-33 to more than 10 ft. Monongahela soils have fragipan at depths ranging from 18 to 30 in.

Texture-Silt loam, loam, and fine sandy loam; occasionally sandy loam and silty clay loam. Solums usually contain less than 20 percent rock fragments. C horizons may contain more than 35 percent rock fragments.

Soil Drainage-Well-drained to moderately well-drained.

Relative Soil Water Supply-High. Low areas flood occasionally.

Soil Fertility-Moderately high to high.

Vegetation-White oak, sweetgum, yellow-poplar, blackgum, elms, red maple, northern red oak, river birch, and hickories; occasional American beech, black willow, pin oak, boxelder, black oak, American sycamore, black walnut, silver maple, white basswood, sourwood, eastern hemlock, Virginia pine, shortleaf pine, eastern white pine, persimmon, and sassafras. Dogwoods, eastern redbud, eastern hophornbeam, American hornbeam, cane, viburnums, American hazel, sumacs, and elderberry are common understory species.

Table 33.-*Forest management interpretations for Landtype 29: Footslopes, terraces, and flood plains with good drainage*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	85	145
Shortleaf pine	75	136
Virginia pine	75	120
N. red oak	80	62
Yellow-poplar	95	98
Sweetgum	90	81
Sycamore	(90)	

MANAGEMENT PROBLEMS

Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate to severe	Slight	Slight to moderate	Slight to moderate	Slight

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Hickories	E. hemlock
Shortleaf pine	American beech	River birch
Virginia pine	Black oak	American hornbeam
Black walnut	Elms	E. hophornbeam
White oak		Sassafras
N. red oak		American hazel
Pin oak		E. redbud
Yellow-poplar		Sumacs
Sweetgum		Red maple
American sycamore		Boxelder
White basswood		Blackgum
		Dogwoods
		Sourwood
		Persimmon

See footnotes 1 and 2 to table 5, p. 23.

Description of Landtype 30:
Terraces and Flood Plains with Poor Drainage

Geographic Setting-Deep, loamy and silty alluvial soils with poor internal drainage on level to gently sloping terraces and flood plains along the Cumberland River and its major tributaries-Clear Fork, Elk Creek, and Elk Valley-in Subregion 3. Slope is 3 percent or less. This landtype occurs in association with Landtype 29, which has good internal drainage.

Dominant Soils-Morehead on terraces; Bonnie, Stendal, Atkins, Stokly, and Newark on flood plains.

Parent Material-On terraces, soils formed in old silty alluvium or loess underlain by old alluvium, while on flood plains, soils formed in more recent alluvium. Alluvium washed from soils formed in residuum weathered from acid sandstones, siltstones, shales, and perhaps loess.

Depth to Bedrock-5 to 10 ft or more.

Texture-Silt loam, loam, and silty clay loam; occasionally sandy loam and fine sandy loam.

Soil Drainage-Somewhat poorly drained and poorly drained.

Relative Soil Water Supply-High to very high. A fluctuating water table is near the surface part of the time, and the landtype is subject to occasional flooding.

Soil Fertility-Moderately high to high.

Vegetation-Pine oak, sweetgum, red maple, green ash, elms, and blackgum; occasional American sycamore, silver maple, shagbark hickory, river birch, yellow-poplar, black willow, and boxelder. Dogwoods, cane, grasses, sedges, and alder are common in the understory.

Table 34.—*Forest management interpretations for Landtype 30: Terraces and flood plains with poor drainage*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft³/acre)
Yellow-poplar	90	90
Sweetgum	90	81
Pin oak	95	

MANAGEMENT PROBLEMS				
Plant competition	Seedling mortality	Equipment limitations	Erosion hazard	Windthrow hazard
Moderate to severe	Moderate to severe	Moderate to severe	Slight	Slight

SPECIES DESIRABILITY		
Most desirable	Acceptable	Least desirable
Pin oak	Hickories	Black willow
Yellow-poplar	Elms	River birch
Sweetgum	Red maple	Silver maple
American sycamore		Boxelder
Green ash		Blackgum
		Dogwoods

See footnotes 1 and 2 to table 5, p. 23.

LITERATURE CITED

Bailey, H. H.; Winsor, J. H. Kentucky soils. Misc. 308. Lexington, KY: University of Kentucky Agricultural Experiment Station; 1964. 174 p.

Beck, D. E. Yellow-poplar site index curves. Res. Note 180. Asheville, NC; U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1962. 2 p.

Beeman, L. E. Computer-assisted resource management. In: Proceedings, Workshop on Integrated Inventories of Renewable Natural Resources, 1978 Jan. 8 12; Tucson, AZ. Gen. Tech. Rep. RM-55. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest Experiment Station; 1978: 375 – 381.

Birdsey, R. A. Tennessee forest resources. Resour. Bull. SO-90. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1983.35 p.

Braun, E. I,. Deciduous forests of eastern North America. Philadelphia, PA: The Blakiston Co.; 1950.596 p.

Broadfoot, W. M.; Krinard, R. M. Guide for evaluating sweetgum sites. Occas. Pap. 176. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1959. 6 p.

Byrne, J. G.; Losche, C. K.; Gass, C. R.; Bottrell, G. D.; Avers, P. E.; Long, J. K.; Manhart, L. G. Soil survey of the McCreary-Whitley area, Kentucky. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service; 1970.83 p. + maps.

Cabrera, H. Patterns of species segregation as related to topographic form and aspect. Knoxville, TN: University of Tennessee; 1969. 111 p. M.S. thesis.

Carmean, W. H. Forest site quality evaluation in the United States. Advances in Agronomy 27: 209 269; 1975.

Colton, G. W. The Appalachian Basin-its depositional sequences and their geological relationships. In: Fisher, G. W.; Pettijohn, F. J.; Reed, J. C., Jr.; Weaver, K. N., eds. Studies of Appalachian geology, central and southern. New York: Interscience Publ.; 1970: 5 47.

Curtis, R. 0.; Post, B. W. Site index curves for even-aged northern hardwoods in the Green Mountains of Vermont. Bull. 629. Burlington, VT: U.S. Department of Agriculture, Forest Service, Vermont Agricultural Experiment Station; 1962.11 p.

Davis, D. D. Site quality evaluation for black cherry (*Prunus serotina* Ehrh.). University Park, PA: Pennsylvania State University; 1966. 77 p. M.S. thesis.

Defler, S. E. Black cherry: Characteristics, germination, growth, and yield. Syracuse, NY: New York State College of Forestry; 1937.129 p. M.F. thesis.

DeSelm, H. R.; Martin, W. H., III; Thor, E. The forest vegetation of Wilson Mountain, Tennessee. In: Pope, P. E., ed. Proceedings, 2d Central Hardwood Forest Conference, 1978 November 14 – 16; West Lafayette, IN: Purdue University; 1978: 23 – 28.

Dietrich, R. V. Geology and Virginia. Charlottesville, VA: University of Virginia Press; 1970.213 p.

Doolittle, W. T. Site index comparisons for several forest species in the southern Appalachians. Soil Science Society of America Proceedings; 1958; 22: 455 – 458.

Englund, K. J. Geology and coal resources of the Elk Valley area, Tennessee and Kentucky. Prof. Pap. 572. Washington, DC: U.S. Geological Survey; 1968.59 p.

Fenneman, N. M. Physiography of eastern United States. New York, NY: McGraw-Hill Book Co.; 1938.714 p.

Fernald, M. L. Gray's manual of botany. 8th ed. New York, NY: American Book Co.; 1950. 1,632 p.

Franzmeier, D. P.; Pederson, E. J.; Longwell, T. J.; Byrne, J. G.; Losche, C. K. Properties of some soils in the Cumberland Plateau as related to slope, aspect, and position. Soil Science Society of America Proceedings; 1969; 33:755 – 761.

Harris, L. D. Details of thin-skinned tectonics in parts of Valley and Ridge and Cumberland Plateau provinces of the southern Appalachians. In: Fisher. G. W.; Pettijohn, F. J.; Reed, J. C., Jr.; Weaver, K. N., eds. Studies of Appalachian geology, central and southern. New York, NY: Interscience Publ.; 1970: 161 – 178.

Hedlund, A.; Earles, J. W. Forest statistics for Tennessee counties. Resour. Bull. SO-32. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1971. 58 p.

Hinkle, C. R. A preliminary study of the flora and vegetation of Cumberland Gap National Historic Park, Middlesboro, KY. Knoxville, TN: University of Tennessee; 1975.236 p. M.S. thesis.

Kingsley, N. P.; Powell, D. S. The forest resources of Kentucky. Resour. Bull. NE-54. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1978. 97 p.

Knetsch, J. L.; Smallshaw, J. The occurrence of drought in the Tennessee Valley. Bull. T 58-2 AE. Knoxville, TN: Tennessee Valley Authority; 1958. 58 p.

Knight, H. A.; McClure, J. P. Virginia's timber, 1977. Resour. Bull. SE-44. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1978.53 p.

Knight, W. R. Relationship of soils and vegetation to topography and elevation in the Cumberland Mountains of Campbell County, Tennessee. Knoxville, TN: University of Tennessee; 1979. 152 p. M.S. thesis.

Lee, R.; Sypolt, C. R. Toward a biophysical evaluation of forest site potential. Forest Science 20: 145 – 154; 1974.

Lietzke, D. A.; Porter, H. C. Interpretative guide to the soils of southwest Virginia TVA counties: supplement to the soil surveys of Bland, Lee, Russell, Scott, Smyth, Tazewell, Washington, and Wise counties. Publ. 763. Blacksburg, VA: Extension Division, Virginia Polytechnic Institute and State University; 1978. 129 p.

Little, E. I,., Jr. Checklist of United States trees (native and naturalized). Agric. Handb. 541. Washington, DC: U.S. Department of Agriculture, Forest Service; 1979.375 p.

Luther, E. T. Our restless earth: the geologic regions of Tennessee. Knoxville, TN: University of Tennessee Press; 1977.94 p.

McCarthy, E. F. Yellow-poplar characteristics, growth, and management. Tech. Bull. No. 356. Washington, DC: U.S. Department of Agriculture; 1933.58 p.

McComb, W. C. Forestry and wildlife habitat management in central hardwoods. Journal of Forestry 80: 490 492; 1982.

McDonald, H. P.; Blevins, R. L. Reconnaissance soil survey of fourteen counties in eastern Kentucky. Soil Conserv. Serv. Series 1962, No. 1. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service; 1965. 72 p. + maps.

McDowell, R. C.; Grabowski, G. J., Jr.; Moore, S. L. Geologic map of Kentucky. Lexington, KY: U.S. Geological Survey in cooperation with Kentucky Geological Survey: 198 1. Scale 1:250,000.

McFarlan, A. C. Geology of Kentucky. Baltimore, MD: Waverly Press; 1943. 531 p.

Milici, R. C.; Spiker, C. T., Jr.; Wilson, J. M. (compilers). Geologic map of Virginia. Charlottesville, VA: Department of Conservation and Economic Development; 1963. Scale: 1:500,000.

Moneymaker, R. H. Soil survey of Anderson County, Tennessee. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service; 1981. 165 p. + maps.

Nelson, T. C.; Clutter, J. L.; Chaiken, L. E. Yield of Virginia pine. Stn. Pap. 124. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1961. 11 p.

Rodriguez, L. E. Evaluation of site quality of an upland hardwood forest at Scott County, Tennessee. Knoxville, TN: University of Tennessee; 1973. 114 p. M.S. thesis.

Schnur, G. L. Yield, stand, and volume tables for even-aged upland oak forests. Tech. Bull 560. Washington, DC: U.S. Department of Agriculture: 1937 (reprinted 1961). 87 p.

Smalley, G. W. Classification and evaluation of forest sites in the Interior Uplands. In: Pope, P. E., ed. Proceedings, 2d Central Hardwood Forest Conference, 1978 November 14 – 16; West Lafayette, IN: Purdue University; 1978: Addendum, 1 – 20.

Smalley, G. W. Classification and evaluation of forest sites for timber production: introduction of a new system for classifying forest sites based on the physical features of the landscape. In: Forest soils and site quality workshop; 1979 May 8 – 9; Auburn, AL: Auburn University; 1979a: 28 – 47.

Smalley, G. W. Classification and evaluation of forest sites on the southern Cumberland Plateau. Gen. Tech. Rep. SO-23. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1979b. 59 p.

Smalley, G. W. Classification and evaluation of forest sites on the western Highland Rim and Pennyroyal. Gen. Tech. Rep. SO-30. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1980. 120 p.

Smalley, G. W. Classification and evaluation of forest sites on the mid-Cumberland Plateau. Gen. Tech. Rep. SO-38. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1982. 58 p.

Smalley, G. W. Classification and evaluation of forest sites on the eastern Highland Rim and Pennyroyal. Gen. Tech. Rep. SO-43. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1983. 123 p.

Smith, M. 0.; Noger, M. C.; Smith, G. E. Some aspects of the stratigraphy of the Pine hlountain front near Elkhorn City, Kentucky with notes on pertinent structural features. Geological Society of Kentucky Annual Spring Field Conference. Lexington, KY: Geological Society of Kentucky in cooperation with Kentucky Geological Survey; 1967. 24 p.

Soil Conservation Service. General soil map, Kentucky. Lexington, KY: U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Kentucky Agricultural Experiment Station and Division of Conservation, Department of Natural Resources and Environmental Protection; 1975. Scale 1:950,000.

Soil Conservation Service. General soil map, Virginia. Richmond, VA: U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Virginia Polytechnic Institute and State University; 1979. Scale 1:750,000.

Soil Survey Staff. Soil survey manual. Agric. Handb. 18. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service; 195 1.503 p.

Soil Survey Staff. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. Agric. Handb. 436. Washington, DC: **U.S.**

Department of Agriculture, Soil Conservation Service; 1975.754 p.
Springer, M. E.; Elder, J. A. Soils of Tennessee. Agric. Exp. Bull. 596. Knoxville, TN: University of Tennessee Agricultural Experiment Station; 1980. 66 p. + maps.
Stearns, R. G.; Mitchum, R. M., Jr. Pennsylvanian rocks of southern Appalachians. Geol. Rep. Investig. No. 14. Nashville, TN: Tennessee Division of Geology; 1962. 26 p.
Swingle, G. D.; Miller, R. A.; Luther, E. T.; Hardeman, W. D.; Fullerton, D. S.; Sykes, C. R.; Garman, R. K. (compilers). Geology map of Tennessee, east-central sheet. Nashville, TN: Tennessee Division of Geology; 1966. Scale 1:250,000.
Tennessee Division of Geology. Sedimentation seminar, Mississippian and Pennsylvanian section on Interstate 75 south of Jellico, Campbell County, Tennessee. Geol. Rep. Investig. No. 38. Nashville, TN; 1981.42 p.
Thor, E.; DeSelm, H. R.; Martin, W. H. Natural reproduction on upland sites in the Cumberland Mountains of Tennessee. Journal of the Tennessee Academy of Science: 44: 96 100; 1969.
Thornthwaite, C. W. An approach toward a rational classification of climate. Geographical Review 38: 55 - 94; 1948.
Trimble, G. R., Jr.; Patric, J. H.; Gill, J. D.; Moeller, G. H.; Kochenderfer, J. N. Some options for managing forest land in the Central Appalachians. Gen. Tech. Rep. NE-12. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1974.42 p.
U.S. Department of Commerce. Climatological data, Virginia annual summary. 86:13. Asheville, NC: U.S. Department of Commerce; 1976a. 13 p.
U.S. Department of Commerce. Climatological data, Kentucky annual summary. 71: 13. Asheville, NC: U.S. Department of Commerce; 197613.14 p.
U.S. Forest Service. Volume, yield, and stand tables for second-growth southern pines. Misc. Pub. No. 50. Washington, DC; U.S. Department of Agriculture, Forest Service; 1929 (slightly revised 1976). 202 p.
Vogel, W. G. A guide for revegetating coal mine spoils in the eastern United States. Gen. Tech. Rep. NE-68. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1981.190 p.
Wertz, W. A.; Arnold, J. F. Land stratification for land-use planning. In: Bernier, B.; Wing-et, C. H., eds. Forest soils and forest land management. Quebec City, Quebec: Les Presses de l'Universite Laval; 1975: 617 729.
Wilson, C. W., Jr., Jewell, J. W.; Luther, E. T. Pennsylvanian geology of the Cumberland Plateau. Tennessee Division of Geology Folio. Nashville, TN: Tennessee Division of Geology; 1956. 2 1 p.
Wilson, C. W., Jr.; Stearns, R. G. Structure of the Cumberland Plateau, Tennessee. Tennessee Rep. Investig. No. 8. Nashville, TN: Tennessee Division of Geology; 1958. 15 p.
Winters, R. K.; Osborne, J. G. Growth and yield of second-growth redgum in fully stocked stands on alluvial lands in the South. Occas. Pap. 54. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1935. 12 p.

APPENDIX
COUNTY SOIL SURVEYS AVAILABLE FOR THE CUMBERLAND MOUNTAINS

*Byrne, J. G., C. K. Losche, C. R. Gass, G. D. Bottrell, P. E. Avers, J. K. Long, and L. G. Manhart. 1970. Soil survey of the McCreary-Whitley area, Kentucky. U.S. Dep. Agric. Soil Conserv. Serv. 83 p. + maps.

McDonald, H. P. and R. L. Blevins. 1965. Reconnaissance soil survey of fourteen counties in eastern Kentucky. U.S. Dep. Agric. Soil Conserv. Serv. Series 1962, No. 1. 72 p. + maps.

*Moneymaker, R. H. 1981. Soil survey of Anderson County, Tennessee. U.S. Dep. Agric. Soil Conserv. Serv. 165 p. + maps.

* Survey contains a section for woodland suitability.

METRIC EQUIVALENTS

1 inch = 2.54 centimeters (exactly)
1 foot = 0.3048 meter (exactly)
1 acre = 0.4047 hectare
1 square foot/acre = 0.2296 square meter/hectare
1 cubic foot/acre = 0.06997 cubic meter/hectare
1 mile = 1.6093 kilometers
1 square mile = 2.5900 square kilometers
°C = (°F-32)/1.8