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The Woody Biomass Resource of Alabama

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CONTENTS

INTRODUCTION 1
METHODS AND DISCUSSION 2
STATE CHARACTERISTICS 3
RESULTS 5
OWNERSHIP 9
FOREST TYPE 10
HARVESTING 11
LITERATURE CITED 12
APPENDIX 13
  RELIABILITY OF THE DATA 13
  DEFINITIONS 13
  SPECIES LIST 15
  TABLES 18

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INTRODUCTION

The extent of total live biomass in a forest ecosystem is summarized by the following classical equation (Odum 1971):

$$\text{Biomass Accumulation} = \text{Gross Productivity} - \text{Plant Respiration} - \text{Animal Respiration} - \text{Saprobe Respiration}$$

This biological equation ignores the human influence on the accumulation of woody biomass. When forests are disturbed by cutting, another reduction factor is introduced to the right side of the equation. Consequently, this has a drastic affect on the overall accumulation of biomass in the forest community.

All of society's wood products originate from woody plants photosynthetic process of organic matter. In the distant past, this forest production was viewed from a lumberman's perspective. Today, the forests of North America are perceived differently than they were only 20 years ago. New viewpoints and forest values now recognize more than lumber use. Recreation, watershed protection, and the wildlife ecosystem are seen also as products of the forest. Beyond this is a new perception of the forest as a large standing stock of utilizable vegetative biomass (phytomass). Many business concerns have become very interested in utilizing this forest biomass as a fuel to supplement or replace petroleum as its supply diminishes and/or its prices rise.

If forest biomass becomes a substantial component of fuel supply, certain resource supply/demand issues become evident. This, in effect, will impact on the future of forest biomass as a renewable resource element. To supply a growing demand for biomass fuel, certain limited management options are available to managers: (1) establishing fuel forests, by planting fast growing species such as pine, sycamore, sweetgum, and cottonwood (planted and cut on very short rotations of 10 years or less); (2) utilizing the non-merchantable upper portion of merchantable trees that are harvested for lumber or paper and utilization of non-merchantable trees; (3) reducing pulpwood consumption by recycling paper and using the diverted wood fiber for fuel; (4) competing with paper and lumber industries for existing forest stands (and thus possibly resulting in option 3).

All of the above approaches, except the third, could have an adverse effect on long-term soil quality maintenance. Jenny (1980) has illustrated that continual removal of one-third or more of the organic residues remaining after tree harvest would have a dramatic effect in reducing soil fertility and water-holding capacity of soils. He also cites several studies demonstrating that continued removal of forest litter and residues, with corresponding organic matter reductions, results in reduced yields and loss of soil texture. Mineral fertilizers can enhance short-term yields but do nothing to restore important soil texture. Concern is growing about maintaining both physical and chemical soil characteristics where total above-ground biomass is removed, especially at frequent intervals (Barber and Van Lear 1984, Bengtson 1981, Kellison 1983, Odum 1983, Phillips and Van Lear 1984).

Potential users of wood energy are the forest industry, light-duty industry, public institutions (schools, hospitals, power companies) and homeowners (primarily heat). In the southern U.S., approximately 50 percent of the forest products industry is energy self-sufficient, with the goal to be totally so in the near future. Approximately 60 percent of the wood energy will come from mill residues, the remainder from forest residues (Kellison 1983). Because oil prices have decreased since 1979, use of wood residues as energy has fallen off.

The organizations that continue to use wood fuel directly from the forest conclude that, presently, this supply must be free stumpage and within a 25-mile radius of the user facility to be economically feasible (Kellison 1983).

Today in the U.S., 3 percent of the total gross energy consumption involves biomass fuels (Department of Energy 1983). By the year 2000, biomass could provide as much as 11 percent of the nation's energy needs (Energy Research Advisory Board 1981). A slight drawback to this is that the energy expended to collect, transport, and convert vegetative biomass to energy results in a net potential energy yield of 5 percent to United States energy production (Energy Research Advisory Board 1981).

It is clear that benefits and risks are associated with all phases of any form of energy production. The

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direct and indirect costs and benefits of utilizing biomass for energy need to be identified and evaluated. The first step in this process involves identification of the resource and its quantity, composition, distribution, and potential availability.

This paper is the second by the Southern Forest Experiment Station Forest Inventory and Analysis Work Unit to characterize the forest biomass resource of a Midsouth State.

METHODS AND DISCUSSION

The fifth Alabama forest inventory was completed in 1982 (Rudis et al. 1984). The primary focus of this project described the growing-stock volume and depicted its distribution throughout the State. In all, 87,000 trees were measured on 3,723 sample plots. The detailed information obtained on these trees is readily adapted to individual allometric, tree biomass equations currently available in the literature.

The Alabama inventory recorded 82 commercial tree species and 19 noncommercial species out of the 127 species listed for the 7 Midsouth states (see Appendix). Also, several infrequent noncommercial species were lumped into a single species category. Prediction equations are not currently available for each of these species.

General equations developed for the softwood, soft hardwood, and hard hardwood groups were used to estimate weights for species in which no coefficients are yet developed. In many instances, species specific coefficients were applied to other species similar in morphology and specific gravity. For example, coefficients have not been developed for all the oaks, thus specific coefficients from other oak species were applied to make these weight estimates. This resulted in a better estimate than with the use of general equations. Recent work has demonstrated that multispecies biomass regressions give an estimate similar to that derived from species- and site-specific tree regressions (Freedman 1984). Even so, refinement of biomass estimates will continue in the future as more individual tree species biomass work is completed.

Appropriate species equations were then applied to the primary tree measurements obtained in the inventory. For trees greater than 5.0 inches in diameter at breast height, tree diameter and total height formulae were used for weight estimates. Trees smaller than 5.0 inches in diameter were estimated using an equation based on diameter alone.

The equations applied were developed for sample trees located on the Gulf and Atlantic Coastal Plain and Piedmont Provinces (Clark et al. 1985 and Clark pers. comm.). Although many of these equations came from areas outside of Alabama, it is believed that the physiographic similarities between the sample plot locations and the area of the Alabama inventory were appropriate for biomass estimates. It is recognized that regional differences in morphological characteristics occur among species but it is not always possible to obtain equations from specific areas inventoried. Analyses of regional species equations have demonstrated intra-species differences. For the most part, these differences occur among hardwoods and have been largest toward the drier portions of the West Gulf. Our approach was to use the most suitable equations available at the time for a given area. Investigators of regional vegetation biomass will have to deal with this problem for some time into the future.

Another problem with our estimates may be in applying these equations to understocked stands or planted stands, common in extensive inventories, because the equations are based on trees growing in natural, fully stocked stands. Estimates for trees with atypical crowns, taper, and weight per cubic foot may be slightly distorted.

In this paper, we present the information in green (fresh) weight. While recognizing that the appropriate and most commonly used scientific approach is to report information in dry weight per square meter, we feel that initial planners, managers, and strategists would prefer green weight, a common and standard purchase unit in the wood using industry. There are no scientific standards established, as yet, for presenting biomass information. The literature is diverse in methodology of component measurement techniques, components reported, and units of measure.

Total biomass, or total green (fresh) weight, is defined as the total weight of wood and bark from a 1-foot stump to the end of the twigs (see Appendix). No dimension limit on the twig end is defined. Fruits, flowers, and leaves are excluded but current year twig growth is included. The merchantable green weight is the weight of wood and bark from a 1-foot stump to a 4-inch top or larger (i.e., some stem anomaly may terminate bole length before a 4-inch top is reached). This includes the log and pole portion of growing-stock trees. The residual is the green weight of the remaining wood and bark of the stand after the merchantable component has been subtracted. This includes the crown weight of merchantable trees plus total sapling weight, total rough and rotten tree weight (minus cull deduction in rotten trees only), and total noncommercial tree weight. Again, fruits, flowers, and leaves are not included in the residual green weight component. Also, stump and roots are not included as a component or in a component anywhere in this report.

The information in this paper is meant to be both informative and useful. Correlating biomass with basal area will allow users to make rough estimates of available biomass for areas they inventory. Basal area per acre is one of the most accurately assessed

variables in the forest survey. It is a consistent and proven measure that can be reliably repeated in the field or adopted to previously inventoried stands. Basal area measurement by other investigators has consistently passed scientific objectivity criteria. When coupled with the number of stems per acre it can be used as a basis for estimating stand growth and yield or other measures of productivity. Research has repeatedly demonstrated the high correlation of basal area with volume and height (Daniel et al. 1979, Husch et al. 1982).

The inclusion of additional statistical information about basal area may help resolve stand structure problems. The basal-area and green-weight per-acre relation can be specified more completely if variances and higher statistical moments are computed. Disturbed stands with a large proportion of the harvestable basal area removed but which maintain a significant component of large trees may show average basal area similar to a young stand which has only numerous small diameter trees. Biomass for the two stands would be vastly different, but the additional statistical moments would allow an estimate of these differences. To our knowledge, no such work has been done at this time.

Many survey plots with low basal area are characterized by a few large trees and numerous small trees. Most likely, plots with low basal area are understocked (a result of disturbance) or are extremely young.

Basal area may be used cautiously as a surrogate for time in stands that do not clearly show an even-aged stand structure. An increase in basal area coupled with a relative contribution of small trees to the total stand basal area can be used to characterize stand development. Total biomass development can then be related to basal area statistics. These estimates may be considerably enhanced by the inclusion of stand average-height and a measure of species morphology.

Citing the above reasons, basal area may provide a more realistic and objective assessment than stand age in the portrayal of biomass estimates, especially for forest survey's mixed-age plots. Even though the literature contains documentation of the correlation between an increase in basal area and an increase in age, most of that work involved natural stands that were well stocked and undisturbed over a long period of time (Odum 1971, Whittaker 1975). This finding does not apply well to heavily disturbed stands where low stocking, in combination with a plurality of larger and older trees, will result in a biomass factor not representative of the age of the stand. Of course, in such instances, stand age determination becomes extremely difficult and highly subjective. It is highly probable that stand age increases as biomass and basal area increase. However, much work needs to be done on disturbed stands before conclusions regarding age and basal area can be drawn.

Correlation of biomass with stand age may also be useful to users but is somewhat limited because of the field limitations in determining ages of particular forest stands. Stand age is one of the most difficult and subjective parameters estimated by inventory field crews. To control consistency checks, Southern Station field crews only assign an exact age to stands that plainly have a plurality of stocking in one age class. In reality, this means that stands with a plurality of trees in a certain diameter and height range are given an age based on ring counts of 3 representative sample trees. Stands disturbed or that regenerated in waves over 10 to 30 years, so that not even one or two age groups are identifiable, are placed in the mixed-age category. The field crews do not have ready access to quantitative information necessary to assign stand age on these questionable, often heavily disturbed stands, where stand classes cannot be recognized consistently among different foresters. With stand age so assigned, we are confident that even-aged plots are in fact even-aged and subsequently stands are not forced into wrong age categories. Age information can be misleading if the wrong plurality is assigned to a plot and, consequently, the wrong trees are bored.

An effort has been made to report available harvest-residual biomass on 18,130,000 acres of timberland in Alabama. This information is compiled only for upland pine sites—i.e., sites on which pine is present or was formerly present. Bottomland sites and hardwood sites (pine totally absent) were not tabulated because harvesting information was not collected on these sites during the inventory. Approximately 3,500,000 acres of mixed hardwood and bottomland sites are excluded from this portion of the analysis.

The biomass of individual cut or removed trees on harvested plots was computed from predicted-diameter-only equations. Trees left standing were measured and the diameter-height equation used. The estimates in various cutting categories give a potential residual green weight, not a utilized residual green weight as it was not possible for field crews to determine whether any residual biomass was utilized on these sites, either through whole tree logging or other systems.

STATE CHARACTERISTICS

To facilitate forest inventory processes, Alabama is divided into 6 survey units: Southwest-South (Unit 1), Southwest-North (Unit 2), Southeast (Unit 3), West Central (Unit 4), North Central (Unit 5), and North (Unit 6). Much of the information presented in this paper is by survey unit (fig. 1). This approach readily portrays regional characteristics of the State.

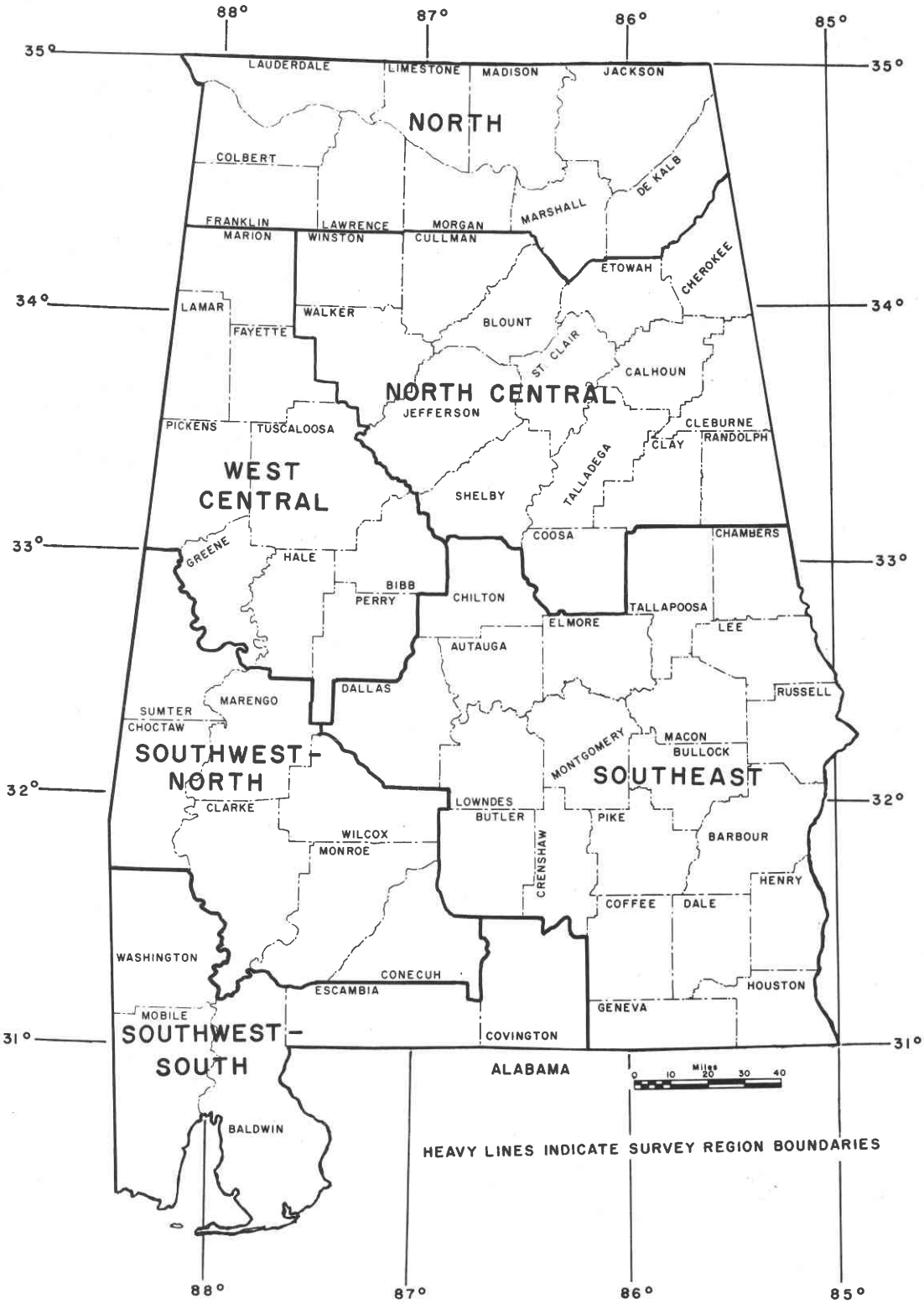

Figure 1.—*Forest survey units in Alabama.*

Since the survey units are aligned with county boundaries, they do not correspond precisely with forest community or geologic boundaries but they do approximate a relatively close correlation with geologic provinces. Most of Alabama lies on the Gulf Coastal Plain below the Fall Line (fig. 2). Included on the Coastal Plain are such major geologic features as the Fall Line Hills, Black Belt, Red Hills, and Southern Pine Hills (Fenneman 1938). The survey units on the Coastal Plain (Southwest-South, Southwest-North, Southeast, and West Central) contain 14,928,600 acres of timberland. The North unit, with 2,187,700 acres of timberland, lies mostly on the Highland Rim Province and the Tennessee Valley proper with the easternmost counties on the Cumberland Plateau. The North Central unit is mostly on the Cumberland Plateau, Coosa Valley, and the Dahlonega Plateau (Piedmont Province). There are 4,542,600 acres of timberland in the North Central unit.

Statewide, timberland totals 21,658,800 acres, 67 percent of the total 32,545,400 acres in the State. With two-thirds of the State in trees, forest vegetation dominates the landscape.

RESULTS

Total green weight of woody biomass in Alabama is 1,551.2 million tons. This is divided into 793.8 million tons of green merchantable weight and 757.5 million tons of green weight residual biomass, almost an even division between these two major components. However, this is an abstract representation and may actually be misleading. Softwood trees morphologically have a larger proportion of their stems in the merchantable section than do hardwoods. Also, softwood trees contain a lesser amount of rough and rotten components (part of the residual) than do the hardwoods. Statewide, 69 percent of the total softwood biomass is in the merchantable component, while only 39 percent of total hardwood biomass is in the merchantable section of hardwoods. When softwoods and hardwoods are combined in Statewide totals, averaging masks the dissimilarities between the two.

Figures 3 and 4 graphically portray the relative distribution of softwood and hardwood biomass throughout the State. In general, hardwood quantities are higher than softwood quantities across the State, but especially so in the southwest, west central, and northeast areas.

Alabama forests average 71.6 tons of green biomass per acre, with 43.2 tons from hardwood and 28.4 tons from softwood. The combined softwood and hardwood merchantable portion averages 36.7 tons per acre and the combined residuals average 35.0 tons per acre. Most of the 28.4 tons per acre of softwood biomass is merchantable, 20.0 tons per acre, leaving 8.4 tons per acre of residual. In contrast, of the 43.2 tons per acre of hardwood, 17.1 tons per acre are merchantable whereas 26.1 tons are residual.

Total biomass concentrations in Alabama, by unit, range from 81 tons per acre (North unit) to 59 tons per acre (Southwest-South unit). The predominance of hardwood in the North unit accounts for most of this higher concentration of biomass. The Southwest-South, Southeast, and North Central units are lowest in biomass density per acre. The forests in these units contain a higher proportion of pine and this contributes to these lower levels.

When comparing the survey units irrespective of density, the Southeast unit has the highest amounts of total green weight, merchantable green weight, and residual green weight. The Southwest-South unit contains the least amounts of total and residual

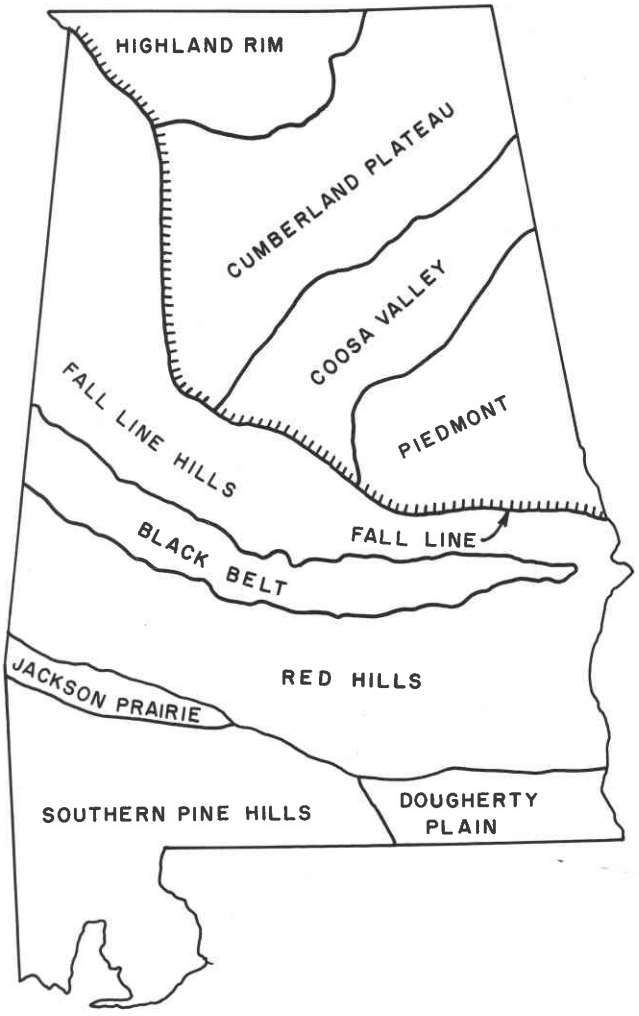

Figure 2.—*Physiographic regions in Alabama.*

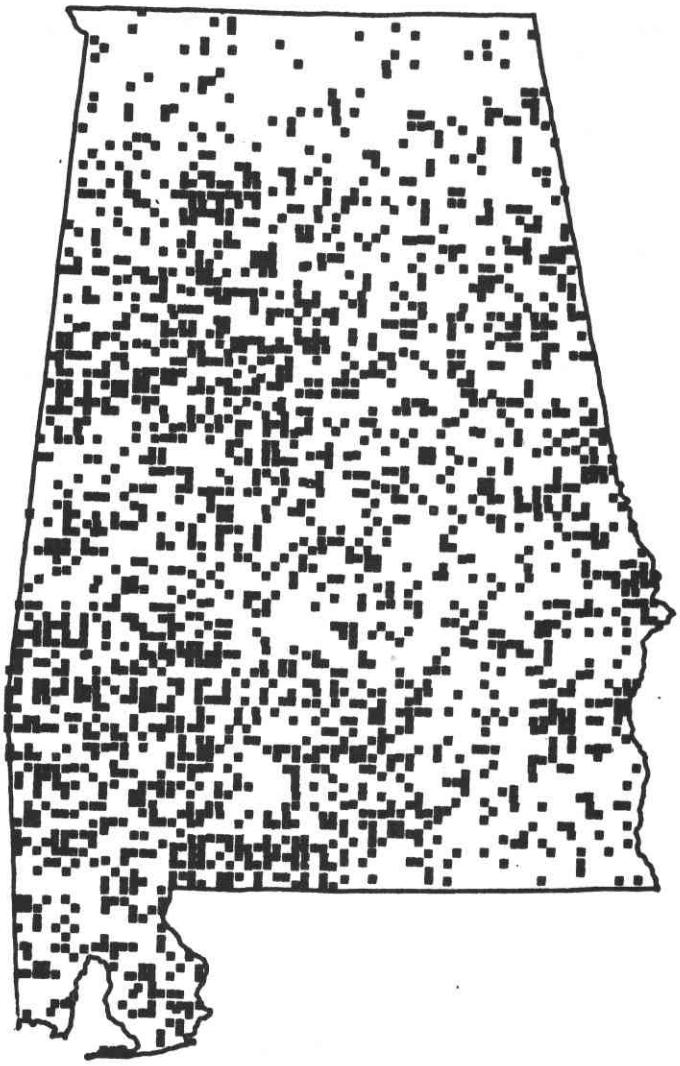

Figure 3.—*Distribution of softwood biomass, each dot representing 300,000 tons woody green weight.*

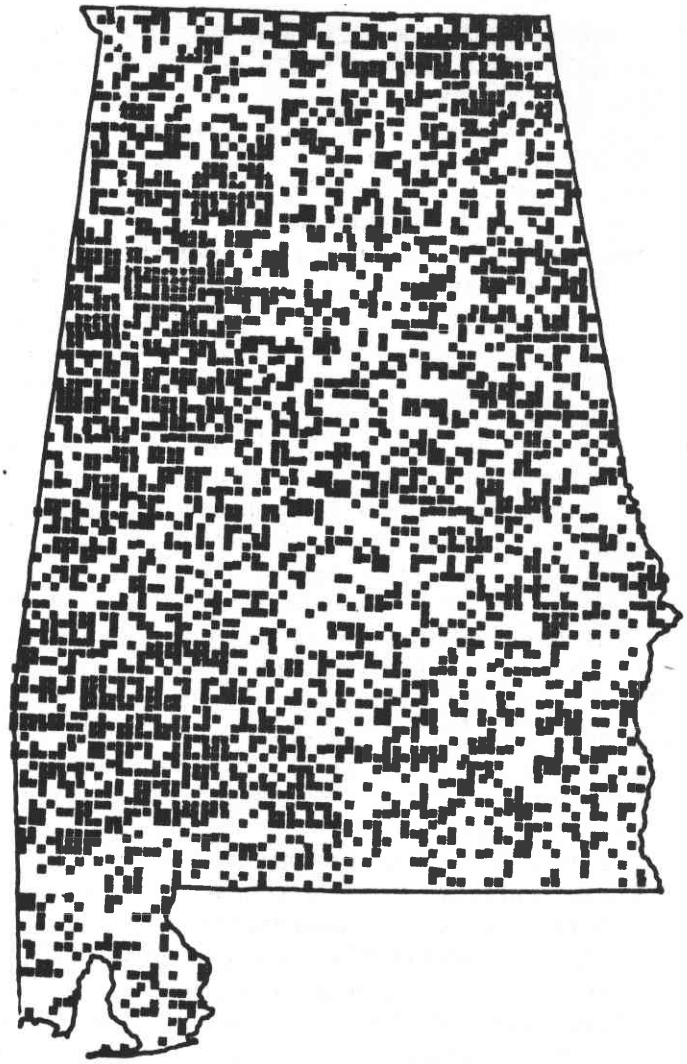

Figure 4.—*Distribution of hardwood biomass, each dot representing 300,000 tons woody green weight.*

weight while the North unit has the least amount of merchantable green weight.

All the inventory units were compared on the basis of the ratio of merchantable weight to residual weight. The Southwest-South unit has the highest merchantable to residual green weight ratio (1.17). The Southwest-North and West Central units follow closely (1.15 and 1.13 respectively) along with the Southeast and North Central units each at 1.00. The North unit has the lowest ratio (0.87) which can be attributed to the high concentration of hardwoods that contribute larger crowns, a higher proportion of rough and rotten trees, and higher sapling densities, all of which make up the residual weight component.

Forest inventory classifies forest stands on the basis of physiography: pine land, upland hardwood, and bottomland hardwood. These three major physiographic classes are not evenly proportioned in Alabama. Statewide, 18,121,100 acres are pine, 2,634,700 are bottomland hardwood, and 902,900 acres are upland hardwood. Eighty-nine percent of the acreage in the bottomland hardwood class lies south and west of the Fall Line. Seventy-eight percent of the upland hardwoods lie north and east of the Fall Line. The pine physiographic class is more evenly dispersed throughout the State with slightly higher concentrations southward.

As might be expected, biomass concentrations of physiographic classes closely adhere to the areal extent of the class. Eighty-nine percent of the bottomland hardwood biomass lies south and west of the Fall Line. Seventy-eight percent of the upland hardwood biomass lies north and east of the Fall Line. The bottomland hardwood and upland hardwood physiographic classes are almost totally hardwood with only 11 and 4 percent, respectively, in softwood biomass.

Statewide, biomass in the pine physiographic class is evenly proportioned between softwood and hard-

wood, 48 percent and 52 percent respectively. Regionally, the Southwest-South unit and the North unit are imbalanced between softwood and hardwood. The Southwest-South unit is composed of 66 percent pine and 34 percent hardwood. The North unit is 29 percent pine and 71 percent hardwood.

Concentrations of biomass on pine land, upland hardwoods, and bottomland hardwoods are 67, 86, and 95 tons per acre, respectively. The high biomass density of bottomland and upland hardwoods can be attributed to (1) higher weights of the crown portion, (2) higher productivity, especially on bottomland sites, and (3) the relatively older age for both groups as a whole (less cutting disturbance). Pine land has been greatly altered and disturbed by cutting, leaving such areas with a relatively younger age and/or lower stocking density. This results in considerably lower amounts of biomass per acre.

There are 2,779,100 acres of artificially regenerated forest stands in Alabama. The majority of these stands are in the southern part of the State with the highest concentration in the Southwest-South and Southwest-North units. Eighteen and 17 percent, respectively, of the timberland in these two units is artificially regenerated, slightly more than one out of every 5 acres.

Biomass on artificially regenerated forest land for the State is 119.9 million tons, about 44 tons per acre. This low amount of biomass per acre is attributed to artificially regenerated stands being predominantly pine, the relatively young age of most of the plantations, and selective exclusion of hardwoods. Statewide, plantations contribute only 8 percent of the total biomass. Plantations are 78 percent pine and 22 percent hardwood by weight.

By contrast, 1,431.3 million tons of biomass is in natural stands, slightly over 75 tons per acre. As expected, a significantly larger proportion of hardwood biomass occurs in natural stands than in artificially regenerated stands, 63 percent and 37 percent respectively. The Southwest-South unit contains the highest proportion of pine (48 percent) and the North unit has the lowest (18 percent).

Alabama is clearly an oak- and loblolly pine-dominated State. Fully 26 percent of the total State biomass is in oaks and 23 percent is in loblolly pine (fig. 5). This is 49 percent of the total State volume in the oak genus and loblolly pine species. In general, the oak proportion decreases toward the southern part of the State and the pine proportion decreases toward the north. The highest concentration of hardwoods in Alabama is in the North unit, the lowest in the Southwest-South unit, 65 and 28 tons per acre, respectively. The highest concentration of softwoods is in the Southwest-North unit and the lowest is in the North unit, 33 and 16 tons per acre respectively.

The *Quercus* genus is by far the dominant hardwood group in the State. At 402.1 million tons of woody biomass, it is approximately 3 times larger than its nearest competitor, sweetgum (fig. 6). The residual

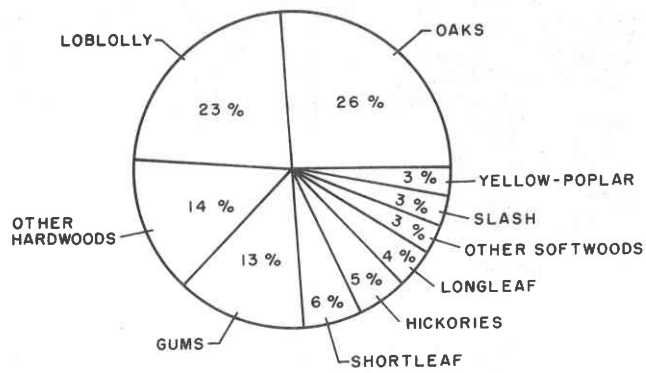

Figure 5.—*Percent of total Alabama woody biomass by species.*

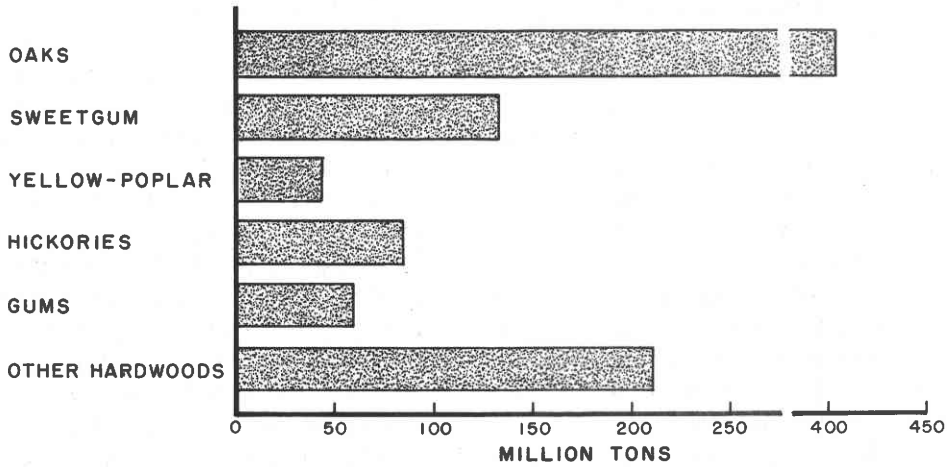

Figure 6.—*Hardwood woody biomass by species in Alabama.*

component of oak will play an important role in the availability of woody biomass. Sweetgum is the next major hardwood component of the Alabama forest ecosystem. At 133.0 million tons of woody biomass, it makes up 14 percent of all hardwoods and almost 9 percent of all woody biomass. Hickories are next, followed by gums and yellow-poplar. The *Nyssa* and *Carya* genera, along with sweetgum and yellow-poplar make up 321.2 million tons of woody biomass. These two genera and two species constitute more than the 211.7 million tons that the remaining 58 commercial and 19 noncommercial hardwood species contribute combined. The hardwood biomass is dominated by 5 genera in Alabama. Together they make up 77 percent of the total hardwood biomass in Alabama.

Of coniferous genera, *Pinus* is by far the dominant. Also recorded were *Chamaecyparis, Juniperus, Taxodium,* and *Tsuga*. In the latter conifers, only *Taxodium* contributed a significant amount to the woody biomass.

Loblolly pine, with 353.5 million tons of biomass, is the dominant conifer in the State and the dominant tree in the State (fig. 7). It is dominant in every unit except the Southwest-South unit where longleaf and slash pine are predominant.

Loblolly pine is more dominant than the entire oak genus in both the Southwest-North and Southeast units; in the West Central unit, it is co-dominant with the oak genus. The next dominant conifer, shortleaf pine, does not approach loblolly concentrations anywhere in the State. At 95.7 millions tons, it makes up only 16 percent of the softwood biomass. Slash and longleaf pine trail even farther behind and only make a significant contribution to total biomass in the Southwest-South unit.

Figure 8 illustrates the relationship between woody biomass and basal area. Basal area was also divided into eight classes to illustrate Alabama's woody biomass. Eighty-seven percent of the total woody biomass in Alabama is on timberland with a basal area of 60 square feet per acre or higher. Furthermore, 17 percent of the total woody biomass is on timberland with a basal area greater than 140 square feet per acre, meaning that 17 percent of the State's total woody biomass is on 8 percent of all timberland. By contrast, lower density stands (less than 60 square feet per acre) account for 12 percent of the State's biomass but occupy 34 percent of total timberland. It should be noted that not all the low density acreage is understocked but includes lands in the regeneration phase after harvest.

There are 7,458,400 acres below and 3,508,300 acres above the optimum management range of 60 to 120 square feet per acre. Slightly over one-half, 863.2 million tons, of Alabama's biomass is on forest land with optimum stocking. Lands that are theoretically overstocked could be thinned of approximately 175.4 million tons (estimation based on decreasing biomass by a conservative 50 tons per acre resulting from decreasing basal area 50 square feet on 3,508,700 acres from 133 to 83 square feet per acre).

A total of 15,973,220 acres of Alabama's timberland is classed as mixed-age. Of the remaining 5,685,600 even-aged acres, 2,779,100 are artificially regenerated. Of the 299.6 million tons of biomass in even-aged stands, 203.8 million tons are softwood, 68 percent of the total. The remaining 1,251.6 million tons in mixed-age stands are heavily dominated by hardwood, 839.2 million tons or 67 percent.

Alabama's hardwood biomass is fairly evenly distributed across the range of size classes (fig. 9). A total of 189.7 million tons of biomass is in the 1.0- to 4.9-inch size class, 20 percent of the State's hardwood biomass. In contrast, very little of the softwood biomass is in the 1.0- to 4.9- and the 15.0-inch and larger size classes. Sixty-nine percent of the softwood biomass is in the 5.0- to 14.9-inch range of diameters.

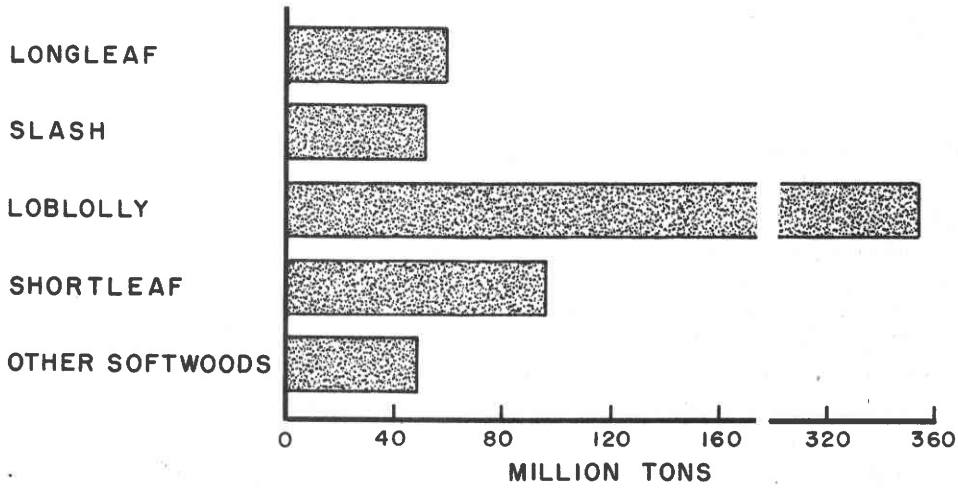

Figure 7.—*Softwood woody biomass by species in Alabama.*

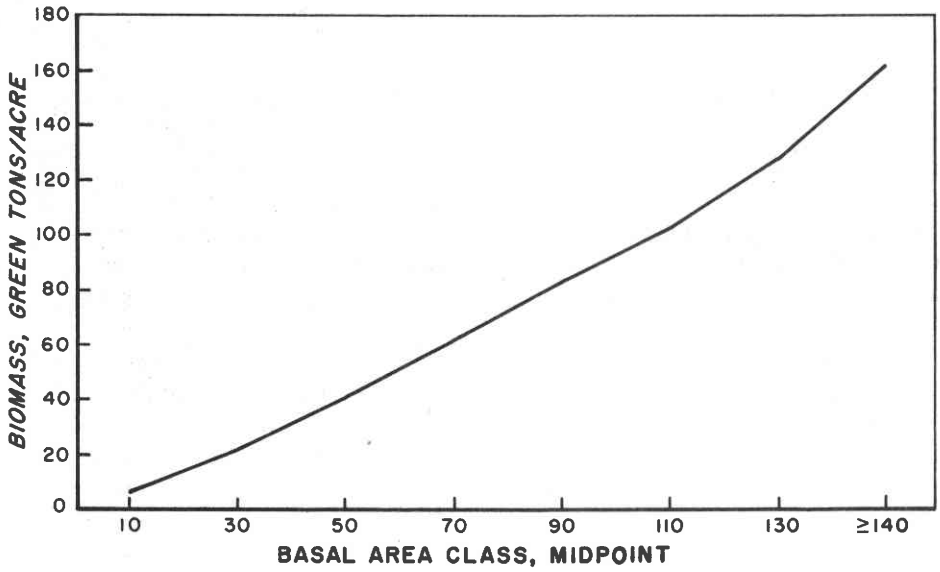

Figure 8.—*Relationship of woody biomass to basal area in Alabama.*

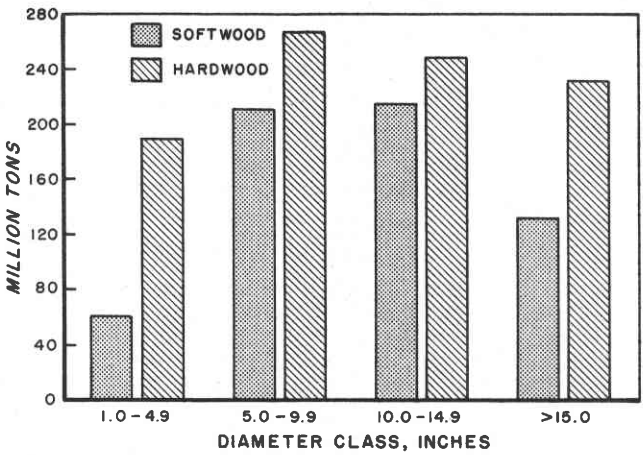

Figure 9.—*Woody biomass by broad diameter classes in Alabama.*

OWNERSHIP

The major proportion of Alabama's woody biomass is on nonindustrial private land. On such lands, 698.9 million tons of total woody biomass is in miscellaneous private ownership and 444.6 million tons is in farm ownership (fig. 10). Together, this is 74 percent of the total woody biomass resource. The next sizeable holdings of biomass are forest industry (20 percent of the resource) followed by public holdings (6 percent of the resource). Most of the hardwood biomass is on nonindustrial private land. A total of 719.5 million tons is on such lands, 77 percent of the State's hardwood biomass. Likewise, 424.1 million tons of softwood biomass is in nonindustrial private ownership, 69 percent of total softwood biomass.

The nonindustrial privately-owned biomass is proportionately highest in the northern portion of the State, in particular the North and North Central units and also in the Southeast unit. The amount of biomass on private land is higher than forest industry or public land in every survey unit. In relation to nonindustrial private biomass volume, forest industry biomass holdings are proportionately highest in the Southeast-South, Southeast-North, and West Central survey units. Public-owned biomass is most significant in the North, North Central, and West Central units. Even so, in the North Central and North units, public-owned biomass is still only 12 percent and 11 percent, respectively, of the 2 units total biomass.

The residual biomass is also highest on nonindustrial private land, 566.2 million tons (75 percent of the State total residual and 36 percent of the total State biomass weight). Seventy-three percent of the State's merchantable biomass is also on nonindustrial private land. It is clear that future interest in biomass availability and procurement will involve the status of private owners.

Biomass concentrations are lowest on nonindustrial private land, 69 tons per acre. Forest industry follows with public ownership highest, 81 and 86 tons per acre respectively. It is evident when looking at hardwood and softwood concentrations that the primary differences between nonindustrial private ownership versus forest industry and public ownership is the difference in softwood biomass. Forest industry manages most intensively for pine and produces softwood concentrations of 40 tons per acre. Public ownership also manages for pine, but much of other public ownership is in bottomland areas comprised mostly of older hardwood stands. This results in public owner-

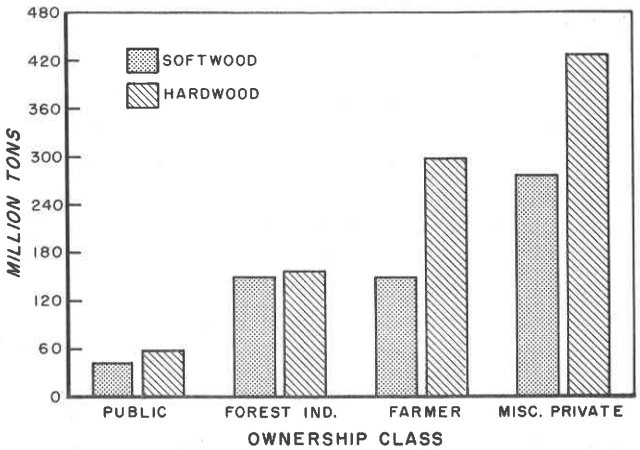

Figure 10.—*Woody biomass by major ownership category in Alabama.*

ship being high in concentrations of both softwood and hardwood biomass, 36 and 50 tons per acre, respectively. Nonindustrial private lands, while nearly equivalent to forest industry and public ownership in hardwood concentrations, rank far below in softwood concentrations. Farm lands are lowest, 23 tons per acre, with miscellaneous private ownerships not faring much better, 27 tons per acre. The primary reasons for low softwood concentrations are selective cutting of pine, leaving non-utilized hardwoods standing, and taking no steps to ensure the re-establishment of pine.

As management activity intensifies in a stand, the level of residual biomass decreases. Since biomass users in industrial concerns cannot compete with lumber and pulp industries for merchantable material, this could become an important consideration since biomass collection will primarily be from residual material remaining on site after removal of merchantable material. In Alabama, the ratio of merchantable to residual biomass on nonindustrial private land is 1.02. Forest industry land has a merchantable to residual ratio of 1.12 and public land has a ratio of 1.15.

FOREST TYPE

Statewide, softwood and hardwood biomass totals are highest in the loblolly-shortleaf and oak-hickory forest types (fig. 11). The loblolly-shortleaf type contains 55 percent of the total softwood biomass in the State. The oak-hickory type contains 46 percent of the State's hardwood biomass. The softwood biomass in the loblolly-shortleaf type is most prominent in the Southwest-North, Southeast, West Central, and North Central units. Hardwood biomass in the oak-hickory type is most prominent in the Southeast, West Central, and North Central units.

Residuals for softwood are highest in the loblolly-shortleaf type, 109.8 million tons. Hardwood residuals are highest in the oak-hickory, oak-gum-cypress, and oak-pine types, at 256.3, 119.8, and 109.9 million tons, respectively.

Highest biomass concentrations are in the oak-gum-cypress forest type, 95 tons per acre. This is due to the older age and higher productivity of these stands that virtually have no softwoods. Only 6 percent of the biomass per acre is softwood. The concentration of biomass in the loblolly-shortleaf type follows at 75 tons per acre, 77 percent of which is softwood. Biomass density for the longleaf-slash, oak-pine, and oak-hickory forest types are next at 63, 66,

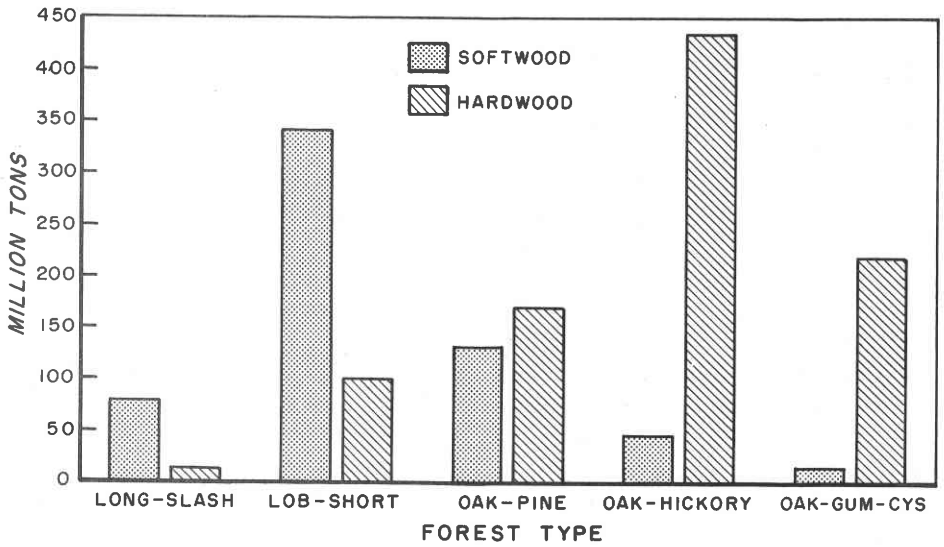

Figure 11.—*Woody biomass by major forest type in Alabama.*

and 66 tons per acre, respectively. Only the oak-pine type is fairly evenly distributed with 44 percent softwood and 56 percent hardwood. All of the other types are heavily skewed either to softwood or hardwood.

Of significance is the amount of rough and rotten tree biomass in the oak-hickory forest type, 85.7 million tons. This is 39 percent of the total rough and rotten biomass. Statewide, there are 12 tons per acre of rough and rotten biomass in the oak-hickory forest type and the 18 tons per acre of rough and rotten biomass in the oak-gum-cypress forest type.

HARVESTING

The Alabama inventory process documented harvesting practices on 18,121,100 acres. This acreage is on upland sites where pine is present or was formerly present. Harvesting information was not collected on 903,000 acres of upland hardwood and 2,634,700 acres of bottomland hardwood sites.

Of these 18,121,100 acres documented, 6,271,400 had some form of cutting practice applied between 1972 and 1982. This includes all types of cutting, from single tree selection to complete clearcuts. Partial cutting accounts for a big portion of harvested acreage, 2,858,800 acres. These harvests include seed tree, strip cutting, shelterwood, group selection, and single tree selection. Slightly over 60 percent of the partial harvest acreage is in the single tree selection category, 1,739,100 acres. It should be noted that single tree selection in the southern States is usually not practiced as a silvicultural tool in the traditional sense but is commonly applied to harvest certain trees without thought of regeneration or stand perpetuation. These cut trees are usually harvested (by nonindustrial private owners) in regard to economics or immediate use (firewood); and in this sense, with increasing intensity, may overlap other partial harvest methods such as diameter limit cut, shelterwood cut, or group selection.

Since field crews only visit the permanent sample plots at a specific point in time, it is not always easy for them to assess the actual harvest system that was applied to the area or to even tell if the site was whole-tree logged or if only merchantable material was removed.

Biomass estimates for harvested trees were predicted in a slightly different manner than live trees on nonharvested acreage. First, total green weight biomass was estimated prior to cutting. This included cut trees, standing trees, commercial and noncommercial trees, rough and rotten trees, saplings, and trees that were knocked down. Trees that were cut were given a predicted diameter based on the time since last inventory up until the time they were cut. Biomass was then predicted using a diameter-only equation since total height was not recorded during the prior inventory. Next, the weight of merchantable section of cut trees was calculated. Finally, the residual of harvested plots was estimated. Residual includes all trees >=1.0-inch that were left standing or were knocked down and the tops and unused portions of all cut trees. Included are cull and noncommercial species. The merchantable section includes the weight of the utilized portion of all cut trees. This includes the stem up to a 4.0-inch merchantable top.

Timberland that was clearcut in Alabama between 1972 and 1982 yielded woody biomass that averaged 95 tons per acre before cutting. Of this, 52 tons per acre was in softwood biomass and 43 tons per acre in hardwood. Timberland that was partially cut averaged 105 tons per acre before cutting operations. On these lands, softwoods averaged 57 tons per acre while hardwoods averaged 48 tons per acre.

One of the most intense forms of cutting application is the clearcut. In Alabama, there were 2,482,200 acres cut in this manner. The highest concentration of clearcutting was in the North Central unit where 15 percent of total timberland was subjected to a cut. The West Central unit was next highest at 13 percent, followed by the Southwest-North and Southeast units, both at 12 percent of timberland being clearcut.

Of most interest is the residual green weight of biomass material left on these lands after clearcutting. A total of 132.2 million tons of crowns and nonutilized material (standing or knocked down) remained after 103.8 million tons of merchantable biomass were cut and removed. The West Central unit has the highest total residual, 59 tons per acre. It is interesting to note that the residual weights on these clearcut lands approaches the State average for total green biomass of 71.6 tons per acre.

The highest softwood residual concentration was in the West Central unit, followed closely by the Southwest-South unit. Excluding the North unit, which naturally has the lowest concentration of softwood, the range of softwood biomass residual was from 23 to 29 tons per acre for the remaining 5 units.

The Southeast and North units both had hardwood residual concentrations of 33 tons per acre, the highest for the State. The lowest hardwood residual was in the Southwest-South unit where softwoods clearly outrank hardwood concentrations. Excluding the Southwest-South unit, the range of residual concentrations was 26 to 33 tons per acre.

Overall, clearcutting as practiced in the State leaves similar residuals in all regions. The amount of total biomass residual remaining on clearcut lands differs by no more than 10 tons per acre between inventory units. The ratio of removed merchantable to residual for total biomass is 1.27. For softwoods, the ratio is 0.88 and for hardwoods it's 2.03. Obviously, the utilization of softwoods, because of morphology and economics, is much higher than hardwoods.

Because of potential practical application for a biomass harvest after merchantable material is removed, biomass on clearcut pine upland sites is reported in two classes: material left alive and standing, and material that was either cut and left on the gound or knocked down in the process of the cutting operation. Retrieval of biomass material that is left on the ground may not be economically feasible, currently, due to equipment limitations and labor intensity.

The amount of standing material left on clearcut pine upland sites averages only 10 tons per acre, Statewide. This is 24 percent of the total residual left on site. Downed biomass averages 42 tons per acre Statewide. For both downed and standing biomass, 50 percent is softwood and 50 percent is hardwood.

The major quantitative difference between clearcuts and partial harvests is the proportion of merchantable material removed. On partially cut lands, 23 percent of the merchantable portion of biomass was cut and removed. On clearcut lands, 44 percent of the merchantable portion of biomass was removed. This results in different quantities and tree classes of biomass remaining after different cutting operations, with partial cut timberland containing varying amounts of merchantable trees in the remaining standing tree population. Only a conjectural estimate can be made of available material for biomass utilization on these partial cut lands because degrees of cutting range so broadly. One possible way to estimate the biomass residual on such lands is to use the same proportion of merchantable material removed, as on clearcut land, and subtract this difference from the current residual. Using the combined proportion of 44 percent for the State (53 percent softwood, 33 percent hardwood), yields 76.2 million tons of residual softwood biomass and 91.6 million tons of residual hardwood biomass, Statewide, on partial cut lands. There are many considerations in collecting residual biomass on these lands such as considering the damage to saplings and pole-size growing-stock trees of the future stand. Another consideration is the varying concentrations of this residual; adequate quantities per acre must be present for a biomass harvesting operation to be feasible.

On timberland that had any form of cutting operation, an estimate can be made of the total residual biomass. A total of 174.3 million tons of residual softwood and 201.4 million tons of residual hardwood biomass were left on upland timberland between 1972 and 1982 (using above adjustment on partial cut timberland). This is approximately 174.4 and 201.5 hundred thousand tons per year average for the State. A realistic estimate would most likely be much less as consideration must be allowed for maintenance of forest site conditions such as soil productivity, organic matter content of soil, nutrient availability, degree of soil disturbance during cutting practices, and slope of land. Any of these conditions, or others, would dictate removing far less or no residual from the forest stand. High soil temperatures, especially in the south, necessitates leaving some material for organic matter refurbishment.

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Appendix

RELIABILITY OF THE DATA

Reliability of the estimates is subject to errors in measurement of individual trees and sampling errors. Tree measurements for biomass estimation are diameter at breast height (d.b.h.) and total height for trees equal to or greater than 5.0 inches d.b.h., and d.b.h. alone for trees smaller than 4.9 inches, mortality trees, and cut trees. Errors in individual tree biomass derive from application of these measurements in biomass equations developed by Clark (1985). They were examined in the analyses but are not reported here. Sampling error is amenable to mathematical evaluation for probability of error. Sampling errors reported here are based on one standard deviation. That is, the probability is two out of three that the values reported here would have been within the limits reported of the true total value.

Estimates for county totals are presented. Aggregate error for more than a single county or for other subsamples may be obtained by applying the formula:

$$SEG = \frac{SET\sqrt{XT}}{\sqrt{XG}}$$

where

SEG = Standard error (SE) of the estimate for the group of counties in percent.

SET = SE of estimate for the State total in percent.

XT = State total for component of interest (total, merchantable or residual).

XG = Total for group of counties.

The first 5 counties of table 37 have been grouped to illustrate the computation of softwood residual biomass standard error percent.

XT = 1911.6 (Hundred thousand tons)

XG = 180.4 (Hundred thousand tons)

SET = 2.1 Percent (table 38)

$$SEG = \frac{2.1\sqrt{1911.6}}{\sqrt{180.4}}$$

SEG = 6.8 Percent

Hence, weight of softwood residual biomass in the 5 counties lies between 168.8 and 192.7 with a probability of two chances out of three.

DEFINITIONS

Biomass Types

Biomass, Woody—The amount of live organic material in woody vegetation. Included is bark and wood; excluded is fruits, flowers, leaves, stump, and roots.

Merchantable Green Weight—Fresh weight of woody biomass of all growing stock trees greater than 5.0 inches d.b.h. from a 1-foot stump to a 4.0-inch diameter outside bark (d.o.b.) or to a point prior to reching a 4.0-inch d.o.b. because of branching, forking, rot, or other factors which would exclude the bole from merchantability.

Residual Green Weight—Fresh weight of woody biomass of the nonmerchantable portion of all growing-stock trees greater than or equal to 5.0 inches d.b.h., all saplings, all noncommercial trees, and all rough and rotten trees.

Total Green Weight—Fresh weight of woody biomass for all live woody vegetation greater than or equal to 1.0-inch d.b.h.. Included are growing-stock, commercial, noncommercial, and rough and rotten (sound portion) trees.

Tree Classes

Commercial Species—Tree species currently or prospectively suitable for industrial wood products. Excluded are noncommercial species such as blackjack oak and blue beech.

Noncommercial Species—Tree species of typically small size, poor form, or inferior quality which normally do not develop into trees suitable for industrial wood products.

Growing-Stock Trees—Live trees of commercial species classified as sawtimber, poletimber, sapling, and seedlings. Rough and rotten trees are excluded.

Rough Trees—Live trees of commercial species that are unmerchantable for saw logs currently or potentially because of roughness or poor form. Also included are all live trees of noncommercial species.

Rotten Trees—Live trees of commercial species that are unmerchantable for saw logs currently or potentially because of rot.

Saplings—Live trees 1.0 to 4.9 inches in diameter.

Hardwoods—Dicotyledonous trees, usually broad-leaved and deciduous.

Softwoods—Coniferous trees, usually evergreen, having needle or scale-like leaves.

Forest Types

Longleaf-Slash Pine—Forests in which longleaf or slash pine, singly or in combination, comprise a plurality of the stocking. Common associates include other southern pines, oak, and gum.

Loblolly-Shortleaf Pine—Forests in which pine and eastern redcedar (except longleaf or slash pine), singly or in combination, comprise a plurality of the stocking. Common associates include oak, hickory, and gum.

Oak-Pine—Forest in which hardwoods (usually upland oaks) comprise a plurality of the stocking, but in which softwoods, except cypress, comprise 25 to 50 percent of the stocking. Common associates include yellow-poplar, elm, maple, and black walnut.

Oak-Gum-Cypress—Bottomland forest in which tupelo, blackgum, sweetgum, oaks, or cypress, singly or in combination, comprise a plurality of the stocking except where pines comprise 25 to 50 percent, in which case the stand would be classified oak-pine. Common associates include cottonwood, willow, ash, elm, hackberry, and maple.

Elm-Ash-Cottonwood—Forests in which elm, ash, or cottonwood, singly or in combination, comprise a plurality of the stocking. Common associates include willow, sycamore, beech, and maple.

Ownership Classes

Public—Forest land which is under jurisdiction of Federal, State, County, or Municipal government and is not withdrawn from timber utilization.

Forest Industry—Forest land owned by companies or individuals operating wood-using plants.

Farmer—Forest land owned by individuals, corporations, or companies whose income from agricultural products (excluding wood products) is greater than 1,000 dollars annually.

Miscellaneous Private—Forest land owned by individuals, corporations, or companies who do not operate wood-using plants and do not have a farm income greater than 1,000 dollars annually.

Miscellaneous Definitions

Timberland—Forest land at least 16.7 percent stocked by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest uses. This land must be greater than or equal to 1 acre, be producing or capable of producing crops of industrial wood (minimum 20 cubic feet per acre per year), and not be withdrawn from timber utilization. Timberland is synonymous with "Commercial Forest Land" in prior usage.

Basal Area—The area in square feet of the cross section at breast height of a single tree or of all the trees in a stand, usually expressed in square feet per acre.

D.b.h. (Diameter at breast height)—Tree diameter in inches, outside bark, measured at 4.5 feet above ground level.

D.o.b. (Diameter outside bark)—Stem diameter in inches, outside bark, measured at various points along the bole.

SPECIES LIST

Scientific and common names of species that occur in the Midsouth States[1]

Genus	Species	Common name
Commercial Species		
Softwoods		
Abies	*balsamea*	balsam fir
	fraseri	Fraser fir
Chamaecyparis	*thyoides*	Atlantic white-cedar
Juniperus	*silicicoloa*	southern redcedar
	virginiana	eastern redcedar
Picea	*mariana*	black spruce
	rubens	red spruce
Pinus	*clausa*	sand pine
	echinata	shortleaf pine
	elliottii	slash pine
	glabra	spruce pine
	palustris	longleaf pine
	ponderosa	ponderosa pine
	pungens	Table Mountain pine
	rigida	pitch pine
	serotina	pond pine
	strobus	eastern white pine
	taeda	loblolly pine
	virginiana	Virginia pine
Taxodium	*distichum* var. *distichum*	baldcypress
	distichum var. *nutans*	pondcypress
Thuja	*occidentalis*	northern white-cedar
Tsuga	*canadensis*	eastern hemlock
	caroliniana	Carolina hemlock
Hardwoods		
Acer	*barbatum*	Florida maple
	negundo	boxelder
	nigrum	black maple
	rubrum	red maple
	saccharinum	silver maple
	saccharum	sugar maple
Aesculus	*glabra*	Ohio buckeye
	octandra	yellow buckeye
Betula	*alleghaniensis*	yellow birch
	lenta	sweet birch
	nigra	river birch
	populifolia	gray birch
Carya	sp.	hickory
	aquatica	water hickory
	illinoensis	pecan
Castanea	*dentata*	American chestnut
	pumila	Allegheny chinkapin
Catalpa	sp.	catalpa
Celtis	*laevegata*	sugarberry
	occidentalis	hackberry
Cornus	*florida*	flowering dogwood

SPECIES LIST

Scientific and common names of species that occur in the Midsouth States[1]—Continued

Genus	Species	Common name
Diospyros	*virginiana*	common persimmon
Fagus	*grandifolia*	American beech
Fraxinus	*americana*	white ash
	nigra	black ash
	pennsylvanica	green ash
	profunda	pumpkin ash
	qradrangulata	blue ash
Gleditsia	*aquatica*	water locust
	triacanthos	honey locust
Gymnocladus	*dioicus*	Kentucky coffeetree
Halesia	*carolina*	Carolina silverbell
Ilex	*opaca*	American holly
Juglans	*cinerea*	butternut
	nigra	black walnut
Liquidambar	*styraciflua*	sweetgum
Liriodendron	*tulipifera*	yellow-poplar
Maclura	*pomifera*	Osage-orange
Magnolia	*acuminata*	cucumbertree
	grandiflora	southern magnolia
	virginiana	sweetbay
Morus	*rubra*	red mulberry
Nyssa	*aquatica*	water tupelo
	ogeche	Ogeechee tupelo
	sylvatica var. *sylvatica*	black tupelo, blackgum
	sylvatica var. *biflora*	swamp tupelo
Persea	*borbonia*	redbay
Platanus	*occidentalis*	American sycamore
Populus	sp.	cottonwood
Prunus	*serotina*	black cherry
Quercus	*alba*	white oak
	bicolor	swamp white oak
	coccinea	scarlet oak
	durandii	Durand oak
	falcata var. *falcata*	southern red oak
	falcata var. *pagodifolia*	cherrybark oak
	imbricaria	shingle oak
	laurifolia	laurel oak
	lyrata	overcup oak
	macrocarpa	bur oak
	michauxii	swamp chestnut oak
	muehlenbergii	chinkapin oak
	nigra	water oak
	nuttallii	Nuttall oak
	palustris	pin oak
	phellos	willow oak
	prinus	chestnut oak
	rubra	northern red oak
	shumardii	Shumard oak
	stellata var. *stellata*	post oak
	stellata var. *paludosa*	Delta post oak
	velutina	black oak

SPECIES LIST

Scientific and common names of species that occur in the Midsouth States[1]—Continued

Genus	Species	Common name
Robinia	*pseudoacacia*	black locust
Salix	sp.	willow
Sassafrass	*albidum*	sassafras
Tilia	*americana*	American basswood
	heterophylla	white basswood
Ulmus	*alata*	winged elm
	americana	American elm
	crassifolia	cedar elm
	pumila	Siberian elm
	rubra	slippery elm
	serotina	September elm
	thomassii	rock elm
Noncommercial Species		
Amelanchier	sp.	serviceberry
Aesculus	sp.	buckeye
Ailanthus	*altissima*	ailanthus, tree-of-heaven
Bumelia	sp.	chittamwood, gum bumelia
Carpinus	*caroliniana*	bluebeech, American hornbeam
Cercis	*canadensis*	eastern redbud
Cotinus	*obovatus*	smoketree
Crataegus	sp.	hawthorn
Magnolia	*macrophylla*	bigleaf magnolia
Malus	sp.	apple
Melia	*azedarach*	chinaberry
Morus	*alba*	white mulberry
Ostrya	*virginiana*	eastern hophornbeam, ironwood
Oxydendrum	*arboreum*	sourwood
Planera	*aquatica*	water-elm
Prosopis	sp.	mesquite
Prunus	sp.	plums, cherries
Quercus	*incana*	bluejack oak
	laevis	turkey oak
	marilandica	blackjack oak
	virginiana	live oak
Vaccinium	*arboreum*	sparkleberry

[1]Names according to: Little, Elbert L., Jr. *Checklist of United States Trees (Native and Nautralized)*. 1978, U.S. Dep. Agr. Handbook No. 541, 375 p.

TABLES

1.—Green weight of woody biomass by component 19
2.—Area of timberland and green tons per acre of total woody biomass 19
3.—Area of timberland by physiographic class 19
4.—Green weight of total woody biomass by physiographic class 19
5.—Green weight of total woody biomass by stand origin 19
6.—Green weight of total softwood, woody biomass by age class 20
7.—Green weight of total hardwood, woody biomass by age class 20
8.—Green weight of total woody biomass of all trees greater than 1.0 inch by size class 20
9.—Green weight of merchantable woody biomass by size class of trees greater than 5.0 inches 20
10.—Green weight of residual biomass by size class of trees greater than 5.0 inches 21
11.—Green weight of rough and rotten woody biomass by size class of trees greater than 5.0 inches 21
12.—Green weight of total woody biomass by softwood species groups 21
13.—Green weight of total woody biomass by hardwood species groups 21
14.—Area of timberland by basal area class 22
15.—Green weight of total woody biomass by basal area class 22
16.—Green weight of merchantable woody biomass by basal area class 22
17.—Green weight of residual woody biomass by basal area class 22
18.—Green weight of rough and rotten woody biomass by basal area class 23
19.—Green weight of sapling woody biomass by basal area class 23
20.—Green weight of total woody biomass by ownership 23
21.—Green weight of merchantable woody biomass by ownership 23
22.—Green weight of residual woody biomass by ownership 24
23.—Green weight of rough and rotten woody biomass by ownership 24
24.—Green weight of sapling woody biomass by ownership 24
25.—Green weight of total woody biomass by forest type 24
26.—Green weight of merchantable woody biomass by forest type 25
27.—Green weight of residual woody biomass by forest type 25
28.—Green weight of rough and rotten woody biomass by forest type 25
29.—Green weight of sapling woody biomass by forest type 25
30.—Total woody biomass by species component and group 26
31.—Area of timberland harvested by type of harvest 26
32.—Green weight of woody biomass on clearcut, pine upland 26
33.—Green weight of woody biomass on partial cut, pine upland 27
34.—Green weight of woody biomass on diameter-limit cut, pine upland 27
35.—Green weight of woody biomass on salvage cut, pine upland 27
36.—Woody biomass remaining after clearcut operation on pine upland, by standing live and downed biomass 28
37.—Green weight of woody biomass by county and species component 28
38.—Sampling errors for green woody biomass components by county 29
39.—Sampling errors for green woody biomass components by unit 31

Table 1.—*Green weight of woody biomass by component,[1] Alabama, 1982*

Forest survey unit	Total green weight	Merchantable green weight	Residual green weight
	Million tons		
Southwest-South	169.3	91.3	78.1
Southwest-North	264.2	141.3	122.9
Southeast	366.3	183.6	182.7
West Central	256.9	136.4	120.6
North Central	317.2	158.9	158.3
North	177.3	82.4	94.9
State	1,551.2	793.8	757.5

[1]Totals may not add due to rounding.

Table 2.—*Area of timberland and green tons per acre of total woody biomass,[1] Alabama, 1982*

Forest survey unit	Thousand acres	Tons/acre
Southwest-South	2,858.2	59.3
Southwest-North	3,382.5	78.1
Southeast	5,415.8	67.6
West Central	3,272.1	78.5
North Central	4,542.6	69.8
North	2,187.7	81.0
State	21,658.8	71.6

[1]Totals may not add due to rounding.

Table 3.—*Area of timberland by physiographic class,[1] Alabama, 1982*

Forest survey unit	Pine	Upland hardwood	Bottomland hardwood
	Thousand acres		
Southwest-South	2,238.3	12.3	607.6
Southwest-North	2,741.9	78.2	562.4
Southeast	4,676.5	84.6	654.6
West Central	2,734.1	23.3	514.7
North Central	4,286.4	112.1	144.1
North	1,443.9	592.5	151.3
State	18,121.1	902.9	2,634.7

[1]Totals may not add due to rounding.

Table 4.—*Green weight of total woody biomass by physiographic class,[1] Alabama, 1982*

Forest survey unit	Pine		Upland hardwood		Bottomland hardwood	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	783.9	372.8	0.0	14.8	112.4	409.5
Southwest-North	1,050.8	921.2	4.0	68.4	54.7	543.2
Southeast	1,480.3	1,533.3	4.1	59.4	35.6	550.2
West Central	956.3	1,057.5	2.0	21.1	25.9	506.6
North Central	1,290.8	1,681.7	5.9	92.3	2.8	98.3
North	322.8	790.0	17.1	480.5	13.0	149.0
State	5,884.7	6,356.5	33.1	736.4	244.4	2,256.8

[1]Totals may not add due to rounding.

Table 5.—*Green weight of total woody biomass by stand origin,[1] Alabama, 1982*

Forest survey unit	Natural stands			Artificially regenerated stands		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	1,491.0	726.1	764.9	202.3	170.1	32.2
Southwest-North	2,427.0	947.8	1,479.2	215.2	161.7	53.5
Southeast	3,365.1	1,268.7	2,096.4	298.7	251.2	47.5
West Central	2,352.6	819.1	1,533.5	215.5	165.0	50.5
North Central	2,986.1	1,167.4	1,818.7	186.6	132.1	54.5
North	1,691.0	299.0	1,392.0	81.4	53.9	27.5
State	14,312.8	5,228.1	9,084.7	1,199.7	934.0	265.7

[1]Totals may not add due to rounding.

Table 6.—*Green weight of total softwood, woody biomass by age class,[1] Alabama, 1982*

Forest survey unit	Age class (midpoint)									
	5	15	25	35	45	55	65	75	85[2]	Mixed
	Hundred thousand tons									
Southwest-South	16.5	63.3	58.6	65.5	47.4	45.4	18.5	5.6	0.0	575.4
Southwest-North	18.1	64.5	65.8	51.0	8.6	16.3	6.6	0.0	0.0	878.6
Southeast	18.2	115.9	130.0	209.7	40.1	27.1	6.1	0.0	0.0	972.8
West Central	14.2	23.9	168.6	128.7	74.0	34.8	4.4	8.6	0.0	526.8
North Central	17.6	30.3	119.1	121.6	29.8	26.1	25.4	0.0	0.0	929.6
North	1.9	22.5	32.5	16.2	21.4	13.7	0.0	3.4	0.3	241.1
State	86.5	320.5	574.6	592.6	221.3	163.4	61.1	17.7	0.3	4,124.4

[1]Totals may not add due to rounding.
[2]Includes 80 years and over.

Table 7.—*Green weight of total hardwood, woody biomass by age class,[1] Alabama, 1982*

Forest survey unit	Age class (midpoint)									
	5	15	25	35	45	55	65	75	85[2]	Mixed
	Hundred thousand tons									
Southwest-South	9.8	8.5	21.4	21.1	25.6	25.0	9.8	0.0	0.0	676.4
Southwest-North	13.5	25.4	15.8	9.9	10.5	6.6	1.8	0.0	7.7	1,441.5
Southeast	18.0	33.1	43.9	124.5	16.3	10.4	2.9	0.0	0.0	1,893.8
West Central	10.5	8.7	30.8	53.7	41.4	33.6	3.9	3.4	0.0	1,399.1
North Central	14.9	19.3	36.5	39.3	33.5	9.1	4.9	13.0	0.0	1,701.9
North	6.4	8.0	13.7	52.5	13.1	10.6	0.0	10.3	25.4	1,279.5
State	73.0	103.1	162.1	301.0	140.3	95.3	23.4	26.8	33.0	8,392.1

[1]Totals may not add due to rounding.
[2]Includes 80 years and over.

Table 8.—*Green weight of total woody biomass of all trees greater than 1.0 inch by size class,[1] Alabama, 1982*

Forest survey unit	1.0–4.9		5.0–9.9		10.0–14.9		≧15.0	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons							
Southwest-South	107.3	187.5	300.5	228.0	327.7	189.8	160.8	192.2
Southwest-North	84.8	298.9	306.3	425.9	405.9	352.6	312.5	455.4
Southeast	147.1	462.6	481.1	630.0	519.9	580.7	371.9	469.7
West Central	86.2	299.2	366.2	456.8	336.9	439.7	194.9	389.5
North Central	141.7	423.3	507.4	566.3	428.0	497.1	222.5	385.6
North	38.8	225.8	144.2	357.7	117.4	419.4	52.6	416.6
State	605.8	1,897.2	2,105.7	2,664.7	2,135.8	2,479.3	1,315.1	2,308.9

[1]Totals may not add due to rounding.

Table 9.—*Green weight of merchantable woody biomass by size class of trees greater than 5.0 inches,[1] Alabama, 1982*

Forest survey unit	5.0–9.9		10.0–14.9		≥15.0	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	222.9	127.1	268.8	94.6	125.1	74.1
Southwest-North	219.8	244.2	324.2	200.2	242.7	181.7
Southeast	335.2	350.6	398.9	303.6	268.0	179.2
West Central	275.4	255.7	276.9	245.2	153.3	157.2
North Central	378.5	307.7	350.1	246.5	173.3	133.1
North	103.8	205.7	95.4	223.5	38.5	156.8
State	1,535.6	1,491.0	1,714.3	1,313.6	1,000.9	882.1

[1]Totals may not add due to rounding.

Table 10.—*Green weight of residual biomass by size class of trees greater than 5.0 inches,*[1] *Alabama, 1982*

Forest survey unit	5.0–9.9		10.0–14.9		≥15.0	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	77.6	100.9	58.9	95.2	35.7	118.1
Southwest-North	86.6	181.7	81.7	152.4	69.7	273.7
Southeast	145.9	279.4	121.0	277.1	103.9	290.5
West Central	90.8	201.1	60.0	194.4	27.7	232.3
North Central	128.9	258.6	77.9	250.6	49.2	252.5
North	40.3	152.0	22.0	195.9	14.2	259.8
State	570.2	1,173.7	421.5	1,165.7	300.4	1,426.9

[1]Totals may not add due to rounding.

Table 11.—*Green weight of rough and rotten*[1] *woody biomass by size class of trees greater than 5.0 inches,*[2] *Alabama, 1982*

Forest survey unit	5.0–9.9		10.0–14.9		≥15.0	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	13.9	55.4	8.7	51.2	7.2	60.8
Southwest-North	26.6	93.9	26.9	55.4	15.6	118.9
Southeast	53.6	153.8	52.5	130.3	43.6	147.4
West Central	16.2	107.2	12.6	71.5	6.1	100.8
North Central	25.7	138.7	18.8	123.0	11.3	139.7
North	11.6	75.8	7.2	73.8	5.6	123.0
State	147.6	624.8	126.7	505.2	89.4	690.6

[1]Includes sound portion only.
[2]Totals may not add due to rounding.

Table 12.—*Green weight of total woody biomass by softwood species groups,*[1] *Alabama, 1982*

Forest survey unit	Longleaf	Slash	Loblolly	Shortleaf	Other	Total
	Hundred thousand tons					
Southwest-South	322.2	368.2	152.7	16.6	36.6	896.3
Southwest-North	38.1	49.5	725.4	206.0	90.7	1,109.5
Southeast	88.4	84.8	1,002.1	286.2	58.5	1,520.0
West Central	50.1	5.5	683.4	161.6	83.4	984.1
North Central	87.9	4.0	793.5	224.9	189.3	1,299.5
North	0.0	0.0	178.1	62.2	112.6	352.9
State	586.7	512.0	3,535.2	957.4	571.1	6,162.3

[1]Totals may not add due to rounding.

Table 13.—*Green weight of total woody biomass by hardwood species groups,*[1] *Alabama, 1982*

Forest survey unit	Oaks	Sweetgum	Yellow Poplar	Hickories	Gums	Other	Total
	Hundred thousand tons						
Southwest-South	264.5	62.4	28.5	17.3	171.3	253.5	797.5
Southwest-North	594.7	283.7	47.5	94.9	90.0	421.9	1,532.7
Southeast	804.2	440.9	112.6	140.1	148.9	496.2	2,143.0
West Central	691.8	262.0	62.7	127.4	113.2	328.2	1,585.2
North Central	975.3	170.0	126.7	244.3	39.2	316.9	1,872.3
North	690.7	111.1	57.4	219.6	40.4	300.4	1,419.5
State	4,021.2	1,330.2	435.3	843.5	603.0	2,117.0	9,350.2

[1]Totals may not add due to rounding.

Table 14.—*Area of timberland by basal area class,[1] Alabama, 1982*

Forest survey unit	Basal area class[2] (midpoint)							
	10	30	50	70	90	110	130	≥140
	Thousand acres							
Southwest-South	408.6	419.1	543.5	476.9	365.2	255.8	200.6	188.6
Southwest-North	388.7	395.5	331.6	558.2	619.5	466.2	330.0	292.8
Southeast	586.3	573.7	838.3	954.0	1,081.9	649.4	397.5	334.7
West Central	338.9	240.1	427.1	547.3	539.8	490.4	369.7	318.7
North Central	507.1	376.6	599.3	869.2	856.9	618.5	394.4	320.7
North	127.7	92.8	263.4	478.8	499.2	365.0	187.3	173.4
State	2,357.3	2,097.8	3,003.3	3,884.5	3,962.4	2,845.4	1,879.5	1,628.8

[1]Totals may not add due to rounding.
[2]Basal area in square feet per acre.

Table 15.—*Green weight of total woody biomass by basal area class,[1] Alabama, 1982*

Forest survey unit	Basal area class[2] (midpoint)							
	10	30	50	70	90	110	130	≥140
	Hundred thousand tons							
Southwest-South	23.0	98.9	213.8	284.9	283.9	250.4	228.7	309.9
Southwest-North	13.5	92.1	144.9	349.7	573.6	523.3	468.8	476.4
Southeast	28.5	138.5	340.6	570.0	888.2	668.9	510.9	517.3
West Central	10.5	58.4	177.0	340.4	453.7	519.2	489.3	520.7
North Central	25.2	87.6	242.8	517.4	679.5	624.3	482.9	511.9
North	5.1	21.7	111.0	300.8	412.4	391.4	239.6	290.3
State	105.8	497.2	1,230.1	2,363.2	3,291.3	2,977.5	2,420.2	2,626.5

[1] Totals may not add due to rounding.
[2] Basal area in square feet per acre.

Table 16.—*Green weight of merchantable woody biomass by basal area class,[1] Alabama, 1982*

Forest survey unit	Basal area class[2] (midpoint)							
	10	30	50	70	90	110	130	≥140
	Hundred thousand tons							
Southwest-South	10.3	51.9	107.5	147.1	151.6	143.2	127.2	173.8
Southwest-North	3.8	38.6	62.4	185.0	314.4	287.5	263.1	258.0
Southeast	9.8	51.7	152.7	274.7	446.1	339.5	276.9	284.2
West Central	3.9	22.7	79.9	167.3	226.8	279.5	280.8	302.8
North Central	9.6	38.1	99.1	228.1	316.8	332.3	262.0	303.2
North	0.8	5.7	47.9	129.2	181.0	186.6	120.1	152.4
State	38.2	208.7	549.5	1,131.4	1,636.7	1,568.6	1,330.1	1,474.4

[1] Totals may not add due to rounding.
[2] Basal area in square feet per acre.

Table 17.—*Green weight of residual woody biomass by basal area class,[1] Alabama, 1982*

Forest survey unit	Basal area class[2] (midpoint)							
	10	30	50	70	90	110	130	≥140
	Hundred thousand tons							
Southwest-South	12.7	47.0	106.2	137.7	132.3	107.2	101.5	136.1
Southwest-North	9.6	53.5	82.5	164.7	259.2	235.8	205.7	218.3
Southeast	18.8	86.8	187.8	295.3	442.1	329.4	234.0	233.1
West Central	6.7	35.7	97.1	173.1	226.9	239.7	208.5	217.9
North Central	15.6	49.4	143.7	289.4	362.7	292.1	220.9	208.8
North	4.3	16.0	63.1	171.7	231.5	204.9	119.5	137.9
State	67.7	288.4	680.4	1,231.9	1,654.7	1,409.1	1,090.1	1,152.1

[1] Totals may not add due to rounding.
[2] Basal area in square feet per acre.

Table 18.—*Green weight of rough and rotten[1] woody biomass by basal area class,[2] Alabama, 1982*

Forest survey unit	Basal area class[3] (midpoint)							
	10	30	50	70	90	110	130	≥140
	Hundred thousand tons							
Southwest-South	1.7	9.5	18.9	37.6	35.7	20.7	32.9	40.2
Southwest-North	1.9	14.3	19.0	45.1	68.7	71.3	59.4	57.9
Southeast	5.0	33.0	60.7	87.9	140.4	105.3	78.5	70.4
West Central	1.2	7.9	30.8	47.2	61.3	60.4	49.3	56.5
North Central	2.4	10.4	47.4	96.3	111.5	83.8	55.1	50.2
North	1.4	5.7	19.0	46.1	72.9	66.9	39.1	45.8
State	13.6	80.8	195.8	360.2	490.5	408.4	314.3	321.0

[1] Includes sound portion only.
[2] Totals may not add due to rounding.
[3] Basal area in square feet per acre.

Table 19.—*Green weight of sapling woody biomass by basal area class,[1] Alabama, 1982*

Forest survey unit	Basal area class[2] (midpoint)							
	10	30	50	70	90	110	130	≥140
	Hundred thousand tons							
Southwest-South	7.4	23.2	55.4	56.4	50.1	39.1	29.4	33.7
Southwest-North	9.3	35.3	74.2	111.2	150.6	107.1	60.2	61.7
Southeast	6.4	25.8	38.9	59.6	72.4	61.8	52.4	66.2
West Central	3.8	17.9	35.6	60.6	80.6	70.2	60.3	56.6
North Central	9.7	24.4	60.1	108.3	128.2	91.9	72.6	69.7
North	2.4	7.5	22.9	60.7	71.3	47.0	25.8	26.8
State	39.0	134.1	287.3	456.8	553.2	417.1	300.7	314.7

[1] Totals may not add due to rounding.
[2] Basal area in square feet per acre.

Table 20.—*Green weight of total woody biomass by ownership,[1] Alabama, 1982*

Forest survey unit	Public		Forest industry		Farmer		Miscellaneous private	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons							
Southwest-South	53.9	14.6	291.4	229.3	149.9	153.0	401.1	400.6
Southwest-North	18.1	24.9	376.1	405.5	289.7	467.3	425.6	635.0
Southeast	60.1	73.8	311.2	268.7	518.1	938.7	630.6	861.8
West Central	100.2	67.6	289.3	329.6	164.2	415.3	430.4	772.7
North Central	156.3	231.7	199.0	239.7	220.4	351.9	723.8	1,049.0
North	33.2	170.0	32.4	99.9	148.7	628.9	138.6	520.7
State	421.7	582.6	1,499.4	1,572.6	1,491.1	2,955.2	2,750.2	4,239.7

[1] Totals may not add due to rounding.

Table 21.—*Green weight of merchantable woody biomass by ownership,[1] Alabama, 1982*

Forest survey unit	Public		Forest industry		Farmer		Miscellaneous private	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons							
Southwest-South	41.2	5.4	201.0	92.2	104.4	56.2	269.9	142.0
Southwest-North	14.5	9.7	262.6	162.1	206.3	194.4	303.3	259.3
Southeast	44.2	31.2	188.5	100.4	352.8	381.3	416.8	320.5
West Central	75.0	25.0	211.7	138.9	120.4	176.5	298.5	317.7
North Central	115.0	84.1	132.5	73.4	153.4	138.3	500.9	391.5
North	23.3	69.8	19.0	42.0	101.6	265.6	93.7	208.6
State	313.1	225.3	1,015.3	609.0	1,038.9	1,212.8	1,883.1	1,639.6

[1] Totals may not add due to rounding.

Table 22.—*Green weight of residual woody biomass by ownership,[1] Alabama, 1982*

Forest survey unit	Public		Forest industry		Farmer		Miscellaneous private	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons							
Southwest-South	12.6	9.2	90.3	137.1	45.5	96.8	131.2	258.5
Southwest-North	3.6	15.2	113.5	243.3	83.4	272.4	122.3	375.7
Southeast	15.9	42.6	122.7	168.3	165.3	557.4	213.8	541.3
West Central	25.9	42.5	77.7	190.7	43.8	238.8	131.9	454.9
North Central	41.3	147.5	66.4	166.3	67.0	213.6	222.9	657.5
North	9.9	100.2	13.4	57.9	47.1	363.3	44.9	312.1
State	109.2	357.3	484.0	963.7	452.2	1,742.4	867.0	2,600.1

[1] Totals may not add due to rounding.

Table 23.—*Green weight of rough and rotten[1] woody biomass by ownership,[2] Alabama, 1982*

Forest survey unit	Public		Forest industry		Farmer		Miscellaneous private	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons							
Southwest-South	2.0	4.6	9.1	40.6	5.6	35.1	13.1	87.5
Southwest-North	0.0	7.4	15.6	69.4	25.7	86.5	27.9	104.9
Southeast	4.0	13.5	39.1	50.6	48.9	187.6	57.7	179.8
West Central	1.9	9.6	9.6	53.0	6.1	74.8	17.4	142.1
North Central	7.1	49.4	6.4	49.1	9.3	74.1	33.1	228.7
North	1.3	29.1	3.0	18.0	12.7	118.9	7.5	106.6
State	16.3	113.5	82.8	280.6	108.3	577.2	156.5	849.7

[1] Includes sound portion only.
[2] Totals may not add due to rounding.

Table 24.—*Green weight of sapling[1] woody biomass by ownership,[2] Alabama, 1982*

Forest survey unit	Public		Forest industry		Farmer		Miscellaneous private	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons							
Southwest-South	1.5	2.1	34.8	51.2	16.0	35.0	54.9	99.1
Southwest-North	1.0	1.5	40.2	81.8	14.1	88.3	29.5	127.3
Southeast	2.1	14.7	38.4	64.2	40.9	182.6	65.7	201.1
West Central	7.1	18.3	21.1	59.8	13.2	72.1	44.8	148.9
North Central	10.7	52.1	29.9	77.5	21.9	66.3	79.2	227.3
North	3.4	28.5	6.2	17.0	12.4	98.6	16.8	81.7
State	25.9	117.2	170.6	351.6	118.6	543.0	290.8	885.4

[1] Includes all trees 1.0 to 4.9 inches in diameter.
[2] Totals may not add due to rounding.

Table 25.—*Green weight of total woody biomass by forest type,[1] Alabama, 1982*

Forest survey unit	Longleaf-slash		Loblolly-shortleaf		Oak-pine		Oak-hickory		Oak-gum-cypress[2]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons									
Southwest-South	528.0	87.7	95.3	28.6	184.9	163.7	35.0	145.3	53.1	371.8
Southwest-North	52.5	12.7	710.7	220.4	223.2	251.8	72.4	506.9	50.8	541.0
Southeast	118.9	16.6	926.6	239.7	325.5	412.6	127.9	941.5	21.0	532.6
West Central	35.1	8.4	649.2	179.3	212.9	292.3	67.6	611.0	19.3	494.1
North Central	56.8	10.9	842.3	260.9	278.4	409.1	119.2	1,093.0	2.8	98.3
North	0.0	0.0	195.3	74.4	100.6	165.0	49.2	1,037.5	7.9	142.6
State	791.3	136.3	3,419.4	1,003.3	1,325.5	1,694.5	471.3	4,335.2	154.9	2,180.4

[1] Totals may not add due to rounding.
[2] Includes elm-ash-cottonwood type.

Table 26.—*Green weight of merchantable woody biomass by forest type,[1] Alabama, 1982*

Forest survey unit	Longleaf-slash		Loblolly-shortleaf		Oak-pine		Oak-hickory		Oak-gum-cypress[2]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons									
Southwest-South	358.9	17.8	56.2	7.1	137.4	54.5	24.1	50.2	40.1	166.2
Southwest-North	32.2	4.1	497.6	75.1	166.7	92.3	51.6	211.4	38.6	243.2
Southeast	82.2	4.0	594.4	73.6	221.7	150.7	88.4	368.6	15.5	236.3
West Central	27.5	1.3	459.4	58.3	155.6	102.7	48.6	260.7	14.5	235.2
North Central	38.6	1.8	587.2	74.5	192.5	131.6	81.8	442.5	1.7	37.0
North	0.0	0.0	126.4	20.9	72.6	63.0	32.0	438.0	6.6	64.1
State	539.4	29.0	2,321.2	309.5	946.5	594.8	326.5	1,771.4	117.0	982.0

[1] Totals may not add due to rounding.
[2] Includes elm-ash-cottonwood type.

Table 27.—*Green weight of residual woody biomass by forest type,[1] Alabama, 1982*

Forest survey unit	Longleaf-slash		Loblolly-shortleaf		Oak-pine		Oak-hickory		Oak-gum-cypress[2]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons									
Southwest-South	169.1	69.9	39.0	21.5	47.5	109.2	10.9	95.1	13.0	205.6
Southwest-North	20.3	8.6	213.1	145.3	56.5	159.5	20.7	295.6	12.1	297.7
Southeast	36.7	12.6	332.2	166.1	103.8	261.9	39.6	572.8	5.5	296.2
West Central	7.6	7.1	189.9	121.1	57.3	189.6	19.0	350.3	4.8	259.0
North Central	18.2	9.1	255.1	186.4	85.9	277.6	37.3	650.5	1.1	61.3
North	0.0	0.0	68.9	53.4	28.0	102.0	17.2	599.5	1.2	78.6
State	251.9	107.3	1,098.2	693.8	379.0	1,099.8	144.7	2,563.8	37.7	1,198.4

[1] Totals may not add due to rounding.
[2] Includes elm-ash-cottonwood type.

Table 28.—*Green weight of rough and rotten[1] woody biomas by forest type,[2] Alabama, 1982*

Forest survey unit	Longleaf-slash		Loblolly-shortleaf		Oak-pine		Oak-hickory		Oak-gum-cypress[3]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons									
Southwest-South	14.1	16.4	6.1	5.2	6.3	34.7	2.3	37.6	0.9	73.4
Southwest-North	1.9	3.0	50.9	33.5	9.1	41.7	5.3	86.3	2.0	103.7
Southeast	14.6	3.4	93.6	40.5	30.2	81.9	9.4	197.5	1.9	108.1
West Central	0.0	3.7	21.4	26.4	9.8	61.2	3.4	98.4	0.4	89.9
North Central	1.1	5.1	33.6	57.9	14.7	99.9	5.6	213.8	0.7	24.6
North	0.0	0.0	14.4	21.7	4.7	32.8	5.3	192.3	0.0	25.9
State	31.7	31.6	220.0	185.2	74.8	352.2	31.3	825.9	5.9	425.6

[1] Includes sound portion only.
[2] Totals may not add due to rounding.
[3] Includes elm-ash-cottonwood type.

Table 29.—*Green weight of sapling[1] woody biomass by forest type,[2] Alabama, 1982*

Forest survey unit	Longleaf-slash		Loblolly-shortleaf		Oak-pine		Oak-hickory		Oak-gum-cypress[3]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons									
Southwest-South	70.1	44.9	18.6	12.8	11.6	48.4	3.3	31.8	3.7	49.6
Southwest-North	11.4	3.2	55.7	78.0	12.7	69.7	4.5	92.5	0.5	55.4
Southeast	4.2	7.8	107.3	90.0	24.8	108.4	10.7	191.9	0.1	64.4
West Central	2.1	2.6	65.8	64.3	13.4	75.6	4.9	114.8	0.1	41.8
North Central	8.0	3.3	90.7	93.6	29.2	109.8	13.8	202.6	0.1	14.1
North	0.0	0.0	25.1	20.4	8.5	35.5	5.2	151.7	0.0	18.2
State	95.8	61.8	363.2	359.1	100.2	447.4	42.4	785.3	4.5	243.5

[1] Includes all trees 1.0 to 4.9 inches in diameter.
[2] Totals may not add due to rounding.
[3] Includes elm-ash-cottonwood type.

Table 30.—*Total woody biomass by species component and group, Alabama, 1982*

Group	All species	Softwood	Hardwood
	Green tons per acre		
Ownership			
Public	86	36	50
Forest industry	81	40	41
Farmer	68	23	45
Miscellaneous private	69	27	42
Forest type			
Longleaf-slash	63	53	9
Loblolly-shortleaf	75	58	17
Oak-pine	66	29	37
Oak-hickory	66	6	60
Oak-gum-cypress[1]	95	6	89
Physiographic class			
Pine	67	32	35
Upland hardwood	86	4	82
Bottomland hardwood	95	9	86
Stand origin			
Natural regeneration	76	28	48
Artificial regeneration	44	34	10

[1]Includes elm-ash-cottonwood type.

Table 31.—*Area of timberland harvested by type of harvest,[1] Alabama, 1982*

Forest survey unit	Clearcut	Partial[2] cut	Diameter-limit cut	Salvage cut
	Thousand acres			
Southwest-South	204.3	380.1	95.7	95.7
Southwest-North	419.3	607.4	146.3	12.0
Southeast	629.3	828.3	285.2	65.4
West Central	413.9	424.1	51.4	11.8
North Central	662.5	468.7	108.1	28.1
North	153.1	150.2	18.3	12.4
State	2,482.2	2,858.8	704.9	225.4

[1]Totals may not add due to rounding.

[2]Includes seed tree, strip cut, shelterwood, group selection, and single tree selection.

Table 32.—*Green weight of woody biomass on clearcut, pine upland,[1] Alabama, 1982*

Forest survey unit	Total green weight[2]		Merchantable green weight[3]		Residual green weight[4]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	108.2	70.7	53.0	24.5	55.2	44.2
Southwest-North	259.6	199.7	162.0	74.9	97.6	121.9
Southeast	296.4	283.6	150.3	85.1	146.1	205.3
West Central	228.8	188.8	109.5	64.0	119.3	124.8
North Central	345.5	257.4	187.0	82.6	158.6	172.8
North	47.7	74.4	21.8	23.3	26.0	51.2
State	1,286.2	1,074.6	683.6	354.4	602.8	720.2

[1]Totals may not add due to rounding.

[2]Includes all trees prior to cutting operation.

[3]Includes only merchantable sections removed during cutting operation.

[4]Includes residual of removed trees and total green weight of all trees left standing or knocked down after cutting operation.

Table 33.—*Green weight of woody biomass on partial cut,[1] pine upland,[2] Alabama, 1982*

Forest survey unit	Total green weight[3]		Merchantable green weight[4]		Residual green weight[5]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	190.2	102.2	47.9	11.6	142.2	90.7
Southwest-North	385.9	292.3	111.0	51.6	274.9	240.8
Southeast	500.8	407.1	155.9	59.9	344.9	347.2
West Central	236.1	203.6	80.7	28.3	155.9	175.3
North Central	256.8	239.3	91.4	27.1	165.4	212.2
North	51.7	122.3	15.1	19.5	36.4	102.8
State	1,621.5	1,366.8	502.0	198.0	1,119.8	1,169.0

[1]Includes seed tree, strip cut, shelterwood, group selection, and single tree selection.
[2]Totals may not add due to rounding.
[3]Includes all trees prior to cutting operation.
[4]Includes only merchantable sections removed during cutting operation.
[5]Includes residual of removed trees and total green weight of all trees left standing or knocked down after cutting operation.

Table 34.—*Green weight of woody biomass on diameter-limit cut, pine upland,[1] Alabama, 1982*

Forest survey unit	Total green weight[2]		Merchantable green weight[3]		Residual green weight[4]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	85.3	36.7	27.8	3.0	57.5	33.7
Southwest-North	103.3	89.3	32.7	22.9	70.6	66.4
Southeast	137.7	135.3	54.4	18.6	83.3	115.2
West Central	26.9	33.3	11.1	5.4	15.8	29.9
North Central	45.6	58.7	17.1	13.8	28.5	44.8
North	6.5	14.8	0.0	4.7	6.5	10.1
State	405.3	368.1	143.1	68.4	262.2	300.1

[1]Totals may not add due to rounding.
[2]Includes all trees prior to cutting operation.
[3]Includes only merchantable sections removed during cutting operation.
[4]Includes residual of removed trees and total green weight of all trees left standing or knocked down after cutting operation.

Table 35.—*Green weight of woody biomass on salvage cut, pine upland,[1] Alabama, 1982*

Forest survey unit	Total green weight[2]		Merchantable green weight[3]		Residual green weight[4]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Hundred thousand tons					
Southwest-South	48.4	43.2	12.8	2.7	35.7	40.5
Southwest-North	12.4	3.2	2.3	0.0	10.5	3.2
Southeast	50.6	21.5	12.4	0.5	38.2	21.0
West Central	12.2	0.9	0.5	0.0	11.7	0.9
North Central	20.6	4.4	4.7	0.0	16.0	4.4
North	6.3	11.2	2.1	3.0	4.2	8.2
State	150.8	84.4	34.7	6.2	116.1	78.2

[1]Totals may not add due to rounding.
[2]Includes all trees prior to cutting operation.
[3]Includes only merchantable sections removed during cutting operation.
[4]Includes residual of removed trees and total green weight of all trees left standing or knocked down after cutting operation.

Table 36.—*Woody biomass remaining after clearcut operation on pine upland, by standing live and downed biomass, Alabama, 1982*[1]

Forest survey unit	Downed biomass			
	Softwood	Hardwood	Softwood	Hardwood
	- Hundred thousand tons -		*--- Green tons per acre ---*	
Southwest-South	46.4	31.0	23	15
Southwest-North	78.8	74.3	19	18
Southeast	132.1	175.5	21	28
West Central	100.3	89.9	24	22
North Central	132.5	129.5	20	20
North	23.7	39.6	16	26
State	513.7	539.8	21	21
	Standing live biomass			
	Softwood	Hardwood	Softwood	Hardwood
	- Hundred thousand tons -		--- Green tons per acre ---	
Southwest-South	8.8	13.2	4	6
Southwest-North	18.8	47.6	4	11
Southeast	13.9	29.8	2	5
West Central	19.0	34.9	5	8
North Central	26.1	43.3	4	7
North	2.4	11.5	2	8
State	89.1	180.4	4	6

[1]Totals may not add due to rounding.

Table 37.—*Green weight of woody biomass by county and species component,*[1] *Alabama, 1982*

County	All species	Softwood			Hardwood		
		Total green weight	Merchantable green weight	Residual green weight	Total green weight	Merchantable green weight	Residual green weight
	Hundred thousand tons						
Autauga	148.7	82.0	57.5	24.5	66.7	21.0	45.7
Baldwin	439.3	234.7	165.6	69.1	204.5	83.2	121.4
Barbour	272.1	135.4	95.3	40.1	136.8	59.9	76.8
Bibb	226.0	112.0	78.5	33.5	114.0	42.1	71.9
Blount	151.3	46.5	33.3	13.2	104.8	46.0	58.8
Bullock	165.7	74.9	49.0	25.9	90.8	34.6	56.2
Butler	257.1	142.5	91.8	50.7	114.6	44.6	70.0
Calhoun	195.2	72.8	54.4	18.4	122.4	46.2	76.2
Chambers	189.9	103.8	69.7	34.1	86.1	34.9	51.2
Cherokee	139.6	49.7	27.7	22.0	89.9	32.5	57.3
Chilton	197.2	75.7	50.1	25.6	121.5	44.6	76.9
Choctaw	424.3	196.1	139.1	57.0	228.3	91.4	136.9
Clarke	592.3	241.6	181.2	60.4	350.7	150.2	200.5
Clay	184.3	63.1	40.6	22.5	121.2	38.8	82.4
Cleburne	237.6	96.7	68.3	28.4	140.9	46.9	93.9
Coffee	164.9	56.9	32.9	24.0	108.1	40.4	67.6
Colbert	138.5	24.1	15.1	9.0	114.4	47.6	66.8
Conecuh	273.4	98.7	58.6	40.1	174.7	67.5	107.2
Coosa	207.7	77.8	49.0	28.8	129.8	46.9	83.0
Covington	248.7	138.6	91.3	47.2	110.1	38.0	72.1
Crenshaw	208.8	81.0	51.2	29.8	127.9	52.7	75.2
Cullman	203.5	92.9	67.2	25.7	110.5	50.4	60.2
Dale	152.6	53.7	38.4	15.4	98.9	38.5	60.4
Dallas	223.3	86.4	53.9	32.5	136.9	49.4	87.5
De Kalb	209.1	65.7	49.0	16.7	143.4	49.2	94.2
Elmore	166.6	45.5	25.5	20.0	121.1	44.8	76.3
Escambia	338.4	211.8	149.4	62.4	126.6	47.4	79.2
Etowah	145.1	55.6	40.3	15.3	89.5	33.4	56.1

Table 37.—*Green weight of woody biomass by county and species component,[1] Alabama, 1982—Continued*

County	All species	Softwood			Hardwood		
		Total green weight	Merchantable green weight	Residual green weight	Total green weight	Merchantable green weight	Residual green weight
	Hundred thousand tons						
Fayette	257.7	85.7	61.6	24.1	172.0	81.5	90.5
Franklin	185.5	45.3	27.1	18.2	140.0	58.4	81.6
Geneva	74.2	21.5	16.3	5.1	52.7	19.2	33.5
Greene	223.5	63.2	48.1	15.1	160.3	67.8	92.5
Hale	198.4	71.5	53.0	18.4	127.0	52.7	74.2
Henry	125.9	46.8	32.9	13.9	79.1	27.5	51.6
Houston	75.9	30.8	18.7	12.1	45.1	18.8	26.3
Jackson	327.3	30.7	19.6	11.1	296.6	121.3	175.3
Jefferson	346.7	175.2	125.6	49.6	171.6	59.6	112.0
Lamar	223.0	57.1	38.0	19.0	165.9	69.5	96.4
Lauderdale	130.7	25.4	15.4	10.1	105.3	42.4	62.9
Lawrence	155.3	37.1	24.0	13.1	118.3	52.0	66.3
Lee	143.1	70.6	40.2	30.4	72.6	24.8	47.7
Limestone	120.5	8.1	6.6	1.5	112.4	52.3	60.2
Lowndes	184.2	68.2	44.3	23.9	116.0	49.9	66.0
Macon	175.5	49.6	33.2	16.4	125.9	49.1	76.8
Madison	182.4	26.7	16.4	10.4	155.7	61.4	94.2
Marengo	319.1	140.6	104.6	36.0	178.5	77.6	100.9
Marion	226.7	74.2	52.4	21.7	152.5	55.7	96.9
Marshall	178.9	53.4	37.7	15.7	125.5	52.4	73.0
Mobile	249.0	125.7	85.1	40.7	123.3	39.2	84.1
Monroe	413.8	172.6	119.6	53.0	241.2	92.4	148.8
Montgomery	173.0	70.5	48.4	22.2	102.4	43.6	58.9
Morgan	144.5	36.5	26.9	9.6	108.0	49.0	59.0
Perry	223.9	105.6	73.3	32.3	118.4	48.8	69.6
Pickens	390.0	166.3	119.1	47.2	223.6	89.4	134.2
Pike	132.2	45.6	31.5	14.1	86.7	34.3	52.3
Randolph	137.0	48.7	32.1	16.6	88.3	32.5	55.8
Russell	190.5	97.2	70.2	27.0	93.4	39.4	54.0
St. Clair	182.7	70.9	46.3	24.6	111.8	41.4	70.4
Shelby	247.7	114.0	80.1	33.9	133.7	40.7	93.0
Sumter	280.0	100.1	77.3	22.8	179.9	73.6	106.3
Talladega	182.8	78.0	53.3	24.7	104.8	33.0	71.8
Tallapoosa	241.4	81.6	51.5	30.1	159.8	61.1	98.7
Tuscaloosa	600.0	248.6	181.5	67.1	351.5	150.7	200.8
Walker	324.2	130.3	94.3	35.9	193.9	73.3	120.6
Washington	418.1	185.4	125.4	60.1	232.6	88.1	144.6
Wilcox	339.4	159.9	106.4	53.5	179.5	73.4	106.0
Winston	286.5	127.3	89.4	37.9	159.2	65.8	93.4
State	15,512.3	6,162.4	4,250.6	1,911.6	9,350.1	3,686.7	5,663.5

[1]Totals may not add due to rounding.

Table 38.—*Sampling errors[1] for green woody biomass components by county, Alabama, 1982*

County	All species			Softwood			Hardwood		
	Total green weight	Merchantable green weight	Residual green weight	Total green weight	Merchantable green weight	Residual green weight	Total green weight	Merchantable green weight	Residual green weight
	Percent								
Autauga	10.0	12.5	9.9	13.6	14.7	14.8	19.3	29.3	16.4
Baldwin	6.9	7.9	10.0	9.1	10.1	9.3	13.4	16.3	15.5
Barbour	6.8	8.9	6.5	12.0	12.9	13.6	11.3	14.6	10.2
Bibb	8.9	12.2	7.8	15.0	17.3	13.0	11.4	14.6	11.1
Blount	11.7	14.3	11.8	24.3	27.3	20.3	16.2	19.0	15.3
Bullock	9.0	10.4	11.2	17.5	18.5	19.4	14.9	15.9	16.2
Butler	8.0	10.6	7.2	11.9	13.7	12.6	12.9	15.4	12.3

Table 38.—*Sampling errors*[1] *for green woody biomass components by county, Alabama, 1982—Continued*

County	All species			Softwood			Hardwood		
	Total green weight	Merchantable green weight	Residual green weight	Total green weight	Merchantable green weight	Residual green weight	Total green weight	Merchantable green weight	Residual green weight
	Percent								
Calhoun	8.0	11.8	7.2	20.7	20.9	22.0	10.9	16.3	9.9
Chambers	6.9	9.7	6.3	13.0	14.5	13.8	14.3	18.8	12.7
Cherokee	9.9	13.9	9.4	17.9	21.1	17.8	16.4	24.5	13.9
Chilton	7.7	10.4	6.5	13.9	15.1	15.7	10.0	14.7	8.5
Choctaw	7.0	8.2	7.6	11.5	12.1	12.8	11.1	14.6	10.1
Clarke	5.4	6.3	5.5	8.9	9.4	10.1	8.1	10.5	7.1
Clay	7.1	9.4	7.1	15.1	16.5	15.5	10.0	13.7	9.5
Cleburne	7.2	8.3	7.5	12.4	12.8	14.3	10.4	14.1	9.9
Coffee	9.8	13.5	8.3	17.4	18.0	22.7	14.6	21.4	11.7
Colbert	9.2	10.7	9.7	21.9	21.4	25.9	11.9	13.9	11.9
Conecuh	9.2	11.7	8.8	13.8	15.8	15.6	13.0	17.1	11.8
Coosa	9.3	11.3	9.2	14.6	17.3	13.8	14.8	18.5	13.4
Covington	7.9	10.5	8.0	12.7	14.4	12.3	13.6	20.7	12.4
Crenshaw	10.8	14.6	9.2	20.7	23.5	20.7	13.3	16.9	12.1
Cullman	9.6	12.6	8.3	21.1	22.9	19.7	14.3	18.3	12.5
Dale	10.3	12.7	10.0	20.2	21.5	19.9	11.9	14.5	11.8
Dallas	8.0	11.3	7.2	16.7	19.6	15.5	10.7	14.8	9.7
De Kalb	9.1	10.7	9.8	17.7	18.8	18.1	13.7	18.4	12.2
Elmore	8.7	12.4	8.2	16.8	20.4	17.9	12.9	17.9	11.7
Escambia	8.0	9.8	7.7	10.3	11.8	10.3	15.9	21.8	13.8
Etowah	9.3	14.6	8.5	23.0	25.7	21.4	13.0	18.1	12.4
Fayette	8.2	10.5	7.2	20.7	21.6	20.5	11.2	13.6	9.9
Franklin	9.6	12.0	8.7	18.1	20.0	20.1	12.2	14.9	11.1
Geneva	10.9	16.8	11.2	32.8	35.7	28.3	16.4	22.9	15.1
Greene	9.5	11.2	9.3	20.8	21.5	21.7	11.5	13.9	10.7
Hale	9.1	11.4	9.6	17.7	19.5	18.5	12.3	14.6	12.6
Henry	10.5	11.7	11.7	20.1	20.5	21.1	16.0	19.6	15.5
Houston	15.0	18.1	14.7	28.5	31.9	30.8	20.4	24.1	19.0
Jackson	5.7	7.5	5.4	22.6	25.6	21.9	6.3	8.5	5.9
Jefferson	7.2	10.3	5.9	13.9	15.5	12.9	9.6	12.3	8.9
Lamar	8.0	10.7	8.0	22.1	22.7	24.9	11.5	15.0	10.8
Lauderdale	8.8	11.6	10.0	39.6	44.1	39.7	12.8	14.2	13.5
Lawrence	9.6	12.4	8.9	23.6	27.8	20.7	13.1	16.3	11.7
Lee	8.9	12.0	9.3	14.9	17.4	15.6	15.9	20.9	15.8
Limestone	12.8	13.7	13.0	74.5	73.6	78.8	12.1	12.9	12.7
Lowndes	9.6	13.0	8.3	20.6	23.4	19.6	12.8	16.6	11.7
Macon	11.1	14.4	10.3	21.3	24.2	21.3	15.0	20.8	13.3
Madison	8.6	12.8	7.7	28.1	34.9	30.1	10.1	14.8	9.5
Marengo	7.0	8.4	7.8	13.1	13.9	13.1	12.8	15.6	11.9
Marion	8.6	12.3	7.8	23.2	24.8	21.7	10.9	14.3	10.1
Marshall	9.5	13.3	8.3	22.7	25.0	23.0	13.4	18.5	11.2
Mobile	8.8	10.8	8.7	11.2	12.6	11.7	13.7	20.2	12.5
Monroe	6.4	7.3	7.0	10.3	11.0	12.8	9.6	11.1	9.5
Montgomery	10.8	12.7	11.5	21.4	21.5	22.9	18.2	22.0	17.5
Morgan	8.9	12.8	7.0	25.1	25.8	25.3	11.6	16.7	9.3
Perry	9.0	11.9	8.3	15.3	18.0	13.4	14.4	17.7	13.7
Pickens	6.6	8.2	6.7	12.5	13.5	12.1	10.8	14.5	9.4
Pike	10.4	14.2	9.1	20.9	22.0	22.9	12.7	18.3	11.8
Randolph	9.6	12.4	9.3	20.7	21.6	21.7	12.2	14.9	12.2
Russell	12.2	13.5	12.7	17.7	18.0	19.8	19.5	28.0	16.2
St. Clair	8.7	10.7	8.5	15.9	17.7	15.2	11.2	13.4	10.9
Shelby	7.0	9.9	6.8	13.6	14.9	13.7	10.2	14.9	9.9
Sumter	8.2	10.5	8.3	18.4	19.2	18.9	11.7	15.5	10.6
Talladega	7.8	11.5	7.4	15.8	16.6	17.0	10.0	16.7	9.7
Tallapoosa	7.5	9.5	7.8	15.5	17.8	16.5	10.3	13.5	10.0
Tuscaloosa	5.1	6.3	5.3	10.3	10.8	10.9	8.7	11.1	7.7
Walker	7.4	9.0	7.4	14.1	15.1	13.5	9.1	11.1	9.1
Washington	6.3	7.7	9.0	9.2	10.2	10.6	11.3	13.6	13.2
Wilcox	8.2	9.8	8.3	12.5	13.7	15.4	13.5	16.4	12.3
Winston	6.7	9.4	6.0	14.5	16.0	14.3	10.8	14.7	9.6
State	1.2	1.4	1.2	2.0	2.2	2.1	1.6	2.1	1.5

[1]By random-sampling formula.

Table 39.—*Sampling errors*[1] *for green woody biomass components, by unit, Alabama, 1982*

Forest survey unit	All species			Softwood			Hardwood		
	Total green weight	Merchantable green weight	Residual green weight	Total green weight	Merchantable green weight	Residual green weight	Total green weight	Merchantable green weight	Residual green weight
	Percent								
Southwest-South	3.4	4.2	4.2	4.7	5.3	4.8	6.1	8.0	6.6
Southwest-North	2.7	3.2	2.8	4.6	4.9	5.3	4.1	5.3	3.8
Southeast	2.1	2.7	2.0	3.8	4.2	4.1	3.1	4.1	2.9
West Central	2.6	3.3	2.5	5.3	5.8	5.3	3.8	4.9	3.5
North Central	2.2	3.0	2.1	4.4	4.9	4.2	3.1	4.2	2.8
North	3.0	3.8	2.9	8.2	9.0	8.2	3.7	4.7	3.5

[1]By random-sampling formula.

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Presents findings and analysis of woody biomass based on the fifth forest survey of Alabama (1982). The green weights by component—total, merchantable, residual, sapling, and rough and rotten—are presented by various categories such as ownership, forest type, physiographic class, size class, basal area, species, and age. After-harvest residual is also presented and discussed.

Additional keywords: biomass, green weight, merchantable weight, residual weight, harvesting, clearcut, basal area, forest ecosystem.

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