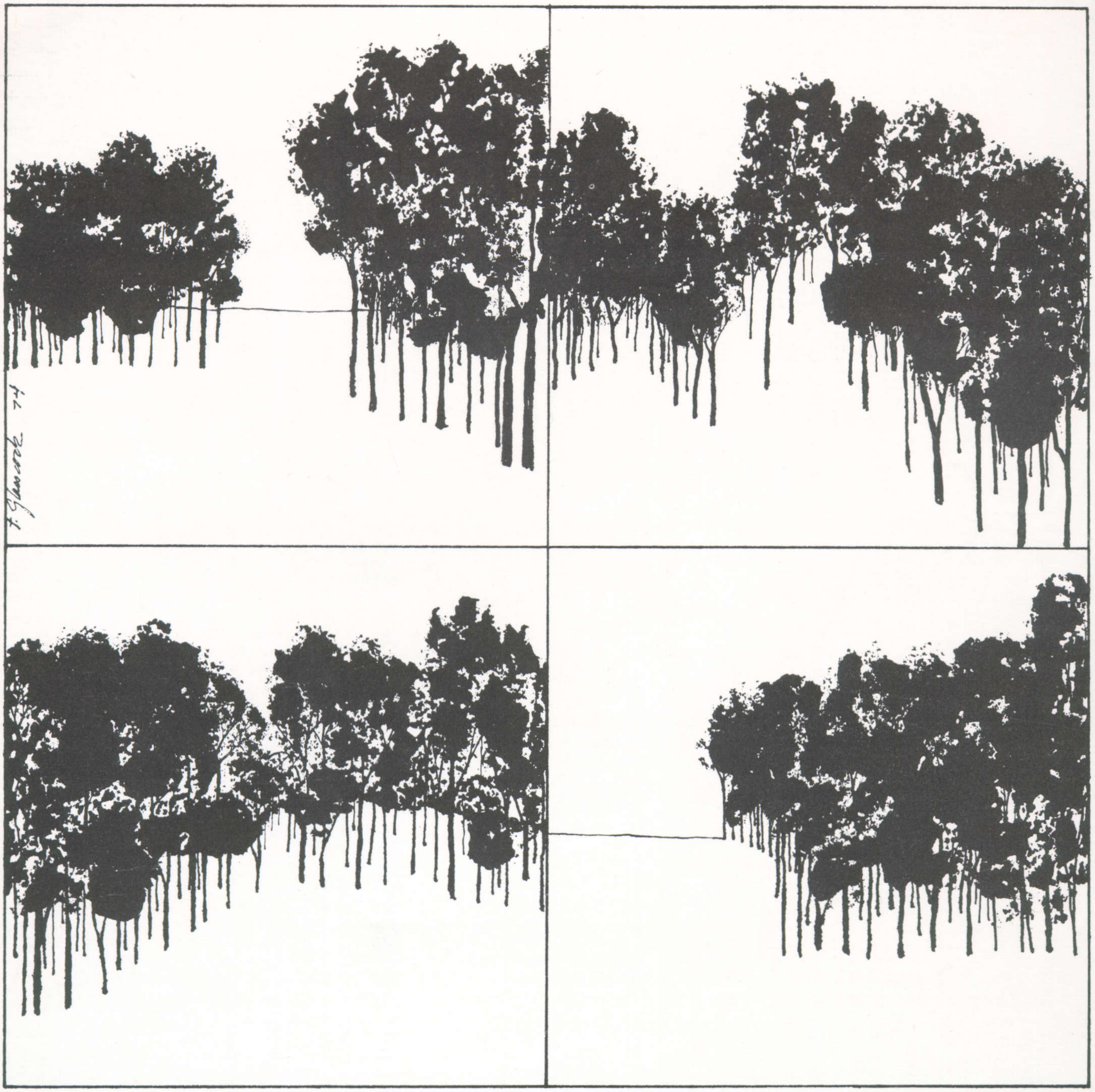

Forest Cover Photo-Interpretation Key for the Warrior Basin Forest Habitat Region in Alabama

DEPARTMENT OF FORESTRY
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EVERT W. JOHNSON and LARRY R. SELLMANN

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 the 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's 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 fifth of the series. (Johnson and Sellmann, 1974, 1975, 1977, and 1978).[2]

The key represents 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 the interpretations. In addition, the keys are designed in such a manner that they can be used with either prints or transparencies and with photography taken under a wide range of film-filter-season-scale combinations. The keys 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 1930's with the advent of 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 keys 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 deep 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

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[1]Professor of Forestry and Research Associate respectively.

[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 quotation marks.

that they can be used by organizations electing to obtain their own photography. It is probable that there will be an increase in the use of such photography since the USDA-ASCS has changed the scale of its photographs, which has the effect of reducing costs to the agency but increasing costs and inconvenience of its customers. Another factor operating to reduce utilization of USDA-ASCS photography of 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 Warrior Basin 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. At the south end of this boundary the line of division is topographically indistinct. Just west of Greeley, in Tuscaloosa County, the boundary becomes visible with the appearance of Rock Mountain, a narrow ridge which runs northeasterly into the Birmingham area. If it had no breaks, this ridge would form the watershed boundary between the Warrior Basin to the west and the Cahaba River drainage to the east. The boundary runs along the base level line at the foot of the eastern slope of the ridge and that of its extension to the north, West Rock Mountain. At the north end of West Rock Mountain, just south of Hueytown, the boundary is again indistinct as it crosses Opossum Valley and Village Creek to the eastern face of the southern extension of Sand Mountain. Since the area is heavily urbanized and the actual boundary is of little significance the line was arbitrarily defined as running due east from the north end of West Rock Mountain to the Louisville and Nashville and the Southern Railroad tracks and from there northeasterly along the tracks to the east face of Sand Mountain adjacent to U.S. Highway 78. Northward from this point the boundary is the base level line on the east face of Sand Mountain to the Crosston-Pinson Road. From this point it runs eastward across the mouth of Murphree Valley to Pinson and then along the base level line of the hills to the east and north of Pinson to the north end of Village Mountain. It then follows the western shores of Mountain Lake and the western and southern shores of Zamora Lake to the eastern escarpment of Blount Mountain and along the base level line at the foot of the escarpment to U.S. Highway 431 west of Gadsden. From this point it follows the southern boundary of the Cumberland Plateau Forest Habitat Region to its western limit in Franklin County. This boundary follows U.S. Highway 431 to the vicinity of Rockledge on the top of the southeastern escarpment of Sand Mountain. From Rockledge westward to the western boundary of Lawrence County the line coincides with the boundary between the Tennessee River and Black Warrior River watersheds, figure 2. The line then follows the same height of land into Franklin County until it becomes indistinct in the vicinity of Pleasant Hill. From this point the Regional boundary has been arbitrarily placed along the outer edge of the Pottsville Formation exposure as the Formation disappears under the sands and gravels of the Coastal Plain. This highly irregular line extends south from Franklin County to Tuscaloosa where it turns eastward toward Greeley and the Ridge and Valley Forest Habitat Region.

In order to simplify the situation along the Coastal Plain - Warrior Basin interface the line was placed west of many patches of Coastal Plain material. Consequently, these patches are included in the Warrior Basin and where appropriate they are recognized in the key.

The Warrior Basin Forest Habitat Region includes essentially the southern 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.

Auburn University and Mississippi State University have jointly developed a map and description 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 and Mountain Forest Habitat Regions (Johnson and Sellman, 1974 and 1975) 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 and Cumberland Plateau Forest Habitat Regions (Johnson and Sellman, 1977 and 1978) because the pattern of species occurrence would not permit it. This also is the situation with the Warrior Basin Forest Habitat Region. Consequently, it is essential that persons using both of the systems realize that they are different.

The Warrior Basin Forest Habitat Region is the southern half of the geologic Cumberland Plateau physiographic region.[3] It consists of a heavily dissected peneplain which is generally lower than that of the Cumberland Plateau Forest Habitat Region to the northeast but is generally higher than the Ridge and Valley to the east and the Highland Rim to the northwest. The peneplain surface gently slopes toward the southwest and there it merges with the Coastal Plain with no topographic evidence of a boundary. The peneplain has been developed on beds or strata of sandstone, shale, coal, limestone, and dolomites, Table 1, which dip to the southwest at a somewhat steeper angle than the peneplain surface, figure

[3]The discussion of the geology of the Warrior Basin is based on material drawn from many sources. Rather than cite these sources in the normal manner, which would be difficult because of the manner of presentation, these sources are listed in a separate bibliographic section under the heading, "Additional References".

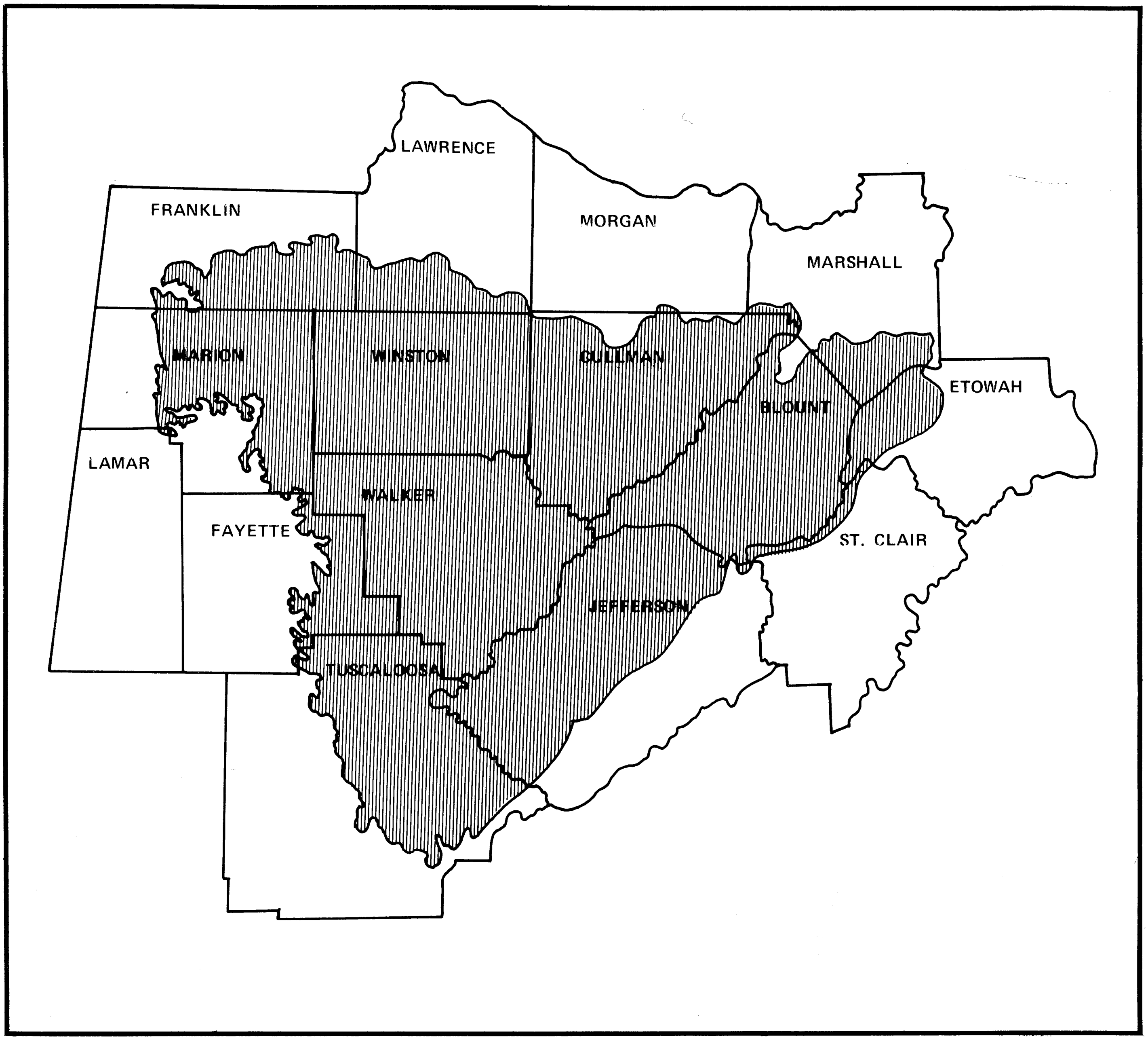


FIGURE 1. Map of the Warrior Basin Forest Habitat Region.

3. The highest portions of the Region are along its northeastern boundary where Blount and Sand Mountains merge. The elevations there reach about 1,100 feet. At the southern edge of the Region, near Tuscaloosa, the elevation is approximately 500 feet.

The surface of the Region is complex. Originally the rocks making up the strata listed in table 1 were laid down as horizontal beds under water. Subsequently the land rose and tilted toward the southwest. At the same time 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 strata 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 has exposed the limestone underlying the peneplain surface, figures 4 and 5. The limestone, which is much less resistant to weathering and dissolution than the overlying sandstone, has been heavily attacked by water along the fractures which has led to the development of valleys. There are two major valleys of this type in the Warrior Basin Forest Habitat Region – Murphree Valley, between Blount and Sand Mountains, and the Sequatchie or Brown's Valley between Sand and Brindley mountains.

Blount and Sand mountains are mesa-like table-lands which have somewhat hollow surfaces because they are formed on synclines. The main portion of the Warrior Basin, west of the Sequatchie anticline, is also on a syncline and has a hollow surface.

Table 1 lists the components of the stratigraphic column in the Region. The surface of virtually all of the Region is

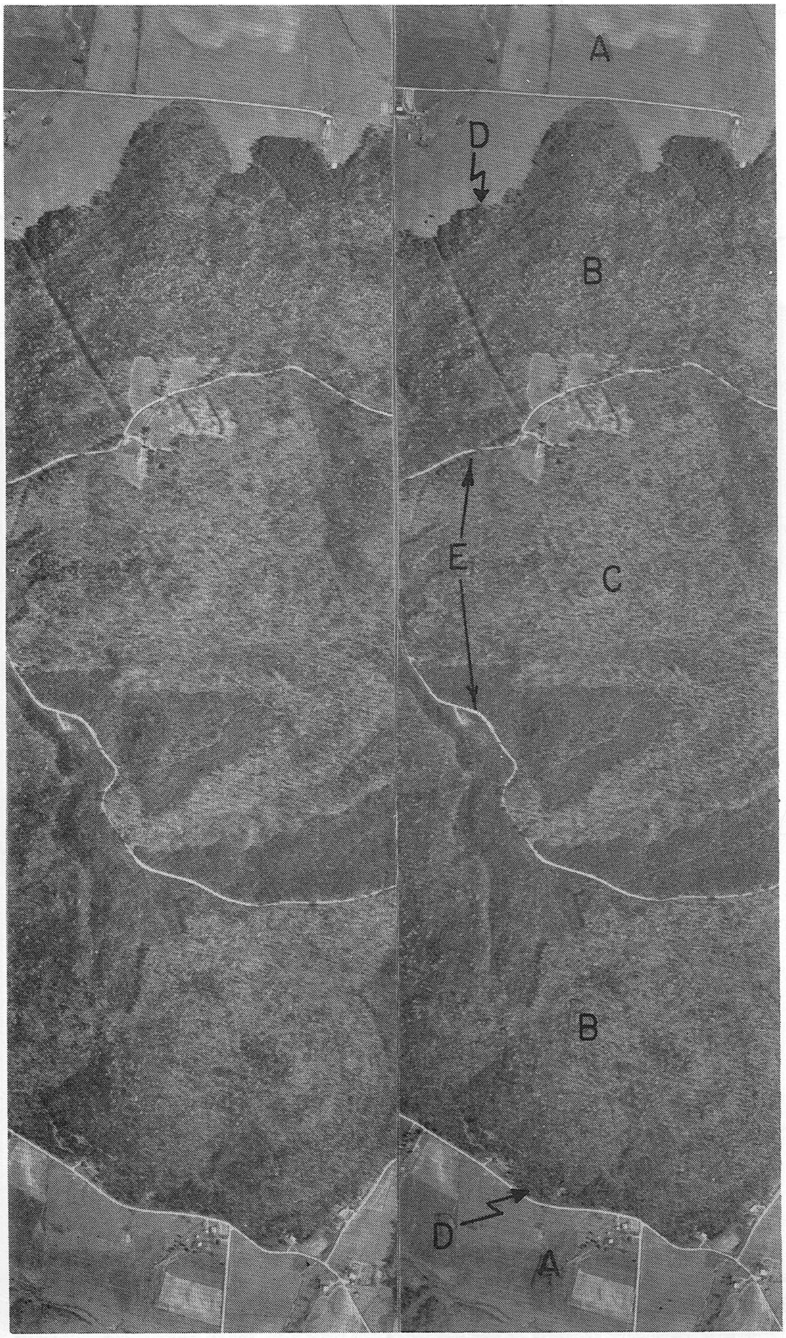


FIGURE 2. Stereogram showing portions of three Forest Habitat Regions: the Highland Rim (A), the Cumberland Plateau (B), and the Warrior Basin (C). The boundary between the Highland Rim and Cumberland Plateau Regions is the base level line at the foot of the escarpment (D). The boundary between the Cumberland Plateau and Warrior Basin Regions is the watershed boundary between the Tennessee River and Black Warrior River drainages. In this stereogram it largely coincides with the road (E). This is near Buzzard's Roost Mountain. (Lawrence County, HI-3MM-28,29).

dominated by the Pottsville Formation. Only in the anticlinal valleys, in the bottoms of certain deep gorges in Lawrence County, and on the eastern escarpment of Blount Mountain, do the underlying strata reach the surface. Along the regional boundary with the Coastal Plain the Pottsville Formation disappears beneath the more recent Coastal Plain deposits. This is a very irregular interface with many patches of Coastal Plain material capping hills in the area adjacent to the boundary. These Coastal Plain deposits are shallow and in many places streams have cut through them forming valleys in the underlying Pottsville materials.

The Pottsville Formation itself is complex. It consists of many layers of sandstone, shale, and coal. It varies enormously in thickness. In the northwest, in Franklin and Lawrence Counties, it is very thin and gorges have been cut through it to the underlying Parkwood and Pennington Formations and, in some places, even into the very top of the Bangor limestone. Further south, in Walker County, the Pottsville Formation is

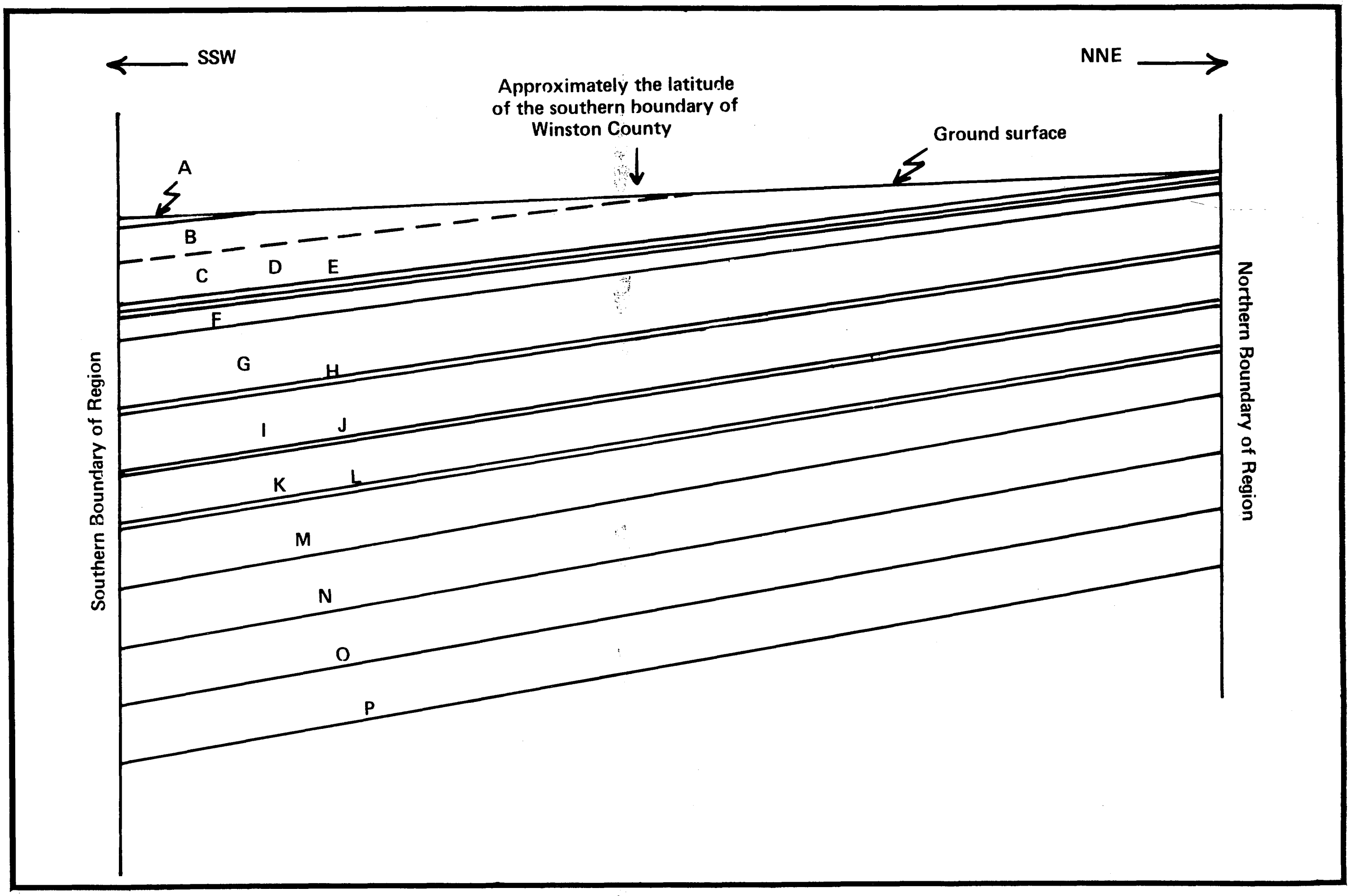


FIGURE 3. Generalized cross-section of the geological strata underlying the Warrior Basin Forest Habitat Region. This drawing has not been made to scale except that strata that are generally thin are shown as being thin and those that generally are thick are shown as thick. At any particular point all the strata shown may not be present. It shows the situation along a line that is generally at a right angle with the strike of the strata. The line generally lies in a South South West to North North East direction. Note that the strata are dipping at a greater angle from the horizontal than the slope angle of the surface. The dip of the strata is about 45 feet per mile. The code letters for the strata are keyed to Table 1. Adapted from Wahl, Harris, and Jefferson, 1971.

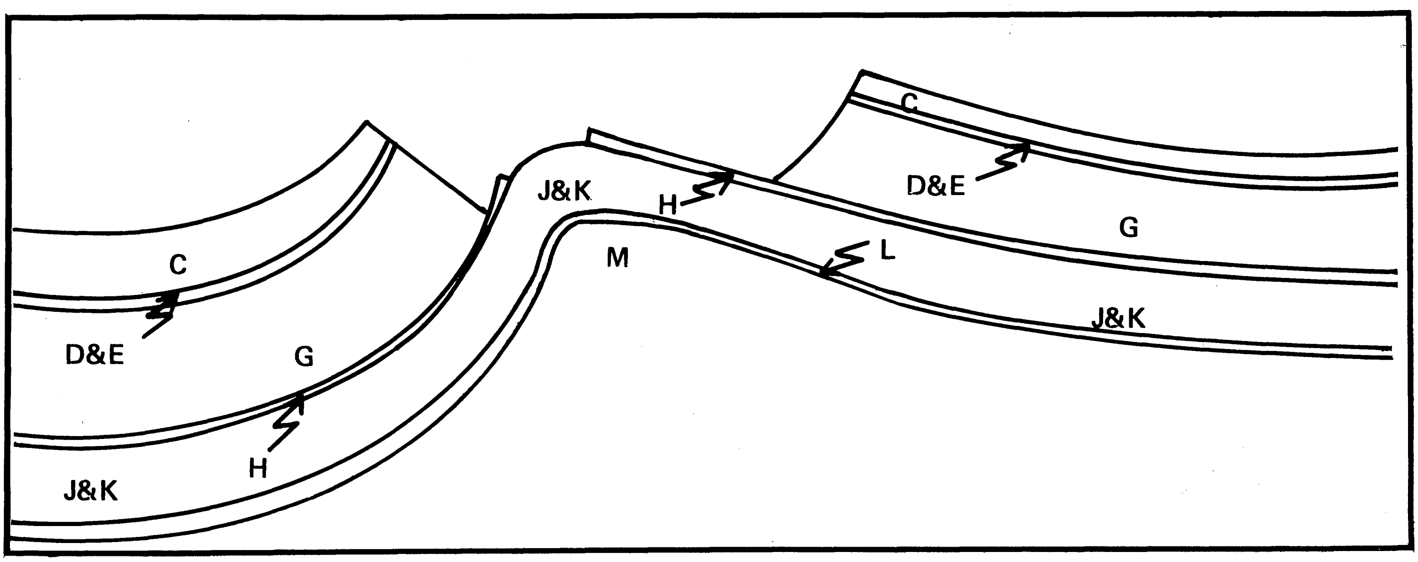


FIGURE 4. Generalized cross-section of the geological strata along a line running at about a right angle to the strike of the strata in the middle to south end of the Sequatchie (or Brown's) Valley. The code letters for the strata are keyed to Table 1. The drawing has not been made to scale. However, to give an idea of the uplift, the difference in elevation between the plateau surface, 3 to 4 miles from the tops of the bounding ridges, and the tops of those ridges is about 500 feet. Adapted from McCalley, 1891, and Butts, 1911.

Table 1. Generalized stratigraphy of the Warrior Basin Forest Habitat Region.[1]

Formation	Code[2]	Character of rock
Coker Formation	A	Lenticular beds of clay, sand, and gravel. (Coastal Plain material.)
Pottsville Formation		Intermixed beds of sandstone, shale, siltstone, conglomerate, and coal.
Upper Productive Beds	B	The upper portion of the Pottsville which has abundant coal.
Lower Unproductive Beds	C	The lower portion of the Pottsville which has relatively little coal. The lowermost of the "lower" beds is sandstone and is referred to as the "Boyle's sandstone member".
Parkwood Formation	D	Thin to medium bedded fine grained well-cemented sandstone.
Pennington Formation	E	Shale with some limestone.
Floyd Shale	F	Shale; fine grained thin bedded sandstone; siltstone.
Bangor Limestone	G	Blue grey limestone. Contains some shale and chert.
Hartselle Sandstone	H	Fine-grained sandstone with siltstone in the lower part.
Gasper Formation and St. Genevieve Limestone	I	Shale. Limestone, medium to thick bedded.
Tuscumbia Limestone	J	Limestone. Contains some chert.
Fort Payne Chert	K	Thin to medium bedded siliceous limestone and dense chert.
Chattanooga State	L	Shale.
Red Mountain Formation	M	Shale and fine grained ferruginous sandstone.
Chickamauga Limestone	N	Fine-grained limestone with chert nodules and partings of shale.
Chepultepec and Cooper Ridge Dolomites	O	Medium to thick bedded dolomite. Weathers to a clayey chert.
Conasauga Formation	P	Shale, interbedded with thin layers of limestone and dolomite.

[1]This is a composite picture of the stratigraphic column. The primary source was Adams, *et al.*, 1926, but this was augmented by the papers listed under "Additional References." The actual stratigraphic column in any individual location may not include all the strata shown above. The beds vary in thickness and pinch out in some places.

[2]The letter codes for the various strata are used to identify them in some of the following figures.

between 1,000 and 3,000 feet thick. The lower strata in the formation are relatively coal-free but higher in the stratigraphic column are a number of important seams of coal and many of lesser significance. Separating these coal seams are sandstones and shales which vary from one another with respect to strength, color, and thickness. Since the peneplain surface is not parallel with the bedding of these strata, the surface of the peneplain exhibits topographic differences caused by the type of rock at or immediately below the surface, figure 3. Sandstone may be soft or hard but, in comparison to the other rocks in the Region, it resists erosion. The harder it is the greater its resistance to erosion. Consequently, dissection of a sandstone surface is slow. The surface remains relatively smooth with relatively shallow stream valleys, figures 6, 7, and 8. Given enough time a stream can entrench itself deeply, figure 6. Shale, on the other hand, is generally soft. It is usually impervious to vertical water movement but is eroded easily by water running over it. A surface made up of nothing but shale tends to be rough with a very dense dendritic net of streams, figure 9. The hills so formed have rounded tops and very steep sides and the lesser valleys have V-cross-sections. In areas where a thin layer of sandstone occurs as a cap over shale the sandstone is sapped from below as the shale is washed away by streams and sub-surface flow along the sandstone-shale interface. This leaves the sandstone unsupported and it breaks away forming cliffs (rimrock) along valleys with steep talus slopes, figures 2 and 10, and V-cross-sections. In an area where the surface stratum is made up of shale, which is underlain by a thin layer of sandstone which, in turn, is underlain by shale, the landscape has an appearance which is noticeably different from that associated with any other geologic situation. The uppermost shale erodes in the usual manner but when the downcutting of the stream reaches the sandstone the rate of erosion is slowed. Where the downcutting has penetrated the sandstone to the underlying shale the rate of erosion is increased. This results in the formation of waterfalls over sandstone edges with associated deep plunge pools and steep walled canyon-like ravines or coves, figure 11. There is a progression of landscapes like these across the Warrior Basin Forest Habitat Region and, since there are some differences in the species complexes associated with rock type, references to the landscapes will be made in the key.

The drainage system of the Warrior Basin Forest Habitat Region is essentially coincident with that of the Black Warrior River. The hollow surfaces of the synclines gather the waters

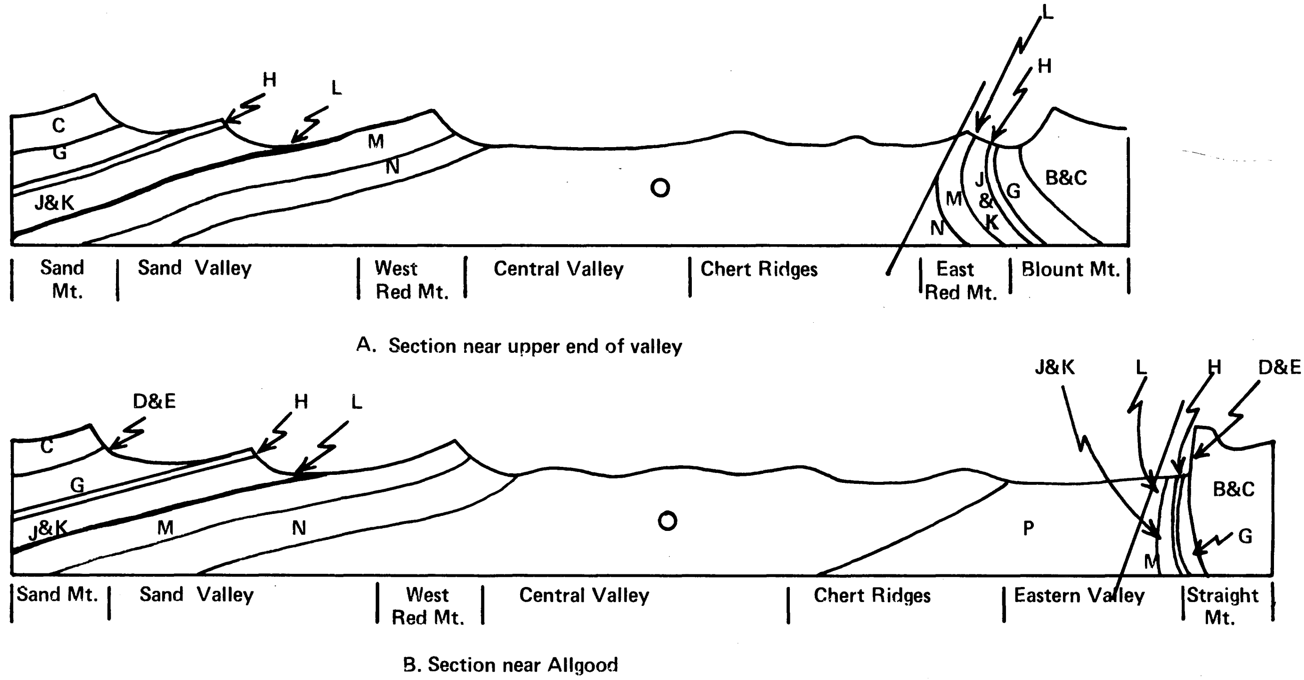


FIGURE 5. Generalized cross-section of the geological strata along two lines running at abour right angles to the strike of the strata in Murphree's Valley. The first cross-section represents the situation near the head of the Valley while the second represents the situation at about the middle of the valley. The code letters for the strata are keyed to Table 1. The drawings have not been made to scale. However, crests of the bounding ridges are about 500 feet above the plateau surfaces, as in the case of the Sequatchie Valley (Figure 4). Adapted from McCalley, 1891 and Gibson, 1893.

and channel them in a generally south to southwesterly direction toward Tuscaloosa and the Coastal Plain. A few streams on the periphery of the Region, especially in the northwest and west, are not in this system and a few from outside the Region flow into it, primarily through Rock Mountain southwest of Birmingham. A curiosity of the regional drainage is that the streams in the anticlinal valleys (Murphree's and the Sequatchie) flow out of the valleys through gaps in their boundary ridges into the streams in the synclines. This occurs because the valley floors are actually higher than the surrounding plateau surfaces, figure 12.

The gradients of the major streams are gentle and meandering has occurred where structural control is absent, figures 6 and 13. The gradients of the tributaries are also generally gentle, figure 7, but near the headwaters they are often steep, figures 2 and 10. Waterfalls occur in areas where streams flow over lips formed by resistant material, figure 11. Where the terrain is flat swampy areas may occur, figure 25C, but they are rare. The construction of the Lewis Smith dam, the navigation dams and locks along the Black Warrior River, and numerous other dams has created lakes whose shores occupy *slope* rather than bottomland positions. Consequently, the vegetative complexes along the lake shores are those usually formed on upland sites, figure 14. This must be taken into account when the key is being used.

The Pottsville Formation was referred to for many years as the "Coal Measures" because of the rich coal seams imbedded in it. The mining of this coal, using both surface, figures 8, 13, 15, and 16, and deep mining, figure 17, procedures, is a dominant activity in the Warrior Basin, especially in the southern portion in Walker, Jefferson, and Tuscaloosa counties. These mining activities, especially the surface mining, have modified the topography and soils over large areas creating conditions different from those in the undisturbed areas. In some cases mine reclamation, including grading of the surface, figure 16, and revegetation, figure 13, has been carried out while in others the mines have simply been abandoned, figure 15. In the former case the vegetative complexes on the reclaimed mines may not be typical of the area and the keys will not be applicable. Where the mine surfaces have been revegetated naturally the species complexes present are not greatly different from those occurring on undisturbed sites. The evidence of mining usually is unmistakable, figure 13, even when mantled in vegetation, and in these areas the key should be used with caution.

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

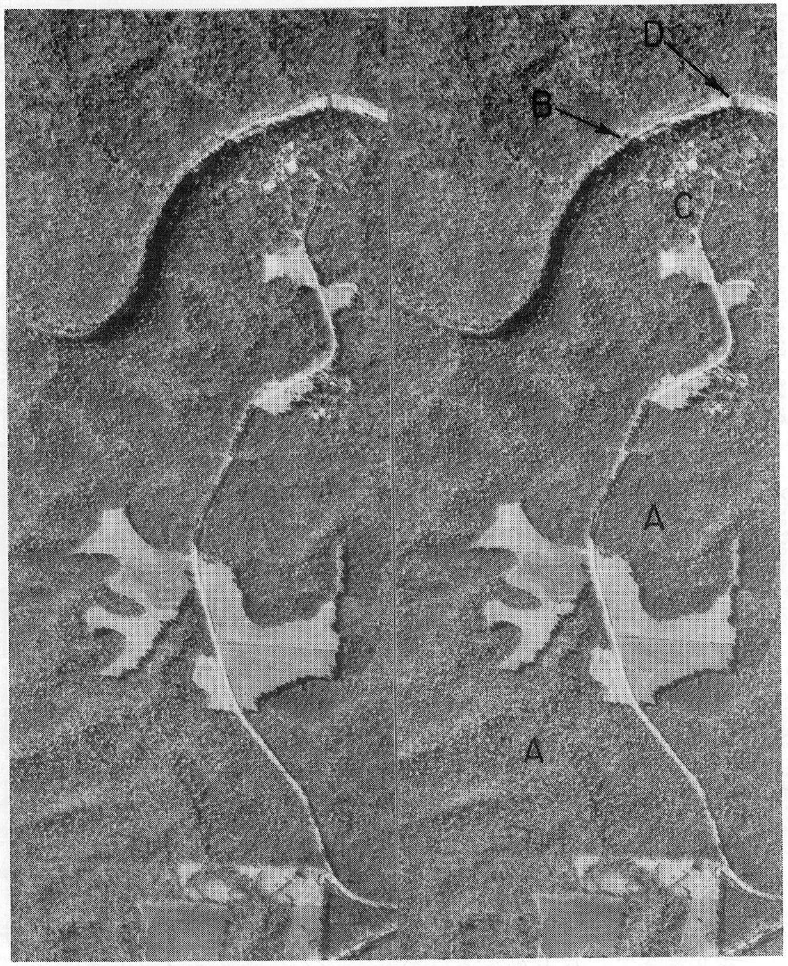


FIGURE 6. Stereogram showing a Class 1 landscape in Zone I where a relatively thick layer of strong sandstone dominates the surface. The plateau surface is relatively smooth with relatively shallow valleys (A). Where a stream has cut deeply the gorge is U-shaped in cross-section and talus is virtually non-existent (B). The major stream is Clear Creek east of Poplar Springs. The structures at the end of the road are at Camp McDowall (C). When full, Smith Lake backs up to the dam below the Camp in the gorge (D). Eastern hemlock occurs in the gorge. (Winston County, 01133 272-258,259).

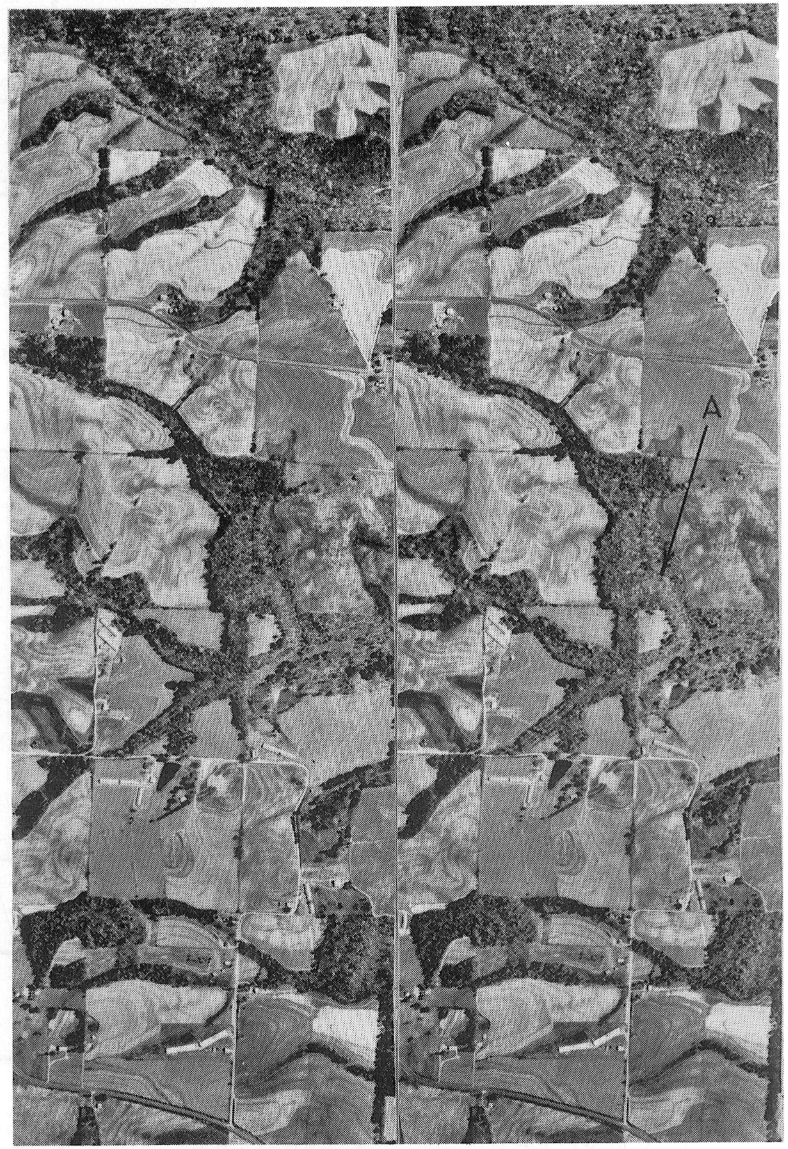


FIGURE 7. Stereogram showing a portion of Zone I with a Class 1 landscape. The surface is dominated by sandstone and is relatively smooth. The streams have cut only relatively shallow valleys into the sandstone and the valley slopes are gentle. Much of the land is in cultivation or pasture. The stand at A would be classed as a bottomland stand. (Cullman County, 01043 172-152,153).

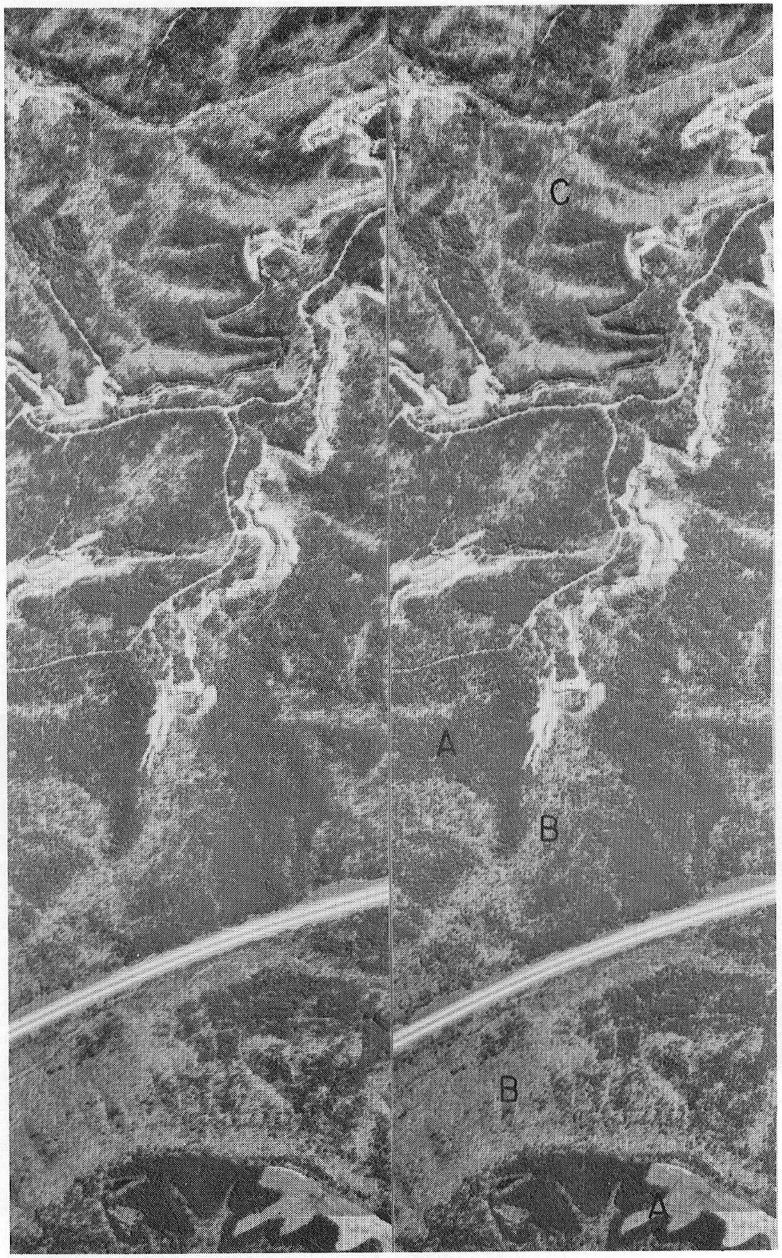


FIGURE 8. Stereogram of a portion of Zone I showing: a portion of the main sandstone plateau (A), which is a Class 1 landscape; the escarpment of the plateau (B) which is made up largely of shale; and an area of dissected shale producing a Class 3 landscape (C). Along the edge of the escarpment is a high-wall surface mine. The flat-topped hill at the bottom of the stereogram is Prospect Mountain, an outlier of the main plateau. (Cullman County, 01043 372-90,91).

FIGURE 9. Stereogram of a portion of Zone I showing an example of a Class 3 landscape where a sandstone cap is lacking and the shale is being heavily eroded. Notice the very dense dendritic stream pattern with a myriad of small streams cutting the shale into small hills with rounded tops and steep side slopes. The dominant pine in a landscape like this is Virginia pine. The texture of Virginia pine (A) is somewhat different from that of loblolly and/or shortleaf pine (B). (Walker County, 01127 572-287,288).

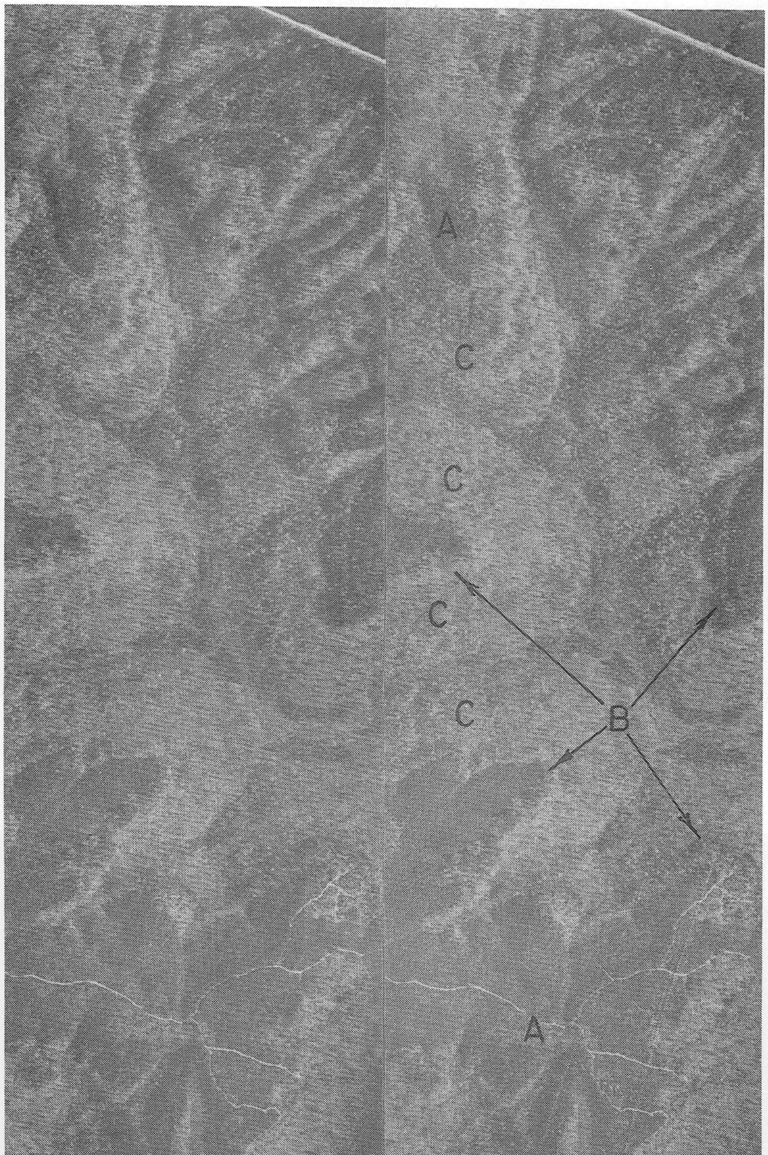


FIGURE 10. Stereogram of a portion of Zone I in the headwaters above Lewis Smith Lake. It is an example of a Class 2 landscape where a relatively thin sandstone cap is being cut apart by erosion of the shale beneath it. Note the relatively smooth plateau tops (A), the presence of rimrock in many cases (B), and the talus forming V-shaped valleys (C). Eastern redcedar is not found in these valleys because limestone is not present. Eastern hemlock, however, is present along the bottoms and lower slopes down to the head of slack water in Lewis Smith Lake. (Lawrence County, HI-3MM-30,31).

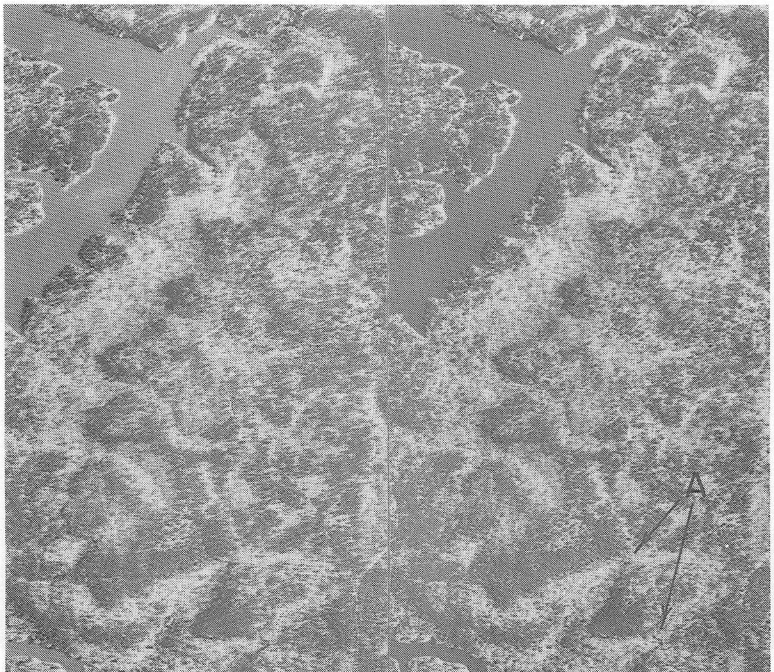


FIGURE 11. Stereogram of a portion of Zone I adjacent to Lewis Smith Lake which has a version of a Class 3 landscape. The plateau surface apparently is made up of shale which is underlain by a stratum of sandstone which, in turn, is underlain by shale. The plateau surface is dissected into a multitude of small hills with rounded crests and steep sides. The sandstone layer is being sapped from below by the erosion of the shale. As the shale wears away the sandstone is left unsupported and it breaks away forming a lip for a waterfall (as at A). The erosion of the shale below the waterfall creates a cove. The dominant pine in this area is Virginia pine. (Winston County, 01133 572-93,94).

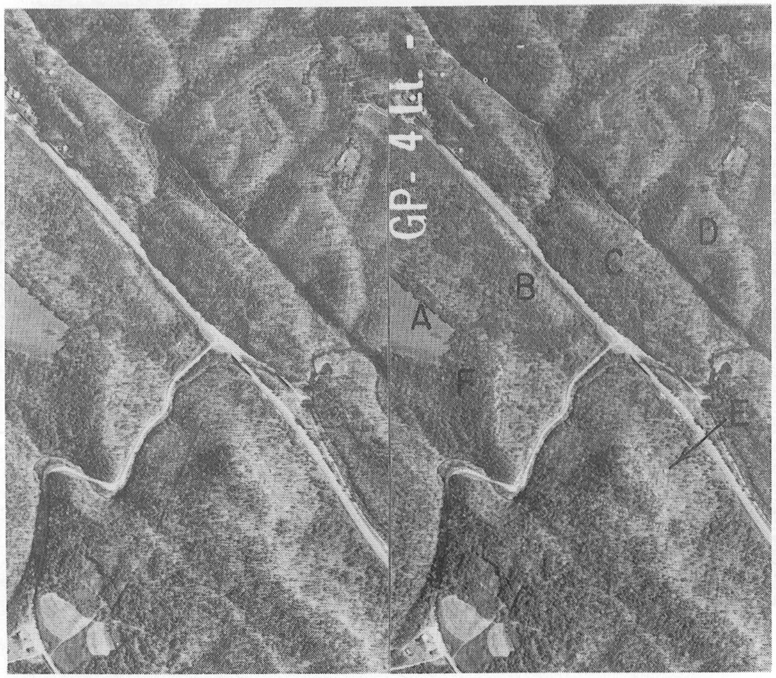


FIGURE 12. Stereogram of a water gap through the western boundary ridge of the Sequatchie (or Brown's) Valley. The valley floor is higher than the plateau surface and consequently the streams flow out, rather than into, the valley. The sequence of strata shown in Figure 4 are evident. The rimrock is Pottsville sandstone (A), the ridge face is Bangor limestone (B), the sharp ridge east of the road is Hartselle sandstone (C), and the hilly area beyond is Tuscumbia limestone and Fort Payne chert (D). Sandstone talus covers the Bangor limestone rather completely and consequently pine is present on the slope at B. The boulders associated with such colluvium are clearly visible on the slopes south of the water gap (E). Longleaf pine occurs along top and upper west-facing slopes of the western boundary ridge (F). (Blount County, GP-4LL-4,5).

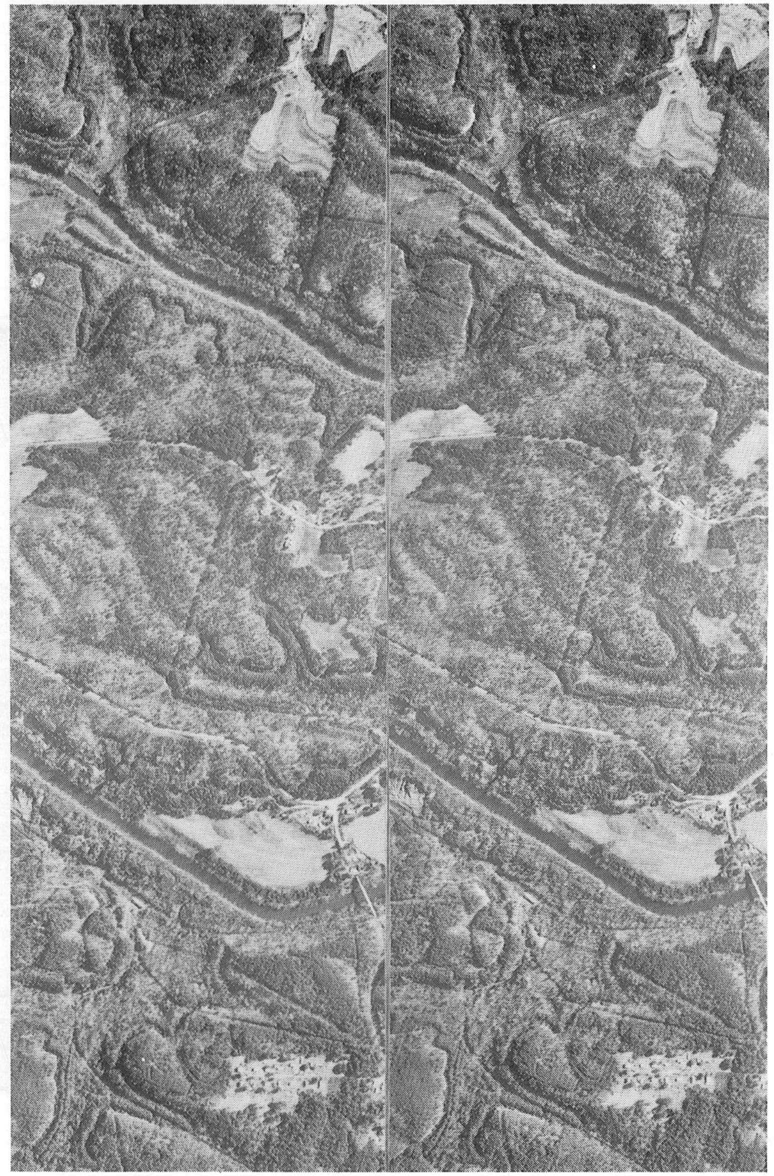


FIGURE 13. Stereogram of an area in Zone I where a great deal of high wall coal mining has been done in the past and the mines have returned to forest. The trees on the old mines appear to be in rows indicating plantations. Most such plantations have been made using loblolly pine but enough exceptions exist to make any automatic assignment of "loblolly pine" to such stands hazardous. The landscape is a mix between Classes 1 and 2. The major stream at the top of the stereogram is the Mulberry Fork and the one nearer the bottom is the Sipsey Fork of the Black Warrior River. Note that the streams have low gradients and meander. Structural control of the streams is present only in a few portions of the Region. (Walker County, 01127 372-53,54).

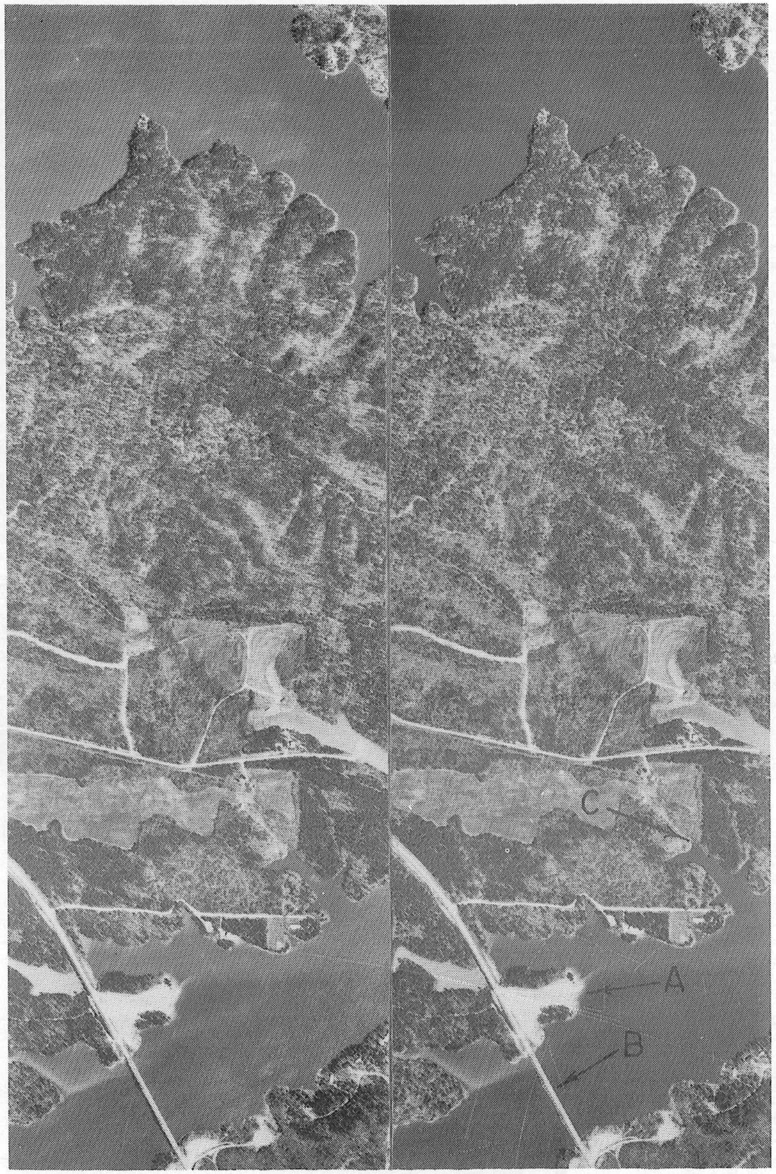


FIGURE 14. Stereogram of a portion of the Lewis Smith Lake area showing the effect of impoundments on slope position. Water depth off the end of the launching ramp at A is about 90 feet deep, while in the channel below the bridge, at B, the water is about 200 feet deep. This means that the sites along the edge of the lake are upland rather than bottomland and this should be taken into account by the interpreter. However, true wet sites occur where streams enter the impoundments, as at C, and black willow and/or hazel alder stands often occur in such situations. The stereogram also shows an area with a complex landscape combining elements of landscape Classes 2 and 3. (Walker and Winston Counties, 01133 572-194 and 01127 572-195).

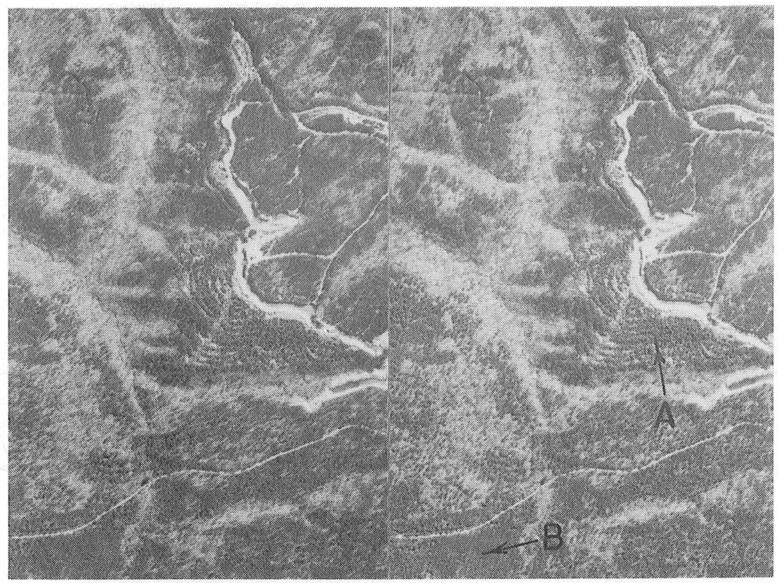


FIGURE 15. Stereogram of a portion of Zone I showing a Class 2 landscape. The surface mine appears to be inactive. The parallel ridges of spoil formed in the mining operation (A), have not been graded but they have a dense forest cover of pine. Since the mine is in a Class 2 landscape the pine might be either loblolly or Virginia pine but the texture of the stand implies loblolly pine. Virginia pine has a texture that is considerably finer, more like the stand at B. (Cullman County, 01043 372-91,92).

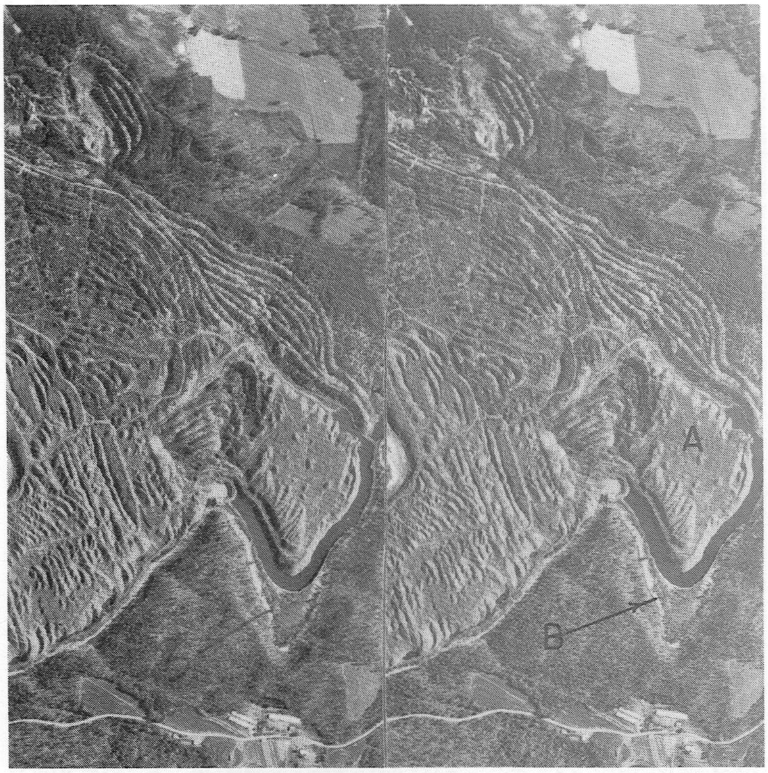
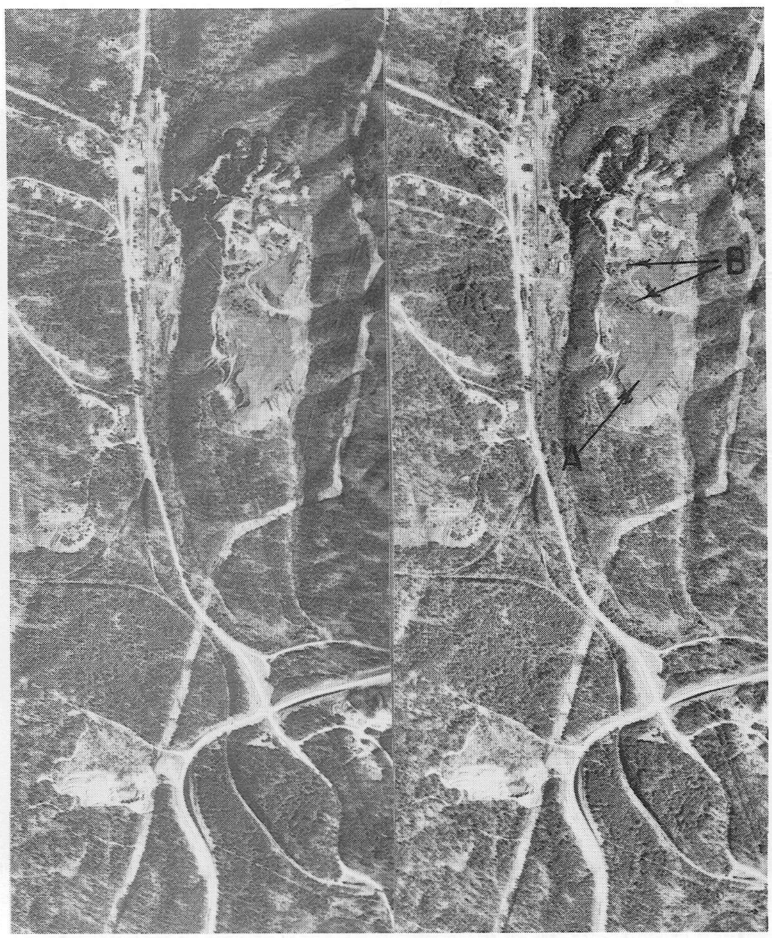


FIGURE 16. Stereogram of a large surface mine. The spoil shows some evidence of grading (A) but much of it is still in the form of parallel ridges. The natural revegetation of the mine is in progress and the various stages can be seen running from the oldest at the upper end to the raw spoil at the bottom. The landscape surrounding the mine is in Class 1 but the pines invading its surface are Virginia pines. The vegetation along the edges of the lakes or ponds, as in B, is probably hazel alder. (Blount County, GP-3LL-261, 262).

FIGURE 17. Stereogram of a deep coal mine. While deep mines like this do not extensively modify the surface of an area as do strip mines, they still produce tailings (as at A) which create some surface impact. Vegetation occurring on such tailings (as at B) may or may not be similar to the vegetation on unmined areas. This cannot be assessed from the aerial photographs. (Walker County, 01127 572-289, 290).



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 also can be assessed on aerial photographs.

In addition to the topography itself, the soil moisture regime is influenced by geologic structure. Horizontally bedded erosion resistant rocks produce landscapes that are essentially level and the soils are usually deep. When such erosion resistant rocks are in moderately to steeply tilted beds, especially when they alternate with weaker materials, the landscape will be rough, with relatively deep moist soils in the valleys and thin dry soils along the ridges. When horizontally bedded erosion resistant material overlies weaker material and breaches have been cut through the overlying material gorges usually occur, producing a very rough landscape, which is quite different from that produced by tilted strata. The soil pattern in such cases usually involves the usual deeper moister soils in the valleys and drier thinner soils on the slopes. The ridge tops, however, may have relatively deep moist soils which is not the usual situation. When weak materials are exposed to erosion by the stripping away of a protective cap the resulting landscape may be very rough with a dense network of streams. The soils in such cases would probably follow the classic pattern with deeper moister soils in the valleys and thinner drier soils on the hill tops. These different surfaces or landscapes can be assessed quite readily using aerial photographs and rough conclusions reached as to the depth and moistness of the soils. However, the photographic assessments often cannot be made with sufficient detail and then it becomes necessary to refer to maps showing the locations of the controlling geologic features.

In the Warrior Basin 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 shale or limestone. The presence of these parent materials has been shown in macro-detail on maps and forms 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.

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 Sellmann, 1974, 1975, 1977 and 1978).

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 become 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, so the contours would be crossed 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 so that they were reasonably accessible and appeared to include a wide variety of stands[4] on different sites. The transects were traversed on foot and the species composition and topographic situation were evaluated and recorded for each stand along

[4]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.

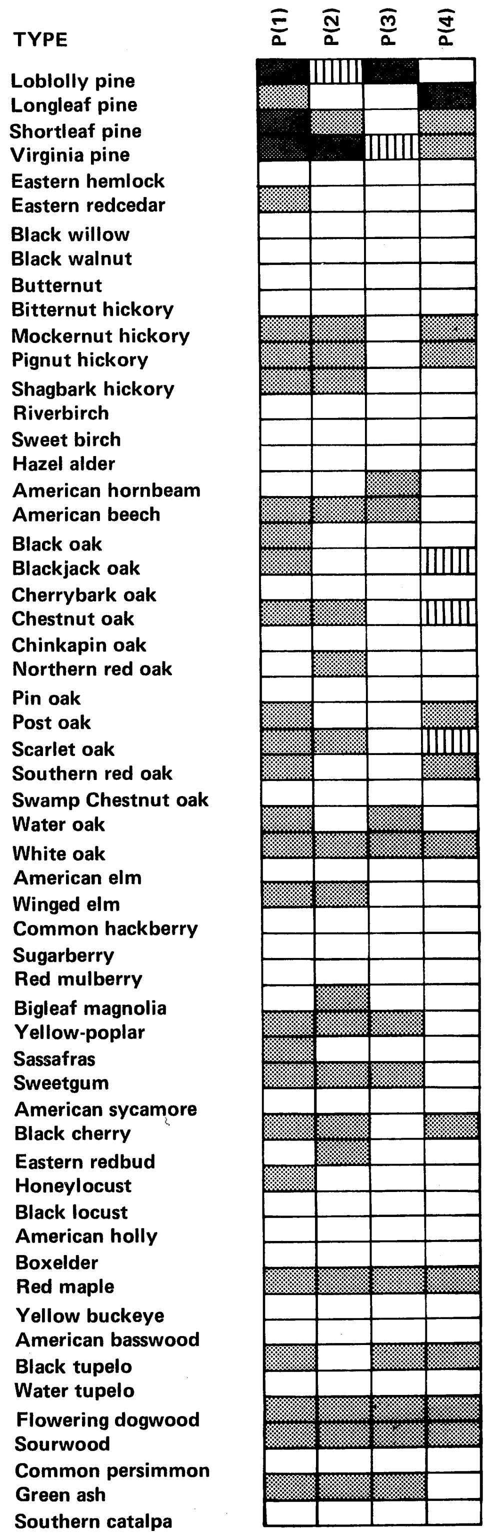


FIGURE 18. Diagram showing relative importance of species within the pine cover types.[1]

[1]Black blocks indicate the most important species, vertically cross-hatched blocks indicate common associates, and speckled blocks indicate species which occur only sporadically or which contribute little to the overstory basal area per acre.

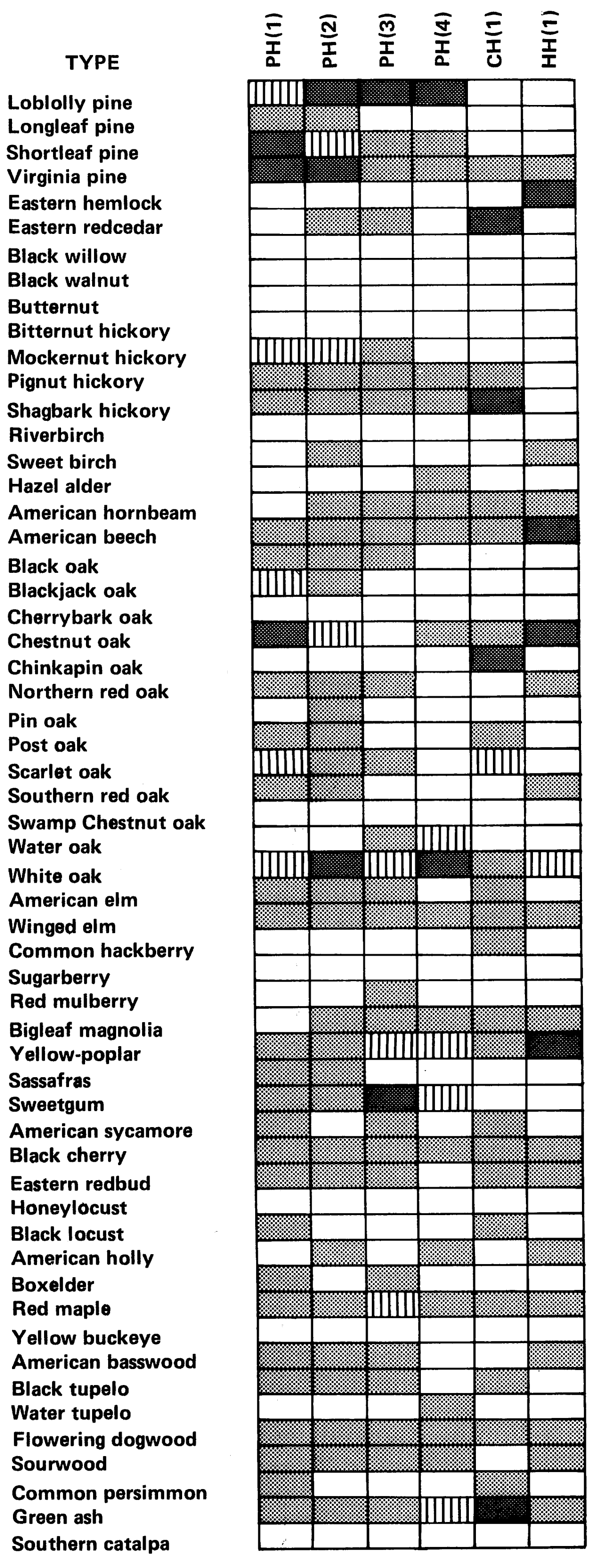


FIGURE 19. Diagram showing relative importance of species within the pine-hardwood, cedar-hardwood, and hemlock-hardwood cover types.

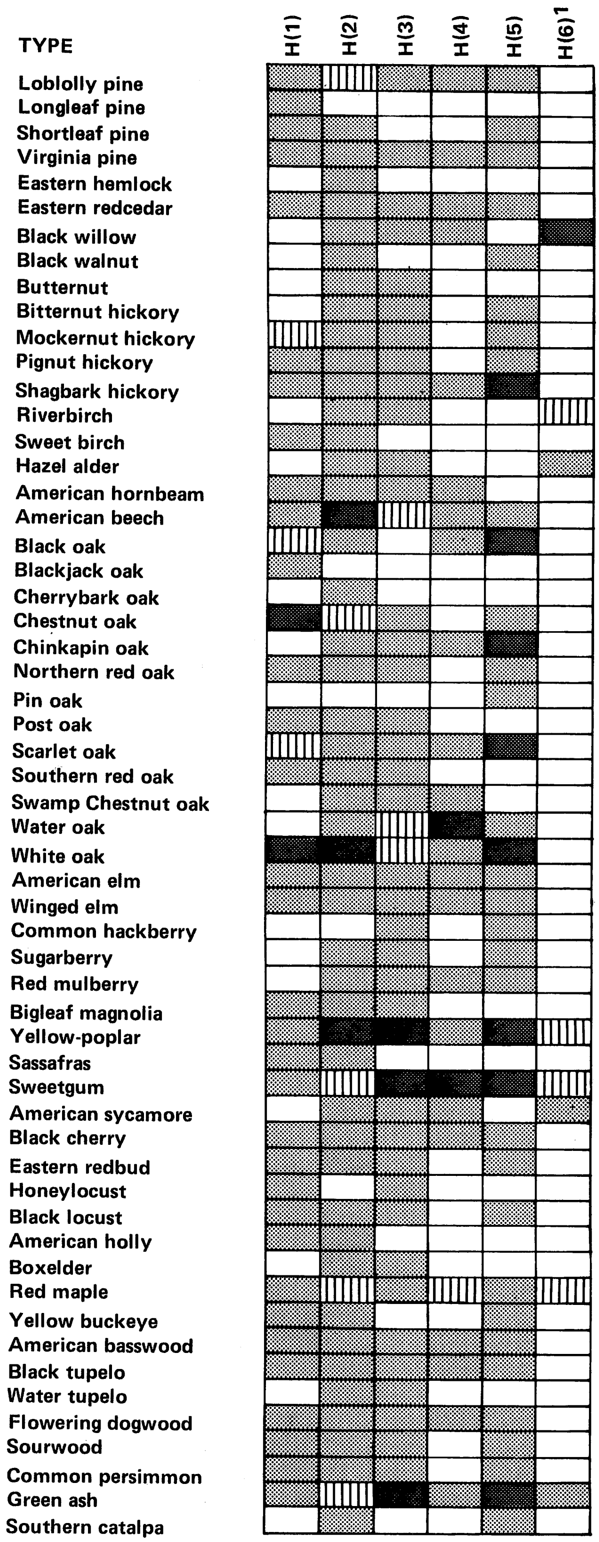


FIGURE 20. Diagram showing relative importance of species within the hardwood cover types.

[1] Hazel alder often is a very important component of this cover type but rarely contributes significantly to the basal area per acre. Consequently, it is shown as a minor species which, in reality, it is not.

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 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 18, 19, and 20, 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 Smith Lake and the Black Warrior 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 52A and the stand in question was on the lower slope facing northwest the forest cover type would be P(2) which is basically a Virginia pine type.[5]

FOREST COVER TYPES

The forest cover types recognized by the key are shown in diagram form in figures 18, 19, and 20.

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

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

TYPE	PH(1)		P(2)		P(3)		P(4)	
Sample	38		9		4		26	
	P	D	P	D	P	D	P	D
Loblolly pine	60	23	67	22	100	59		
Longleaf pine	8	2					100	71
Shortleaf pine	60	29	11	2			15	3
Virginia pine	74	35	100	58	50	18	46	1
Eastern hemlock								
Eastern redcedar	8	<1						
Black willow								
Black walnut								
Butternut								
Bitternut hickory								
Mockernut hickory	39	<1	33	5			54	1
Pignut hickory	16	<1	22	<1			4	<1
Shagbark hickory	3	<1	11	<1				
River birch								
Sweet birch								
Hazel alder								
American hornbeam					50	<1		
American beech	3	<1	22	<1	100	7		
Black oak	24	1						
Blackjack oak	21	<1					65	7
Cherrybark oak								
Chestnut oak	50	3	22	<1			61	8
Chinkapin oak								
Northern red oak			11	<1				
Pin oak								
Post oak	29	<1					11	<1
Scarlet oak	29	3	11	2			54	5
Southern red oak	21	1					27	4
Swamp chestnut oak								
Water oak	3	<1						
White oak	29	1	56	5	50	5	50	<1
American elm								
Winged elm	5	<1	11	<1				
Common hackberry								
Sugarberry								
Red mulberry								
Bigleaf magnolia			22	<1				
Yellow-poplar	3	<1	22	3	25	3		
Sassafras	5	<1						
Sweetgum	5	<1	78	<1	100	5		
American sycamore								
Black cherry	24	<1	56	<1			8	<1
Eastern redbud			22	<1				
Honeylocust	5	<1						
Black locust								
American holly								
Boxelder								
Red maple	42	<1	33	<1	75	<1	50	<1
Yellow buckeye								
American basswood								
Black tupelo	18	<1			25	3	65	<1
Water tupelo								
Flowering dogwood	42	<1	56	<1	25	<1	61	<1
Sourwood	47	<1	11	<1	25	<1	69	<1
Common persimmon								
Green ash	13	<1	44	3	100	<1		
Southern catalpa								

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

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

TYPE	PH(1)		PH(2)		PH(3)		PH(4)		CH(1)		HH(1)	
Sample	88		81		23		7		31		7	
	P	D	P	D	P	D	P	D	P	D	P	D
Loblolly pine	34	9	65	21	100	42	100	43				
Longleaf pine	11	3	9	<1								
Shortleaf pine	68	21	33	10	9	1	29	3				
Virginia pine	57	14	63	17	9	2	29	2	6	<1	14	3
Eastern hemlock											100	53
Eastern redcedar	6	<1	4	<1	4	<1			97	40		
Black willow												
Black walnut												
Butternut												
Bitternut hickory												
Mockernut hickory	55	5	51	5	4	<1						
Pignut hickory	15	<1	36	1	4	<1	29	5	6	<1		
Shagbark hickory	1	<1	9	1	22	3	29	<1	74	12		
River birch												
Sweet birch			2	<1							29	<1
Hazel alder							14	<1				
American hornbeam			4	<1	43	<1	57	<1	3	<1	14	<1
American beech	3	<1	12	<1	26	3	14	2	3	<1	57	11
Black oak	34	2	27	2	4	<1						
Blackjack oak	33	5	9	2								
Cherrybark oak												
Chestnut oak	60	13	49	10			14	<1	6	<1	43	11
Chinkapin oak									87	17		
Northern red oak	2	<1	6	1	17	<1					14	<1
Pin oak			1	<1								
Post oak	35	2	22	2					3	<1		
Scarlet oak	42	8	28	4	17	3			61	9		
Southern red oak	24	5	15	2							14	<1
Swamp chestnut oak												
Water oak					13	3	71	11				
White oak	31	5	73	14	43	5	57	12	16	<1	43	6
American elm	1	<1	5	<1	13	1			3	<1		
Winged elm	3	<1	15	<1	26	<1	43	3	29	<1	14	<1
Common hackberry									3	<1		
Sugarberry												
Red mulberry					9	<1						
Bigleaf magnolia	2	<1	16	<1	4	<1	14	<1	10	<1	57	<1
Yellow-poplar	13	3	19	2	52	9	86	7	19	<1	57	12
Sassafras	13	<1	4	<1								
Sweetgum	7	<1	19	1	87	18	86	7				
American sycamore	1	<1			9	<1			10	1		
Black cherry	26	<1	22	<1	61	<1	14	<1	23	<1	14	2
Eastern redbud	1	<1	6	<1	3	<1			35	<1	14	<1
Honeylocust												
Black locust	1	<1							16	<1		
American holly			4	<1			14	<1			14	<1
Boxelder	1	<1			4	<1						
Red maple	41	<1	63	<1	70	4	100	<1	19	<1	86	<1
Yellow buckeye												
American basswood	2	<1	1	<1	17	<1					14	2
Black tupelo	28	<1	26	<1	13	<1			3	<1		
Water tupelo							29	<1				
Flowering dogwood	28	<1	42	<1	34	<1	43	1	13	<1		
Sourwood	38	<1	35	<1	17	<1	29	<1			14	<1
Common persimmon	1	<1							13	<1		
Green ash	6	<1	12	<1	48	1	29	5	97	15	14	<1
Southern catalpa												

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

TYPE	H(1)		H(2)		H(3)		H(4)		H(5)	
Sample	215		167		78		16		37	
	P	D	P	D	P	D	P	D	P	D
Loblolly pine	30	3	26	5	19	3	31	3	16	2
Longleaf pine	1	<1								
Shortleaf pine	30	4	4	<1					5	<1
Virginia pine	37	3	14	1	6	1	6	<1	11	<1
Eastern hemlock			5	<1						
Eastern redcedar	9	<1	2	<1	4	<1	6	<1	16	2
Black willow			2	<1	8	<1	6	<1		
Black walnut			4	<1					3	<1
Butternut			2	<1	5	<1				
Bitternut hickory			<1	<1	3	<1			3	<1
Mockernut hickory	53	8	12	1	3	<1			11	2
Pignut hickory	29	4	25	3	9	1			24	3
Shagbark hickory	12	2	19	3	10	1	6	<1	62	12
River birch			2	<1	26	4				
Sweet birch	2	<1	4	<1						
Hazel alder			3	<1	13	<1				
American hornbeam	1	<1	14	<1	63	<1	25	<1		
American beech	14	1	51	12	47	5	13	<1	21	3
Black oak	35	5	10	1			13	2	16	6
Blackjack oak	10	3								
Cherrybark oak			<1	<1						
Chestnut oak	73	25	27	7	5	<1			19	2
Chinkapin oak			2	<1	1	<1	31	3	29	6
Northern red oak	11	32	18	4	5	<1			24	4
Pin oak									5	<1
Post oak	20	3	3	<1	1	<0				
Scarlet oak	41	5	13	2	10	1	6	<1	30	7
Southern red oak	11	3	4	<1	1	<1				
Swamp chestnut oak			1	<1	1	<1	6	<1		
Water oak			11	2	37	8	94	35	3	<1
White oak	57	14	72	16	36	7	19	2	54	12
American elm	2	<1	6	<1	28	4	6	<1	13	1
Winged elm	9	<1	28	<1	8	<1	13	<1	27	<1
Common hackberry					9	32			5	1
Sugarberry			2	<1	5	<1			5	<1
Red mulberry			3	<1	1	<1	23	<1	8	<1
Bigleaf magnolia	15	<1	29	<1	6	<1				
Yellow-poplar	26	4	71	14	62	16	19	2	38	9
Sassafras	11	<1	<1	<1					3	<1
Sweetgum	10	1	46	8	60	15	94	41	38	12
American sycamore			5	<1	35	3	6	<1		
Black cherry	33	<1	37	1	14	<1	6	<1	27	2
Eastern redbud	6	<1	16	<1	10	<1			3	<1
Honeylocust	1	<1			3	<1				
Black locust	1	<1	1	<1	5	<1			8	<1
American holly	1	<1	2	<1	3	<1				
Boxelder			4	<1	9	<1				
Red maple	51	<1	84	5	59	4	56	7	35	<1
Yellow buckeye	3	<1	8	<1					3	<1
American basswood	3	<1	16	2	10	<1	19	<1	19	2
Black tupelo	36	2	20	2	9	<1	19	3	3	<1
Water tupelo			1	<1	19	3				
Flowering dogwood	54	<1	46	<1	20	<1	13	<1	49	<1
Sourwood	37	<1	25	<1	4	<1			8	<1
Common persimmon	1	<1	3	<1	1	<1				
Green ash	17	1	37	4	63	12	44	<1	70	6
Southern catalpa			1	<1					3	<1

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 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 and to bolster the prism data when the latter were scarce.

The scarcity or absence of prism data for some cover types was caused primarily by the very high degree of purity of the species mix, as in pine plantations and many natural pine stands. In the case of the black willow type (H(6)) the stands usually were too dense to use a prism and the species composition was assessed subjectively.

The diagrams in figures 18, 19, and 20 are pictorial representations of the final cover types. The black blocks represent species that usually are dominant, the vertically cross-hatched blocks represent species that are common associates, and the stippled 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 drier sites on the left and the cover types associated with the moister sites on the right. This provides a visualization of the shifts in species importance as the nature 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 16 cover types have been defined: four pine, four pine-hardwood, one cedar-hardwood, six hardwood, and one hemlock-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 18, 19, and 20 which show the relative importance of the species within the types. For example, in figure 19 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(1) shortleaf pine, blackjack oak, chestnut oak, and scarlet oak are apt to be more important than in PH(2) and in PH(2) loblolly pine and 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, eastern hemlock is found on the floors and lower slopes of the gorges of the streams flowing into Smith Lake. The creation of the lake apparently destroyed much of this forest cover type. The second unusual situation involves eastern white pine which has been found on the Bankhead National Forest. White pine occurred naturally in the area but the stands currently present are all plantations. Natural regeneration is present, however, and white pine may continue to be a minor component of the pine stands in the National Forest.

DESCRIPTIONS OF THE VARIABLES

Zones

In the Forest Habitat Regions previously studied (Johnson and Sellman, 1974, 1975, 1977, and 1978) it was found that definite species association-bedrock geology relationships existed. In order to incorporate these relationships into the keys the Regions were subdivided into zones based on the geology and the patterns of occurrence of the species associations. Relationships of this type were also found to exist in the Warrior Basin Region. Consequently, the Region was divided into two zones. The locations of these zones are shown on the county maps in Appendix III.

Broadly speaking, only two geologic conditions exist in the Warrior Basin Forest Habitat Region: (1) the synclinal plateau dominated by the sandstones and shales of the Pottsville Formation and (2) the anticlinal valleys formed when the sandstones of the Pottsville Formation were arched upward until they broke permitting the exposure and differential erosion of the steeply dipping underlying strata of shale, limestone, sandstone, and dolomites. Differences exist in the forest cover in the two areas and consequently they were designated zones. Zone I includes the synclinal plateau areas and Zone II the anticlinal valleys.

There was considerable temptation to divide Zone I into several zones because of topographic differences which were evident on the aerial photographs, topographic maps, and satellite imagery used in the preparation of this report. These differences, however, appear to have very little effect on the forest cover types and, consequently, no further subdivision was made. The key is constructed, however, so as to recognize that, while Virginia pine is found almost everywhere in the Zone, it tends to be the dominant pine on soils derived from shale. Furthermore, it recognizes that loblolly pine challenges Virginia pine for dominance on soils derived from sandstone. This differentiation is accomplished by recognizing the sandstone and shale nature of the geologic material at or just below the surface stratum. These landscapes were discussed earlier in the section of the report in which the Region was described. Three such landscapes are recognized in the key: Class 1, sandstone dominated plateau surface, figures 6, 7, and 8A; Class 2, sandstone capped shale with gorges, figures 2, 10, and 15; and Class 3, shale dominated densely dissected areas, figures 8C, 9, and 11.

The surface of Class 1 landscapes is relatively level and much of the land is under cultivation. The drainage is dendritic but not very dense. Stream cutting has not progressed very far and gorge or canyon-like valleys are relatively rare. If gorges are present, as in figure 6, the gorge cross-section is essentially U-shaped and talus is not present along the canyon walls. This landscape is characteristic of the northeastern and eastern portions of the Zone including a belt across the middle of Cullman County, from Jones Chapel to the Sequatchie (Brown) Valley, the Sand Mountain area south to about U.S. Highway 231 west of Oneonta, and much of Blount Mountain.

The Class 2 landscape is rough. Profiles of transects across such a landscape would be angular showing deep gorges cut into a relatively flat peneplain. The gorges may or may not have cliffs or rimrock along their edges but talus is present, figures 2 and 10, making the gorges essentially V-shaped. The streams have few abrupt gradient changes but in some cases, apparently where the sandstone cap is relatively thin and the shale below is relatively soft, sapping of the sandstone cap can form cup-shaped coves with waterfalls of considerable height as occurs in the Bee Branch Scenic Area. This landscape occurs primarily in the drainage basin of the Lewis Smith Lake but, since it often is a precursor of the third landscape, it may be found elsewhere.

The Class 3 landscape, like the second, is rough, but the profile of a transect across it would be quite different from the one from the second landscape. Instead of angularity the profile would show rounded hills with steep sided valleys. Cliffs and talus slopes would be most unusual. The drainage pattern in this landscape is dendritic and very dense, figure 9. It is found primarily in the southern portion of the Zone below a line from about Birmingham to Carbon Hill in western Walker County but does occur elsewhere. In some cases coves and waterfalls can be found in a primarily shale area when a thin sandstone layer occurs between layers of shale, as is shown in figure 11. This situation is most likely to occur just to the south of the areas where Class 2 landscapes are common.

Between and interspersed among the broad areas mentioned above are areas where no one of the landscapes is dominant, figures 13 and 14. Consequently, one cannot simply draw lines on a map of the Zone and say that a specific condition exists inside those lines. It is necessary to determine the situation at the stand being evaluated and to use that information with the key.

In the portions of Zone I adjacent to the Coastal Plain interface, a number of hills are capped by Coastal Plain deposits of sand and gravel. The bulk of these are shown on the county maps in Appendix III. However, the scale of these maps is quite small and this has resulted in some loss of information regarding these patches. For more precise and detailed information on these deposits the user of the key is referred to the geologic maps produced by the Geological Survey of Alabama. At the time of writing, such maps were available for all the counties involved except Fayette (see "Additional References"). Information about these Coastal Plain deposits is of value because longleaf pine is found on them and is rare over most of the remainder of the Zone.

The cross-sectional structure of the Sequatchie Valley is shown in figure 4 and that of the Murphree Valley in figure 5. The stereograms in figures 21-26 provide additional information concerning the structure of the two zones. For the purpose of forest cover assessment it is necessary to separate the sandstone, limestone, and chert areas. Fortunately, the positions of these strata can be predicted with considerable precision and the process for doing this has been imbedded in the key.

On the county maps in Appendix III the Regional 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 Warrior Basin Region, however, these transition zones are very narrow and conditions change abruptly. Consequently, errors in forest cover evaluations caused by transition zones should be minimal.

Topographic Positions On Hills

Hills in the Region have been divided into two categories: round-topped (the usual case) and flat-topped plateau remnants. On the round-topped hills the upland sites have been divided into four classes: *crest, upper slope, middle slope,* and *lower slope;* as shown in figure 27. The lower bound of the upland zone is the base level, which is the upper edge of the overflow area, if one exists, or the bank of the stream if no overflow area is present. The crest extends across the top of the hill and down to a point where the main downward slope of the hill begins.[6] The length of the slope between the base level and the lower edge of the crest is divided equally into the three slope classes, which are self-explanatory. On flat-topped hills, which usually have rimrock present, the above classification has been somewhat modified so as to recognize the presence of the rimrock, figure 28.

An interpreter should mentally transfer these diagrams to the stereogram with which he is working 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.

Aspect

The key recognizes that 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

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

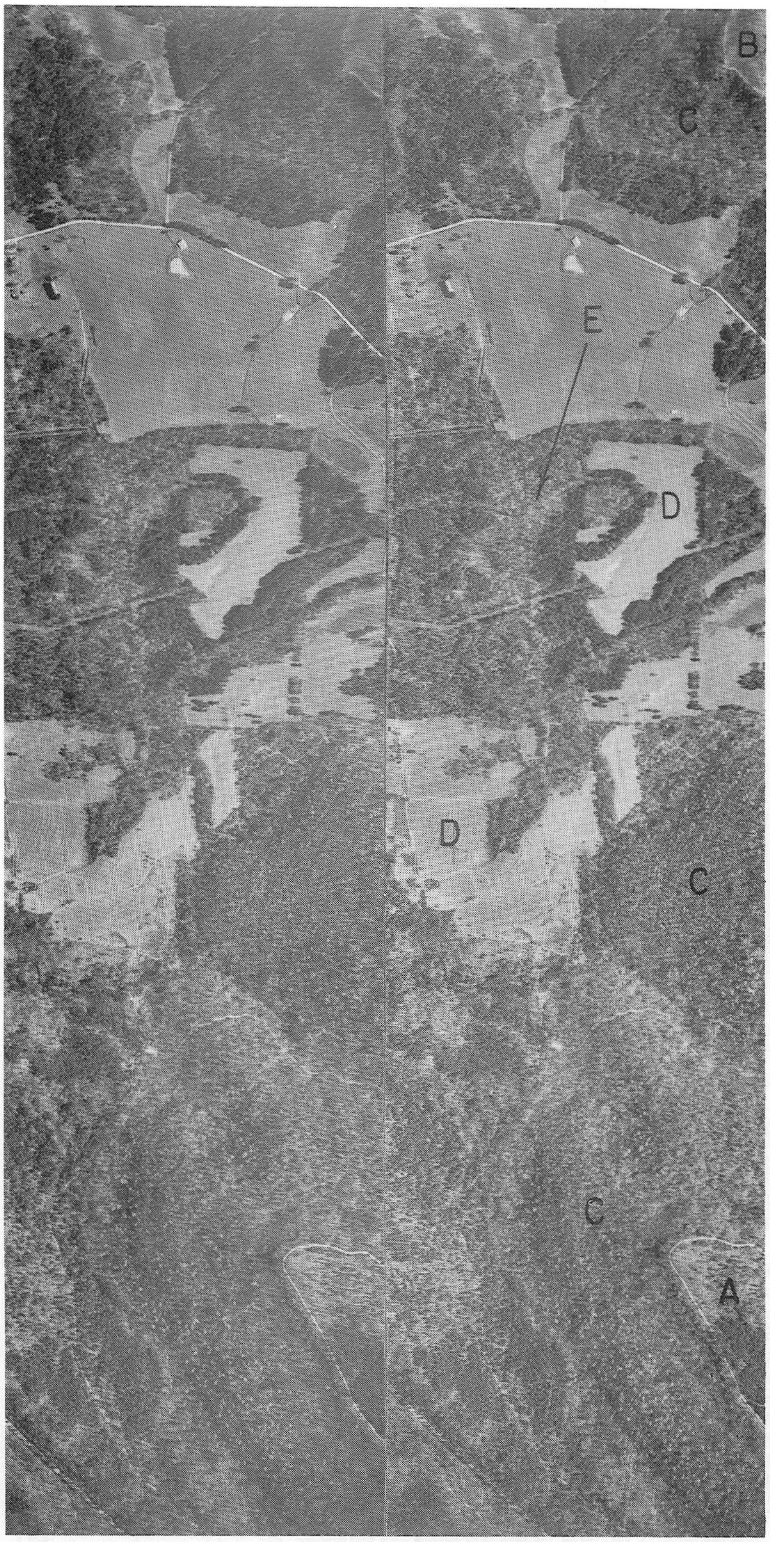


FIGURE 21. Stereogram of a portion of the Sequatchie (or Brown's) Valley showing the geologic structure. The original sandstone caprock of the Pottsville Formation occurs on a plateau remnant (Bryant Mountain) at A and the eastern escarpment at B. The escarpment walls are Bangor limestone (C). The flat valley floor is Hartselle sandstone (D). The hardwood stand at E is associated with the drainage system and is to be considered a bottomland stand. (Blount County, GP-4LL-5,6).

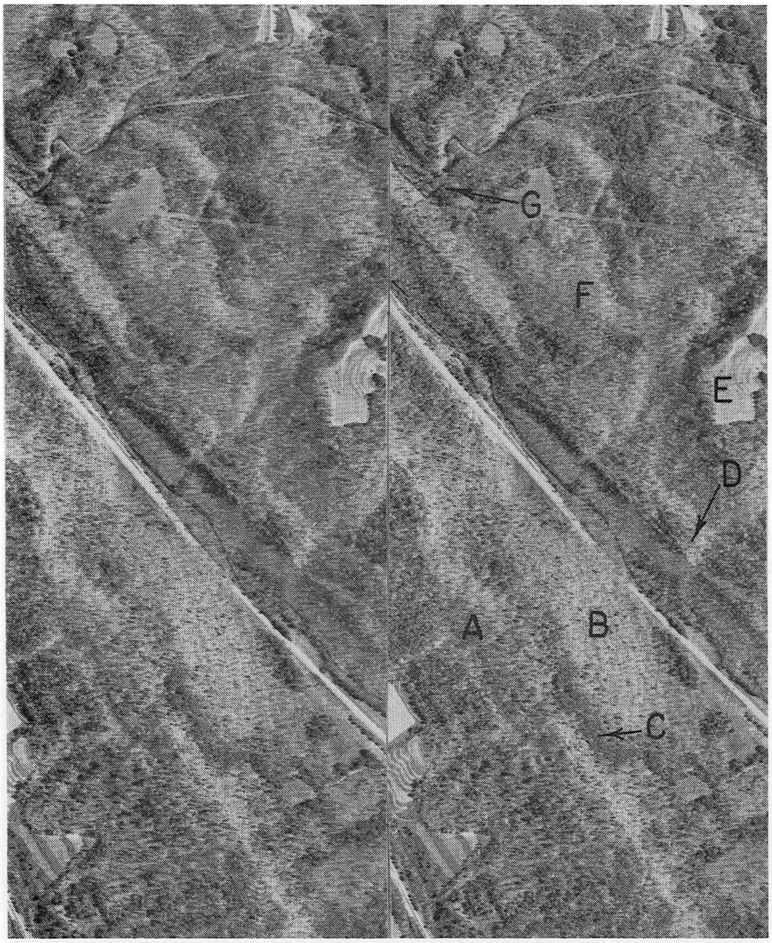


FIGURE 22. Stereogram of a portion of the Sequatchie (or Brown's) Valley showing the sequence of geologic strata. The western boundary ridge is Pottsville sandstone (A). The east facing slope of the ridge is Bangor limestone (B). Sandstone talus extends down-slope varying distances. (Pine occurs where sandstone talus is present as at (C)). The contour-line-like striations at B are good evidence for the presence of limestone, as is the absence of pines. The dark crowns on the limestone are eastern redcedars. The Hartselle sandstone can be seen as an almost vertical dike-like structure at D. It also forms the nearly horizontal field at E. The jumbled hills east of the Hartselle sandstone ridge are Tuscumbia limestone and Fort Payne chert (F). The stream at G is approximately 15 feet wide, the critical stream width in the Warrior Basin Forest Habitat Region. (Blount County, GP-4LL-4,5).

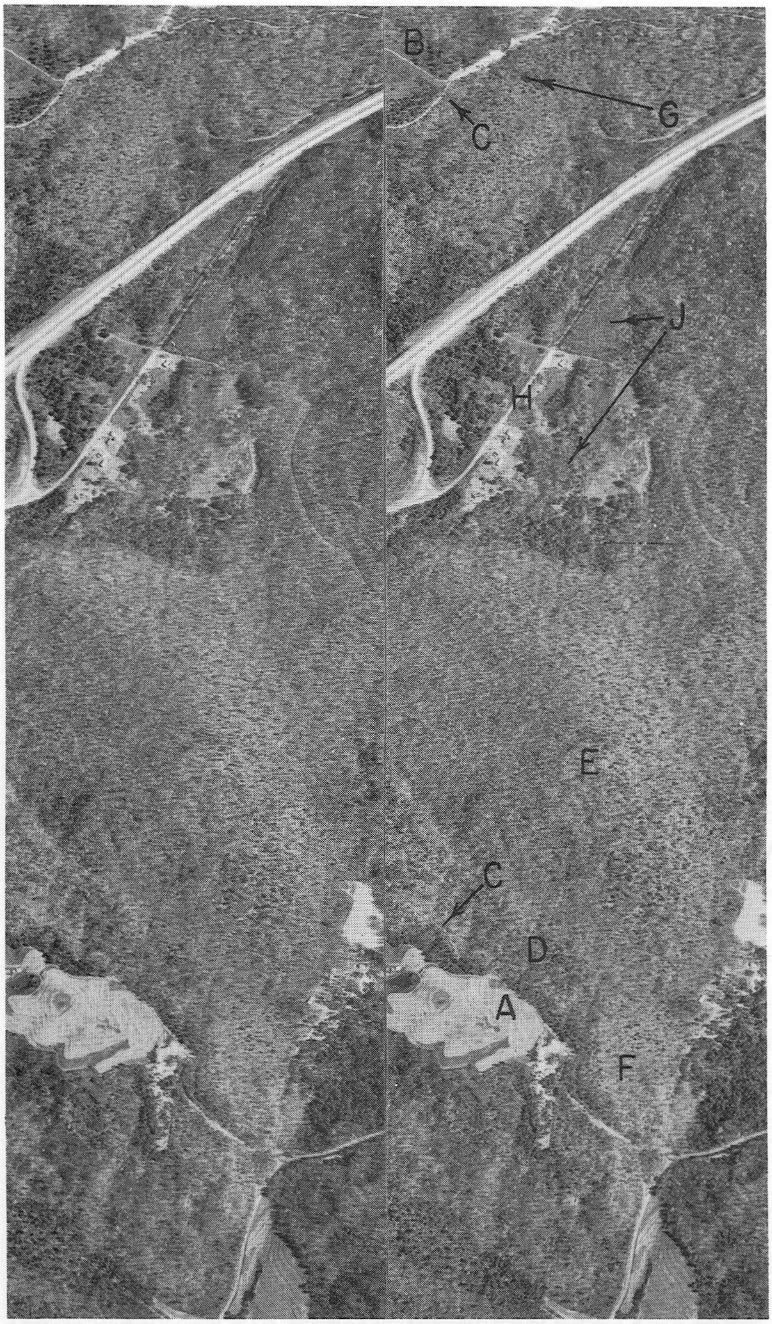


FIGURE 23. Stereogram of a portion of the Sequatchie (or Brown's) Valley near its southern terminus. The western boundary ridge is at A and the eastern at B. Sandstone rimrock can be seen at C. The faces of the ridges facing the valley are largely limestone. At D, however, the limestone has been covered by sandstone talus. As a result pine occurs almost to the foot of the slope. The light-toned hill in the center of the stereogram (E) is a remnant of the plateau from which all the sandstone material has been stripped. The rounded, rather than angular, configuration is typical of hills lacking an erosion-resistant cap. The dark toned crowns on it and the slopes at F and G are eastern redcedars. The flat valley floor (H) is on the Hartselle sandstone. The stand at I is on the flat valley floor but is not to be confused with bottomland stands. "Bottomland" stands are associated with streams such as those at J. (Blount County, GP-4LL-18,19).

FIGURE 24. Stereogram of a portion of the western part of Murphree's Valley showing the sequence of geologic strata. Sand Mountain, the western boundary of the Valley, is capped with Pottsville sandstone (A). A very abrupt cliff of this material can be seen in the extreme lower right corner of the stereogram. The face of the escarpment is Bangor limestone (B) but it may be more or less covered by sandstone talus, as it is here. Pine is present over most of the face but so is eastern redcedar indicating a patchy distribution of the sandstone material. The minor ridge below the escarpment is Hartselle sandstone (C) and sands from this formation floor the valley. Hence the name "Sand Valley". These sands cover the outcrop of Fort Payne chert between the Hartselle sandstone ridge and the next major ridge, which is West Red Mountain (D) which is largely sandstone. Beyond West Red Mountain are the cherts and dolomites of the Central Valley derived from the Chepultepec and Cooper Ridge dolomites (E). (Blount County, GP-2LL-46,47).

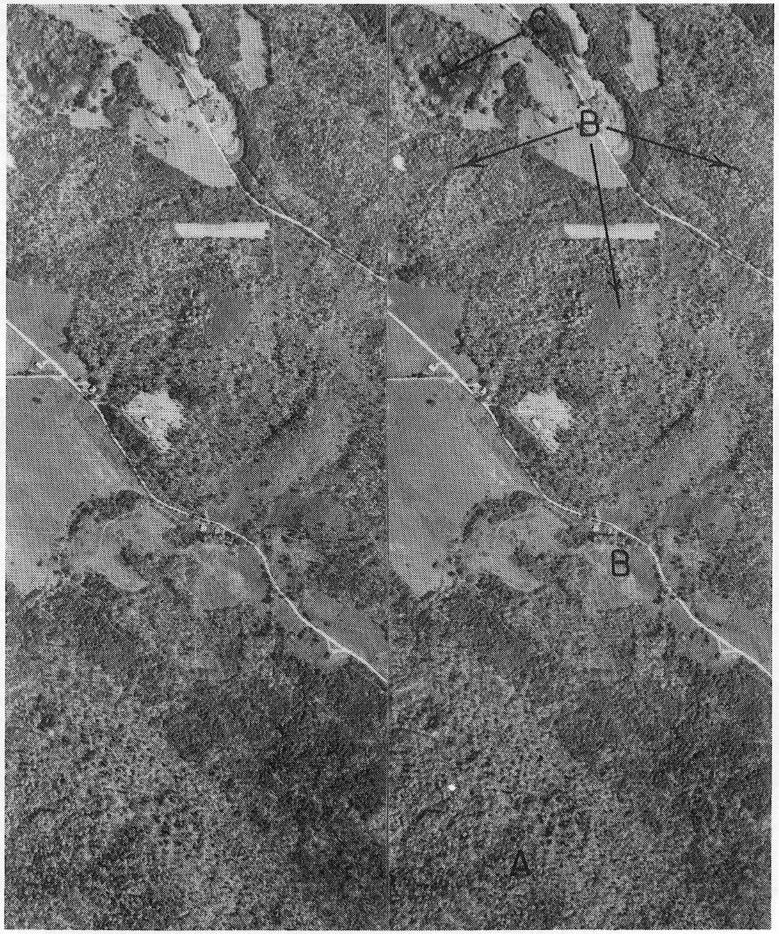


FIGURE 25. Stereogram of a portion of Murphree's Valley showing West Red Mountain (A) and some of the Central Valley and chert ridges made up of the Chepultepec and Cooper Ridge dolomites (B). Compare the rounded nature of the chert hills with the angular configuration of the sandstone ridge. A swampy area is shown at C. (Blount County, GP-2LL-26,27).

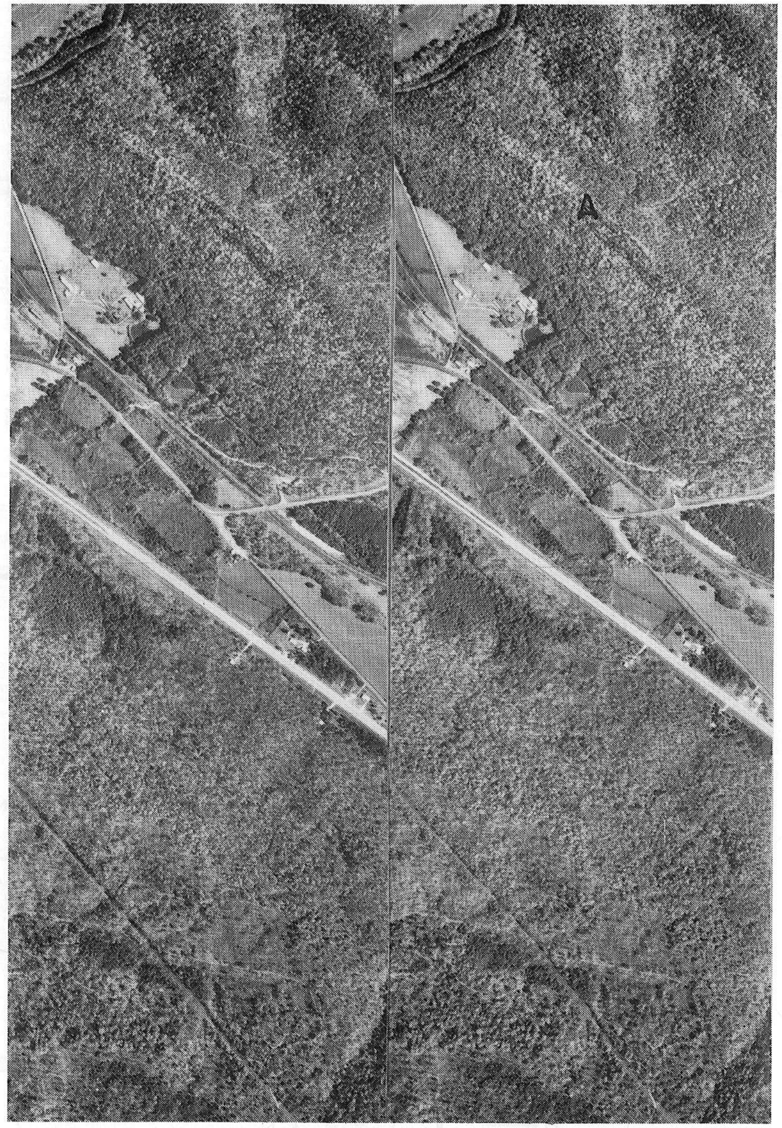


FIGURE 26. Stereogram of a portion of the eastern side of Murphree's Valley showing a portion of Straight Mountain (A), a strongly upturned portion of the Pottsville Formation sandstones. Inland Lake, on the top of Blount Mountain, lies just off the stereogram to the East. (Blount County, GP-2LL-43,44).

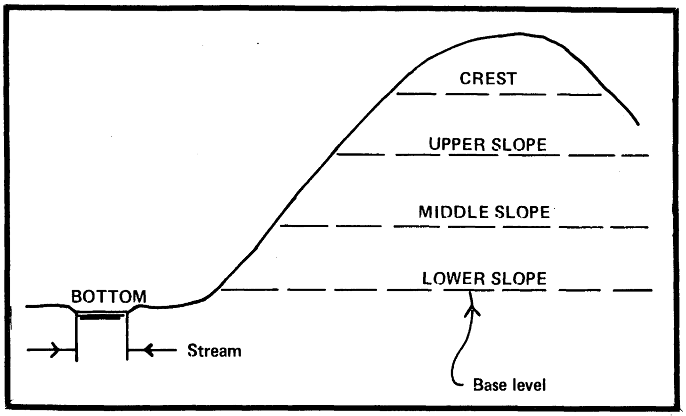


FIGURE 27. Idealized cross-section of a round-topped hill and valley showing the topographic positions and the base level. This diagram applies to all round-topped hills, regardless of size, type of landscape, or position within the landscape.

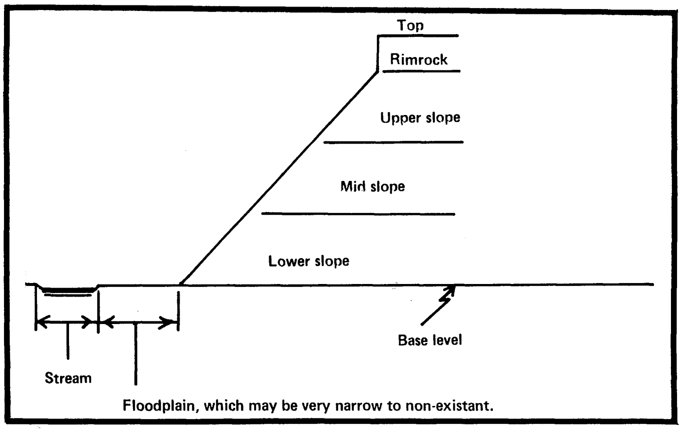


FIGURE 28. Idealized cross-section of a flat-topped plateau remnant with exposed rimrock and talus showing the topographic positions and the base level. This diagram also applies to gorges in a Class 2 landscape.

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 52-56.

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 photographs. Such areas have been classed as "flat" and recognized as such in the key.

Bottomland Sites

The sites adjacent to streams and subject to overflow from time to time, i.e., those sites below the base level previously described, figures 27 and 28, have been divided into four categories:

(1) those occurring on flat valley bottoms but not immediately adjacent to a stream, figure 23I.

(2) those adjacent to or straddling streams that are 15 feet or less in width, figure 7A, 21E, and 23J. This includes all parts of the stream from the headwaters down to the point where the stream attains a width of 15 feet, regardless of Zone and the types of material from which the soils were derived. It must be realized that the magnitude "15 feet" is an arbitrary value and that the species differences indicated by the key as taking place at such a stream width actually may take place when the stream is narrower or wider than 15 feet. However, on the average, 15 feet appears to provide a good working value.

(3) those adjacent to or straddling streams that exceed 15 feet in width (see the large streams in figures 6 and 13).

(4) those along the edges of artificial impoundments, figure 14. A number of the streams have been dammed forming lakes or ponds. Most of these are small farm ponds but a few are of significant size. The largest is that behind Lewis Smith Dam, which is used for the production of electrical power. The Black Warrior River has been dammed at a number of places in order to ensure sufficient depth for barge traffic to and from Port Birmingham. Where streams enter such lakes and ponds and where the water is shallow and the bottom is alternately exposed and covered as the water-level in the impoundment fluctuates, stands of black willow and/or hazel alder often occur, figure 14C. In most cases these are the only true wet-site conditions associated with the impoundments. The forest cover along the margins of the lakes is more nearly like that associated with the upland slope positions that the stands would have occupied if there was no lake, than it is like the cover found in normal drainage conditions. Consequently, the impoundment edges cannot be classed with the drainage and the upland slope positions for the stands being interpreted 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 69 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 this 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 (compare figure 10, taken in November, with figure 11, taken in March), 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, figures 2 and 29. When the lightest tones are nearly pure

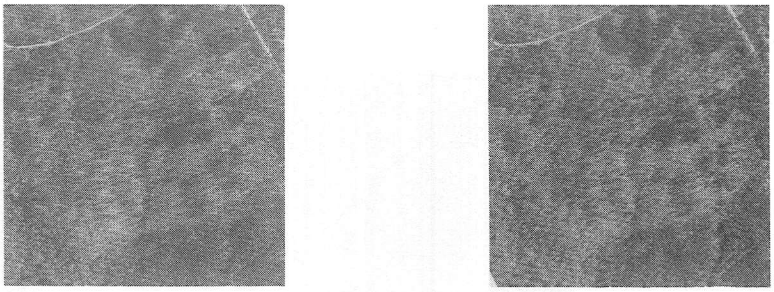


FIGURE 29. Stereogram with low contrast.

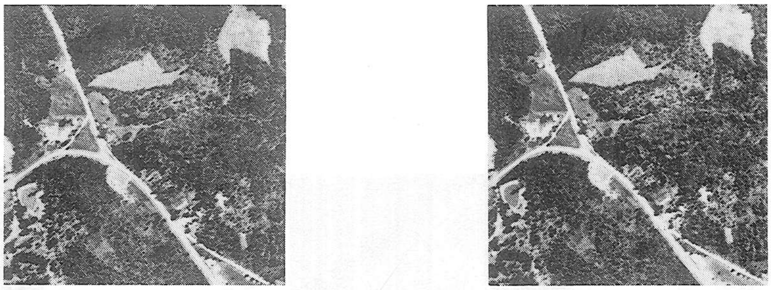


FIGURE 30. Stereogram with high contrast.

white and the darkest tones are nearly black, the print is said to have high contrast and is termed a constrasty or "hard" print, figure 30. 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 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 dark grey; and (3) less than 30 percent of the crowns dark grey. Neither season of photography nor contrast level of the print greatly effects 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 31.

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 32. Though shadows are seldom as clear as shown in figure 32, they usually can be used to estimate the relative density of the hardwood component. Figure 33 shows a relatively dense stand of hardwoods whose presence is revealed by their shadows.

Some broad-leaved tree species (e.g., sweetbay) are evergreen, and some (e.g., southern red oak) hold their dead leaves until the 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 this time of the year. 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 34.

Different stands having the same ratio of dark to light crowns may differ considerably in appearance because of difference in stand density. Figures 35-50 are stereograms that show examples of the three different tone classes with different stand density levels. Examples are also shown where the hardwood component must be evaluated from shadows.

Texture

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 no use has been made of texture as a diagnostic tool in these keys. However, a textural difference

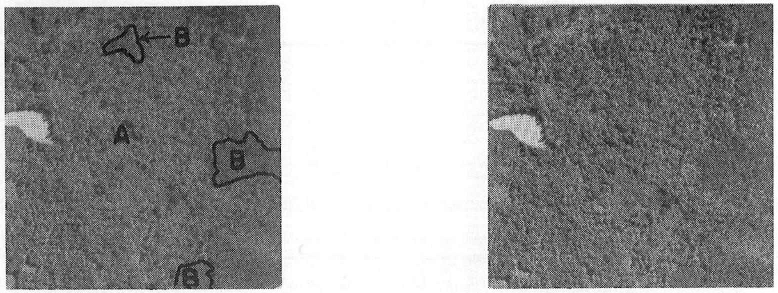


FIGURE 31. Stereogram showing hardwoods (A) and pine (B) during the fall color season.

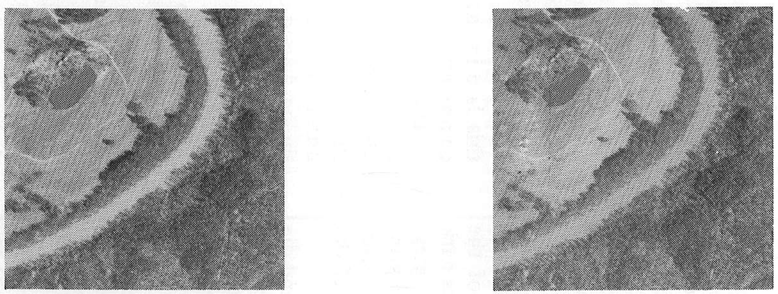


FIGURE 32. Stereogram showing shadows of hardwoods falling clear on the surface of a stream. Crown characteristics are quite clear.

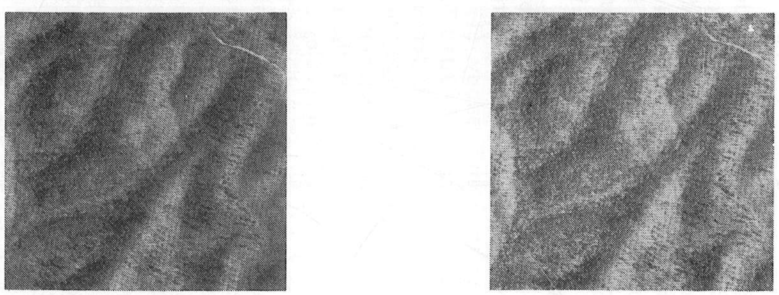


FIGURE 33. Stereogram showing shadows of hardwoods in a relatively dense stand. Note the striated appearance of the shadows. Density of the striations is correlated with stand density.

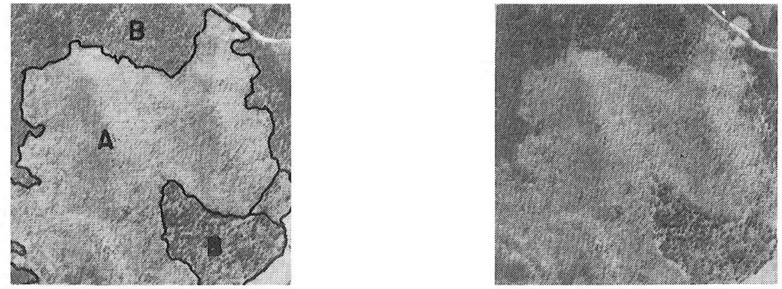


FIGURE 34. Stereogram showing the contrast between hardwoods (A) and pines (B) in early spring when the leaves are beginning to open.

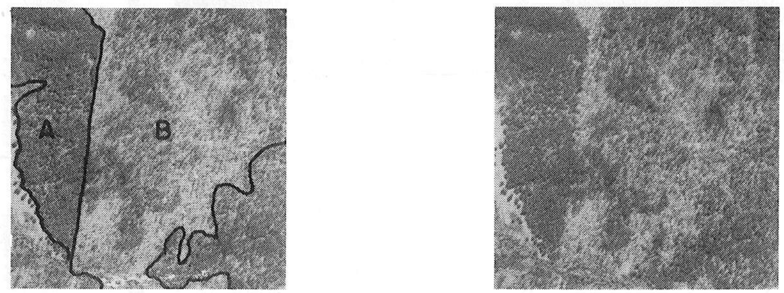


FIGURE 35. Stereogram of a dense stand of pine (A) adjacent to a stand of mixed pine and hardwoods (B).

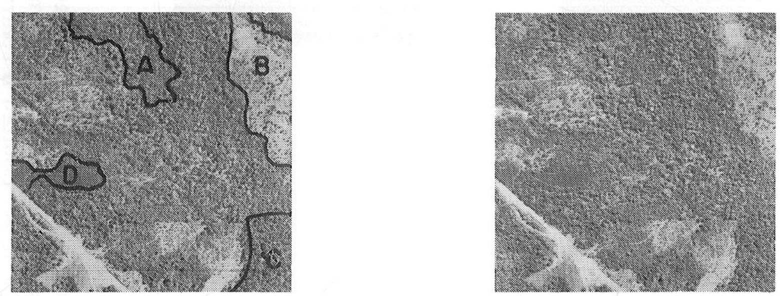


FIGURE 36. Stereogram of a medium dense stand of pine (A), a field restocking to pine (B), a dense stand of mixed pine and hardwoods (C), and a small, dense pine plantation (D).

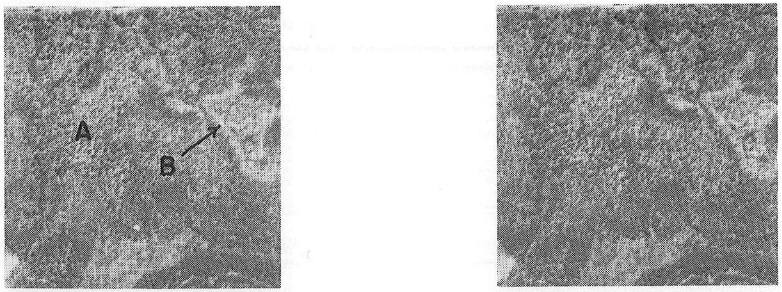


FIGURE 37. Stereogram of an open stand of pine (A), with light toned brush along the stream (B).

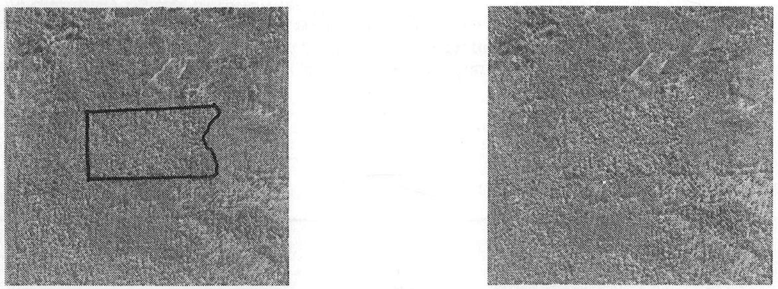


FIGURE 38. Stereogram of a dense mixed pine-hardwood stand. The photographs were taken during the fall color season. Discrimination between the pines and hardwoods is based on the differences in the tones of grey associated with the two species groups.

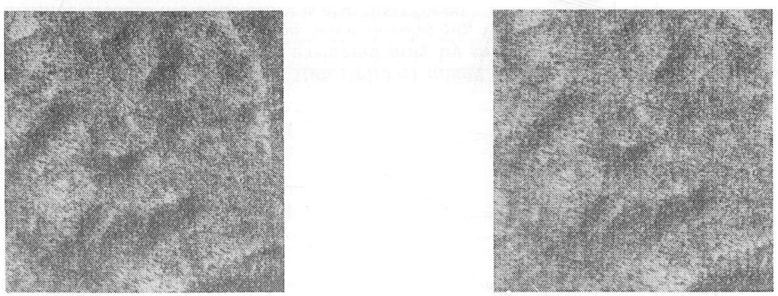


FIGURE 39. Stereogram of a dense mixed pine-hardwood stand. The photographs were taken during winter when leaves were off most of the hardwoods. The pine crowns are still full. Bare hardwoods are identified by their shadow pattern and light-toned crowns identify hardwoods still holding leaves.

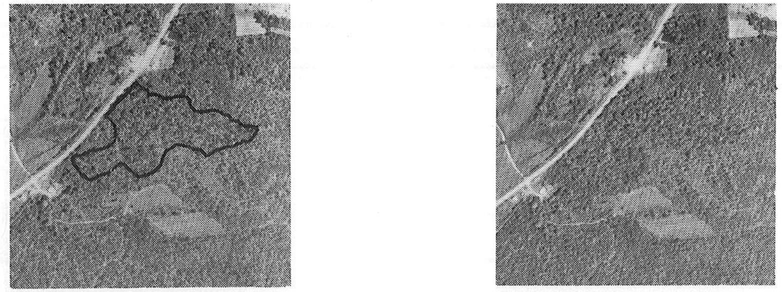


FIGURE 40. Stereogram of a two-storied, mixed pine-hardwood stand. The overstory has medium stocking. The photographs were taken during the fall color season. Discrimination between pines and hardwoods is on the basis of tones of grey.

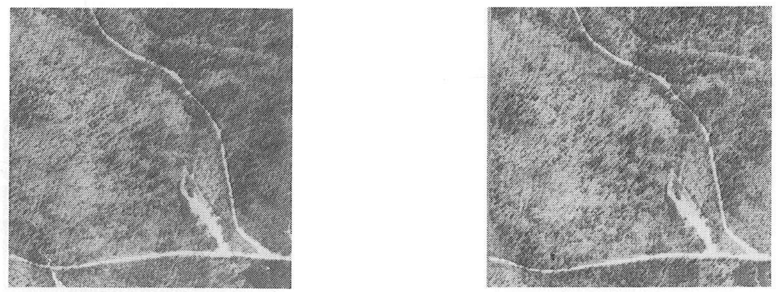


FIGURE 41. Stereogram of a medium-stocked, mixed pine-hardwood stand. The photographs were taken in the spring before leaf development was complete. The hardwood component is revealed primarily by shadows.

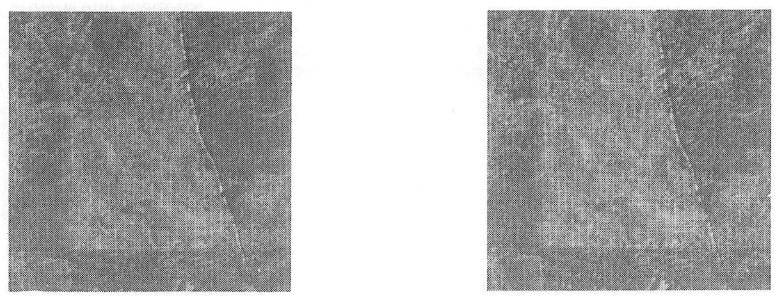


FIGURE 42. Stereogram of a cut-over area with a thin residual stand of mixed pines and hardwoods. The hardwood crowns are light-toned while the pine crowns are dark toned.

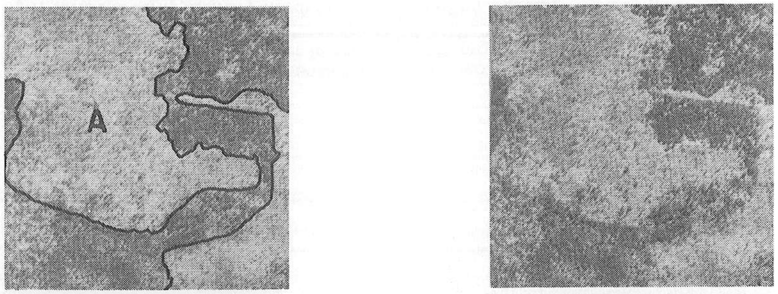


FIGURE 43. Stereogram of a thin stand of mixed pines and hardwoods (A). The hardwood component can be evaluated only by shadows. Though photographed in the spring when the leaves were developing, the hardwood crowns are not distinct because the understory is also light-toned.

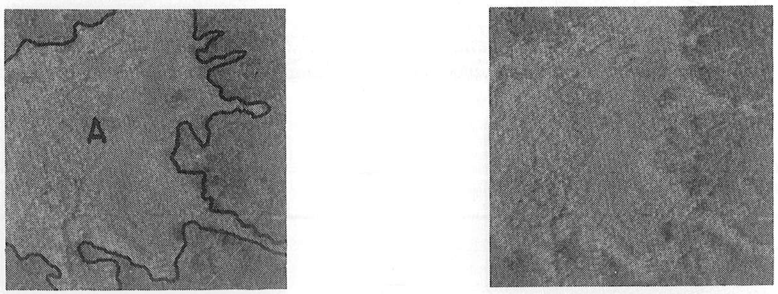


FIGURE 44. Stereogram of a dense stand of hardwoods (A). The photographs were taken in winter and nearly all of the hardwood leaves have fallen. Although the contrast level is low, the few remaining leaves cause the hardwood crowns to be distinctly lighter in tone than the pine crowns.

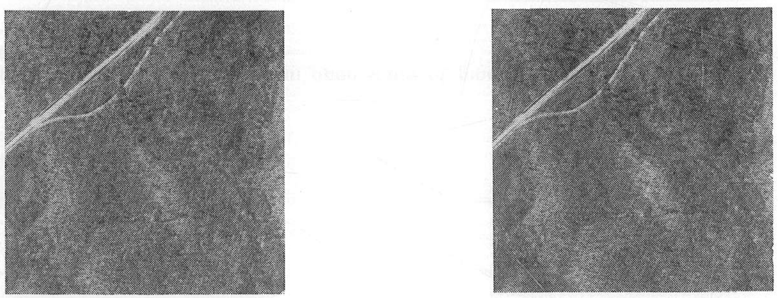


FIGURE 45. Stereogram of a dense stand of hardwoods. The photographs were taken in the winter when few of the hardwood crowns still bore leaves. Density of the stand must be judged from the shadows.

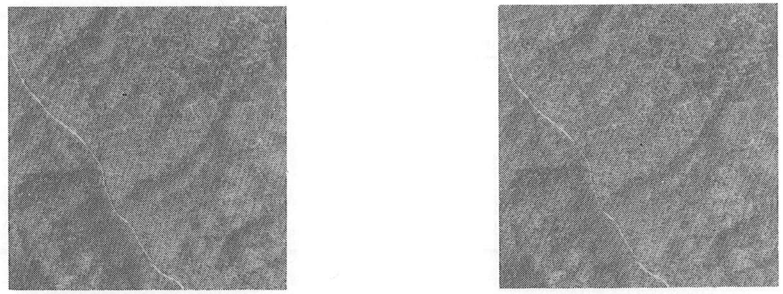


FIGURE 46. Stereogram of a patchy stand of hardwoods ranging from medium to high density. Though the photographs were taken in winter many of the hardwoods still bear leaves. Density of the stand must be judged jointly from the crowns and shadows.

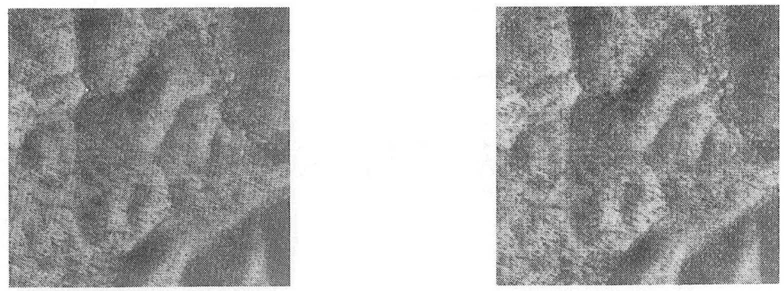


FIGURE 47. Stereogram of a medium dense hardwood stand. The density must be judged primarily from shadows.

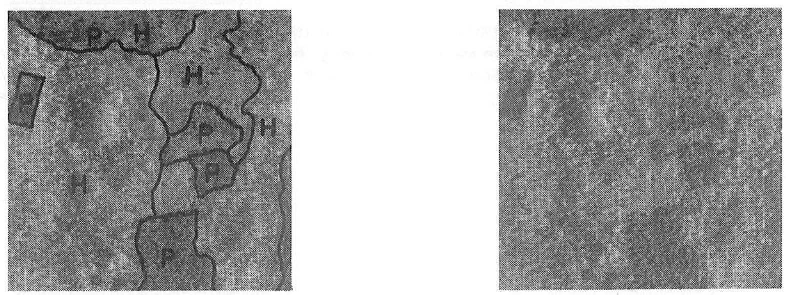


FIGURE 48. Stereogram showing a variety of hardwood and pine stands. The photographs were taken in winter, but many of the hardwoods still retain their leaves. Stand density must be judged from grey tones of crowns and from shadow patterns.

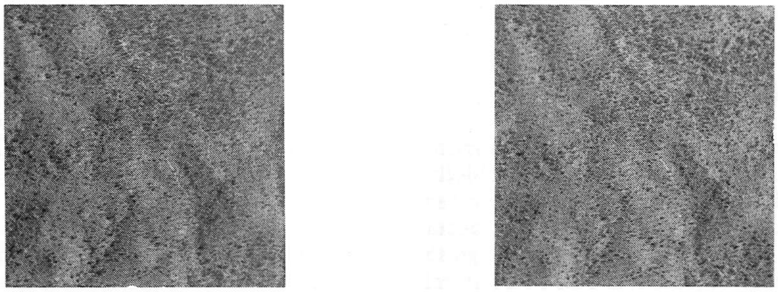


FIGURE 49. Stereogram of a thin stand of hardwoods in the fall color season. The hardwood crowns are visible and can be used to determine relative density of the hardwood component.

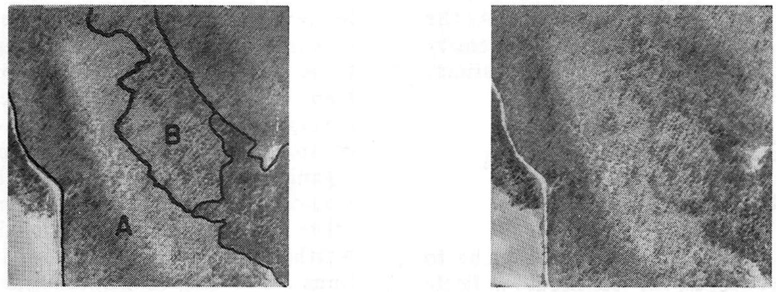


FIGURE 50. Stereogram of a medium to low density hardwood stand (A). The pine component of this stand is less than 30 percent of the stand basal area. In stand B, the density remains medium to low, but the pine component is sufficiently large for the stand to be classed as pine-hardwood. Relative density of the hardwood component can be determined from the shadow pattern.

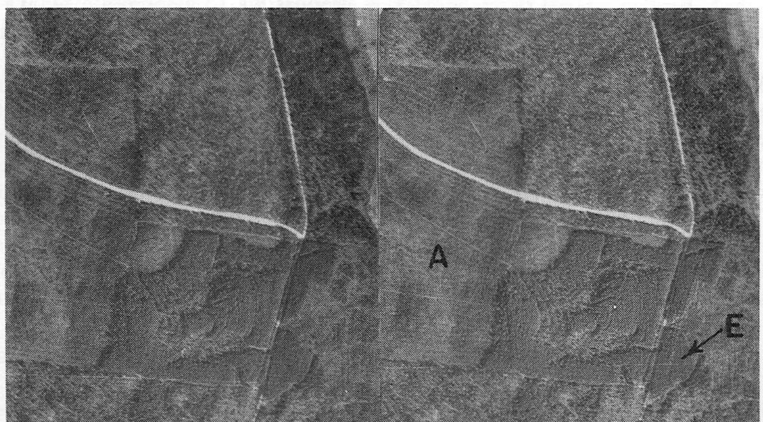


FIGURE 51. Stereogram showing pine plantations of varying ages. (A) is a newly established plantation with very small trees. The planting follows the contour. (B) is made up of somewhat larger trees than in (A) and planting failure in places is evident. (C) is a plantation of sapling size with high survival and few gaps. The rows of trees are still distinguishable. (D) shows two stands that are reaching pulpwood size and still the rows are visible. (E) is a very dense pulpwood-sized stand where the rows are no longer visible. The extreme uniformity of the plantations contrast sharply with the much less uniform natural stand at (F).

between Virginia pine and the other pines is pointed out in figure 9.

Plantations

Pine plantations are found in many places in the Warrior Basin 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 patterns 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, figure 51. As the plantations grow older, they maintain uniformity of density and tree size, but 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 paratmeters 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 geologically 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 Warrior Basin 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 ease 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.

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 percent 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 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

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

Zone	Site	Pine Correct	Pine Would[1] Qualify	Pine Wrong	Pine-Hardwoods Correct	Pine-Hardwoods Would[1] Qualify	Pine-Hardwoods Wrong	Hardwoods Correct	Hardwoods Would[1] Qualify	Hardwoods Wrong
I	Crest	6	3	0	14	4	2	4	2	3
	Upper slope	2	0	0	7	1	1	15	2	5
	Mid slope	7	0	0	7	4	1	22	3	3
	Lower slope	2	0	1	6	2	0	16	10	3
II	Crest				2	0	0	2	0	0
	Upper slope	3	0	0	3	0	0	3	2	0
	Mid slope				1	1	1	8	3	1
	Lower slope	0	2	0				4	1	1
Stream bottoms (<15')					3	1	1	17	8	7
Stream bottoms (>15')						1	0	12	9	4
Flats								2	2	2
		20	5	1	43	14	6	105	42	29

Table 5 continued.

Zone	Site	Cedar-Hardwoods Correct	Cedar-Hardwoods Would[1] Qualify	Cedar-Hardwoods Wrong	Hemlock-Hardwoods Correct	Hemlock-Hardwoods Would[1] Qualify	Hemlock-Hardwoods Wrong
I	Crest						
	Upper slope						
	Mid slope						
	Lower slope				2	0	0
II	Crest						
	Upper slope	1	0	0			
	Mid slope	1	0	0			
	Lower slope	2	1	0			
Stream bottoms (<15')					0	0	1
Stream bottoms (>15')							
Flats							
		4	1	0	2	0	1 /273

[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. area.

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 will 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 Sellman, 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 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 the key has these attributes, his results should be satisfactory.

LITERATURE CITED

Adams, G. I.; Butts, C.; Stephenson, L. W.; and Cooke, W. 1926. *Geology of Alabama.* Ala. Geol. Survey. 312 pp.

Avery, T. E. 1966. *Forester's guide to aerial photo-interpretation* USDA - Forest Service. Agric. Handbook 308. 40pp.

Avery, T. E. 1977. *Interpretation of aerial photographs.* 2nd Ed. Burgess Pub. Co., Minneapolis, Minn. 324pp.

Butts, C. 1911. *Birmingham Folio. Geological Atlas of the United States.* USDI - Geological Survey, Folio 175, Field Ed. 180pp.

Clark, R. C. 1972. *The woody plants of Alabama.* Missouri Botanical Garden Press, St. Louis, Mo. 242pp.

Fenneman, N. M. 1938. *Physiography of eastern United States.* McGraw-Hill Book Co., New York, N.Y. 714pp.

Gibson, A. M. 1893. *Report on the geological structure of Murphree's Valley.* Geol. Surv. of Ala., Spec. Rpt. 4. 132pp.

Harlow, W. M. and Harrar, E. S. 1968. *Textbook of dendrology.* 5th Ed. McGraw-Hill Book Co., Inc., New York. 512pp.

Hodgkins, E. J.; Cannon, T. K.; and Miller, W. F. 1976. *Forest habitat regions from satellite imagery, States of Alabama and Mississippi.* (A map and text). Auburn Univ. (Ala.) Agri. Exp. Sta. and Mississippi Agri. and Forestry Exp. Sta.

Johnson, E. W. and Sellmann, L. R. 1974. *Forest cover photo-interpretation key for the Piedmont Forest Habitat Region in Alabama.* Auburn Univ. (Ala.) Agri. Exp. Sta. Forestry Dept. Series No. 6. 51pp.

Johnson, E. W. and Sellmann, L. R. 1975. *Forest cover photo-interpretation key for the Mountain Forest Habitat Region in Alabama.* Auburn Univ. (Ala.) Agri. Exp. Sta. Forestry Dept. Series No. 7. 54pp.

Johnson, E. W. and Sellmann, L. R. 1977. *Forest cover photo-interpretation key for the Ridge and Valley Forest Habitat Region in Alabama.* Auburn Univ. (Ala.) Agri. Exp. Sta. Forestry Dept. Series No. 9. 55pp.

Johnson, E. W. and Sellmann, L. R. 1978. *Forest cover photo-interpretation key of the Cumberland Plateau Forest Habitat Region in Alabama.* Auburn Univ. (Ala.) Agri. Exp. Sta. Forestry Dept. Series No. 10. 79pp.

Johnston, W. D., Jr. 1930. *Physical divisions of northern Alabama.* Ala. Geol. Survey Bul. 38. 48pp.

Johnston, W. D., Jr. 1932. A revision of physical divisions of northern Alabama. *Jour. Washington Acad. of Sciences* 22:8:220-223.

McCalley, H. 1891. *Report on the Coal Measures of the Plateau Region of Alabama.* Geol. Surv. of Ala., Spec. Rpt. 3. 238pp.

Moessner, K. E. 1960. *Training handbook, basic technique in forest photo-interpretation.* USDA - Forest Service. Intermountain For. and Range Exp. Sta. 73pp. offset.

Northrop, K. G. and Johnson, E. W. 1970. Forest type identification. *Photogrammetric Engineering.* 36:483-490.

Parker, R. G. and Johnson, E. W. 1969. *Identification of forest condition classes on near vertical aerial photographs taken with a K-20 camera.* Auburn Univ. (Ala.) Agri. Exp. Sta. Forestry Dept. Series No. 3. 8pp.

Sapp, C. D. and Emplaincourt, J. 1975. *Physiographic regions of Alabama.* Ala. Geol. Survey Map. 168.

Spurr, S. H. 1960. *Photogrammetry and photo-interpretation.* Second Ed. Ronald Press, New York, 472pp.

Wahl, K. D.; Harris, W. F.; and Jefferson, P. O. 1971. *Water resources and geology of Winston County, Alabama.* Geol. Surv. of Ala., Bull. 97. 51pp.

Wilson, R. C., *et. al.* 1960. Photo-interpretation in forestry. Chap. 7 in *Manual of photo-interpretation.* pp. 457-520. Amer. Soc. Photogram., Washington, D.C.

ADDITIONAL REFERENCES

Anonymous. 1961. *Map of Tuscaloosa County, Alabama, showing distribution of geologic formations and ground water supplies.* Geol. Surv. of Ala., Map 16. (Map with text.)

Anonymous, 1964. *Forest cover types of North America.* Soc. Amer. Foresters, Washington, D.C. 67pp.

Causey, L. V. 1961. *Generalized geologic map of Etowah County, Alabama.* Geol. Surv. of Ala. Map 15.

Causey, L. V. 1963. *Generalized geologic map of St. Clair County, Alabama.* Geol. Surv. of Ala. Map 21. (Map with text.)

Erhlich, R. 1964. *Field trip guidebook to the Pottsville Formation in Blount and Jefferson Counties, Alabama.* Alabama Geol. Soc., Tuscaloosa, Ala. Mimeo. 12pp.

Erhlich, R. 1964. *Some ostracods from the Pennington Formation of Alabama.* Geol. Surv. of Ala., Circ. 29. 15pp.

Fowells, H. A. 1965. *Silvics of forest trees of the United States.* USDA - Forest Service. Agri. Handbook 271. 762pp.

Harper, R. M. 1942. *Natural resources of the Tennessee Valley region in Alabama.* Geol. Surv. of Ala., Spec. Rpt. 17. 93pp.

Harper, R. M. 1943. *Forests of Alabama.* Geol. Surv. of Ala., Monograph 10. 230pp.

Harris, W. F. and Causey, L. V. (Undated.) *Geologic map of Marion County, Alabama.* Geol. Surv. of Ala. Map 104.

Harris, W. F. Jr. and McMaster, W. M. 1963. *Generalized geologic map of Lawrence County, Alabama.* Geol. Surv. of Ala. Map 31. (Map with text.)

Hodgkins, E. J. (ed.) 1965. *Southeastern forest habitat regions based on physiography.* Auburn Univ. (Ala.) Agri. Exp. Sta. Forestry Dept. Series No. 2. 10pp.

McKee, J. W. 1975. *Pennsylvania sediment-fossil relationships in part of the Black Warrior Basin of Alabama.* Geol. Surv. of Ala. Cir. 95. 43pp.

McKinney, F. K. 1972. *Nonfenestrate Ecoprocta (BRYOZOA) of the Bangor limestone (Chester) of Alabama.* Geol. Surv. of Ala. Bull. 98. 144pp.

Metzger, W. J. 1965. *Pennsylvanian stratigraphy of the Warrior Basin, Alabama.* Geol. Surv. of Ala. Cir. 30. 80pp.

Peace, R. R., Jr. 1963. *Geologic map of Franklin County, Alabama.* Geol. Surv. of Ala. Map 22.

Sanford, T. H., Jr. 1966. *Generalized geologic map of Marshall County, Alabama.* Geol. Surv. of Ala. Map 60.

Smith, W. E. (ed.) 1967. *A field guide to Mississippian sediments in northern Alabama and southcentral Tennessee.* Ala. Geol. Soc., Tuscaloosa, Ala., Guidebook for the Fifth Annual Field Trip. Mimeo. 144pp.

Wahl, K. D. and O'Rear, D. M. 1972. *Geologic map of Walker County, Alabama.* Geol. Surv. of Ala. Map 123.

APPENDIX I

Forest Cover Photo-Interpretation Key for the Warrior Basin 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 51. . . . . .Pine plantation[2]
1. Stand not as above. 2
   2. Stand is on an upland site, figures 27 and 28. 3
   2. Stand is on a streambottom site 65
3. Stand shows evidence of rows. Stocking thin or patchy, figures 51A and B . . . . Pine plantation
3. Stand not as above. 4
   4. Stand is in Zone I (See maps in Appendix III). 5
   4. Stand is in Zone II. 40
5. Stand is on Coastal Plain material. (See maps in Appendix III and, if possible, refer to the county geological maps prepared by the Geological Survey of Alabama). 6
5. Stand is not on Coastal Plain material 15
   6. More than 30 percent of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, 37A, 38-43 and 50B. 7
   6. Tree crowns are not as above 14
7. Stand is north of Tuscaloosa County. 8
7. Stand is in Tuscaloosa County 11
   8. Stand is on a flat area without discernible slope. . . .9
   8. Stand is on a definite hill 10
9. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .P(1)[3]
9. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B. . . . . .PH(2)[3]
   10. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .figure 52A[3]
   10. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .figure 52B[3]
11. Stand is on a flat area without discernible slope. 12
11. Stand is on a definite hill .13
   12. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .P(4)
   12. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .PH(2)[3]
13. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .figure 52A[3]
13. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . . . .figure 52B[3]
   14. Stand is on a flat area without discernible slope. H(2)
   14. Stand is on a definite hill . . . . .figure 52C
15. Stand is in a Class 1 landscape, figures 6, 7, and 8A . . . 16
15. Stand is *not* in a Class 1 landscape 21
   16. Stand is on a flat area without discernible slope. . . 17
   16. Stand is on a definite hill 19
17. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .P(1)
17. Tree crowns are not as above 18
   18. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B. . .PH(2)
   18. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A . . . . H(3)
19. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .figure 52A[4]
19. Tree crowns are not as above 20
   20. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .figure 52B[4]
   20. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A . . . . .figure 52C
21. Stand is in a Class 2 landscape, figures 2, 10, and 15. . . 22
21. Stand is in a Class 3 landscape, figures 8C, 9, and 11 . . 35
   22. Stand is *on* a plateau remnant, including the rimrock if it is present, figure 10A. 23
   22. Stand is in a ravine or gorge, *below* the rimrock, if the rimrock is present, figure 10C 31
23. Stand is on a flat area without discernible slope. 24
23. Stand is on the rimrock or a definite hill 26
   24. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .P(1)
   24. Tree crowns are not as above 25
25. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .PH(2)
25. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . . . . . H(2)
   26. Stand is on the rimrock 27
   26. Stand is on a definite hill 29
27. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .P(2)
27. Tree crowns are not as above 28
   28. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B. . .PH(1)
   28. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . . H(1)
29. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . figure 52A
29. Tree crowns are not as above 30
   30. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .figure 52B

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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 Warrior Basin 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]Virginia pine occurs only sporadically on Coastal Plain material. In Tuscaloosa County P(1) is replaced by P(4) and the Virginia pine in PH(1) is replaced by longleaf pine. North of Tuscaloosa the Virginia pine is replaced by loblolly and, to a lesser extent, shortleaf pine in both the pine and pine-hardwood types.

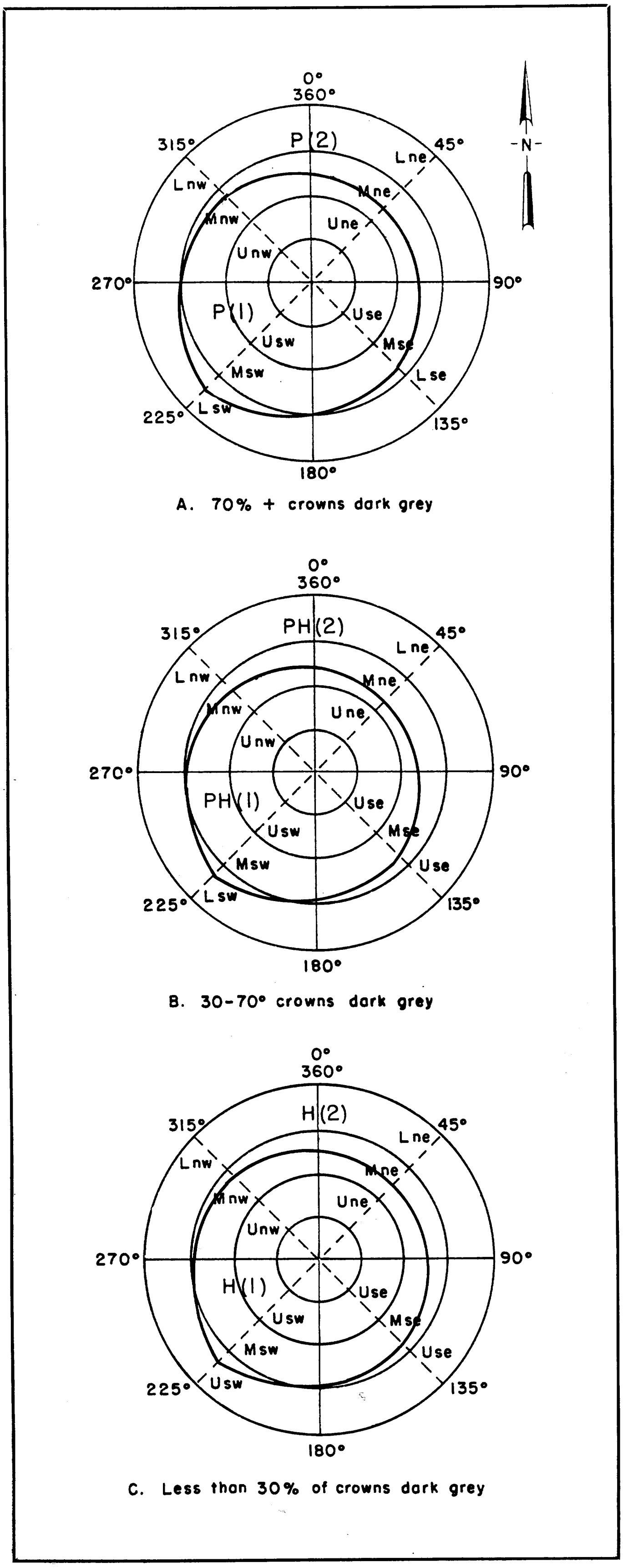
[4]Longleaf pine is found on the crests and western upper slopes of the western boundary ridges of both the Sequatchie and Murphree's Valleys and also on the southern end of Blount Mountain. The pine and pine-hardwood cover types should be modified in these areas to compensate for this occurrence.

30. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A . . . . .figure 52C
31. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .figure 53A[5]
31. Tree crowns are not as above 32
32. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B. 33
32. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. 34
33. Stand is in the watershed of Lewis Smith Lake west of Jones Chapel in Cullman County and above the highest lake level . . . . .figure 53B[5]
33. Stand is not as above . . . . .figure 53B
34. Stand is in the watershed of Lewis Smith Lake, west of Jones Chapel in Cullman County and above the highest lake level. . figure 53D
34. Stand is not as above . . . . .figure 53C
35. Stand is on a flat area without discernable slope 36
35. Stand is on a definite hill 38
36. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .P(1)
36. Tree crowns are not as above. 37
37. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .PH(2)
37. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . . . . . H(2)
38. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . figure 52A
38. Tree crowns are not as above. 39
39. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .figure 52B
39. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . .figure 52C
40. Stand is on the western boundary ridge of either valley or is on West Red Mountain in Murphree's Valley, figures 4, 5, 12, 22, 23, 24, 25, and 26 41
40. Stand is not as above 43
41. 70 percent or more of the overstory crowns are dark grey, figures 34B, 35A, 36A and B, and 37A. (Note that longleaf pine occurs along the western boundary ridge of the Sequatchie Valley.). . . . . .figure 54A[4]
41. Tree crowns are not as above 42
42. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .figure 54B[4]
42. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A . . . . .figure 54C
43. Stand is on the eastern boundary of the Sequatchie Valley, figure 21B 44
43. Stand is not as above 46
44. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . figure 55A
44. Tree crowns are not as above. 45
45. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .figure 55B
45. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . .figure 55C
46. Stand is on Straight Mountain, East Red Mountain, or the ridge of Hartselle sandstone in Sand Valley in Murphree's Valley, figures 5, 24C, and 26A 47
46. Stand is not as above 49
47. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . figure 52A
47. Tree crowns are not as above. 48
48. 30 to 70 percent of the overstory crowns are dark grey, figures 38-43 and 50B . . . . .figure 52B
48. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A . . . . .figure 52C
49. Stand is on a flat-topped plateau remnant in the Sequatchie Valley, figure 21A 50
49. Stand is not as above 61
50. Stand is on the *top* of the plateau remnant, including the rimrock. 51
50. Stand is on the escarpment 59
51. Stand is on the rimrock 52
51. Stand is on the top 54
52. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . .P(2)
52. Tree crowns are not as above 54
53. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .PH(1) (with less loblolly pine than shown)
53. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . . . . . H(1)
54. Stand is on a flat area without discernible slope. . . 55
54. Stand is on a definite hill 57
55. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A .P(1)
55. Tree crowns are not as above. 56
56. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .PH(2)
56. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A . . . . H(2)
57. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . figure 52A
57. Tree crowns are not as above. 58
58. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .figure 52B
58. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A . . . . .figure 52C
59. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . figure 56A
59. Tree crowns are not as above. 60
60. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .figure 56B
60. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A . . . . .figure 56C
61. Stand is on a round-topped plateau remnant above the Hartselle sandstone in the Sequatchie

[5]Eastern hemlock is present along the bottoms and lower slopes of the ravines or gorges in the watershed of Lewis Smith Lake above the impounded water and west of Jones Chapel in Cullman County. It occurs in all species mixes and the pine and pine-hardwood cover types must be modified in recognition of the hemlock's presence.

Valley, figure 23E 62

61. Stand is not as above (includes the low hills and flats carved out of the Tuscumbia limestone and Fort Payne chert in the Sequatchie Valley, figures 4 and 22F, and those in the Central Valley and chert hills portions of the Murphree Valley, figures 5, 24E, and 25B 63
    62. More than 30 percent of the overstory tree crowns are dark grey . . . . CH(1)
    62. Less than 30 percent of the overstory tree crowns are dark grey . . . . H(6)
63. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A. P(1) (with less Virginia pine than shown)
63. Tree crowns are not as above 64
    64. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B. . .PH(2) (with less Virginia pine than shown)
    64. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . . H(5)
65. Stand is on a flat valley floor but not associated with a stream, figure 23I. 66
65. Stand associated with a stream, figures 21E and 23J. . . 68
    66. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A . . . . P(3)
    66. Tree crowns are not as above 67
67. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B . . . . .PH(3)
67. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . . . . . H(4)
    68. Stream is impounded 69
    68. Stream is running free 70
69. Stand is on recent alluvium at a place where a stream enters the impoundment, figure 14C . . . . . . H(6)
69. Stand is not as above, figure 14 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 2 in the key and proceed as with upland stands.
    70. Stream is less than 15 feet in width (at a scale of 1:20,000 fifteen feet is very close to 0.01 inch), figure 22G. Includes swampy areas, figure 25C 71
    70. Stream is wider than 15 feet 75
71. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A. . 72
71. Tree crowns are not as above 73
    72. Stand is along a ditch or stream with open fields adjacent to it or in a swampy area with only short trees . . . . H(6)
    72. Stand is not as above . . . . .P(3)
73. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B. (In the drainage of Lewis Smith Lake, above the impoundment, eastern hemlock is present in the gorge bottoms) . . . . .PH(3)
73. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. 74
    74. Stand is in the drainage of Lewis Smith Lake, above the impoundment, figures 2 and 10. . . . . HH(1)
    74. Stand is not as above . . . . H(2)
75. 70 percent or more of the overstory tree crowns are dark grey, figures 34B, 35A, 36A and B, and 37A .P(3)
75. Tree crowns are not as above 76
    76. 30 to 70 percent of the overstory tree crowns are dark grey, figures 38-43 and 50B. . .PH(4)
    76. Less than 30 percent of the overstory tree crowns are dark grey, figures 44-49 and 50A. . . H(3)



A. 70% + crowns dark grey

B. 30-70° crowns dark grey

C. Less than 30% of crowns dark grey

FIGURE 52. Forest cover type distribution on sandstone or shale dominated round-topped hills in Zone I or sandstone structural ridges in Zone II.

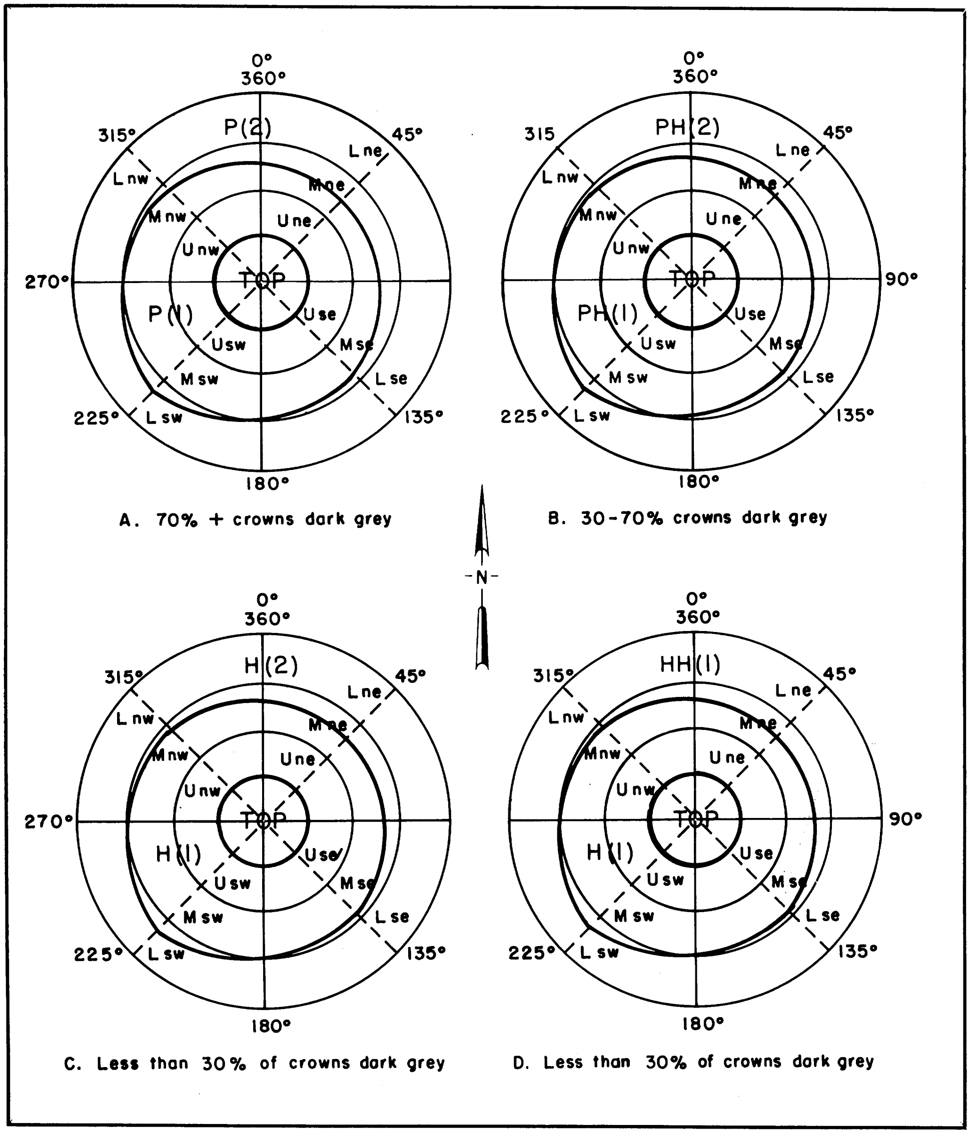


FIGURE 53. Forest cover type distribution in ravines or gorges of Landscape Class 2 in Zone I. Figure D applies in the watershed of Lewis Smith Lake, west of Jones Chapel and above the slack water mark.

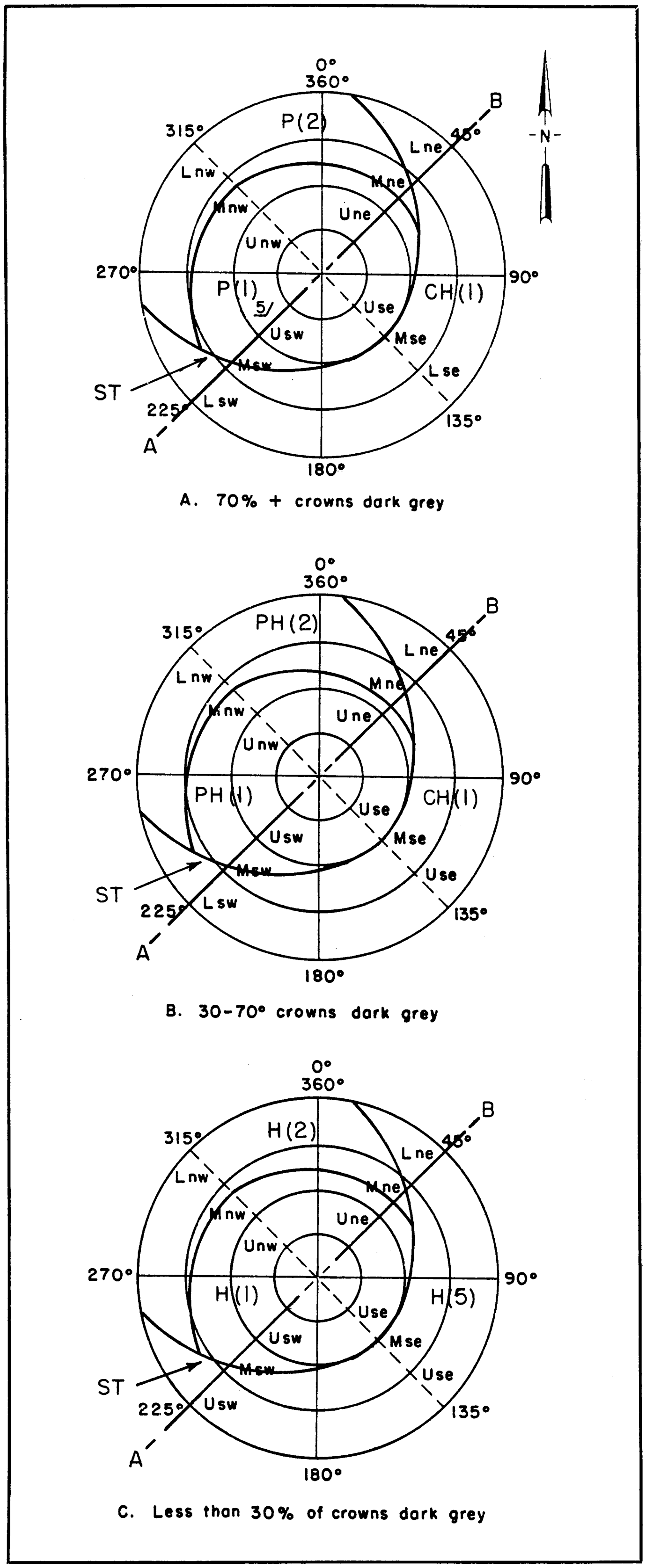


FIGURE 54. Forest cover type distribution on the western boundary ridges of the Sequatchie and Murphree's Valleys and on West Red Mountain in Murphree's Valley. The line AB shows the approximate direction of the ridge line. ST indicates the lower limit of the sandstone talus.

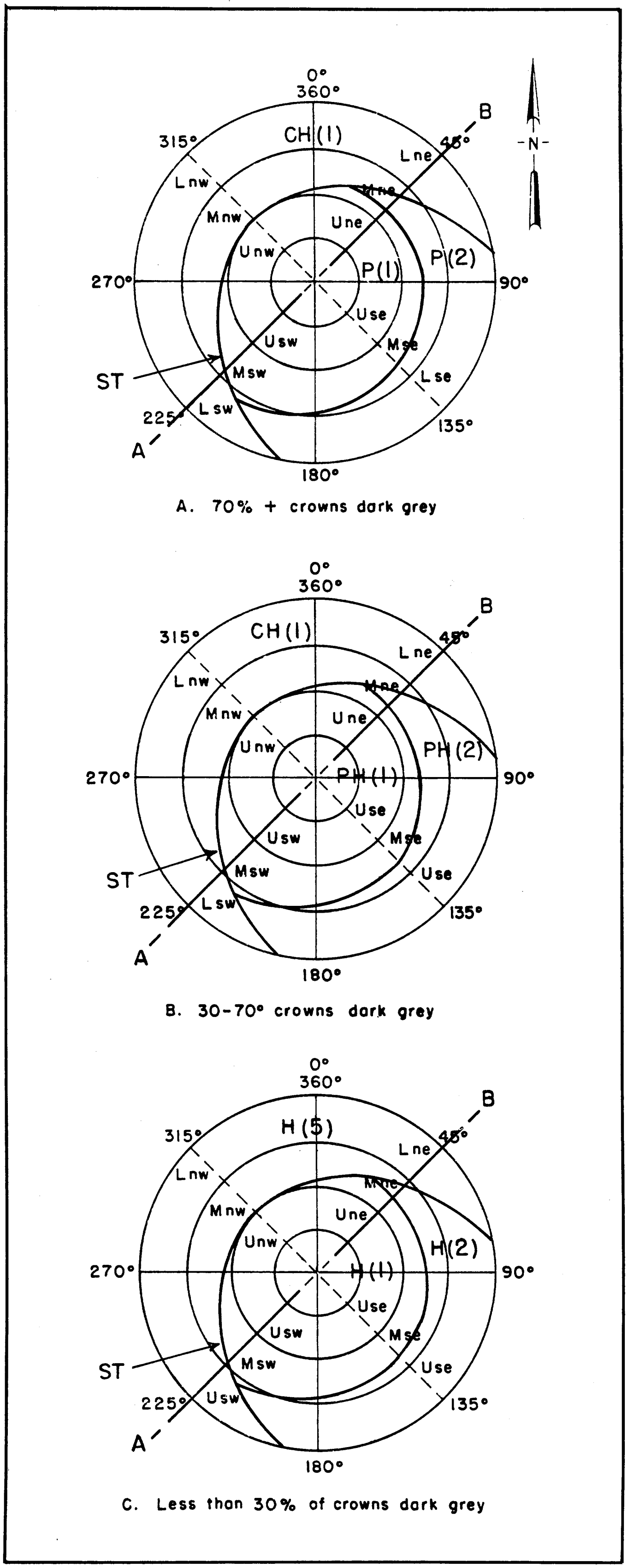


FIGURE 55. Forest cover type distribution on the eastern boundary ridge of the Sequatchie Valley. The line AB shows the approximate direction of the ridge line. ST indicates the lower limit of the sandstone talus.

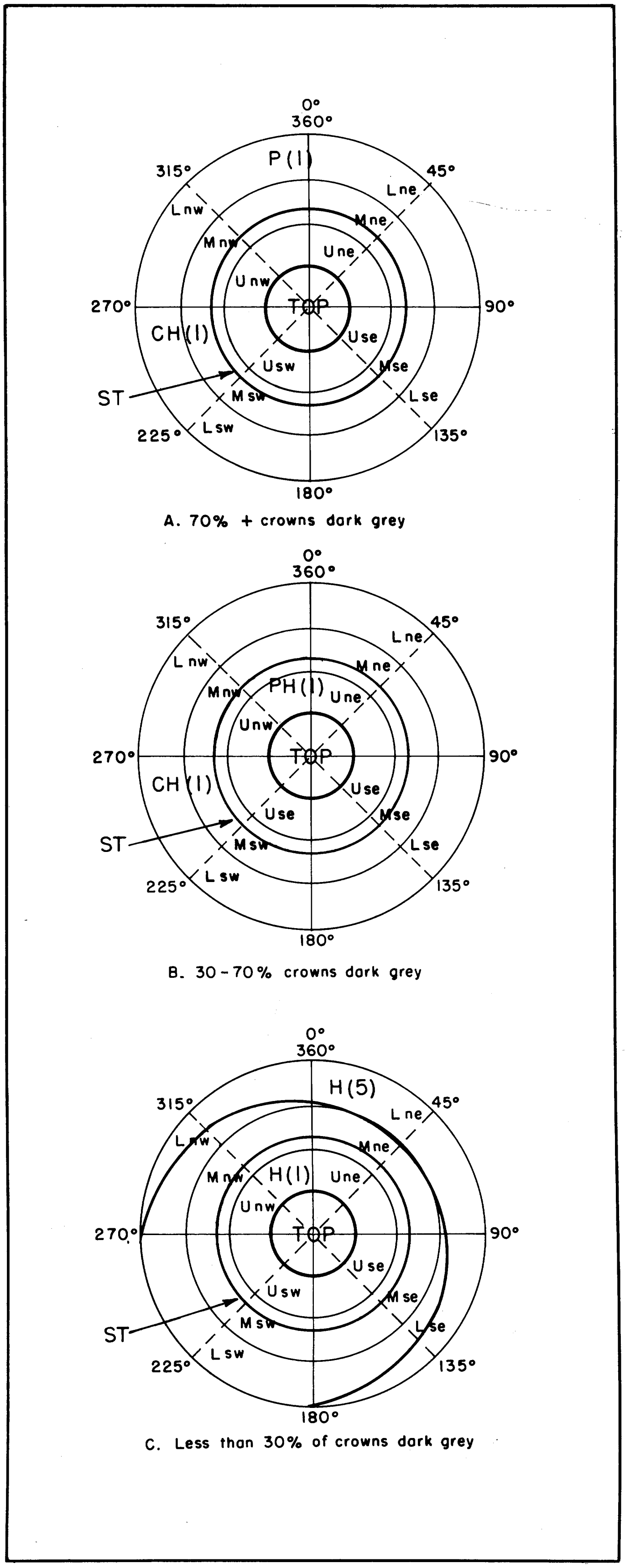


FIGURE 56. Forest cover type distribution on flat-topped plateau remnants in the Sequatchie Valley. ST indicates the lower limit of the sandstone talus.

APPENDIX II

Scientific Names of the Tree Species[1]

Conifers

Pine Family	*PINACEAE*
Loblolly pine	*Pinus taeda* L.
Longleaf pine	*Pinus palustris* Mill.
Shortleaf pine	*Pinus echinata* Mill.
Virginia pine	*Pinus virginiana* Mill.
Eastern hemlock	*Tsuga canadensis* (L.) Carr.
Cypress or Cedar Family	*CUPRESSACEAE*
Eastern redcedar	*Juniperus virginiana* L.

Broad-leaved Trees

Willow or Poplar Family	*SALICACEAE*
Black willow	*Salix nigra* Marsh.
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.
Sweet birch	*Betula lenta* L.
Hazel alder	*Alnus serrulata* (Aiton) Willd.[2]
American hornbeam	*Carpinus caroliniana* Walt.
Beech Family	*FAGACEAE*
American beech	*Fagus grandifolia* Ehrh.
Black oak	*Quercus velutina* Lam.
Blackjack oak	*Quercus marilandica* Muenchh.
Cherrybark oak	*Quercus falcata* var. *leucophylla* (Ashe) Palmer and Steyerm.
Chestnut oak	*Quercus prinus* L.
Chinkapin oak	*Quercus muehlenbergii* Engelm.
Northern red oak	*Quercus rubra* L.
Pin oak	*Quercus palustris* Muenchh.
Post oak	*Quercus stellata* Wangenh.
Scarlet oak	*Quercus coccinea* Muenchh.
Southern red oak	*Quercus falcata* Michx.
Swamp chestnut oak	*Quercus michauxii* Nutt.
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.
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.
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 Warrior Basin Forest Habitat Region

KEY

Zone I

Zone II

Coastal Plain

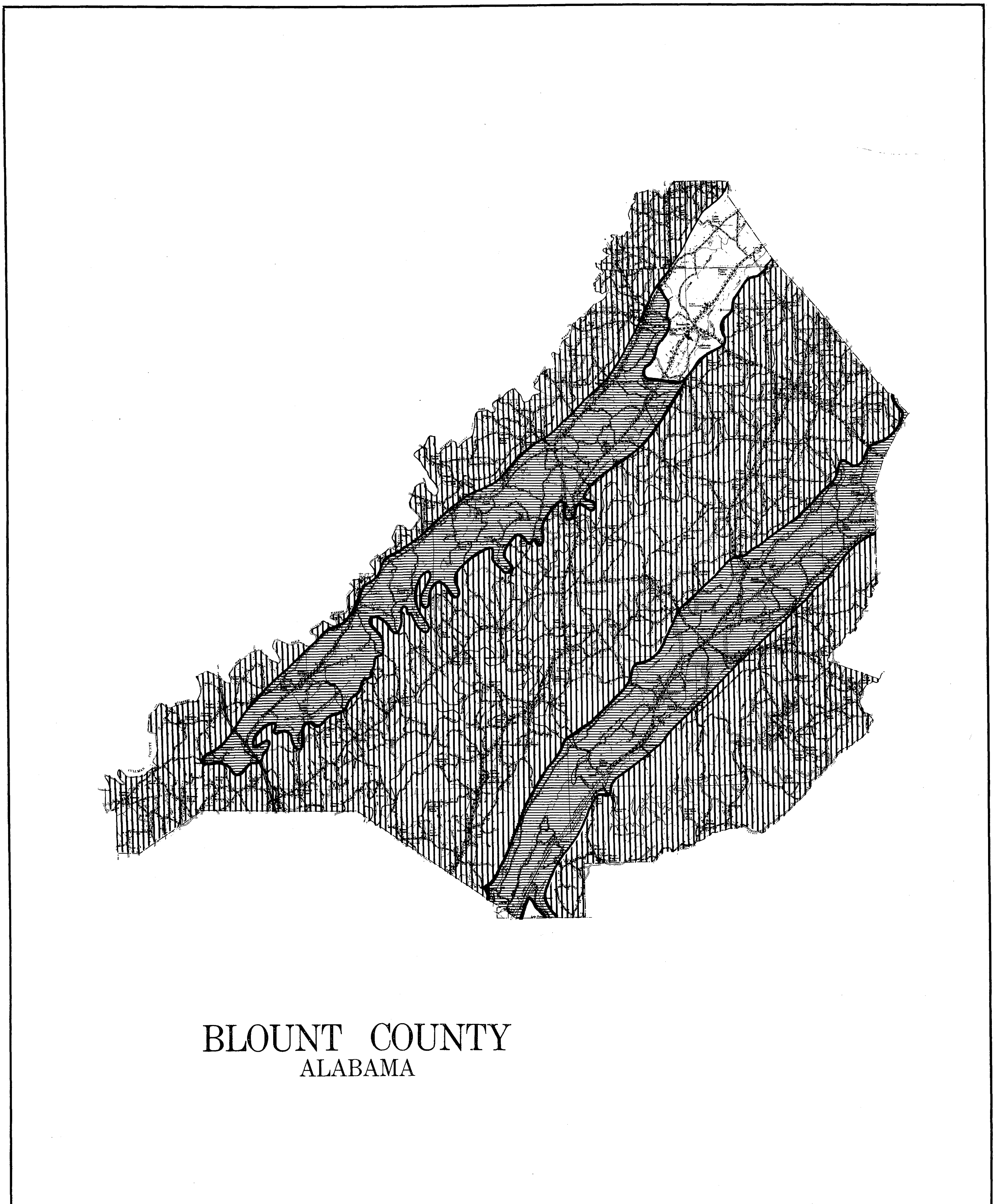


FIGURE 57. Blount County.

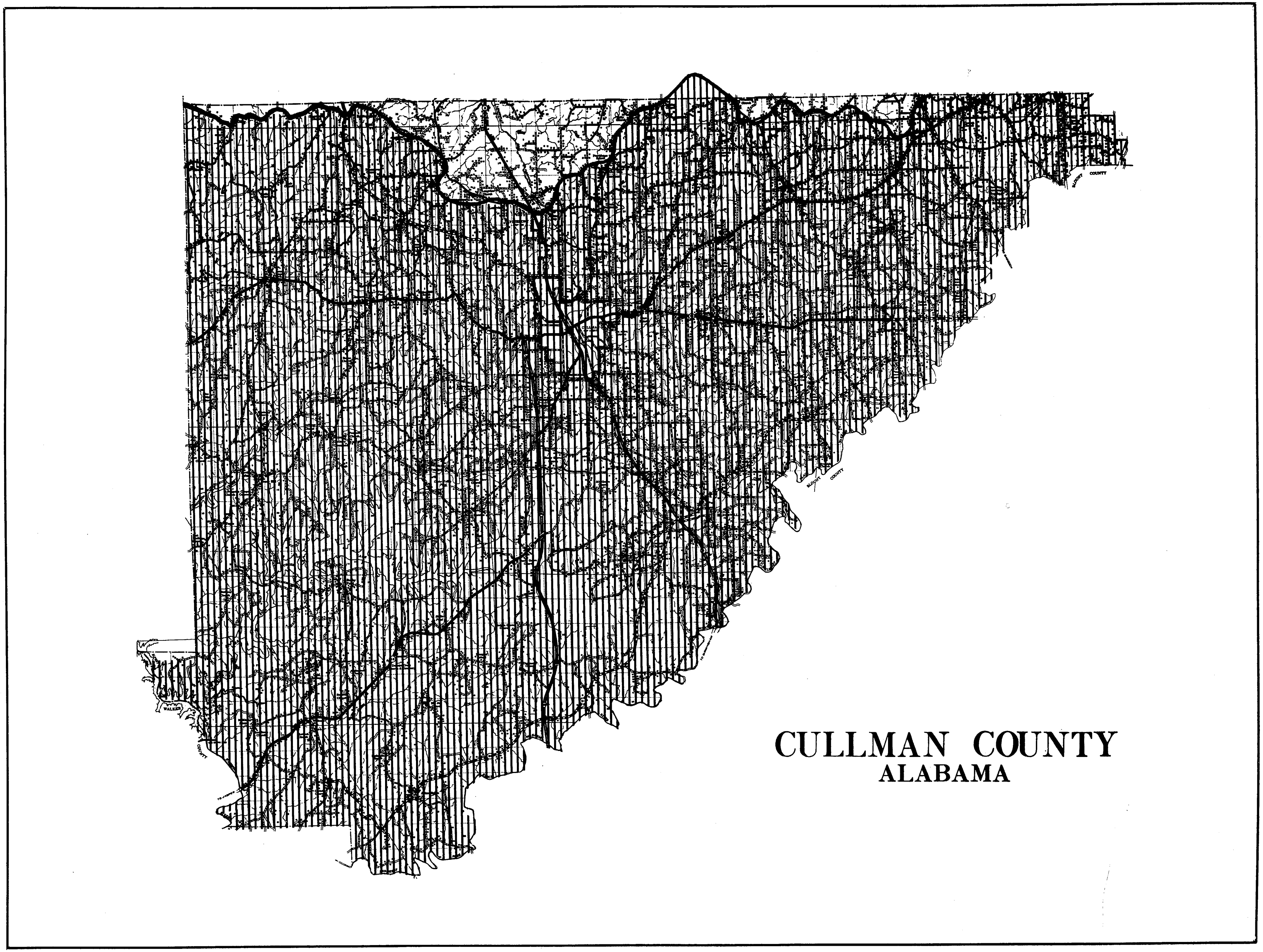


FIGURE 58. Cullman County.

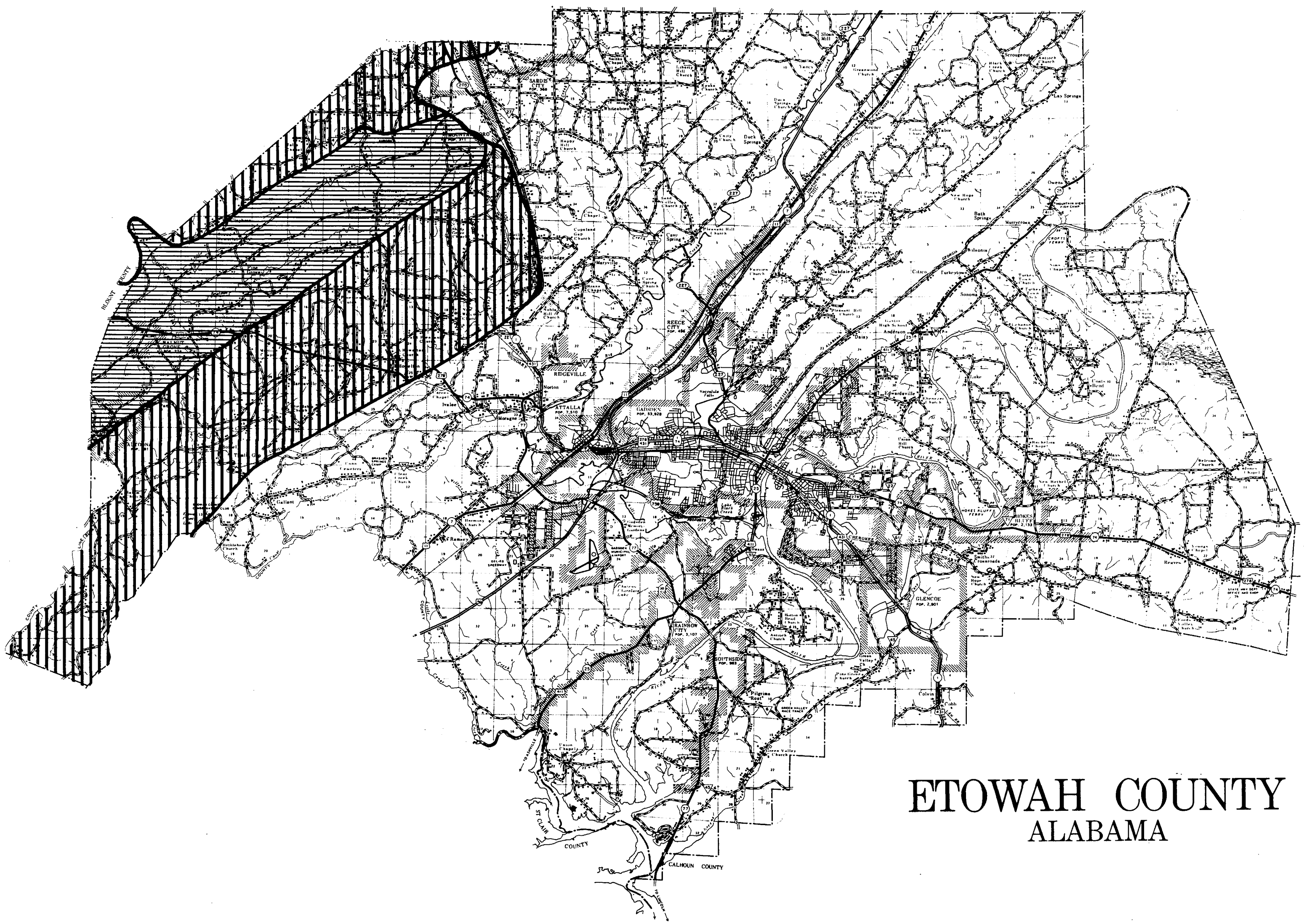


FIGURE 59. Etowah County.

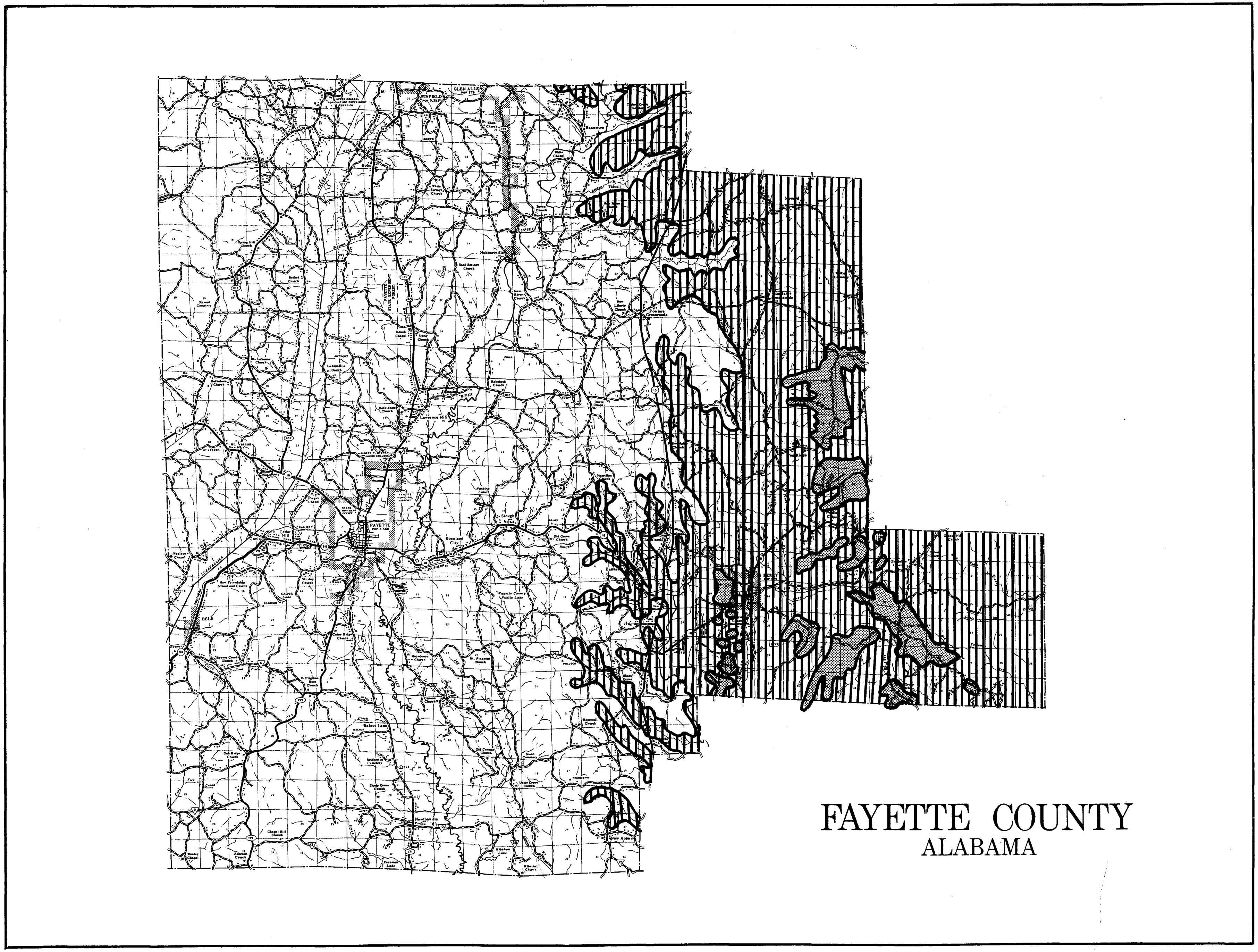
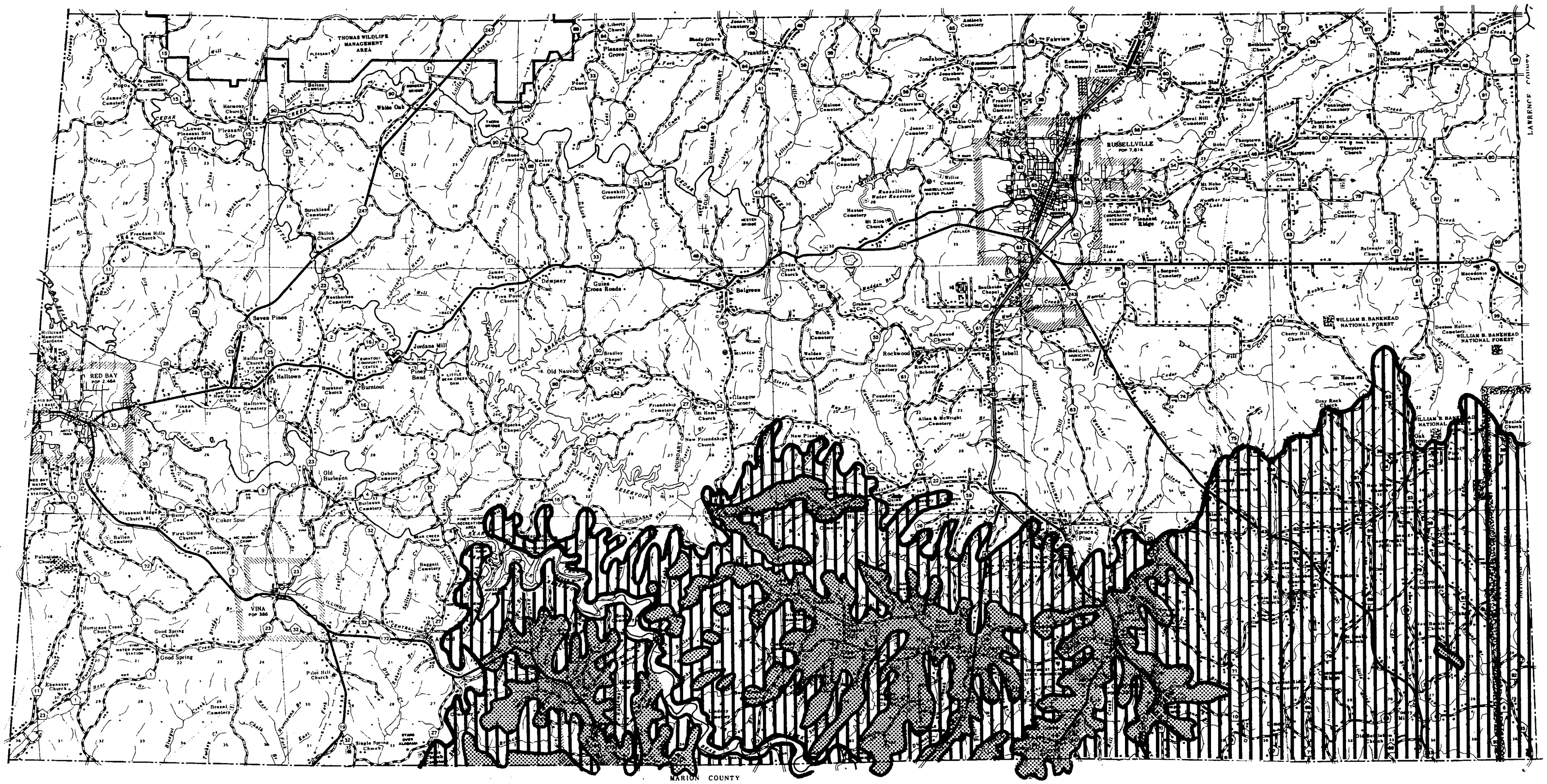


FIGURE 60. Fayette County.



FRANKLIN COUNTY
ALABAMA

FIGURE 61. Franklin County.

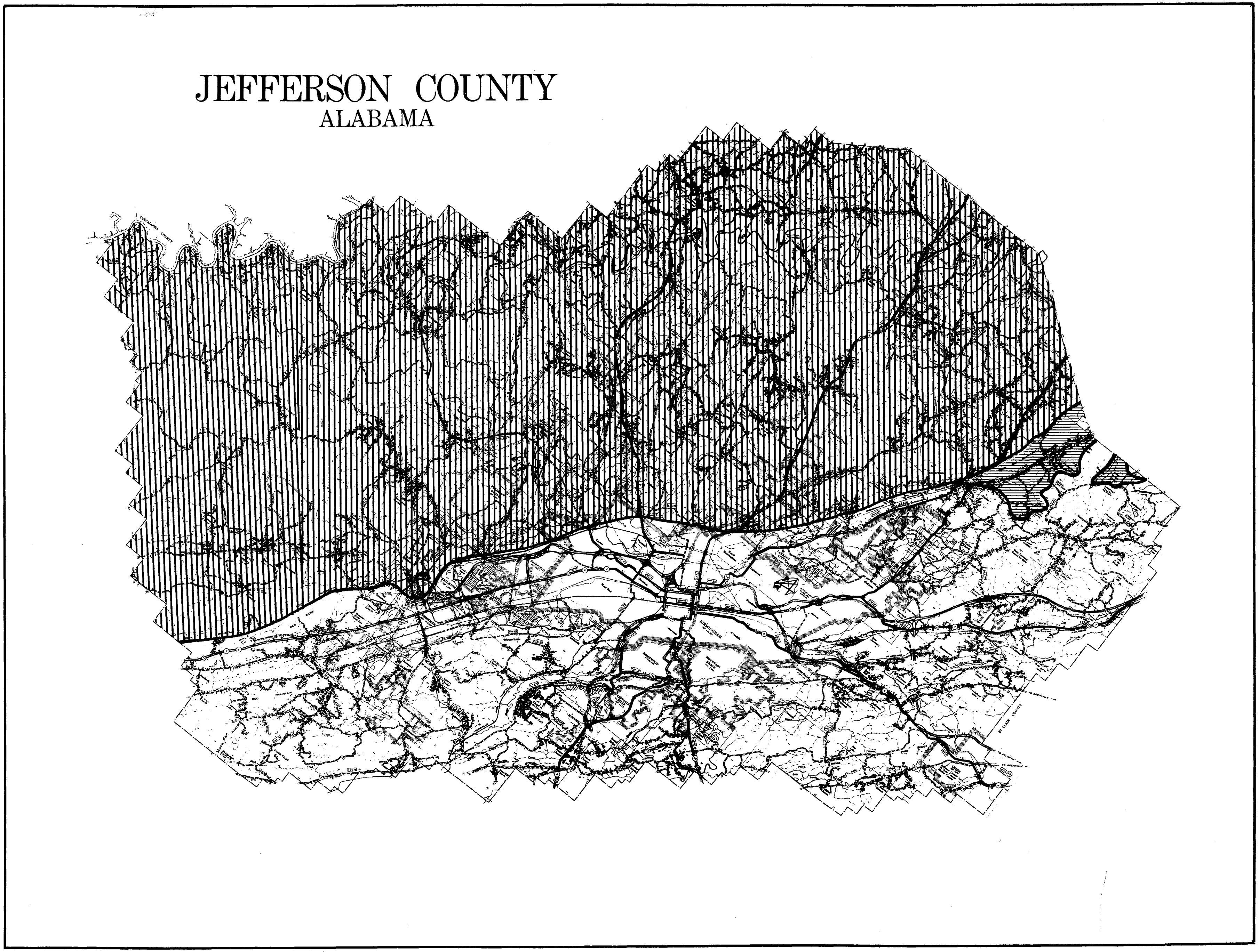


FIGURE 62. Jefferson County.

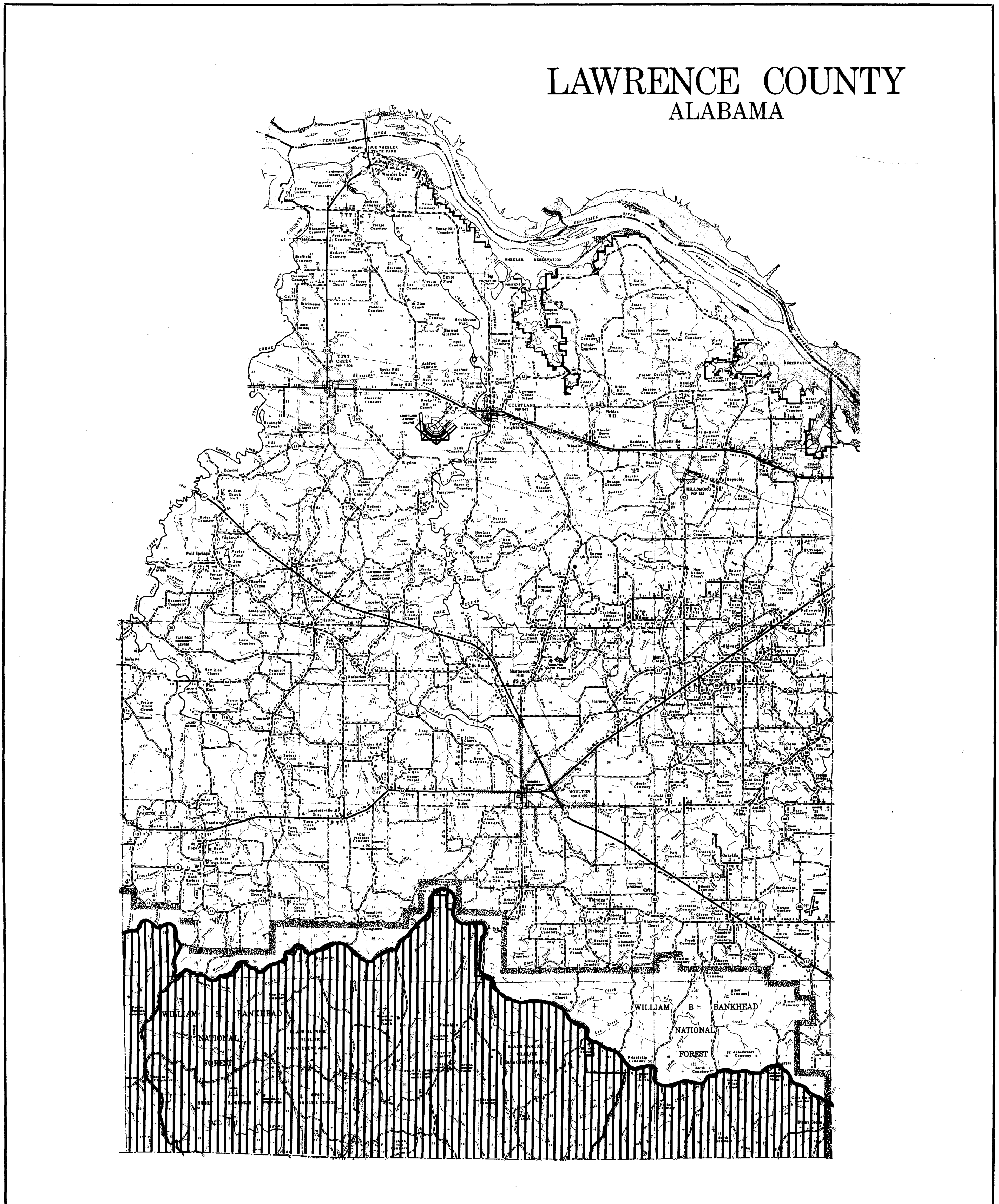


FIGURE 63. Lawrence County.

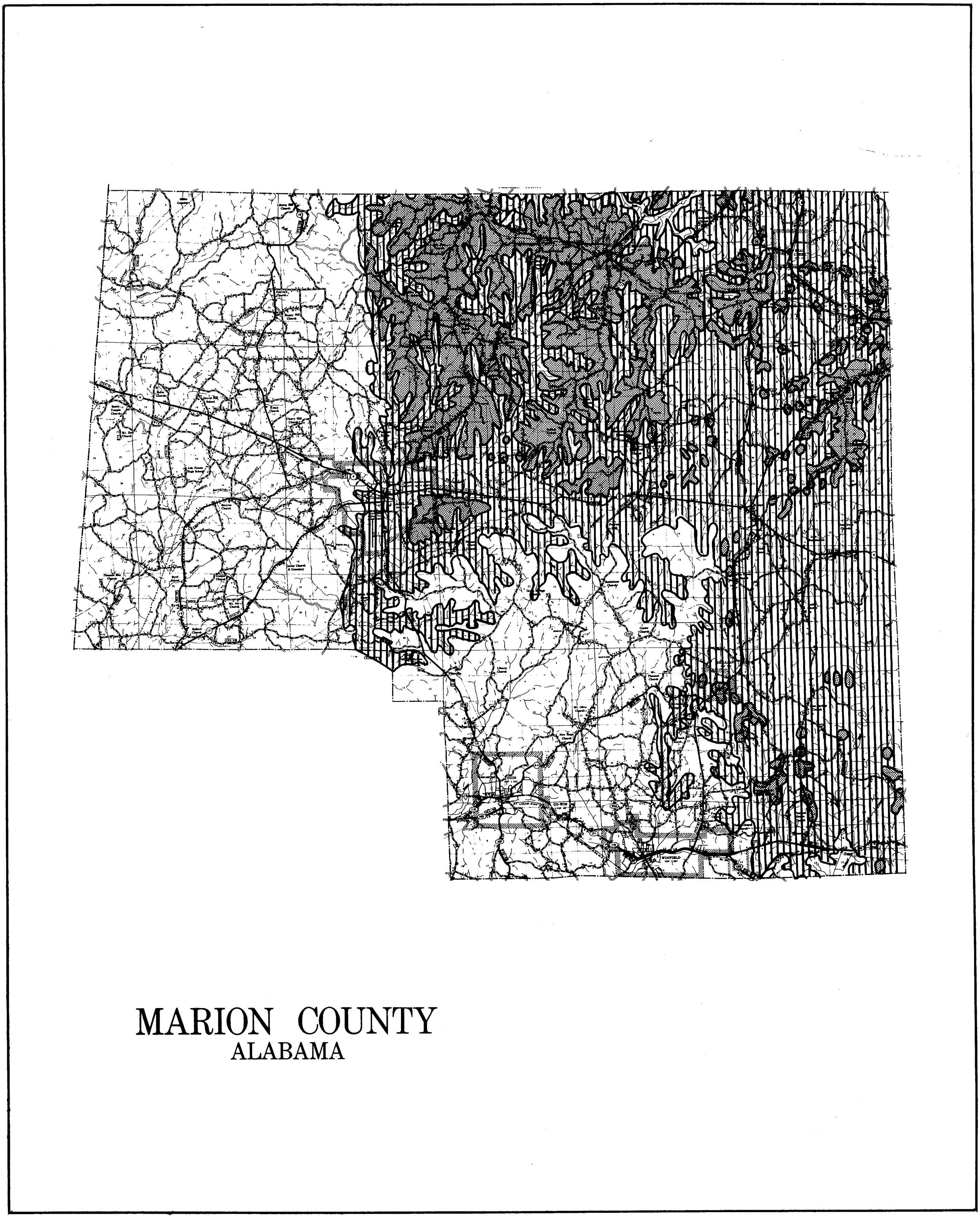


FIGURE 64. Marion County.

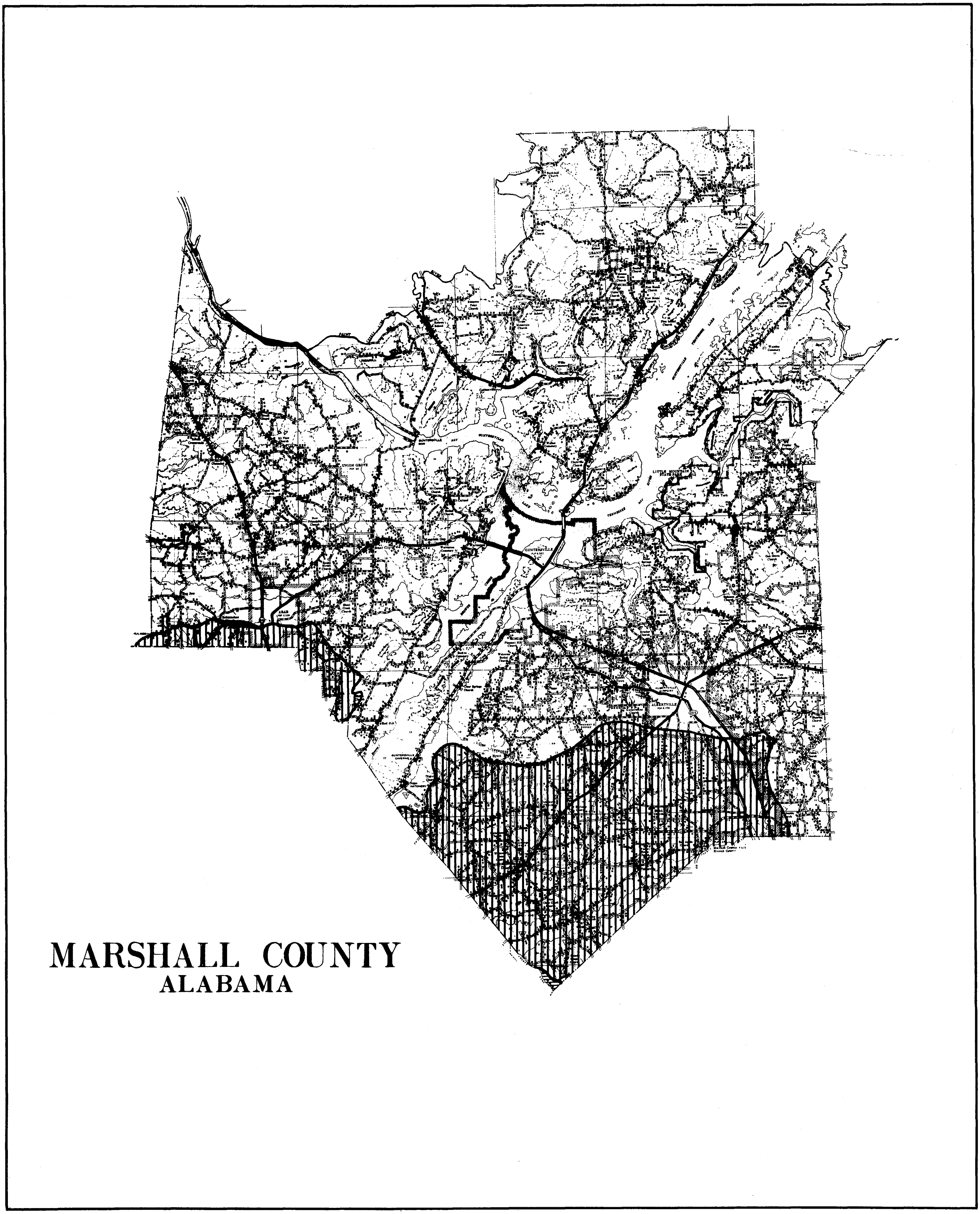


FIGURE 65. Marshall County.

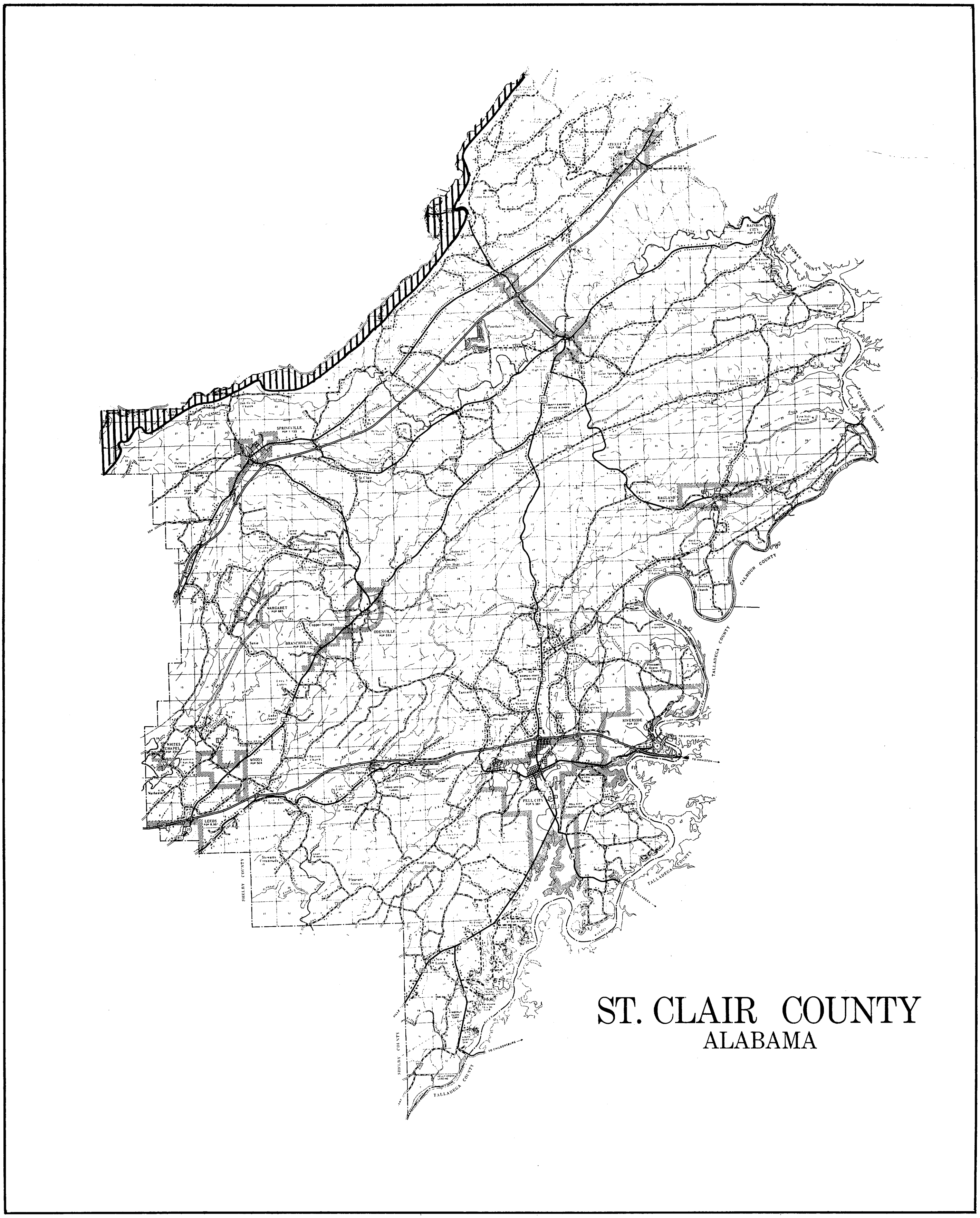


FIGURE 66. St. Clair County.

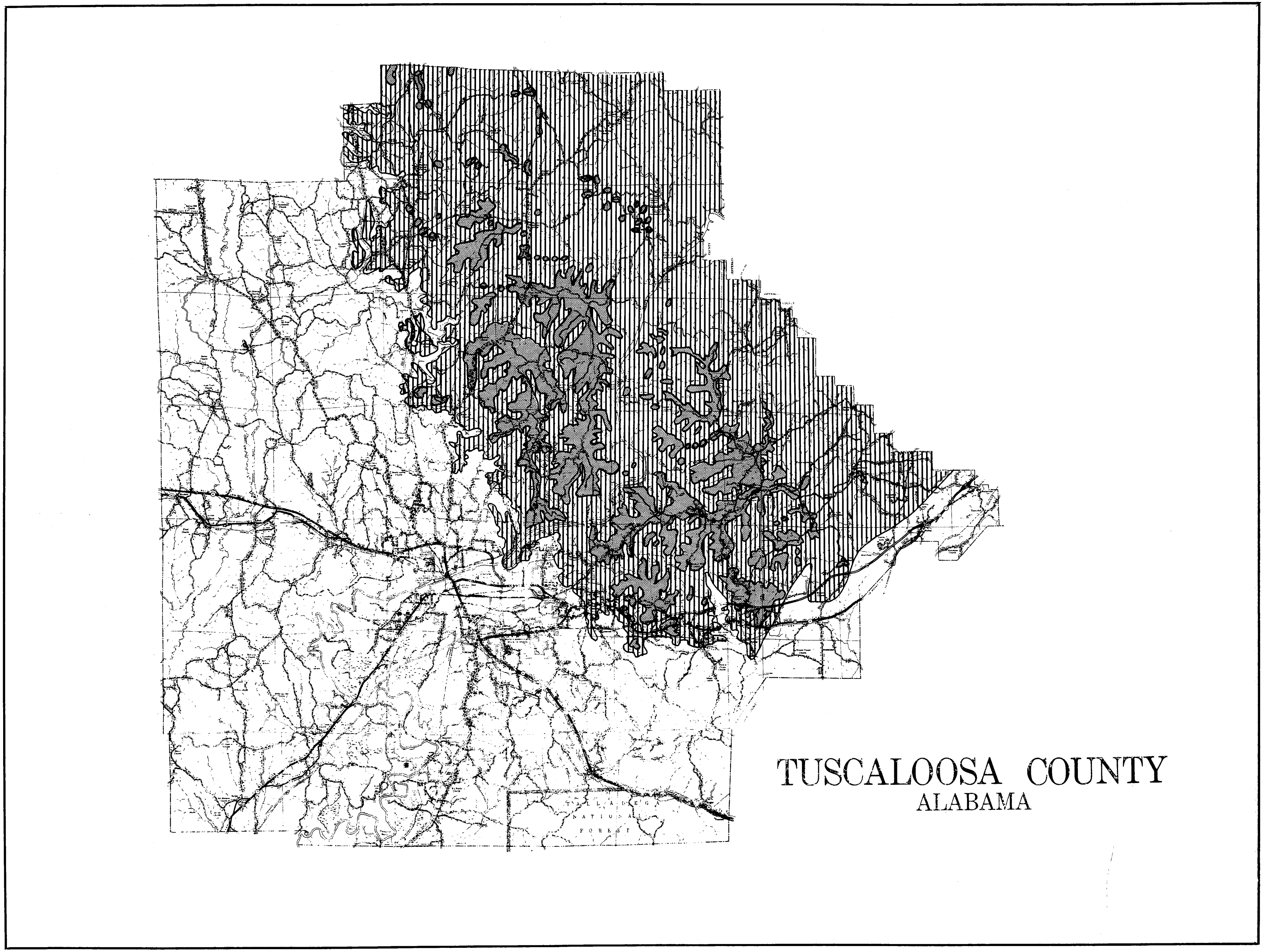


FIGURE 67. Tuscaloosa County.

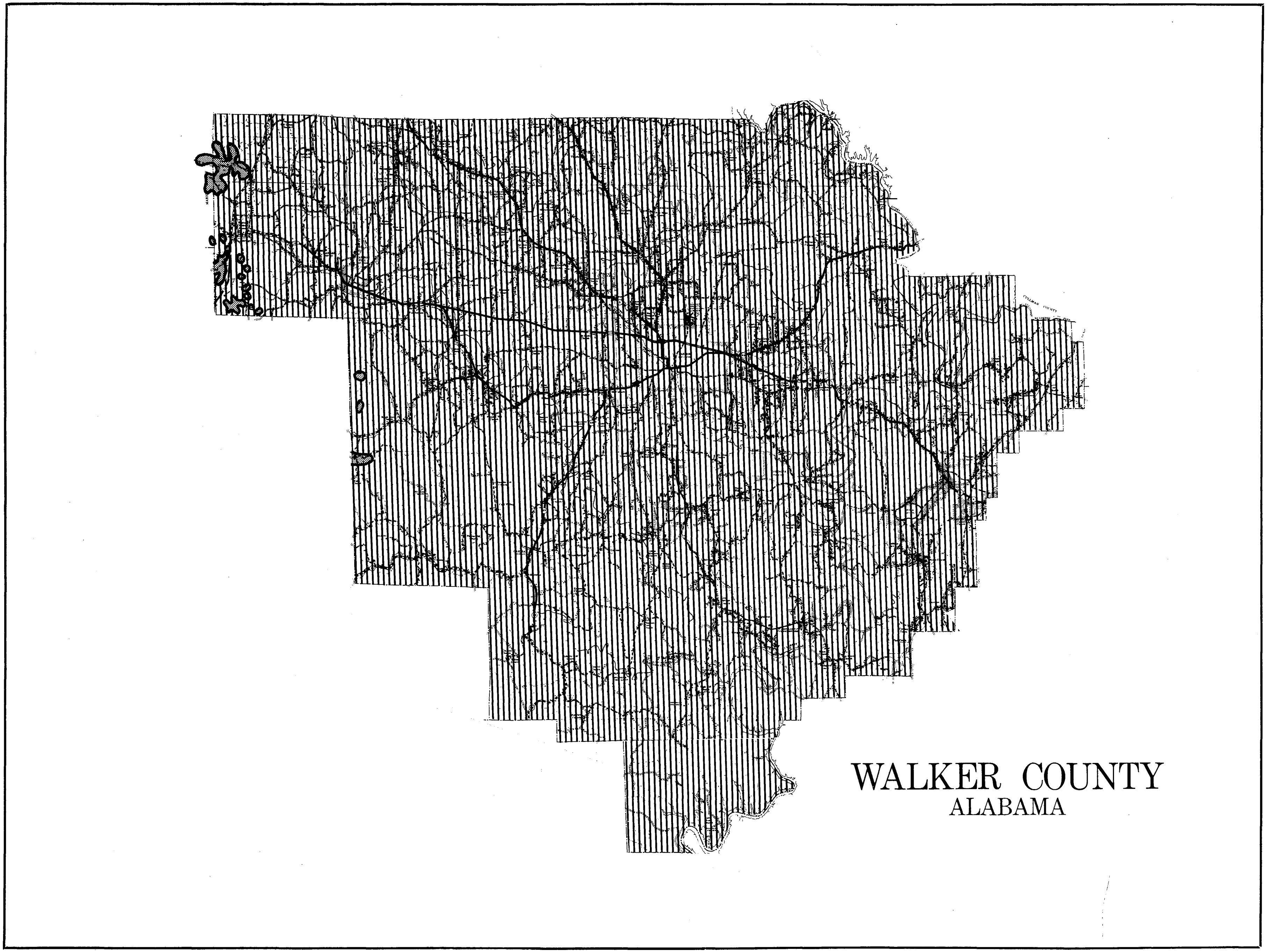


FIGURE 68. Walker County.

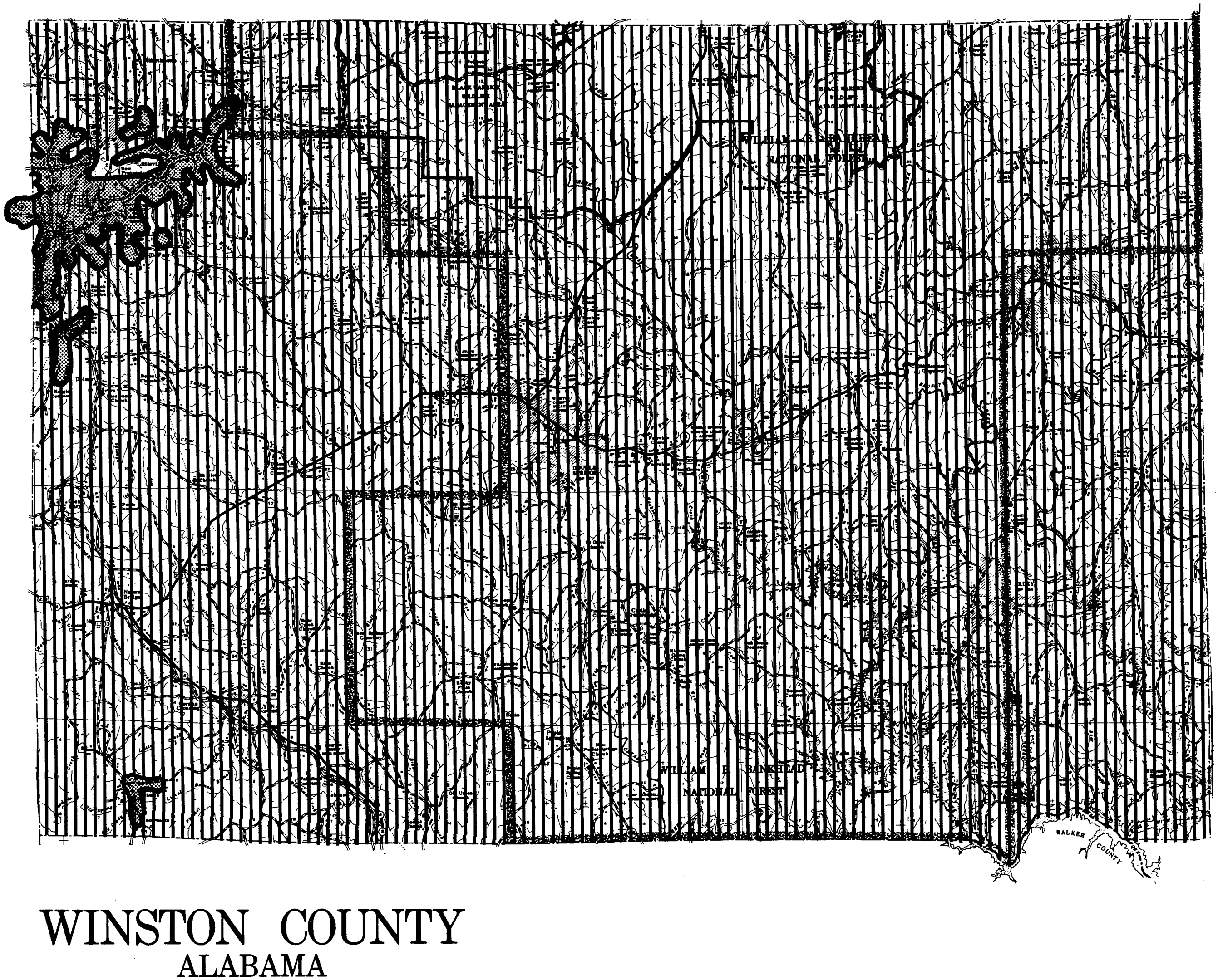
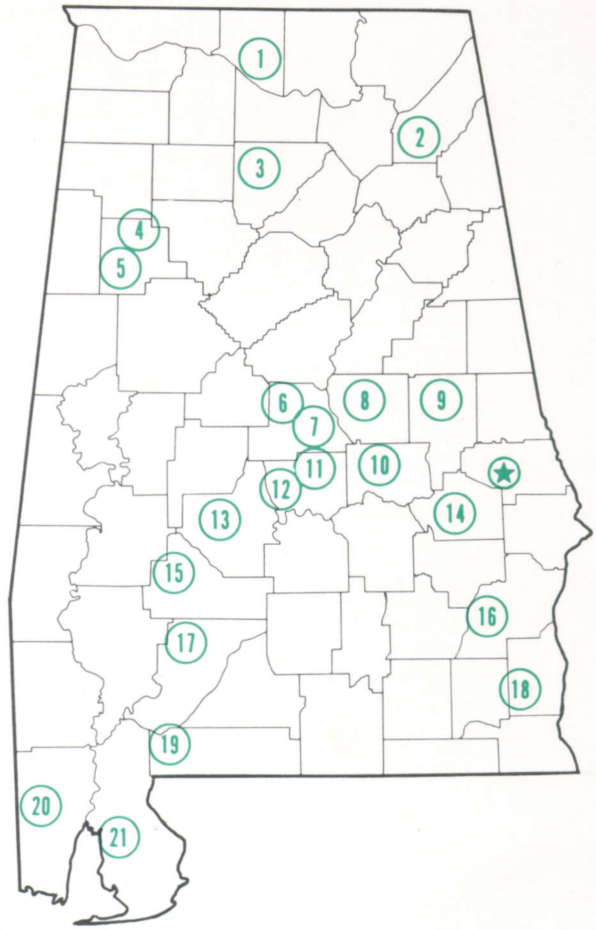


FIGURE 69. Winston County.

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.