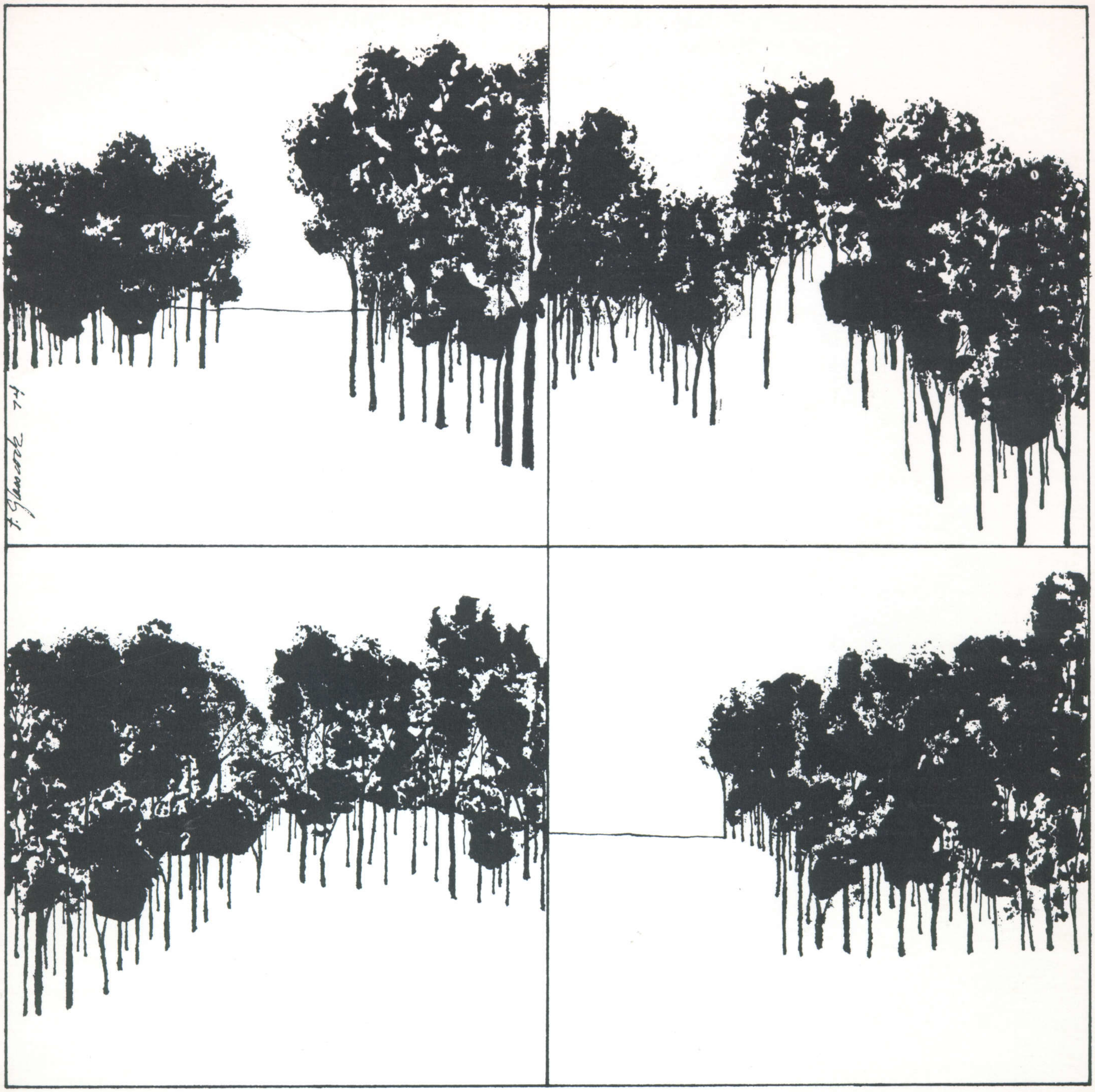

Forest Cover Photo-Interpretation Key for the Cumberland Plateau Forest Habitat Region in Alabama

DEPARTMENT OF FORESTRY
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INTRODUCTION

Photo-interpretation keys for forest cover provide a means by which persons can assess the nature of the cover when it is imaged on aerial photographs. Such persons might wish to do this for the purpose of stratifying the cover prior to an inventory, to assess the cover when planning logging, stand conversion, or site preparation operations, or to assess fuel types when developing a fire control plan. Others might use the keys to assist in evaluating the forest cover when developing forest management plans, environmental impact statements, or land-use plans. The list of potential uses of keys of this type is long and is still growing. The keys are valuable tools for land management professionals, and as these people become more aware of their potential, their utilization will undoubtedly increase.

Relatively few forest cover type photo-interpretation keys have been developed for civilian use anywhere and, as far as can be determined from an extensive search of the literature, only two (Parker and Johnson, 1969; and Northrop and Johnson, 1970) were developed for conditions in Alabama before 1971. Furthermore, these two keys are applicable only to very small areas and both require special photography. In order to fill this gap and make aerial photographs more useful to forest land managers, the Department of Forestry in Auburn University Agricultural Experiment Station embarked on a program to construct a key for each of a set of forest habitat regions into which the State will be divided. This is the fourth of the series. (Johnson and Sellmann, 1974, 1975, and 1977).[2]

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[2] It is intended that the publication containing the key for any given forest habitat region be an independent unit incorporating all the information needed for the use of the key for that region. However, much of the written material will be essentially common to several, if not all, of the regions. It would be very difficult to rephrase this material in enough different ways so that the wording would be different from region to region. As a consequence, no attempt will be made to rephrase these common sections nor will they be set off with quotations marks.

The keys represent a departure from current practice in that they are designed for use by humans, not automatic data processing devices, and that they are based primarily on ecological relationships rather than spectral signatures. This general design was chosen deliberately because it was felt that the keys should be of use to all land managers in the regions covered, not only to those with access to special aerial photography and to the complex and expensive equipment needed when reflectance patterns are used as the basis for interpretations. In addition, the keys are designed for use with either prints or transparencies and with photography taken under a wide range of film-filter-season-scale combinations. They should therefore be of value to most land managers in the areas covered.

Initially the objective was to prepare keys so that U.S. Department of Agriculture - Agricultural Stabilization and Conservation Service (USDA-ASCS) photographs could be used to stratify forest cover into meaningful cover types. The USDA-ASCS aerial photographic program began operating in the early nineteen-thirties with the advent of the federal crop control programs. Until recently these photographs have been made using panchromatic film in cameras equipped with a 8.25 inch focal length lens and a Wratten No. 12 (minus-blue) filter. The photographic scale has been 1:20,000 at approximately mean ground elevation and the format size, except for the very earliest photographs, has been 9 x 9 inches. Recently the photographic specifications have been changed, for reasons of economy, so that the scale is 1:40,000 and the focal length of the camera lens is 6 inches. This key has been developed using the 1:20,000 photographs. However, the design of the key is such that it can be used with little or no modification with photographs taken at other scales. The scales probably should be no larger than 1:10,000 because an insufficient area of ground surface would be visible on a single stereopair to permit an accurate evaluation of the topographic positions of the stands in question. This problem would be aggravated if small format sizes (e.g., 70 mm photography) were used. It is possible that the keys could be used with scales as small as 1:100,000 if the base-height ratio was such that a good stereo-image of that ground surface could be obtained. With such small scales the major problems probably would be associated with the branch-bottom conditions where the evaluation is based on apparent stream width.

The key probably could be used, with little or no modification, with black and white infrared photography, either conventional (exposed through a deep red filter, such as the Wratten 89B) or modified (exposed through a dark yellow filter, such as the Wratten No. 12 "minus-blue" filter). With some modification they probably could also be used with normal color or infrared color photography.

It probably is well that the keys have been designed in this way because it means that they can be used by organizations electing to obtain their own photography. There will probably be an increase in the use of such photography since the USDA-ASCS has changed the scale of its photographs, which reduces costs to the agency but increases costs and inconvenience of its customers. Another factor operating to reduce utilization of USDA-ASCS photography by the forest industry is the lack of consumer control of photographic contrast and season of photography.

The keys have been designed to indicate the probable species composition of the stands being examined. They provide no information on the condition of the stands (i.e., the sizes of trees making up the stands or their density). Stand conditions can be evaluated using a number of procedures which have been described elsewhere (Avery, 1966 and 1977; Moessner, 1960; Spurr, 1960; Wilson *et al.*, 1960). It must be kept in mind that aerial photographs record the situation as of a given point in time. The longer the time between film exposure and photo-interpretation, the greater is the probability of errors in photo-interpretation. Forests are dynamic and change with time. Natural events such as plant succession, insect or disease attacks, or wind storms may change the species composition in a given area after the photographs are taken. Man-caused changes, such as logging, clearing, planting, burning, may be even more extensive and profound. For example, the practice of introducing species into areas in which they are not native or planting species off their normal sites will completely invalidate a photo-interpretation key based on normal species occurrence-site relationships. For these reasons, one must not expect these keys to yield accurate results when the photographs are old or where land use has tended to destroy the usual species occurrence-site relationships.

DESCRIPTION OF THE REGION

The location of the Cumberland Plateau Forest Habitat Region is shown in generalized form in figure 1 and in detail on the county maps in Appendix III. It adjoins the Ridge and Valley Forest Habitat Region on the east with the boundary between the two regions coinciding with the base level line (figures 21 and 27) at the foot of the eastern escarpment of Lookout Mountain. This regional boundary extends from the Alabama-Georgia border to Gadsden at the southern end of Lookout Mountain. From Gadsden the boundary crosses the mouth of Wills Valley along U.S. Highway 431. It then follows U.S. 431 to the top of Sand Mountain. On the top of Sand Mountain it coincides with the height of land separating the watersheds of the Tennessee and Black Warrior Rivers as far west as the point where the watershed boundary becomes indistinct as the rocks of the Cumberland Plateau and Warrior Basin Forest Habitat Regions disappear under the Coastal Plain deposits in Franklin County. Across Lawrence County and into Franklin County the strip of land in the Cumberland Plateau Region is very narrow but yet it is recognized as a separate unit by the geologists who refer to the strip as the "Sand Mountain District" (Harris and McMaster, 1965). From the western terminus eastward, the Habitat Region boundary coincides with the boundary of the Moulton Valley, along the base line at the foot of the Brindley Mountain escarpment, to the Tennessee River at the point where the river passes Whitesburg and Wallace mountains. The regional boundary crosses the Tennessee River at this point and follows the base of the western slopes of Wallace, Green, and Huntsville mountains into the Huntsville area. It then loops around the northern end of Huntsville Mountain to the vicinity of Moontown where it crosses the Flint River valley to Reed Mountain. From this point it follows the bases of Berry, Lewis, Backbone, and Hale mountains to the Alabama-Tennessee border.

Lying outside the boundary described above are several pieces of land which have been included in the Cumberland Forest Habitat Region. The largest of these is Chandler Mountain, which is located southwest of Gadsden. West of Huntsville are several outliers which are knobs or hills projecting above the general ground level and are remnants of the Cumberland Plateau which have not yet been completely eroded away.

The Cumberland Plateau Forest Habitat Region includes essentially the northern half of the Alabama portion of the Cumberland Plateau Section of the Appalachian Plateaus physiographic province (Fenneman, 1938; Johnston, 1930 and 1932; and Sapp and Emplaincourt, 1975). This division of the geologic Cumberland Plateau was made because the forest types found south of the defined boundary differed appreciably from those found north of the boundary. The portion of the Cumberland Plateau Section which lies to the south of the watershed boundary has been designated the Warrior Basin Forest Habitat Region and a separate key is being developed for it.

Auburn University and Mississippi State University have jointly developed a map and descriptions for a system of forest habitat regions occurring in Mississippi and Alabama (Hodgkins, Cannon, and Miller, 1976). This system was not in existence when the photo-interpretation keys for the Piedmont (Johnson and Sellman, 1974) and the Mountain (Johnson and Sellman, 1975) Forest Habitat Regions were developed. Fortuitously, the bounds of these two regions coincided quite closely with their Hodgkins-Cannon-Miller counterparts. It was hoped that this pattern could be continued with the photo-interpretation keys being developed for the Hodgkins-Cannon-Miller regions. Unfortunately it was impossible to do this in the case of the Ridge and Valley Forest Habitat Region (Johnson and Sellman, 1977) because the pattern of species occurrence would not permit it. This also is the situation with the Cumberland Plateau Forest Habitat Region. Consequently, it is essential that persons using the systems realize that they are different.

The Cumberland Plateau Forest Habitat Region consists of a heavily dissected peneplain which stands higher than any of the surrounding forest habitat regions. This peneplain has been developed on beds or strata of sandstone and limestone (table 1) which dip gently toward

Table 1. Generalized stratigraphy of the Cumberland Plateau Forest Habitat Region (Sanford, 1966).

Formation	Thickness (feet)	Character of Rock
Pottsville Formation	400±	Sandstone, brown and gray, medium to coarse-grained, thin-to-thick bedded; gray shale; siltstone, conglomerate, and coal beds.
Pennington Formation	100±	Limestone, gray, argillaceous, crystalline, and dolomitic; red and green shale.
Bangor Limestone	350±	Limestone, blue-gray, crystalline, oolitic, and dolomitic; contains shale and chert nodules.
Hartselle Sandstone	0-20	Sandstone, tan and gray, fine-to-coarse-grained, contains green shale and limestone.
Gasper Formation	150± (Gasper Formation and St. Genevieve Limestone combined)	Limestone, gray crystalline, and oolitic; some shale.
St. Genevieve Limestone		Limestone, light-gray to gray, crystalline and oolitic.
Tuscumbia Limestone	200±	Limestone, gray, crystalline, contains chert nodules.
Fort Payne Chert	150±	Limestone, gray to yellow, crystalline; blue-gray dense chert.
Chattanooga Shale	20±	Shale, black, fissile, pyritiferous; contains sandstone.
Red Mountain Formation	200±	Shale, tan; tan and gray fine-grained ferruginous sandstone; limestone.
Chickamauga Limestone	?	Limestone, blue-gray, fine-grained, argillaceous; contains chert nodules and partings of shale.
Newala Limestone	?	Limestone, pearl-gray to dark-gray, thick-bedded, with little dolomite.

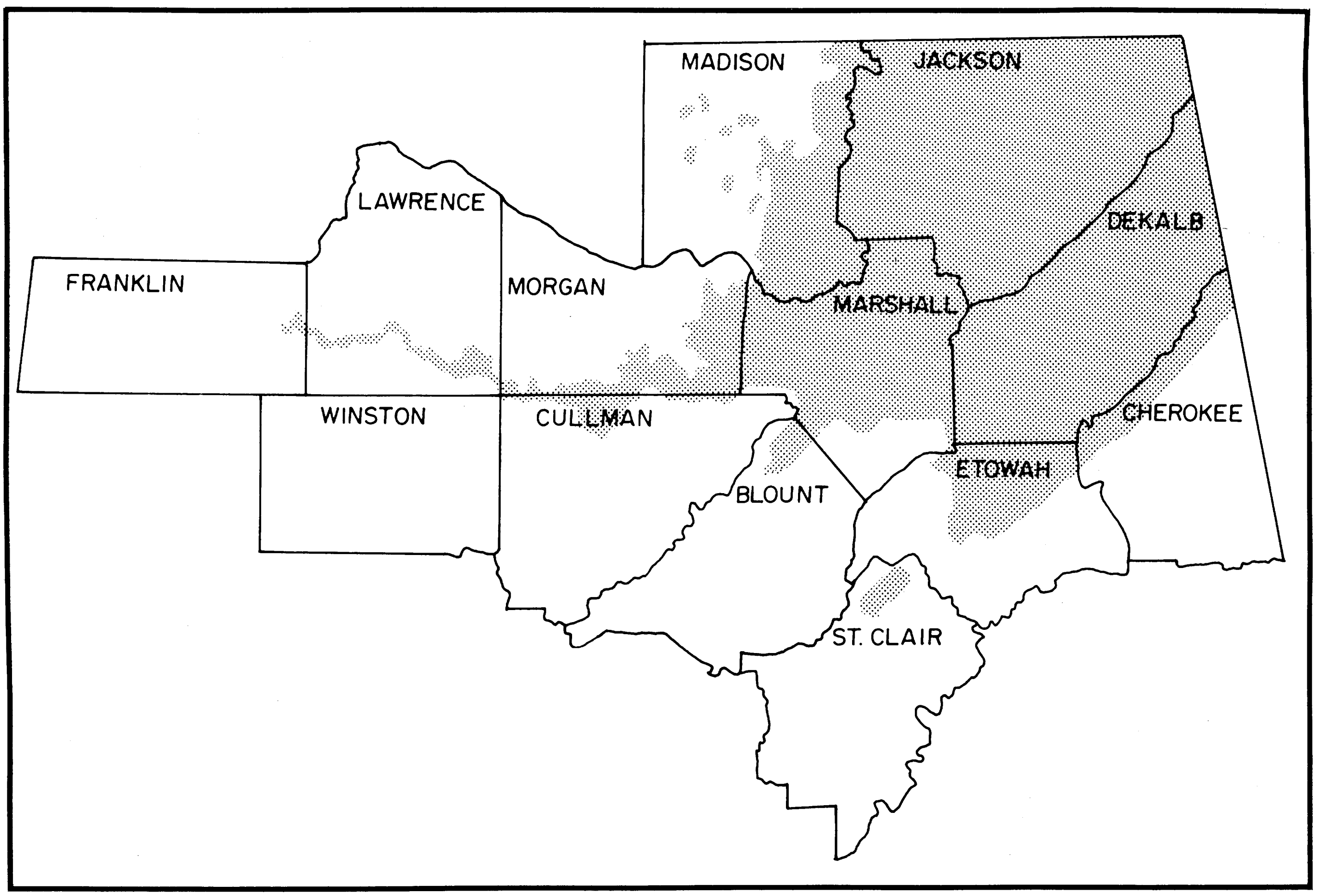

FIGURE 1. Map of the Cumberland Plateau Forest Habitat Region.

the south. In Alabama the highest portions of the peneplain are along the Alabama-Georgia and Alabama-Tennessee state lines where altitudes approach 2,000 feet. The altitude of the peneplain at the southern margin of the Region, along the watershed boundary between the Tennessee and Black Warrior rivers on Brindley Mountain, is approximately 1,000 feet. The lowest altitudes in the Region, approximately 500 feet, are found along the Tennessee River.

The surface of the Cumberland Plateau peneplain is dominated by the Pottsville sandstone, which is resistant to erosion. As can be seen from table 1, this sandstone cap is underlain by a number of limestone strata. These limestones are susceptible to attack by water and erode much more readily than do the sandstones. This pattern of occurrence in the stratigraphic column and the relative erodability of the individual strata have had a profound influence on the development of the topography of the Region.

Rocks making up the strata listed in table 1 were originally laid down as horizontal beds under water. Subsequently the land rose and heavy lateral stresses were imposed on the rocks causing the strata to bend in an undulating manner forming a series of anticlines, where the strata bent upward, and synclines, where the surface bent downward. Resistance to this bending was less in the anticline areas than in the synclines and, consequently, the upward bending became intense resulting in the buckling, fracturing, and, in some places, thrust faulting of the strata. This fracturing of the erosion-resistant sandstone exposed the underlying water-soluble limestones to weathering and dissolution. In turn, this has led to the development of valleys along the fracture zones. There are two major valleys of this type in the Cumberland Plateau Forest Habitat Region - Wills Valley, between Lookout and Sand Mountains, and the Sequatchie Valley, west of Sand Mountain and in which the Tennessee River flows until it turns to the west at Guntersville.

Lookout and Sand mountains are mesa-like tablelands which have somewhat hollow surfaces because they are formed on synclines (figures 2 and 4). The tops of both mountains are dominated by Pottsville sandstone which erodes very slowly. However, the edges of the mountains are subject to sapping as the underlying limestones are dissolved away leaving the sandstone unsupported. This has resulted in a line of vertical, or nearly vertical, cliffs (rimrock) at the edges of the tablelands with deposits of scree or talus below the cliffs (figures 2 and 3). Certain of the strata below the Pottsville sandstone cap are more resistant to erosion than the others. These form benches or lines of outcrops at varying distances down the talus slope.

On the tops of Sand and Lookout mountains, streams have low gradients and cut into the surface very slowly (figure 4). However, where the streams spill over the edge

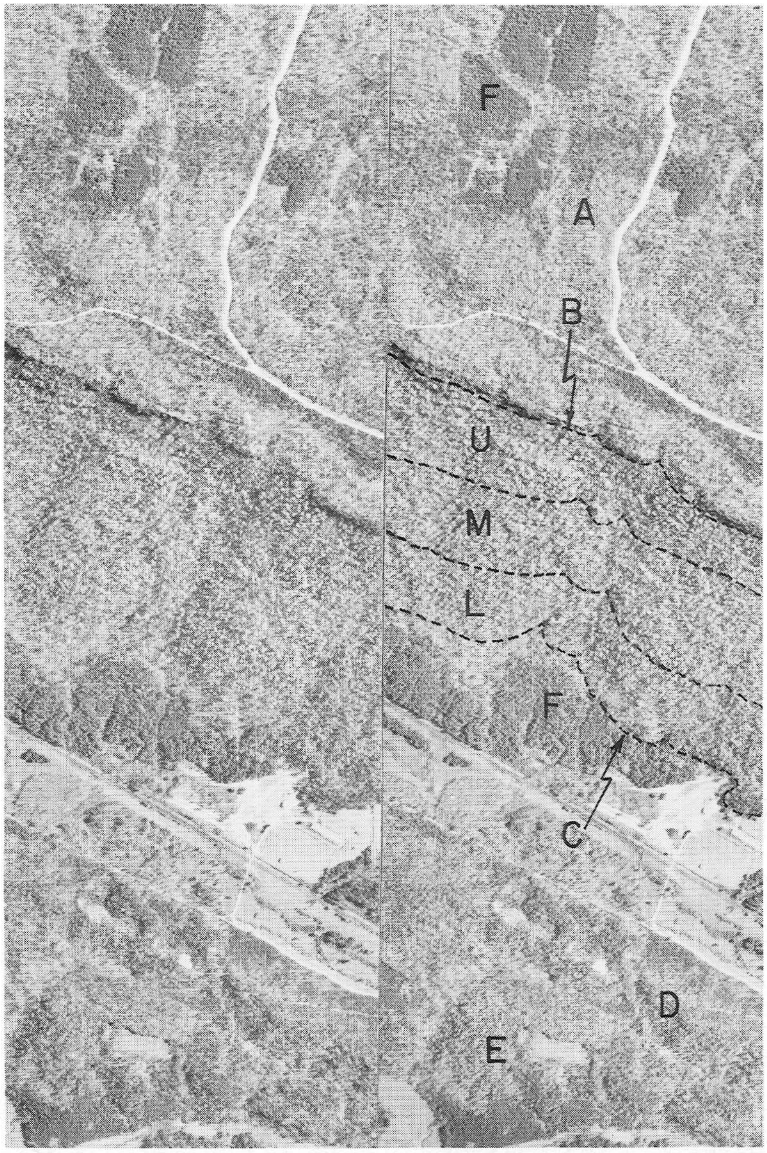

FIGURE 2. Stereogram of a portion of the northwestern escarpment of Lookout Mountain showing: (A) the somewhat concave top of the mountain; (B) the sandstone cliffs at the escarpment edge; (C) the base-level line at the foot of the escarpment which marks the boundary between Zones IV and V; (D) a structural ridge in the Wills Valley, Zone IV; (E) a minor non-linear hill; and (F) a pine plantation. The dark crowned trees along the rimrock are Virginia pine. The slope positions for the escarpment of a flat-topped mountain are delineated using dashed lines. The upper slope is labelled (U), middle slopes (M), and lower slopes (L). (DeKalb County, PM-1LL-37,38).

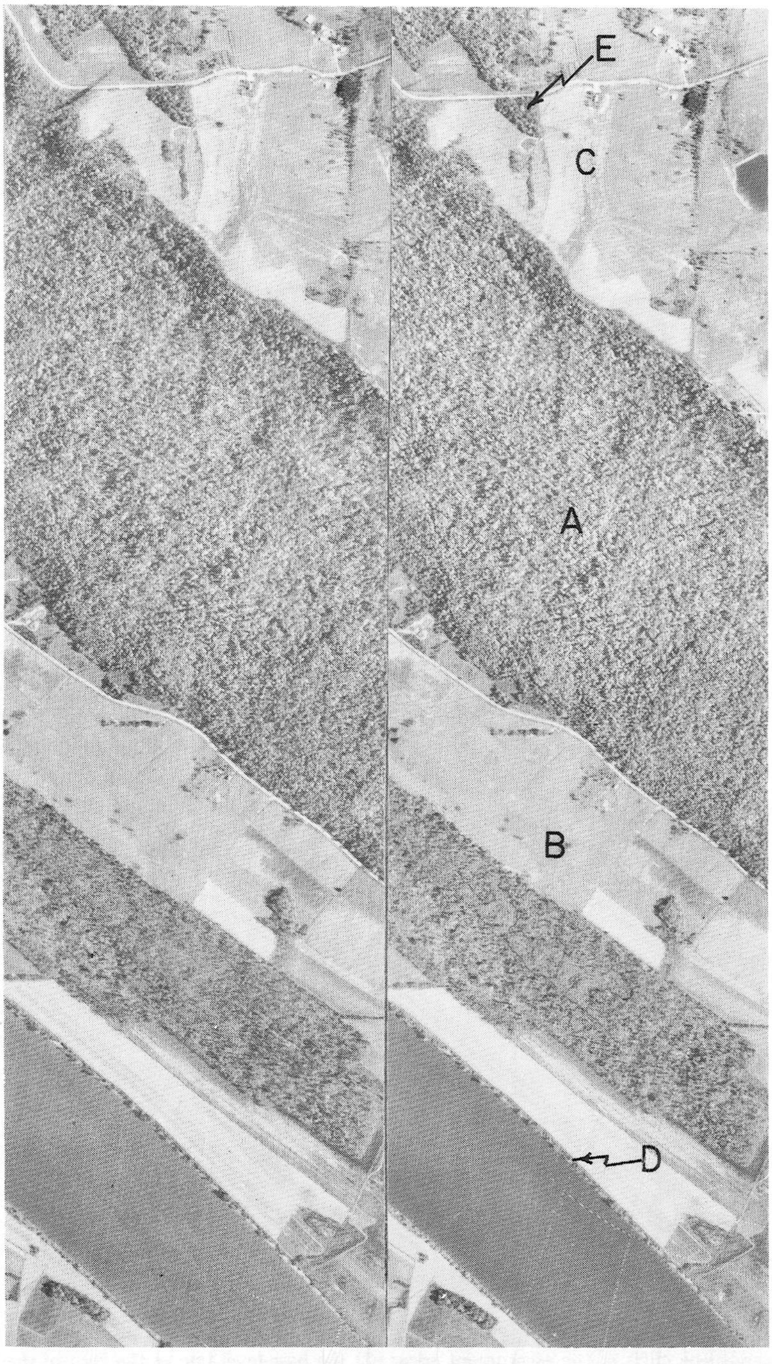

FIGURE 3. Stereogram of a portion of the northwestern escarpment of Sand Mountain. Zone I includes the escarpment proper from the base of the cliffs to the base-level line (A), Zone II is the floor of the Sequatchie Valley (B), and Zone III is the top of Sand Mountain (C). Approximately the upper third of the escarpment slope is made up of sandstone material while the remainder is material derived from limestone. Due to the thickness of the forest cover, neither benches nor stream channels are visible and consequently the boundary between the two types of geologic material cannot be located with any degree of confidence. In spite of the appearance of stand homogeniety the change in the species complexes across the sandstone-limestone boundary is dramatic. (D) indicates the narrow band of vegetation that is in the 'bottomland' site assigned to the Tennessee River by the key. (E) is a stand on an upland 'flat', an area without discernable slope. (F) is a pure hardwood stand on a 'flat' on the valley floor. The texture of the stand at (G), made up of very small light-toned crowns, indicates the presence of water tupelo. (Jackson County, BPS-1MM-11,12).

FIGURE 4. Stereogram of a portion of the northwestern part of Lookout Mountain showing the escarpment and the somewhat concave surface of the mountain top which leads to the surface drainage flowing away from the escarpment edge. (DeKalb County, PM-1LL-36,37).

of the rimrock the cutting is accelerated and augmented by sapping of the sandstone as the limestone below is dissolved away by the running water. This action has resulted in canyon-like gorges being cut into the tablelands. One of the deepest gorges in the eastern United States, Little River Canyon in Lookout Mountain (figure 5), was formed in this way. This type of surface dissection has progressed much further to the west of the Sequatchie Valley than it has on Sand and Lookout mountains. West of the Sequatchie Valley the Jackson County Mountains are simply much smaller versions of Sand and Lookout mountains (figures 6 and 7). They are mesa-like tablelands separated by steep-walled valleys. Like Sand and Lookout mountains many of the Jackson County Mountains have sandstone caps and steep talus slopes topped by vertical cliffs (figures 6 and 7). As in the case of Sand and Lookout mountains the talus slopes are broken in places by benches or outcrops of resistant materials (figure 20). The valley floors between these mountains consist primarily of colluvium from the slopes above them.

The Cumberland Plateau Region is drained by the Tennessee River west of the divide on Sand Mountain, by Wills Creek between the divide on Sand Mountain and the divide on Lookout Mountain, and by minor tributaries of the Coosa River east of the divide on Lookout Mountain. The gradients of the Tennessee River and Wills Creek are gentle but meandering is minimal due to the structural controls (see maps in Appendix III). The tributaries are fast flowing down the escarpments with many waterfalls. However, on the tops of the mountains (figure 4) and on the valley floors where the terrain is flat the tributaries have gentle gradients, meander, and, in some places, form swampy areas (figure 8B). Within the Cumberland Forest Habitat Region the Tennessee River flows free for a very short distance below Guntersville Dam and for a somewhat longer distance between the state line and the upper end of Guntersville Lake. Consequently, much of the shore of the river occupies *slope* positions and the vegetative complexes along this shore are those usually found on upland sites rather than in bottomland situations (figure 9B). This must be taken into consideration when the key is being used.

ECOLOGICAL FOUNDATION OF THE KEY

All persons concerned with plant ecology are aware of the correlations existing between species occurrence and site conditions. This key, like its predecessors in this series, is built on the supposition that particular species complexes occupy particular situations in a repeatable pattern and that these situations can be recognized on aerial photographs. A primary factor controlling the character of a site is the soil moisture regime, the availability of water to the plants on the site. This is controlled by a number of factors, some of which can be assessed on aerial photographs. These latter factors are associated with topography. Upland sites are drier than bottomland sites and both usually can be distinguished on the photographs. Within the upland areas soil moisture availability is a function of position on the slope and steepness and aspect of the slope. These can be assessed on aerial photographs. In the bottomland areas the degree of wetness of a site can be evaluated on the basis of position of that site within the drainage system (e.g., along an intermittent stream at or near the headwaters, along a constant flow stream near the middle of the system, or along a major stream), the width of the stream at the location of the stand and the width of the attendant floodplain. All these can be assessed on aerial photographs.

In addition to the topography itself, the soil moisture regime is influenced by geologic structure. In areas of erosion resistant rock the topography is usually rough, especially if the rock strata are tilted, and the soils are thin

FIGURE 5. Stereogram of a portion of Little River gorge in Lookout Mountain. This is one of the deepest canyon-like gorges in the eastern United States. The very heavy shadows cast by the steep walls interfere seriously with the photo-interpretation process. (DeKalb County, GT-2LL-199,120).

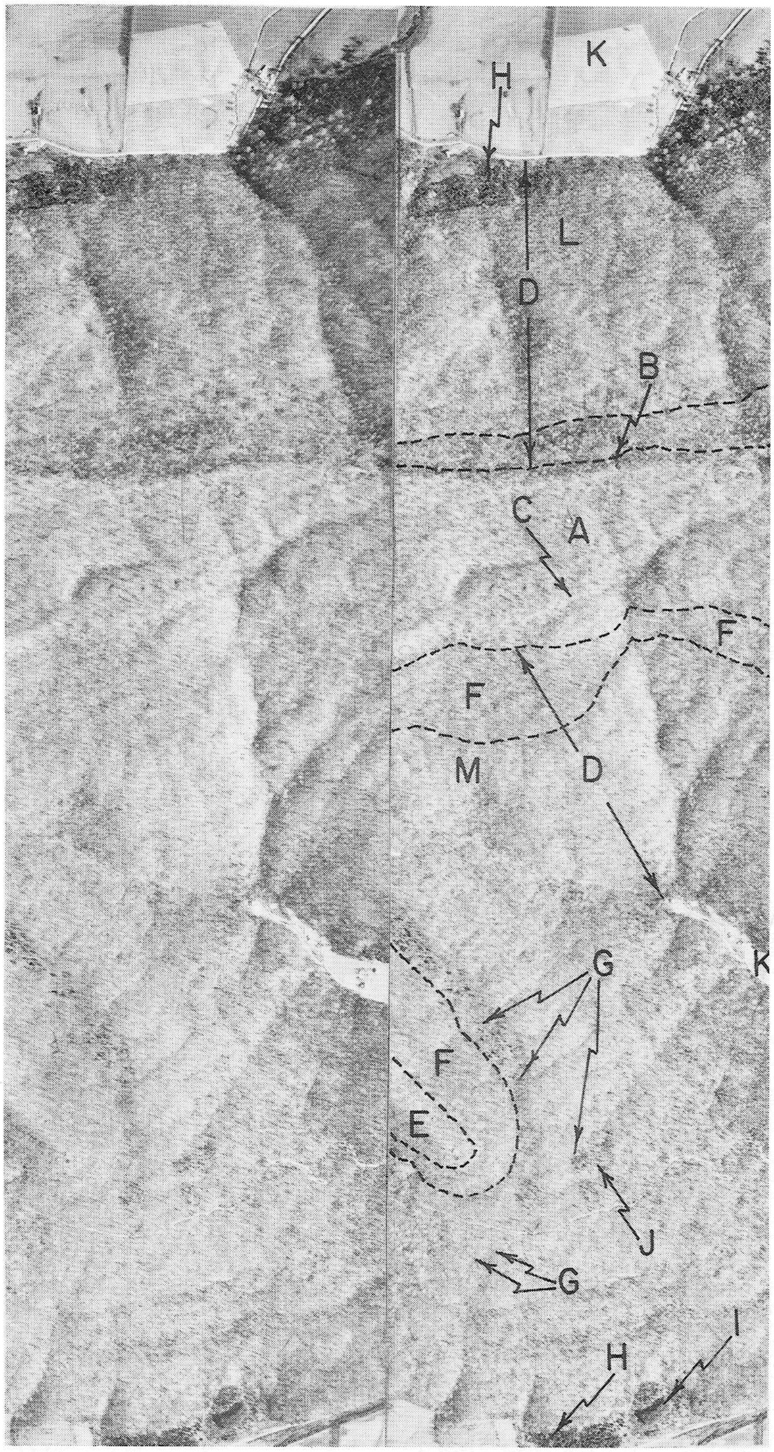

FIGURE 6. Stereogram of a strip across a flat-topped Jackson County mountain in Zone I showing: (A) the top of the mountain which, in this case, is quite rough; (B) an abrupt edge of the escarpment without a line of cliffs; (C) cliffs or rimrock; (D) the escarpment; (E) a peninsula-like remnant of the plateau top with the rimrock reduced to a pile of rubble at the peninsula tip; (F) the primary bench below the rimrock; (G) the line of streamheads marking the boundary between the sandstone material above and the limestone material below the streamheads; (H) a stand of cedars; (I) a stand of loblolly pines; (J) scattered cedars; (K) the valley floor which is part of Zone II; (L) mixed cedar-hardwoods; and (M) pure upland hardwoods. (Jackson County, BPS-3MM-42,43).

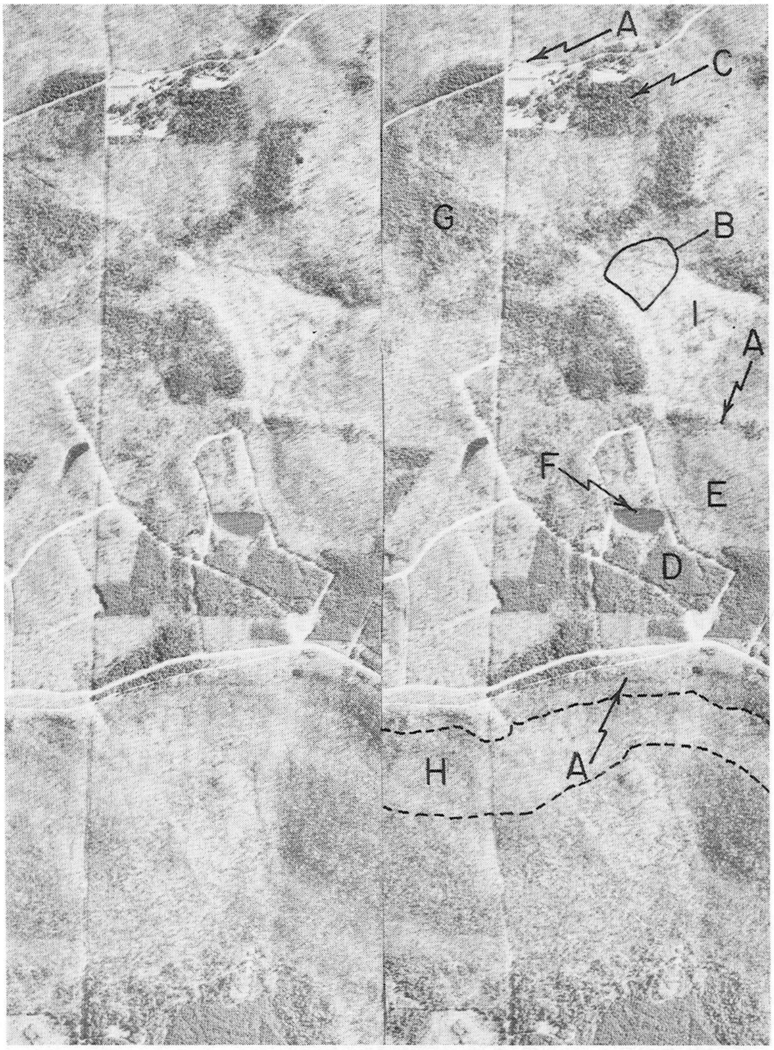

FIGURE 7. Stereogram of a flat-topped Jackson County mountain with a relatively level surface. The rim is clearly evident but the cliffs are hidden in the trees (A). Large boulders fallen from the cliffs can be seen at (B). The sandstone soils on the top support both natural (C) and planted (D) stands of pine as well as hardwoods (E). Natural swamps are rare to non-existent on these mountains but where streams have been dammed, such as at ponds (F), the ponds may degenerate into swampy areas. The stand at (G) is on a minor hill on the tabletop. This minor topography is recognized in the key. The primary bench (H) is visible between the base of the cliffs to the line of streamheads, which in this case are almost hidden in the trees. At (I) the primary bench is absent and sandstone colluvium covers the entire slope. (Madison County, HM-5MM-9,10).

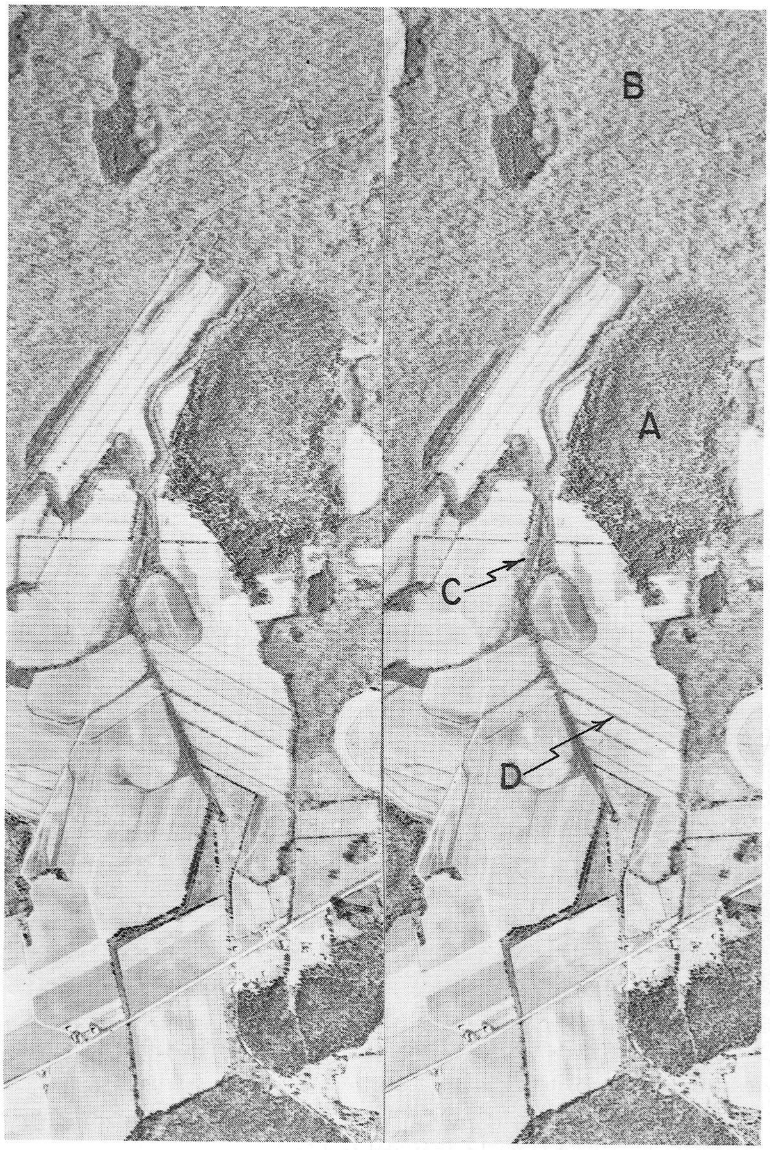

FIGURE 8. Stereogram of a portion of a flat valley floor in Zone II showing: (A) a low non-linear hill; (B) a swampy area with hardwood cover; (C) a channelized stream or ditch used to carry off excess water; and (D) a ditch along which a stand of black willow and hazel alder (Forest Cover Type H(20)) has become established. The width of this stream at (C) is approximately 10 feet at the point of the arrow. Note the meandering stream in the swamp area. (Jackson County, BPS-2MM-280,281).

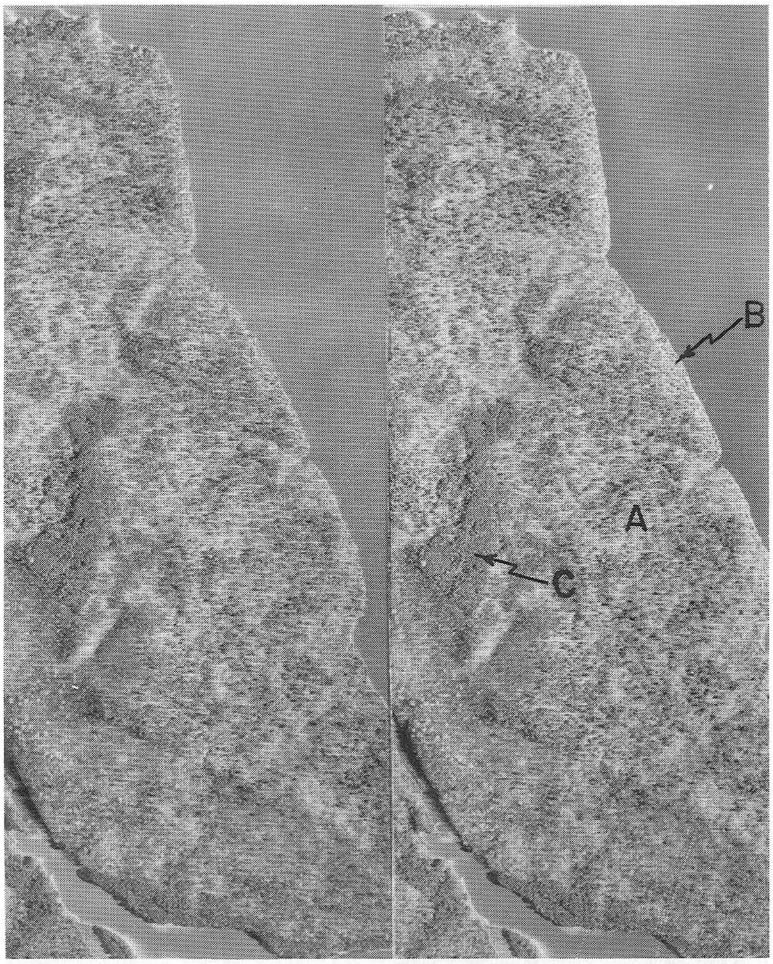

FIGURE 9. Stereogram of a badly eroded Jackson County mountain on the edge of Guntersville Lake. The escarpments are dominated by sandstone colluvium and bear mixtures of pines and hardwoods. (A). Along the shore of the lake wave erosion has removed the sandstone overburden and has attacked the underlying limestone creating a very steep sea cliff (B). The dark crowned trees on this cliff are cedars. On the top of the mountain, on the sandstone material, is a pine plantation (C). (Marshall County, HO-2MM-24,25).

thereby producing dry sites. In areas where the rocks are weak the topography usually is gentle to flat, and the soils are deep, and the sites are relatively moist. Surface roughness can be assessed quite readily using aerial photographs and rough estimates made of the depth and moistness of the soils. However, the photographic information often is not sufficiently conclusive and it becomes necessary to refer to maps showing the locations of the controlling geologic features.

In the Cumberland Plateau Forest Habitat Region soil moisture regime is a controlling factor in the distribution of species but its importance is matched by the nature of the parent material from which the soils were developed. Species complexes on soils derived from sandstone are considerably different, topographic position by topographic position, than those on soils derived from limestone. The presence of these parent materials has been shown in macro-detail on maps and form the basis for the zones recognized in the key. However, in certain situations the maps provide insufficient detail and recourse must be made to aerial photographic information. On sunlit sides of the mountains and hills this aerial photographic information usually is adequate but when an area is shadowed the needed photographic detail cannot be seen and a detailed assessment cannot be made.

Plant communities tend to change with time, becoming more and more stable as far as species composition is concerned. This natural phenomenon is called plant succession. There is no single most stable species composition or climax community. The climax varies from site to site within a region. Successional stages are difficult to determine from aerial photographs. Little more can be done than to assume that the pine or cedar cover types represent earlier stages and the pine-hardwood, cedar-hardwood and hardwood cover types represent later stages. These assumptions seem reasonable. Pines and cedars are shade-intolerant pioneer species that occupy areas soon after the forest cover has been removed by one means or another. There are, of course, light-seeded intolerant hardwood species that may invade a denuded area along with the pines and/or cedars, creating a mixed forest cover. As time goes on, however, heavier seeded, more tolerant species become established beneath the pioneer species, and the stand eventually becomes a pure hardwood stand consisting of heavy seeded tolerant species. Therefore, the percentage of dark crowns (pine and/or cedar) in the overstory of a stand may be used as a rough measure of the stage of succession. Man's activities in the forest will not modify these general conclusions to any great extent. If a stand is clearcut and the residual hardwoods are heavily damaged or eliminated by mechanical or chemical means, the new stand probably will be pine or cedar, depending on the parent material of the soil. If there is no site preparation, it is likely that, because of their sprouting capability, the new stand will consist almost entirely of hardwoods. In any case, it is logical to expect an increasing percentage of heavy seeded, tolerant species as the percentage of dark toned crowns in the stand canopy decreases. This is the only way the photo-interpreter can judge stage of succession.

The combination of topographic, geological, and broad species range information apparently can lead to reasonably reliable estimates of forest cover type occurrence when used in conjunction with tonal differences on the photographs.

DEVELOPMENT OF THE KEY

It was accepted initially that habitat-species occurrence relationships exist and that the problem was to determine which of these relationships could be used by a photo-interpreter attempting to determine the species composition of stands imaged on aerial photographs. The information needed to determine these relationships was obtained during extensive field operations of a reconnaissance nature. Formal statistical testing procedures were not used in any phase of the work leading to the construction of the key. This follows the pattern evolved during the development of the previous keys in this series (Johnson and Sellman, 1974, 1975, and 1977).

Initially a reconnaissance was made of the Region for the purpose of obtaining a working knowledge of its geography and species complexes. No quantitative information was gathered during this stage of the operation. Instead, the emphasis was placed on becoming sufficiently familiar with the situation so that planning of subsequent field operations would be facilitated.

In the course of this reconnaissance, relationships were sought between species complexes and the characteristics of the sites where those species complexes occurred. Attention was paid to bedrock geology, deposition of alluvium and colluvium, topographic positions, aspects, steepness of slopes, and other factors that might be used to assist in the photo-interpretation of the stands. Certain relationships quickly became apparent. It was obvious that the Region would have to be subdivided into zones based on the presence or absence of limestone and sandstone. In addition, topographic position and aspect had considerable influence on the occurrence of the species complexes. Steepness of slope and crest width, however, had little or no influence.

Following the preliminary reconnaissance, a more intensive study of the species complex - site relationships was initiated. The planning for this study was based on the knowledge obtained in the course of the reconnaissance. For this study, transects were run across representative terrain, in such a manner as to cross the contours at approximately right angles, from the crests to the bases of the hill masses. These transects were widely dispersed across the Region in an attempt to cover as many conditions as was feasible. Initially these transects were laid out on aerial photographs. They were chosen in such a manner that they were reasonably accessible and appeared to include a wide variety of stands[3] on different sites. The transects were traversed on foot and the species composition and topographic situation were evaluated and recorded for each stand along each transect. Species composition was evaluated by ocular examinations of the stands, during which all tree species present were recorded, and by point sampling, with a prism having a basal area factor of 10 square feet per acre, so as to obtain estimates of basal areas per acre, by species, in the overstory. The sampling points were arbitrarily selected to represent typical parts of the stands. No attempts were made to use any form of formal probability sampling.

The data obtained from these transects fell into patterns

[3]For this work the term "stand" was defined as an area of forest land which appeared to have, on the photographs, a more or less homogeneous character with respect to species, tree sizes, and crown closure.

which, when combined with the subjective knowledge obtained during the reconnaissance and subsequent field work, provided first approximations for the variables which were eventually incorporated into the key. The forest cover types shown in diagram form in figures 10, 11, and 12, constitute descriptions of species complexes which occurred repeatedly. These were tentatively described at an early stage, and the descriptions were crystallized after further field work provided a stronger base.

After the preliminary relationships described above had been tentatively organized into a key, field operations were modified to provide a basis for checking and improving the key. For this purpose, a large proportion of the roads in the Region were systematically travelled and the forest cover alongside the roads was compared to the key, site by site. In order to avoid the biasing effect of human activities near well-travelled roads, most of this checking was done on back-country and woods roads, passable only with a pickup truck or an all-terrain vehicle. In addition to this vehicular reconnaissance, much work was done on foot. A number of hills in each of the zones were explored on foot to make sure that the slope position-aspect-species occurrence relationships indicated in the key were correct. A motorboat was used to obtain access to the shores of the Tennessee River impoundments. The field crews would stop at intervals along the shore and record conditions along transects oriented perpendicularly to the water's edge. Whenever the key was found lacking it was expanded or modified. This process was continued until it appeared that the key yielded correct results in all parts of the Region.

DESCRIPTION OF THE KEY

The Key consists of two parts (see Appendix I). The first is a dichotomous elimination key which leads either directly to a forest cover type or to a diagram of a hill. If one is referred to the hill diagram he should determine, from the photographs, the topographic position of the plot or stand in question and then he should locate that point on the diagram. The probable forest cover type occupying that position would then be read directly from the diagram. For example, if the first part of the key referred the interpreter to figure 57A and the stand in question was on the lower slope facing northeast the forest cover type would be P(4) which is basically a loblolly pine type.[4]

FOREST COVER TYPES

The forest cover types recognized by the key are shown in diagram form in figures 10, 11, and 12.

The development of these type descriptions was a complex operation which was carried out simultaneously with the development of the key. Initially a few broad types were recognized. However, as the need for subdivision of the Region into Zones became evident it also became evident that the cover types could be correspondingly refined. As the work progressed the Zone pattern became firmer and as this occurred the cover type descriptions followed the same pattern.

The data upon which the cover type descriptions are based are of two types. As has been described, sampling points were established in what were considered representative stands. Initially these points were located along

[4]See Appendix II for the scientific names of the species mentioned.

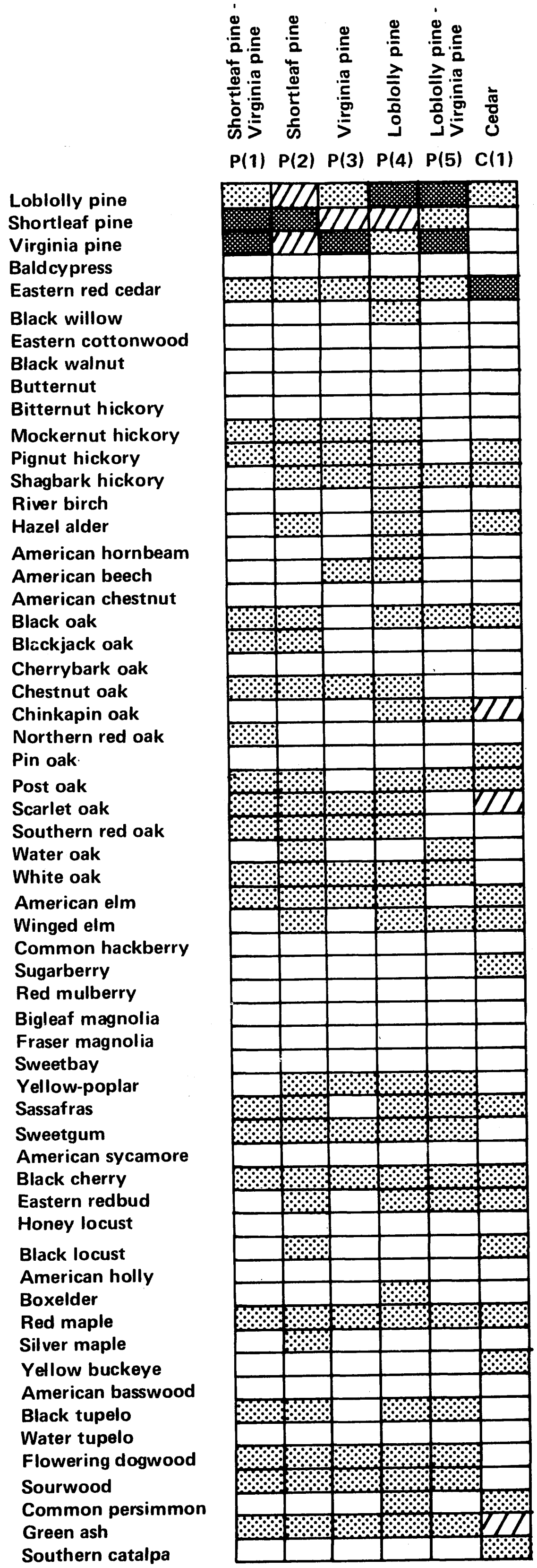

FIGURE 10. Diagram showing relative importance of species within the pure pine and cedar cover types.

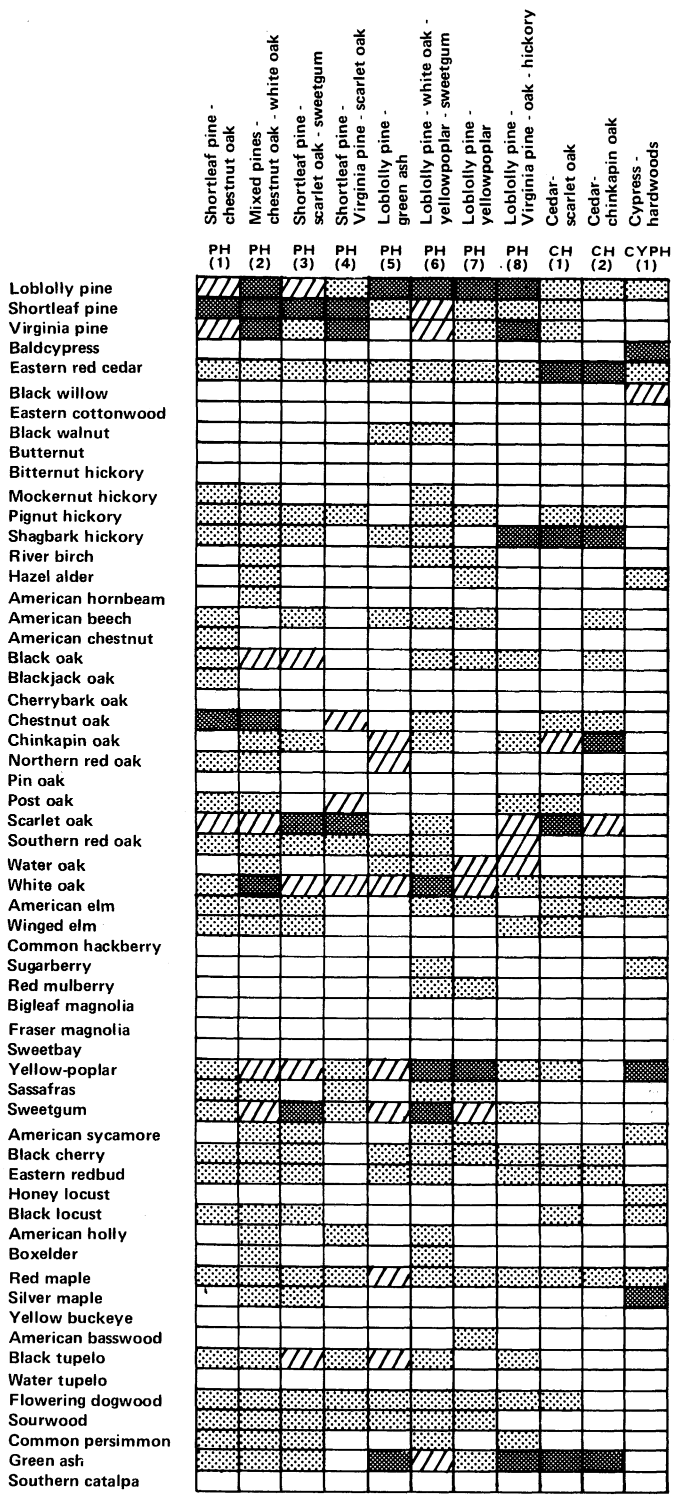

FIGURE 11. Diagram showing relative importance of species within the pine-hardwood and cedar-hardwood cover types.

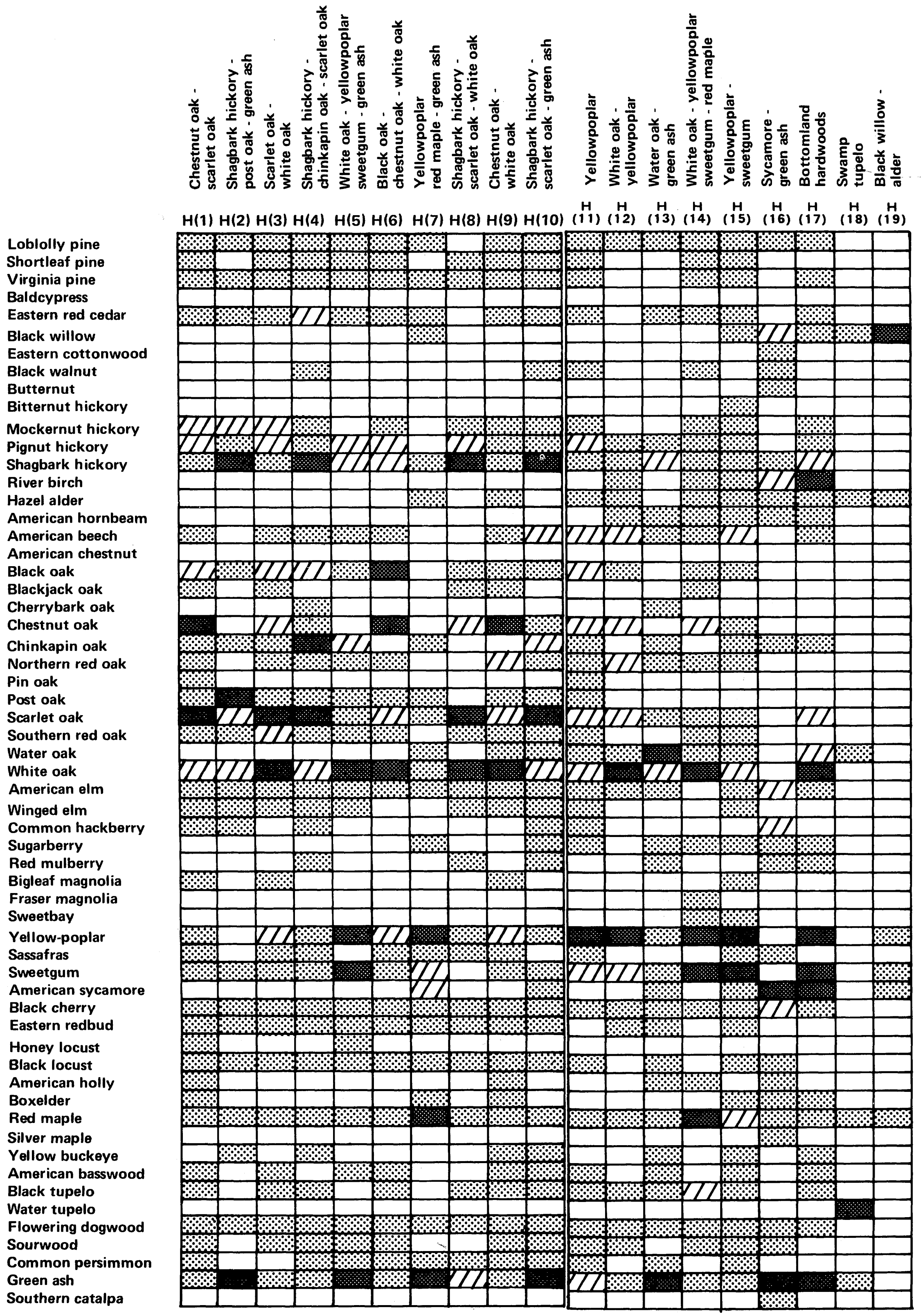

FIGURE 12. Diagram showing relative importance of species within the hardwood cover types.

transects but later, when supplemental information was needed, such points were located without reference to transects. At each of these points a prism sweep was made. The trees selected by the prism were tallied by species. In addition, a tally was made of all the tree species occurring in the stand but not detected by the prism sweeping process. No attempt was made in this sampling process to conform to the rules of formal probability sampling. The impossibility of developing a sampling frame in an exploratory study of this type precluded the use of formal sampling procedures. However, studies involving formal sampling can be built on this work since the key forms the basis for the development of sampling frames.

The results of this sampling are summarized, within the context of the final cover types, in tables 2, 3, and 4. These tables, under the column heading "P", show the **rate of occurrence** of each species in the form of a percentage of the stands sampled. This occurrence value made use of both the prism data and the species tallies previously mentioned. The tables also show, under the column heading "D", the **degree of dominance** of each species in terms of the average percent of the total basal area of the overstory. These values are based **only** on the prism data. The utilization of the supplemental data in the rate of occurrence computations results in some apparent anomalies where occurrence rates are high but dominance rates are low. Flowering dogwood is an excellent example of such a species. It occurs widely but only rarely are overstory concentrations of dogwood trees found.

The second source of information used in the development of the cover type descriptions was the accumulated experience of the persons doing the field work. These people were professionally trained foresters who were well prepared to accumulate mental impressions of cover type-site relationships as well as species associations. Heavy use was made of this accumulation of knowledge. It was used to confirm the evidence of the prism data, to bolster the prism data when the latter were scarce, and, in some cases, total dependence had to be placed on it when prism data were totally lacking.

The scarcity or absence of prism data for some cover types is the result of several factors. First, forest cover on much of the level terrain in all Zones is limited since the areas are heavily used for agriculture. Related to this was the difficulty of obtaining legal access to much of this land. Another reason is the scarcity of occurrence of certain conditions. For example, natural pine or pine-hardwood stands are rare to non-existent on the flat floor of the Sequatchie Valley (Zone 1). In still other cases the cover types were found but no need was felt for the prism data. This was the case with pine plantations and swamp tupelo stands (H(18)) where the composition involved essentially only a single species. In the case of the black willow type (H(19)) the stands usually were too dense to use a prism and the species composition was assessed subjectively.

The diagrams in figures 10, 11, and 12 are pictorial representations of the final cover types. The heavy dot pattern blocks represent species that usually are dominant, the diagonally cross-hatched blocks represent species that are common associates, and the light dot pattern blocks represent species that occur sporadically or have little significance as far as contributing to stand basal area is concerned. The diagrams are arranged, with some exceptions, with the cover types associated with the poorer sites on the left and the cover types associated with the better sites on the right. This provides a visualization of the shifts in species importance as quality of the sites change. In previous keys of this series the cover types were described in words as well as in this diagram form. Feedback from users of the keys indicates that the diagrams convey the information about the species composition more readily than do the word descriptions. For this reason the word descriptions have not been included in this key.

A total of 36 cover types have been defined: 5 pine, 1 cedar, 8 pine-hardwood, 2 cedar-hardwood, 19 hardwood, and one cypress-hardwood. It is recognized that this detail is not needed by most persons involved with land management. However, when it became evident that this detail could be achieved the decision was made to proceed in the direction of detail rather than that of generality. The reasoning behind this decision was that users could always combine types but the reverse could not be done.

The reason for the detail can best be seen on figures 10, 11, and 12 which show the relative importance of the species within the types. For example, in figure 11 it can be seen that the list of species occurring in PH(1) is practically the same as that for PH(2). However, in PH(2) loblolly pine, black oak, yellow-poplar, sweetgum, and, especially, white oak, are more likely to be important stand components than in PH(1). This reflects the generally moister sites with which PH(2) is associated. There are differences between the cover types but admittedly they are subtle.

Since the cover types are based on topographic positions and percentage of dark-toned crowns and not on the actual species groupings themselves, their stability with regard to species components is dependent on the number of species involved. Some of the cover types, such as the pure pine types, are relatively simple and involve only one, two, or three critical species. The pine-hardwood and hardwood types involve many more species and can be very complex. **Since species composition is controlled by a number of interacting factors** including site quality, stand history, stage in succession and proximity to seed sources, **it is possible for species that are expected to be primary components to be reduced to a minor representation or even to be absent. It also is possible for species to occur as primary components when normally they would be minor components or absent.** These aberrations cannot be avoided.

Two unusual species distribution situations which exist in the Region should be noted. First, a stand of baldcypress was found on a small group of islands off the mouth of South Sauty Creek in Lake Guntersville. The stand contains vigorous reproduction and should be able to maintain itself. The second unusual situation involves eastern hemlock which has been found growing on the lower slopes of the upper reaches of Pisgah Gorge on Sand Mountain (zone 1) (figure 56).

DESCRIPTIONS OF THE VARIABLES

Zones

The single most critical factor controlling the distribution of species in the Cumberland Plateau Forest Habitat Region is the nature of the parent material from which the soils are derived. There are two major and several minor parent material categories. The first major category includes the sandstones, primarily from the Pottsville Formation, which forms the surface of the Plateau. In addition, there

Table 2. Occurrence and dominance values for species within the pine and cedar cover types.

TYPE	P(1)		P(2)		P(3)		P(4)		P(5)		C(1)	
Sample	36		48		2		24		17		15	
	P	D	P	D	P	D	P	D	P	D	P	D
Loblolly pine	22	8	41	14			83	51	94	63		
Shortleaf pine	64	35	85	59	100	35	79	31	41	6		
Virginia pine	86	46	33	14	100	53	38	4	82	28		
Baldcypress												
Eastern red cedar	3	< 1	33	< 1			46	3	65	< 1	100	74
Black willow							4	< 1				
Eastern cottonwood												
Black walnut												
Butternut												
Bitternut hickory												
Mockernut hickory	47	3	17	< 1			17	1				
Pignut hickory	39	1	29	< 1	50	< 1	38	< 1			13	2
Shagbark hickory			13	< 1			13	< 1	18	< 1	40	2
River birch							4	< 1				
Hazel alder			2	< 1			4	< 1			6	< 1
American hornbeam												
American beach							17	< 1				
American chestnut												
Black oak	3	< 1	29	1			13	1	6	< 1	6	< 1
Blackjack oak	27	< 1	17	< 1								
Cherrybark oak												
Chestnut oak	56	3	35	3	50	13	4	< 1				
Chinkapin oak							4	< 1	18	< 1	53	5
Northern red oak	6	< 1										
Pin oak											13	1
Post oak	33	< 1	17	2			17	1	18	1	6	< 1
Scarlet oak	17	< 1	33	3			38	2			47	6
Southern red oak	11	1	14	< 1	50	< 1	20	< 1				
Water oak			2	< 1					35	< 1		
White oak	8	< 1	17	< 1			21	< 1	12	< 1		
American elm	3	< 1	4	< 1			13	< 1			20	1
Winged elm			8	< 1			25	< 1	29	< 1	20	< 1
Common hackberry												
Sugarberry											6	< 1
Red mulberry												
Bigleaf magnolia												
Fraser magnolia												
Sweetbay												
Yellow-poplar			10	< 1			33	2	6	< 1		
Sassafras	14	< 1	16	< 1			13	< 1	6	< 1	6	< 1
Sweetgum	6	< 1	16	< 1			33	< 1	29	1		
American sycamore												
Black cherry	25	< 1	17	< 1			21	< 1	23	< 1	6	< 1
Eastern redbud			4	< 1			4	< 1	29	< 1	13	< 1
Honey locust												
Black locust			4	< 1							20	< 1
American holly												
Boxelder							4	< 1				
Red maple	44	< 1	15	< 1	50	< 1	21	< 1	18	< 1	33	< 1
Silver maple			2	< 1								
Yellow buckeye											13	< 1
American basswood												
Black tupelo	25	1	15	< 1			4	< 1	41	< 1		
Flowering dogwood	19	< 1	35	< 1	50	< 1	33	< 1	12	< 1		
Sourwood	19	< 1	31	< 1	50	< 1	17	< 1	6	< 1		
Common persimmon							4	< 1			27	< 1
Green ash	6	< 1	17	< 1			20	< 1	12	< 1	100	8
Southern catalpa											6	1

Table 3. Occurrence and dominance values for species within the pine-hardwood, cedar-hardwood, and cypress-hardwood cover types.

TYPE	PH(1)		PH(2)		PH(3)		PH(4)		PH(5)		PH(6)		PH(7)		PH(8)		CH(1)		CH(2)		CYPH(1)	
Sample	70		56		11		7		3		21		5		11		19		16		6	
	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D
Loblolly pine	33	6	55	19	55	15			100	47	61	25	100	51	55	20	16	1			17	< 1
Shortleaf pine	87	32	57	18	64	29	71	23	33	< 1	81	12	40	5	9	5	5	< 1				
Virginia pine	31	7	46	13	27	5	71	25			48	11	40	5	73	19	5	1				
Baldcypress																					100	50
Eastern red cedar	27	< 1	16	< 1	64	< 1	29	< 1			9	< 1	20	< 1	48	2	100	47	100	45	17	< 1
Black willow																					100	4
Eastern cottonwood																						
Black walnut											4	< 1										
Butternut																						
Bitternut hickory																						
Mockernut hickory	33	5	12	< 1							4	< 1										
Pignut hickory	47	4	36	< 1	27	2	43	< 1			14	< 1	40	< 1			11	1	6	< 1		
Shagbark hickory	11	< 1	23	3	9	< 1			33	< 1	9	< 1			73	11	63	14	44	11		
River birch			2	< 1							4	< 1	20	3								
Hazel alder			5	< 1									20	< 1							83	< 1
American hornbeam			9	< 1																		
American beech	1	< 1			18	< 1			100	< 1	24	< 1	20	3					13	< 1		
American chestnut	1	< 1																				
Black oak	34	5	23	3	18	4					4	< 1	20	< 1	9	2			6	< 1		
Blackjack oak	20	2																				
Cherrybark oak																						
Chestnut oak	73	18	29	7			57	8			24	3					5	< 1	6	1		
Chinkapin oak			39	< 1	9	1			33	7	9	< 1			27	4	63	8	75	14		
Northern red oak	3	< 1	4	1					33	6												
Pin oak																			6	3		
Post oak	34	5	14	2			57	7							9	< 1	16	< 1				
Scarlet oak	54	7	34	6	45	11	71	23			24	3			27	5	68	11	75	8		
Southern red oak	10	1	29	2	9	< 1	14	3	33	< 1	14	< 1			18	6						
Water oak			17	1					33	< 1	29	4	60	7	45	5						
White oak	33	3	45	8	45	5	57	9	33	6	48	9	80	6	45	3	5	< 1	6	1		
American elm	10	< 1	21	< 1	9	< 1					33	< 1	40	3			16	< 1	44	< 1	33	< 1
Winged elm	1	< 1	7	< 1	18	< 1									9	< 1	32	< 1				
Common hackberry																						
Sugarberry											4	1									17	4
Red mulberry											4	< 1	20	< 1								
Bigleaf magnolia																						
Fraser magnolia																						
Sweetbay																						
Yellow-poplar	7	< 1	32	5	45	5			33	6	33	8	80	13	18	1	5	< 1			67	22
Sassafras	21	< 1	21	< 1			14	< 1			9	< 1	20	< 1								
Sweetgum	7	< 1	32	3	73	18			33	8	81	12	60	5	36	1						
American sycamore			1	< 1	18	< 1					4	< 1	20	< 1							17	3
Black cherry	26	< 1	21	< 1	36	< 1			33	< 1	14	< 1	40	< 1	36	2	11	< 1	6	< 1		
Eastern redbud	3	< 1	17	< 1	36	< 1			33	< 1	24	< 1			9	< 1	42	< 1	25	< 1		
Honey locust																					17	< 1
Black locust	4	< 1	3	< 1	9	< 1											11	< 1			17	3
American holly			1	< 1			14	< 1			9	< 1										
Boxelder			1	< 1							4	< 1										
Red maple	14	< 1	30	< 1	55	< 1	29	< 1	33	7	48	3	40	< 1	9	< 1	16	< 1	31	< 1	17	< 1
Silver maple			13	< 1	9	1															83	13
Yellow buckeye																						
American basswood													20	< 1								
Black tupelo	27	2	3	< 1	27	3	14	< 1	33	7	9	2			36	3						
Flowering dogwood	47	< 1	62	< 1	54	< 1	86	< 1	67	< 1	48	< 1	100	< 1	9	< 1	5	< 1				
Sourwood	36	< 1	13	< 1	9	< 1	100	2	33	< 1	4	< 1	40	< 1								
Common persimmon	1	< 1	5	< 1	18	< 1					9	< 1			9	2			25	1		
Green ash	9	< 1	48	2	27	1			33	8	48	4	40	< 1	73	8	89	13	88	17		
Southern catalpa																						

Table 4. Occurrence and dominance values for species within the hardwood cover types.

TYPE	H(1)		H(2)		H(3)		H(4)		H(5)		H(6)		H(7)		H(8)		H(9)		H(10)	
Sample	198		12		37		75		12		45		18		15		46		83	
	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D
Loblolly pine	19	2	17	1	8	7	12	1	17	3	7	< 1	39	5			26	3	16	2
Shortleaf pine	43	5			59	4	4	< 1	8	< 1	22	2			13	< 1	20	1	4	< 1
Virginia pine	23	1	25	< 1	30	1	21	1	8	< 1	4	< 1	17	2	7	< 1	7	< 1	7	< 1
Baldcypress																				
Eastern red cedar	17	< 1	92	2	51	0	80	4	33	< 1	16	< 1	56	1			11	< 1	74	5
Black willow													61	2						
Eastern cottonwood																				
Black walnut							1	< 1											2	< 1
Butternut																				
Bitternut hickory																				
Mockernut hickory	33	4	25	6	30	3	8	1			20	3			7	1	34	5	6	1
Pignut hickory	43	5	25	2	57	7	22	4	25	6	51	10			40	7	37	8	18	3
Shagbark hickory	30	5	92	91	30	4	79	21	58	8	36	6	17	4	80	24	41	6	73	18
River birch																				
Hazel alder													28	< 1			2	< 1		
American hornbeam																				
American beech	6	< 1			8	1	8	1	8	< 1	18	1					13	2	32	6
American chestnut																				
Black oak	45	9	25	2	24	5	28	6	8	< 1	62	15			27	2	11	1	16	3
Blackjack oak	10	2			3	1									13	1	2	< 1		
Cherrybark oak							1	< 1												
Chestnut oak	77	31			14	7	9	2			82	27			40	5	76	19	5	< 1
Chinkapin oak	2	< 1	8	2	5	< 1	54	14	42	8			17	2					43	9
Northern red oak	11	2			8	< 1	28	5	8	2	22	4					28	5	12	2
Pin oak	1	< 1																		
Post oak	21	4	50	20	22	4	16	3	8	< 1	9	< 1	11	3			9	< 1	4	< 1
Scarlet oak	44	10	33	9	86	32	59	13	17	3	36	6	17	2	67	18	33	7	52	13
Southern red oak	7	1	17	2	32	8	5	1	25	3	9	< 1			13	1	15	4	6	1
Water oak													11	< 1			2	< 1	6	< 1
White oak	39	6	33	6	62	13	45	9	50	17	60	12	6	3	93	29	83	20	46	7
American elm	8	< 1	67	2	8	< 1	25	1	67	3	9	1	28	5	13	< 1	13	< 1	32	2
Winged elm	4	< 1	8	< 1	5	< 1	6	< 1	8	< 1					2	< 1	2	< 1	1	< 1
Common hackberry	1	< 1	8	2			1	< 1											1	< 1
Sugarberry													11	< 1					6	< 1
Red mulberry							2	< 1							7	< 1			1	< 1
Bigleaf magnolia	3	< 1																		
Fraser magnolia																				
Sweetbay																				
Yellow-poplar	20	3			30	3	14	2	50	10	44	6	67	25	7	< 1	50	6	27	4
Sassafras	25	< 1			24	< 1	8	< 1			29	< 1	6	< 1	7	< 1	7	< 1		
Sweetgum	6	< 1	8	< 1	5	< 1	1	< 1	58	14	9	< 1	28	8			17	2	27	3
American sycamore													44	7					2	< 1
Black cherry	16	< 1	58	2	19	< 1	16	< 1	58	1	30	< 1	22	2	40	< 1	26	< 1	18	< 1
Eastern redbud	7	< 1	17	< 1	11	< 1	26	< 1	50	< 1	11	< 1	11	< 1	20	< 1	19	< 1	32	< 1
Honey locust	1	< 1							8	1										
Black locust	2	< 1	42	< 1	5	< 1	13	< 1	8	< 1	11	< 1	22	3	40	< 1	11	< 1	15	< 1
American holly	1	< 1															4	< 1		
Boxelder	1	< 1											6	< 1			2	< 1		
Red maple	29	< 1	17	< 1	27	< 1	1	1	67	3	33	< 1	67	13	7	1	61	2	50	2
Silver maple																				
Yellow buckeye			8	< 1			1	< 1									4	< 1	1	< 1
American basswood	5	< 1			3	< 1			33	4	4	< 1					13	< 1	10	< 1
Black tupelo	29	2			14	2	5	< 1			24	3			7	< 1	23	1	5	< 1
Flowering dogwood	6	< 1	33	< 1	81	< 1	30	< 1	67	< 1	87	< 1	6	< 1	53	< 1	65	< 1	29	< 1
Sourwood	38	< 1			43	< 1	1	< 1	17	< 1	44	< 1					43	< 1	5	< 1
Common persimmon	3	< 1					18	< 1	17	3	2	< 1	17	< 1	13	1	2	< 1	19	2
Green ash	13	< 1	92	21	8	< 1	67	3	58	10	7	< 1	78	11	60	8	26	3	71	14
Southern catalpa																				

Table 4 Continued.

TYPE	H(11)		H(12)		H(13)		H(14)		H(15)		H(16)		H(17)	
Sample	75		8		22		31		53		20		12	
	P	D	P	D	P	D	P	D	P	D	P	D	P	D
Loblolly pine	31	4	36	6	22	3	32	5	32	4	20	< 1		
Shortleaf pine	12	1					19	1	8	< 1				
Virginia pine	16	< 1					32	3	6	< 1				
Baldcypress														
Eastern red cedar	24	1			41	< 1	3	< 1	32	< 1				
Black willow									2	< 1	65	7	17	< 1
Eastern cottonwood											15	3		
Black walnut	1	< 1					3	< 1			10	3		
Butternut														
Bitternut hickory									2	< 1				
Mockernut hickory	12	< 1					3	< 1	2	< 1			8	< 1
Pignut hickory	45	8	37	2	9	< 1	23	2	13	3			8	2
Shagbark hickory	35	5	13	2	41	8	13	< 1	30	4	10	2	33	6
River birch							3	< 1	8	< 1	25	6	50	11
Hazel alder	3	< 1	5	< 1			19	< 1	2	< 1	30	< 1	17	< 1
American hornbeam														
American beech	47	9	62	7	14	2	3	< 1	47	9			8	1
American chestnut														
Black oak	25	7	25	5			13	< 1	4	< 1				
Blackjack oak							3	< 1						
Cherrybark oak					5	< 1								
Chestnut oak	32	9	25	7			45	8	13	3				
Chinkapin oak	8	1			14	< 1			15	1	10	1	8	< 1
Northern red oak	17	3	25	5	18	5	13	2	8	1				
Pin oak	4	< 1												
Post oak	9	1												
Scarlet oak	47	9	62	8	9	3	3	< 1	17	3			17	5
Southern red oak	16	2					13	1	6	< 1				
Water oak	16	2	13	1	68	32	3	< 1	15	3			25	6
White oak	67	9	100	20	50	8	74	18	47	9			50	9
American elm	28	< 1	50	4	68	4			49	2	50	9	50	< 1
Winged elm	3	< 1							2	< 1				
Common hackberry	13	< 1									25	6		
Sugarberry	1	< 1			27	2	3	< 1	9	< 1	5	2	8	1
Red mulberry					5	< 1					15	< 1	8	< 1
Bigleaf magnolia														
Fraser magnolia							3	< 1						
Sweetbay														
Yellow-poplar	67	10	100	20	23	4	74	18	85	24			58	11
Sassafras	1	< 1							8	< 1	30	5		
Sweetgum	29	6	50	5	59	3	65	11	66	17			42	11
American sycamore					14	2			32	3	65	17	75	10
Black cherry	28	1	25	< 1	23	< 1	26	< 1	40	< 1	25	7	50	< 1
Eastern redbud			13	< 1	9	< 1			15	< 1				
Honey locust														
Black locust	20	< 1			9	< 1			2	< 1	15	2		
American holly					5	< 1	13	< 1			5	< 1		
Boxelder									2	< 1	30	< 1	42	< 1
Red maple	52	1	87	3	45	3	90	21	68	5	10	< 1	75	3
Silver maple											40	< 1		
Yellow buckeye					14	< 1			6	< 1			17	< 1
American basswood	9	< 1			23	1			17	1			8	< 1
Black tupelo	5	< 1	25	< 1	18	4	45	7	9	< 1			8	2
Flowering dogwood	63	< 1	87	< 1	5	< 1	45	< 1	57	< 1	5	< 1	17	< 1
Sourwood	16	< 1	25	< 1			32	< 1	13	< 1	5	< 1		
Common persimmon	8	< 1			9	< 1			15	< 1				
Green ash	63	7	75	4	86	14	16	1	40	3	95	30	83	16
Southern catalpa														

are some local outcrops of the Hartselle Formation occurring at or below midslope on the escarpments of the mountains. The soils derived from the sandstones are suitable for pines and for certain hardwoods such as chestnut oak. The limestones constitute the second major category of parent materials. There are several limestone formations underlying the Pottsville Formation (table 1) of which the Bangor and St. Genevieve are probably the most important. The soils derived from those limestones support species complexes that are considerably different from those found on the sandstone derived soils. Among the species preferring the limestone soils are eastern redcedar and chinkapin oak. Because of these strong parent material-species complex correlations it was essential that the two categories be recognized in the key. To simplify this and other problems the Region was divided into zones.

Zones I and II together, with one minor exception, include the part of the Region lying west of the western rim of Sand Mountain. This is an area which has been heavily dissected leaving flat-topped mesa or butte-like mountains or tablelands (figures 6 and 7), along with worn-down, rounded-off remnants of such flat-topped areas (figures 13 and 20). Separating these hill masses are valleys that are usually flat (figures 8, 14H, and 15) but which may contain low hills (figure 16) or structural ridges (figures 17 and 18). The high ground in this area, including the mountain sides or escarpments, has been included in zone I while the valley floors and their associated topographic features have been included in zone II.

There is no doubt that the problem of species complex identification is more difficult in zone I than in any of the other zones. The mesa or butte-like mountains in this zone are capped with sandstone of the Pottsville Formation which is resistant to erosion but, when undermined by the dissolution of the underlying limestone, fractures and falls away leaving a line of cliffs around the rims of the mountains and producing talus or scree below the cliffs. The presence of rimrock is evidence that the sandstone cap is in place and that sandstone-derived soils are present on the mesa top (figures 6C and 14D). When the area of the top has been reduced to practically nothing the line of cliffs becomes sporadic (figure 19B and C) or completely absent (figure 20). In the latter case the sandstone may still be present but its presence may be difficult to ascertain. When this situation exists the problem can only be resolved by referring to the distribution of cedars. Cedars rarely occur on sandstone but are usually present on limestone so if a situation as in figure 20 occurs one can assume that sandstone is still present. On the other hand, if the situation is as in figure 13, the assumption must be made that the sandstone is gone.

Below the cliffs are accumulations of fallen rock (talus or scree) which more or less cover the slopes (figures 6F, 7B, 14E, 19E). When this sandstone colluvium dominates the surface the species complexes that are present are the ones associated with sandstone. Consequently, the extent of this material must be determined. This is a photo-interpretation problem of considerable complexity. Complicating the problem is the fact that the absolute thickness of the sandstone cap increases from north to south and from west to east and the amount of topographic relief decreases from north to south so that in the southern and eastern portions of the zone the sandstone material may dominate the slopes all the way to the base level line

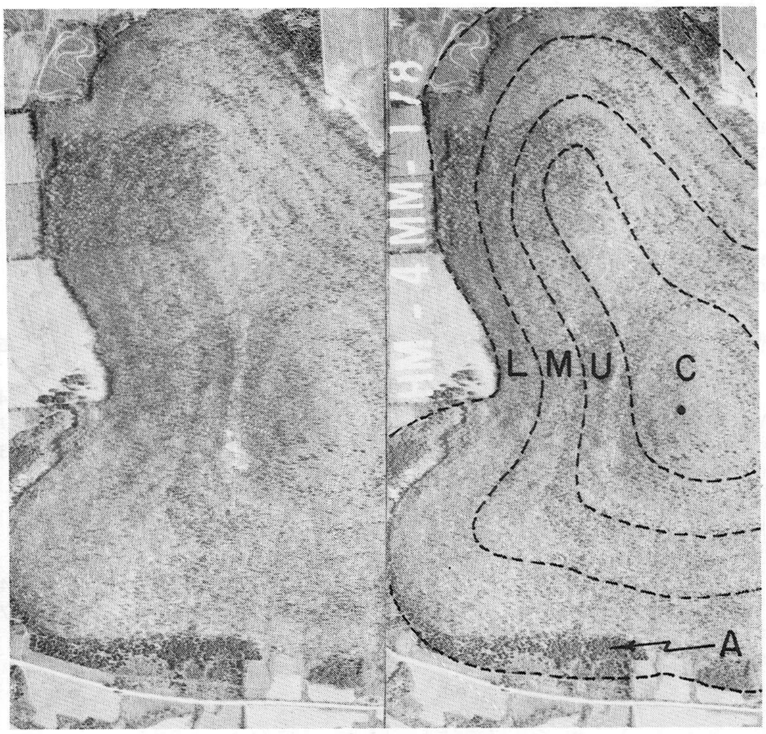

FIGURE 13. Stereogram of a portion of a Jackson County mountain which has had its sandstone cap completely eroded away leaving only limestone. Note the lack of rimrock or even boulders at the top. The dashed lines indicate the boundaries of the topographic positions. The crest is labelled (C), the upper slope (U), the middle slope (M), and the lower slope (L). (A) is a stand of cedars. (Madison County, HM-4MM-178,179).

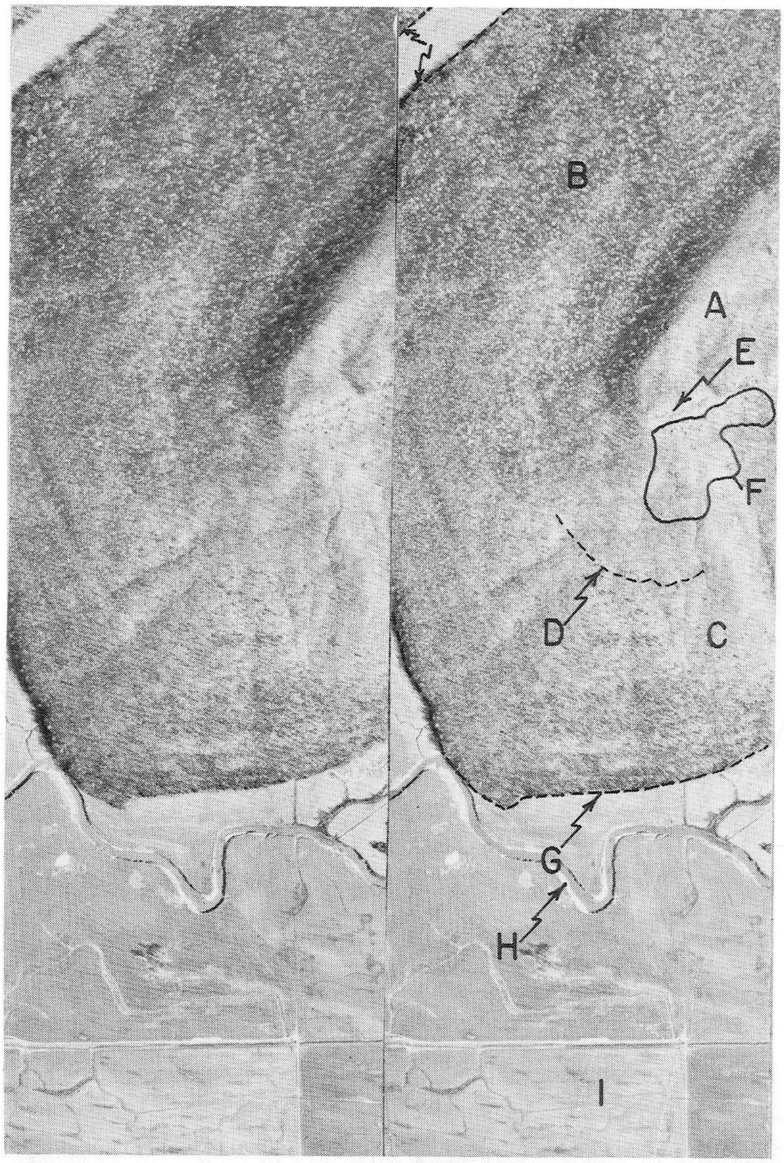

FIGURE 14. Stereogram of a portion of the Jackson County mountain area showing the uplands in Zone I and the flat valley floor in Zone II. The primary bench is not well defined because of the sandstone talus which often is extremely heavy at the point of a hill or spur. Note the top of the mountain (A) which is sandstone; the difference in appearance between a mountain slope in shadow (B) and in full sunlight (C); the difficulty of tracing the base of the sandstone talus (D) into the shadows or distinguishing stream channels; the rimrock cliffs (E) and the large blocks of sandstone fallen from the cliffs (F); the base-level line marking the boundary between Zone I and Zone II (G); the stream cutting into the valley floor (H); and the flat valley floor (I). (Jackson County, BPS-3MM-199,120).

FIGURE 15. Stereogram of a portion of Zone II showing the typical flat surface configuration. Note the stream incising the surface (A); the clear shadows of pine (B) and eastern redcedar (C); a stand of loblolly pine (D); and the hardwoods along the stream (E). (Madison County, HM-4MM-147,148).

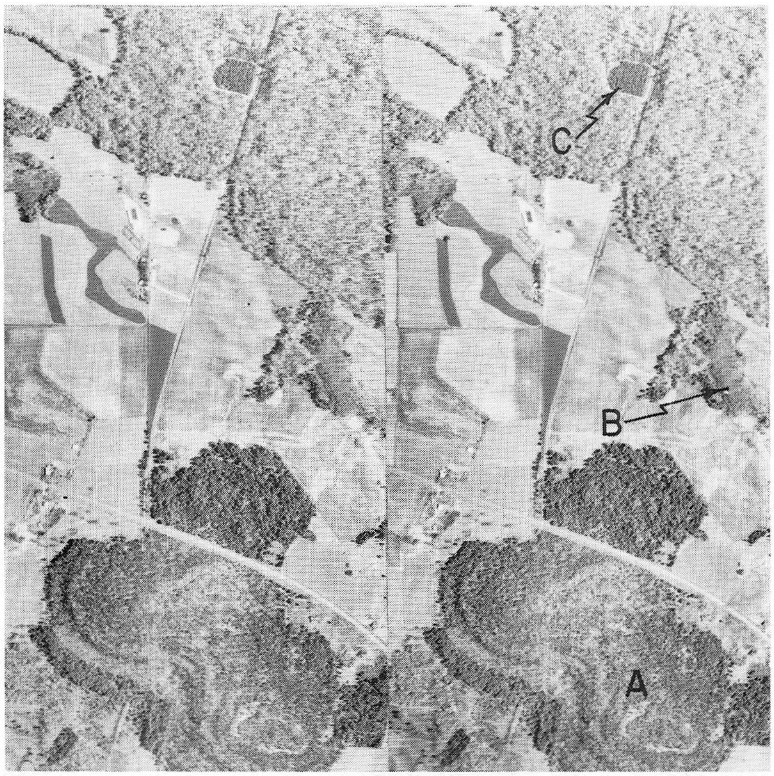

FIGURE 16. Stereogram of portion of the southern end of the Sequatchie Valley in Zone II showing a low non-linear hill covered with a stand of cedar (A), a small swampy area (B), and a pine plantation (C). (Marshall County, HO-2MM-52,53).

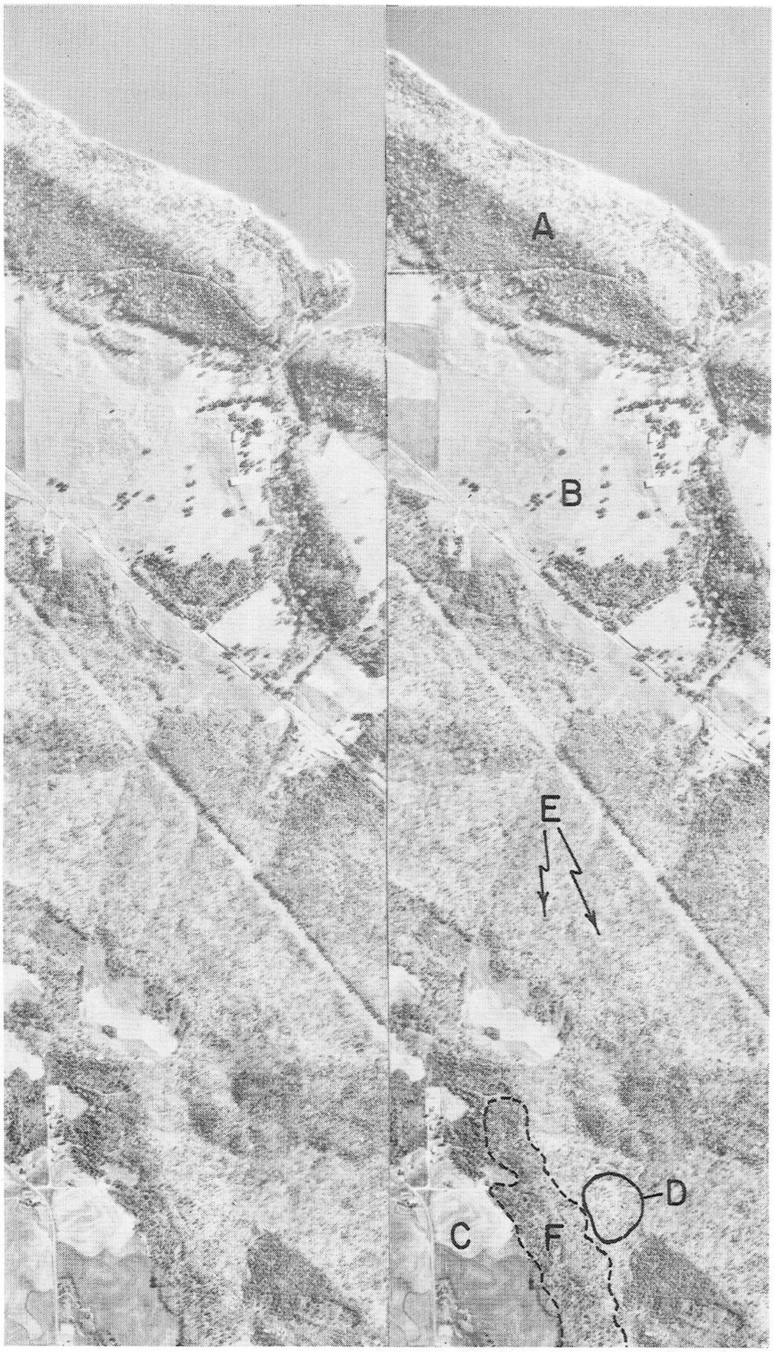

FIGURE 17. Stereogram of portion of Pieston Island in Guntersville Lake showing a structural ridge made up largely of sandstone (A), which is in Zone II; and portion of the valley floor which is undulating rather than flat (B); and part of a flat-topped Jackson County mountain (C). Sandstone colluvium can be seen far downslope (D) but a primary bench is not well defined. The parallel streams usually associated with limestone have progressed far enough uphill at (E) that the sandstone material is being cut. The stands in the area labelled (F) are classed as rimrock stands. (Marshall County, HO-1MM-66,67).

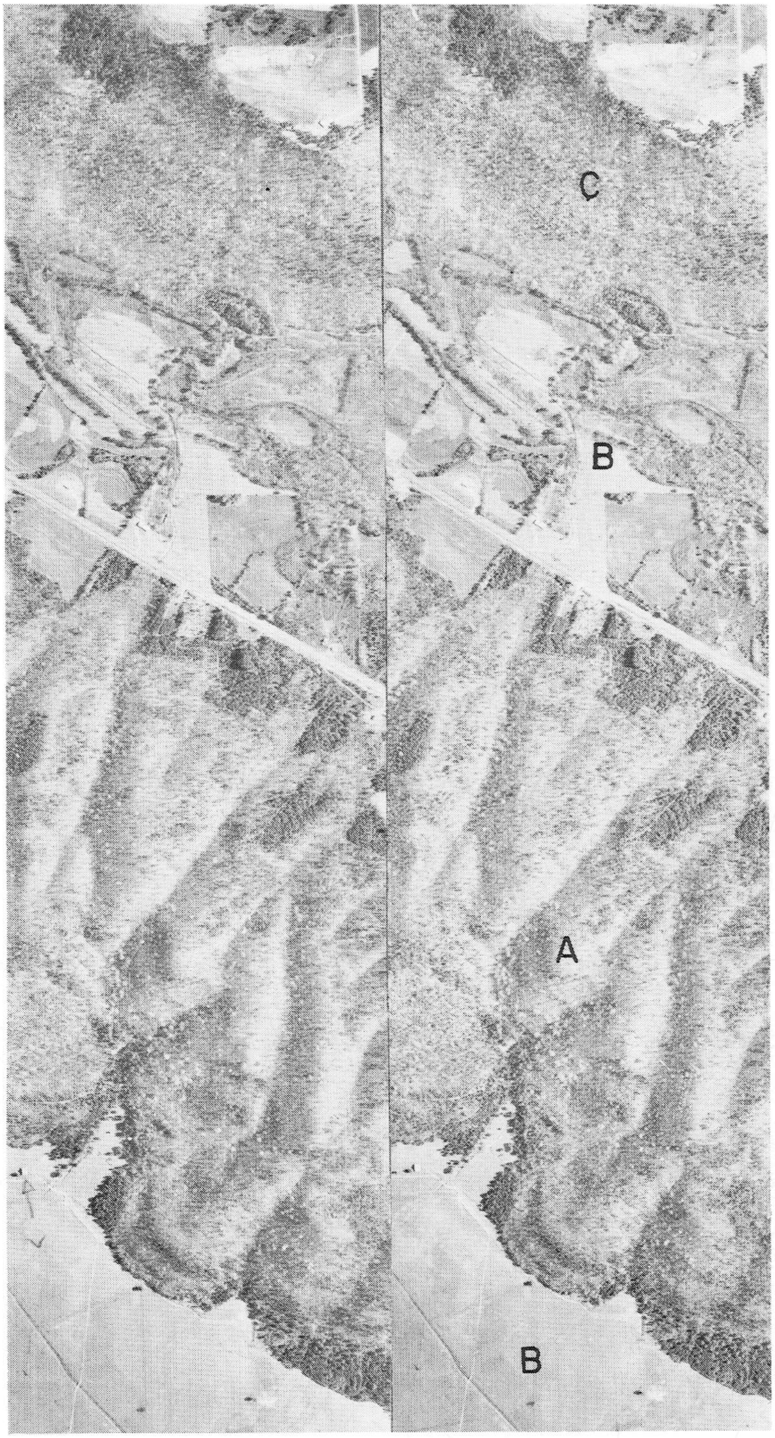

FIGURE 18. Stereogram of a portion of the "Dividing Ridge", a monoclinal structural ridge of chert, dolomite, and shale which dominates the Sequatchie Valley south of Guntersville Lake (A). The flat valley floors, typical of Zone II are shown at (B). The northwestern escarpment of Sand Mountain (C) is in Zone I. (Marshall County, HO-2MM-53,54).

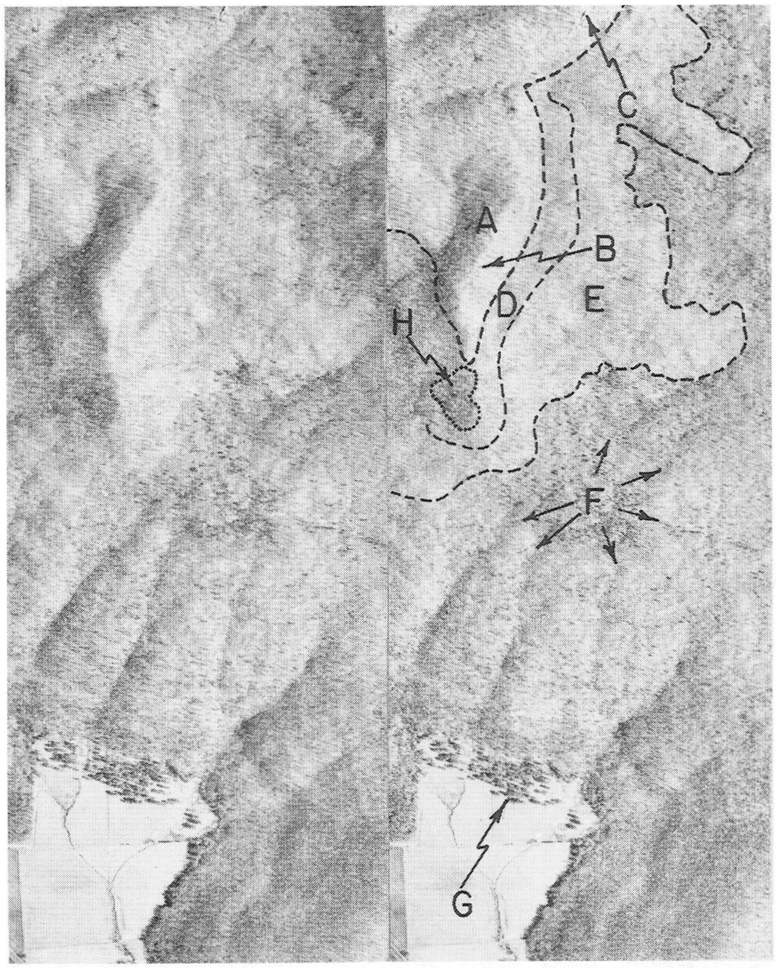

FIGURE 19. Stereogram of a degenerate Jackson County mountain. The top of the mountain is heavily dissected (A), the rimrock is poorly defined (B) with cliffs appearing only sporadically (C), the primary bench is narrow (D), and the sandstone colluvium or talus extends far downslope (E). The more or less parallel stream channels associated with limestone can be seen at (F). Some excellent pine shadows are visible at (G). The stand at (H) is classed as a rimrock stand. (Jackson County, BPS-3MM-57,58).

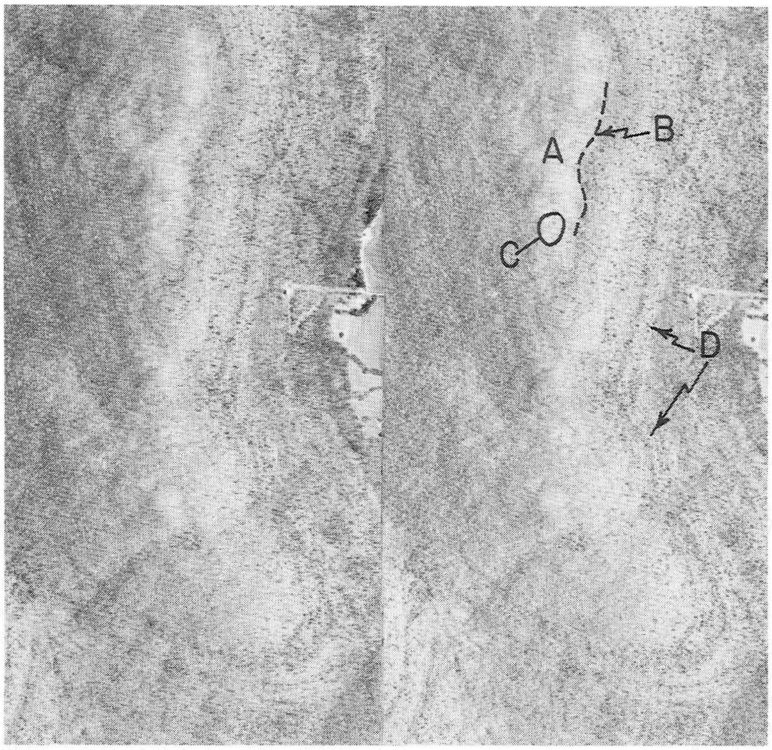

FIGURE 20. Stereogram of a Jackson County mountain on which the sandstone cap is almost entirely eroded away. The summit is rounded with no cliffs or other angularities. The presence of sandstone (A) can be deduced by the lightness of the photographic tone at the summit compared to the limestone area below. (B) marks the boundary between the two geologic materials. Cedars are conspicuously absent in the sandstone area. In some cases on mountains of this sort scattered sandstone boulders can be seen along the crest (C). In the limestone area the light toned outcrops (D), along with the dark crowns of the cedars, give the appearance of contour lines. (Madison County, HM-4MM-146,147).

(figure 21). In the northeastern portion of the zone the sandstone cap is thinner and more limestone has been exposed by erosion. Furthermore, in some cases the erosion process has progressed far enough so that the entire sandstone cap has been stripped from a hill leaving it dominated by limestone (figure 13). This occurs only in the portion of the zone north and west of the Tennessee River. In this area the base of the sandstone stratum is at about 1,300 feet so elevation can be used profitably to separate sandstone-topped and sandstone-free hills.

In zone I the limestones are in relatively early stages of decomposition. The layers of solid rock are being broken up and the resulting rock fragments are often quite large producing a very rough and rocky surface condition. Usable soil is found only in the interstices between the large rock blocks and, in general, the fertility of the soil is low.

Zone II is made up of the valley floors between the hills of zone I. Generally these valley floors are flat but in places there are low hills (figures 8A, 16A, 17B, and 22) and structural ridges (figures 17A and 18A). The floors are formed from alluvium and colluvium from the surrounding hills which have been worked and reworked by moving water and other soil developing forces to produce soils that are deep and fertile. Almost all of the zone is under cultivation. Forest cover is present only in small patches (figures 8, 14, 15, and 16). Streams, most of them small, meander across the flat valley floors incising new channels (figures 8, 14G, and 15A).

The structural ridges, which are found in the Sequatchie Valley proper (figures 17A and 18A), are the remnants of strata which at one time arched upward forming the anticline along which the valley formed. These ridges are linear and have a definite southwest to northeast orientation. The rocks making up these ridges are heterogenous and include dolomites, chert, and limestones. The ridge crests often are made up of shale or sandstone.

It should be noted that the limestones in zone II produce different soil conditions than those in zone I and consequently the species complexes in the two limestone areas are different. In general, the limestone soils in zone II are deeper, more productive, and have smaller rock fragments than those in zone I.

Zone III includes Sand Mountain from the edge of its western escarpment, including the rimrock, to the foot of its eastern escarpment (figure 3). The surface of the zone is dominated by sandstone and the species complexes reflect this situation. Sand Mountain is formed on a syncline and consequently it has a somewhat hollow surface. Much of the drainage is away from the edges but the main streams have cut deep canyon-like gorges through the rimrock and into the table top (figures 5 and 23). Eventually this process will cut the mountain into buttes like the mountains formed north and west of the Tennessee River. The walls of these gorges are upstream extensions of the boundary escarpments of the mountain and should be so considered in the interpretation process. Sand Mountain is an important agricultural area and the forest cover on the mountain is patchy. Coal is being strip-mined in the northern part of the zone but, as yet, the extent of this mining is limited.

Zone IV includes Wills Valley which lies between Sand and Lookout Mountains and, like the Sequatchie Valley, lies along an anticline which cracked and subsequently was eroded into a valley. The upward arching strata forming the anticline have formed structural ridges trending along the axis of the valley (figures 2, 24, and 25). These are similar to those in the Sequatchie Valley but contain less limestone and more chert and shale. In many respects Wills Valley is an extension of the Ridge and Valley Forest Habitat Region and valid arguments can be advanced that it should have been included in that Region. There are, however, some differences in the species complexes which would have to have been recognized and, in any case, it would have to be treated as a separate zone.

Zone V is very similar to zone III. It includes all of Lookout and Chandler mountains from the foot of their western escarpments to the foot of their eastern escarpments. Like Sand Mountain, Lookout Mountain is a syncline with a hollow surface which is being cut apart by gorges cutting through the rimrock (figures 2, 4, and 5). Sandstone dominates the surface throughout the zone, including the escarpments. In spite of the similarities between the two zones there are sufficient differences in the vegetative complexes to warrant the division.

On the county maps in Appendix III the region and zone boundaries are shown as lines. It must be remembered that, in actuality, these lines indicate transition zones (ecotones) across which conditions change. In the Cumberland Plateau Region, however, most of these transition zones are very narrow and conditions change abruptly. This can be seen in figures 2C, 3A, and 14G. Consequently, errors in forest cover evaluations cause by transition zones should be minimal.

Hill Configurations

Three fundamentally different hill configurations exist in the Cumberland Plateau Forest Habitat Region. Hills in the first category resemble mesas or buttes in that they have more or less flat tops, a line of cliffs, or remnants of cliffs, rimming the top, and steep talus or scree slopes below the rimrock (figures 2, 3, 4, 6, 7, 9, 21, and 23). The talus may be broken by outcrops of relatively erosion-resistant material (figures 21 and 29D). The major hills or mountains in the region, including Lookout, Sand, Brindley, Chandler, and the flat-topped Jackson County mountains, fall into this category. All of the hills in this group have sandstone caps. The nature of the erosion of these caps, primarily from sapping from below, causes the angularity of the hill profiles.

The second configuration category includes hills which are linear ridges formed from tilted rock strata (figures 2D, 17, 18, 24A, and 25), which are referred to as "structural ridges". In the Cumberland Plateau Forest Habitat Region structural ridges are found only in the valley zones (II and IV) where they were formed from strata which cracked when the lateral pressure on the anticlines became excessive.

The last category includes all the remaining hills. They may have any shape other than flat-topped or linear (figures 2E, 8A, 16, 20, 22, and 24B). Hills of this type are formed in all the zones, on the tabletops and in the valleys, and they vary in size from minor rises to hills which approach in magnitude some of the smaller flat-topped hills. In many cases they are remnants of hills which once were in the first category.

Topographic Positions

The upland sites, regardless of hill configuration, have been divided into four classes: **crest** or **top**, **upper slope**, **midslope** and **lower slope**; as shown in figures 26 and 27.

The lower bound of the upland areas is the base level, which is the upper edge of the overflow area. In the case of

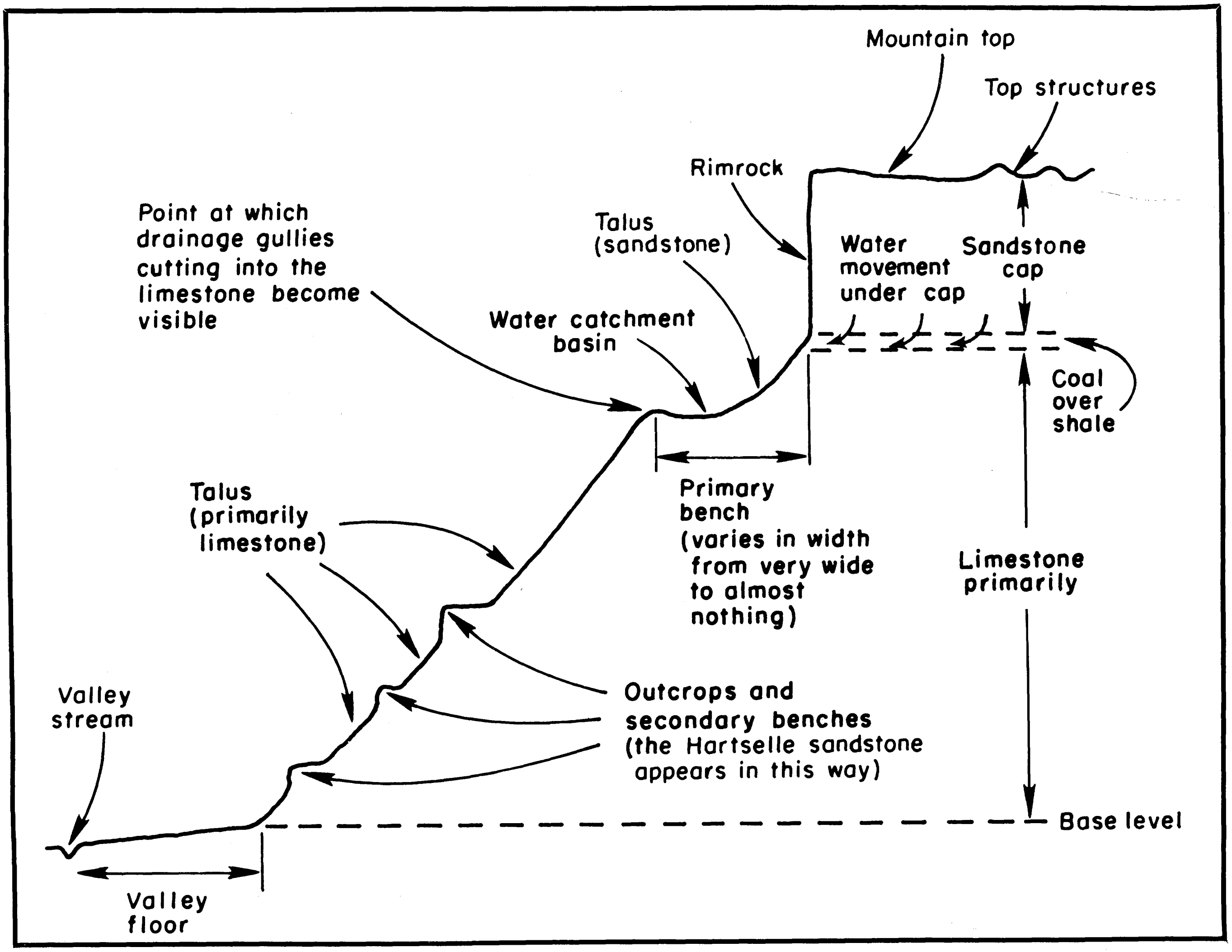

FIGURE 21. Idealized cross-section of a flat-topped mountain in Zone I.

the major hills this coincides with the foot of the escarpments at the transition between the valley floor and the mountain slope. In the case of the minor hills, such as those on the mesa tops and the undulations of the valley floors the base level concept is applied to the **local** streambottom. If no overflow area is present the base level is at the top of the stream bank.

The top, in the case of a flat-topped mountain, is the area lying inside the line of cliffs or rimrock and includes the rimrock itself. This is a tableland which may cover, as in the case of Sand and Lookout mountains, many square miles and is not level. It contains hills and these must be considered individually. Each has its own base level, referenced to its local stream, and should be divided into the four topographic positions.

In the case of non-flat-topped hills the top or crest extends across the top of the hill and down to a point where the main downward slope of the hill begins.[5]

Regardless of hill configuration the length of the slope between the base level and the lower edge of the crest is divided equally into the three slope classes. Spurs should be treated as separate hills except at their junction with the main hill mass. At such junctions, and also where saddles occur (figure 29E), the mid-slope class should be used.

Figure 2 shows a portion of a flat-topped mountain where the slope positions have been delineated for illustrative purposes. Figure 13 shows a similar delineation of the slope positions on a non-flat-topped mountain. In practice an interpreter should do this delineating mentally to determine the topographic position on which the unknown stand occurs. One must recognize that forest stands usually extend over more than one topographic situation and that a certain amount of averaging must be done. Although the key probably would be more accurate in classifying the cover at points or on plots, with good judgement the interpreter can achieve reasonable accuracy with stands.

Presence Of Sandstone Or Limestone

As has been mentioned repeatedly, the species complexes on sandstone derived soil material differ substantially from those on limestone derived soil material. The region was divided into zones largely in recognition of this fact. Limestone does not occur in zones III (Sand Mountain) or V (Lookout Mountain). Both limestone and

[5] Another definition of the crest is the convex portion of the hilltop.

FIGURE 22. Stereogram of a portion of Zone II northwest of Grant where the process of erosion of the Cumberland Plateau has reached the point where the sandstone is completely gone and the removal of the limestone is well advanced. These hills are low and jumbled, but the contour-line-like lines of cedar along the stratum outcrops are still visible. The soils in areas like these are further developed than those of the limestone portions of the mountain escarpments and the species complexes found on the two sites are somewhat different. (Marshall County, HO-1MM-220,221).

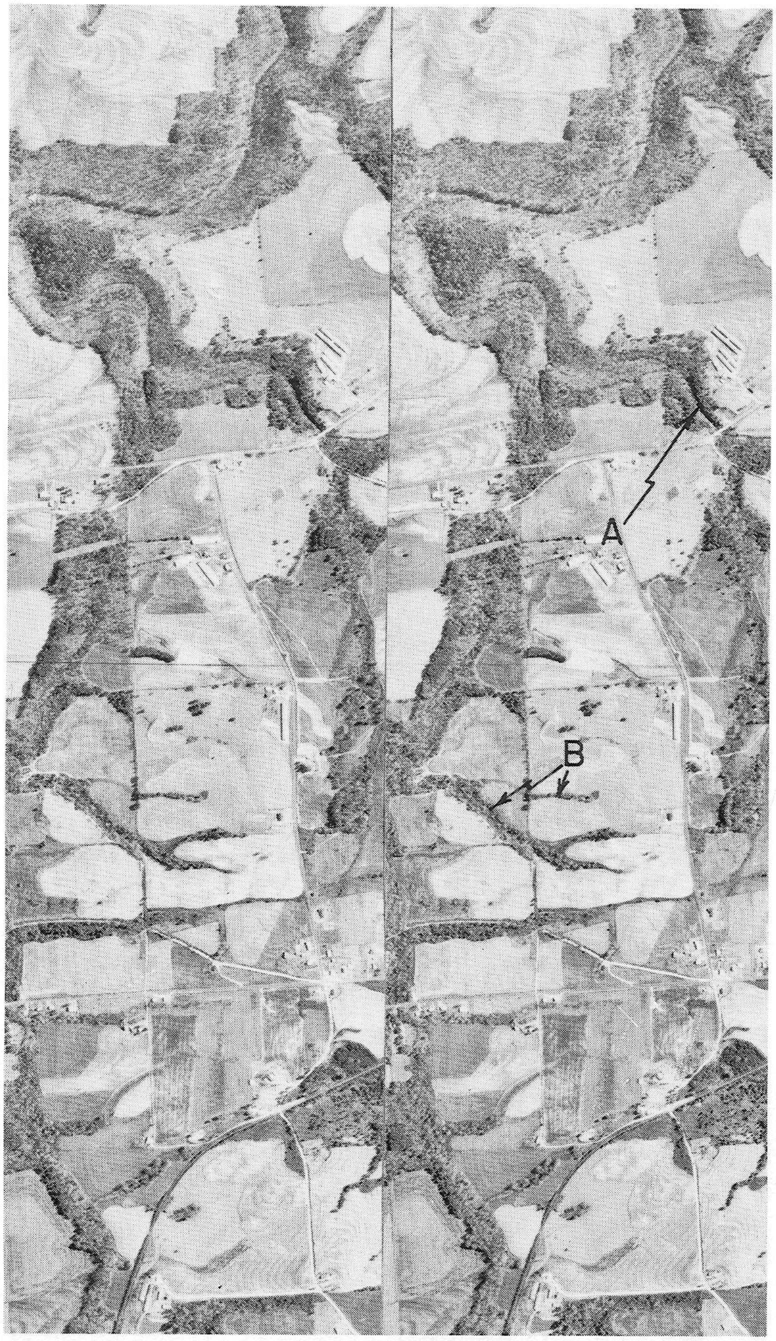

FIGURE 23. Stereogram of the stream system leading into Short Creek Gorge on Sand Mountain (A). Note the gentleness of the stream gradients on the tabletop and their steepness when they enter the gorge. This process, in time, will reduce Sand Mountain to a set of flat topped mountains like those presently found west of the Tennessee River in Jackson County. The narrowness of the bottomland sites associated with the minor streams can be seen at (B). The intensity of the agricultural development of Sand Mountain is evident in this stereogram. (Marshall County, HO-1MM-123,124).

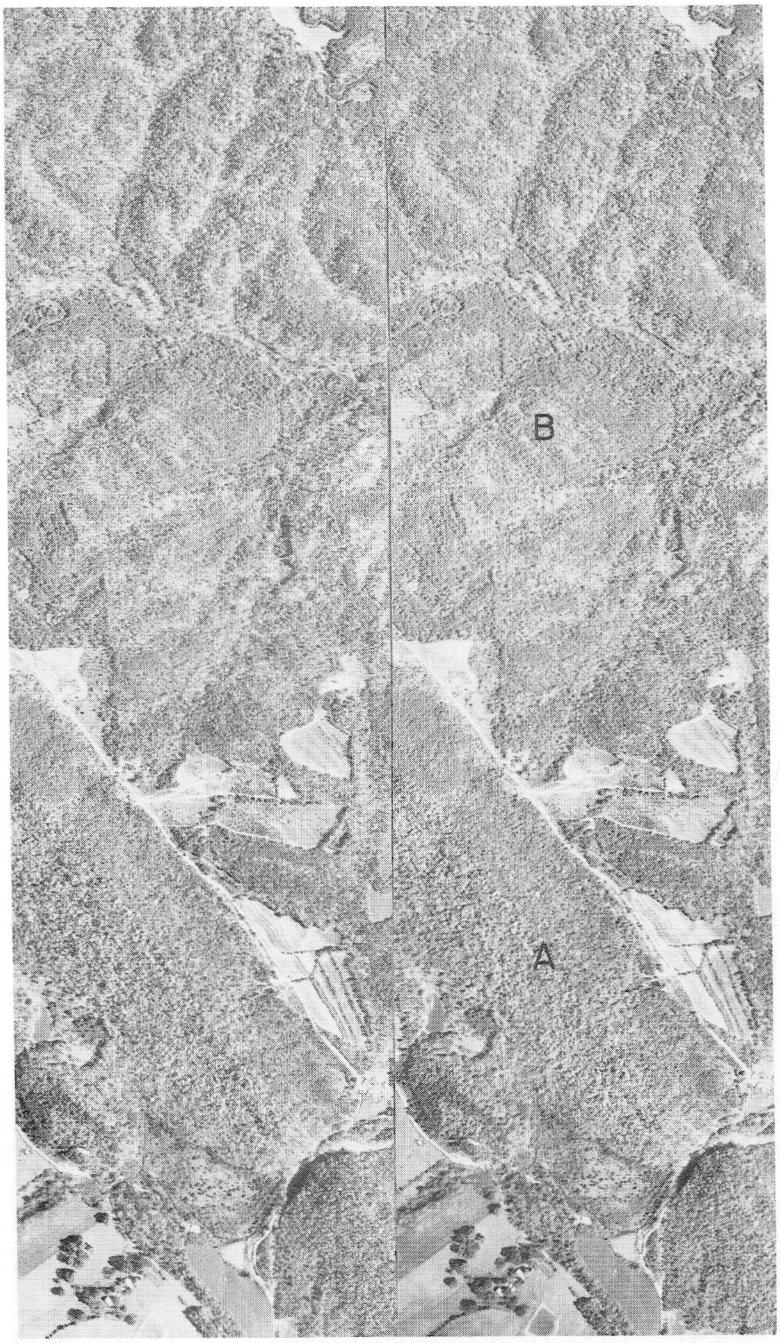

FIGURE 24. Stereogram of a portion of Wills Valley, Zone IV, showing a structural ridge (A) and jumbled non-structural hills (B). (Etowah County, GP-1LL-252,253).

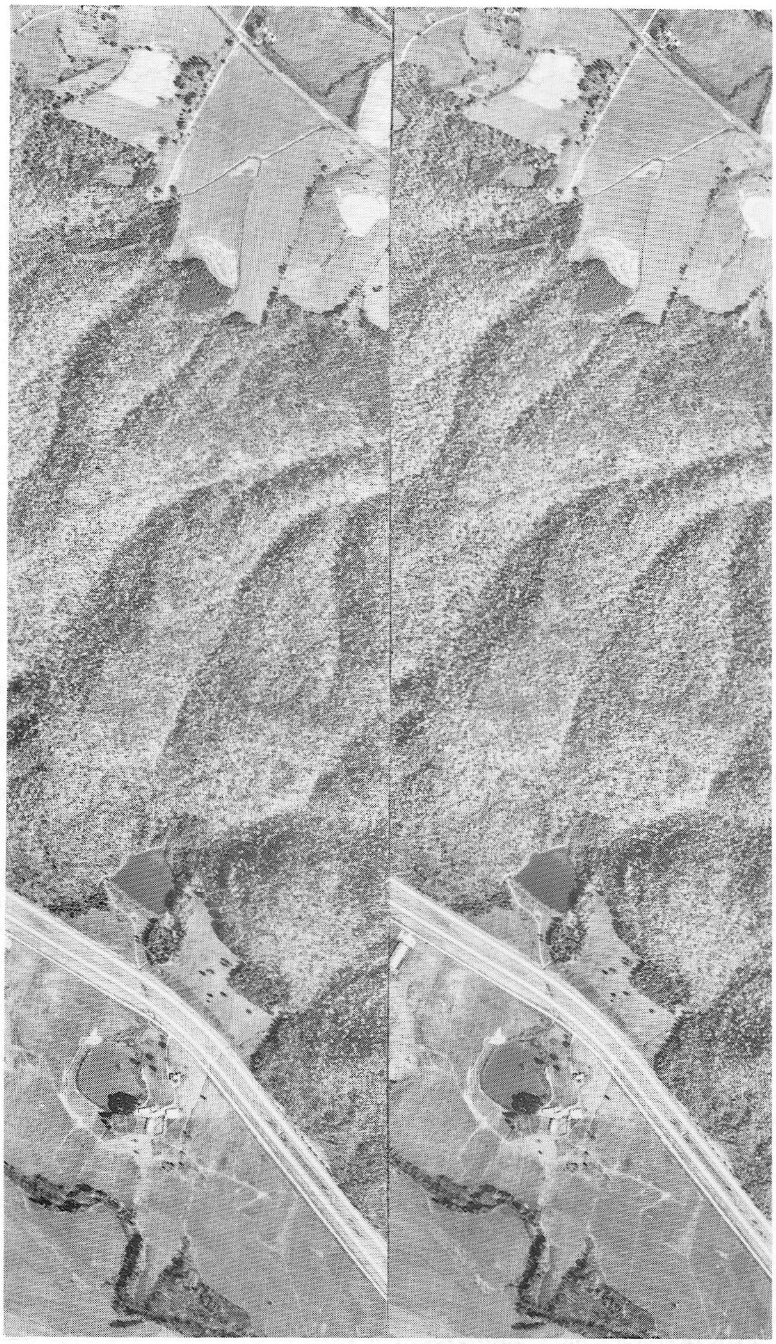

FIGURE 25. Stereogram of "Big Ridge", the major structural ridge in Wills Valley, Zone IV. This ridge is largely sandstone but is capped with shale. (DeKalb County, PM-2LL-97,98).

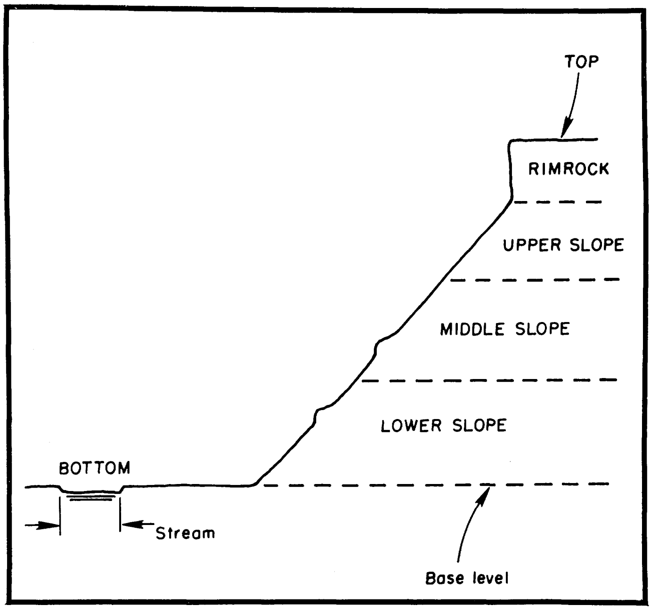

FIGURE 26. Idealized cross-section of a flat topped mountain escarpment, where only sandstone is present, showi the topographic positions and the base-level.

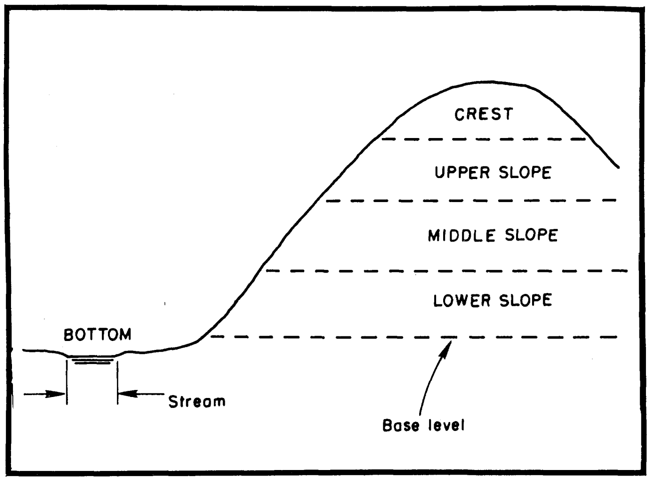

FIGURE 27. Idealized cross-section of a non-flat-topped hill showing the topographic positions and the base-level.

sandstone, along with chert, dolomites, and shales, occur in the valley zones (II and IV) but this causes little difficulty to the photo-interpreter because the geologic materials are sufficiently closely associated with specific landforms, which are readily identifiable, so that the extent of each can be assessed without difficulty. In zone I, however, especially north of Guntersville, the problem of determining whether sandstone or limestone material covers a particular point or area becomes acute. This area is where the dissection of the Cumberland Plateau is far advanced. The mountains and hills in the area are in varying stages of dissolution. Some still have an extensive sandstone cap, others have only a remnant of the cap, and others have no sandstone remaining. Where the sandstone material is present some is in the form of talus or scree which covers part of the escarpment face. The problem of interpretation is to determine the boundary of this sandstone material.

The clues available for distinguishing between sandstone and limestone material are subtle and require great care in their interpretation. One of the more useful of these clues results from the fact that limestone erodes more rapidly and in a somewhat different manner than sandstone. As can be seen in figures 6G, 19F, and 28, the escarpment face may be laced by more or less parallel and quite uniformly spaced drainage channels. The channels are narrow and deep and show up quite well on the photographs, provided the forest cover is not too dense (figure 3) or that the escarpment is not in shadow (figure 14B). **These channels are found only in the limestone areas.** Sandstone simply does not produce a drainage pattern of this type. The upper limit of these streams occurs at or just below the downhill boundary of the sandstone material. Consequently, the line of streamheads can be assumed to mark the boundary.

Often a bench can be seen immediately below the cliffs (figures 6B, 19D, 21, and 28). The surface of this bench is covered by sandstone talus. The water for the streams appearing in the limestone area, as described above, usually comes from catchment basins in this bench as is shown in figure 21. Consequently, the line of streamheads usually occurs immediately below the bench (figure 28).

At the end of a hill, as in figures 6, 14, and 28, the water catchment area at the top of the escarpment is proportionally much smaller than it is along the side of a hill. Consequently, less water is available and the stream channels mentioned above are much less evident and may be entirely missing.

A very useful clue to the presence of limestone is the presence of cedars. Cedar crowns usually are as dark or darker than the crowns of pines and have narrower and more spire-shaped crowns. This crown configuration can sometimes be detected stereoscopically but usually reference must be made to shadows (figures 6H, 6J, 9B, 13A, 15C, 16A, 20D, 22, and 30B).

In some cases, especially when the sandstone cap of a hill is in its last stages before complete removal but is still visible (figure 30) or when the sandstone cap is especially thick relative to the total relief, as in the Brindley Mountain area (figure 31) or the Sequatchie Valley south of Guntersville (figure 18C), the sandstone material can cover the entire slope. This can be detected by the photo-inter-

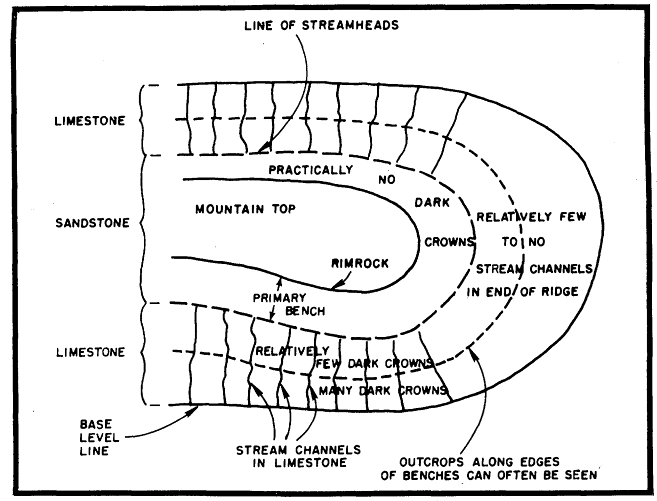

FIGURE 28. Plan diagram of a portion of a flat-topped mountain in Zone I showing the top, primary bench, the stream channels in the limestone, and the distribution of cedars revealed by their dark toned crowns.

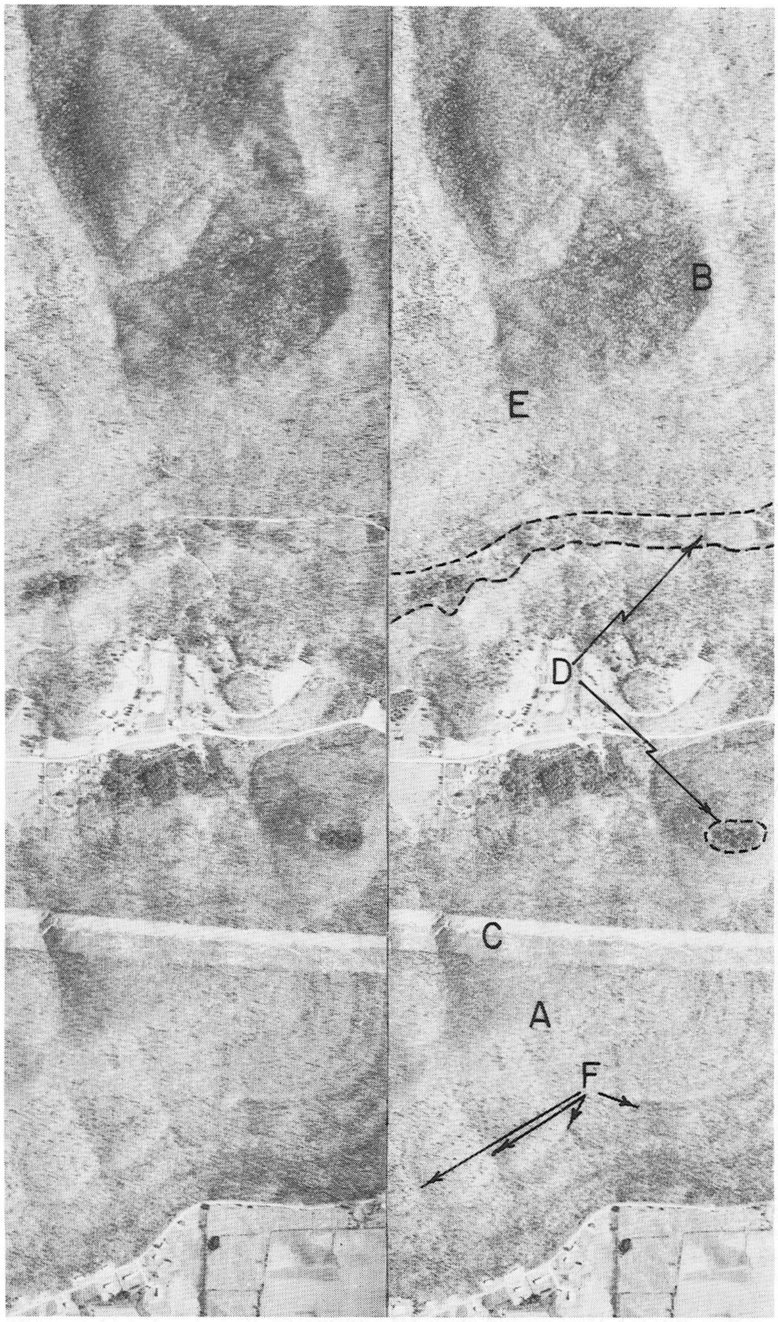

FIGURE 29. Stereogram showing the end of a spur from a Jackson County mountain from which the sandstone cap has been completely removed (A) and a mountain which has been eroded to the point that the top is reduced to a peak (B). The stand of trees at (B) would be classed as a rimrock stand. The horizontal bedding of the strata is evident as outcroppings on both mountains, especially in the powerline right-of-way (C). A resistant stratum of Hartselle sandstone forms a distinct bench at (D). The dark crowned trees at (D) on both mountains are pines. The saddle at (E) would be considered as occupying a middle slope position. The more or less parallel system of escarpment streams associated with limestone can be seen at (F). (Madison County, HM-4MM-177,178).

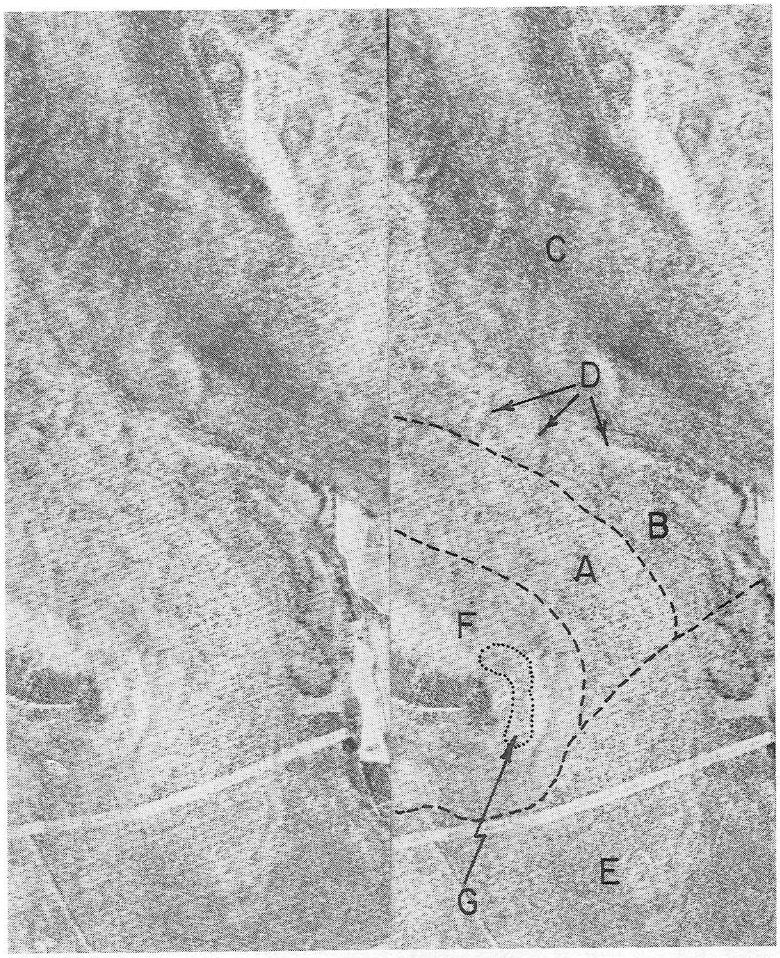

FIGURE 30. Stereogram of a portion of the escarpment of a flat-topped Jackson County mountain which is dominated by sandstone colluvium almost to the base level (A). In this area the dark-crowned trees are shortleaf pine. Below the sandstone material, as at (B), the dark-crowned trees are cedars. Note the absence of stream channels in the sandstone material and the difficulty of assessing the situations on the shadowed slope at (C). Immediately below the sandstone material, however, the streams appear (D). In the area labelled (E) no streams are evident. This is typical of spur ends. The primary bench is at F. The stand at (G) would be classed as a rimrock stand. (Madison County, HM-5MM-8,9).

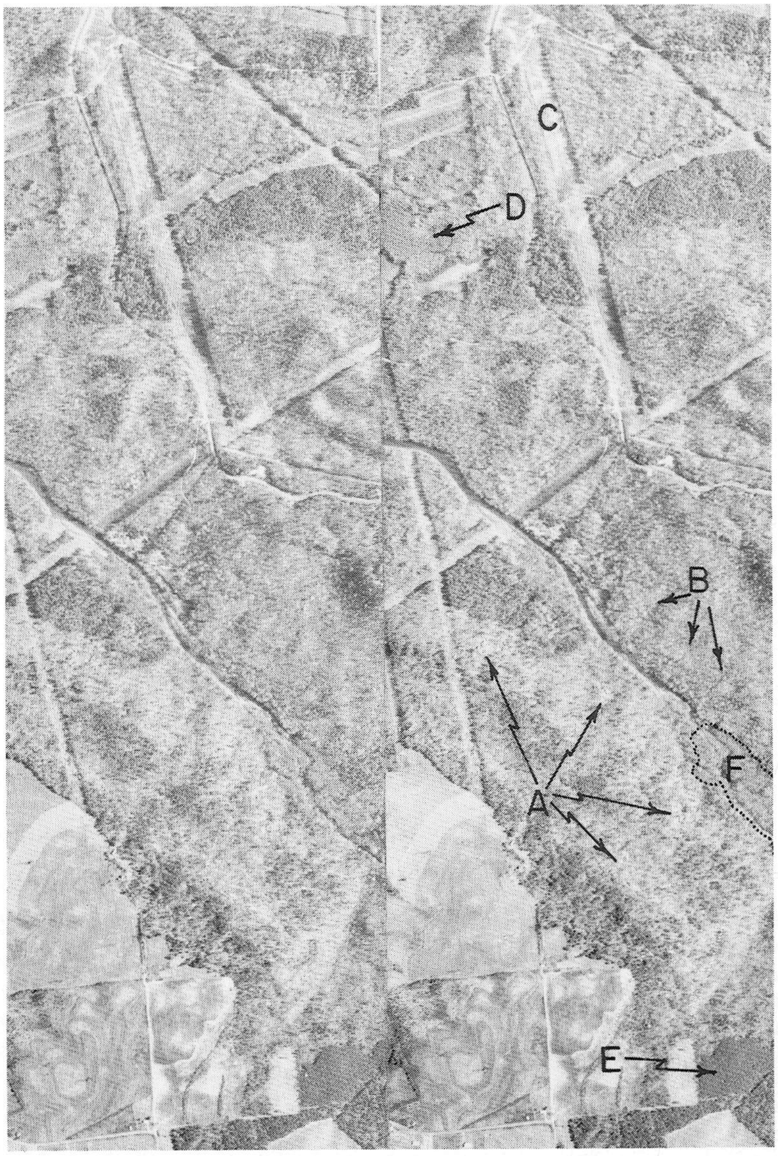

FIGURE 31. Stereogram of a portion of the escarpment of Brindley Mountain just west of Guntersville Dam. Note that the escarpment is much lower than those on the mountains further north. Sandstone dominates almost the entire escarpment. The pattern of stream channels associated with limestone is absent on the slope labelled (A), on which large blocks of sandstone can be seen, indicating that sandstone material dominates the surface. At (B) the presence of a narrow limestone exposure is revealed by the typical stream channel pattern. A portion of the flat valley floor of Zone II appears at (C). (D) is a swampy area supporting a pure stand of water tupelo. The photographic texture of this stand, with small light-toned crowns, is typical of water tupelo. No other species complex produces a similar texture. (E) is a very dense young natural stand of Virginia pine. The texture in this case is that which is often associated with Virginia pine. (F) is a stand of bottomland hardwoods along a stream having a width greater than 10 feet. (Marshall County, HO-2MM-79,80).

preter through the absence of the stream channels previously described and by the presence of large blocks or boulders of sandstone all the way to the base of the hill (figure 31A).

When sandstone material is present in zone I it almost always comes from the Pottsville Formation which forms the surface of the Cumberland Plateau. However, sandstone also occurs in strata below the surface, occasionally forming outcrops and benches on the escarpments of the hills (figures 21 and 29D). The Hartselle sandstone is the most significant of these strata. Since the soils derived from these sandstones are similar to those derived from the Pottsville material and support similar vegetative complexes, the photo-interpreter should be aware of these benches and should assess the vegetation on them in terms of sandstone in spite of the fact that the areas involved are far downslope. However, they are rare and of little significance and should cause little difficulty.

Aspect

The key recognizes that both the moisture regime and the vegetative distribution pattern are influenced by the aspect of a slope. Theory and empirical evidence indicate that the coolest and moistest sites occur on the northeast facing slopes while the hottest and driest conditions are found on the southwest facing slopes. The axis of maximum effect is therefore located along the N45°E-S45°W line. The distribution of species is essentially symmetrical on either side of this line, as is shown in the hill patterns in figures 57 to 64.

Aspect, of course, is present only if the land slopes. In many cases, however, the slope is so gentle that it cannot be detected on the photograph using simple equipment. Such areas have been classed as "flat" and recognized as such in the key.

Bottomland Sites

The sites below the base level (figures 21, 26, 27) are on overflow areas and should be considered bottomland sites. It should be remembered, however, that the base level concept applies to minor hills, rises, and undulations as well as to major hills and mountains. The bottomland sites considered in the key are those defined by the topography immediately adjacent to the streams, not by the base levels used to separate zones. Consequently, bottomland sites will be found on the mesa tops and the escarpment walls as well as in the valleys between the mountains. Each stream and its associated overflow area must be considered individually.

The following bottomland categories have been recognized:

(1) the free-flowing portion of the Tennessee River, which is the only major stream in the region. Within the region, the Tennessee flows free only from the Tennessee state line to about Bellefonte Island and for about 24 miles below Guntersville Dam. Where it is free-flowing, the Tennessee River is relatively deeply incised into its valley floor and the forest sites to which the Key refers are only those immediately along the bank (figure 3D). Beyond the bank is the main valley floor of zone II.

(2) those along free-flowing streams with a stream width equal to or greater than ten feet.

(3) those along free-flowing streams, intermittent as well as constant-flow, with a stream width less than ten feet.

At the headwaters, along the essentially intermittent streams, the forest cover type referred to in the key will apply only to a very narrow strip of trees, perhaps only one tree wide, on each side of the stream. As the streams become larger the accompanying bottomland site condition usually becomes wider but it may never be more than two or three trees in width, on each side of the stream (figures 8C and 23B), particularly if the stream is in a relatively deep channel with well defined banks. If the stream is cutting into a flat valley floor in zones II or IV (figures 14H and 15A) the bottomland site usually will apply only to the streambank. In such a case the sites beyond the bank are to be considered upland sites. If the stream is in a gorge, with a V-shaped cross-section (figures 5 and 23A), the bottomland site again is limited to the streambank proper. The escarpment wall begins immediately above the bank. On the other hand, a swamp may develop and the bottomland site become extensive (figures 8B, 15E, 16B, 31D and F) if the stream is not actively downcutting but instead is meandering over an area that is essentially flat. Such swamp conditions are rare except on the valley floors in zone II. In many cases in zone II these wet areas have been drained and the land placed under cultivation (figure 8). Usually the forest cover in the swampy areas is essentially the same as that found in the bottoms of similar streams and consequently the key makes no specific mention of swamps. Deep swamps bearing almost pure stands of water tupelo can be found covering limited areas in the portion of zone II adjacent to the sections of the Tennessee River where its immediate flood plain is not covered by Lake Guntersville (figures 3G and 31D). The presence of these tupelo swamps can be detected by the appearance of the canopy as described in the section on Texture and Crown Shape.

In areas where the original forest cover has been removed, as in areas in cultivation (as along the small streams and ditches in figures 8, 15, 18, and 23), or where the overstory has been logged off, the bottomland site may develop dense stands of hazel alder in which may be found black willow, yellow-poplar, sweetgum, and other wet site species. This is a transitional stage in the succession and the distribution of species is highly variable. Because of this instability a hazel alder type has not been recognized and the condition has not been recognized in the key.

A number of the streams in the Cumberland Plateau Forest Habitat Region, including the Tennessee River, have been dammed forming lakes or ponds (figures 4, 7F, and 25). The margins of these lakes or ponds are typical of bottomlands only where the streams enter the impoundments. The forest cover along the remainder of the lake margins is more nearly like that associated with upland slope positions than it is like the cover found in normal drainage conditions (figures 9B and 17). Consequently, the impoundment edges cannot be classed with the drainage and the upland slope positions for the stands must be estimated by the interpreter. The key makes provision for the interpreter who considers such edges in the "bottomland" condition and returns the search to the upland portion of the key (see step 139 in the key). In this process the key ceases to be a truly dichotomous key but in the interest of efficiency the modification was made.

Photographic Tone

The most valuable photo-image characteristic for distinguishing between softwoods and hardwoods on black and white aerial photographs is photographic tone. Hardwoods, as a group, reflect more light than do softwoods, usually making them appear lighter in tone on photographic prints than the softwoods. This tendency can be accentuated by the appropriate choice of photographic specifications.

The photographic specifications used by the ASCS fail to produce photographs that are ideal for forest cover identification. While the film and filter combination is acceptable, the season of the year may or may not be suitable because the agency only requires photography that will distinguish field from forest. Since the only seasonal condition that interferes seriously with its requirement is snow cover, most of the photographs made for the ASCS are taken in the summer in the North and in the late fall, winter, or early spring in the South. This latter period is the worst possible for taking aerial photographs that are to be used for forest cover evaluation because the hardwood leaves are dying, have fallen, or are just developing. Consequently, photographic tones associated with hardwood cover are subject to wide variations and have been given minimal weight in the key. Nevertheless, tone cannot be ignored completely since it is essential to the estimation of relative proportions of hardwoods and softwoods.

A further factor influencing photographic tone is contrast, which is defined as the range in grey tones, from the lightest to darkest, appearing on the print. When this range is short, i.e., the lightest tone is not much different from the darkest tone, the print is said to have low contrast and is termed a soft print (figure 32). When the lightest tones are nearly pure white and the darkest tones are nearly black, the print is said to have high contrast and is termed a contrasty, or hard print (figure 33). Contrast is controlled in the printing process, and the usual objective is to choose a contrast level that will reveal the maximum detail. If the contrast is not optimum, detail, i.e., information, is lost. In ordering photographs from the ASCS, one is given no opportunity to specify the contrast level, and the ASCS makes little or no effort to provide an optimal contrast. Only rarely does the contrast meet the desires of a forest photo-interpreter. Tonal differences between hardwoods and softwoods are often minimal, making the photo-interpretation problem more difficult. This problem has been accentuated in recent years with the advent of electronic dodging devices. When not appropriately programmed these devices can produce photographs on which species differences have been completely obliterated.

The key in this publication recognizes three tonal situations, based merely on the proportion of dark (softwood) crowns in the stand canopy. (1) 70 percent or more of the crowns are dark grey; (2) 30 to 70 percent of the crowns are dark grey; and (3) less than 30 percent of the crowns dark grey. Neither season of photography nor contrast level of the print greatly affects the detectability of the dark grey crowns. However, the evaluation of the hardwood component of the canopy is strongly influenced by these factors.

In the fall, leaves of deciduous trees decline in vigor and die in a pattern that is far from uniform, leaving some crowns visible and others invisible. Underestimation of the hardwood proportion results. In addition, tonal differences between hardwoods and softwoods are reduced during this period, particularly when the contrast level is high (figure 34).

In winter when the deciduous trees bear no leaves, the crowns are invisible on photographs and the tone is a reflection of the ground cover and has little or no relation to the hardwood trees themselves. The only evidence that trees are present are shadows. When the shadows of bare trees fall clear on a smooth surface, they may provide good evidence for evaluation of the forest cover (figure 35). Though shadows are seldom as clear as shown in figure 35 they often can be used to estimate the relative density of the hardwood component. Figure 36 shows a relatively dense stand of hardwoods whose presence is revealed by their shadows.

Some broadleaved tree species (e.g., sweetbay) are evergreen, and some (e.g., southern red oak) hold their dead leaves until they new leaves appear in the spring. This causes no problem so long as the photographs were taken on panchromatic film, because both live and dead hardwood leaves usually appear lighter on such photographs than do the softwood crowns. However, black and white infrared film provides little differentiation in tone between softwood crowns and dead hardwood leaves.

Tonal differences between hardwoods and softwoods appear to be at their maximum after the leafing-out process is essentially complete but before the leaves are fully mature. There should be no difficulty in classifying a stand into one of the tone classes on photographs made at that time. Unfortunately, ASCS photography in the South rarely is taken this late in the spring and dependence must be placed on the combination of tone and shadows (figure 37).

Different stands having the same ratio of dark to light crowns may differ considerably in appearance because of difference in stand density. Figures 38 to 53 are stereograms that show examples of three different tone classes with different stand density levels. Examples are also shown where the hardwood component must be evaluated from shadows.

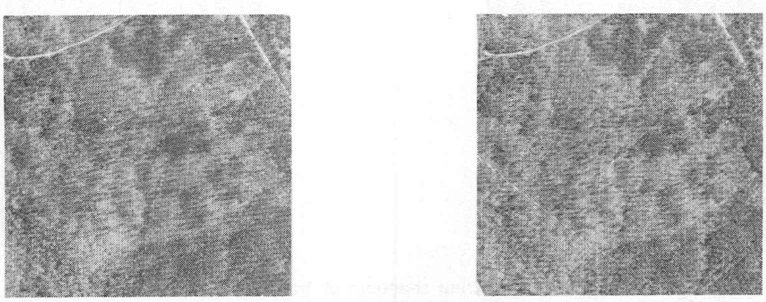

FIGURE 32. Stereogram with low contrast.

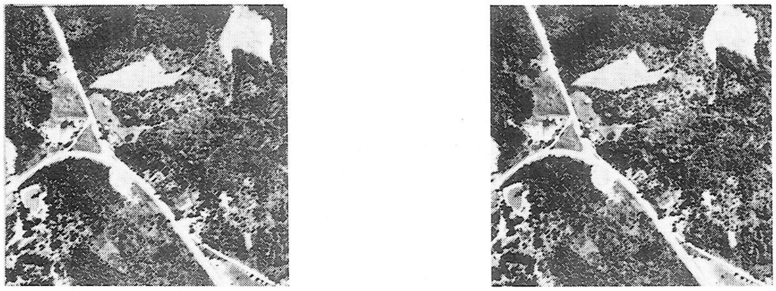

FIGURE 33. Stereogram with high contrast.

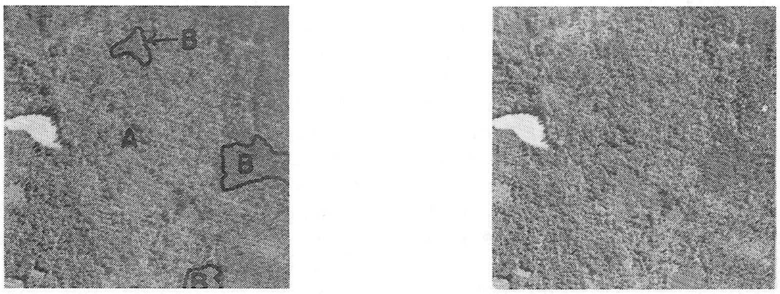

FIGURE 34. Stereogram showing hardwoods (A) and pine (B) during the fall color season.

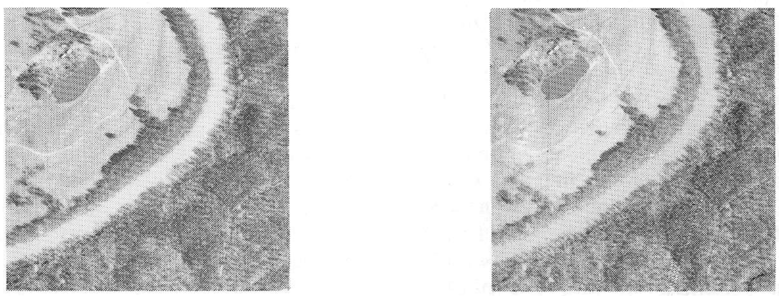

FIGURE 35. Stereogram showing shadows of hardwoods falling clear on the surface of a stream. Crown characteristics are quite clear.

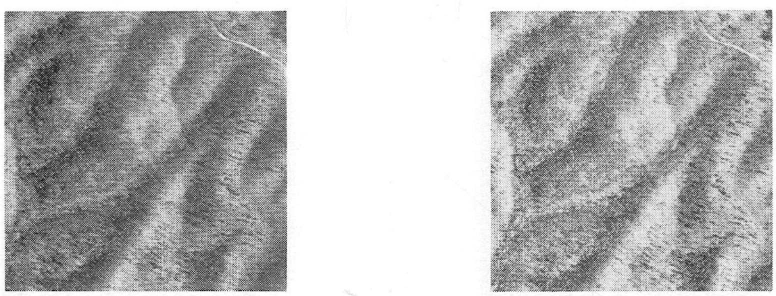

FIGURE 36. Stereogram showing shadows of hardwoods in a relatively dense stand. Note the striated appearance of the shadows. Density of the striations is correlated with stand density.

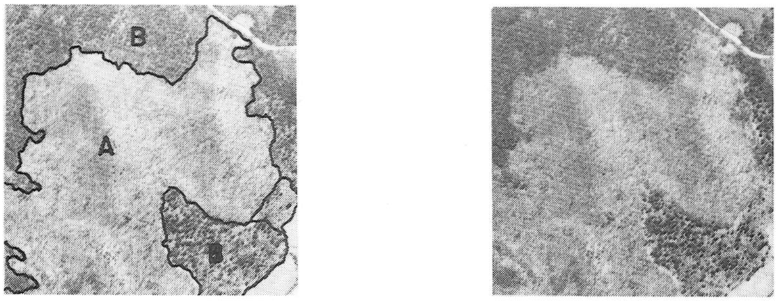

FIGURE 37. Stereogram showing the contrast between hardwoods (A) and pines (B) in early spring when the leaves are beginning to open.

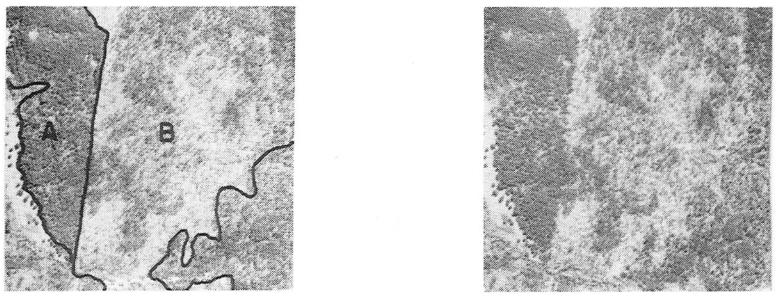

FIGURE 38. Stereogram of a dense stand of pine (A) adjacent to a stand of mixed pine and hardwoods (B).

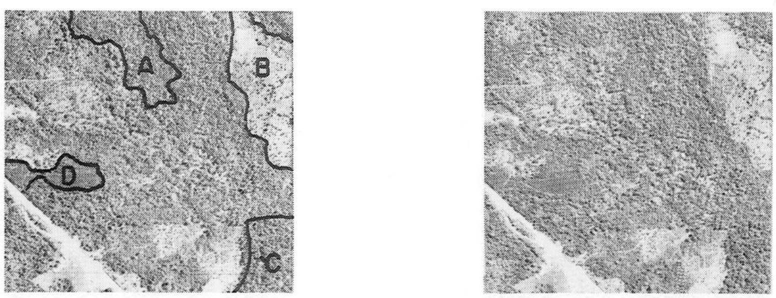

FIGURE 39. Stereogram of a medium dense stand of pine (A), a field restocking to pine (B), a dense stand of mixed pine and hardwoods (C), and a small, dense pine plantation (D).

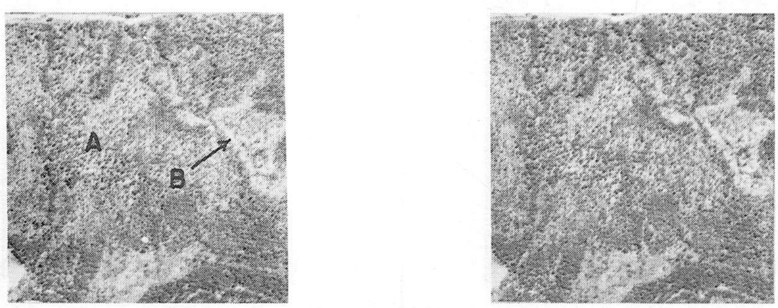

FIGURE 40. Stereogram of an open stand of pine (A), with light-toned brush along the stream (B).

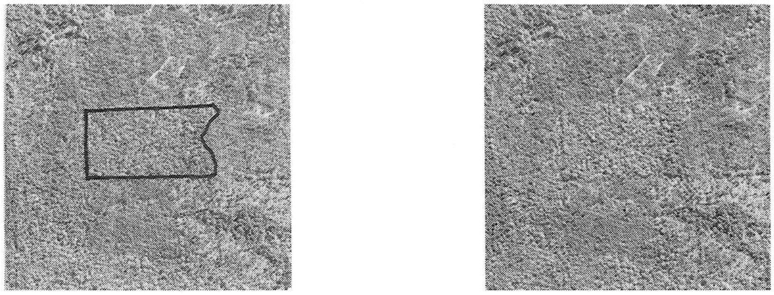

FIGURE 41. Stereogram of a dense mixed pine-hardwood stand. The photographs were taken during the fall color season. Discrimination between the pine and hardwoods is based on the differences in the tones of grey associated with the two species groups.

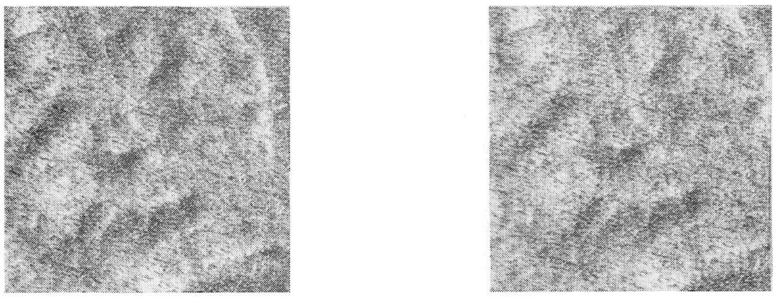

FIGURE 42. Stereogram of a dense mixed pine-hardwood stand. The photographs were taken during winter when leaves were off most of the hardwoods. The pine crowns are still full. Bare hardwoods are identified by their shadow pattern and light-toned crowns identify hardwoods still holding leaves.

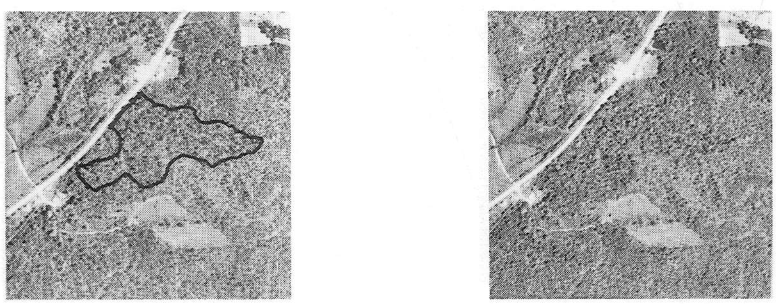

FIGURE 43. Stereogram of a two-storied, mixed pine-hardwood stand. The over-story has medium stocking. The photographs were taken during the fall color season. Discrimination between pines and hardwoods is on the basis of tones of gray.

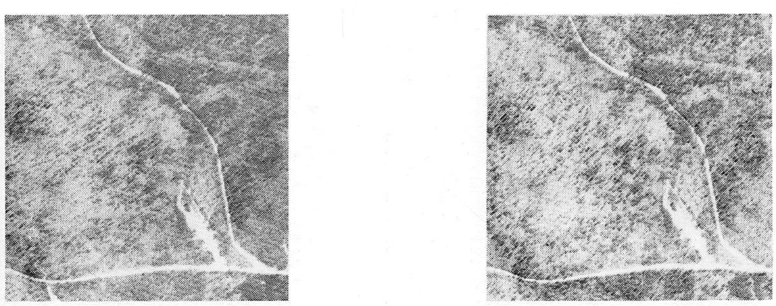

FIGURE 44. Stereogram of a medium-stocked, mixed pine-hardwood stand. The photographs were taken in the spring before leaf development was complete. The hardwood component is revealed primarily by shadows.

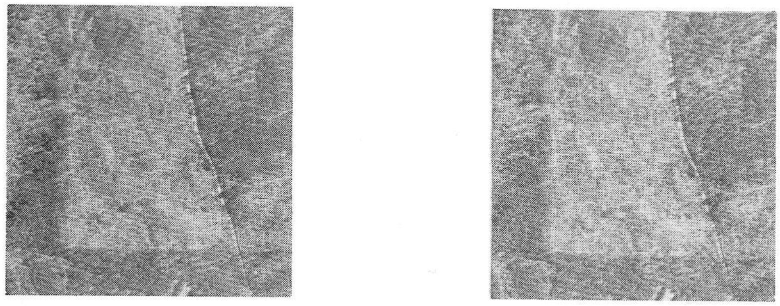

FIGURE 45. Stereogram of a cut-over area with a thin residual stand of mixed pines and hardwoods. The hardwood crowns are light-toned while the pine crowns are dark toned.

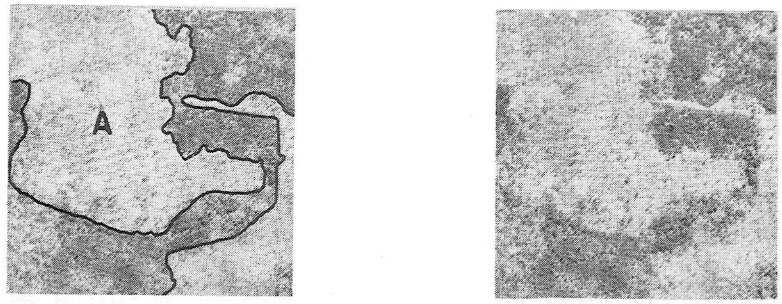

FIGURE 46. Stereogram of a thin stand of mixed pines and hardwoods (A). The hardwood component can be evaluated only by shadows. Though photographed in the spring when the leaves were developing, the hardwood crowns are not distinct because the understory is also light-toned.

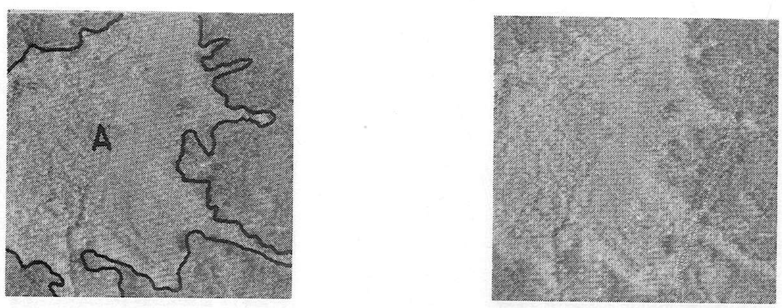

FIGURE 47. Stereogram of a dense stand of hardwoods (A). The photographs were taken in winter and nearly all of the hardwood leaves have fallen. Although the contrast level is low, the few remaining leaves cause the hardwood crowns to be distinctly lighter in tone than the pine crowns.

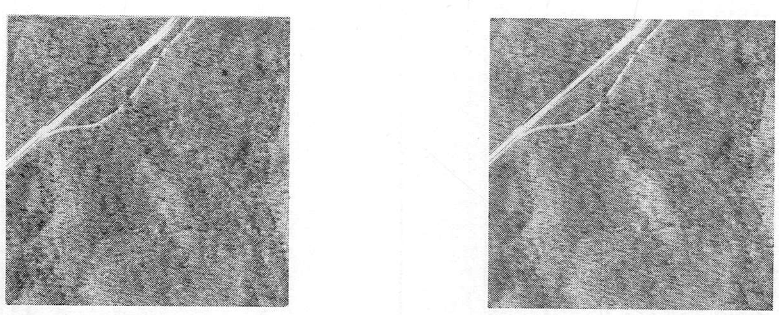

FIGURE 48. Stereogram of a dense stand of hardwoods. The photographs were taken in winter when few of the hardwood crowns still bore leaves. Density of the stand must be judged from the shadows.

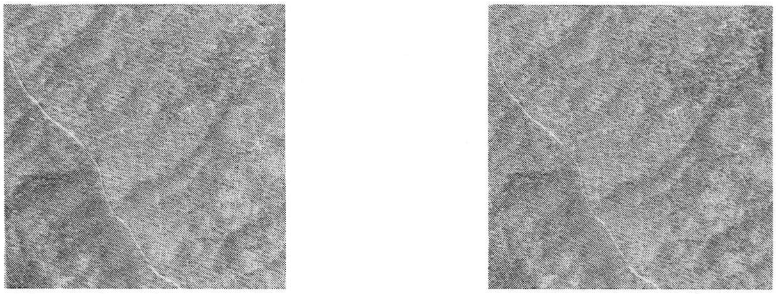

FIGURE 49. Stereogram of a patchy stand of hardwoods ranging from medium to high density. Though the photographs were taken in winter, many of the hardwoods still bear leaves. Density of the stand must be judged jointly from the crowns and shadows.

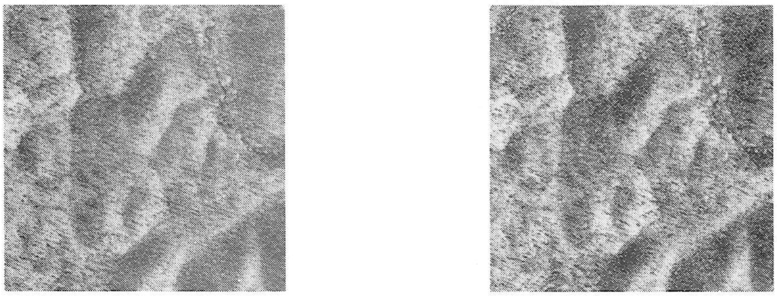

FIGURE 50. Stereogram of a medium dense hardwood stand. The density must be judged primarily from shadows.

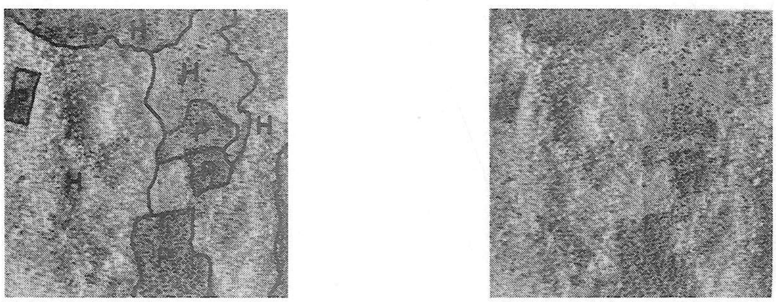

FIGURE 51. Stereogram showing a variety of hardwood and pine stands. The photographs were taken in winter, but many of the hardwoods still retain leaves. Stand density must be judged from grey tones of crowns and shadow patterns.

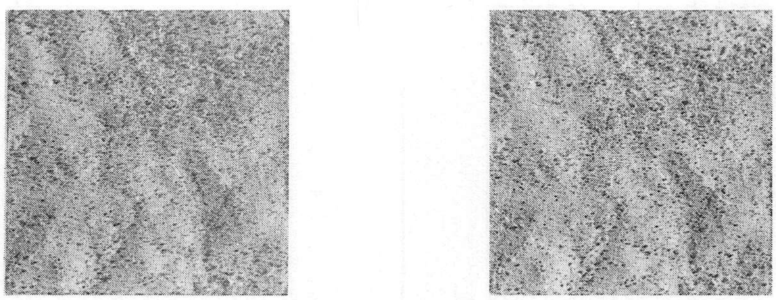

FIGURE 52. Stereogram of a thin stand of hardwoods in the fall color season. The hardwood crowns are visible and can be used to determine relative density of the hardwood component.

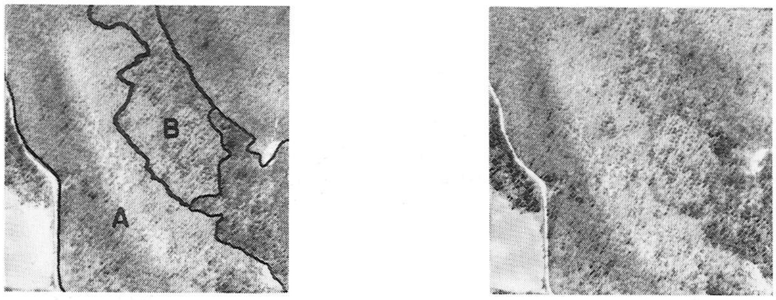

FIGURE 53. Stereogram of a medium to low density hardwood stand (A). The pine component of this stand is less than 30 percent of the stand basal area. In stand (B), the density remains medium to low, but the pine component is sufficiently large for the stand to be classed as pine-hardwood. Relative density of the hardwood component can be determined from the shadow pattern.

Stand Texture And Crown Shape

To the experienced forest photo-interpreter the arrangement and character of the fine detail of the forest cover often yields valuable clues to the species composition and condition of forest stands. Unfortunately there are no standard textures which can be used as the basis of communication between interpreters. Each interpreter describes texture in terms of things with which he is familiar. Communication is prevented if the person given the description is not familiar with the simile. For this reason relatively little use has been made of texture as a diagnostic tool in these keys. There are, however, conditions in the Cumberland Plateau Forest Habitat Region where texture is of sufficient importance to justify its inclusion in the key.

The presence of cedar is an indication that the stand is on limestone derived material which is of critical importance insofar as the photo-interpretation is concerned. Consequently, if cedar can be detected, limestone can be assumed. Figure 54 shows the texture of a stand where the proportion of cedar is high (A) and where the proportion is low (B). Individual crowns often are difficult

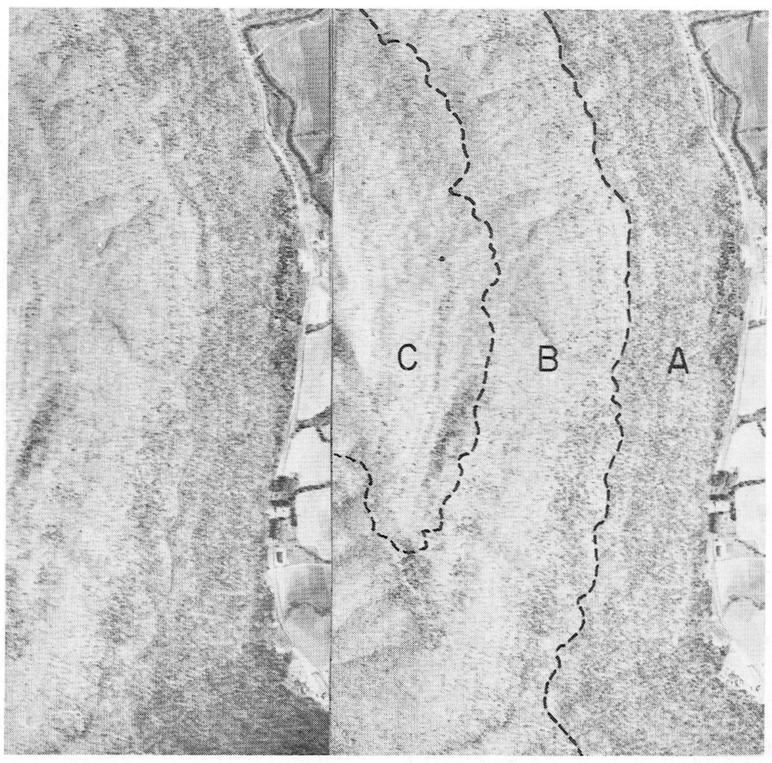

FIGURE 54. Stereogram showing a cedar-hardwood stand with a large cedar component (A) and one with a relatively small cedar component (B). The abrupt change in cedar density as shown in this stereogram is typical. It appears to occur at the boundary between the Gasper-St. Genevieve and the Bangor limestones. It has been hypothesized, but not tested, that the difference in cedar occurrence is caused by a difference in the chemical composition of the two limestones. The primary bench (C) between the cliffs and the line of heads of streams forming the typical parallel stream pattern associated with limestone can be seen clearly. (Jackson County, BPS-2MM-247,248).

to evaluate but when considered in terms of a texture the stands containing cedar usually can be identified. If the crowns of individual dark-toned trees can be seen sufficiently clearly, crown shape may be an additional diagnostic tool for separating pine and cedar. Pine crowns are usually somewhat more rounded and puffy looking than the crowns of cedars which usually are more pointed than pines. In forest conditions these shapes can only be assessed through stereoscopy but along stand edges and in very open stands shadows often can be used to assess the crown shapes. The difference in crown shapes is clearly revealed by shadows in figure 15.

In addition to its use in distinguishing between pine and cedar, texture is of primary importance in the identification of water tupelo stands. The texture shown in figure 31D, made up of very small light toned crowns, is distinctive and apparently occurs only with water tupelo.

Plantations

Pine plantations are found in many places in the Cumberland Plateau Forest Habitat Region. Most are composed of loblolly pine but some Virginia pine has been planted. Trees are often planted on sites where they would be unlikely to occur naturally. For this reason, the key does not distinguish between species of planted pines because it is based on natural occurrence patterns. When these are violated the key is invalidated.

Young pine plantations are characterized by a comparatively high uniformity of stand density and tree height. In addition, the rows often can be distinguished (figures 2F, 7D, 9C, and 16C). As the plantations grow older, they maintain uniformity of density and tree size, but the rows become less and less distinct. Nevertheless, a plantation is seldom hard to identify.

TESTING THE KEY

Objectives Of The Testing Program

The primary objective of any test of a key should be to determine its validity. In other words, the test should indicate how well the key would perform if no errors were made in any decision based on the key.

A secondary objective of the testing program should be to determine whether or not the key is easy to use and, if not, where the decision points that present difficulty occur.

Test Program Rationale

The basic validity of an aerial photographic forest cover key can be evaluated only by sampling a portion of the forest stands in the region under study. Each of these stands would have to be visited to determine its species composition and to evaluate or measure on the ground the parameters used at the several decision points in the key. The parameter information then would be used to follow decision paths through the key. The key provides, at the end of each decision path, an estimate of the species composition as determined in the field. Since there are many paths which might be used in a key and all should be evaluated for validity, the sample must include stands that are geographically widely dispersed, that represent a wide variety of species groupings and a wide spectrum of topographic sites. In order to keep the cost of the testing program within reasonable limits, the stands in the sample must be reasonably accessible, both physically and legally. Because of these constraints, it would be difficult to use probability sampling or any formal statistical design in the testing program. However, if the sampling is too selective, it will fail to represent the intended population. To avoid bias, the sample must be selected in advance of the field work. This can be accomplished by means of index mosaics and aerial photographs. The mosaics would be used to lay out logical routes of travel while the photographs would be used to locate the sample stands.

The results of a testing program such as this would indicate error rates by conditions or by groupings of conditions. These error rates would be point estimates of the true error rates. Valid confidence intervals could not be computed for these estimates because of the method of sampling. Nevertheless, the estimates should be of value because they indicate approximately where the basic strengths and weaknesses of the key occur. The key for the Cumberland Plateau Forest Habitat Region was subjected to a test based on this reasoning.

In order to obtain information regarding the ease of using the key it would be necessary to assemble a representative sample of the persons apt to utilize a key of this type and then have the members of this sample use the key to evaluate a series of stands. The actual compositions of these stands would have to be determined in the field. Error rates, by decision paths, resulting from this test could be used as a measure of the east of using the key.

As in the case of the validity test, the sample set of stands should include as many different cover types as possible and should occupy as many different site types as possible. If this is done the probability would be high that most, if not all, the decision paths would be explored and that most, if not all, the points of ambiguity would be found by the testers.

A sampling design that would yield these error rates could be developed. Implementing the design, however, would not be simple. The persons making up the testing team would have to be drawn from the universe of potential key users, but the team could not include anyone who had been involved in developing the key. The bulk of the team would have to consist of persons not employed by the developing organization (Auburn University), and their participation would be at the pleasure of their employers. Experience with other key testing programs (Parker and Johnson, 1969; Northrop and Johnson, 1970) indicates that some organizations are willing to make certain of their personnel available for such purposes. Understandably, the time that these organizations are willing to allot to this type of activity is quite limited. Since the amount of time needed to test a key adequately is relatively great, particularly if the testers are to be made familiar with the key and its terminology, it is almost impossible to assemble a team to do the work. As a result, no formal attempt was made to recruit a team to test this key for ease of use.

It must be realized that in the process of development the key was continually subjected to testing and revision by the persons responsible for the project. In addition, a number of persons within the University community were asked to try the key and to offer suggestions for possible revisions. No numerical records were kept of these attempts. However, comments generated by this process received attention and the key was modified in response to these comments. This process has undoubtedly made the key easier to use than it otherwise might be.

Table 5. Results of the tests made to evaluate the validity of the key.

Zone	Site	Pine Would Correct	Pine Would Qualify	Pine Would Wrong	Pine-Hardwoods Would Correct	Pine-Hardwoods Would Qualify	Pine-Hardwoods Would Wrong	Hardwoods Would Correct	Hardwoods Would Qualify	Hardwoods Would Wrong
I	Flat-topped mountain									
	Top, including rim	2	0	0	3	2	0	6	0	0
	Escarpment									
	Bench visible				1	0	0	18	3	0
	Bench not visible									
	Drains visible									
	Upper slope									
	Mid slope	1	0	0	1	0	0	8	0	1
	Lower slope	1	0	0	2	3	3	8	7	4
	Drains not visible									
	Upper slope				1	2	1	10	4	0
	Mid slope	1	2	0	2	1	0	3	6	3
	Lower slope	1	0	0				2	4	0
	Mountain spurs	0	1	0	0	0	1	6	1	4
	Other upland sites	1								
II.	Structural ridges	4	1	0	3	3	0	12	13	2
	Other upland sites	1	0	0	0	3	1	9	5	6
III	Top, including rim	3	0	0	5	0	0	3	1	0
	Escarpment	1	1	0	4	0	0	7	0	0
IV	Structural ridges				4	0	0	13	3	0
	Other upland sites									
V	Top, including rim	8	1	0	13	4	0	10	3	0
	Escarpment	4	1	0	5	4	0	17	5	1
	Stream bottoms	4	1	1	4	4	0	20	10	1
	Tennessee River banks & islands							4	0	0
		32	8	1	48	26	6	156	65	22

Table 5 continued.

Zone	Site	Cedar Correct	Cedar Would Qualify	Cedar Wrong	Cedar-Hardwoods Correct	Cedar-Hardwoods Would Qualify	Cedar-Hardwoods Wrong	Cypress-Hardwoods Correct	Cypress-Hardwoods Would Qualify	Cypress-Hardwoods Wrong
I	Flat-topped mountain									
	Top, including rim									
	Escarpment									
	Bench visible	3	0	0	2	0	0			
	Bench not visible									
	Drains visible									
	Upper slope									
	Mid slope									
	Lower slope									
	Drains not visible									
	Upper slope									
	Mid slope									
	Lower slope									
	Mountain spurs				1	0	0			
	Other upland sites					1				
II	Structural ridges	1	0	0	3	0	0			
	Other upland sites	2	0	0	1	0	0			
III	Top, including rim									
	Escarpment									
IV	Structural ridges									
	Other upland sites									
V	Top, including rim									
	Escarpment									
	Stream bottoms									
	Tennessee River banks & islands							2	0	0
		6	0	0	7	1	0	2	0	0 /380

[1]These stands fit the description of the indicated cover type if the description is interpreted broadly. e.g., if the normally dominant species are replaced by common associates and the normally dominant species are represented sufficiently to provide an appreciable portion of the stand basal area.

Test Results

The plan for the development of the key included provisions for a testing process to determine its validity. Approximately a quarter of the prism point data obtained in the field were reserved for this test. Table 5 summarizes the results. As can be seen in table 5, three levels of correctness were recognized. In order for a stand to be classed as correctly identified, one or more of the primary species had to dominate the stand (i.e., had a total basal area in excess of 50% of the basal area of the stand). If one or more of the secondary species dominated the stand and one or more of the primary species were present in sufficient quantity to provide some appreciable portion of the stand basal area the stand was classed as "qualifying". If none of the primary species were present in the stand, regardless of the dominance of the secondary species, the stand was classed as being incorrectly identified.

The results of the test are quite good. Because of the flexibility of the type descriptions in the case of the pine-hardwoods and hardwoods, the relatively high rate of correct identifications is not surprising. However, the flexibility was considerably less in the case of the pine types and yet the rate of correct identifications was high. This evidence indicates that the key is constructed in such a manner as to recognize occurrence patterns with considerable reliability.

The evidence available at this point indicates that the key is fundamentally valid. However, this does not mean that everyone using the key would obtain similar results. The key must be used properly or the results will be unsatisfactory. In the description of the key for the Piedmont Forest Habitat Region (Johnson and Sellmann, 1974) was a statement regarding the attributes of an ideal user of the key. Perhaps it would be well to restate that description. The interpreter should be thoroughly familiar with the key and should have a good understanding of all the terms used in the key; he should be capable of making all measurements or estimates required by the key; he should be sufficiently familiar with local conditions that he would be likely to sense a blunder in the making; and, lastly, he would be imbued with a desire to do his work well. If the person using this key has these attributes, the results of his use of the key should be satisfactory.

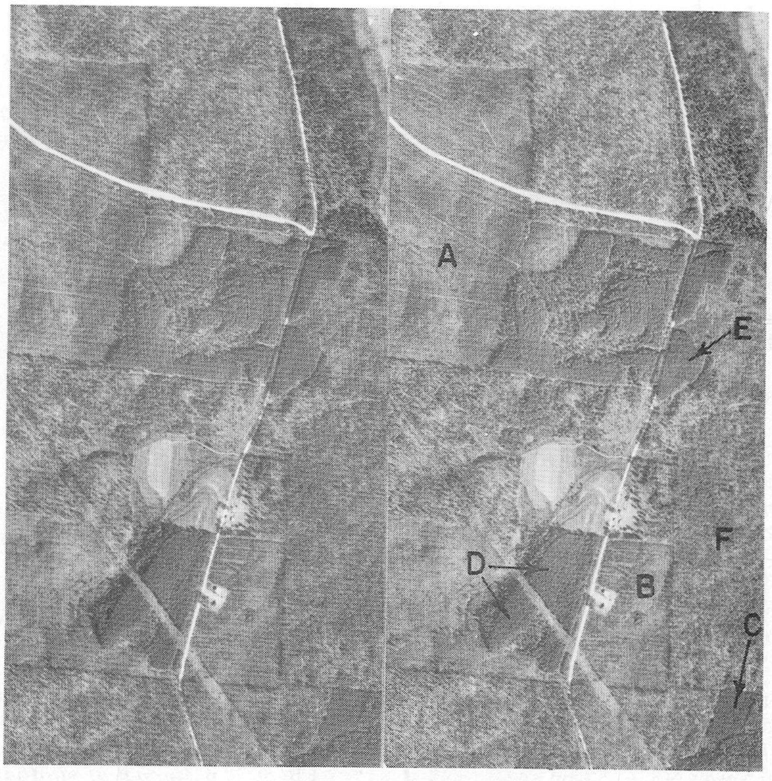

FIGURE 55. Stereogram showing plantations of pine of varying ages. (A) is a newly established plantation with very small trees. The planting follows the contour. (B) is made up of somewhat larger trees than in (A) and planting failure in places is evident. (C) is a plantation of sapling size with high survival and few gaps. The rows of trees are still distinguishable. (D) shows two stands that are reaching pulpwood size and the rows are still visible. The extreme uniformity of the plantations contrasts sharply with the much less uniform natural stand at (F).

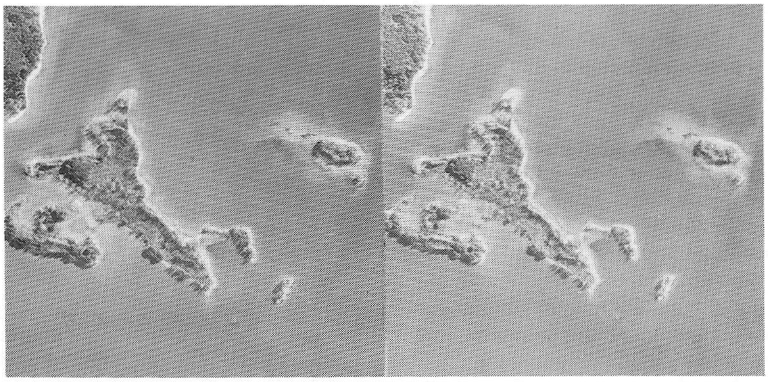

FIGURE 56. Stereogram of a group of islands in Guntersville Lake off South Sauty Creek on which baldcypress was found. All age classes from reproduction to pole-sized trees were present. (Jackson County, HO-1MM-12,13).

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APPENDIX I

Forest Cover Photo-Interpretation Key for the Cumberland Plateau Forest Habitat Region in Alabama

1. Stand highly uniform with regard to density, tree heights, crown widths, and tone. Photographic tone[1] is dark grey. Rows may or may not be visible. May be on any site (figure 55)......... .... .Pine plantation[2]
1. Stand not as above. 2
   2. Stand is on an upland site (figures 21, 26, and 27) 3
   2. Stand is on a streambottom site. This includes the minor drains in all zones. Gorges, except immediately adjacent to the streams are *not* streambottom sites. The walls fit into the "escarpment" category 124
3. Stand shows evidence of rows. Stocking thin or patchy (figures 55A and B) . . . . Pine plantation
3. Stand not as above. 4
   4. Stand is in zone I (See Appendix III. Note that zone I includes the northwest escarpment of Sand Mountain, the gorges cutting into Sand Mountain, and a small patch on the eastern escarpment of Sand Mountain adjacent to the Alabama-Georgia state line.) 5
   4. Stand is not in zone I. 70
5. Stand is on the top or side slopes of a *flat-topped* mountain, plateau, or plateau remnant of any size. The top of the mountain is rimmed by cliffs (figures 6C and 14E) or, if cliffs are not present or visible, it has an abrupt edge (figures 6B, 7A, 30, and 31). Plateau remnants with angular summits are also included (figures 6A, 9, 19A, 21, 26, and 29B) as are remnants where only residual piles of boulders remain of the sandstone cap. The walls of gorges (figure 23A), cutting into Sand Mountain, fall into this category. . . 6
5. Stand is on the top or side slopes of a hill or mountain spur which does not have a flat or angular summit or rock outcrops or cliffs at its crest (figures 13, 20, 27, and 29A). This situation is limited essentially to the part of zone I which is north and west of the Tennessee River 51
   6. Stand is on the *top* of the mountain, plateau, or plateau remnant, *including the rimrock.* "Top" is used here in its broad sense, as including all of the top, regardless of secondary topography on it (figures 6A, 6E, 7, 14A, and 18C) 7
   6. Stand is on the *escarpment* or side slopes of the mountain, plateau, or plateau remnant *below the rimrock or plateau edge* (figures 3A and 6D), including the walls of the gorges cutting into Sand Mountain (figure 23A) 15
7. Stand is on or immediately adjacent to the rimrock (figures 6B, 7A, 17F, 19H, 29B, and 30G). 8
7. Stand is not as above 10
   8. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . P(1)
   8. Tree crowns are not as above 9
9. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . .PH(4)
9. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . H(1)
   10. Stand is in an area without discernible slope, a "flat" (figure 3E) 11
   10. Stand is on a hill (figure 7G) 13
11. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . P(1)
11. Tree crowns are not as above 12
   12. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . . . . .PH(2)
   12. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . H(1)
13. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A). . . . . figure 57A
13. Tree crowns are not as above 14
   14. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B). . . . . .figure 57B
   14. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . .figure 57C
15. The primary bench at the foot of the rimrock is clearly visible (figures 6F, 7H, 21, 28, and 54C)[3] 16
15. The primary bench is not present (figure 17D), or it cannot be distinguished because of confused topography (figures 9 and 31), or it is obscured by excessive sandstone talus (figures 14D, 17, 19D, 29B, and 30F). Gorge walls are included in this category.[3] This situation is common south of Guntersville on Brindley and Sand Mountains . . . 42
   16. The escarpment drainage is clearly visible as more or less parallel sharply defined channels with the streamheads at or just below the primary bench (figures 6G, 19F, 28, 29F, and 54)[3 4] 17

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[1]References to photographic tone are applicable to photographs taken using panchromatic film and a deep yellow (e.g., Wratten No. 12) filter or with black and white infrared film and a deep yellow (e.g., Wratten No. 12) or deep red (e.g., Wratten No. 89B) filter. The key can also be used with infrared color photography because softwood crowns are shown with darker hues than hardwood crowns. In the case of normal color photography, however, the differences in hues between softwoods and hardwoods are minimal and, consequently, the key should not be used with such photography.

[2]Pine plantations in the Cumberland Plateau Forest Habitat Region are mainly loblolly pine, but Virginia pine has been planted sporadically. Because site has not been an appreciable factor in the choice of species to plant, it is difficult or impossible to recognize the species in a given plantation.

[3]Shadows (figures 14B,C, and D; and 30C) or heavy forest cover (figures 3A and 7) will often prevent an assessment of the situation. In such cases, if possible, refer to the corresponding slope positions on nearby comparable sunlit slopes with sufficiently thin forest cover so that the ground conditions can be evaluated.

16. The escarpment drainage is not as above. Escarpment drainage often is poorly defined on the ends of mountains or mountain spurs (figures 14D, 28, and 30E). Sometimes sandstone talus will extend below the primary bench preventing the development of the drainage pattern associated with limestone. This can occur on either the flanks (figure 19E) or ends of the mountain and is most likely to occur when the sandstone cap is in the form of a peninsula and is breaking down relatively rapidly (figures 14, 29B, and 30F)[3] [4] 27
17. Stand is on the primary bench[3] 18
17 Stand is below the primary bench[3] 20
18. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . .P(2)
18. Tree crowns are not as above 19
19. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . .PH(1)
19. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . H(8)
20. Stand is on a bench (Hartselle sandstone, figures 21 and 29D)[3] THIS RARELY OCCURS 21
20. Stand is not on a bench[3] 23
21. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . .P(2)
21. Tree crowns are not as above 22
22. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . . . . Figure 59B
22. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . H(8)
23. 70 percent or more of the overstory tree crowns are dark grey 24
23. Tree crowns are not as above 25
24. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . Figure 58A
24. The dark toned crowns are more or less pointed and appear as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . . .C(1)
25. 30 to 70 percent of the overstory tree crowns are dark grey 26
25. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . .figure 58C
26. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . .figure 58B
26. The dark toned crowns are more or less pointed and appear as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . . CH(1)
27. Stand is on the primary bench.[3] 28
27. Stand is below the primary bench.[3] 30
28. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . .P(2)
28. Tree crowns are not as above 29
29. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . .PH(1)
29. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . H(8)
30. Stand is on sandstone talus which extends below the primary bench or is on a sandstone (Hartselle Formation) bench below the primary bench. Evidence for sandstone includes non-linear, more or less random, accumulations of boulders (figures 7B, 14F, 17D, 19E, and 31A). These should not be confused with the boulders and rock blocks found along stratum outcrops as in figure 29C. The latter usually are of limestone. In addition, sandstone often has a lighter photographic tone than the limestone material further downslope. This light tone will be similar to that of the primary bench (figures 19E and 30A)[3] 31
30. Stand is not on sandstone talus (figure 30E) . . . 35
31. 70 percent or more of the overstory tree crowns are dark grey 32
31. Tree crowns are not as above 33
32. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A[3] . . . . figure 58A
32. The dark toned crowns are more or less pointed and appear as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . .C(1)
33. 30 to 70 percent of the overstory tree crowns are dark grey 34
33. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . .figure 58C
34. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A[3] . . . . .figure 58B
34. The dark toned crowns are more or less pointed and appear as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS CH(1)
35. Stand is on a bench (Hartselle sandstone, figures 21 and 29D).[3] THIS RARELY OCCURS 36
35. Stand is not on a bench[3] 38
36. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . .P(2)
36. Tree crowns are not as above 37

[4]Clearly defined stream channels of this type are associated with limestone. Since limestone rarely surfaces south of Guntersville, the phenomenon of parallel escarpment streams will be limited essentially to the northern part of zone I. The pattern will occur south of Guntersville but in very restricted areas (figure 31B).

[5]Reduce the relative importance of shortleaf pine from 1 to 2 and increase that of Virginia pine from 2 to 1.

37. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . .PH(1)
37. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . H(8)

38. 70 percent or more of the overstory tree crowns are dark grey 39
38. Tree crowns are not as above 40

39. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . Figure 58A
39. The dark toned crowns are more or less pointed and appear as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . . .C(1)

40. 30 to 70 percent of the overstory tree crowns are dark grey 41
40. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . Figure 58C

41. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . Figure 58B
41. The dark toned crowns are more or less pointed and appear as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . CH(1)

42. The escarpment drainage is clearly visible as more or less parallel sharply defined channels.[3] THIS RARELY OCCURS WHEN THE MOUNTAIN IS FLAT-TOPPED AND NO PRIMARY BENCH IS PRESENT 43
42. The escarpment drainage is not as above. Usually sandstone talus extends the length of the slope. Evidence for sandstone includes non-linear, more or less random, accumulations of boulders (figures 7B, 14F, 17D, 19E, and 31A). These should not be confused with the boulders and rock blocks found along stratum outcrops as in figure 29C. The latter are usually limestone. In addition, sandstone often has a lighter photographic tone than the limestone material further downslope. (figures 19E and 30A)[3] Gorge walls fall into this category 47

43. 70 percent or more of the overstory tree crowns are dark grey 44
43. Tree crowns are not as above 45

44. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . figure 58A
44. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] .C(1)

45. 30 to 70 percent of the overstory tree crowns are dark grey 46
45. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . .figure 58C

46. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . .figure 58B
46. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . . CH(1)

47. 70 percent or more of the overstory tree crowns are dark grey 48
47. Tree crowns are not as above 49

48. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . figure 59A
48. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . .C(1)

49. 40 to 70 percent of the overstory tree crowns are dark grey 50
49. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . .figure 59C

50. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . .figure 59B
50. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . . . . .C(1)

51. Sandstone cap is not completely eroded away. Evidence of this is a somewhat lighter photographic tone, an almost complete absence of cedars, and, in some cases, scattered boulders (figure 20). North and west of the Tennessee River, where this condition is most apt to occur, the base of the sandstone stratum is approximately at the 1,300 foot elevation. Refer to the appropriate U.S. Geological Survey topographic map 52
51. Sandstone cap is completely absent (figures 13C and 29A). 66
52. Stand is on the sandstone cap 53
52. Stand is below the sandstone cap 57

53. 70 percent or more of the overstory tree crowns are dark grey 54
53. Tree crowns are not as above 55
54. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A . . .P(2)
54. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B. THIS RARELY OCCURS . . .C(1)

55. 30 to 70 percent of the overstory tree crowns are dark grey 56
55. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . H(1)

56. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A. . PH(1)
56. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B. THIS RARELY OCCURS . . . . CH(1)
57. Stand is on a bench (Hartselle sandstone, figures 21 and 29D).[3] 58
57. Stand is not on a bench.[3] 62
58. 70 percent or more of the overstory tree crowns are dark grey 59
58. Tree crowns are not as above 60
59. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . P(2)
59. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . . . . C(1)
60. 30 to 70 percent of the overstory tree crowns are dark grey.[3] 61
60. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A).[3] . . . . H(8)
61. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . figure 59B
61. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . . . . CH(1)
62. 70 percent or more of the overstory tree crowns are dark grey.[3] 63
62. Tree crowns are not as above 64
63. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . figure 60A
63. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . . . C(1)
64. 30 to 70 percent of the overstory tree crowns are dark grey.[3] 65
64. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A).[3] . . . . figure 60C
65. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . figure 60B
65. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . CH(1)
66. 70 percent or more of the overstory tree crowns are dark grey 67
66. Tree crowns are not as above 68
67. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . figure 60A
67. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . . . C(1)
68. 30 to 70 percent of the overstory tree crowns are dark grey.[3] 69
68. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A).[3] . . . . figure 60C
69. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . figure 60B
69. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . CH(1)
70. Stand is in zone II (Appendix III). 71
70. Stand is not in zone II 91
71. Stand is on a structural ridge (figures 17A and 18A). These ridges are shown as such on the county maps in Appendix III. 72
71. Stand is not on a structural ridge 76
72. 70 percent or more of the overstory tree crowns are dark grey 73
72. Tree crowns are not as above 74
73. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . figure 61A
73. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . . . . C(1)
74. 30 to 70 percent of the overstory tree crowns are dark grey 75
74. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A).[3] . . . . figure 61C
75. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . figure 61B
75. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . . . . CH(1)
76. Stand is on a rounded hill (figures 8A, 16A, and 22) 77
76. Stand is on a flat or gently undulating site (figures 6K, 14I, 15, 17B, 18B, and 31C). 86
77. Stand is on a major hill such as those shown in figure 22. These hills are remnants of, or spurs from, hills such as those in zone I and, consequently, are lower than the zone I hills. Hills of this type are common north and west of the Tennessee River but rare elsewhere 78
77. Stand is on a minor hill such as those shown in figures 8A and 16A 82
78. 70 percent or more of the overstory tree crowns are dark grey 79
78. Tree crowns are not as above 80
79. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . figure 60A
79. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . . . C(1)
80. 30 to 70 percent of the overstory tree crowns are dark grey 81

80. Less than 30 percent of the overstory pine crowns are dark grey (figures 47 through 52 and 53A).[3] . . . . .figure 60C
81. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] THIS RARELY OCCURS . . . . .figure 60B
81. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] . . . CH(1)
82. 70 percent or more of the overstory tree crowns are dark grey 83
82. Tree crowns are not as above 84
83. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A . . . . figure 62A
83. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B . . . . . .C(1)
84. 30 to 70 percent of the overstory tree crowns are dark grey 85
84. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). .figure 62C
85. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A . . . . .figure 62B
85. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B . . . . CH(1)
86. 70 percent or more of the overstory tree crowns are dark grey. THIS RARELY OCCURS 87
86. Tree crowns are not as above 88
87. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A . . . . .P(5)
87. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B . . . . . .C(1)
88. 30 to 70 percent of the overstory tree crowns are dark grey. THIS RARELY OCCURS 89
88. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). 90
89. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A . . . . .PH(8)
89. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B . . . . CH(2)
90. Stand has a texture similar to that shown in figures 3G and 31D (very small light-toned crowns). .H(18)
90. Stand is not as above . . . . .H(13)
91. Stand is in zone III (Sand Mountain, Appendix III) . 92
91. Stand is not in zone III. 100
92. Stand is on the *top* of the mountain, including the rimrock. Top is used here in its broad sense, as including all of the top, regardless of the secondary topography on it (figures 3C and 23). 93
92. Stand is on an *escarpment* or side slope of the mountain. *The northwestern escarpment, including the gorges, is part of zone I, as is a small part of the southwestern escarpment adjacent to the Georgia state line* (figure 68), *and should not be considered here* 98
93. Stand is on or immediately adjacent to the rimrock (figures 6B, 7A, 17F, 19H, 29B, and 30G) or is on an area without discernable slope, a "flat" (figure 3E) 94
93. Stand is on a hill (figure 7G) 96
94. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A). . . . . .P(1)
94. Tree crowns are not as above 95
95. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . .PH(1)
95. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . H(1)
96. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A). . . . . figure 57A
96. Tree crowns are not as above 97
97. 30 to 40 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B). . . . . .figure 57B
97. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . .figure 57C
98. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A). . . . . figure 59A
98. Tree crowns are not as above 99
99. 30 to 40 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B). . . . . .figure 59B
99. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A). . . . . .figure 59C
100. Stand is in zone IV (Wills Valley, Appendix III). 101
100. Stand is in zone V (Lookout Mountain, Appendix III). 116
101. Stand is on a structural ridge (figures 2D, 24A, and 25) 102
101. Stand is not on a structural ridge 107
102. 70 percent or more of the overstory tree crowns are dark grey 103
102. Tree crowns are not as above 104
103. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . . . figure 64A
103. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . . . . . . .C(1)
104. 30 to 70 percent of the overstory tree crowns are dark grey 105
104. Less than 30 percent of the overstory tree crowns are dark grey 106
105. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . . . .figure 64B

105. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . CH(1)

106. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A.[3] . . . . .figure 64C

106. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B.[3] THIS RARELY OCCURS . . . . Figure 60C

107. Stand is on a rounded hill (figures 2E and 24B) 108

107. Stand is on a flat or gently undulating site (figures 6K, 14I, 15, 17B, 18B, and 31C) 112

108. 70 percent or more of the overstory tree crowns are dark grey 109

108. Tree crowns are not as above 110

109. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A. . . . . figure 63A

109. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B . . . . .C(1)

110. 30 to 70 percent of the overstory tree crowns are dark grey 111

110. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . .figure 63C

111. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A. . . . . .figure 63B

111. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B . . . . CH(1)

112. 70 percent or more of the overstory tree crowns are dark grey 113

112. Tree crowns are not as above 114

113. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A. . . . . .P(5)

113. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B . . . . .C(1)

114. 30 to 70 percent of the overstory tree crowns are dark grey 115

114. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) .H(13)

115. The dark toned crowns are rounded and puffy, appearing as the pine crowns in figures 9A, 15D, 17D, 19G, 29D, and 30A. . . . . .PH(8)

115. The dark toned crowns are more or less pointed, appearing as the cedar crowns in figures 6H and J, 9B, 15C, 20D, 22, 30B, and 54A and B . . . . CH(1)

116. Stand is on *top* of the mountain, including the rimrock. Top is used here in its broad sense, as including all of the top, regardless of the secondary topography on it (2A and B and 4) 117

116. Stand is on an *escarpment* or side slope of the mountain (figures 2 and 4). The walls of gorges (figure 5) fall into this category 122

117. Stand is on or immediately adjacent to the rimrock (figures 6B, 7A, 17F, 19H, 29B, and 30G) or is on an area without discernable slope, a "flat" (figure 3E) 118

117. Stand is on a hill (figure 7G) 120

118. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . .P(1)

118. Tree crowns are not as above 119

119. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) .PH(1)

119. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . H(1)

120. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . figure 64A

120. Tree crowns are not as above 121

121. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . . . . .figure 57B

121. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . .figure 57C

122. 70 percent or more of the overstory tree crowns are dark grey (figures 37B, 38A, 39A and B, and 40A) . . . . .figure 59A[5]

122. Tree crowns are not as above 123

123. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) . . . . .figure 59B[5]

123. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) . . . . .figure 59C

124. Stand is on the islands in Guntersville Lake off the mouth of South Sauty Creek (See "C" in figure 71 and also figure 56) . . . . CYPH(1)

124. Stand is not as above 125

125. Stand is associated with a free-flowing stream. The Tennessee River is free-flowing north of Bellefonte Island and for about 24 miles below Guntersville Dam 126

125. Stand is on the edge of an impoundment 143

126. 70 percent or more of the overstory tree crowns are dark grey 127

126. Tree crowns are not as above 128

127. Stand is along a ditch or small stream in or between cultivated fields (figure 8D) or in a recently logged area. Stand is dense. Vegetative cover is low and shrubby but may have occasional larger and taller trees . . . . .H(19)

127. Stand is not as above . . . . .P(4)

128. 30 to 70 percent of the overstory tree crowns are dark grey (figures 41 through 46 and 53B) 129

128. Less than 30 percent of the overstory tree crowns are dark grey (figures 47 through 52 and 53A) 130

129. Stream width is 10 feet or less. At a photographic scale of 1:20,000 the 10 foot width is 0.006 inches (figure 80). . . . . .PH(6)
129. Stream width is greater than 10 feet . . . . .PH(7)
130. Stand is in zone I, which includes the gorges on the northwestern side of Sand Mountain (Appendix III). . . . . . . .H(15)
130. Stand is not in zone I 131
131. Stand is in zone II (Appendix III). 132
131. Stand is not in zone II 135
132. Stream is on a structural ridge (figures 17A and 18A). These ridges are shown as such on the county maps in Appendix III . . . . .H(15)
132. Stream is not on a structural ridge 133
133. Stand is immediately adjacent to the edge of the Tennessee River (figure 3D) . . . . .H(16)
133. Stand is associated with a stream on a rounded hill or on the undulating or flat floor of the zone (figures 3F and G, 8, 14H, 18B, and 31C and D). 134
134. Stand has a texture similar to that shown in figures 3G and 31D (very small light-toned crowns). . . . . .H(18)
134. Stand is not as above . . . . .H(13)
135. Stand is in zone III (Sand Mountain, Appendix III) 136
135. Stand is not in zone III. 138
136. Stream is on the *top* of the mountain. Top is used here in its broad sense, as including all of the top, regardless of the secondary topography on it (figures 3C and 23). 137
136. Stream is on the *escarpment* or side slope of the mountain. Only the southeastern escarpment of Sand Mountain is in zone III . . . . .H(14)
137. Stream width is 10 feet or less. At a photographic scale of 1:20,000, the 10-foot width is 0.006 inches (figure 8C). . . . . .H(14)
137. Stream width is greater than 10 feet . . . . . . .H(17)
138. Stand is in zone IV (Wills Valley, Appendix III) 139
138. Stand is in zone V (Lookout Mountain, Appendix III) 140
139. Stream width is 10 feet or less. At a photographic scale of 1:20,000, the 10-foot width is 0.006 inches (figure 8C). . . . . .H(15)
139. Stream width is greater than 10 feet . . . . .H(17)
140. Stream is on the *top* of the mountain. Top is used here in its broad sense, as including all of the top, regardless of the secondary topography on it (figures 2A, 4, and 23) . . . . .H(14)
140. Stream is on an *escarpment* or side slope of the mountain (figures 2 and 4). The walls and bottoms of gorges fall into this category (figure 5). 141
141. Stream is on the northwestern escarpment . . . .H(15)
141. Stream is on the southeastern escarpment 142
142. Stream width is 10 feet or less. At a photographic scale of 1:20,000, the 10-foot width is 0.006 inches (figure 8C). . . . . .H(14)
142. Stream width is greater than 10 feet . . . .H(12)
143. Stand is on recent alluvium subject to overflow from fluctuating water levels, e.g., sandbars, ends of islands, and shoals and flats at the mouths of streams entering the impoundment. .H(20)
143. Stand is not as above 144
144. Stand is on a wave-cut cliff (figure 9B) . . .C(1)
144. Stand is not as above . . . .Estimate how far the base level is below the lake surface. From the estimated base level determine the slope position and aspect as though the lake was not there. Return to item 3 in the key and proceed as with upland stands.

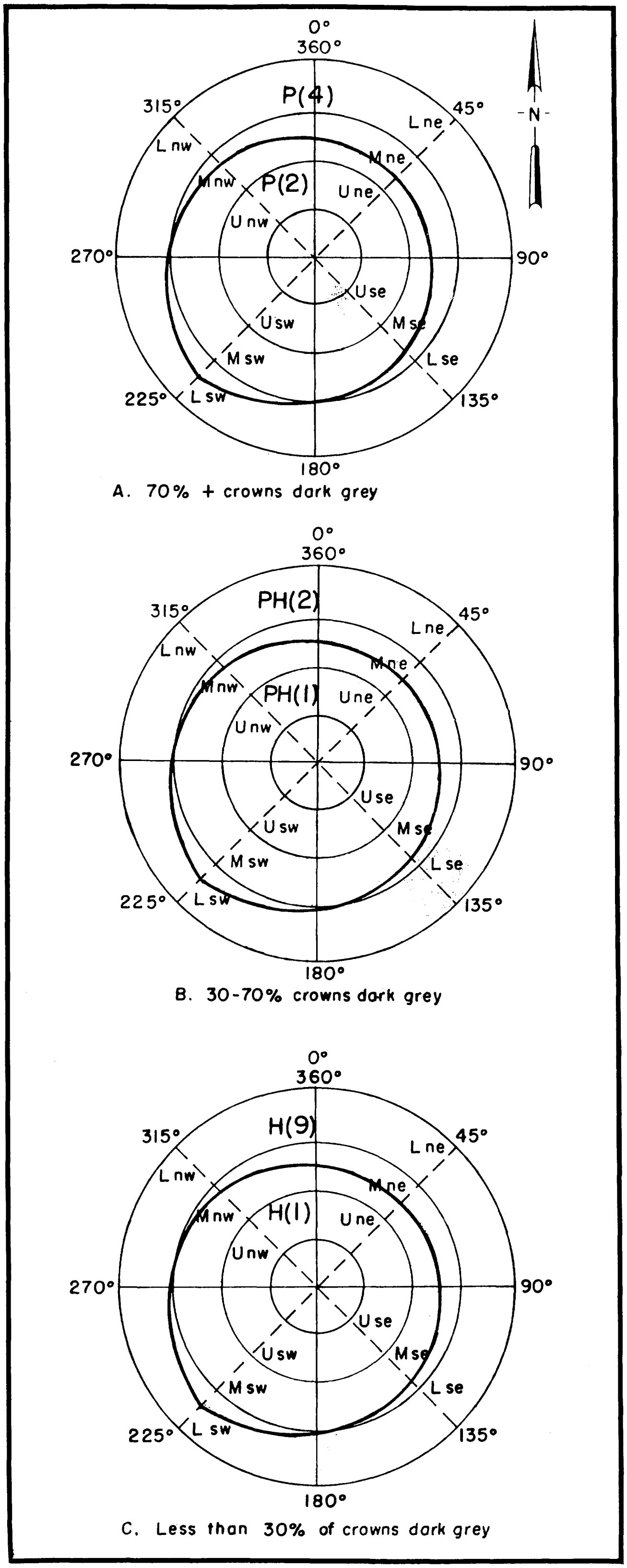


FIGURE 57. Forest cover type distribution of the secondary topographic features on the tops of the flat-topped mountains or plateaus. If the stand is on a saddle (Figure 29E), use the cover type occurring at midslope when the aspect is N45°W.

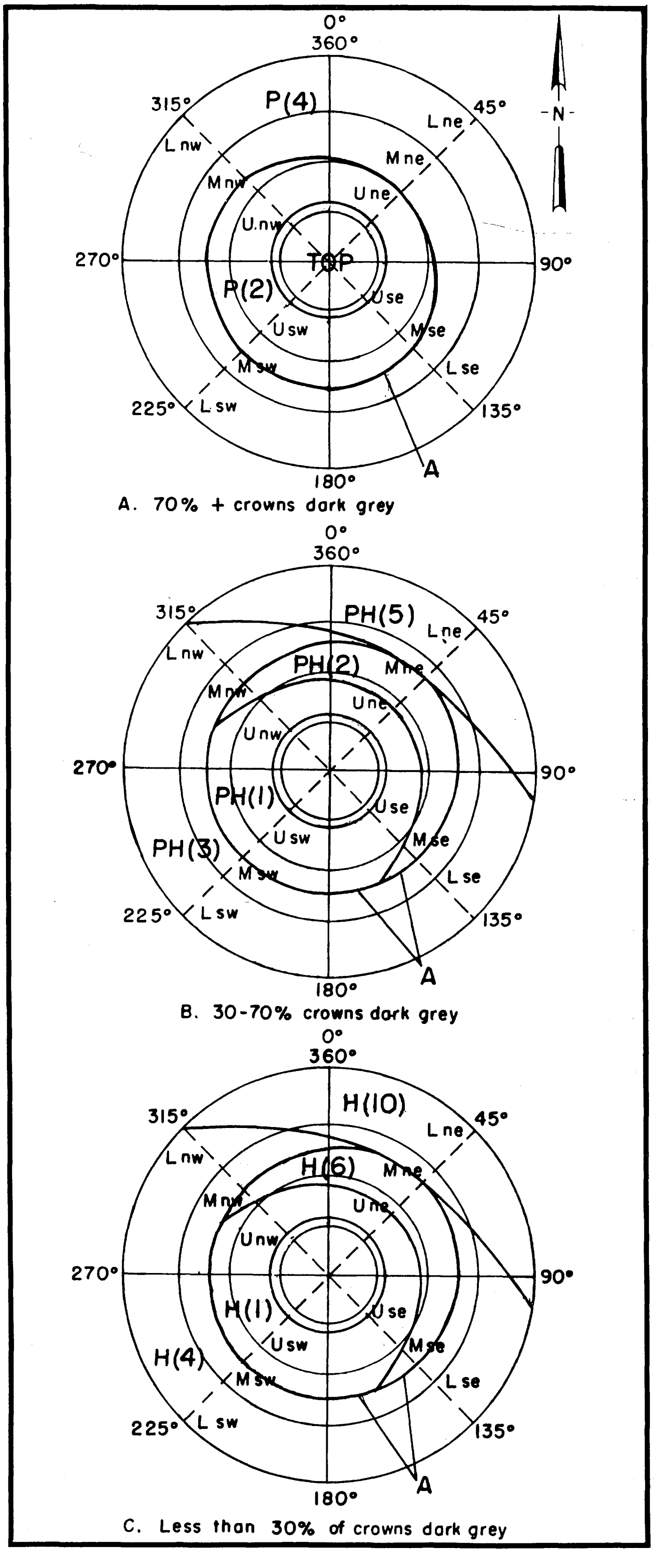


FIGURE 58. Forest cover type distribution in Zone I on the escarpments of flat-topped mountains or remnants of flat-topped mountains still retaining a sandstone cap. 'A' marks the lower limit of the sandstone talus. Consequently the position of this boundary is variable. If the stand is on a saddle (Figure 29E), use the cover type occurring at midslope when the aspect is N45°W. If the stand is in the upper reaches of Pisgah Gorge, eastern hemlock will be found on the lower slopes as a species of secondary importance.

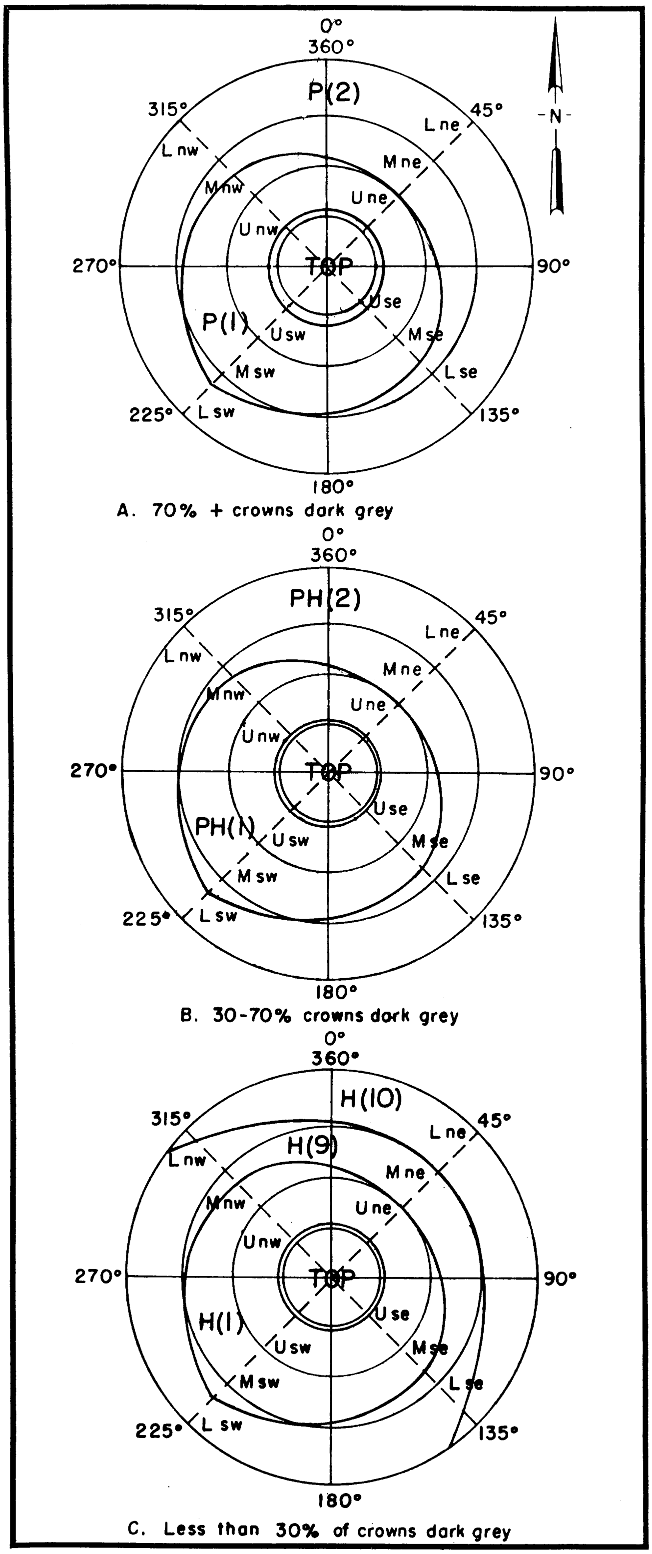


FIGURE 59. Forest cover type distribution of the escarpments of flat-topped mountains in Zone I where sandstone talus covers the entire slope, on the southeastern escarpment of Sand Mountain (Zone III), and both escarpments of Lookout Mountain (Zone V). On the escarpments of Lookout Mountain the relative importance of shortleaf pine in P(1), P(2), PH(1), and PH(2) is reduced to the second level while that of Virginia pine is increased to the first level.

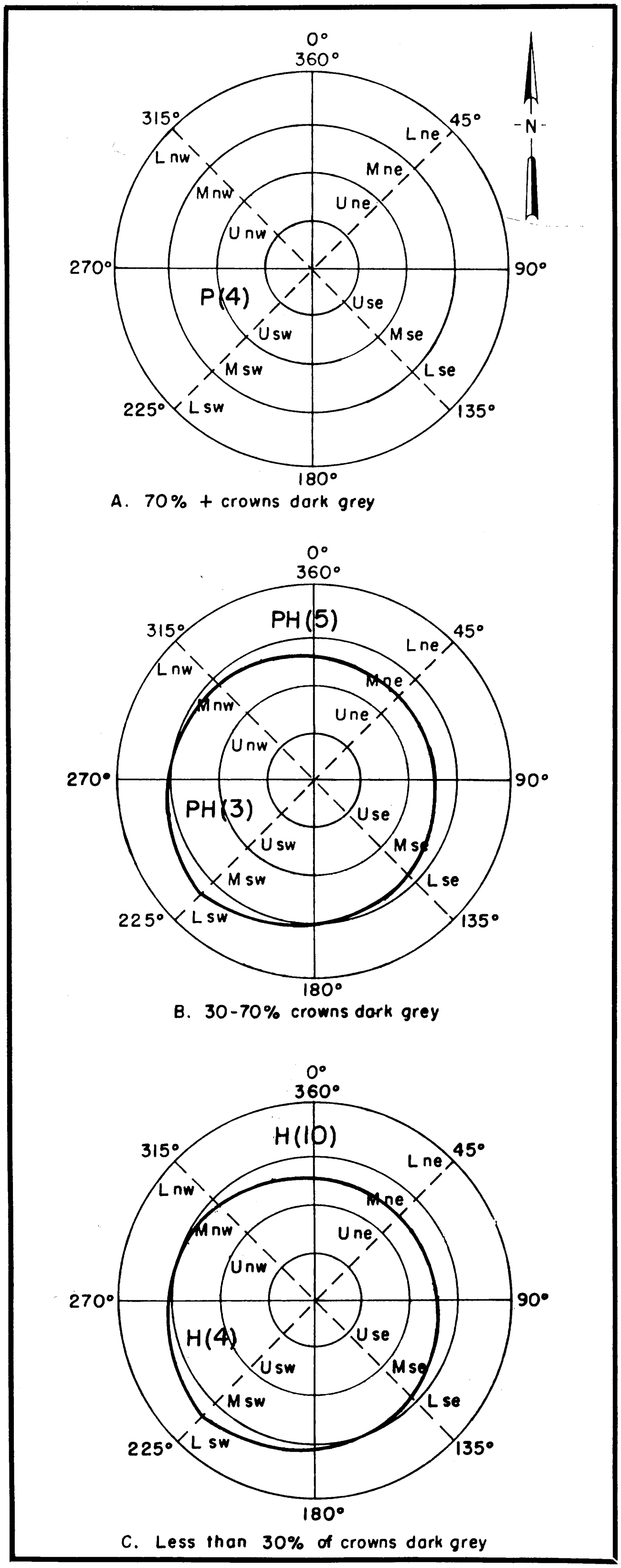


FIGURE 60. Forest cover type distribution on mountains whose sandstone caps have been completely eroded away. If stand is on a saddle (Figure 29E), use the cover type occurring at midslope when the aspect is N45°W.

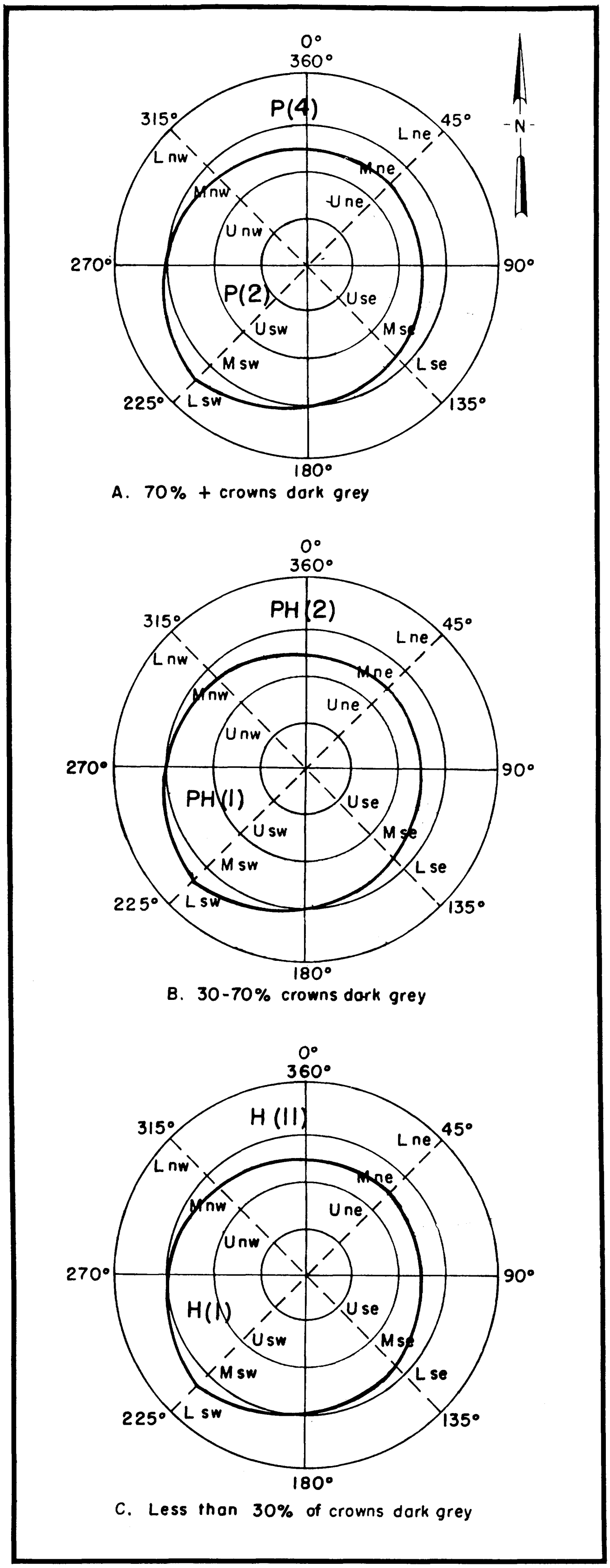


FIGURE 61. Forest cover type distribution on structural ridges in Zone II.

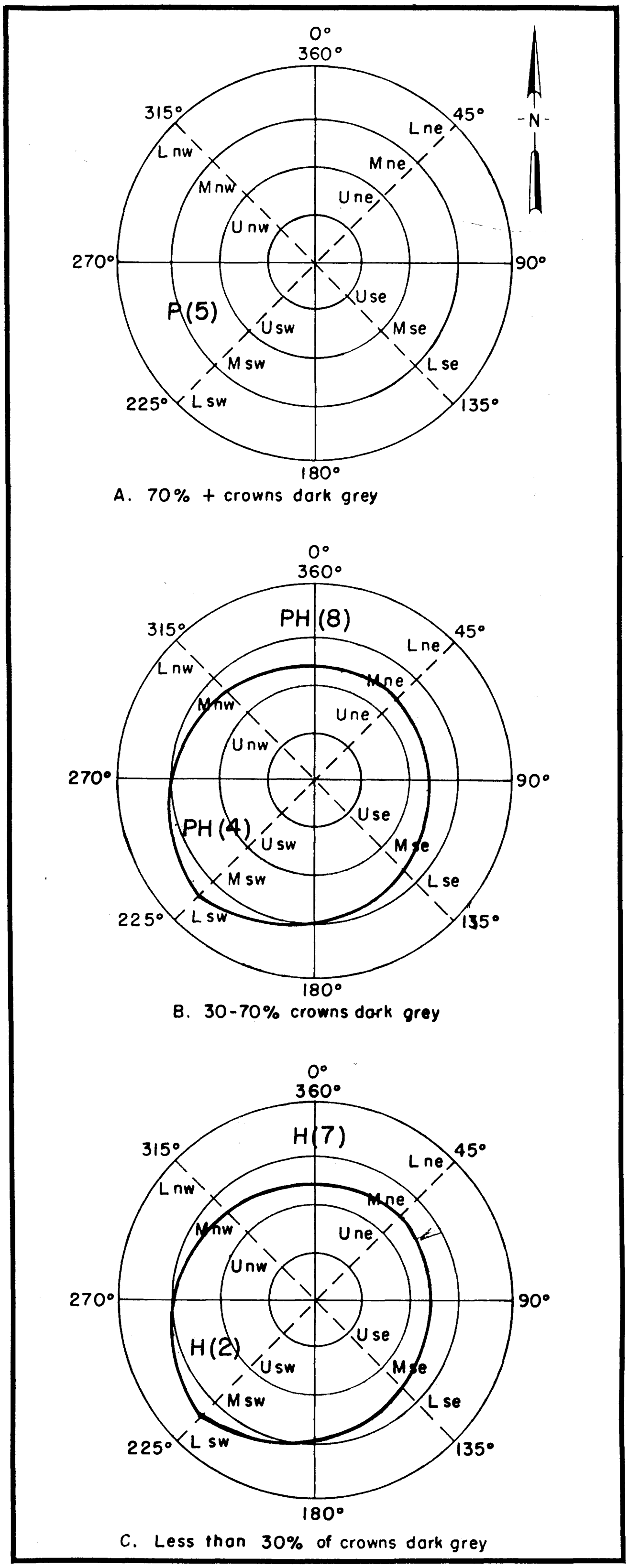


FIGURE 62. Forest cover type distribution on the rounded hills on the undulating valley floors of Zone II. If stand is on a saddle (Figure 29E), use the cover type occurring at midslope when the aspect is N45°W.

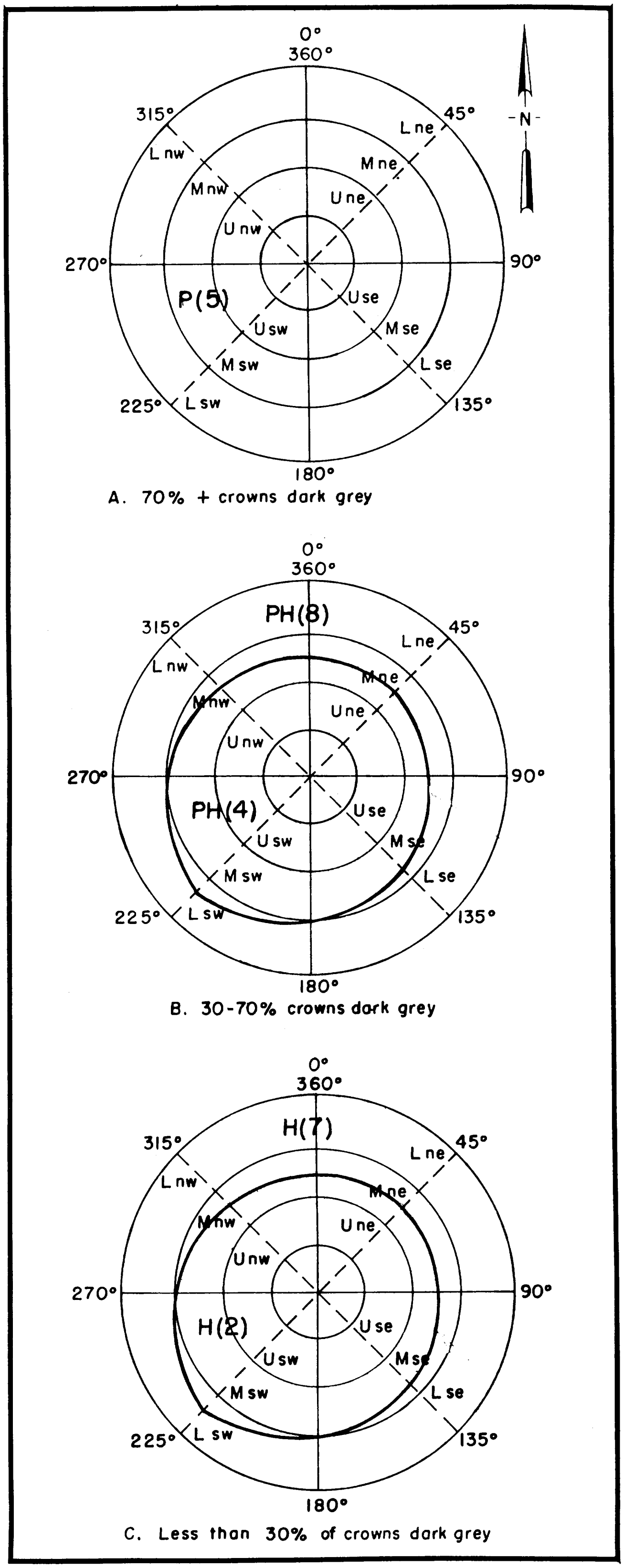


FIGURE 63. Forest cover type distribution of the rounded hills on the undulating valley floors of Zone IV. If stand is on a saddle (Figure 29E), use the cover type occurring at midslope where the aspect is N45°W.

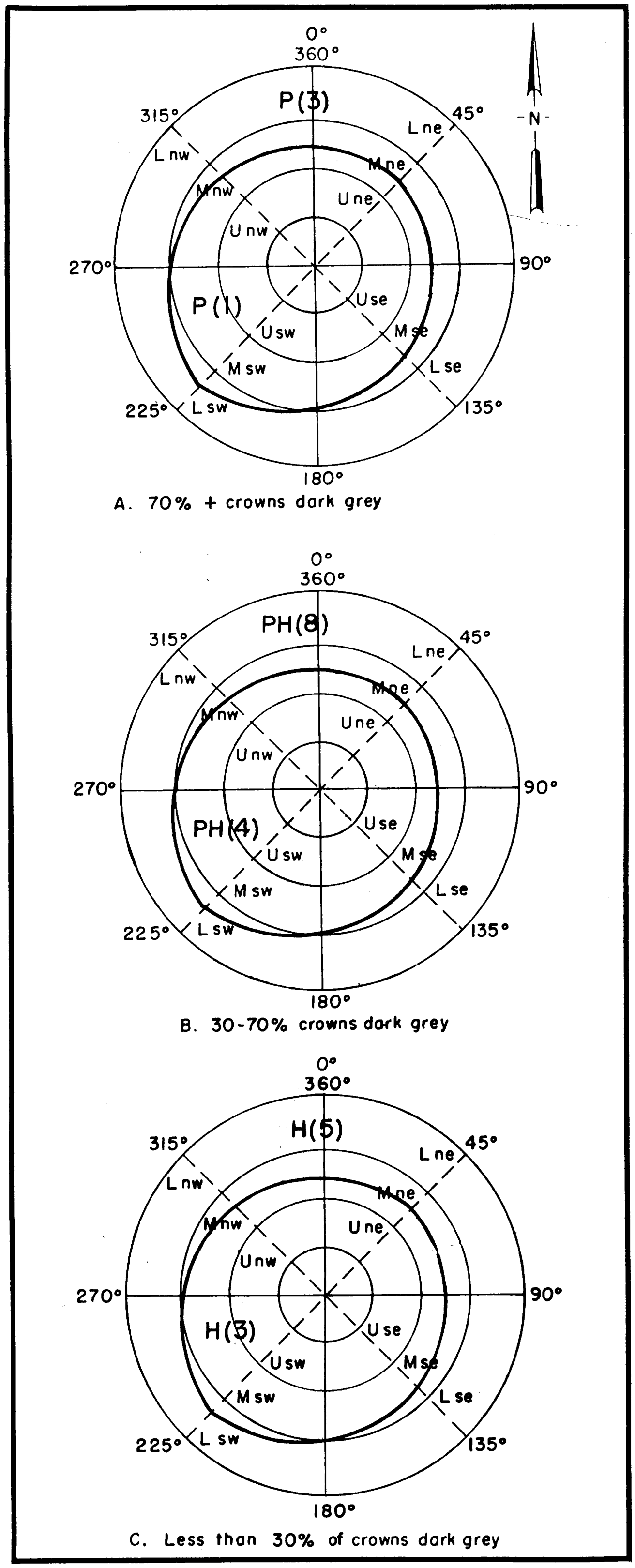


FIGURE 64. Forest cover type distribution on structural ridges in Zone IV. Figure 64A also applies to the secondary topographic features on top of Lookout Mountain in Zone V. If stand is on a saddle (Figure 29E), use the cover type occurring at midslope when the aspect is N45°W.

APPENDIX II

Scientific Names of the Tree Species[1]

Conifers

Pine family — *PINACEAE*
- Loblolly pine . . . *Pinus taeda* L.
- Shortleaf pine . . . *Pinus echinata* Mill.
- Virginia pine . . . *Pinus virginiana* Mill.
- Eastern hemlock . . . *Tsuga canadensis* (L.) Carr.

Redwood Family — *TAXODIACEAE*
- Baldcypress . . . *Taxodium distichum* (L.) Rich.

Cypress or Cedar Family — *CUPRESSACEAE*
- Eastern redcedar . . . *Juniperus virginiana* L.

Broad-leaved Trees

Willow or Poplar Family — *SALICACEAE*
- Black willow . . . *Salix nigra* Marsh.
- Eastern cottonwood . . . *Populus deltoides* Bartr.

Walnut Family — *JUGLANDACEAE*
- Black walnut . . . *Juglans nigra* L.
- Butternut . . . *Juglans cinerea* L.
- Bitternut hickory . . . *Carya cordiformis* (Wangenh.) K.Koch
- Mockernut hickory . . . *Carya tomentosa* Nutt.
- Pignut hickory . . . *Carya glabra* (Mill.) Sweet
- Shagbark hickory . . . *Carya ovata* (Mill) K. Koch

Birch Family — *BETULACEAE*
- River birch . . . *Betula nigra* L.
- Hazel alder . . . *Alnus serrulata* (Aiton) Willd.[2]
- American hornbeam . . . *Carpinus caroliniana* Walt.

Beech Family — *FAGACEAE*
- American beech . . . *Fagus grandifolia* Ehrh.
- American chestnut . . . *Castanea dentata* (Marsh.) Barkh.
- Black oak . . . *Quercus velutina* Lam.
- Blackjack oak . . . *Quercus marilandica* Muenchh.
- Cherrybark oak . . . *Quercus falcata* var. *leucophylla* (Ashe) Palmer and Steyerm.
- Chestnut oak . . . *Quercus montana* L.
- Chinkapin oak . . . *Quercus muehlenbergii* Engelm.
- Northern red oak . . . *Quercus rubra* L.
- Post oak . . . *Quercus stellata* Wangenh.
- Scarlet oak . . . *Quercus coccinea* Muenchh.
- Southern red oak . . . *Quercus falcata* Michx.
- Water oak . . . *Quercus nigra* L.
- White oak . . . *Quercus alba* L.

Elm Family — *ULMACEAE*
- American elm . . . *Ulmus americana* L.
- Winged elm . . . *Ulmus alata* Michx.
- Common hackberry . . . *Celtis occidentalis* L.
- Sugarberry . . . *Celtis laevigata* Willd.

Mulberry Family — *MORACEAE*
- Red mulberry . . . *Morus rubra* L.

Magnolia Family — *MAGNOLIACEAE*
- Bigleaf magnolia . . . *Magnolia macrophylla* Michx.
- Fraser magnolia . . . *Magnolia fraseri* Walt.
- Sweetbay . . . *Magnolia virginiana* L.
- Yellow-poplar . . . *Liriodendron tulipifera* L.

Laurel Family — *LAURACEAE*
- Sassafras . . . *Sassafras albidum* (Nutt.) Nees

Witchhazel Family — *HAMAMELIDACEAE*
- Sweetgum . . . *Liquidambar styraciflua* L.

Sycamore Family — *PLATANACEAE*
- American sycamore . . . *Platanus occidentalis* L.

Rose Family — *ROSACEAE*
- Black cherry . . . *Prunus serotina* Ehrh.

Pulse or Pea Family — *LEGUMINOSAE*
- Honeylocust . . . *Gleditsia triacanthos* L.
- Black locust . . . *Robinia pseudoacacia* L.
- Eastern redbud . . . *Cercis canadensis* L.

Holly Family — *AQUIFOLIACEAE*
- American holly . . . *Ilex opaca* Ait.

Maple Family — *ACERACEAE*
- Boxelder . . . *Acer negundo* L.
- Red maple . . . *Acer rubrum* L.
- Silver maple . . . *Acer saccharinum* L.

Buckeye Family — *HIPPOCASTANACEAE*
- Yellow buckeye . . . *Aesculus octandra* Marsh.

Linden Family — *TILIACEAE*
- White basswood . . . *Tilia heterophylla* Vent.

Tupelo Family — *NYSSACEAE*
- Black tupelo . . . *Nyssa sylvatica* Marsh.
- Water tupelo . . . *Nyssa aquatica* L.

Dogwood Family — *CORNACEAE*
- Flowering dogwood . . . *Cornus florida* L.

Heath Family — *ERICACEAE*
- Sourwood . . . *Oxydendrum arboreum* DC.

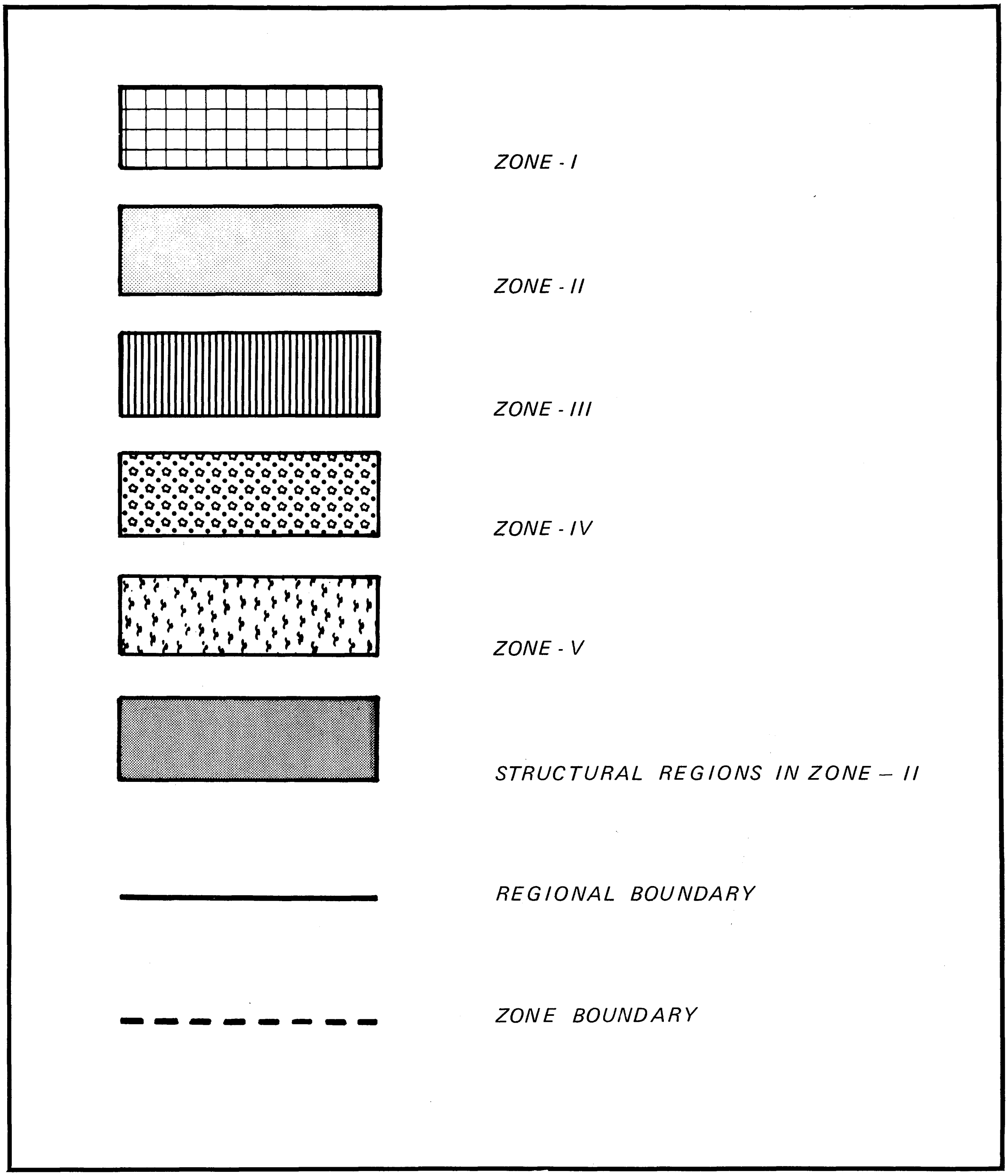
Ebony Family — *EBENACEAE*
- Common persimmon . . . *Diospyros virginiana* L.

Olive Family — *OLEACEAE*
- Green ash . . . *Fraxinus pennsylvanica* Marsh.

Trumpetcreeper Family — *BIGNONIACEAE*
- Southern catalpa . . . *Catalpa bignonioides* Walt.

[1]Harlow and Harrar, 1968.
[2]Clark, 1972.

APPENDIX III
COUNTY MAPS SHOWING LOCATION OF THE VEGETATIVE ZONES OF THE CUMBERLAND PLATEAU FOREST HABITAT REGION KEY



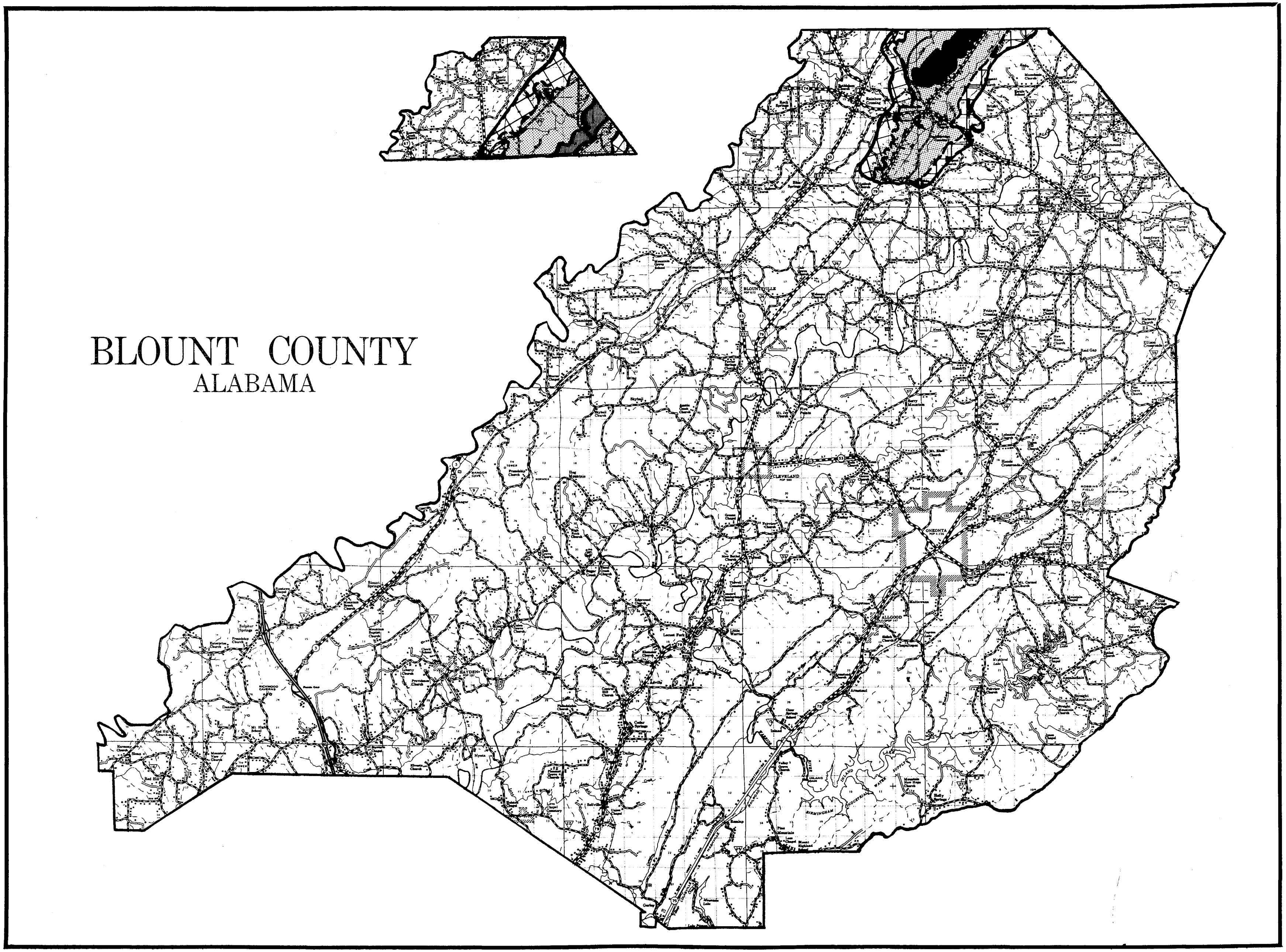


FIGURE 65. Blount County.

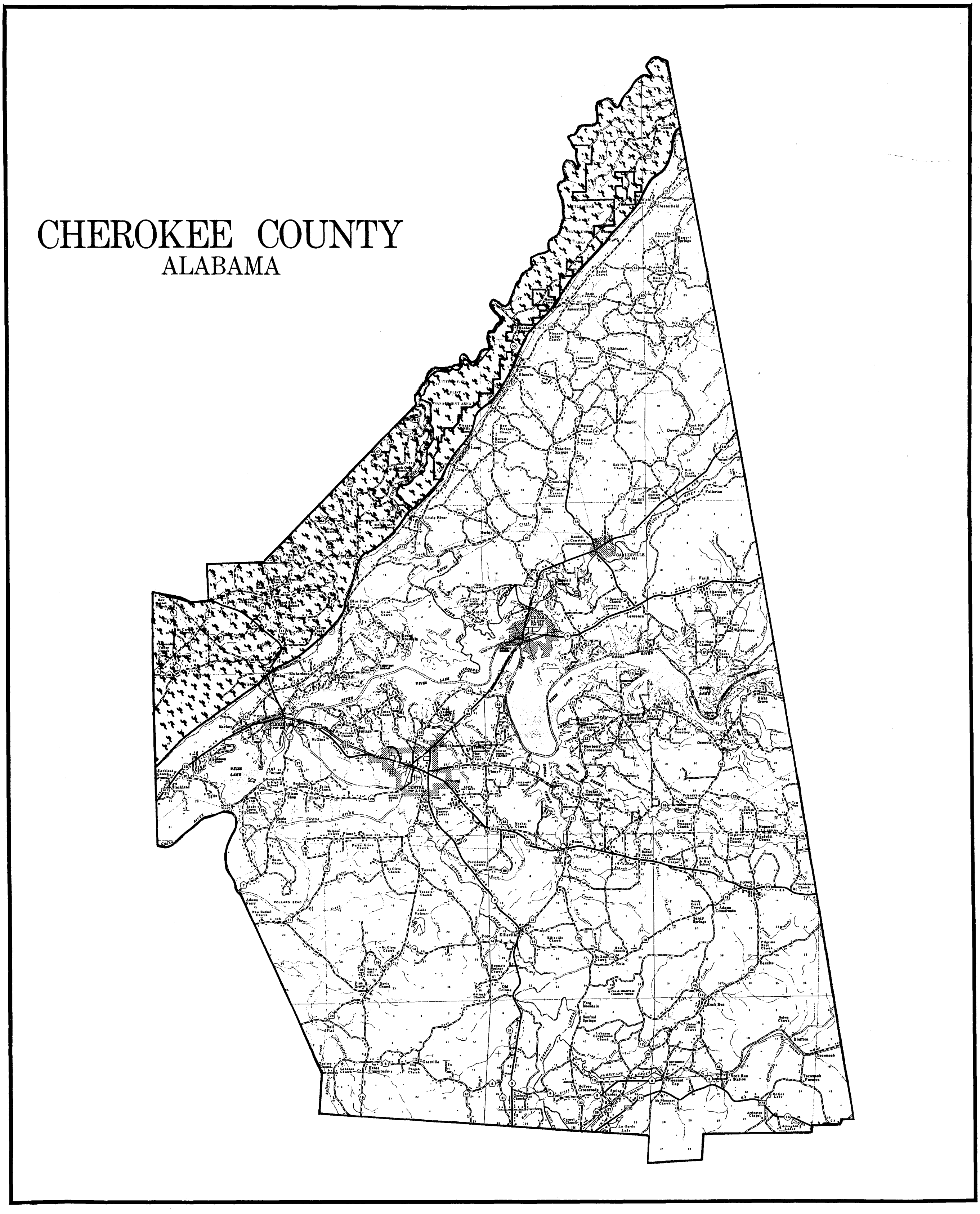


FIGURE 66. Cherokee County.

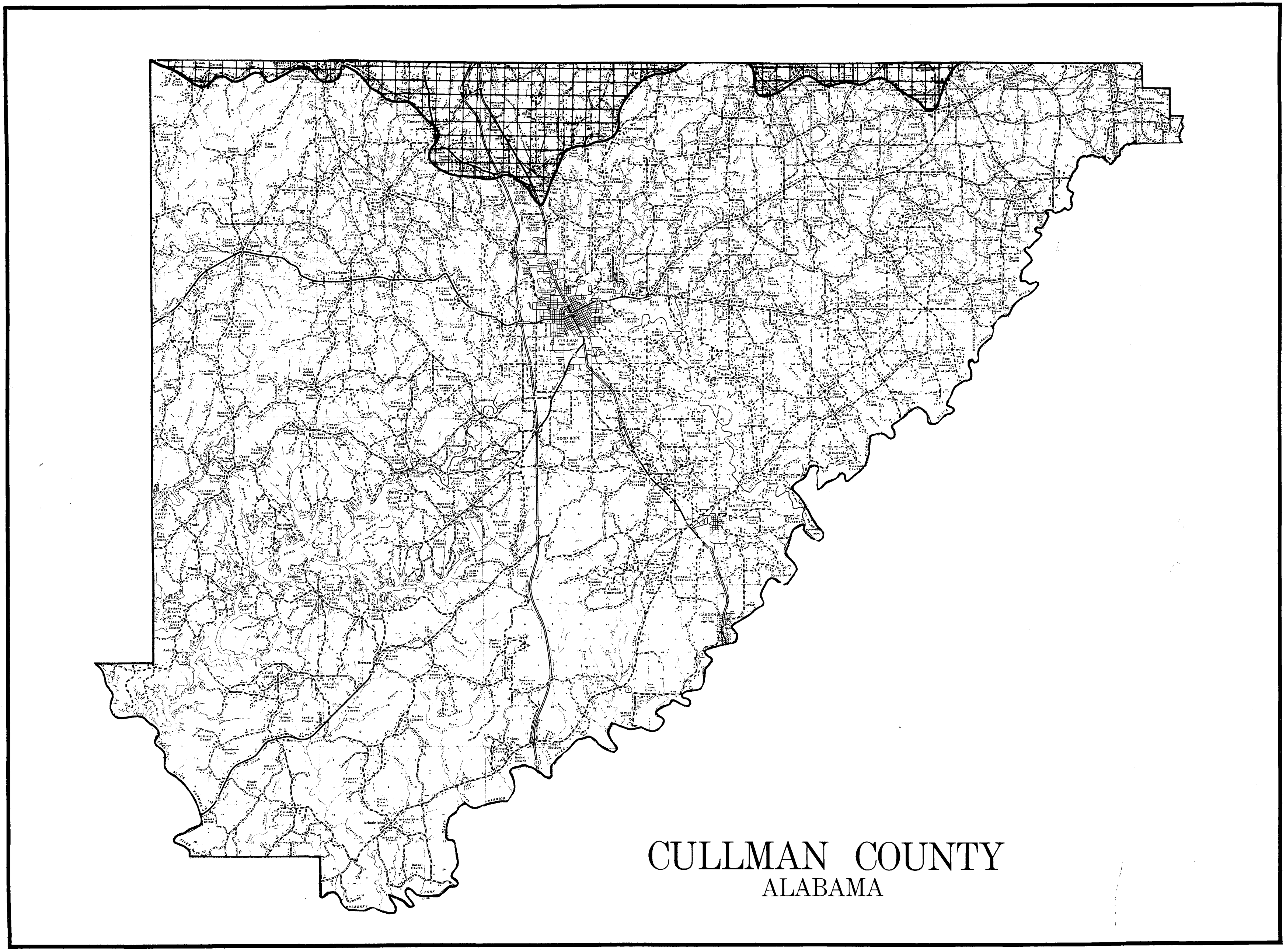


FIGURE 67. Cullman County.

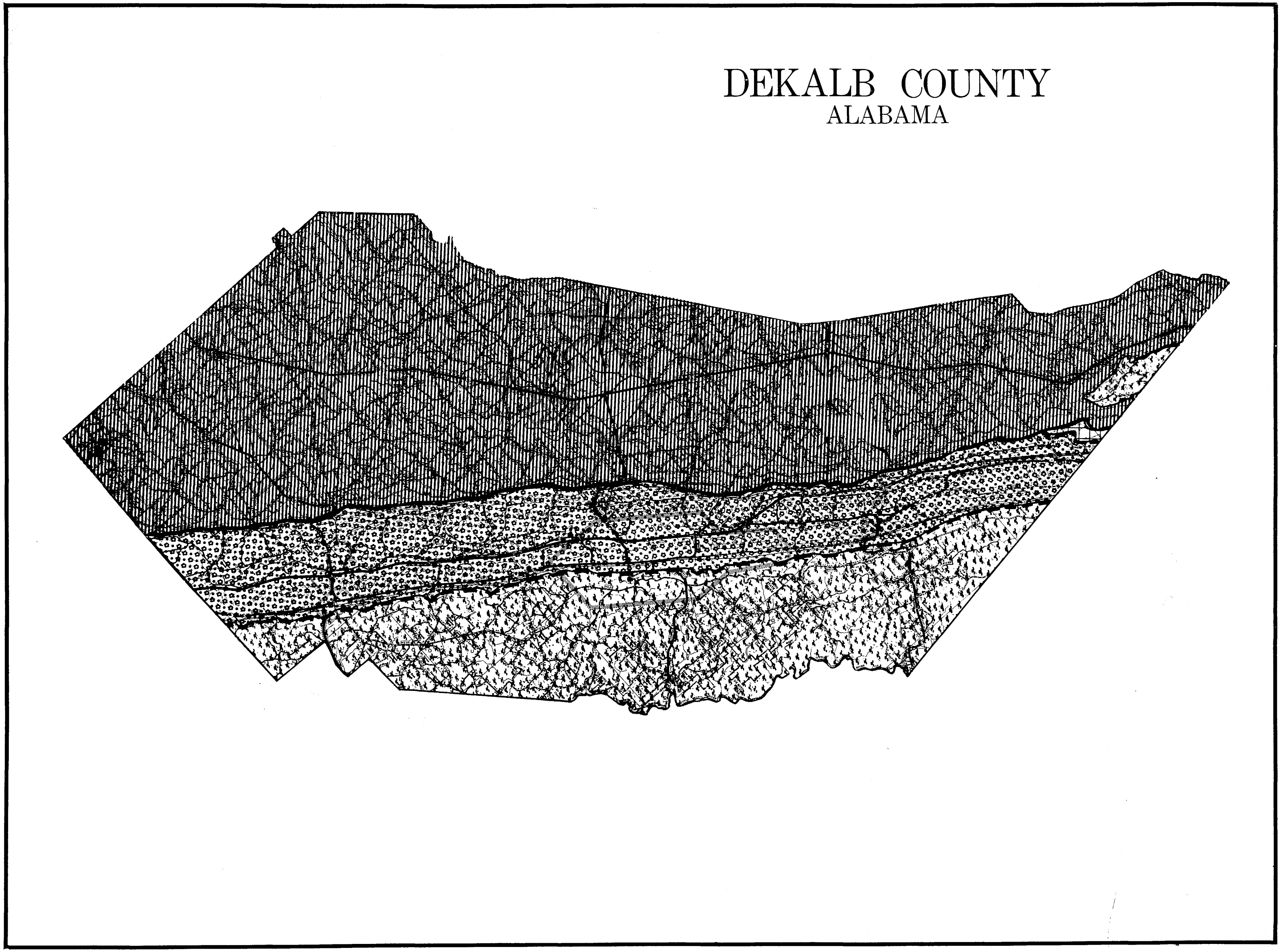


FIGURE 68. DeKalb County.

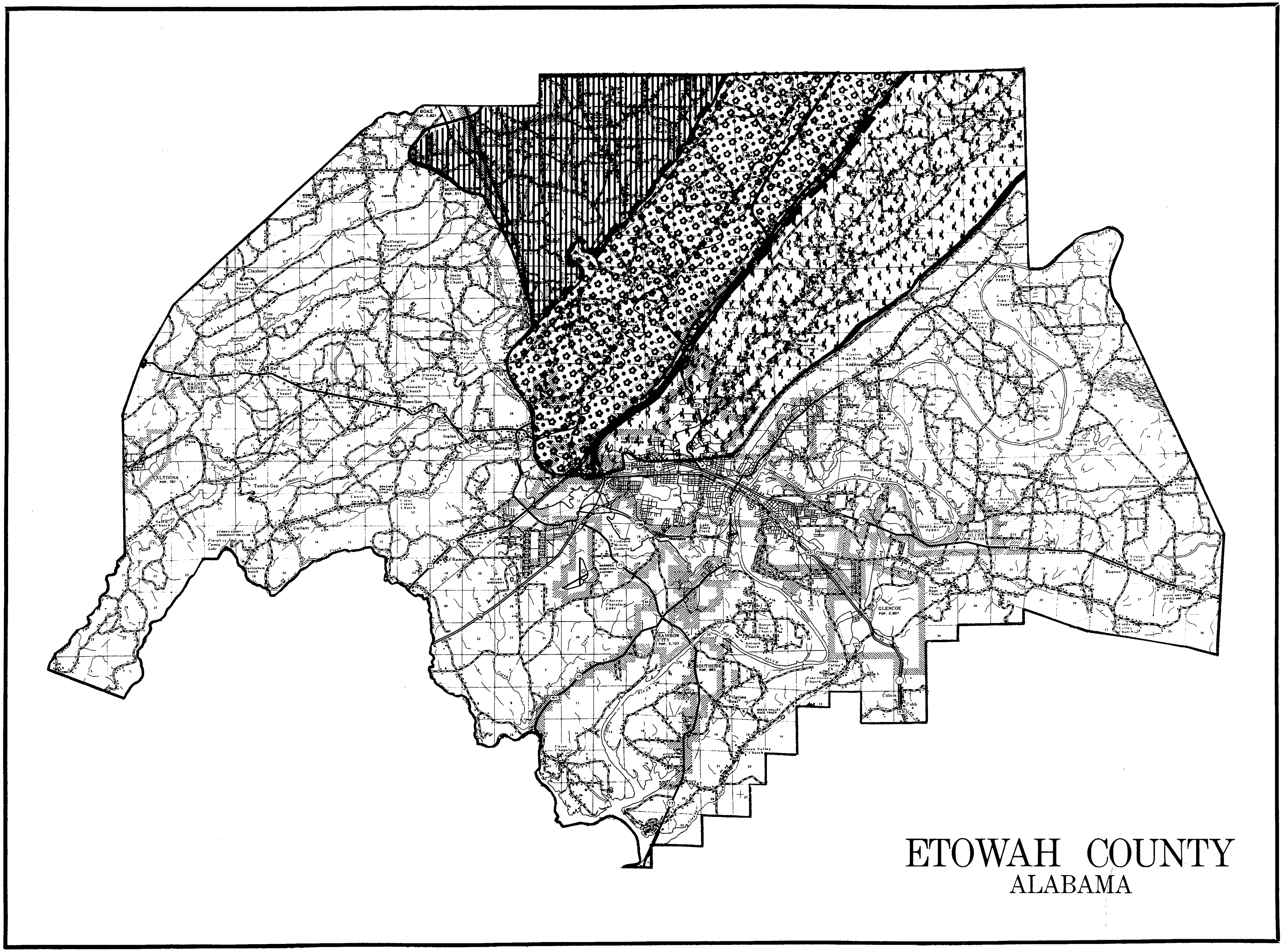


FIGURE 69. Etowah County.

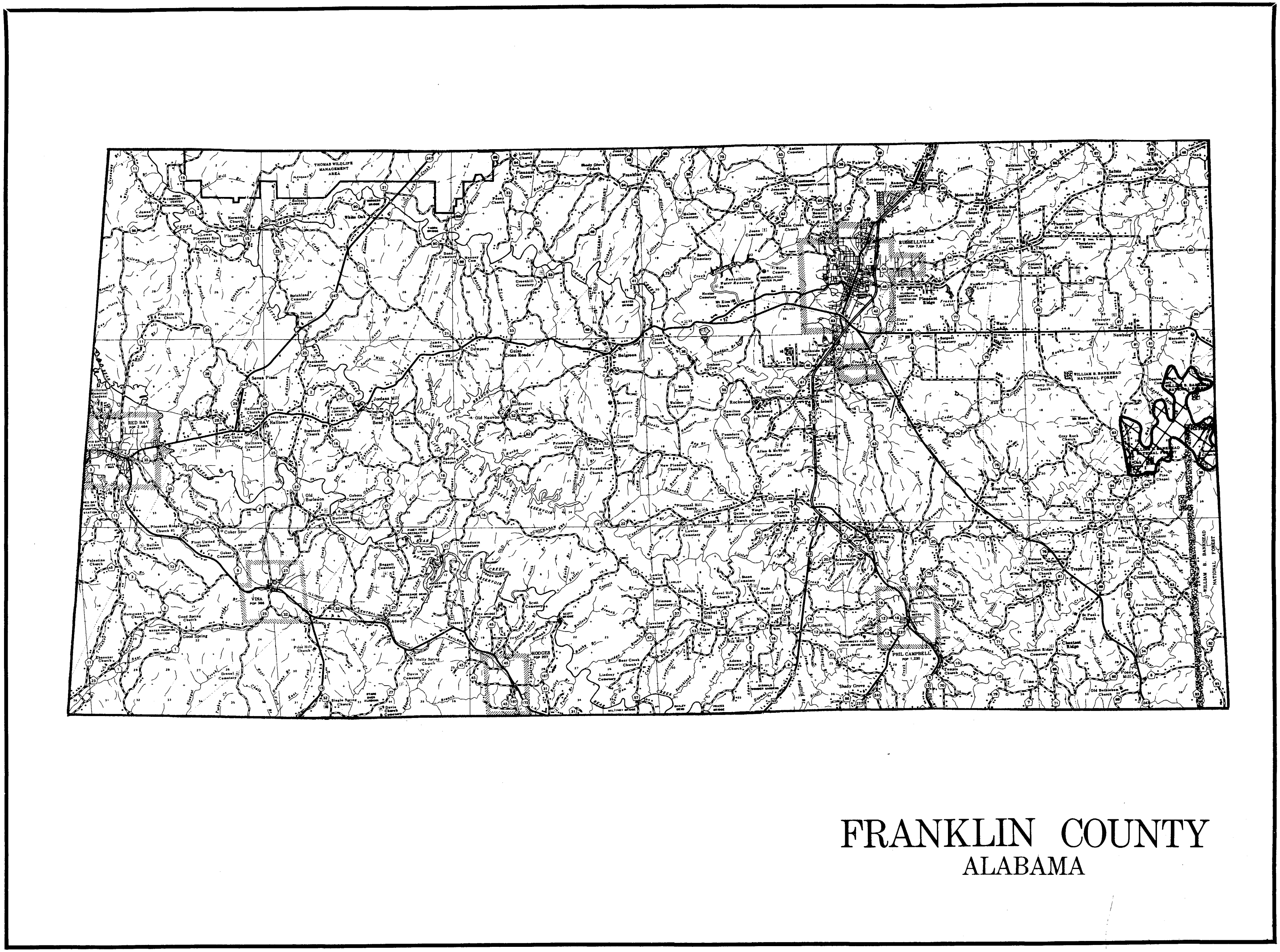


FIGURE 70. Franklin County.

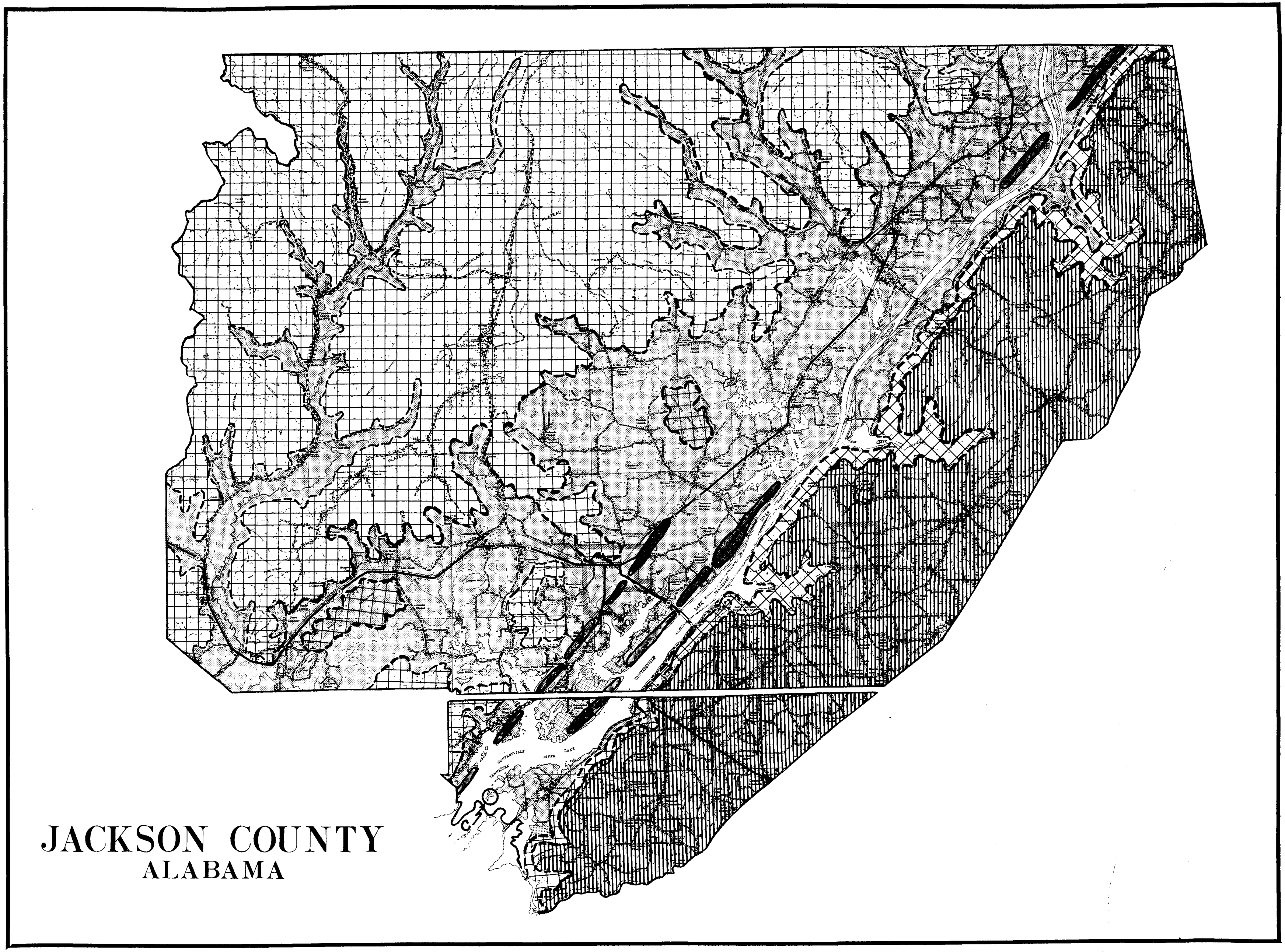


FIGURE 71. Jackson County.

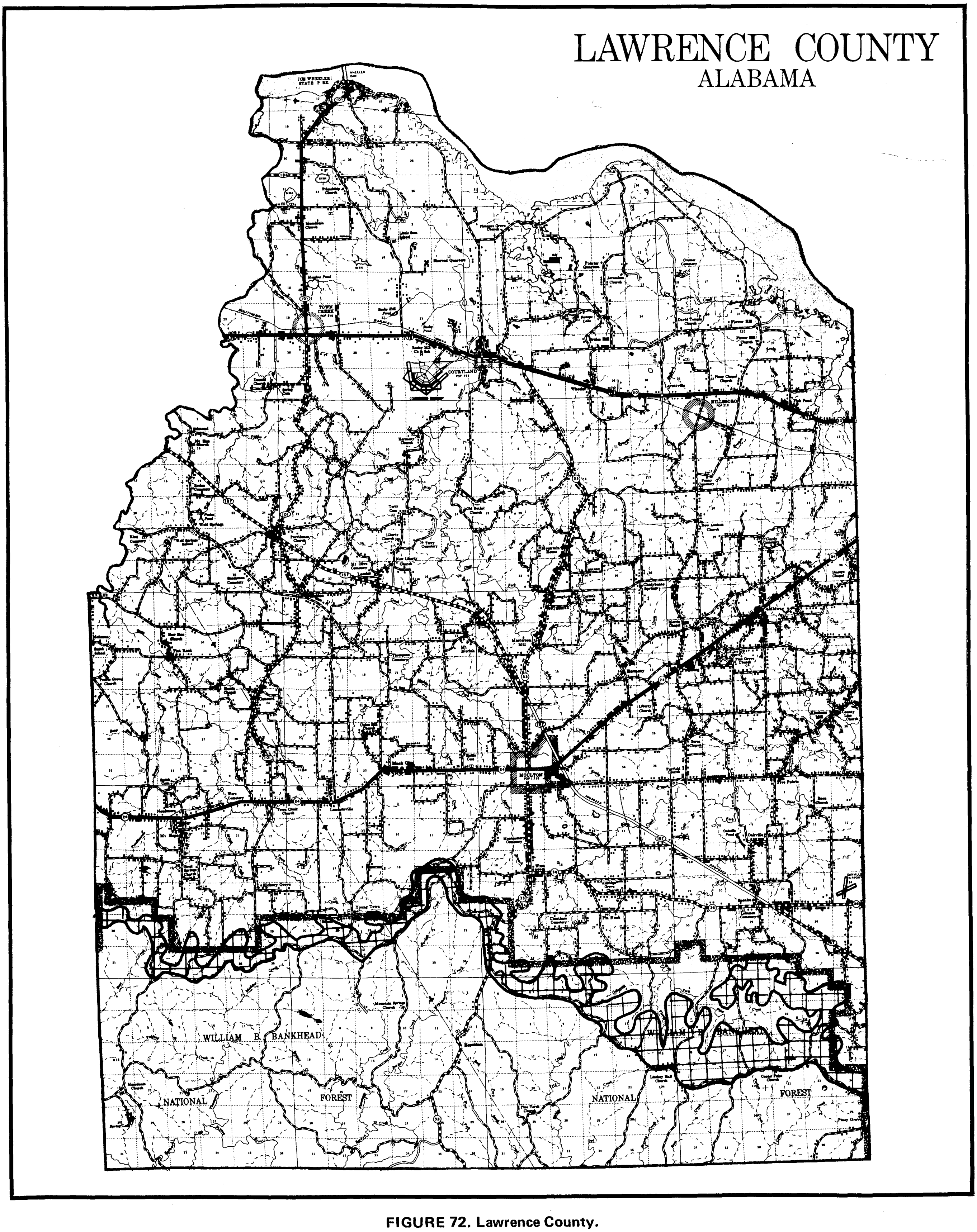


FIGURE 72. Lawrence County.

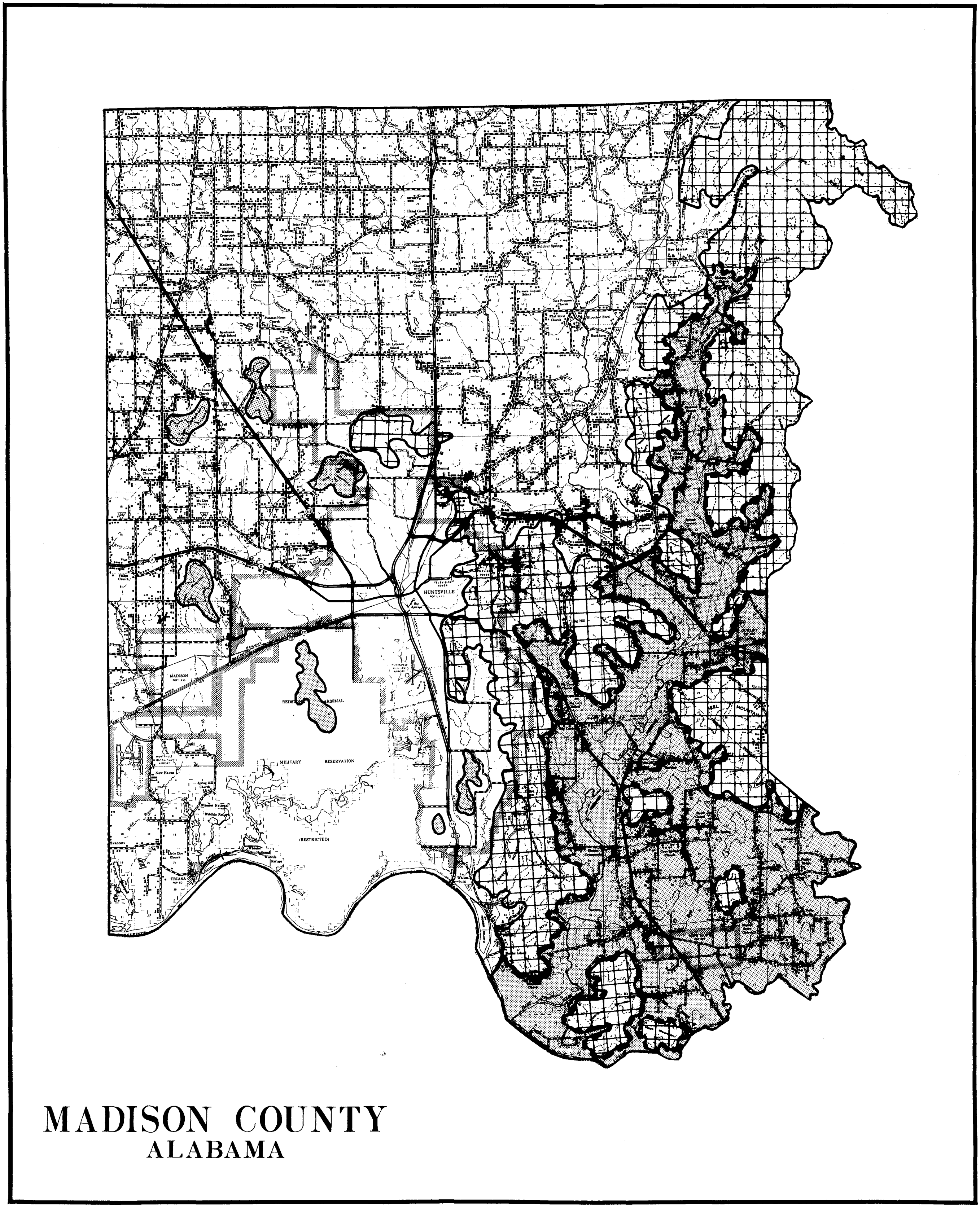


FIGURE 73. Madison County.

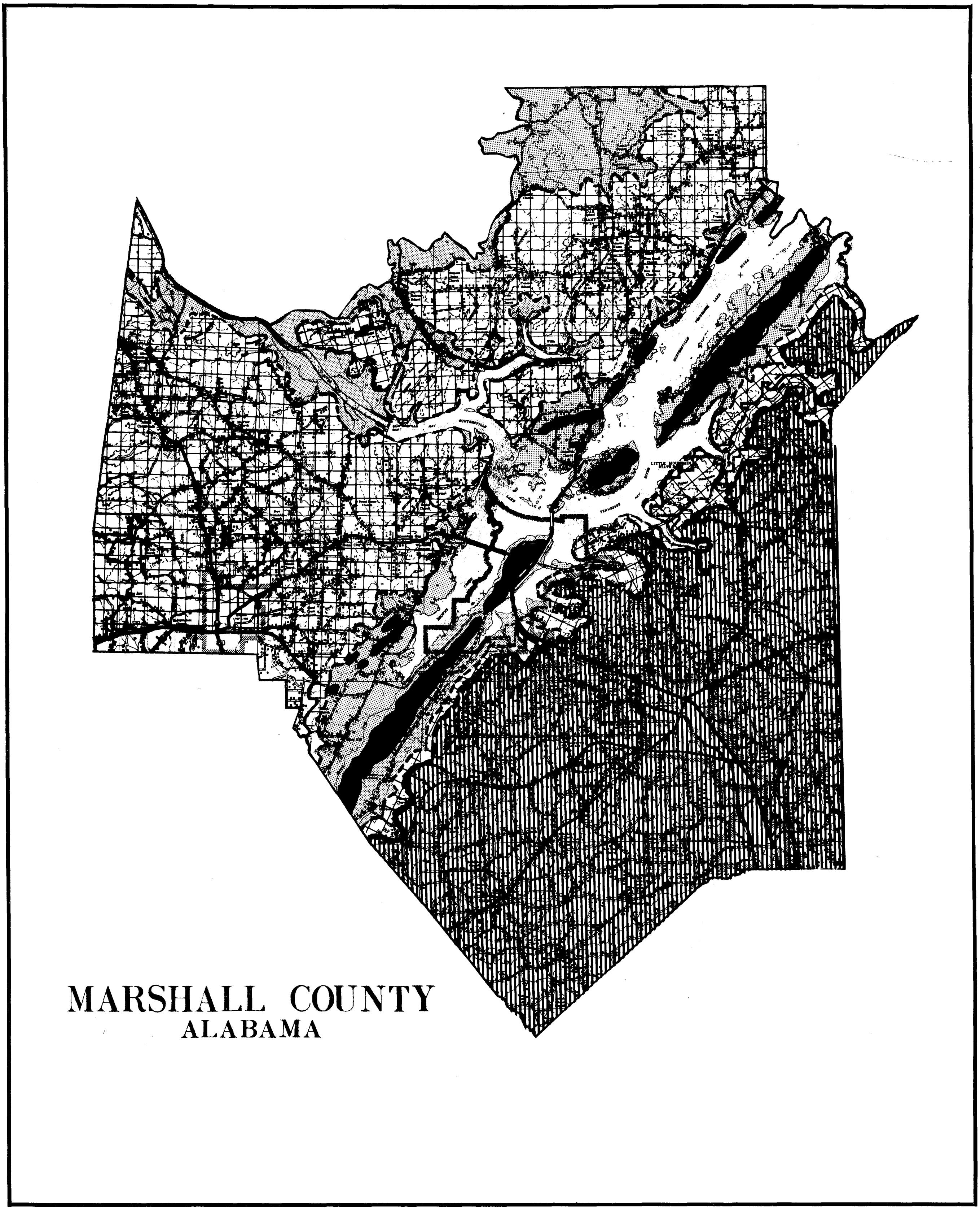


FIGURE 74. Marshall County.

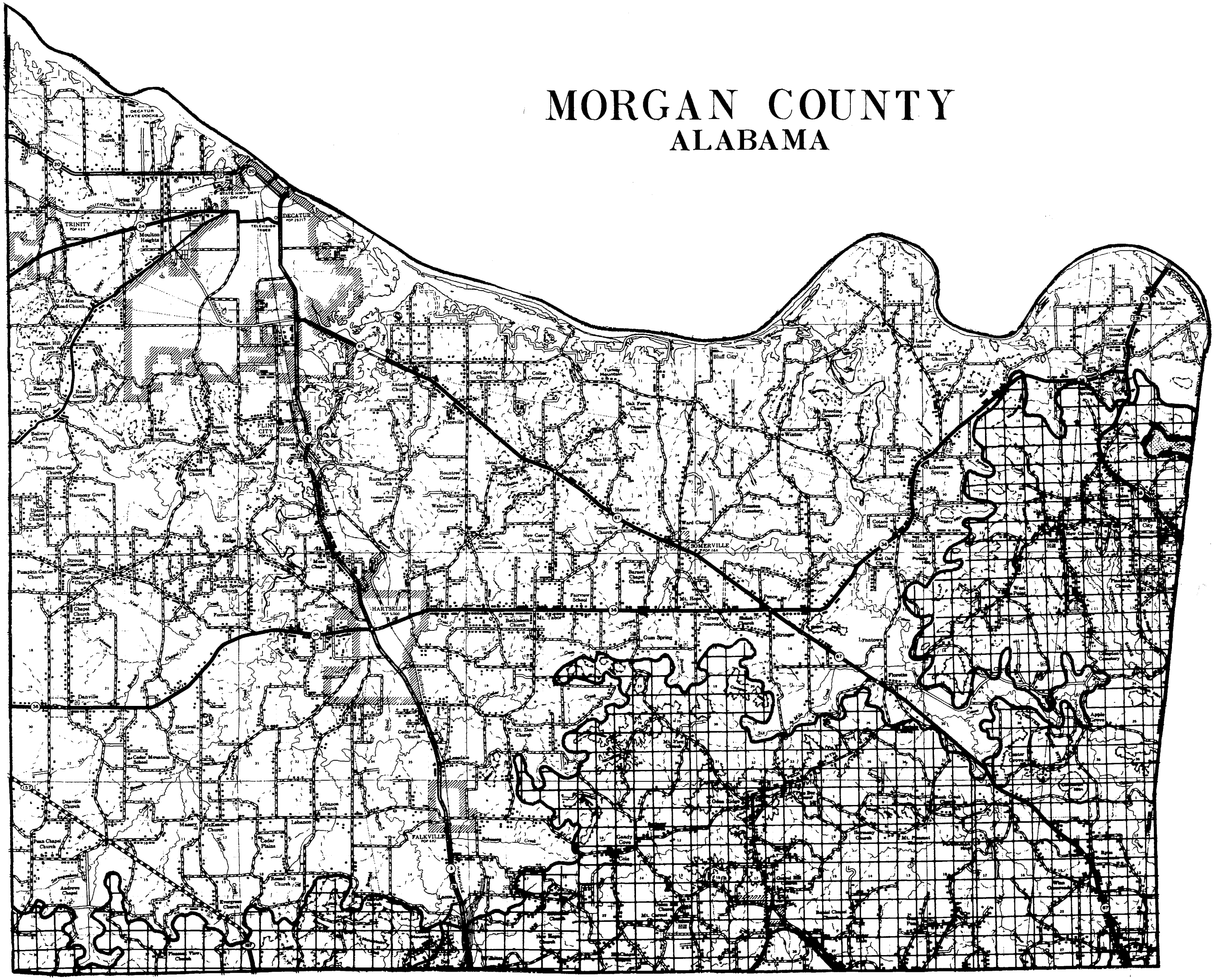


FIGURE 75. Morgan County.

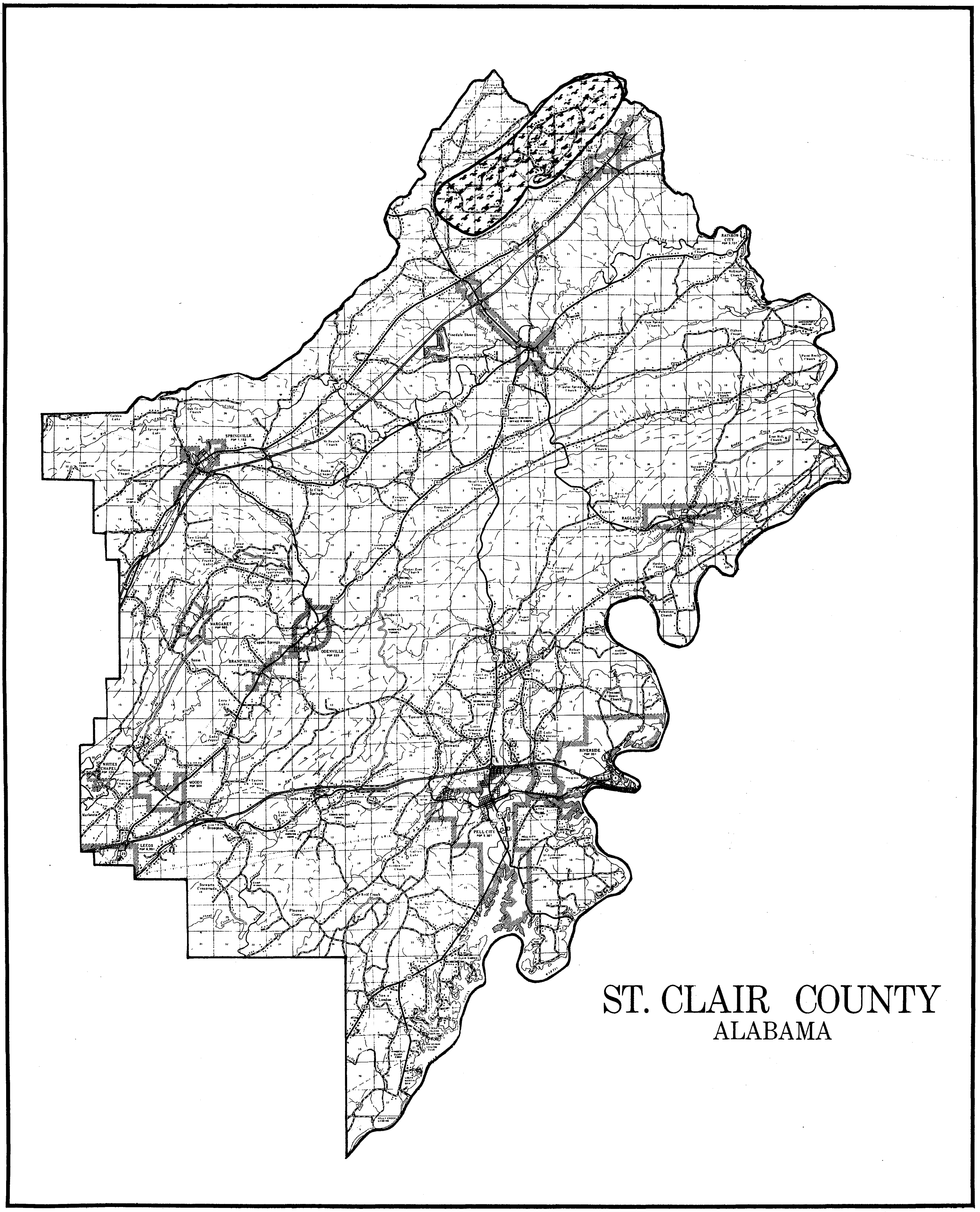
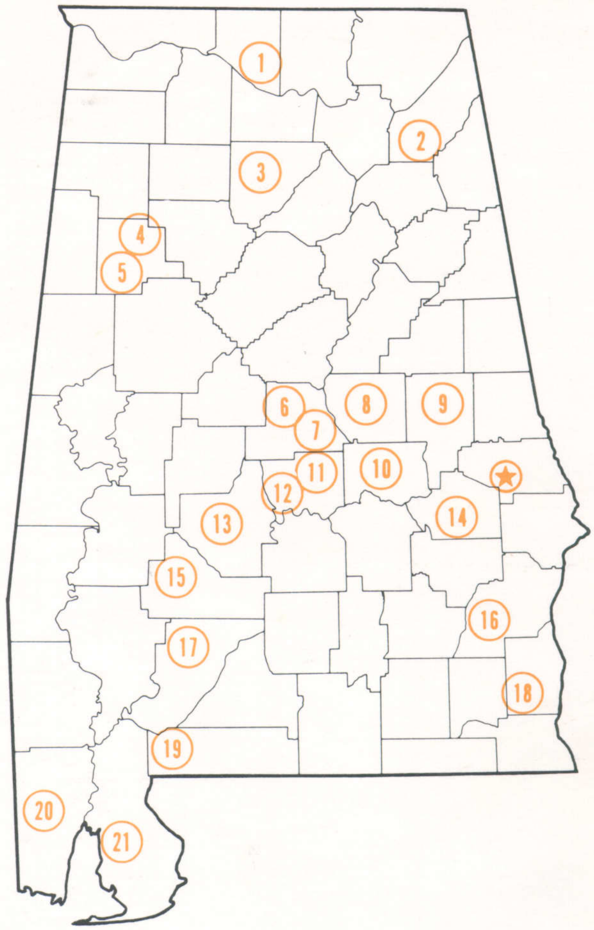


FIGURE 76. St. Clair County.

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.