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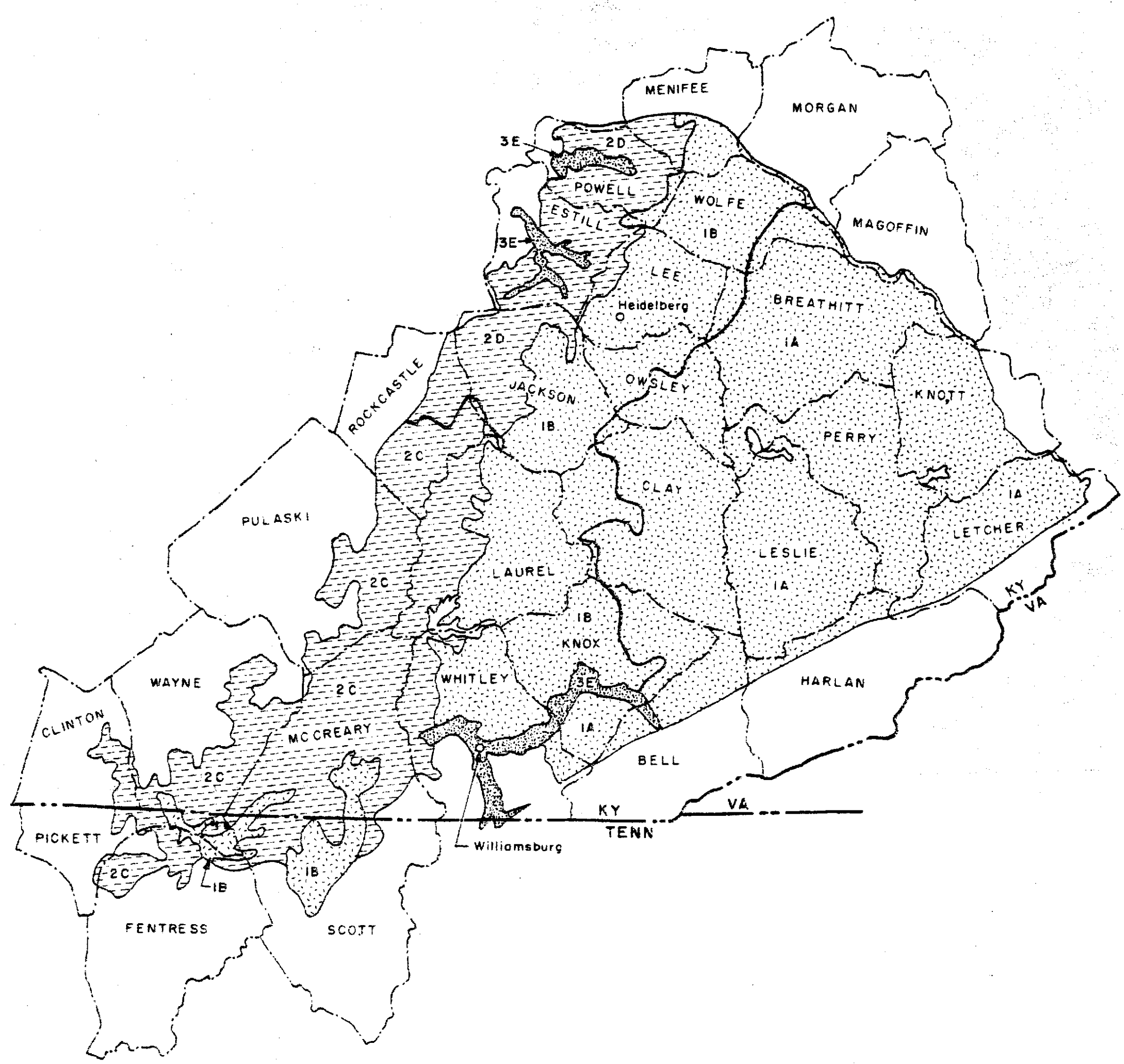
Classification and Evaluation of Forest Sites on the Northern Cumberland Plateau

Glendon W. Smalley



SUMMARY

This paper presents a comprehensive forest site classification system for the northern Cumberland Plateau in north central Tennessee and eastern Kentucky. The system is based on physiography, geology, soils, topography, and vegetation. Twenty-four 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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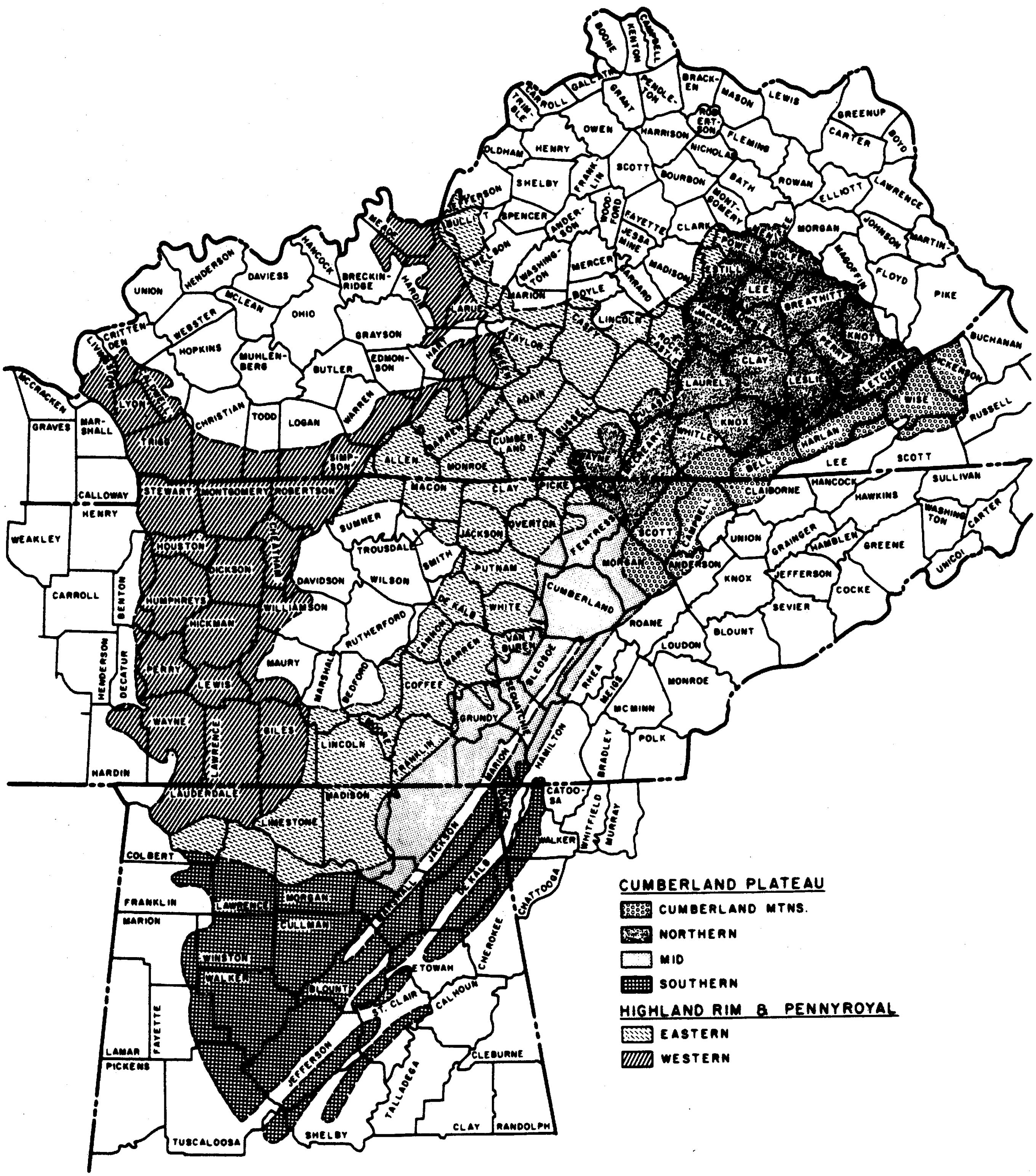

Figure 1.—*Physiographic provinces and regions of the Interior Uplands.*

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INTRODUCTION

This report classifies and evaluates forest sites on the Northern Cumberland Plateau (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 and information was extrapolated from adjacent regions. Extrapolation was particularly necessary with productivity data. All sources of data are documented, so the user can gauge 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 (SCS) in the Woodland Suitability sections of county soil surveys. This similarity should facilitate the integration of information contained in county soil surveys[1] into 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.

[1]See Appendix for available soil surveys.

The rationale and methodology of the system and status of reports appeared in the proceedings of the Second Central Hardwood Forest Conference (Smalley 1978), the Forest Soils and Site Quality Workshop (Smalley 1979a), and the 12th Annual Hardwood Symposium (Smalley 1984a). Site classification guides for the Southern Cumberland Plateau, the Western Highland Rim and Pennyroyal, the Mid-Cumberland Plateau, the Eastern Highland Rim and Pennyroyal, and the Cumberland Mountains regions have been published (Smalley 1979b, 1980, 1982, 1983, 1984b).

NORTHERN CUMBERLAND PLATEAU REGION

This region covers about 6,900 mi^2 in all or parts of three counties in Tennessee and 23 in Kentucky. It extends south to north from about north latitude 36°30′ to 37°55′ and east to west from about west longitude 82°35′ to 85°10′. The region extends from south of Oneida in Scott County, TN to the northern watershed boundary of the Kentucky River, including the Red River in Powell, Menifee, and Wolfe Counties, KY, a distance of about 120 mi (fig. 2). North of the Kentucky River watershed the Cumberland Plateau is called the Allegheny Plateau (Fenneman 1938).

Geographically, the Northern Cumberland Plateau consists of the southern two-thirds of the Mountains and Eastern Coalfield region in Kentucky (Bailey and Winsor 1964) plus parts of three northern counties in Tennessee. In Tennessee, it joins the Mid-Cumberland Plateau about on a line from Oneida to Jamestown in Fentress County (Smalley 1982). The Northern Plateau is bounded on the southeast by the Jellico Mountains and Pine Mountain of the Cumberland Mountain region (Smalley 1984b).

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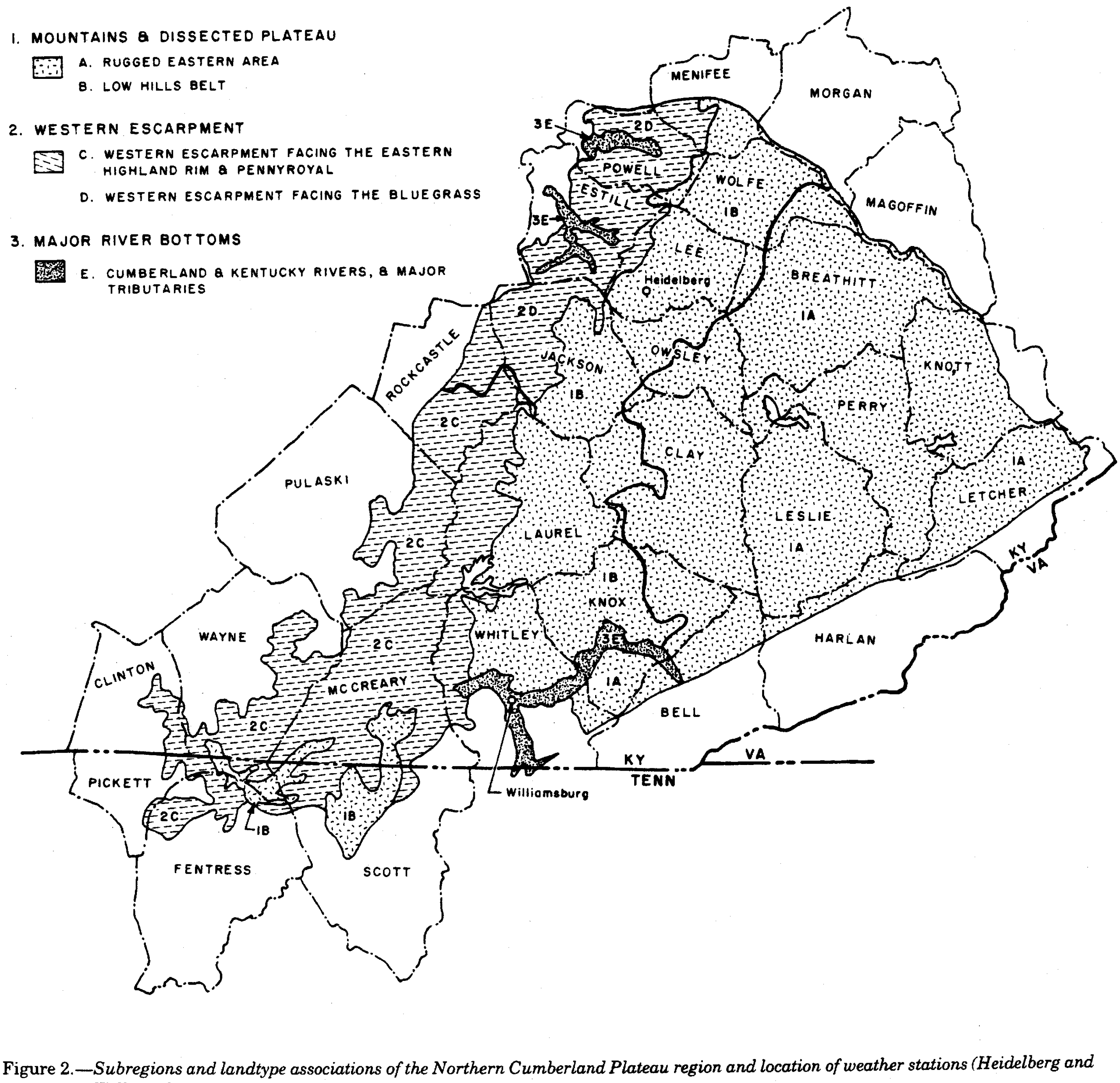

Figure 2.—*Subregions and landtype associations of the Northern Cumberland Plateau region and location of weather stations (Heidelberg and Williamsburg).*

The Northern Cumberland Plateau has three distinct sections. The largest section is the Rugged Eastern Area (Braun 1950, Bailey and Winsor 1964). It is also called the Mountain and Creekbottom Area by McFarlan (1943) and Bladen (1973). West of the Rugged Eastern Area is the Low Hills Belt (Braun 1950, Bailey and Winsor 1964). The section is called the Cumberland Plateau by Bladen (1973). The westernmost section is the Western Escarpment (Bailey and Winsor 1964). Braun (1950) called this area the Cliff Section, and McFarlan (1943) called it the Ridgetop and Limestone Valley Settlements Area.

The Western Escarpment has two distinct parts. South of the junction of the Muldraugh's Hill escarpment with the Western or Pottsville escarpment in Rockcastle County, KY, the Northern Cumberland Plateau faces the Eastern Highland Rim and Pennyroyal region (Smalley 1983). North of the junction, the Plateau faces the Kentucky Bluegrass region (Fenneman 1938, McFarlan 1943). The belt of conical hills known as the Knobs, between the Bluegrass region and the Western Escarpment of the Northern Cumberland Plateau, was included in the Eastern Highland Rim and Pennyroyal region (Smalley 1983).

Climate

The region has a temperature 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 are 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 sea level for two stations in Kentucky located in towns on the Cumberland and Kentucky Rivers (fig. 2). Consequently, the data do not indicate climatic conditions in narrow mountain valleys or on high ridges.

Mean temperature for the region is about 56°F. The date of last freeze is mid- to late April, and the date of first freeze is mid-October. The frost-free period ranges from 180 to 190 days but is probably 10 to 20 days shorter at higher elevations. The temperature often falls below freezing at night in December, January, and February. The upper 6 to 8 in of soils in narrow mountain valleys and on cool slopes may stay frozen much of the winter. Intermittent freezing and thawing occur on south- and west-facing slopes, mountain ridges, and broader ridges, and in hollows at lower elevations. Though air temperature does not appear to vary much across the region, local temperatures vary considerably because of relief, 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, and upper slopes and mountaintops are generally cold.

Southerly winds prevail from May to September and northerly winds from November to March. Average velocity ranges from 6 to 11 mph but probably exceeds 11 mph on the mountaintops. Severe winds are infrequent and most are associated with late spring and summer thundershowers.

Annual precipitation averages about 46 in and ordinarily is well distributed throughout the year. Seasonal precipitation is greatest in the winter and least in the fall, but the wettest month is July. Short periods of very wet or very dry weather are common. Thunderstorms that commonly occur from March through August are of short duration but often are accompanied by high-intensity rainfall. 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 the valleys and snow, sleet, or freezing rain on the mountaintops. Average annual snowfall is 10 to 16 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 to a week or more several times each growing season. Soil mois-

Table 1.—*Average monthly and annual precipitation (in inches) and elevation above mean sea level for two weather stations on the Northern Cumberland Plateau*[1]

Station and county	Years of record	Elevation (ft)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
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
Heidelberg Lock 14; Lee, KY	62	663	3.81	3.76	4.57	3.95	3.82	4.27	5.29	3.77	2.87	2.09	3.47	3.42	45.09

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

Table 2.—*Average monthly and annual temperature (°F) and length of warm period for two weather stations on the Northern Cumberland Plateau*[1]

Station and county	Years of record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Warm period days[2]
Williamsburg Whitley, KY	80	38	40	47	58	66	73	76	75	69	59	47	39	57	188
Heidelberg Lock 14; Lee, KY	44	36	38	48	57	65	72	76	74	68	58	46	38	56	178[3]

[1]U.S. Department of Commerce (1976).
[2]Mean period from last 32°F to first 32°F (U.S. Department of Agriculture 1941).
[3]Value for Beattyville, Lee County, KY.

ture stress is more common and severe on upper mountain slopes facing south and west, on shallow soils, and on sandy-textured soils.

Geology, Topography, and Soils

The Northern Cumberland Plateau is underlain mostly by Pennsylvanian sandstone, conglomerate, siltstone, shale, and coal belonging to the Crab Orchard and Crooked Fork groups in Tennessee (Swingle and others 1966) and the Lee and Breathitt formations in Kentucky (McDowell and others 1981). In Tennessee, the Rockcastle member of the Crab Orchard group is most extensive, while the Breathitt is most extensive in Kentucky. Generally, these sedimentary strata dip gently to the southeast but become nearly level in the Rugged Eastern area.

North of the junction with the Muldraugh's Hill escarpment in Rockcastle County, KY, the Western Escarpment lies east of the traditional margin of the Plateau. The Western Escarpment lacks the prominence of farther south because of the thinning of the Rockcastle sandstone and the pronounced southeasterly dip of strata away from the Cincinnati Arch centered under the Kentucky Bluegrass region (see Braun 1950, p. 89). Here the Western Escarpment is a transition zone consisting of narrow ridges and hills capped with Lower Pennsylvanian sandstone and underlain by mid- and upper Mississippian rocks.

South of the junction, the Western Escarpment is fairly thick, nearly continuous, and very ragged. Below the Rockcastle sandstone escarpment the scarp slope cuts across nearly horizontal strata of Mississippian limestone, dolomite, sandstone, and shale. In places, the slope is smooth, but in other places, the slope is interrupted with benches supported by more resistant Mississippian rocks.

Alluvial deposits of Quaternary age occur along the Cumberland, Kentucky, and Red Rivers and some of the major tributaries (McDowell and others 1981).

Regional topography ranges from gentle in parts of the Low Hills Belt to rugged and complex in the Rugged Eastern Area and the Western Escarpment. Slope varies from nearly level to very steep.

The maturely dissected Rugged Eastern Area is characterized by narrow winding ridgetops, steep sideslopes, and narrow winding valleys. Some of the roughest land in the Eastern United States is in the upper basin of the Kentucky River. Elevation gradually increases toward the southeast where some mountain crests near Pine Mountain are about 2,000 ft above mean sea level. Relief is 500 to 700 ft in the western part and increases to about 900 to 1,000 ft in the eastern part. There is little flat land except on a few broader ridges and in river and creek bottoms. Sideslopes are often benched, reflecting the presence of thin, more resistant layers of sandstone sandwiched between thick layers of shale.

The Low Hills Belt, characterized by submature dissection and undulating topography, is the smoothest part of the Northern Plateau. The belt, about 25 mi wide, extends from Whitley and Knox Counties northward to Wolfe County. Valleys vary in width and are moist, even swampy in places. Larger streams and rivers have cut moderately deep gorges in the Plateau surface that are rimmed with discontinuous sandstone cliffs. Slopes below the cliffs are steep and strewn with rocks. Relief is only 100 to 150 ft in the undulating parts but is 300 ft or more in the vicinity of gorges. Elevation ranges from 1,300 to 1,500 ft in the north and decreases gradually to 1,100 to 1,200 ft in the south.

The Western Escarpment Area is maturely dissected, more so in the northern part than in the southern part because of a more pronounced dip of the rocks and exposure of less resistant carbonate rocks farther north. The area is characterized by long, narrow to moderately broad ridgetops, steep sideslopes, and narrow to moderately broad valleys. Some gently rolling to rolling broad ridges occur in southern Kentucky and northern Tennessee. The average elevation of the Plateau surface is about 1,400 ft in the vicinity of the Kentucky and Red Rivers and rises to 1,800 to 2,000 ft in southern Kentucky and northern Tennessee. Relief averages 200 ft in the vicinity of small creeks and streams but increases to 600 to 800 ft near larger streams and rivers.

Streams are entrenched in steep-sided valleys whose walls are often capped with sandstone cliffs. Overhanging rock shelters and natural bridges are frequent. Rapids and waterfalls are typical in free-flowing creeks and streams. These features are well displayed in the Red River Gorge and along the South Fork of the Cumberland River.

The northern part of the Western Escarpment has long, narrow, convex ridgetops and long, narrow streambottoms that gradually widen westward. Sideslopes are divided by a nearly continuous limestone escarpment higher on the slope from east to west. Local relief is from 400 to 600 ft.

In the southern part, sideslopes are broken with nearly continuous sandstone cliffs, but limestone crops out on lower slopes and on convex spur ridges extending out into the Highland Rim and Pennyroyal.

The Northern Plateau is drained by the Cumberland and Kentucky River systems (McDowell and others 1981, Swingle and others 1966, Bladen 1973). The Cumberland River breaches Pine Mountain at Pineville, KY, in a narrow watergap at an elevation of about 1,000 ft, then turns northeastward and follows the backslope of Pine Mountain for nearly 60 mi (Smalley 1984b). Lake Cumberland, formed behind Wolfe Creek Dam, has a normal level of 723 ft and extends nearly to Cumberland Falls State Park and a short distance up the Rockcastle River. Laurel River Lake, west of Corbin, was built by the U.S. Army Corps of Engineers for flood control and recreation. South Fork, another tributary, originates on the Cumberland Plateau in northern Tennessee; it has been designated a Wild and Scenic River.

The Kentucky River used to be the only navigable river that crossed the Western Escarpment of the Plateau. Barge traffic was possible to Beattyville in Lee County, where the main river branched into three forks. In 1983, commercial use of the river was suspended upstream from Frankfort in Franklin County. The North Fork originates 168 mi upstream near the Virginia state line. The Middle Fork originates 97 mi upstream in Leslie County. Buckhorn Lake, on the Middle Fork west of Hazard, is a 1,200-acre manmade lake that furnishes flood control and recreation. The South Fork originates 75 mi upstream at the confluence of Goose Creek and the Red Bird River.

The Red River Gorge, in Menifee and Powell Counties, is a scenic geological area on the Daniel Boone National Forest. Westward, the Red River flows through the Knobs region in a moderately wide valley before joining the Kentucky River northeast of Richmond.

Most of these rivers and streams flow in deep, fairly narrow valleys on the Plateau, except in the uppermost reaches where stream profiles are broad V-shaped to U-shaped. Many towns, including several county seats, are located on the flood plains, with built-up areas extending up nearby slopes. Flooding of flood plains is frequent; extent and severity of damage increase downstream.

Soils have formed from material weathered from a variety of sedimentary rocks. Generally, these soils are pale, loamy to clayey, friable, and low in fertility, and vary in content of rock fragments. The more extensive soils are classified as loamy or clayey, mixed or siliceous, mesic Dystrochrepts and Hapludults. Some Hapludalfs occur in the northern part of the Western Escarpment. Soils forming in spoil material from surface mining of coal are classified as Udorthents.

In the Rugged Eastern Area, soils on upper mountain slopes and ridges formed in material weathered from shale or sandstone, depending on elevation. Probably two-thirds or more of the soils are colluvial. On some slopes, colluvium extends three-fourths or more of the way to the mountain crests. On some mountain slopes, a series of narrow benches and short cliffs form a stairstep pattern. Soils on ridgecrests are 2 to 4 ft deep; soils on steep, convex upper slopes and points of ridges are 1 to 3 ft deep; and soils on colluvial slopes are 5 to 15 ft deep. In coves and on cool slopes at higher elevations, soils have dark surface horizons. In the Rugged Eastern Area, soils are mostly well-drained and are generally somewhat heavier textured than soils common to the smoother part of the Low Hills Belt and the Western Escarpment. Shale-derived soils are about as clayey as those formed over Mississippian limestone, shale, and siltstone in the northern part of the Western Escarpment.

In the Low Hills Belt, soils on gently sloping to sloping broader ridges and short smooth slopes are moderately deep to deep and well-drained; they formed in material weathered mostly from sandstone and conglomerate. Loamy colluvial soils have developed on long, strongly sloping to steep sideslopes. Also, colluvial soils occur on steep, rocky slopes below sandstone cliffs in gorges along major creeks and streams.

In the southern section of the Western Escarpment Area, soils on narrow ridges and hills above the sandstone cliffs are typically moderately deep and well-drained with loamy subsoils. Colluvial soils that occur on steep upper scarp slopes are loamy, deep, and well-drained. On lower scarp slopes, colluvial soils are bisequal with subsoil horizons forming in material weathered from the underlying Mississippian limestone, and soils on toeslopes formed almost entirely in limestone material.

In the northern section of the Western Escarpment Area, soils on narrow ridges and hills formed in material weathered from thin sandstone and conglomerate caprock. Below the relatively short sandstone cliffs, on some spur ridges, and on the associated steep sideslopes, soils formed in residuum or colluvium weathered from Mississippian limestone, shale, siltstone, and sandstone.

Moderately extensive deep, well-drained to poorly drained, mostly loamy alluvial soils occur on flood plains and terraces along the Cumberland and Kentucky Rivers and major tributaries. Farther upstream, bottom soils are deep, moderately well-drained to well-drained, and loamy. Generally, alluvial soils are moderately fertile and well-suited to agriculture, but seasonal wetness limits their use.

Common residual upland soils are Alticrest, Berks, Dekalb, Gilpin, Latham, Lily, Muskingum, and Ramsey. Common colluvial soils are Brookside, Cranston, Cutshin, Grimsley, Jefferson, Rigley, Shelocta, and Zenith. Common alluvial soils are Atkins, Bonnie, Clifty, Combs, Cuba, Ealy, Grigsby, Philo, Pope, Sewanee, Stendal, and Stokly.

There is little smooth land in the Northern Cumberland Mountain Region, and most of it is used for agriculture or building sites. Forests occupy 48 to 95 percent of Northern Cumberland Plateau counties. Seventeen of the 26 counties are more than three-fourths forested (Staff, Renewable Resources Evaluation Research Work Unit 1982, Kingsley and Powell 1978). Counties having the lowest percentages of forest land lie in the Highland Rim-Pennyroyal physiographic province as well as the Cumberland Plateau. Large tracts are owned by lumber and coal companies. All of five ranger districts and part of another district of the Daniel Boone National Forest lie in the Northern Cumberland Plateau Region.

Considerable land has been disturbed by surface mining for coal and drilling for natural gas and oil. Federal regulations now require the rehabilitation of surface-mined land and drilling sites. Some reclaimed land is being used for shopping centers, schools, athletic fields, airports, and subdivisions. Those uses depend on easy accessibility and/or proximity to existing developed areas. The potential for using reclaimed land for improved pasture and forests is high, but is currently not being realized. Most land disturbed before passage of reclamation laws gradually reverts to forest, but soil erosion, stream sedimentation, and surface- and ground-water pollution will be serious problems for many years. Bryan and Hewlett (1981) found that average storm flows from six small watersheds in Breathitt County, KY, were not changed by surface mining, whereas average peak flows increased 36 percent, but only in the summer. Small peak flows doubled, moderate flows increased about one-third, peak flows of about 100 csm were largely unaffected, and larger peak flows may have been reduced by surface mining. The maximum annual storm flows, usually occurring in winter or spring, were slightly reduced. No time trend in either storm flows or peak flows was detected. They concluded that surface mining was not a serious floodwater discharge problem.

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 some undisturbed steep slopes and is exacerbated by road construction. 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 gently 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 having poor aeration at the base of slopes, especially those underlain by shale.

Aspect affects air and soil temperatures by altering insolation. 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 Northern Cumberland Plateau in McCreary County, KY. 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. Also, lower slopes tended to be more moist than upper slopes because of internal moisture flow. These moister soils warm more slowly because of the relatively high specific heat of water and shorter periods of time they are exposed to direct sunlight.

However, Lee and Sypolt (1974) suggested that in areas of high summer precipitation, such as the Northern Cumberland Plateau, 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. Although attempts to quantify the effects of shading generally have been unsuccessful, the effects are evident both in forest stand composition and tree growth rates. Shading effects are now being recognized by soil surveyors, e.g., in the soil survey of Leslie and Perry Counties, KY (Hayes 1982), the Shelocta-Cutshin association, consisting of deep, well-drained soils on northerly mountain slopes, in coves, and on benches was extended 10 to 15 percent up the opposing southerly slopes before changing to a Shelocta-Gilpin association.

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). On the Northern Cumberland Plateau, nearly all soils are classed as mesic, but a few are thermic. The temperature regime of mesic soils ranges from 8° to 15°C (47° to 59°F), and the regime of thermic soils ranges from 15° to 22°C (59° 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 at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower. In the descriptions of landtypes that follow, 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 sandstones, siltstones, and shales on the Northern Cumberland Plateau have deep, well-developed sola and appear relatively stable despite fairly steep slopes (Franzmeier and others 1969). Soils on midslopes contain more 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, whereas 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 slopes.

Bailey and Avers (1971) studied colluvial soils on slopes east and west of the Pottsville escarpment in Kentucky. East of the escarpment, Pennsylvanian-age rocks of the Breathitt or Lee formations underlie relatively short, smooth, concave slopes that average 34 percent in gradient. West of the escarpment, Mississippian-age rocks of the New Providence Formation underlie relatively long, smooth, convex slopes that average 48 percent in gradient. White oak, pignut and mockernut hickories, and scarlet oak dominated both areas. East of the escarpment, yellow-poplar, blackgum, and Virginia and shortleaf pines were common associates. Slopes west of the escarpment had more scarlet oak, and common associates were chestnut oak and sassafras.

Soils over Pennsylvanian rocks were classified in the Shelocta series (fine-loamy, mixed, mesic Typic Hapludult), and those over Mississippian rocks were classified in the Cranston series (coarse-loamy, mixed, mesic Typic Hapludalf). Cranston soils have since been reclassified into the ultic subgroup of Hapludalfs. Cranston soils have coarser texture, higher pH, and higher percentage of base saturation, and they provide significantly better forest growth conditions than Shelocta soils. On northeast slopes, yellow-poplar and oaks grew better on Cranston soils than on Shelocta soils, and oaks grew at about the same rate on southwest slopes on both soils. On Cranston soils, site index of oaks varied by 14 ft between cool and warm aspects; on Shelocta soils, oak site index varied by only 7 ft between cool and warm aspects.

Vegetation

The late Dr. E. Lucy Braun conducted extensive vegetation studies on 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.

The centrum of Braun's mixed mesophytic forest region is in the Cumberland Mountains (Smalley 1984b), southeast of the Northern Cumberland Plateau. However, the mixed mesophytic forest occurs throughout the Cumberland and Allegheny Plateaus in Tennessee and Kentucky. Northeastward on the Allegheny Plateau the mixed mesophytic forest changes gradually to northern forest types dominated by American beech, sugar maple, eastern hemlock, and eastern white pine. Southward on the Cumberland Plateau oaks become more common, and yellow pines dominate certain topographic situations. The true mixed mesophytic communities are confined to cool valley slopes (Smalley 1979b, 1982).

In Braun's mixed mesophytic forest, 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 were not universally present. Physiographic climaxes were numerous and added to the diversity of the region. Other locally important species were yellow birch, river birch, black cherry, cucumbertree, white ash, red maple, blackgum, black walnut, shagbark hickory, and bitternut hickory. Composition and relative abundance varied 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 attained canopy position. The shrub and herbaceous vegetation was rich and varied.

Recently, Ware (1982) clarified, by a Bray-Curtis polar ordination, the distributional relationships among species in the Cumberland Mountains. Yellow buckeye, white basswood, and sugar maple were concentrated in stands at the opposite end of the vegetational gradient from eastern hemlock and white oak. The distribution of yellow-poplar overlapped that of all five of these species. American beech was important all across the ordination except in stands containing a high proportion of white basswood and yellow buckeye. The ordination supported Braun's treatment of the mixed mesophytic forest as a single integrating complex rather than several remotely related forest communities.

Braun (1950) described the primary forest of the Rugged Eastern Area of Kentucky as a mosaic of climax and subclimax communities. Diversity of topography, soils, and micro-climate was largely responsible for the complexity of the forests. Generally, the mixed mesophytic forest occurred on slopes, with white basswood most conspicuous on cool slopes and American beech proportionately more on warm slopes. Also, oaks, particularly white oak, were conspicuous on warm slopes. Eastern hemlock occurred in some ravines and was usually accompanied by rhododendron. Umbrella magnolia was conspicuous in ravines, whereas bigleaf magnolia was sometimes dominant in second-growth stands. On soils formed mostly from sandstone, pitch pine and shortleaf and/or Virginia pine were dominant. On ridgetops and upper slopes, mixed oak and oak-hickory communities were common. Chestnut, white and black, were the most common oaks, while post oak was prevalent on the driest sites. In saddles of ridges, the mixed mesophytic forest communities mingled with mixed oak and oak-hickory communities.

In the Low Hills Belt, the mixed mesophytic forest was not as extensive as in the Rugged Eastern Area or the Western Escarpment. In this topographically subdued area, mid- and lower slopes supported a white oak-American beech community that changed to mixed oaks or oak-hickory on upper slopes and ridges. Broad, saucer-shaped valleys, typical of streamheads, were moist or even swampy. These streambottom forests were composed mostly of red maple, sweetgum, pin oak, blackgum, and swamp white oak; patches of alder were common. In less-wet areas, white oak and American beech were common. River birch was common along the banks of larger streams and rivers. As the streams flow westward, they become entrenched into strata of lower Pennsylvanian age. The mixed mesophytic forest occupied these coves and ravine slopes.

In the Western Escarpment, margins above the sandstone cliffs were dominated by pines, mountain-laurel, vacciniums, and other heath shrubs. Scarlet and chestnut oaks were often mixed with the pines. In places, open pine stands supported extensive grass cover. Slopes, except those that had been cleared, were occupied by mixed mesophytic communities. Eastern hemlock was dominant in the narrow gorges and on north-facing talus slopes below the sandstone cliffs. Here rhododendron formed impenetrable thickets. Umbrella, bigleaf, and Fraser magnolias, and American holly were also common understory species. As the gorges widen and the streams emerged from between the bordering cliffs, American beech dominated the sloping terraces and valley floors. White oak and American beech were most abundant on southerly slopes, while more typical mixed mesophytic communities were on cool slopes. Chinkapin oak occurred on calcareous soils formed from parent material of Mississippian origin. Occasionally, eastern white pine occurred with eastern hemlock in the gorges.

Existing 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 Northern Cumberland Plateau forests. Also, the absence or reduction in occurrence of wildfire since organized fire protection began has altered forest composition and succession patterns. Selectively logged stands have similar composition and frequencies of occurrence but lack the large trees seen in photos illustrating Braun's book (1950, chapter 4). The species composition of most second-growth stands originating after commercial clearcutting is similar to the composition of the original stands, but frequencies of occurrence differ considerably. A few scattered old-growth remnants of the mixed mesophytic forest remain.

Martin (1975) described the largest protected remnant, the Lilley Cornett Woods, in Letcher County in the Rugged Eastern Area of Kentucky about 5 mi northwest of Pine Mountain, the northwest boundary of the Cumberland Mountains Region (Smalley 1984). This old-growth forest is registered as a National Landmark with the U.S. Department of Interior and as a Natural Area with the Society of American

Foresters. A sugar maple—white basswood—yellow-poplar community occurs on the cool colluvial slopes of a large east-facing cove but occupies less than 10 percent of the old-growth area. The major species in the community are recognized mesophytes. Eastern hemlock occurs throughout the forest but dominates only about 5 percent of the area.

Nearly 50 percent of the old-growth forest is occupied with communities dominated by American beech in association with yellow buckeye, sugar maple, and white oak. Chestnut oak, white oak, and other mixed oak communities are common on warm slopes, ridgetops, and upper convex slopes on all aspects. These oak communities occur on about 35 percent of the area.

This old-growth mixed mesophytic forest is continuously disturbed by scattered tree falls (Romme and Martin 1982). Nearly half of the gaps in the dominant canopy were caused by uprooting or stem breakage of American beech. The largest number of gaps were formed in the summer months. Tree fall was unrelated to regional weather patterns but was strongly influenced by local windstorms of high velocity and short duration. This disturbance pattern suggests a "shifting mosaic steady-state" model of forest development. Based on a short period of monitoring, the average life expectancy of dominant trees was estimated to be 269 years.

Another remnant of the mixed mesophytic forest is in Rock Creek Gorge, Laurel County, KY, and represents the Western Escarpment of the Northern Cumberland Plateau region (Winstead and Nicely 1976). The gorge has been designated a natural area. The gorge, bounded by a sandstone cliff, averages about 160 ft deep and 0.25 mi wide. It extends about 1.2 mi from the head of the gorge to the confluence with the Rockcastle River. Eighty-two percent of the total stand basal area of 207 ft^2 ac^{-1} is dominated by eastern hemlock, yellow-poplar, sweet birch, and red maple. Minor species are northern red oak, American holly, blackgum, black cherry, American beech, white oak, bigleaf magnolia, American hornbeam, and flowering dogwood. Several of the largest eastern hemlocks were 30 in d.b.h. and larger; several yellow-poplars exceeded 40 in d.b.h.

Muller (1982, 1983) compared an old-growth portion of the Lilley Cornett Woods (Big Everidge Hollow) with an adjacent 35-year-old second-growth forest (Pollbranch Hollow). Basal area of trees ≥ 4 in d.b.h. was 121 ft^2 ac^{-1} in the old-growth hollow and 107 ft^2 ac^{-1} in the second-growth hollow. There were more white oak, sugar maple, American beech, and white ash trees in the old-growth forest than in the second-growth forest but more northern red oak and yellow-poplar in the second growth than in the old growth. Only white oak and white ash had significantly more basal area in the old growth than in the second growth. Basal area of non-commercial species—black locust, sassafras, eastern redbud, and flowering dogwood—in the second growth was nearly double that in the old growth, suggesting that some form of timber stand improvement might substantially increase the composition and growth of commercial species. The second-growth forest has not exhibited a strong species shift. The diameter distribution of both the old-growth and second-growth forests was described very well by inverse J-shaped functions.

Herman and See (1973) reported on succession following a seemingly moderately hot wildfire in Tight Hollow, an old-growth mesic forest located on a tributary of the Middle Fork of the Red River. Tight Hollow is typical of headwater areas in the Low Hills section of the Northern Cumberland Plateau. The hollow is ringed with a sandstone cliff, and local relief is about 240 ft. Forty-seven years after the fire, the overstory in the burned area consists of yellow-poplar and overmature eastern hemlock that survived the fire. Yellow-poplar comprises 71 percent of the stand basal area. Minor overstory species are bigleaf magnolia, umbrella magnolia, sweet birch, and red maple. Major understory species are eastern hemlock, rhododendron, sweet birch, yellow-poplar, and red maple. The unburned part of the hollow supports an eastern hemlock—yellow-poplar community, with extensive windthrow of the hemlock. Rhododendron, flowering dogwood, and umbrella and bigleaf magnolias dominate the understory.

Fifty years after being commercially clearcut and subjected to frequent wildfires, streambottoms and north slopes in the Rugged Eastern Area were dominated by yellow-poplar and contained a lush understory of American hornbeam, cucumbertree, bigleaf magnolia, umbrella magnolia, and American beech (Carpenter 1976). South-facing slopes were dominated by white oak, American beech, northern red oak, and hickories. Only 10 of 25 major woody species were common to all three sites—sugar maple, sweet birch, American hornbeam, American beech, white ash, yellow-poplar, bigleaf magnolia, cucumbertree, umbrella magnolia, and sassafras. Slippery elm, American sycamore, and red mulberry occurred only in the streambottoms, whereas pignut hickory, shagbark hickory, mockernut hickory, and northern red oak occurred only on south slopes. American basswood was the only species restricted to north slopes. Despite strong differences in soils and microclimate, black walnut, sourwood, red maple, blackgum, and white oak occurred on south slopes and in streambottoms. Only eastern hemlock was restricted to north slopes and streambottoms. Basal area per acre of all trees taller than 4.5 ft was 185 ft^2 in streambottoms, 140 ft^2 on north slopes, and 137 ft^2 on south slopes.

Fedders (1983) studied the vegetation of the 320-acre Spencer-Morton Preserve in Powell County, KY.

The highest ridges were about 1,400 ft in elevation and were capped with Pennsylvanian sandstones and conglomerates, whereas slopes were underlain with Mississippian siltstone, shale, and fine-grained sandstone. The soils of the Preserve were common to the Cumberland Plateau, indicating that the Preserve should be assigned to the western escarpment section of the northern Plateau and not to the Knobs region of the Eastern Highland Rim and Pennyroyal (see LTA-H in Smalley 1983). Although Braun (1950) asserted that mixed mesophytic forests once occupied many of the slopes in this area, there was no indication from the current oak and hickory communities that mixed mesophytic forests were present in the Preserve in presettlement time. Chestnut oak, pignut hickory, white oak, black oak, and mockernut hickory were the dominant overstory species, and sassafras, red maple, and flowering dogwood were the dominant understory species. The typical dominants of mixed mesophytic forests—American beech, white basswood, yellow buckeye, and sugar maple—were virtually absent. The substantial presence of oaks and hickories in the understory suggests a stable species composition in the future.

Safley (1970) described the vegetation of the gorges, the submaturely dissected plateau top, and a small portion of the adjacent Jellico Mountains in the watershed of the South Fork of the Cumberland River in southern Kentucky and northern Tennessee. Twenty-two forest types were identified—white oak was dominant in 15, chestnut oak was dominant in 5, and northern red oak was dominant in 2. Eastern redcedar, Virginia pine, and shortleaf pine were dominant in eight forest types, but in only two—eastern redcedar and Virginia pine-eastern white pine—were conifers the sole dominants. Eastern hemlock occurred in 13 forest types but was dominant in only 2. American beech was dominant in only three forest types. Mixed mesophytic forest types were restricted to the most protected sites. Overall, vegetation was intermediate in composition between the Mixed Mesophytic Forest region and oak-hickory types of the Western Mesophytic Forest region. Dominance of white oak is characteristic of the Cliff Section of the Mixed Mesophytic Forest region.

These studies sought to identify and classify existing old-growth and second-growth forest communities. Other investigators have attempted to relate the growth of selected commercially valuable tree species to soil properties and topographic factors.

Byrne and others (1965) studied the relation of forest composition and stand structure to the occurrence of Dekalb and Wellston soils on narrow, gently sloping ridgetops in McCreary County, KY. Dekalb soils were dominated by shortleaf pine, with lesser frequencies of Virginia pine, oaks, and mockernut hickory. Wellston soils were dominated by scarlet, white, chestnut, and black oaks, with lesser frequencies of shortleaf pine, Virginia pine, and pignut hickory. On Dekalb soils, shortleaf pine had a mean site index (base age 50 years) of 61±7 ft, and on Wellston soils, it had a mean site index of 70±5 ft. They concluded that inherent differences in soil texture and thickness probably resulted in different rates of natural succession, variation in species adaptability, and relative site potential. These inherent differences have direct application for forest management planning.

Hutchins and others (1976) found that soils, microclimate, and vegetation differed greatly between exposed northeast- and southwest-facing slopes in the Rugged Eastern Area of Kentucky near Hazard. Fine-loamy Shelocta soils had developed on northeast slopes, and coarse-loamy Rigley soils had developed on southwest slopes. Air temperature, throughfall, soil temperature, and annual fluctuation of soil temperature were all significantly greater on southwest than on northeast slopes. There were more species of trees >4 in d.b.h. on northeast slopes, and these tended to be the more mesophytic ones, including yellow-poplar, American basswood, and cucumbertree. On southwest slopes, plant communities were less diverse and were composed mostly of oaks and hickories. Stands on northeast slopes had higher basal areas than those on southwest slopes.

In the Rugged Eastern Area, Honeycutt and others (1982) found that the height growth of white oak was significantly related to tree age, nitrogen content of the A horizon, aspect, slope position, and thickness of the B horizon. The ranking of site index among soils was Shelocta > Wernock loam variant > Rigley, but only the difference in site index between Shelocta and Rigley soils was statistically significant. The ranking among sites was lower slopes > broad ridges > mid-slopes, and differences between all pairs were statistically significant. No mean site indices were reported for either soils or sites.

Also in the Rugged Eastern Area, Eigel and others (1982) found that the height growth of yellow-poplar was significantly related to tree age, organic matter content of the A horizon, thickness of the A horizon, stand basal area, thickness of the solum, and pH of the A horizon. The ranking of site index among soils was Cutshin (102) > Shelocta (99) > Pope (96) > Gilpin (91), and among sites was coves (107) > sideslopes (99) > streambottoms (96). No statistics were given to indicate which, if any, of the differences between pairs in either group was significant. No comparisons were made between site indices in either of these two studies and those published by SCS for specific soils.

Besides describing the vegetation of the Spencer-Morton Preserve, Fedders (1983) found that species occurrence, frequency, and basal areas were significantly related to several soil and site variables, but only a small amount of variation was explained by the best multiple regressions.

The effort by SCS to determine mean site indices of selected tree species by soil series and the few studies mentioned above are the only attempts to determine relative or absolute productivity of Northern Cumberland Plateau forest sites other than on a regional basis (Staff of Renewable Resources Evaluation Research Work Unit 1982, Kingsley and Powell 1978).

SUBREGIONS AND LANDTYPE ASSOCIATIONS

I divided the Northern Cumberland Plateau Region into three subregions: (1) mountains and dissected plateau, (2) Western Escarpment, and (3) major river bottoms (fig. 2). Minor river bottoms and streambottoms are included in Subregions 1 and 2. Subregions 2 and 3 were divided into two landtype associations (LTA's) each, whereas Subregion 3 has only one landtype association. Landtype associations correspond closely to soil associations on general soil maps for Tennessee and Kentucky (Soil Conservation Service 1975, Springer and Elder 1980) (table 3). A description of these landtype associations follows.

Subregion 1: Mountains and Dissected Plateau

Landtype Association-A: Rugged Eastern Area.— This LTA bears the name assigned to the area by Braun (1950) and coincides with the more mountainous eastern area of Bailey and Winsor (1964). It corresponds to the eastern part of soil association G-3 (Jefferson-Shelocta-Steinsburg) in Kentucky. Also included is a portion of soil association G-2 (Latham-Shelocta) south of the Cumberland River in eastern Whitley and southern Knox Counties, KY. This portion of soil association G-2 borders on the Cumberland Mountain Region (Smalley 1984). Topographically, it is too rugged to be included in soil association G-2, an area of more subdued relief assigned to LTA-B.

Table 3.—*Subregions and landtype associations of the Northern Cumberland Plateau region*

Subregion	Landtype association
1. Mountains and dissected plateau	A. Rugged Eastern Area
	B. Low Hills Belt
2. Western Escarpment	C. Western escarpment facing the Eastern Highland Rim and Pennyroyal
	D. Western escarpment facing the Bluegrass
3. Major river bottoms	E. Cumberland and Kentucky Rivers and major tributaries.

Landtype Association-A is a maturely dissected plateau having a characteristic dendritic drainage pattern. Elevation ranges from 1,000 to more than 2,500 ft. Relief ranges from 300 to nearly 1,000 ft being greatest in the southeast and diminishing toward the southwest and the northwest.

Terrain consists of narrow, winding ridge crests steep, often benched sideslopes; and narrow, winding valleys. Small areas of smooth land occur on mountaintops, footslopes, benches, and streambottoms.

The bedrock is interbedded sandstone, siltstone shale, and coal. Soils on ridges and convex upper slopes formed in residuum. Soil texture is a function of elevation because strata are nearly horizontal. Soils from shale are clayey, and those from sandstone are loamy. Nearly half of LTA-A consists of soils formed in colluvium.

Narrow benches and short sandstone cliffs occur on some of the steeper slopes. Soils on ridgetops average 2 to 4 ft to rock; those on upper slopes average 1 to 3 ft, and those on colluvial slopes are 5 to more than 15 ft deep. These soils are mostly pale, loamy and clayey, friable, with varying amounts of rock fragments. Soils having dark surface layers occur in places at higher elevations and in cool, moist coves.

The narrow, winding valleys represent the majority of smooth land in LTA-A, and most of the sparse population live here. These 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 soils.

Large tracts are owned by timber and coal companies. The Red Bird Ranger District of the Daniel Boone National Forest is located in LTA-A. Contour mining has disturbed thousands of acres and has resulted in the acidification and siltation of streams. By altering the landform, surface mining has changed drainage patterns and has affected the rate of physical and chemical processes of soil formation. Soils developing in mine spoil contain 35 to 80 percent rock and coal fragments. These young soils are well-drained, with moderately slow permeability; run-off is rapid. Reaction ranges from neutral to extremely acid.

Nearly 90 percent of LTA-A 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 (table 4) are recognized: 1–13.

Landtype Association-B: Low Hills Belt.—This LTA bears the name assigned to the area by Braun (1950) and coincides with the West Central Plateau Area of Bailey and Winsor (1964). It corresponds to most of soil association G-2 (Latham-Shelocta) in Kentucky. Also included are smooth, broad areas interspersed with the more rugged terrain of LTA-C along the

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

Landtype number and name	Subregions[1]				
	1		2		3
	Landtype associations[1]				
	A	B	C	D	E
1. Narrow sandstone ridges and convex upper slopes	**[2]	*	**	**	
2. Narrow shale ridges, points, and convex upper slopes	**	**	*	*	
3. Shallow soils and sandstone outcrops	**	*	**	**	
4. Broad sandstone ridges—north aspect	*	***	**	*	
5. Broad sandstone ridges—south aspect	*	***	**	*	
6. Undulating shale uplands	*	**	*	*	
7. Upper mountain slopes—north aspect	***				
8. Upper mountain slopes—south aspect	***				
9. Colluvial mountain slopes, benches, and coves—north aspect	***	**			
10. Colluvial mountain slopes, benches, and coves—south aspect	***	**			
11. Surface mines	**	**	*	*	
12. Mountain footslopes, fans, terraces, and streambottoms with good drainage	**	*	*	*	
13. Mountain terraces and streambottoms with poor drainage	**	*	*	*	
14. Undulating sandstone uplands		***	**	*	
15. Upper escarpment slopes and benches—north aspect		*	***	***	
16. Upper escarpment slopes and benches—south aspect		*	***	***	
17. Lower escarpment slopes and benches—north aspect			***	***	
18. Lower escarpment slopes and benches—south aspect			***	***	
19. Shallow soils and limestone outcrops			**	***	
20. Colluvial siltstone slopes—north aspect				**	
21. Colluvial siltstone slopes—south aspect				**	
22. Limestone ridges and convex upper slopes			*	*	
23. Footslopes, terraces, and flood plains with good drainage					***
24. Terraces and flood plains with poor drainage					***

[1]See table 3 for names of subregions and landtype associations.
[2]Frequency of occurrence is common (***), frequent (**), or occasional (*). Ratings are made within each landtype association (vertically). Comparison of landtype frequency among landtype associations (horizontally) is not valid.

Tennessee-Kentucky border (fig. 2). These areas were delineated as soil associations H-11 (Lily-Lonewood-Ramsey-Gilpin) and H-12 (Lily-Ramsey-Gilpin) in Tennessee but were not recognized on the Kentucky General Soil Map (Soil Conservation Service 1975). I extended soil associations H-11 and H-12 along broad ridges into McCreary and Wayne Counties, KY, including an area near Gilreath and Pine Knot designated as Clymer-Dekalb soil association in the McCreary-Whitley area soil survey (Byrne and others 1970). These smoother areas along the Tennessee-Kentucky border are continuations of similar extensive areas in the Mid-Cumberland Plateau Region (Smalley 1982). It would have been more appropriate to assign them to the Mid-Plateau rather than have them as discontinuous parts of LTA-B in the Northern Plateau region.

Soil association G-2, lying south of the Cumberland River, was excluded from LTA-B. Nearly all of this exclusion is in the Jellico Mountains, which are part of the Cumberland Mountains Region (Smalley 1984b). The remainder of the excluded part of soil association G-2 was placed in LTA-A.

Landtype Association-B is a submaturely dissected plateau with a moderately dense dendritic drainage pattern. Elevation ranges from 900 to 1,500 ft. Relief ranges from 150 to nearly 500 ft. Streams become more entrenched from east to west. Terrain consists of narrow winding to moderately broad ridgetops; short, steep sideslopes; and narrow V-shaped valleys. A moderately extensive acreage of smooth land occurs on ridgetops, and small discontinuous patches of level land occur in the narrow valleys. This smooth land is suitable for hay and pasture, and tobacco, corn, and small grains are the major farm crops.

Sandstones and conglomerates of lower Pennsylvanian age are dominant in the western part of LTA-B, but eastward younger Pennsylvanian shales and siltstones are more common. Loamy soils on broad ridges and upper slopes formed in residuum weathered from sandstone and conglomerate. Clayey soils on narrow convex ridges and upper slopes formed in residuum weathered from siltstone and shale. In the western part of LTA-B a sandstone cliff separates the ridgetops from the sideslopes in places. Further east, intermittent sandstone cliffs are common on sideslopes. One-third or more of LTA-B consists of soils formed in colluvium. Soils on ridgetops average 2 to 4 ft to rock, whereas those on upper slopes are somewhat shallower. Soils on colluvial slopes are 5 ft or more deep. Upland soils are mostly pale, loamy and clayey, and friable, with varying amounts of rock fragments. Alluvial soils are mostly deeper than 5 ft, pale, loamy, and friable.

Timber and coal companies own some large tracts. A small acreage of the Daniel Boone National Forest lies in LTA-B. Surface mining for coal is not as extensive as in LTA-A. There is some surface mining for fire clay and some production of oil and natural gas. Problems associated with surface mining are the same as those discussed under LTA-A, but they are not as extensive or serious. Soils developed in mine spoil contain 35 to 80 percent rock and coal fragments. These young soils are well-drained, with moderately slow permeability; run-off is rapid. Reaction ranges from neutral to extremely acid. Despite its mild relief, over 70 percent of LTA-B is forested with a mixture of hardwoods and conifers. Species composition and stand density vary greatly with aspect and slope position. Because LTA-B is not as rugged as LTA's A, C, and D, the degree of shading from adjacent land masses has only a minor influence on species composition and stand density. Fourteen landtypes (table 4) are recognized: 1–6 and 9–16. Subregion 2: Western Escarpment.

Landtype Association-C: Western Escarpment facing the Eastern Highland Rim and Pennyroyal.—This LTA bears the name assigned by Bailey and Windor (1964). However, LTA-C is restricted to the part south of Rockcastle County that borders on LTA-D (weakly dissected plateau—red soils) in the Eastern Highland Rim and Pennyroyal region (Smalley 1983). It also corresponds to the southern part of Braun's (1950) Cliff Section.

Landtype Association-C coincides with the western block of soil association G-3 (Jefferson-Shelocta-Steinsburg) in Kentucky and extends into north central Tennessee, where it corresponds to soil association H-22 (Ramsey-Lily-Grimsley-Gilpin).

Landtype Association-C represents the dissected western or Pottsville escarpment of the Cumberland Plateau. The western margin is incised by numerous coves cut by the Cumberland River and its major tributaries. Elevation ranges from 1,200 to 2,200 ft, and local relief is less than 60 ft on a few smooth broad areas and 500 to 800 ft in the incised gorges and in the vicinity of points of the Plateau jutting into the Highland Rim and Pennyroyal.

This LTA consists mostly of narrow, winding ridgetops flanked by moderately steep to steep sideslopes. Low hills protrude above the general level of the Plateau, and moderately broad ridgetops occur in places. Stream channels are incised into the Plateau surface, and the narrow U-shaped or V-shaped cross-sections are bounded by nearly continuous sandstone cliffs. Close to the Plateau edge, stream channels are narrow, steep-sided, and rock-strewn. They end abruptly at the Plateau escarpment.

Soils on narrow ridgetops and upper slopes are 2 to 4 ft deep, and those on broader, smoother ridgetops are somewhat deeper. Soils from sandstone are loamy; those from shale are clayey. Colluvial soils on sideslopes and on slopes of protruding shale hills are deeper than 4 ft. Deep, stony, colluvial soils are common below the sandstone free face. The boulder-strewn escarpment usually consists of a series of short, steep slopes broken with narrow sloping benches. On toeslopes of the escarpment, soils are formed from limestone and calcareous shale. Outcrops of limestone are common.

Timber and coal companies own some large tracts. Almost all of the Stearns, Somerset, and London Ranger Districts of the Daniel Boone National Forest are situated in LTA-C. Surface mining for coal is not as extensive as in LTA-A. There is some production of oil and natural gas, particularly in Wayne County, KY. Problems associated with surface mining are the same as those discussed in LTA-A but are not as extensive or as serious. Soils developed in mine spoil contain a high percentage of rock and coal fragments. These young soils are well-drained, with moderately slow permeability; run-off is rapid. Reaction ranges from neutral to extremely acid.

Nearly three-fourths of LTA-C is forested with a mixture of hardwoods and conifers. Species composition and stand density vary greatly with aspect, slope, and degree of shading by adjacent land masses, particularly in the narrow heads of gorges. Fifteen landtypes (table 4) are recognized: 1, 3–6, 11–19, and 22.

Landtype Association-D: Western Escarpment facing the Bluegrass.—This LTA bears the name assigned by Bailey and Winsor (1964). However, LTA-D is restricted to the part north of Rockcastle County that faces the Bluegrass Region. It also corresponds to the northern part of Braun's (1950) Cliff Section. Landtype Association-D coincides with Kentucky soil association G-5 (Shelocta-Brookside-Jefferson).

Landtype Association-D lies between the Low Hills Belt (LTA-B) on the east and the Eastern Kentucky Knobs (LTA-H) of the Eastern Highland Rim and Pennyroyal Region (Smalley 1983) on the west. The boundary between the poorly defined western escarpment of the Cumberland Plateau and the strongly dissected belt of Knobs is indistinct.

This area of ridges and valleys, underlain by mid- and upper Mississippian strata, has traditionally been considered part of the Cumberland Plateau. Pennsylvanian rocks cap the higher ridges and become more prominent eastward. The Pottsville escarpment is very ragged because of the numerous coves cut by the Kentucky River and its major tributaries. Streams are entrenched in steep-sided, narrow valleys ringed with sandstone cliffs. Valleys are commonly 0.1 mi wide or less, but they gradually widen as streams progress into the Knobs Region. Rock shelters, natural bridges, and waterfalls are common. Intermittent limestone cliffs are common on mid- to lower slopes. Elevation ranges from 600 to 1,200 ft in the northern part and 1,000 to 1,500 ft in the southern end. Relief varies mostly from 150 to 400 ft but ranges to 600 ft in places.

Soils on narrow to moderately broad ridgetops are mostly 2 to 4 ft deep, loamy, well-drained, and friable. Those on steep convex upper slopes are not as deep. Colluvial soils on steep hillsides and on steep, benchy, side slopes of gorges are deeper than 5 ft, loamy, and friable. Those below sandstone cliffs have a high content of sandstone rock fragments, and large sandstone boulders cover the surface. Those below limestone cliffs have a lower content of limestone and sandstone rock fragments in the soil mass and fewer boulders on the surface. Soils in streambottoms are deep, loamy, friable. Internal drainage ranges from well-drained to poorly drained.

Timber and coal companies own some large tracts. Nearly all of the Berea and Stanton Ranger Districts are located in LTA-D. Surface mining for coal is not as extensive as in LTA-A. There is considerable productivity of oil and natural gas, particularly in Powell, Estill, and Lee Counties. Problems associated with surface mining are the same as those discussed in LTA-A but are not as extensive or as serious; salt water pollution is a problem with oil and gas drilling. Soils developed in mine spoil contain a high percentage of rock and coal fragments. These young soils are well-drained, with moderately slow permeability; run-off is rapid. Reaction ranges from neutral to extremely acid.

Nearly three-fourths of LTA-D is forested with a mixture of hardwoods and conifers. Species composition and stand density vary greatly with aspect, slope, and degree of shading by adjacent land masses, particularly in narrow gorges. Eighteen landtypes (table 4) are recognized: 1–6 and 11–22.

Subregion 3: Major River Bottoms

Landtypes Association-E: Cumberland and Kentucky Rivers and Major Tributaries.—This LTA corresponds to soil associations A-8 (Pope-Bonnie-Allegheny) and A-9 (Morehead-Whitley-Cuba) on the Kentucky General Soil Map. Soil association A-8 occurs along the Cumberland River from the Whitley-McCreary County line east to Williamsburg and south along Clear Creek. Soil association A-9 occurs along the Cumberland River upstream from Williamsburg nearly to Pineville and along the Red River in Powell County. Landtype Association-E 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 bottoms of the Cumberland River and its major tributaries in the eastern half of Whitley County and in Knox County, KY, to either the Allegheny-Huntington-Newark or the Allegheny-Cotaco-Huntington soil association[2]. Another survey in prog-

[2]Personal communication with Paul M. Love, Chief of Survey Party, Knox and East-Whitley Counties, KY. Soil Conservation Service, Barbourville, KY. 1982.

ress assigns the Elk Valley and the lower reaches of Elk Creek in Campbell County, TN to the Atkins-Whitley-Ealy soil association, an extension of Kentucky general soil association A-8[3]. In Estill County, KY, Newton and others (1974) placed the bottoms of the Kentucky River and its larger tributaries in the Huntington-Newark-Morehead association.

Landtype association-E is the same as LTA-H in the Cumberland Mountain Region (Smalley 1984b). Downstream, bottoms of the Cumberland River and its major tributaries are designated as LTA-M in the Eastern Highland Rim and Pennyroyal Region (Smalley 1983) and as LTA-L in the Western Highland Rim and Pennyroyal Region (Smalley 1980).

Landtype Association-E 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 and footslopes are steeper, and relief may exceed 100 ft.

Fluctuating water tables and flooding limit the use of this LTA and affect its management. Most of the bottoms of the Cumberland Kentucky Rivers and their major tributaries have been cleared for agriculture, but woodlands, some extensive, are scattered all along these rivers. Some poorly drained 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 (table 4) are recognized: 23 and 24. Bottoms of smaller rivers, creeks and streams in the Northern Cumberland Plateau region are assigned to Landtypes 12 and 13. Footslopes, terraces, alluvial fans, and streambottoms in the long narrow coves that finger deeply into Landtype Association-C were described as Landtype 21 in the Eastern Highland Rim and Pennyroyal region (Smalley 1983).

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.

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

The Northern Cumberland Plateau region has 24 landtypes distributed among three subregions and five landtype associations (table 4). Many are common to two or more associations, while others are characteristic of only one landtype association. In table 4, the frequency of occurrence of each landtype is qualitatively rated as common, frequent, or occasional, based on acreage within each landtype association. For example, Landtypes 7 to 10 in LTA-A dominate the landscape; Landtypes 1 to 3 and 11 to 13 are not as extensive, and Landtypes 4 to 6 comprise only a small portion of LTA-A. Comparison of landtype frequencies among landtype associations is not valid. Figures 3 to 6 depict how these landtypes occur on the landscape.

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
0–2	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**. These series link this site classification system with county soil surveys published by SCS. Users who wish more detailed information can refer 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 derived from rocks with few weatherable minerals. Consequently, the most fertile soils of the Northern Cumberland Plateau region are rated only moderate, except that those along mountain streams and the Cumberland and Kentucky Rivers, which are more fertile.

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. 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 5–28). 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 heights 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 1960, Broadfoot and Krinard 1959, 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. Base age is 50 years for all species except eastern cottonwood, for which it is 30 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).

In a few cases when no values were available, site indices of important species were estimated; where they occur in tables 5–28, these estimated values are enclosed in parentheses.

Average annual growth expressed in cubic feet per acre was calculated from available yield tables (Doolittle 1956, 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 Northern Cumberland Plateau or for areas that do not include the Northern Cumberland Plateau.

Yields were 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 5–28 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.

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

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 season. The rating is *moderate* if slope is 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 is *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 run-off. *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 figure 2. Landtypes common to each landtype association and their frequencies of occurrence are shown in table 4. Landtype descriptions and landscape drawings (figs. 3–6) 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 5–28).

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. 7) that 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 7½-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 sys-

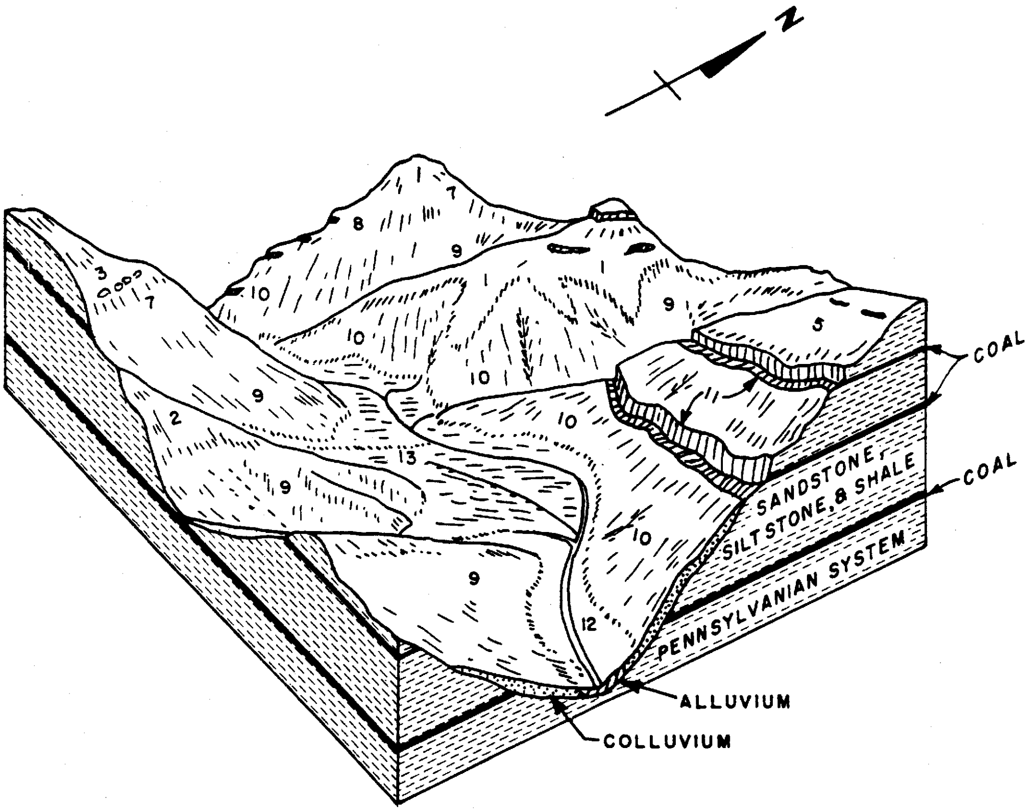

Figure 3.—*Landtypes characteristic of Landtype Association A (Rugged Eastern Area) in Subregion 1. Adapted from figures 3 and 5 in Hayes (1982).*

LEGEND

1. Narrow sandstone ridges and convex upper slopes.
2. Narrow shale ridges and convex upper slopes.
3. Shallow soils and sandstone outcrops.
5. Broad sandstone ridges—south aspect.
7. Upper mountain slopes—north aspect.
8. Upper mountain slopes—south aspect.
9. Colluvial mountain slopes—north aspect.
10. Colluvial mountain slopes—south aspect.
11. Surface mines.
12. Mountain footslopes, fans, terraces, and streambottoms with good drainage.
13. Mountain terraces and streambottoms with poor drainage.

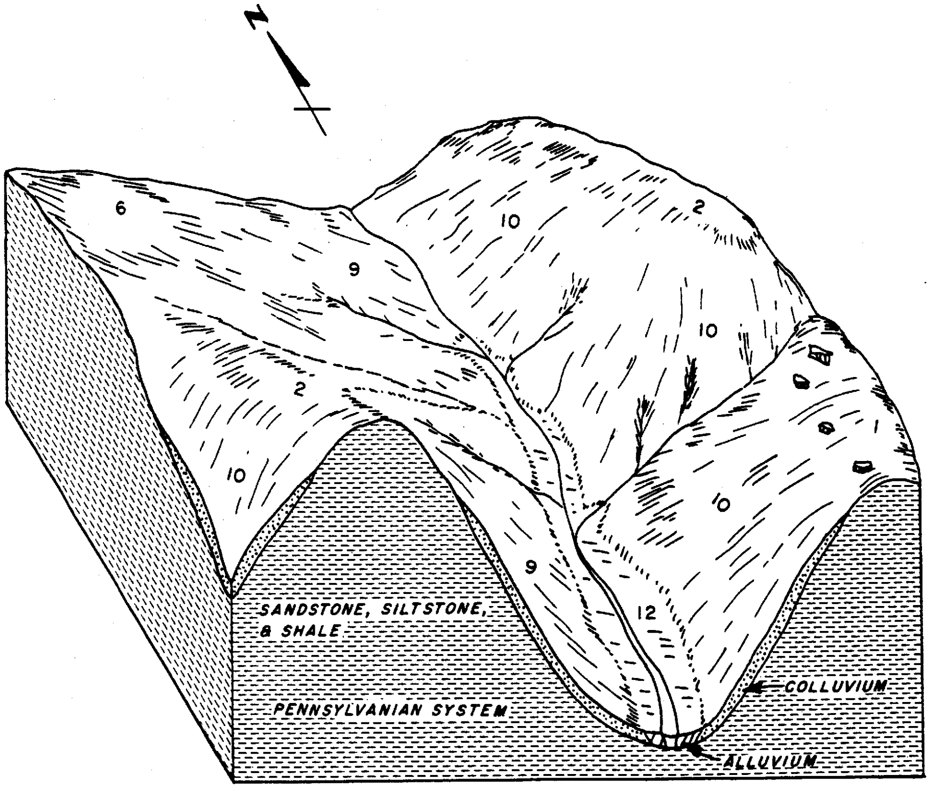

Figure 4.—*Landtypes characteristic of Landtype Association B (Low Hills Belt) in Subregion 1. Adapted from figure 8 in Newton and others (1974).*

LEGEND

1. Narrow sandstone ridges and convex upper slopes.
2. Narrow shale ridges and convex upper slopes.
6. Undulating shale uplands.
9. Colluvial mountain slopes, benches, and coves—north aspect.
10. Colluvial mountain slopes, benches, and coves—south aspect.
12. Mountain footslopes, fans, terraces, and streambottoms with good drainage.

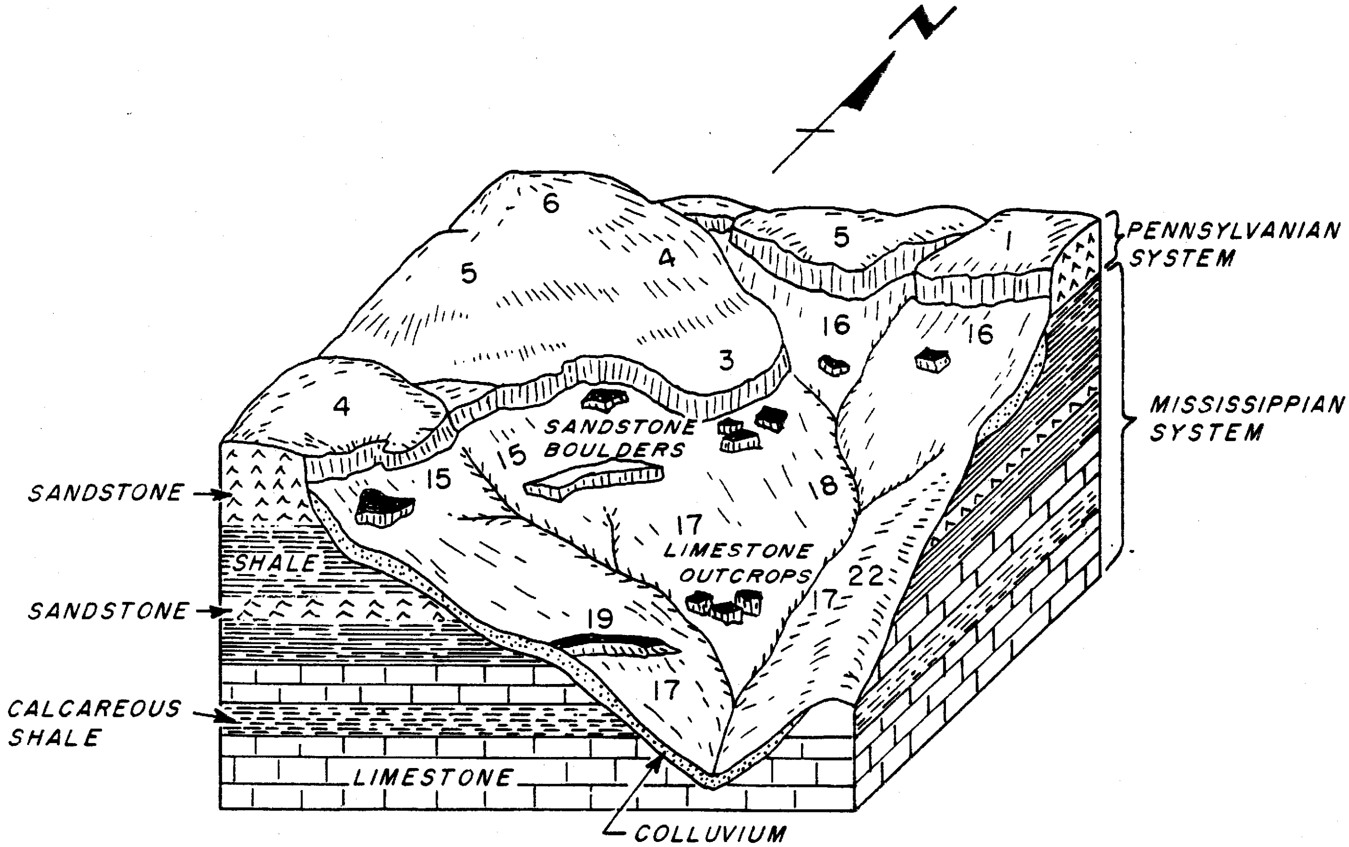

Figure 5.—*Landtypes characteristic of Landtype Association C (Western Escarpment facing the Eastern Highland Rim and Pennyroyal) in Subregion 2.*

LEGEND

1. Narrow sandstone ridges and convex upper slopes.
3. Shallow soils and sandstone outcrops.
4. Broad sandstone ridges—north aspect.
5. Broad sandstone ridges—south aspect.
6. Undulating shale uplands.
15. Upper escarpment slopes and benches—north aspect.
16. Upper escarpment slopes and benches—south aspect.
17. Lower escarpment slopes and benches—north aspect.
18. Lower escarpment slopes and benches—south aspect.
19. Shallow soils and limestone outcrops.
22. Limestone ridges and convex upper slopes.

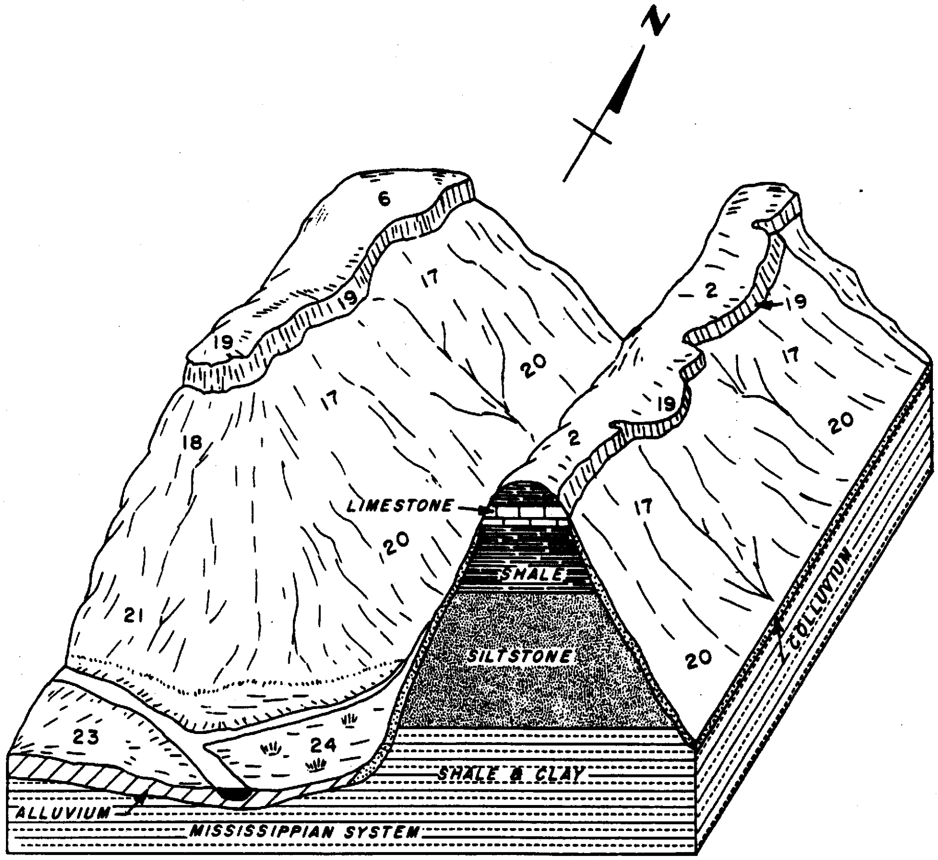

Figure 6.—*Landtypes characteristic of Landtype Association D (Western Escarpment facing the Bluegrass) in Subregion 2 and Landtype Association E (Cumberland and Kentucky Rivers and major tributaries) in Subregion 3. Adapted from figure 5 in Newton and others (1974).*

LEGEND

2. Narrow shale ridges and convex upper slopes.
6. Undulating shale uplands.
17. Lower escarpment slopes and benches—north aspect.
18. Lower escarpment slopes and benches—south aspect.
19. Shallow soils and limestone outcrops.
20. Colluvial siltstone slopes—north aspect.
21. Colluvial siltstone slopes—south aspect.
23. Footslopes, terraces, and flood plains with good drainage.
24. Terraces and flood plains with poor drainage.

tem 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 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.

Although the northern geographical extent of the Northern Cumberland Plateau is the watershed boundary of the Kentucky River, landtypes occurring in LTA's A (Rugged Eastern Area) and B (Low Hills Belt) are applicable to the southern part of the Allegheny Plateau in northeast Kentucky—essentially general soil map associations G-3 (Jefferson-Shelocta-Steinsburg) and G-2 (Latham-Shelocta), respectively (Soil Conservation Service 1975). However, landtypes in this publication should not be applied to Kentucky soil associations G-1 (Berks-Cranston) and G-6 (Vandalia-Upshur).

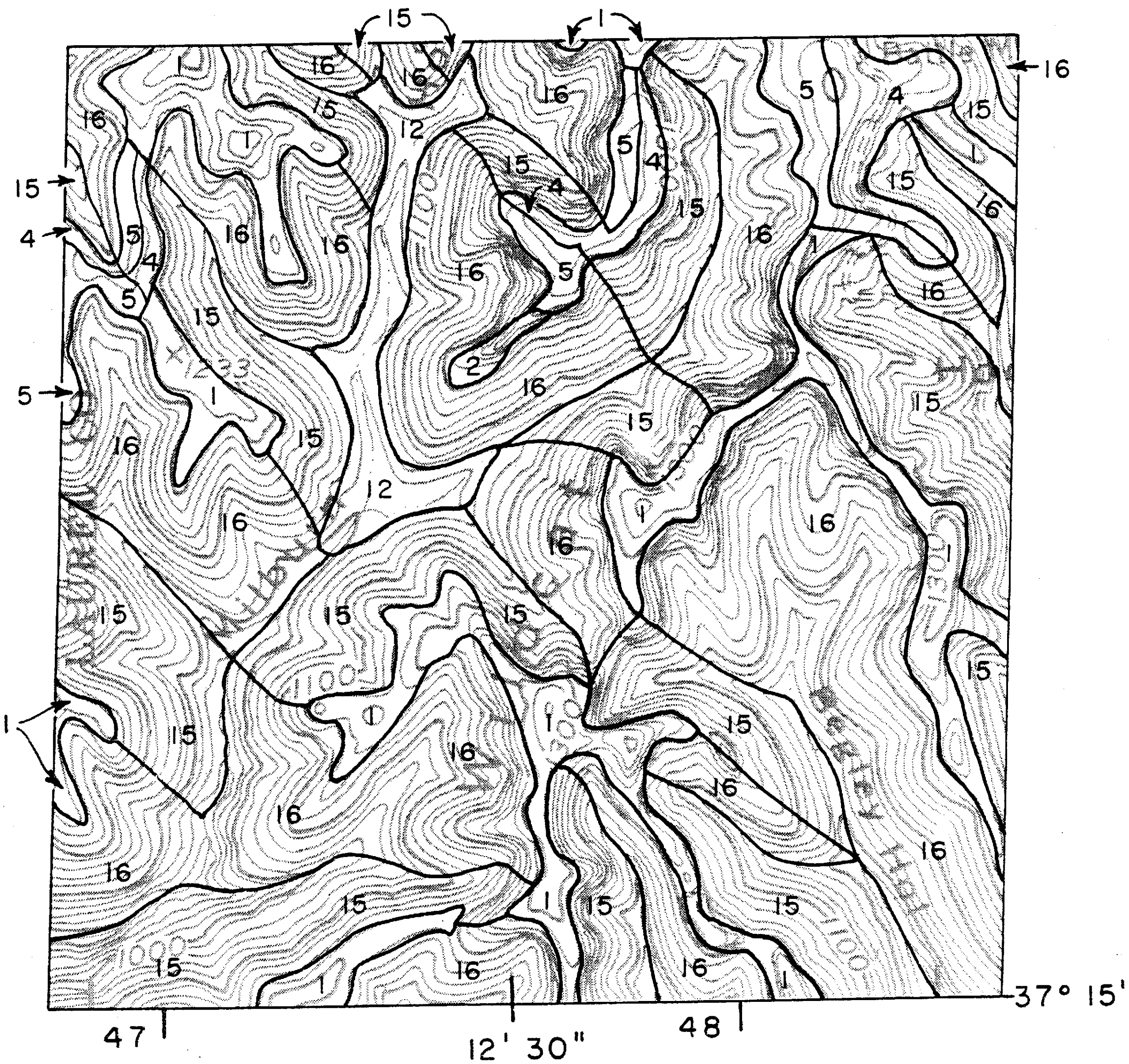

Figure 7.—*A sample landtype map showing Landtype Association-C (Western Escarpment facing the Eastern Highland Rim and Pennyroyal) in Subregion 2. Map covers a tract of about 700 acres in the southwest quarter of the Livingston Quadrangle along the Laurel-Rockcastle County Line, KY. Scale is 1:12,000. See table 4 for names of landtypes. Compare with Map 19, Soil Survey of Laurel and Rockcastle Counties, KY (Ross and others 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 sandstone. Outcrops of sandstone and rock fragments on the surface are common and, in places, extensive enough to recognize Landtype 3 (shallow soils and sandstone outcrops). Landtype 1 occurs frequently in LTA's A, C, and D and occasionally in LTA-B. It usually is found in association with Landtypes 7 and 8 and, in places, with Landtypes 4, 5, and 14. Landtypes 7 and 8 usually occupy the steep upper slopes below Landtype 1, but, in places, Landtypes 9 and 10 may extend upslope to join Landtype 1. Landtype 1 also occurs in association with Landtype 11 and may be replaced by Landtype 11 following surface mining. Areas of shallow soils and sandstone outcrops may be extensive enough to recognize Landtype 3.

Dominant Soils—Ramsey, Alticrest, Wallen, Muskingum, Steinsburg, and Dekalb.

Bedrock—Horizontal to slightly tilted acid sandstone, conglomerate, and quartzite, with thin strata of siltstone and shale in places.

Depth to Bedrock—7 to 40 in.

Texture—Loam, sand loam, fine sandy loam; occasionally silt 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. Steinsburg and Dekalb soils may have 60 percent or more rock fragments in the C horizon.

Soil Drainage—Well-drained to somewhat excessively drained.

Relative Soil Water Supply—Low.

Soil Fertility—Low.

Vegetation—Chestnut oak, red maple, scarlet oak, hickories, black oak, white oak, Virginia pine, and southern red oak; occasional post oak, shortleaf pine, pitch pine, blackjack oak, black locust, blackgum, eastern redcedar, and eastern white pine. Sassafras, sourwood, flowering dogwood, vacciniums, sumac, persimmon, buffalo-nut, Carolina buckthorn, mountain-laurel, and azaleas 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] (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 to moderate	Moderate to severe	Moderate to severe	Slight to severe	Moderate to severe

SPECIES DESIRABILITY

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

[1]Site indices 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 1960, Broadfoot and Krinard 1959, 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 species except cottonwood, for which it is 30 years.

[2]Annual growth of natural stands calculated from published yields at 50 years: eastern white pine (Doolittle 1956), inside-bark volume of total stem, all trees; 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 to 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 > 4.5 in d.b.h.; sweetgum (Winters and Osborne 1935, table 13), inside-bark volume to a 4.0-in i.b. top, trees > 4.5 in d.b.h.

Description of Landtype 2: Narrow Shale Ridges, Points, and Convex Upper Slopes

Geographic Setting—Shallow to moderately deep, loamy and silty soils on sloping to very steep ridge-tops, points of ridges, and adjoining convex upper slopes in Subregions 1 and 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. On these steep, convex ridges, surface and subsurface run-off is rapid, resulting in a dry site. Aspect does not seem to be a dominant site factor. Soils formed in loamy and silty residuum from shale, siltstone, and, in places, fine-grained sandstone. Shale fragments are common on the surface. Landtype 2 occurs extensively on mountain crests at varying elevations in LTA-A and on tops of hills and ridges that project above the general level of the sandstone uplands in LTA's B and C in association with Landtypes 6, 7, and 8. Often Landtype 2 is disturbed or entirely removed during surface mining of coal if seam(s) are at relatively shallow depths (Landtype 11). Landtype 2 also occurs with Landtype 6 on hills and ridges underlain by Mississippian shales and siltstones in LTA-D in association with Landtypes 20 and 21.

Dominant Soils—Petros, Weikert, Berks, and Muskingum; possibly Gilpin, Wernock, and Latham.

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

Depth to Bedrock—10 to 40 in.

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

Soil Drainage—Excessively drained to well-drained.

Relative Soil Water Supply—Very low to low.

Soil Fertility—Low.

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

Table 6.—*Forest management interpretations for Landtype 2: Narrow shale ridges, points, and convex upper slopes*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/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. 25.

Description of Landtype 3: 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. Landtype 3 is frequent in LTA's A, C, and D; occasional in LTA-B. It represents the thin to moderately thick sandstone free faces that occur intermittently on steep mountain slopes and benches (Landtypes 9 and 10). Landtype 3 occurs frequently in association with upper mountain slopes (Landtypes 7 and 8) and narrow sandstone ridges (Landtype 1) in LTA's A, B, C, and D. It occurs above the free face of the escarpment in LTA's C and D in association with sandstone ridges (Landtypes 1, 4, and 5). Landtype 3 also occurs extensively along deeply incised streams and creeks (Landtypes 12 and 13) in LTA-B and occasionally in LTA's C and D.

Dominant Soils—Ramsey and sandstone outcrops; possible Alticrest, Wallen, Steinsburg, and Dekalb.

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 in the solum is usually less than 35 percent, but it 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, buffalo-nut, mountain-laurel, vacciniums, lichens, mosses, grasses, and Carolina buckthorn are common understory species.

Table 7.—*Forest management interpretations for Landtype 3: 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	38

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. 25.

Description of Landtype 4:
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 4 is common in LTA-B, frequent in LTA-C, and occasional in LTA's A and D. It is associated with other sandstone ridges and uplands (Landtypes 1, 5, and 14). Hills, ridges, and associated slopes that occur above the general level of the sandstone uplands are dominated by shale and siltstone (Landtypes 2, 6, and 9). Most sandstone ridges end abruptly at the sandstone free face (Landtype 15) or merge with Landtype 3. Landtype 4 may merge with Landtypes 12 or 13 in the heads of hollows.

Dominant Soils—Lily, Alticrest, Wallen, Muskingum, Steinsburg, 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, red maple, southern red oak, chestnut oak, hickories, black oak, blackgum, shortleaf pine, and Virginia pine; occasional yellow-poplar, northern red oak, black cherry, black locust, post oak, white ash, eastern white pine, and eastern redcedar. Flowering dogwood, sassafras, serviceberry, sourwood, persimmon, buffalo-nut, lespedezas, sumac, viburnums, vacciniums, azaleas, and smilax are common understory species.

Table 8.—*Forest management interpretations for Landtype 4: 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	70
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	Post oak	Sassafras
Virginia pine	Chestnut oak	Serviceberry
White oak	N. red oak	Black locust
Yellow-poplar	Black oak	Red maple
Black cherry	S. red oak	Blackgum
	Scarlet oak	Flowering dogwood
	White ash	Sourwood
		Persimmon

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 5: 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 5 is common in LTA-B, frequent in LTA-C, and occasional in LTA's A and D. It is associated with other sandstone ridges and uplands (Landtypes 1, 4, and 14). Hills, ridges, and associated slopes that occur above the general level of the sandstone uplands are dominated by shale and siltstone (Landtypes 2, 6, and 10). Most sandstone ridges end abruptly at the sandstone free face (Landtype 16) or merge with Landtype 3. Landtype 5 may merge with Landtypes 12 or 13 in the heads of hollows.

Dominant Soils—Lily, Alticrest, Wallen, Muskingum, Steinsburg, 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—Chestnut oak, white oak, scarlet oak, red maple, southern red oak, hickories, black oak, post oak, blackgum, Virginia pine, and shortleaf pine; occasional black locust, yellow-poplar, eastern redcedar, and eastern white pine. Dogwoods, sassafras, sourwood, persimmon, vacciniums, sumac, viburnums, buffalo-nut, serviceberry, mountain-laurel, and smilax are common understory species.

Table 9.—*Forest management interpretations for Landtype 5: Broad sandstone ridges—south aspect*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	70	115
Shortleaf pine	60	102
Virginia pine	60	53

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. 25.

Description of Landtype 6:
Undulating Shale Uplands

Geographic Setting—Moderately deep, silty and clayey soils on gently sloping to moderately steep, rounded ridges and adjoining convex upper slopes in Subregions 1 and 2. Typically these undulating uplands are wider than 350 ft and maybe 1,000 ft or more wide. Slope ranges from 5 to 15 percent, but the area with slope greater than 10 percent is small 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 6 occurs frequently in LTA-B and only occasionally in LTA's A, C, and D. It represents the broader crests of mountains in LTA-A, the tops of higher hills and ridges that occur above the general level of the sandstone uplands in LTA's B and C, and the crests of hills and ridges in LTA-D.

Landtype 6 occurs mostly in association with Landtypes 2, 4, 5, 14, 20, and 21. In the Rugged Eastern Area (LTA-A), it occurs above Landtypes 7 and 8 and occasionally above Landtypes 9 and 10 in gaps. Landtype 6 is often disturbed by surface mining.

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

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

Table 10.—*Forest management interpretations for Landtype 6: 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. 25.

Description of Landtype 7: 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 Subregion 1. 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 7 is limited to LTA-A, where it occurs below Landtypes 2, 6, and occasionally 1 and 4 and above Landtype 9. Upper reaches of Landtypes 12 and 13 may extend into Landtype 7. Areas of shallow soils and sandstone ledges may be extensive enough to recognize Landtype 3. Surface mines (Landtype 11) occur extensively in association with Landtype 7.

Dominant Soils—Muskingum, Gilpin, and Berks; possibly Dekalb and Steinsburg. Zenith and Cutshin occur on cool slopes and in coves, particularly in LTA-A. 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, red maple, yellow-poplar, northern red oak, black oak, and sugar maple; occasional black locust, white basswood, blackgum, 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, buffalo-nut, and grape are common understory species.

Table 11.—*Forest management interpretations for Landtype 7: 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 to 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	Sassafras
Black walnut	Cucumbertree	Serviceberry
White oak	Sugar maple	E. redbud
N. red oak	Yellow buckeye	Black locust
Yellow-poplar	White basswood	Sumac
White ash		Red maple
		Flowering dogwood

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 8: Upper Mountain Slopes— South Aspect

Geographic Setting—Moderately deep, loamy and silty soils on moderately steep to very steep upper one-third to one-half of south slopes in Subregion 1. 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 8 is limited to LTA-A, where it occurs below Landtypes 2, 6, and occasionally 1 and 5, and above Landtype 10. Upper reaches of Landtypes 12 and 13 may extend into Landtype 8. Areas of shallow soils and sandstone ledges may be extensive enough to recognize Landtype 3. Surface mines (Landtype 11) occur extensively in association with Landtype 8.

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

Bedrock—Siltstone, shale, coal, and clay; possible 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, and shortleaf pine; occasional yellow-poplar, northern red oak, hickories, black locust, Virginia pine, elms, and eastern white pine. Flowering dogwood, sassafras, sourwood, serviceberry, sumac, viburnums, vacciniums, mountain-laurel, buffalo-nut, and grape are common understory species.

Table 12.—*Forest management interpretations for Landtype 8: 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	Sassafras
Shortleaf pine	Chestnut oak	Serviceberry
Virginia pine	Black oak	Black locust
White oak	Scarlet oak	Sumac
N. red oak	Elms	Red maple
Yellow-poplar		Blackgum
		Flowering dogwood
		Sourwood

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 9:
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 Subregion 1. 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 south-facing colluvial slopes (Landtype 10), particularly the coves, that are shaded extensively by adjacent land masses should be classified as Landtype 9. Landtype 9 is common in LTA-A and frequent in LTA-B. Landtype 9 occurs below Landtype 7 but may border on Landtypes 1, 2, 4, 6, or 14 in gaps. Upper reaches of Landtypes 12 and 13 usually extend into Landtype 9, and, in places, they merge with major river bottoms (Landtypes 23 and 24). Surface mines (Landtype 11) occur extensively in association with Landtype 9.

Dominant Soils—Jefferson, Grimsley, Shelocta, and Rigley. Zenith and Cutshin occur on cool slopes and in coves, particularly in LTA-A. 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, and 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, red maple, and American beech; occasional sugar maple, cucumbertree, yellow buckeye, eastern hemlock, eastern white pine, black oak, white ash, blackgum, white basswood, and black birch. Flowering dogwood, American hornbeam, vacciniums, grape, viburnums, hydrangea, spicebush, pawpaw, and strawberry-bush are common understory species.

Table 13.—*Forest management interpretations for Landtype 9: Colluvial mountain slopes, benches, and coves—north aspect*

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
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 to severe	Moderate to severe	Slight

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
E. white pine	Hickories	E. hemlock
White oak	American beech	Black 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. 25.

Description of Landtype 10:
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 Subregion 1. 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 extensively by adjacent land masses and should be classified as having a north aspect (Landtype 9). Landtype 10 is common in LTA-A and frequent in LTA-B. Landtype 10 occurs below Landtype 8, but may border on Landtypes 1, 2, 5, 6, or 14 in gaps. Upper reaches of Landtypes 12 and 13 usually extend into Landtype 10, and, in places, it merges with major river bottoms (Landtypes 23 and 24). Surface mines (Landtype 11) occur extensively in association with Landtype 10.

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, red maple, hickories, black oak, 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, pawpaw, and spicebush are common understory species.

Table 14.—*Forest management interpretations for Landtype 10: Colluvial mountain slopes, benches, and coves—south aspect*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf pine	65	135
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
		Red maple
		Blackgum
		Flowering dogwood

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 11:
Surface Mines

Geographic Setting—Nearly vertical high walls and young, loamy, rocky soils forming in heterogeneous 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 and auger mining (common in LTA-A) the spoil is smoothed to form benches with steep to very steep outer slopes and to partially cover the high wall. Benches ranges from 70 to 150 ft or more in width, and the high walls are generally 60 ft or more high. 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 (common in LTA's B, C, and D) reclamation standards require restoration to about 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—Fairpoint 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 texture of silt loam, loam, silty clay loam, or clay loam. Thirty-five to 80 percent of the 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 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 native woody species are eastern redcedar, yellow-poplar, black locust, red maple, Virginia pine, shortleaf pine, American sycamore, winged elm, hickories, white oak, scarlet oak, blackgum, post oak, blackjack oak, chestnut oak, black oak, sweetgum, black willow, cottonwood, river birch, sumac, persimmon, and sassafras. Two common exotic species are white poplar and royal paulownia. Consult Vogel's (1981) guide for specific recommendations for revegetating mine soils.

Table 15.—*Forest management interpretations for Landtype 11: 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	White poplar
Shortleaf pine	Hickories	Black willow
Virginia pine	Post oak	River birch
E. cottonwood	Chestnut oak	Blackjack oak
White oak	Black oak	Winged elm
Yellow-poplar	Scarlet oak	Sassafras
Sweetgum	Black locust	Sumac
American sycamore	Red maple	Blackgum
	Green ash	Persimmon
		Royal paulownia

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

Description of Landtype 12: 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 streams and creeks in Subregions 1 and 2. Slope ranges from 0 to 15 percent but is generally less than 6 percent. Landtype 12, in association with Landtype 13, occurs as long, narrow, winding, sometimes discontinuous strips of land bordering drainages. Short sandstone cliffs (Landtype 3) often separate the slopes and ridges from the terraces and streambottoms. Upper reaches of Landtype 12 extend into Landtypes 9 and 10 and occasionally into Landtypes 7 and 8 in LTA-A. In less rugged terrain, heads of hollows may extend into Landtypes 4, 5, and 14. Below the sandstone free face, Landtype 12 occurs in association with Landtypes 15 to 18, 20, and 21.

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 washed from soils formed in residuum and colluvium from acid sandstone, siltstone, and shale, and possibly limestone and calcareous 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 0 to 35 percent in the solum and to 60 percent in lower B and C horizons.

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

Relative Soil Water Supply—High. Irrigated by subsurface flow. Seeps occur on footslopes in winter and spring. Streambottoms have seasonal water table at depths of 2 to 5 ft for 1 to 3 months. This landtype is subject to frequent flash floods following short, high intensity storms and occasional general flooding following long, sustained 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, 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 16.—*Forest management interpretations for Landtype 12: Mountain footslopes, fans, terraces, and streambottoms with good drainage*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	90	154
Shortleaf pine	80	148
Virginia pine	75	120
N. red oak	80	62
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	Black oak	Black willow
Black walnut	Scarlet oak	River birch
White oak	American elm	American hornbeam
N. red oak		E. hophornbeam
Yellow-poplar		American beech
Sweetgum		Umbrella magnolia
American sycamore		Sassafras
		Red maple
		Boxelder
		Blackgum
		Dogwoods
		Sourwood

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 13: 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 streams and creeks in Subregions 1 and 2. Slope ranges from 0 to 4 percent. Landtype 13, in association with Landtype 12, occurs as long, narrow, discontinuous strips of land bordering mountain streams. Short sandstone cliffs (Landtype 3) often separate the slopes and ridges from the terraces and streambottoms. Upper reaches of Landtype 13 extend into Landtypes 9 and 10, and occasionally into Landtypes 7 and 8 in LTA-A. In less rugged terrain, heads of hollows may extend into Landtypes 4, 5, and 14. Below the sandstone free face, Landtype 13 occurs in association with Landtypes 15 to 18, 20, and 21.

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

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

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

Texture—Silt loam and silty clay loam; occasionally sand loam and 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 frequent flash floods following short, high-intensity storms and occasional general flooding following long, sustained storms.

Soil Fertility—Moderately high to high.

Vegetation—Red maple, sweetgum, blackgum, yellow-poplar, white oak, American sycamore; occasional E. 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 17.—*Forest management interpretations for Landtype 13: Mountain terraces and streambottoms with poor drainage*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/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. 25.

Description of Landtype 14:
Undulating Sandstone Uplands

Geographic Setting—Moderately deep to deep, loamy and silty soils on nearly level to rolling broad uplands that typically occupy the smoother, but not necessarily the highest parts, of the landscape in Subregions 1 and 2. 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 formed in loamy residuum from acid sandstone, siltstone, and shale. Landtype 14 is most common in LTA-B but occurs in LTA's C and D. It occurs in association with other sandstone ridges (Landtypes 1, 4, and 5). Hills and ridges that occur above these uplands are dominated by shale and siltstone (Landtypes 2, 6, and 9). The heads of hollows (Landtypes 12 and 13) may extend into Landtype 12.

Dominant Soils—Lily, Clarkrange, Lonewood, Crossville, Tilsit, and Clymer.

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

Depth of Bedrock—20 to 90 in. Clarkrange and Tilsit 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 Tilsit, which are moderately well-drained.

Relative Soil Water Supply—Medium.

Soil Fertility—Moderately low.

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

Table 18.—*Forest management interpretations for Landtype 14: Undulating sandstone mountain uplands*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. white pine	80	136
Shortleaf pine	65	113
Virginia pine	70	92
White oak	70 }	52
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

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 15:
Upper Escarpment Slopes and Benches—North Aspect

Geographic Setting—Deep to very deep, loamy soils formed in colluvium from sandstone, siltstone, and shale and underlain by similar rocks in subregions 1 and 2. Landtype 15 occupies the gently sloping to very steep upper one-third to one-half of northerly slopes that extend from the Plateau sandstone free face to the adjacent Eastern Highland Rim and Pennyroyal and Bluegrass regions or it borders coves and gorges that may extend several miles into the interior of the Plateau. Slope ranges from 5 to 70 percent. Much of the surface is covered with sandstone boulders and fragments. In LTA-B, the sandstone free face may occur one-fourth to one-third of the distance from the ridgetop to the streambottom. Here a short colluvial slope, similar to Landtype 15, may occur between the free face and the ridge (Landtypes 1, 2, 4, or 6). Landtype 15 occurs above Landtypes 12 and 13 or 23 and 24 in gorges of the Plateau interior where streams have not cut through the sandstone caprock. Where streams have cut through the sandstone caprock into the underlying Mississippian rocks, Landtype 15 occurs above Landtype 17. In the upper reaches of narrow gorges, the lower one-fourth to one-half of south-facing upper slopes (Landtype 16) should be included with Landtype 15 because shading mollifies the normal warm microclimate. As gorges widen, the effect of shading diminishes.

Dominant Soils—Grimsley, Jefferson, Shelocta, Rigley, and Zenith; possibly pockets of Ramsey, Alticrest, and Steinsburg. Formerly mapped as sandstone rockland or bouldery colluvial land.

Bedrock—Sandstone, siltstone, and shale.

Depth to Bedrock—40 to 60 in or more, except for Ramsey, Alticrest, and Steinsburg, which are less than 40 in deep.

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, and black locust; occasional blackgum, elms, red maple, southern red oak, eastern hemlock, eastern white pine, chinkapin oak, sweet birch, black cherry, black walnut, and cucumbertree. 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 19.—*Forest management interpretations for Landtype 15: Upper escarpment 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 (White oak, N. red oak, S. red oak)
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	Moderate to severe	Slight to moderate	Slight

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

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 16: Upper Escarpment Slopes and Benches—South Aspect

Geographic Setting—Deep to very deep, loamy soils formed in colluvium from sandstone, siltstone, and shale and underlain by similar rocks in Subregions 1 and 2. Landtype 16 occupies the gently sloping to very steep upper one-third to one-half of southerly slopes that extend from the Plateau sandstone free face to the adjacent Eastern Highland Rim and Pennyroyal and Bluegrass regions or it borders coves and gorges that may extend several miles into the interior of the Plateau. Slope ranges from 5 to 70 percent. Much of the surface is covered with sandstone boulders and fragments. In LTA-B, the sandstone free face may occur one-fourth to one-third of the distance from the ridgetop to the streambottom. Here a short colluvial slope, similar to Landtype 16, may occur between the free face and the ridge (Landtypes 1, 2, 5, or 6). Landtype 16 occurs above Landtypes 12 and 13 or 23 and 24 in gorges of the Plateau interior where streams have not cut through the sandstone caprock. Where streams have cut through the sandstone caprock into the underlying Mississippian rocks, Landtype 16 occurs above Landtype 18. In the upper reaches of narrow gorges, the lower one-fourth to one-half of Landtype 16 should be included with north-facing upper slopes (Landtype 15) because shading mollifies the normal warm microclimate. As gorges widen, the effect of shading diminishes.

Dominant Soils—Grimsley, Jefferson, Shelocta, and Rigley; possibly pockets of Ramsey, Alticrest, and Steinsburg. Formerly mapped as sandstone rockland or bouldery colluvial land.

Bedrock—Sandstone, siltstone, and shale.

Depth to Bedrock—40 to 60 in or more, except for Ramsey, Alticrest, and Steinsburg, which are less than 40 in deep.

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 15.

Soil Fertility—Moderate low to 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, southern red oak, shortleaf pine, and Virginia pine. Dogwood, viburnums, eastern redbud, sourwood, azaleas, and grape are common understory species.

Table 20.—*Forest management interpretations for Landtype 16: Upper escarpment 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)	48 (White oak, N. red oak, S. red oak, bracketed)
N. red oak	65	
S. red oak	(65)	

MANAGEMENT PROBLEMS

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

SPECIES DESIRABILITY

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

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 17:
Lower Escarpment Slopes and Benches—North Aspect

Geographic Setting—Moderately deep to deep loamy and clayey soils formed in colluvium from limestone, shale, siltstone, and sandstone and in limestone residuum, and underlain by limestone, siltstone, and shale in Subregion 2. Landtype 17 occupies the gently sloping to very steep lower one-half to two-thirds of north slopes that extend from the Plateau sandstone free face to the adjacent Eastern Highland Rim and Pennyroyal and Bluegrass regions or it borders coves and gorges that may extend several miles into the interior of the Plateau. It also occurs on northern slopes of narrow spur ridges below Landtype 22 in LTA-C and colluvial slopes below intermittent limestone cliffs in LTA-D. Slope ranges from 2 to 75 percent. Outcrops of limestone may cover up to 40 percent of the surface, but sandstone boulders also may be present. Shallow soils and limestone outcrops may be extensive enough to recognize Landtype 19; often mapped as soil complexes. Landtype 17 is absent in gorges of the Plateau where streams have not cut through the sandstone caprock. Where streams have cut through the sandstone caprock into the underlying Mississippian rocks, this landtype usually occurs downslope from Landtype 15 and above Landtypes 12 and 13 or 23 and 24. In the lower reaches of narrow gorges, some or all of south-facing lower slopes (Landtype 18) should be included with Landtype 17 because shading mollifies the normal warm microclimate. As gorges widen, the effect of shading diminishes.

Dominant Soils—Bouldin, Brookside, Shelocta, and Talbott. Formerly mapped as limestone rockland or bouldery colluvial land.

Bedrock—Limestone; occasionally siltstone and shale.

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

Texture—Channery to stony loam, sandy loam, silt loam, and silty clay loam.

Soil Drainage—Well-drained and moderately well-drained.

Relative Soil Water Supply—Medium to low. Usually soil water percolates deep into the limestone, but seeps and springs are associated with Brookside soils.

Soil Fertility—Moderate to moderately low.

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

Table 21.—*Forest management interpretations for Landtype 17: Lower escarpment slopes and benches—north aspect*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. redcedar	45	....
White oak	70	52–62 (White oak, N. red oak)
N. red oak	80	
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
Black walnut	E. redcedar	Ironwood
White oak	E. white pine	Winged elm
N. red oak	Hickories	Hackberry
Black oak	Post oak	E. redbud
Yellow-poplar	Chestnut oak	Blackgum
	Chinkapin oak	Dogwood
	Scarlet oak	
	Elms	
	Sugar maple	

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 18:
Lower Escarpment Slopes and Benches—South Aspect

Geographic Setting—Moderately deep to very deep, loamy and clayey soils formed in colluvium from limestone, shale, siltstone, and sandstone and in limestone residuum, and underlain by limestone, siltstone, and shale in Subregion 2. Landtype 18 occupies the gently sloping to very steep lower one-half to two-thirds of south slopes that extend from the Plateau sandstone free face to the adjacent Eastern Highland Rim and Pennyroyal and Bluegrass regions or it borders coves and gorges that may extend several miles into the interior of the Plateau. It also occurs on southern slopes of narrow spur ridges below Landtype 22 in LTA-C and on colluvial slopes below intermittent limestone cliffs in LTA-D. Slope ranges from 2 to 75 percent. Outcrops of limestone may cover up to 40 percent of the surface, but sandstone boulders also may be present. Shallow soils and limestone outcrops may be extensive enough to recognize Landtype 19; often mapped as complexes. Landtype 18 is absent in gorges of the Plateau where streams have not cut through the sandstone caprock. Where streams have cut through the sandstone caprock into the underlying Mississippian rocks, this landtype usually occurs downslope from Landtype 16 and above Landtypes 12 and 13 or 23 and 24. In the lower reaches of narrow gorges, some or all of Landtype 18 should be included with north-facing lower slopes (Landtype 17) because shading mollifies the normal warm microclimate. As gorges widen, the effect of shading diminishes.

Dominant Soils—Bouldin, Brookside, Shelocta, and Talbott. Formerly mapped as limestone rockland or bouldery colluvial land.

Bedrock—Limestone; occasionally siltstone and shale.

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

Texture—Channery to stony loam, sandy loam, silt loam, and silty clay loam.

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

Relative Soil Water Supply—Low to very low. Usually soil water percolates deep into the limestone, but seeps and springs are associated with Brookside soils.

Soil Fertility—Moderate to moderately low.

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

Table 22.—*Forest management interpretations for Landtype 18: Lower escarpment slopes and benches—south aspect*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf Pine	55	90
Virginia pine	60	53
E. redcedar	45	....
White oak	50	32

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

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

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 19: Shallow Soils and Limestone Outcrops

Geographic Setting—Small to extensive areas of limestone outcrops interspersed with patches of shallow to moderately deep, clayey soils in Subregion 2. In LTA-C, this intricate pattern of soils and rock outcrops occurs in gorges of steams that have cut through the sandstone caprock and on footslopes of Plateau spur ridges bordering the Eastern Highland Rim and Pennyroyal in association with Landtypes 17 and 18. In LTA-D, Landtype 19 represents the intermittent limestone cliffs and bands of shallow soils immediately above these cliffs. Limestone or shale ridges (Landtypes 22, 6, or 2) and, in a few places, shale slopes (Landtypes 20 and 21) occur above the cliffs, and Landtypes 17 and 18 occupy the rocky colluvial slopes below the cliffs. Eastern redcedar often dominates this landtype. Slope ranges from 2 to 60 percent. The soil mass may contain up to 65 percent limestone slabs. More than 50 percent of the soil surface may be exposed limestone, and, where exposure is extensive, the limestone is often terraced. The intermittent cliffs in LTA-D are not quite vertical because of the regional dip to the southeast.

Dominant Soils—Barfield, Fairmount, Gladeville, and limestone rockland. Pockets of moderately deep Talbott, Colbert, and Caneyville may occur in this landtype.

Bedrock—Limestone and thin strata of calcareous clay shale.

Depth to Bedrock—Mostly less than 20 in but ranges up to 40 in where Talbott, Colbert, and Caneyville soils occur.

Texture—Silty clay loam, silty clay, and clay.

Soil Drainage—Well-drained to excessively drained, except for Colbert soils, which are moderately well-drained.

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

Soil Fertility—Moderate.

Vegetation—Eastern redcedar, hickories, blue ash, hackberry, white ash, and elms; occasional honeylocust, Virginia pine, blackjack oak, black walnut, butternut, yellow-poplar, southern red oak, and osage-orange. Forbs, grasses, sumac, eastern redbud, winged elm, Carolina buckthorn, rusty blackhaw, hawthorns, and pricklypear are common in the understory. Very small openings (<1 acre) of native grassland occur in this landtype. Little bluestem is dominant, while big bluestem, Indiangrass, side-oats grama, and other grasses and forbs are frequent constituents.

Table 23.—*Forest management interpretations for Landtype 19: 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	Black walnut	Blackjack oak
E. redcedar	Butternut	Winged elm
	Hickories	Hackberry
	S. red oak	Osage-orange
	Elms	E. redbud
	Yellow-poplar	Honeylocust
	White ash	
	Blue ash	

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 20: Colluvial Siltstone Slopes— North Aspect

Geographic Setting—Deep, loamy, and gravelly soils on sloping to very steep lower two-thirds to three-fourths of north slopes west of the Plateau sandstone free face in LTA-D, Subregion 2. The linear to convex sideslopes and concave toeslopes range from 2 to 60 percent but are dominantly greater than 12 percent. Soils formed in coarse, loamy colluvium washed from acid siltstone and shale of lower Mississippian origin. Landtype 20 occurs below shale ridges (Landtypes 2 and 6) and above terraces, streambottoms, and flood plains (Landtypes 12 and 13 or 23 and 24). In places, Landtype 20 occurs between shale ridges and limestone cliffs (Landtype 19).

Dominant Soil—Cranston.

Bedrock—Siltstone and shale.

Depth to Bedrock—4 to 20 ft.

Texture—Gravelly silt loam. The weighted average of pebbles and channers of acid siltstone in the control section is less than 35 percent by volume but may range up to 60 percent in the A and C horizons and up to 45 percent in the B horizon.

Soil Drainage—Well-drained.

Relative Soil Water Supply—Medium to high.

Soil Fertility—Moderate.

Vegetation—White oak, scarlet oak, black oak, and hickories; occasional chestnut oak, shortleaf pine, American beech, cucumbertree, yellow-poplar, northern red oak, white ash, southern red oak, blackgum, red maple, and black locust. Dogwood, sassafras, serviceberry, sourwood, and smilax are common understory species.

Table 24.—*Forest management interpretations for Landtype 20: Colluvial shale slopes—north aspect*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
N. red oak	80	62
Yellow-poplar	90	90

MANAGEMENT PROBLEMS

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

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
White oak	Shortleaf pine	American beech
N. red oak	Hickories	Sassafras
Yellow-poplar	Chestnut oak	Black locust
White ash	Black oak	Red maple
	S. red oak	Blackgum
	Scarlet oak	Dogwood
	Cucumbertree	Sourwood

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 21:
Colluvial Siltstone Slopes—South Aspect

Geographic Setting—Deep, loamy, and gravelly soils on sloping to very steep lower two-thirds to three-fourths of south slopes west of the Plateau sandstone free face in LTA-D, Subregion 2. The linear to convex sideslopes and concave toeslopes range from 2 to 60 percent but are dominantly greater than 12 percent. Soils formed in coarse, loamy colluvium washed from acid siltstone and shale of lower Mississippian origin. Landtype 21 occurs below shale ridges (Landtypes 2 and 6) and above terraces, streambottoms, and flood plains (Landtypes 12 and 13 or 23 and 24). In places, Landtype 20 occurs between shale ridges and limestone cliffs (Landtype 19).

Dominant Soil—Cranston.

Bedrock—Siltstone and shale.

Depth to Bedrock—4 to 20 ft.

Texture—Gravelly silt loam. The weighted average of pebbles and channers of acid siltstone in the control section is less than 35 percent by volume but may range up to 60 percent in the A and C horizons and up to 45 percent in the B horizon.

Soil Drainage—Well-drained.

Relative Soil Water Supply—Medium.

Soil Fertility—Moderate.

Vegetation—White oak, scarlet oak, chestnut oak, shortleaf pine, and hickories; occasional red maple, northern red oak, scarlet oak, black oak, blackgum, and black locust. Sassafras, dogwood, sourwood, serviceberry, and smilax are common understory species.

Table 25.—*Forest management interpretations for Landtype 21: Colluvial shale slopes—south aspect*

PRODUCTIVITY		
Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf pine	70	125
Scarlet oak	70	52

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	Sassafras
White oak	Black locust	Red maple
Chestnut oak	N. red oak	Blackgum
Black oak		Dogwood
S. red oak		Sourwood

See footnotes 1 and 2 to table 5, p. 25.

Table 25.—*Forest management interpretations for Landtype 21: Colluvial shale slopes—south aspect*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
Shortleaf pine	70	125
Scarlet oak	70	52

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	Sassafras
White oak	Black locust	Red maple
Chestnut oak	N. red oak	Blackgum
Black oak		Dogwood
S. red oak		Sourwood

See footnotes 1 and 2 to table 5, p. 25.

Table 26.—*Forest management interpretations for Landtype 22: Limestone ridges and convex upper slopes*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/acre)
E. redcedar	45	....
N. red oak	75	52–57 (N. red oak, Black oak, Scarlet oak)
Black oak	75	
Scarlet oak	70	
Yellow-poplar	85	80

MANAGEMENT PROBLEMS

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

SPECIES DESIRABILITY

Most desirable	Acceptable	Least desirable
Shortleaf pine	Virginia pine	E. hophornbeam
Black walnut	Hickories	Winged elm
White oak	Chestnut oak	Sassafras
N. red oak	Black oak	E. redbud
Yellow-poplar	S. red oak	Red maple
White ash	Scarlet oak	Blackgum
	Elms	Dogwood
		Sourwood
		Persimmon

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 23: 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 and Kentucky Rivers and their major tributaries in Subregion 3. Slope ranges from 0 to 20 percent on footslopes and terraces but is 5 percent or less on flood plains. This landtype occurs in association with Landtype 24, which has poor internal drainage.

Dominant Soils—Allegheny, Monongahela, Cotaco, Captina, and Elk on footslopes and terraces; Cuba, Steff, Pope, Philo, Huntington, Lindside, and Combs on floor plains.

Parent Material—On terraces, soils formed in old silty alluvium, and on flood plains, parent material consists of more recent alluvium. Alluvium washed from soils formed in residuum or colluvium weathered from acid sandstone, siltstone, shale, and limestone.

Depth to Bedrock—3 1/2 to more than 10 ft. Monongahela and Captina soils have fragipans at depths ranging from 18 to 30 in and 16 to 30 in, respectively.

Texture—Silt loam, loam, and fine sandy loam; occasionally sandy loam and silty clay loam. Solums usually contain less than 35 percent rock fragments. C horizons may contain more than 35 percent rock fragments or lenses of gravel. In Captina soils, the lower part of the fragipan may contain up to 75 percent chert 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, southern red oak, shingle oak, 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 27.—*Forest management interpretations for Landtype 23: 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
Northern 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	Southern red oak	E. hophornbeam
White oak	Shingle oak	Sassafras
N. red oak	Elms	American hazel
Pin oak		E. redbud
Yellow-poplar		Sumacs
Sweetgum		Red maple
American sycamore		Boxelder
		Blackgum
		Dogwoods
		Sourwood
		Persimmon

See footnotes 1 and 2 to table 5, p. 25.

Description of Landtype 24: 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 and Kentucky Rivers and their major tributaries in Subregion 3. Slope is 4 percent or less. This landtype occurs in association with Landtype 23, which has good internal drainage.

Dominant Soils—Morehead on terraces; Stendal, Atkins, Stokly, Melvin, and Newark on flood plains.

Parent Material—On terraces, soils formed in old silty alluvium, and on flood plains, parent material consists of more recent alluvium. Alluvium washed from soils formed in residuum or colluvium weathered from acid sandstone, siltstone, shale, and limestone.

Depth to Bedrock—5 to 10 ft or more.

Texture—Silt loam, loam, and silty clay loam; occasionally sandy loam and fine sandy loam. Coarse fragment content is usually less than 20 percent in the solum but may range up to 60 percent below 40 in.

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—Pin oak, sweetgum, swamp white oak, red maple, green ash, elms, and blackgum; occasional American sycamore, silver maple, shagbark hickory, shellbark hickory, river birch, yellow-poplar, black willow, hackberry, boxelder, and cottonwood. Dogwoods, cane, grasses, sedges, ferns, alder, common poison-ivy, and common trumpet-creeper are common in the understory.

Table 28.—*Forest management interpretations for Landtype 24: Terraces and flood plains with poor drainage*

PRODUCTIVITY

Species	Site index[1]	Average annual growth[2] (ft^3/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
E. cottonwood	Shagbark hickory	Black willow
Swamp white oak	Shellbark hickory	River birch
Pin oak	Elms	Silver maple
Yellow-poplar	Hackberry	Boxelder
Sweetgum	Red maple	Blackgum
American sycamore		Dogwoods
Green ash		

See footnotes 1 and 2 to table 5, p. 25.

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APPENDIX

COUNTY SOIL SURVEYS AVAILABLE FOR THE NORTHERN CUMBERLAND PLATEAU

*Avers, P. E.; Austin, J. S.; Long, J. K.; Love, P. M.; Hail, C. W. Soil survey of Menifee and Rowan Counties and Northwestern Morgan County, Kentucky. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service; 1974. 88 p. + maps.

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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

Smalley, Glendon W. 1986 Classification and evaluation of forest sites on the Northern Cumberland Plateau. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. SO-60. 74 p.

Presents a comprehensive forest site classification system for the Northern Cumberland Plateau in north-central Tennessee and eastern Kentucky. The system is based on physiography, geology, soils, topography, and vegetation.

Additional keywords: Site index, mean annual increment, soil properties, pines, hardwoods.

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