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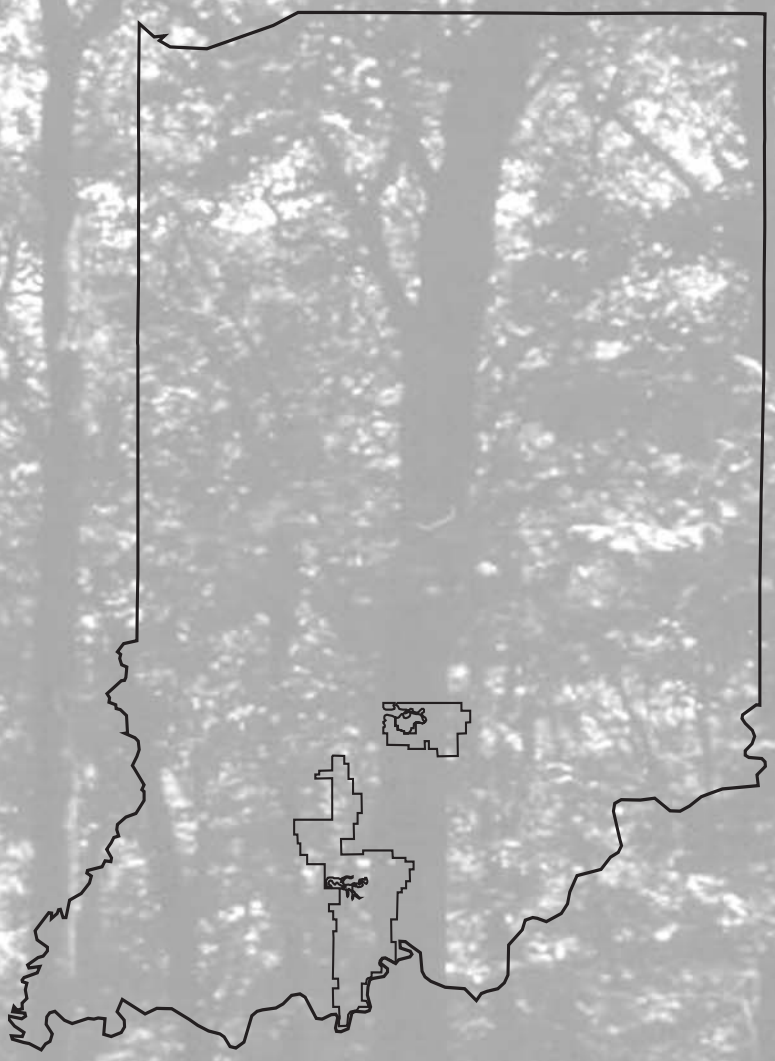
The Forest Resources of the Hoosier National Forest, 1998

Earl C. Leatherberry



Cover map source: ESRI® Data and Map

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The Forest Resources of the Hoosier National Forest, 1998

Earl C. Leatherberry

The Hoosier National Forest is characterized by hills and areas of extensive sandstone bluffs, steep-sided ridges, irregular and gently rolling lowland plains, and bottomlands (McNab and Avers 1994). Numerous caves and karst features are present. Native Americans populated the area as early as 11,000 years ago by establishing small encampments. European-Americans established permanent settlements starting during the late 1700s. According to Jordon and Kaups (1989) early European-American settlers of the region established cultural traditions associated with backwoods farming that included, among other things, a subsistence pattern organized around slash and burn farming with a disregard for conservation. Later, African-American settlers arrived from the antebellum South seeking freedom from racial persecution. They also established settlements in the region and contributed to establishing the foundation of the area's backwoods pioneer culture.

After more than 100 years of exploitive timber extraction, land clearing, and agricultural practices that created eroded hillsides, the Governor of Indiana asked Congress to authorize the USDA Forest Service to buy cutover, tax-delinquent lands for the creation of a national forest. The first parcels, mostly eroded farmland, were purchased in 1935. The Hoosier National Forest was formally established in 1951 from lands in Brown, Crawford, Dubois, Jackson, Lawrence, Martin, Monroe, Orange, and Perry Counties (fig. 1). The Hoosier has the distinction of being the only national forest to assume the nickname of the State where it is located.

The Hoosier National Forest is noted regionally for a number of special things. For one, wildlife is abundant, creating excellent hunting and wildlife observation opportunities. Game species include wild turkey (*Meleagris gallopavo*), white-tailed deer (*Odocoileus virginianus*), gray squirrel (*Sciurus carolinensis*) and migratory waterfowl. Other mammals include gray fox (*Urocyon cinereoargenteus*) and opossum (*Didelphis virginiana*). Common birds include pileated woodpecker (*Dryocopus pileatus*) and several neotropical migrant songbirds. Federally designated species include the endangered Indiana bat (*Myotis sodalis*) and the threatened bald eagle (*Haliaeetus leucocephalus*). The Hoosier also produces an array of products that are collected such as mushrooms, nuts, berries, and fruits. In addition, the Forest has several unique places. For instance, the Pioneer Mothers Memorial Forest, an old-growth forest, is a living monument to the once massive deciduous forests that covered the region. The Charles C. Deam Wilderness, Indiana's only congressionally designated wilderness, is one of the few places in the region where ecological processes occur largely free from human intervention. The Hoosier also has numerous tourist and recreation attractions. People from throughout the region, including many from the major population centers—Indianapolis, Bloomington, Evansville, and Louisville—come to the Hoosier to experience the backcountry by traversing the approximately 240 miles of trail or by touring on the Forest road system. In addition, the water resources of the Hoosier attract people. Anglers and boaters use Lake Monroe, a 10,750-acre impoundment near Bloomington, or Patoka Lake, an 8,800-acre impoundment in the southern section of the Forest. Water recreation also occurs on smaller lakes including Indian, Celina, Tipsaw, and Saddle Lakes.

About the Author:

Earl C. Leatherberry, Resource Analyst, received a bachelor's degree in geography from North Carolina Central University and a master's degree in geography from the University of Michigan. He joined the Forest Service in 1973 and has been with the Forest Inventory and Analysis unit since 1985.

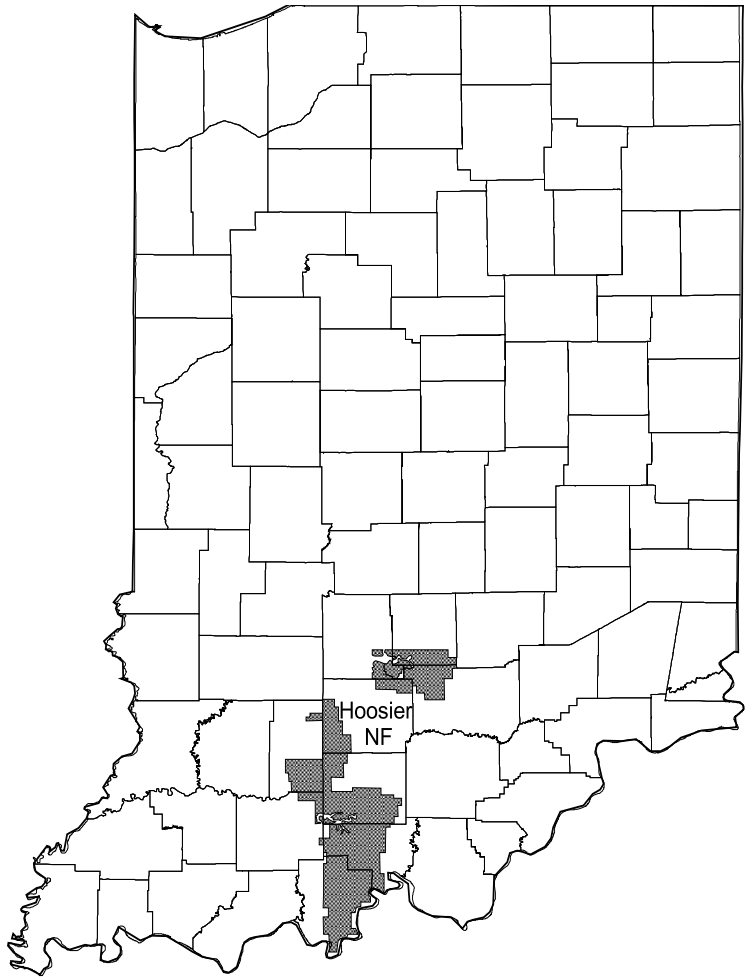


Figure 1.—*Location of the Hoosier National Forest in Indiana. (Data source: ESRI® Data and Map.)*

This report provides information about the status and condition of forest resources of the Hoosier National Forest. Data for this analysis were collected as part of the 1998 Indiana forest inventory conducted by the North Central Research Station's Forest Inventory and Analysis (FIA) Program. The primary purpose of this report is to provide information that describes, in a general way, the status and condition of forest resources within the Hoosier National Forest. Estimates of change in the status and condition of forest resources are based on FIA data collected in 1986 (the previous Indiana inventory) and 1998. Data provided are estimates based on scientifically reliable survey techniques and estimation procedures (see appendix for details). However, because data are estimates and have associated sampling errors, the reader is advised to take into account the range that is associated with a particular statistic (see appendix for details). Also, the FIA program uses standard definitions and terms that may differ from those used by the Hoosier National Forest in management plans and other Forest documents. This is especially true with land use information. Therefore, the reader is cautioned that information presented here should not be compared with information in the Hoosier National Forest's Land and Resource Management Plan (Forest Plan) or other documents without accounting for differences in definitions and other considerations such as inventory methods. For example, the FIA timberland classification implies that land is capable of producing a sustained crop of wood and is not legally or administratively withdrawn from timber harvesting. However,

this is not meant to imply that all timberland on the Hoosier is subject to harvest. The Hoosier's Forest Plan details the allocation of land for specific uses and management activities.

FOREST AREA

Forest land area within the Hoosier National Forest totals 186,000 acres. Forest land on the Hoosier amounts to about 4 percent of Indiana's 4.5 million acres of forest land. For every 10 acres of forest land on the Hoosier, 9 (169,800 acres) are timberland[1]. Reserved forest land, forest land where timber harvesting is prohibited by administrative or legislative decree, accounts for 16,200 acres. One such area is the Charles C. Deam Wilderness Area, one of the largest contiguous tracts of wilderness in the Central Hardwood region. Approximately 2 percent (3,400 acres) of land area in the Hoosier is nonforest land, mostly glades or meadows, or land used as roads and utility rights-of-way.

[1] See the appendix for definitions of this and other terms used in the report.

FOREST COMPOSITION

The Hoosier's forest land is comprised of a wide variety of tree species along with shrubs and understory vegetation. The native species mix is the result of interactions between species and environmental factors including climate, hydrology, topography, and soil. Humans have influenced species composition through practices such as selective harvesting and reforestation with pines. To facilitate describing forest composition, the various tree species found on the Hoosier are grouped into forest types that reflect the combinations of tree species that occur on a particular site. The classification is based on the species forming a plurality of live tree stocking on the site. Forest types in which hardwood stands predominate, occupy the majority of timberland on the Hoosier. Oak-hickory is the dominant forest type, occupying slightly more than half of all timberland area (fig. 2). The maple-beech-birch type is second in abundance, occupying 26 percent of the timberland area. Conifer forest types—white pine and shortleaf-Virginia pine, and the oak-pine type combined—occur on 12 percent of the timberland and provide a significant conifer presence on the Forest.

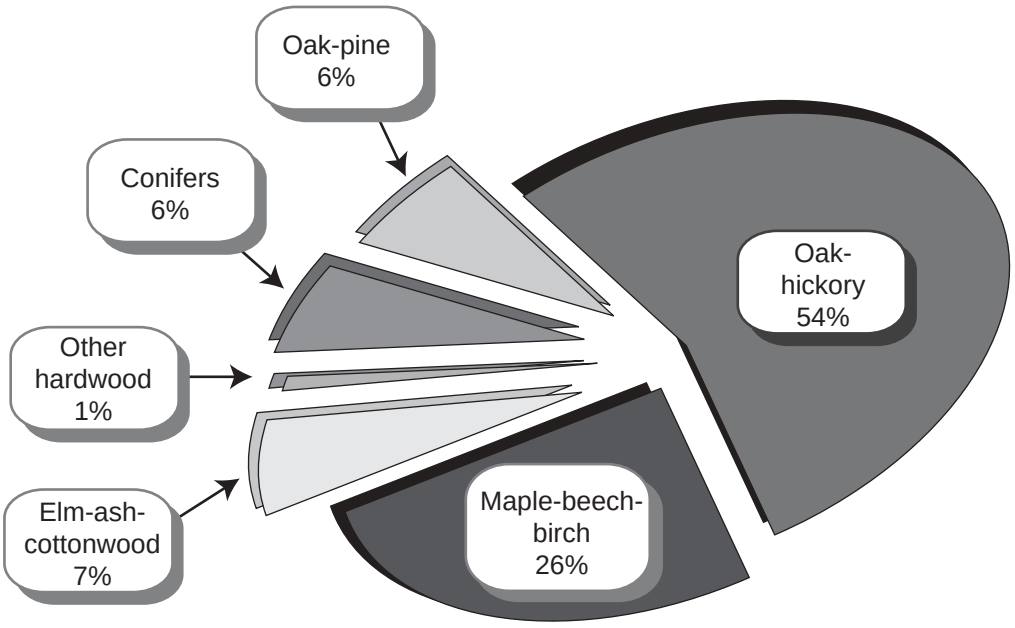


Figure 2.—*Area of timberland by major forest type, Hoosier National Forest, 1998.*

The oak-hickory type decreased in area by nearly 19,000 acres between 1986 and 1998. During the same time, the maple-beech-birch type increased by 15,000 acres.

The number of different tree species can also serve as an indicator of species composition throughout the Forest. There are an estimated 115.6 million live trees at least 1 inch in diameter at breast height (d.b.h.) on the Hoosier. Live trees include growing-stock trees along with noncommercial, rough, and rotten trees 1 inch d.b.h. and larger. On average, there are about 681 trees for every acre of timberland on the Hoosier. The number of trees per acre far exceeds the average for the State, 553 trees per acre. The most abundant tree species group is hard maples (sugar maple) with 20 million trees, accounting for 17 percent of all trees on the Hoosier (fig. 3). The next most abundant species group, soft maples (red and silver maple), has slightly more than half the number of hard maple trees.

With over one-half of the timberland area in the oak-hickory forest type, the high number of maple trees on the Hoosier points out the significant presence of those species in the oak-hickory forest type there. Many of these trees are small. Eight of every ten trees on the Hoosier are less than 5 inches d.b.h. These smaller trees are generally found in the understory of stands dominated by larger trees. Stands dominated by small trees are virtually absent on the Hoosier.

The significant presence of small trees reflects a forest in transition. A closer look at the proportion of smaller trees within the five most abundant tree species on the Hoosier reveals that small trees make up the vast majority of elm and maples as shown below:

Species (Rank in abundance)	Percent of trees less than 5 inches d.b.h.[1]
Elm (4)	92
Hard maple (1)	87
Soft maple (2)	87
Yellow-poplar (3)	65
Select white oak (5)	42

[1] See tables 3 and 4 in appendix for more detailed statistics on number of all live trees and number of growing-stock trees.

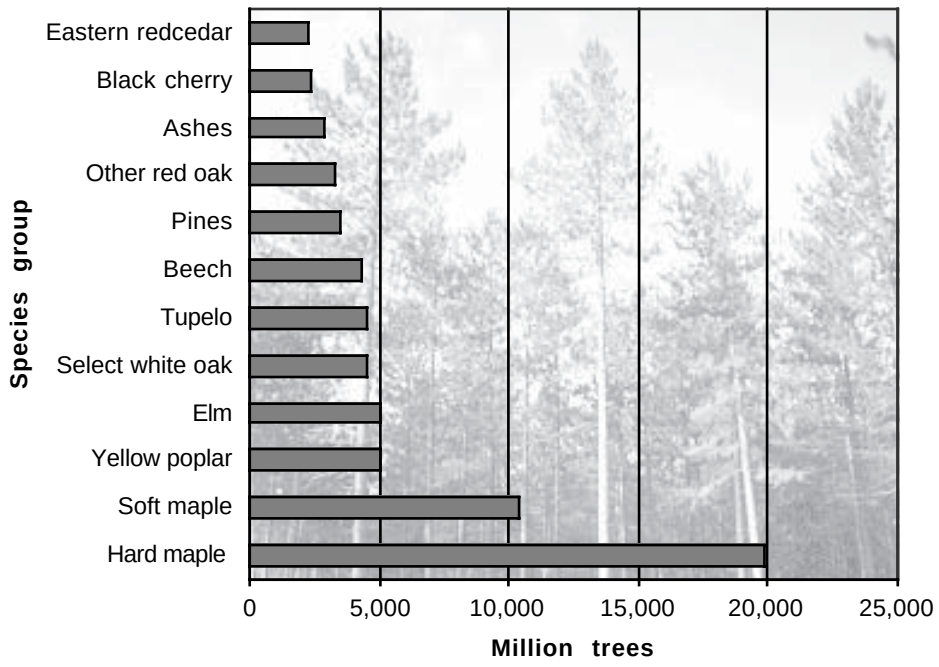


Figure 3.—*Number of all live trees on timberland by select species groups, Hoosier National Forest, 1998.*

The large proportion of smaller elms is related to Dutch elm disease. Typically, seedlings and saplings are less susceptible than larger elm trees to the disease because they are not attractive to the bark beetles and are less likely to root graft. Few of the smaller elms grow beyond the sapling-seedling size. However, maples are becoming a larger component of the species mix in forest stands on the Hoosier. The prevalence of maples in stands suggests that oak dominated stands are trending to maple dominated stands. This is most likely due to the shade tolerance of maples and their establishment beneath the canopies of the oaks and other shade-intolerant hardwood species. Maples can become established with reduced disturbance. As stands are left undisturbed, maples eventually could replace the less shade tolerant oaks. The increased dominance of maples has the potential of lowering the biotic diversity of the Hoosier. Further, less shade tolerant species such as red and white oaks are coincidentally more economically valuable species and appear to not be keeping pace with most other hardwood species in terms of number of trees and, specifically, regeneration.

CHANGE IN FOREST STRUCTURE

Stand-size class is a measure of the average diameter of the dominant trees in a stand and reflects the size structure of stands on the Forest. There are three stand-size classes: sawtimber—large trees; poletimber—medium trees; and sapling/seedling—small trees. The structure of stands on the Hoosier changed rather dramatically between inventories (fig. 4). In 1986, 59 percent of timberland was in sawtimber-size stands, 36 percent was in poletimber, and 5 percent was in sapling-seedling-size stands. By 1998, sawtimber-size stands had increased to 84 percent of timberland area while poletimber-size stands had declined to 13 percent of timberland area. The area with stands dominated by small trees (sapling/seedling-size trees) declined between 1986 and 1998 to 3 percent of timberland area on the Hoosier.

The increase in area of sawtimber-size stands and the corresponding decrease in poletimber

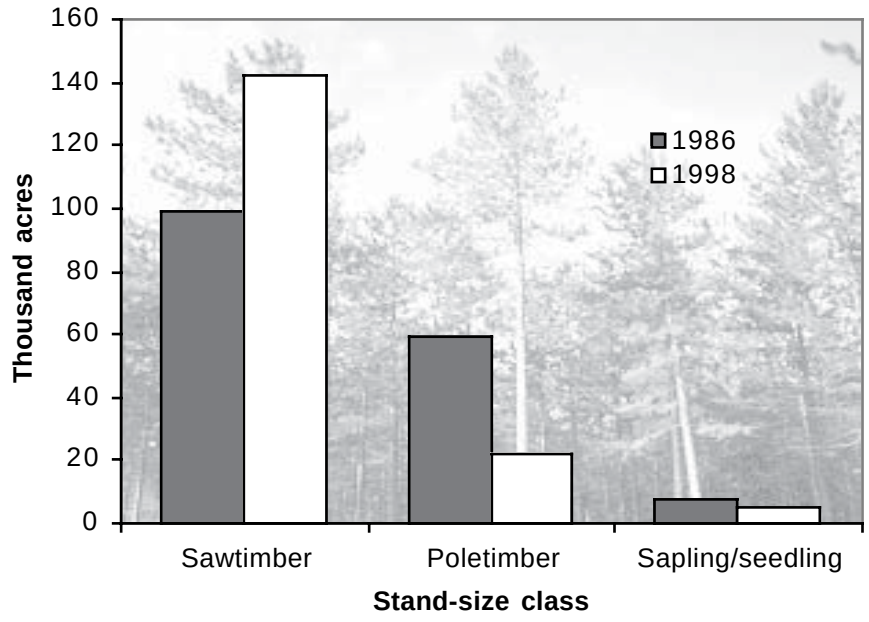


Figure 4.—*Average stand-size class for timberland in the Hoosier National Forest, 1998.*

reflect the evolving nature of the Hoosier's forests. The substantial area of sawtimber-size stands points to a maturing forest. Since the 1930s, following a period when much of the area was denuded of forests, planting and other reforestation programs, along with natural regeneration, have established tree covered lands. Over the years, stands on the Forest have grown sequentially from one size class to the next moving toward maturity. As stands on the Hoosier continue to mature, sawtimber stands will continue to increase at the expense of the poletimber and sapling/seedling stand-size classes.

The virtual absence of sapling-seedling stands suggests a lack of significant disturbance in stands on the Forest. Disturbance occurs through natural occurrences such as blowdowns, human activities such as timber harvesting, or other management activities that open stands to sunlight and expose mineral soil. Over the years, a decrease in timber harvesting activities has reduced the occurrence of large-scale disturbances that can lead to the establishment of sapling-seedling stands.

Stocking, a relative measure of tree density on the land, provides a means of describing how trees occupy a site. Eighty-one percent (136,200 acres) of the timberland on the Hoosier is moderately or fully stocked with growing-stock trees. Stocking levels on the Hoosier differ significantly from the rest of the State as shown below:

Stocking class	Hoosier NF	Indiana
	(Percent of timberland)	
Nonstocked-poorly stocked	6	23
Moderately-fully stocked	81	69
Overstocked	13	8
Total	100	100

An estimated 13 percent (22,900 acres) of the timberland on the Hoosier is overstocked. Trees in overstocked stands typically grow more slowly and have less vigor than those in the moderately or fully stocked class.

VOLUME OF WOOD

To determine how much wood fiber is on the Hoosier, the net volume of live trees 5 inches d.b.h. and larger from a 1-foot stump to a 4-inch top diameter outside bark was ascertained. Total volume of all live trees is 326.7 million cubic feet, which equates to 1,924 cubic feet per acre of timberland. As a comparison, on timberland across Indiana, the average volume of all live trees per acre is about 125 cubic feet less than on the Hoosier. There is an additional 4.4 million cubic feet of wood volume in salvable dead trees, the standing or down trees that contain merchantable volume. The relatively high level of wood volume per acre on the Hoosier is partly a reflection of forestry management practices that have occurred on those lands over the past half-century.

Half of the volume of all live trees is contained in trees that are at least 15 inches d.b.h. Within the Hoosier there are stands of rather majestic, towering hardwoods. Fully 18 percent of the total volume of wood is in trees that are 21 inches d.b.h. and larger. The majority of large diameter trees are oaks, beech, yellow-poplar, and sycamore. Nine percent of the volume on the Hoosier is in softwood species, most of that in shortleaf pines. Only about 5 percent of the total wood volume is in short-log, rough, or rotten trees.

CHANGE IN TIMBER VOLUME

Growing-stock Volume

Ninety-five percent (309.4 million cubic feet) of all live tree volume is considered growing-stock volume, the volume in trees that meets specified standards of size, quality, and merchantability. Growing-stock volume is the prime measure of wood volume and excludes rough, rotten, and dead trees. Between 1986 and 1998, net growing-stock volume increased by 35 percent—from 229.5 million cubic feet to 309.4 million cubic feet. With the increase in growing-stock volume, average timberland volume per acre also increased from about 1,383 cubic feet in 1986 to 1,822 in 1998. Among the major species, yellow-poplar, a fast growing species, had the largest total cubic foot increase in growing-stock volume, adding 12.6 million cubic feet between 1986 and 1998. The largest percentage increase occurred in the soft maple species group, rising from 2.5 million cubic feet in 1986 to 13.2 million cubic feet in 1998, a 410-percent increase (fig. 5). Growing-stock volume in hard maples also increased substantially, from 15.7 million cubic feet to 27.8 million cubic feet.

Although growing-stock volume in maples increased substantially between inventories, it amounts to only about one-third the volume of oaks. Although oaks continued to put on volume between inventories, oak volume was added at a slower rate than in most other species. For example, in 1986, oak volume accounted for almost half of the total growing-stock volume, but by 1998 it had declined to 43 percent of the total. However, the continued expansion of oak volume indicates that large oak stands and oak trees continue to have a significant presence on the Forest. Several locally minor species—bigtooth aspen, the ashes, basswood, and select hickory—declined in growing-stock volume from 1986 to 1998.

Sawtimber Volume

Sawtimber volume is a subset of growing-stock volume. It is the volume of the saw log portion of live sawtimber measured in board feet. Sawtimber volume is generally measured with the International 1/4-inch rule. However, the Doyle rule is widely applied to measure sawtimber volume in Indiana. Therefore, information about sawtimber volume is presented using both the International 1/4-inch rule and the Doyle rule. In the text, the

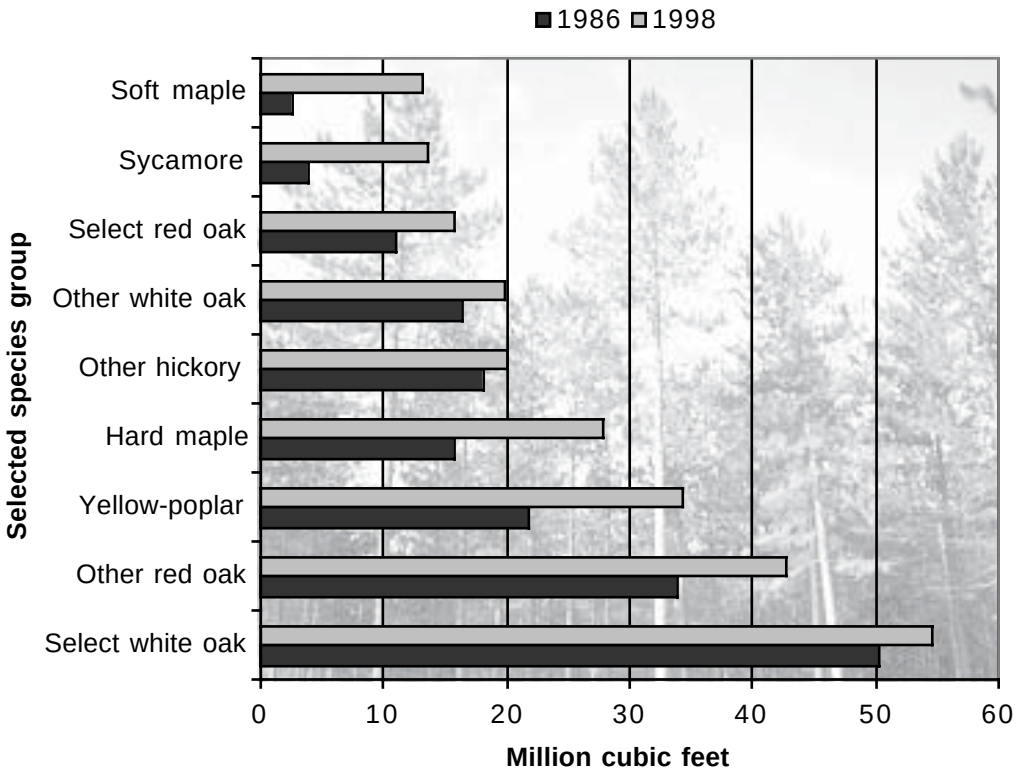


Figure 5.—*Growing-stock volume by major species group, Hoosier National Forest, 1986 and 1998.*

International 1/4-inch rule measure is presented and the Doyle rule measure is presented in parentheses. Sawtimber volumes are presented in both International 1/4-inch rule and Doyle rule in the tables in the appendix. To convert from Doyle rule to International 1/4-inch rule, see the appendix for conversion factors.

Between 1986 and 1998, sawtimber volume on the Forest increased by 60 percent, from 771.7 million board feet to 1.2 billion board feet (459.7 mbf to 776.8 mbf, Doyle). Some species had a substantial gain in sawtimber volume, more than doubling in the case of pines, hard and soft maples, elm, sycamore, and black walnut. Species declining in sawtimber volume were bigtooth aspen, sweetgum, and tupelo. Of total sawtimber volume, one-fourth was in trees with diameters of 21 inches or greater. On an individual species basis, three species—select white oak with 229.7 million board feet (148.3 mbf, Doyle); other red oak with 188.4 million board feet; (123.0 mbf, Doyle); and yellow-poplar with 148.5 million board feet (99.2 mbf, Doyle)—account for 46 percent of the sawtimber volume on the Forest.

FACTORS ASSOCIATED WITH RECENT CHANGE IN TIMBERLAND RESOURCES

The composition and structure of timberland on the Hoosier have changed significantly over time. For a period of about 100 years (1850s to 1950s), humans played a large role in shaping the forest. For example, human-induced wildfires, excessive logging, land clearing for agriculture, and widespread erosion altered the forest landscape. However, in recent years most of the change to the Hoosier landscape has come from the interaction between management activities, natural plant succession, and to a lesser extent, natural disturbances, such as localized wildfires or blowdowns. An analysis of average annual change in growth, mortality, and removals provides information about factors that influenced some of the change in the timberland resources of the Forest.

Between surveys, average annual gross growth (average net annual growth plus mortality) on the Hoosier amounted to 11.2 million cubic feet for growing stock (fig. 6). Annual growing-stock mortality averaged 2.1 million cubic feet.

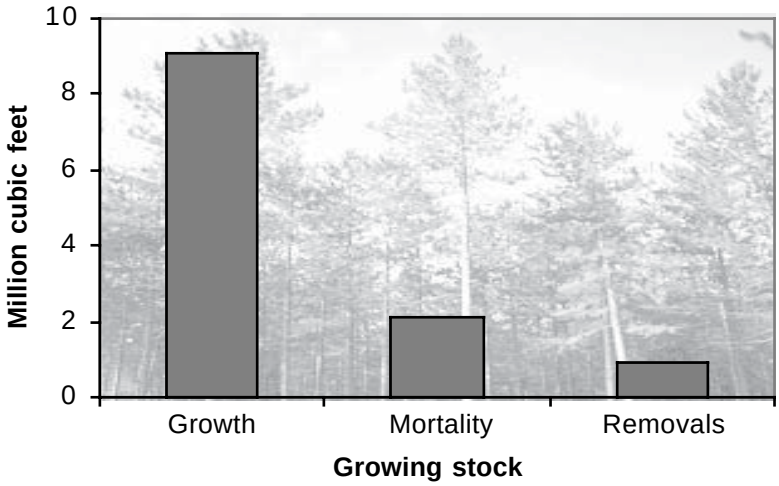


Figure 6.—*Average annual growth, mortality, and removals of growing stock on timberland on the Hoosier National Forest between 1986 and 1997.*

In addition, some 900 thousand cubic feet of growing-stock volume were removed from the Hoosier annually between 1986 and 1997. Removals include not only volume that was harvested but also volume that was left standing but “removed” through land use change. (See appendix, definition of terms under other removals.) On the Hoosier, average annual harvesting levels are below the FIA estimate.

The net increase in volume (gross growth minus mortality and removals) on the Hoosier averaged 8.1 million cubic feet of growing stock, including 37.5 million board feet of sawtimber (20 mbf, Doyle), each year between 1986 and 1997. On an average per acre basis, there was a net increase (gross growth minus mortality and removals) of 48 cubic feet of growing stock per acre per year on the Hoosier.

Timber harvesting on the Forest has been reduced over the years. For example, average annual removals amount to only about 10 percent of the average annual growth rate. Timber removals were concentrated around only two species—select white oak and yellow-poplar. Combined, they accounted for 86 percent of the 940,000 cubic feet of average annual removals of growing stock on the Hoosier. The majority of the other average annual removals of growing stock were from the other oak species groups.

A comparison of average annual removals on the Forest with those from the State and region reveals a significant difference. On a per acre basis, the annual rate of timber removals between 1986 and 1997 statewide for Indiana was 20 cubic feet of growing stock per acre. In an eight-county region in southeast Indiana, adjacent to the Ohio and Kentucky borders, it was 17 cubic feet per acre. On the Hoosier, however, the average annual removal rate per acre was 5.5 cubic feet. The removal rate on the Forest represents 0.3 percent of the total growing-stock volume whereas for the State it represents 1.3 percent. Perhaps more revealing is the growth to removals ratio. For the State, stands grew 2.5 times the volume being removed. On the Hoosier, stands grew 9.6 times the volume removed.

The relative low level of timber removals on the Forest is reflected in the continuing accumulation of volume. Forests are aging. Because of the maturing of oak stands and the limited ability of white and red oak to regenerate under shade, the regeneration of these species can be problematic. In general, the health of stands on the Hoosier is good. However, average annual mortality of growing-stock volume is 2.1 million cubic feet and exceeded removals by almost 1.2 million cubic feet. About 41 percent of growing-stock average annual mortality volume is from the oak species groups. The continued emergence of maples as a component of forest stands is reflected in hard maple mortality, which accounted for about 9 percent (185 thousand cubic feet) of growing-stock average annual mortality. Stands on the Hoosier should be monitored for future change. The continuing aging of stands may result in increased mortality, especially in overstocked stands that may be susceptible to insect infestation or disease.

CONCLUSION

The Hoosier National Forest was carved out of exploited, degraded, often abandoned land. Over the past 50 years, much of that land has been restored to its original splendor. Today, the national forest that bears the State's nickname provides a wide array of goods and services to many people. The origin of the term “Hoosier” is not known with certainty. But, the citizens of Indiana bear the nickname with pride and look to the Hoosier National Forest with affection. As the region's population expands—Indiana's population grew 9.7 percent during the 1990s to 6.1 million in 2000, and the populations of eight counties in and around Indianapolis each grew by at least 20 percent—the Hoosier National Forest staff faces the challenge of being stewards of a resource that meets diverse public needs while maintaining its ecological integrity.

APPENDIX

PUBLIC ACCESS TO FIA DATA

The data presented in this report represent only a portion of the data collected. However, the data collected in both the 1986 and 1998 Indiana inventories can be easily accessed. Data can be obtained over the Internet by accessing the USDA Forest Service FIA Web site (http://www.fia.fs.fed.us) and clicking on the Online Databases button. Data from the inventories of every State used to develop the 1997 Resources Planning Act (RPA) assessment can also be accessed at this site. Three independent databases are maintained here: the National FIA Database, the National Resources Planning Act (RPA) Inventory Database, and the National Timber Products Output (TPO) RPA Database.

The National FIA Database contains data from the previous (1986) and current (1998) ground plot-based inventories that were used to produce most of the estimates in this report. This includes all estimates of area; number of trees; volume; biomass; average annual net growth, mortality, and removals; and current net growth and mortality. The data are stored so that users can download portions of the database onto their own computers and produce their own estimates, or they can use an online table generation program to create user-specified tables similar to those presented in this report. This database is described in Miles *et al.* (2001) and is documented online. Copies of the database and a table generation program are also available on a CD-ROM, which can be obtained by contacting the Program Manager, FIA, North Central Research Station, 1992 Folwell Avenue, St. Paul, MN 55108, (651) 649-5139.

The National RPA Inventory Database contains data from all States and represents a "point-in-time" inventory. Indiana inventory results contribute to this database. RPA inventories are conducted on a 10-year cycle with midcycle updates every 5 years. RPA inventories differ from FIA inventories in that historically FIA inventories have been periodic and based on the year of completion of field work for any individual State. Results are published as soon as possible after the field work results are compiled and analyzed. RPA inventories use the FIA inventory results and update them to a common year. The most recent RPA inventory represents the FIA inventories of all 50 States updated to the common year of 1997. Results are published on a regular cycle. This database is available online at http://www.fia.fs.fed.us.

ACCURACY OF THE SURVEY

FIA information is based on a sampling procedure designed to provide reliable statistics at the State and Survey Unit levels. Consequently, the reported figures are estimates only. A measure of reliability of these figures is given by sampling errors. The level of sampling error used by FIA means that the chances are two out of three that if a 100-percent inventory had been made, using the same methods, the results would have been within the limits indicated.

For example, the estimated growing-stock volume in the Hoosier National Forest in 1998, 309,436 thousand cubic feet, has a sampling error of ± 8.92 percent (± 27,602 thousand cubic feet). The growing-stock volume from a 100-percent inventory would be expected to fall between 337,038 thousand cubic feet and 281,834 thousand cubic feet (309,436 ± 27,602), there being a one in three chance that this is not the case. The tabulation on the next page shows the sampling errors for the Hoosier National Forest:

Item	Hoosier NF	Sampling error
Forest land	*Thousand acres*	*Percent*
Timberland area (1998)	169.8	8.03
Growing stock	*Thousand cubic feet*	
Volume (1998)	309,436	8.92
Average annual net growth (1986-1997)	9,055	11.80
Sawtimber (International 1/4-inch rule)	*Thousand board feet*	
Volume (1998)	1,231,023	11.40
Average annual net growth (1986-1997)	41,562	11.24

As survey data are broken down into sections smaller than Forest totals, the sampling error increases. For example, the sampling error for timberland area in a particular forest type is higher than that for total timberland area in the Forest. To estimate sampling error for data smaller than Forest totals, use the following formula:

$$E = \frac{(SE)\sqrt{(\text{Forest total volume or area})}}{\sqrt{(\text{Volume or area smaller than Forest total})}}$$

Where:
E = Sampling error in percent.
SE = National Forest total error for volume of area.

For example, to compute the error on the area of timberland in the oak-hickory type for the Hoosier, proceed as follows:

1) Total area of oak-hickory type from table 2 = 91.1 thousand acres.
2) Total area for all timberland in the Hoosier National Forest from table 1 = 169.8 thousand acres.
3) Total Forest error for timberland area = 8.03 percent.
4) Using the above formula:

$$E = \frac{(8.03)\sqrt{169.8}}{\sqrt{91.1}}$$

E = 0.1096 or 10.96 percent sampling error for the oak-hickory forest type.

SURVEY PROCEDURES

The 1998 Indiana survey used a two-phase sample for stratification that remeasured the inventory plots from the 1986 inventory and used a growth model in the estimation of both current conditions and change over time. Two-phase sampling, also called double sampling, consists of a phase 1 sample used to estimate area by strata and a phase 2 sample used to estimate the average value of parameters of interest within these strata. The estimated population total is the sum across all strata of the estimated strata area times the estimated mean.

The 1986 Indiana inventory was intensified to provide lower sampling errors and to improve county-level estimates. Funding to intensify the 1986 inventory was provided by the Indiana Department of Natural Resources—Division of Forestry. Because the 1998 inventory was not intensified, it is based on the measurement of fewer ground plots than the 1986 inventory. In the 1998 inventory, only a 50-percent systematic sample of the 1986 ground plots was used because of the lower sampling intensity. New plots were established only to replace 1986 plots that could not be remeasured. These new plots were established as near as possible to the original plot. The growth model used in the Indiana survey design was the Central States Stand and Tree Evaluation and Modeling System (STEMS) (Miner *et al.* 1988). Because

of the remeasurement nature of the 1998 inventory, procedures for both the 1986 and 1998 inventories are discussed.

PHASE 1 STRATIFICATION

1986 Photo Plot Sampling of Aerial Photographs

In the 1986 inventory, the aerial photographs were assembled into township mosaics, and a systematic grid of 121 one-acre photo plots (each plot representing approximately 190.4 acres) was overlaid on each township mosaic. Each of these photo plots was examined by aerial photo interpretation specialists and classified stereoscopically based on land use, forest type, and stand-size density. A total of 126,629 photo plots formed the basis for the 1986 stratification. From these photo plots, a systematic sample of 11,440 plots were selected as ground plots and further examined by survey crews to verify the classification and to take further measurements. Of the ground plots, 2,140 plots were on forest land. These 1986 ground plots formed the basis for the remeasured ground plots in the 1998 inventory.

1998 Computer-assisted Classification of Satellite Images

Between inventories, FIA changed its phase 1 methods. Current inventories are based on a computer-assisted classification of LandSat Thematic Mapper satellite imagery. Image classification was conducted by Indiana State University as part of the Gap Analysis Program (GAP). The purpose of GAP (a nationwide multi-agency cooperative program) is to provide broad geographic information on the status of ordinary species and their habitats. FIA used the GAP classifications to form two initial strata, forest and nonforest strata. Pixels that were within 60 m (2-pixel width) of a forest/nonforest edge formed two additional strata—forest/nonforest and nonforest/forest. Forest pixels within 2 pixels of a nonforest pixel (in any direction) were classified forest/nonforest, and nonforest pixels within 2 pixels of a forest pixel were classified nonforest/forest. An overlay of all national forest land ownership was used to identify all lands owned by the Hoosier National Forest. The national forest lands were treated as a single stratum. In the rest of Indiana, stratification and estimation were conducted at the county or county group level. Final estimation of area by strata for the Hoosier National Forest was based on 845,763 pixels.

In the 1986 inventory, the stratification was completed by interpretation of the photo plots. The move to GAP satellite imagery changed FIA's phase 1 sample from being based on one photo plot every 190.4 acres to a sample based on a classified pixel every 0.22 acres. The increased intensity of the phase 1 sample greatly improved estimates of the area within each stratum, particularly at the county level. Thus, the stratification used in the 1998 inventory was based on 104 million pixels rather than the classification of 126,629 photo plots. Also, because classification was conducted using a computer-assisted algorithm across the entire State, biases in the photo plot sampling method that resulted from differences in photo quality, age of photography, and experience of the photo interpreter were eliminated, and classification was consistent across the entire State.

PHASE 2 GROUND PLOT MEASUREMENTS

1986 Plot Design

In 1986, plots classified as timberland were measured. Each ground plot consisted of a cluster of 10 subplots covering approximately 1 acre. At each subplot, trees 5.0 inches or more in d.b.h. were sampled on a 37.5 basal area factor (baf) variable-radius plot, and trees less than 5.0 inches d.b.h. were sampled on a 1/300-acre fixed-radius plot. The arrangement of the 10 subplots within the plot was adjusted if they were located in a land use that was different from subplot 1. Under the estimation

procedures used in this inventory, the entire plot measurement represented a single land classification. Thus, if a subplot was located outside of the land classification for the plot, it was rotated into the land classification. For example, if subplots 1 through 9 were located in a forest land classification and subplot 10 fell in a field, subplot 10 was rotated back into the forest land classification. These plots were established, monumented, and measured as part of the 1986 field inventory. Timberland plots were monumented using metal stakes and permanent paint marks on trees to facilitate the remeasurement of the plot. Plots on other land uses were monumented with a pinprick on the aerial photograph.

1998 Plot Design

In 1998 phase 2, a set of ground plot locations from the 1986 inventory were transferred to the most recent aerial photographs available and overlaid onto the classified satellite imagery. Those 1986 ground plots that definitely were not forest land were classified as nonforest and were not sent to the field for measurement unless the plot had been a forest plot in the 1986 inventory, or it was so close to a forest edge that part of the plot could possibly fall in a forest area. If any portion of the plot included forest land (including reserved forest land, unproductive forest land, and timberland), it was either remeasured or modeled. New plots were only established if the original plot could not be relocated, in which case a new plot was established in what was considered the original plot location. Measuring ground plots on all forest lands represented a major change between the 1986 and 1998 inventories. In 1986, plots on reserved and unproductive forest land were not measured.

All ground plots were classified as "undisturbed" or "disturbed" by comparing the 1986 and 1998 aerial photography of the plot location. Disturbance here refers to a major change in forest vegetation caused by factors such as harvesting, land use change, or a major mortality event. All disturbed plots and a one-third sample of the undisturbed plots were remeasured to obtain estimates of current condition and changes since the last inventory. In the remeasurement of the 1986 ground plots, only subplots 1 through 5 were measured. On these five subplots, all trees measured on these plots in 1986 were remeasured or otherwise accounted for, and all new trees that should be tallied using the 1986 plot design were identified and measured. These measurements formed the basis for change estimates between the two inventories such as average annual net growth, mortality, and removals.

Two-thirds of the ground plots that were timberland at the time of the 1986 inventory and determined to be undisturbed until the 1998 inventory were projected to the current time using STEMS. This procedure gave projected estimates of current volume and growth for these undisturbed plots. The comparison of the projected 1986 ground plots (two-thirds of the total sample) and observed values on the remeasured 1986 ground plots (one-third of the total sample) of the undisturbed forest plots provided local calibration data. The calibration data were used to adjust the projected values of the undisturbed plots that were not remeasured. The adjustment procedure is a modified version of the method described by Smith (1986).

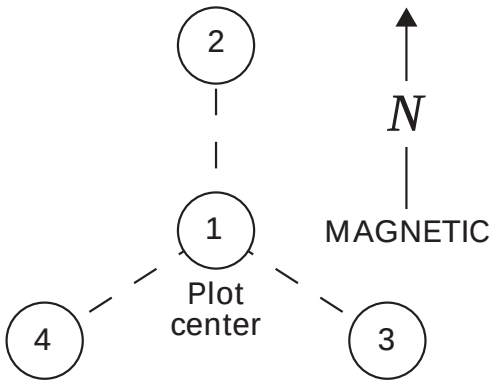
The undisturbed timberland plots that were not remeasured played a crucial role in the survey design. These plots were determined to be undisturbed and had conditions that could be simulated by STEMS. The STEMS growth model was used to "grow" the old plot and tree data to produce an estimate of current data. Thus, these plots were treated as ground plots in the estimation of forest area, number of trees, volume, net growth, and mortality even though they were not revisited. The plot record for each modeled plot was sent to the field for verification of current ownership information.

All old plots classified as disturbed were sent to the field for remeasurement to assess and verify changes since the last inventory. Disturbance refers to any change on a plot that can be detected on the aerial photographs and that the

STEMS growth processor cannot predict, such as catastrophic mortality, cutting, regenerating stands, and land-use change.

In the 1998 inventory, the new plot design used was based on the Forest Health Monitoring program (FHM) plot design. The new 1998 design was laid over the 1986 design so that estimates of change could be based on the old plot design and estimates of current conditions could be based on the new plot design.

The overall plot layout for the new design consisted of four subplots spaced 120 feet apart in a triangular arrangement (fig. 7). The center of the new plot was located at the same point as the center of the 1986 plot. All trees less than 5 inches d.b.h. were measured on a 6.8-foot-radius (1/300 acre) circular microplot located at the center of each of the four subplots. Trees with diameters 5 inches and larger were measured on a 24-foot-radius (1/24 acre) circular plot. Each subplot was mapped for forest condition. Subplots were not rotated even if they fell into another condition. Factors that would determine a change in condition from subplot one were changes in forest type, stand-size class, land use, ownership, and density. Each condition that occurred anywhere on one of the subplots was identified, described, and mapped if the condition in total met or exceeded 1 acre in size (the 1-acre minimum size for a condition to be identified could include land off-plot). Each condition was assigned a condition number, and condition information was recorded.



From subplot center	120' to subplot center	Azimuth
1	2	0°
1	3	120°
1	4	240°

Figure 7.—*Standard plot layout for 1998 Indiana inventory.*

Another change in plot measurements that came with the 1998 inventory was the determination of the exact plot location of every ground plot in the inventory. For plots that were visited in the field, this was done using a Global Positioning System (GPS) device at plot center. For the nonforest and undisturbed forest plots that were not visited, plot location was determined by transferring the old plot location from the aerial photography to an unclassified, geo-corrected Landsat™ image. Both procedures provided an accurate location that was used to link the ground plots to the classified gap data used for stratification.

ESTIMATION

The following sections briefly describe the estimation procedures used to produce the resource tables presented in this and other FIA reports as well as the estimates produced by the table generation programs that are available on CD-ROM or over the Internet. The estimation procedures for computing statistics from this sampling design are somewhat complicated by the fact that not all parameters of interest are observed on every plot. For estimation purposes, the inventory is considered as three different samples: one that uses only the plots that were actually remeasured, one that uses the remeasured and updated plots, and one that uses all plots (remeasured, updated, and new plots).

All estimates from this inventory are based on double sampling for stratification. Cochran (1977) provides a good general presentation of double sampling for stratification, and Loetsch and Haller (1964) provide a more detailed presentation in a forest inventory context. Scott and Bechtold (1995) describe details of the estimation arising from changes in the plot design related to observing more than one condition on a plot.

Current (1998) Area

In double sampling for estimation, each phase 2 sample (ground plot) in a stratum is assigned an area equal to the total estimated area in that stratum divided by the number of phase 2 samples (ground plots) in the stratum. This assigned area is referred to as the expansion factor for the plot and represents the individual plot's contribution to the estimation of current total area. A typical plot in the 1998 inventory has an expansion factor of about 3,650 acres. This amount will vary from plot to plot because of the random variability in the sampling process.

The 1998 plot design was used to estimate all 1998 area estimates such as those presented in tables 1 and 2. When a ground plot was observed to be entirely within a single condition, the plot's contribution towards the estimated total area of that condition was the plot's total expansion factor. When a plot straddled more than one condition, the expansion factor was allocated to the various conditions in direct proportion to the proportion of the plot that condition occupied. For example, a plot with an expansion factor of 3,600 acres that was observed to be 50 percent in oak-hickory timberland, 30 percent in maple-beech timberland, and 20 percent in nonforest land would contribute 1,800 acres to the total estimated area of oak-hickory timberland, 1,080 acres to the total estimated area of maple-beech timberland, and 720 acres to the total estimate of nonforest land. The estimates of current area were based on all ground plots (remeasured, projected, and new) and the four strata defined by the 1998 gap classification.

The average expansion factor for a plot of 3,650 acres can be used to estimate approximately how many plots contribute to a particular area estimate. This is useful to users concerned with the significance of an estimate. For example, table 2 reports there are 91,100 acres of timberland in the oak-hickory type on the Hoosier. Using the 3,650 acres per plot as an average expansion factor, we estimate that about 26 plots would be observed to be oak-hickory timberland. In actuality, oak-hickory timberland was observed on more than 26 plots. Some plots were entirely in the oak-hickory type and others were partially in the oak-hickory type.

Area Change (1986-1998)

Area change estimates were based only on remeasured and projected plots and used the four strata defined by the 1998 gap classification. New plots were not included in the sample because they did not provide observations from two points in time. Area change estimates were based on the 1986 plot design and its remeasurement: the condition found at plot center in both inventories. These estimates thus reflect observations taken at permanent points where land use, forest type, and other condition classifications were determined at

two different times (1986 and 1998). The average plot expansion factor for change estimation was 3,700 acres; thus a plot that was observed to be timberland in 1986 and nonforest in 1998 represented 3,700 acres that changed from timberland to nonforest.

Volume

Estimates of volume per acre were made from the trees measured or modeled on all ground plots (remeasured, projected, and new) and the four strata defined by the 1998 gap classification. These estimates came from measurements taken on the new 1998 plot design. Estimates of volume per acre were multiplied by the area estimates to obtain estimates of total volume.

Net cubic foot volumes were based on Hahn and Hansen (1991) for use in the Central States. For the Indiana inventory, the merchantable height equation presented in Hahn and Hansen (1991) was used in conjunction with Stone's equation (see appendix I in Hahn and Hansen 1991) to estimate gross volume. This estimate was then corrected by species for variation in bark and cull volume to yield an estimate of net volume, using the coefficients presented in Hahn and Hansen (1991).

The Forest Service reports all board foot volume in International 1/4-inch rule. In Indiana, the Doyle log rule is commonly used. See table A for a comparison of the two rules (Wenger 1984).

Table A.—*Board-foot volumes and board-foot to cubic-foot ratios for International 1/4-inch and Doyle log rules*

Diameter (inches)	Volume in board feet		Board feet per cubic foot	
	Doyle log rule	International 1/4”	Doyle log rule	International 1/4”
6	4	20	0.92	4.59
8	16	40	2.23	5.59
10	36	65	3.38	6.11
12	64	95	4.32	6.42
14	100	135	5.08	5.85
16	144	180	5.69	7.11
18	196	230	6.22	7.30
20	256	290	6.65	7.53
25	441	460	7.47	7.80
30	676	675	8.06	8.05
35	961	925	8.50	8.18
40	1,296	1,220	8.83	8.32

To determine the equivalent Doyle log rule board foot contents of a log from the International 1/4-inch rule, use table B below. For example, a 12-inch diameter log that is 16 feet long has an International 1/4-inch volume of 95 board feet. To convert to Doyle, multiply 95 by 0.67 to obtain 64 board feet, which is the Doyle equivalent for a 12-inch 16-foot log.

Table B.—*International 1/4-inch rule to Doyle log rule conversion factors*

Diameter of log small end (inches)	Length of log in feet					
	8	10	12	14	16	18
8	0.53	0.50	0.48	0.40	0.40	0.40
10	0.60	0.63	0.60	0.56	0.55	0.53
12	0.71	0.73	0.69	0.66	0.67	0.65
14	0.77	0.78	0.75	0.76	0.74	0.72
16	0.85	0.82	0.83	0.81	0.80	0.79
18	0.89	0.87	0.86	0.86	0.85	0.83
20	0.95	0.91	0.91	0.90	0.88	0.87
25	1.00	0.99	0.97	0.97	0.96	0.94
30	1.04	1.03	1.02	1.01	1.00	0.99
35	1.07	1.06	1.05	1.04	1.04	1.03
40	1.09	1.08	1.08	1.07	1.06	1.06

Net Growth, Mortality, and Removals

In this report, major components of changes in timber volume (growth, mortality, and removals) are reported for two different time periods. Average annual change is an estimate of the change that occurred between inventories.

Average annual net growth and mortality (1986-1997

Estimates of average annual net growth and mortality per acre were made from the trees on plots that were measured in 1986 and then remeasured or modeled in 1998. The four strata defined by the 1998 gap classification were used for stratification. All estimates of average annual net growth and mortality came from measurements taken using the 1986 plot design.

On remeasured plots, estimates of average annual net growth and mortality per acre came from the remeasured diameters of trees and from observation of trees that died between inventories, using methods presented by VanDeusen *et al*. (1986). Growth and mortality estimates for old undisturbed plots that were updated were derived in the same manner as remeasured plots. The STEMS growth model was adjusted by Survey Unit to meet local conditions, using data from the undisturbed remeasurement plots. As with volume, total growth and mortality estimates were obtained by multiplying the per acre estimates by area expansion factors.

Average annual removals (1986-1997)

Estimates of average annual removals per acre were made from the trees on plots that were measured in 1986 and then remeasured in 1998. The 1986 photo plot sample was used for stratification. All estimates of average annual removals came from measurements taken using the 1986 plot design. New plots and projected plots were not used to estimate average annual removals. These estimates were

obtained from trees measured in the last survey and cut or otherwise removed from the timberland base. Because remeasurement plots were a subset of the total ground plots, and not all remeasurement plots had cutting, average annual removals estimates have greater sampling probability than volume, net growth, and mortality estimates.

TREE AND LOG GRADES

Log and tree grades were based on the classification of external characteristics as indicators of quality. Log grades and/or tree grades were taken on every sawtimber-size tree measured on the new 1998 four-point plot. Sawtimber softwood trees were graded for quality and assigned a butt log grade. Sawtimber hardwood trees were graded for quality and assigned a tree grade. The volume yield by log grade or tree grade for this sample was used to distribute the volume of the ungraded trees (those on projected plots) by species group. In previous inventories, sawtimber trees were graded on only a third of sample plots.

Hardwood sawtimber trees were graded according to Hanks (1976). The best 12-foot section of the lowest 16-foot hardwood log was used for grading. Hardwood sawtimber trees that did not meet minimum tree grade specifications for grades 1 through 3 were assigned grade 4 according to Forest Service standard specifications for hardwood construction logs described by Rast *et al.* (1973).

Softwood sawtimber trees were graded according to specifications described by Ostrander and Brisbin (1971). For all softwoods, the first merchantable 16-foot log, or shorter lengths down to 12 feet, was used for grading.

Hardwood Tree Grades for Factory Lumber [a]

Grade factor	Tree grade 1	Tree grade 2	Tree grade 3
Length of grading zone (feet)	Butt 16	Butt 16	Butt 16
Length of grading section [b] (feet)	Best 12	Best 12	Best 12
D.b.h., minimum (inches)	16 [c]	13	11
D.i.b., minimum at top of grading section (inches)	13 [c] 16 20	11 [d] 12	8
Clear cuttings (on the 3 best faces) [e]			
Length, minimum (feet)	7 5 3	3 3	2
Number on face (maximum)	2	2 3	Unlimited
Yield in face length (minimum)	5/6	4/6	3/6
Cull deduction (including crook and sweep, but excluding shake) maximum within grading section (percent)	9	[f]	50

[a] *Hanks (1976)*

[b] *Whenever a 14- or 16-foot section of the butt 16-foot log is better than the best 12-foot section, the grade of the longer section will become the grade of the tree. This longer section, when used, is the basis for determining the grading factors such as diameter and cull deduction.*

[c] *In basswood and ash, d.i.b. at top of grading section must be 12 inches and d.b.h. must be 15 inches.*

[d] *Grade 2 trees can be 10 inches d.i.b. at top of grading section if they otherwise meet surface requirements for small grade 1's.*

[e] *A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth of the surface of the grading section as divided lengthwise.*

[f] *Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2 trees, if size and surface of grading section qualify as grade 1. If rot shortens the required clear cuttings to the extent of dropping the butt log to grade 2, do not drop the tree's grade to 3 unless the cull deduction for rot is greater than 40 percent.*

Forest Service Standard Specifications for Hardwood Construction Logs (tie and timber logs) [a, b]

Position in tree	Butts and uppers
Minimum diameter, small end	8 inches
Minimum length without trim	8 feet
Clear cuttings	No requirements
Sweep allowance	One-fourth of the diameter at the small end for each 8 feet of length.
Sound surface defects:	
Single knots	Any number, if no one knot has an average diameter above the callus in excess of one-third of the log diameter at point of occurrence.
Whorled knots	Any number, if the sum of knot diameters above the callus does not exceed one-third of the log diameter at point of occurrence.
Holes	Any number, provided none has a diameter over one-third of the log diameter at point of occurrence and none extends more than 3 inches into included timber [c].
Unsound surface defects:	Same requirements as for sound defects if they extend into included timber. No limit if they do notl Logs must e sound internally.

[a] *Rast* et al. *(1973).*

[b] *These specifications are minimum for the class. If, from a group of logs, factory logs are selected first, thus leaving only nonfactory logs from which to select construction logs, then the quality range of the construction logs so selected is limited, and the class may be considered a grade. If selection for construction logs is given first priority, it may be necessary to subdivide the class into grades.*

[c] *Included timber is always square, and dimension is judged from small end.*

Eastern White Pine Saw log Grade Specifications [a]

Grading factor	Log grade 1	Log grade 2	Log grade 3	Log grade 4
1. Minimum scaling diameter (inches)	14[b]	6	6	6
2. Minimum log length (feet)	10[c]	8	8	8
3. Maximum weevil injury (number)	None	None	2 injuries[d]	No limit
4. Minimum face requirements	Two full length or four 50%[e] length good faces (in addition, log knots on balance of faces shall not exceed size limit of grade 2 logs).	**NO GOOD FACES REQUIRED** Maximum diameter of log knots on three best faces: **SOUND RED KNOTS** not to exceed 1/6 scaling diameter and 3" maximum	not to exceed 1/3 scaling diameter and 5" maximum **OVERGROWN/DEAD/BLACK KNOTS** not to exceed 1/6 scaling diameter and 2 1/2" max.	Includes all logs not qualifying for No. 3 or better and having at least 1/3 of their gross volume in sound wood suitable for manufacture into standard lumber.
5. Maximum sweep or crook (%)	20	30	40	66 2/3
6. Maximum total scaling deduction (%)	50	50	50	66 2/3

After the tentative grade is established from face examination, the grade will be reduced whenever the following defects are evident:

7. Conks, punk knots, and pine borer damage on bark surface.[f] Degrade one grade if present on one face.

[a] Ostrander and Brisbin (1971).

[b] 12- and 13-inch logs with four full-length good faces are acceptable.

[c] 8-foot logs with four full-length good faces are acceptable.

[d] 8-foot Number 3 logs limited to one weevil injury.

[e] Minimum 50% length good face must be at least 6 feet.

[f] Factors 7 and 8 are not cumulative (total degrade based on more serious of the two).

No log is to be degraded below grade 4 if net scale is at least one-third of goss scale.

Log Grades for All Other Softwood Logs

Grade 1

1. Trees must be 16 inches in diameter or larger, grading section 12 feet in length or longer, and with deduction for defect not over 30 percent of gross scale.

2. Trees must be at least 75 percent clear on each of three faces.

3. All knots outside clear cutting must be sound and not more than 2-1/2 inches in size.

Grade 2

1. Trees must be 12 inches in diameter or larger, grading section 12 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross scale deducted for defect.

2. Trees must be at least 50 percent clear on each of three faces or 75 percent clear on two faces.

Grade 3

1. Trees must be 6 inches in diameter or larger, grading section 12 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross contents of the log.

Note: Diameters are diameter inside bark (d.i.b.) at small end of grading section.
Percent clear refers to percent clear in one continuous section.

METRIC EQUIVALENTS OF UNITS USED IN THIS REPORT

1 acre = 4,046.86 square meters or 0.405 hectare.
1,000 acres = 405 hectares.
1 cubic foot = 0.0283 cubic meter.
1 foot = 30.48 centimeters or 0.3048 meter.
1 inch = 25.4 millimeters, 2.54 centimeters, or 0.0254 meter.
1 pound = 0.454 kilograms.
1 ton = 0.907 metric tons.

TREE SPECIES GROUPS IN INDIANA

(LITTLE 1981)

Softwoods

Eastern redcedar ..... *Juniperus virginiana*
Tamarack ..... *Larix laricina*
White spruce ..... *Picea glauca*
Jack pine ..... *Pinus banksiana*
Shortleaf pine ..... *P. echinata*
Red pine ..... *P. resinosa*
Eastern white pine ..... *P. strobus*
Scotch pine ..... *P. sylvestris*
Virginia pine ..... *P. virginiana*
Baldcypress ..... *Taxodium distichum*

Hardwoods

Hard maples[1]
- Black maple ..... *Acer nigrum*
- Sugar maple ..... *A. saccharum*

Soft maples[2]
- Red maple ..... *A. rubrum*
- Silver maple ..... *A. saccharinum*

Birches
- Yellow birch[1] ..... *Betula alleghaniensis*
- Gray birch[2] ..... *B. populifolia*
- River birch[2] ..... *B. nigra*
- Paper birch[2] ..... *B. papyrifera*

Select hickories[1]
- Pecan ..... *Carya illinoensis*
- Shellbark hickory ..... *C. lacinosa*
- Shagbark hickory ..... *C. ovata*
- Mockernut hickory ..... *C. tomentosa*

Other hickories[1]
- Water hickory ..... *C. aquatica*
- Bitternut hickory ..... *C. cordiformis*
- Pignut hickory ..... *C. glabra*

American chestnut[2] ..... *Castanea dentata*
Hackberry[2] ..... *Celtis occidentalis*
Common persimmon[1] ..... *Diospyros virginiana*
American beech[1] ..... *Fagus grandifolia*

Ashes
- White ash[1] ..... *Fraxinus americana*
- Black ash[2] ..... *F. nigra*
- Green ash[1] ..... *F. pennsylvanica*
- Blue ash[1] ..... *F. quadrangulata*

Butternut[2] ..... *Juglans cinerea*
Black walnut[1] ..... *Juglans nigra*
Sweetgum[2] ..... *Liquidambar styraciflua*
Yellow-poplar[2] ..... *Liriodendron tulipifera*
Water tupelo[2] ..... *Nyssa aquatica*

Black tupelo[2] ..... *N. sylvatica* var. *sylvatica*

Swamp tupelo (Blackgum)[2] ..... *N. sylvatica* var. *biflora*

Sycamore[2] ..... *Platanus occidentalis*

Populus[2]

- Balsam poplar ..... *Populus balsamifera*
- Eastern cottonwood ..... *P. deltoides*
- Bigtooth aspen ..... *P. grandidentata*
- Quaking aspen ..... *P. tremuloides*

Black cherry[2] ..... *Prunus serotina*

Select white oaks[1]

- White oak ..... *Quercus alba*
- Swamp white oak ..... *Q. bicolor*
- Bur oak ..... *Q. macrocarpa*
- Swamp chestnut oak ..... *Q. michauxii*
- Chinkapin oak ..... *Q. muehlenbergii*

Other white oaks[1]

- Overcup oak ..... *Q. lyrata*
- Chestnut oak ..... *Q. prinus*
- Post oak ..... *Q. stellata*

Select red oak[1]

- Cherrybark oak ..... *Q. falcata* var. *pagodifolia*
- Northern red oak ..... *Q. rubra*
- Shumard oak ..... *Q. shumardii* var. *shumardii*

Other red oaks[1]

- Scarlet oak ..... *Q. coccinea*
- Northern pin oak ..... *Q. ellipsoidalis*
- Southern pin oak ..... *Q. falcata*
- Shingle oak ..... *Q. imbricarta*
- Blackjack oak ..... *Q. marilandica*
- Pin oak ..... *Q. palustris*
- Black oak ..... *Q. velutina*

Black willow[2] ..... *Salix nigra*

Sassafras[2] ..... *Sassafras albidum*

American basswood[2] ..... *Tilia americana*

Elms

- Winged elm[2] ..... *Ulmus alata*
- American elm[2] ..... *U. americana*
- Siberian elm[2] ..... *U. pumila*
- Slippery elm[2] ..... *U. rubra*
- Rock elm[1] ..... *U. thomasii*

Other hardwoods

- Boxelder[2] ..... *Acer negundo*
- Ohio buckeye[2] ..... *Aesculus glabra*
- Yellow buckeye[2] ..... *A. octandra*
- European alder[2] ..... *Alnus glutinosa*
- Northern catalpa[2] ..... *Catalpa speciosa*
- Flowering dogwood[1] ..... *Cornus florida*

Honeylocust[1] ..... *Gleditsia triacanthos*
Kentucky coffeetree[1] ..... *Gymnocladus dioicus*
Mulberry[2] ..... *Morus* spp.
White poplar[2] ..... *Populus alba*
Black locust[1] ..... *Robinia pseudoacacia*

Noncommercial species

Ailanthus ..... *Ailanthus altissima*
Pawpaw ..... *Asimina triloba*
American hornbeam ..... *Carpinus caroliniana*
Eastern redbud ..... *Cercis canadensis*
Hawthorn ..... *Crataegus* spp.
Osage-orange ..... *Maclura pomifera*
Apple ..... *Malus* spp.
Eastern hophornbeam ..... *Ostrya virginiana*
Pin cherry ..... *Prunus pensylvanica*
Wild plum ..... *Prunus* spp.
Chokecherry ..... *P. virginiana*
Peachleaf willow ..... *Salix amygdaloides*
Diamond willow ..... *S. bebbiana*
American mountain-ash ..... *Sorbus americana*

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[1] *This species or species group is considered a hard hardwood, with an average specific gravity greater than or equal to 0.50.*

[2] *This species or species group is considered a soft hardwood, with an average specific gravity of less than 0.50.*

DEFINITION OF TERMS

Average annual mortality of growing stock

The average cubic foot volume of sound wood in growing-stock trees that died in one year. Average annual mortality is the average for the years between inventories (1986 to 1997 in this report).

Average annual mortality of sawtimber

The average board foot volume of sound wood in sawtimber trees that died in one year. Average annual mortality is the average for the years between inventories (1986 to 1997 in this report).

Average annual removals from growing stock

The average net growing-stock volume in growing-stock trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Average annual removals of growing stock are the average for the years between inventories (1986 to 1997 in this report) and are based on information obtained from remeasurement plots (see Survey procedures in appendix).

Average annual removals from sawtimber

The average net board foot sawtimber volume of live sawtimber trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Average annual removals of sawtimber are the average for the years between inventories (1986 to 1997 in this report) and are based on information obtained from remeasurement plots (see Survey procedures in appendix).

Average annual net growth of growing stock

The annual change in cubic foot volume of sound wood in live sawtimber and poletimber trees and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes. Average annual net growth of growing stock is the average for the years between inventories (1986 to 1997 in this report).

Average annual net growth of sawtimber

The annual change in the board foot volume of live sawtimber trees and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes. Average annual net growth of sawtimber is the average for the years between inventories (1986 to 1997 in this report).

Basal area

Tree area, in square feet, of the cross section at breast height of a single tree. When the basal areas of all trees in a stand are summed, the result is usually expressed as square feet of basal area per acre.

Biomass

The aboveground volume of all live trees (including bark but excluding foliage) reported in green tons (i.e., green weight). Biomass has four components:

Bole.—Biomass of a tree from 1 foot above the ground to a 4-inch top outside bark.

Tops and limbs.—Total biomass of a tree from a 1-foot stump minus the bole.

1- to 5-inch trees.—Total aboveground biomass of a tree from 1 to 5 inches in diameter at breast height.

Stump.—Biomass of a tree 5 inches d.b.h. and larger from the ground to a height of 1 foot.

Commercial species

Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam, Osage-orange, and redbud.)

Cord

One standard cord is 128 cubic feet of stacked wood, including bark and air space. Cubic feet can be converted to solid wood standard cords by dividing by 79.

Corporate

Lands owned by a private corporation not in the business of operating primary wood-using plants.

County and municipal land

Land owned by counties and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Cropland

Land under cultivation within the last 24 months, including cropland harvested, crop failures, cultivated summer fallow, idle cropland used only for pasture, orchards, active Christmas tree plantations indicated by annual shearing, nurseries, and land in soil improvement crops, but

excluding land cultivated in developing improved pasture.

Cull

Portions of a tree that are unusable for industrial wood products because of rot, missing or dead material, form, or other defect.

Current annual net growth of growing stock

The annual change in volume of sound wood in live sawtimber and poletimber trees and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes, reported for a single year (1997 in this report). Current net growth is based on an estimate of the current annual increment of each growing-stock tree in the inventory.

Current annual net growth of sawtimber

The annual change in the volume of live sawtimber trees and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes, reported for a single year (1997 in this report). Current net growth is based on an estimate of the current annual increment of each growing-stock tree in the inventory.

Current annual removals from growing stock

The current net growing-stock volume in growing-stock trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Current annual removals of growing stock are reported for a single year (1997 in this report); they are based on a survey of primary wood processing mills to determine removals for products and on information from remeasurement plots (see Survey procedures in appendix) to determine removals due to land use change.

Current annual removals from sawtimber

The current net board foot sawtimber volume of live sawtimber trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Current annual removals of sawtimber are reported for a single year (1997 in this report); they are based on a survey of primary wood processing mills to determine removals for products and on information from remeasurement plots (see Survey procedures in appendix) to determine removals due to land use change.

Diameter class

A classification of trees based on diameter outside bark, measured at breast height 4.5 feet above the ground. (Note: d.b.h. is the common abbreviation for diameter at breast height.) Two-inch diameter classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

Diameter at breast height (d.b.h.)

The outside bark diameter at 4.5 feet (1.37 m) above the forest floor on the uphill side of the tree. For determining breast height, the forest floor includes the duff layer that may be present but does not include unincorporated woody debris that may rise above the ground line.

Forest industry land

Land owned by companies or individuals operating primary wood-using plants.

Forest land

Land at least 10 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparing specified standards with basal area and/or number of trees, age or size, and spacing.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and windbreak strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails or clearings in forest areas shall be classed as forest if less than 120 feet wide. Water bodies (rivers, streams, or lakes) less than 30 feet in width shall be classed as forest. Water bodies more than 30 feet in width are classified as water (see definitions for Tree, Land, Timberland, Reserved forest land, Other forest land, Stocking, and Water).

Forest type

A classification of forest land based on the species forming a plurality of live tree stocking. The associated species for each forest type are based on net volume of growing stock by species group. Major forest types are:

White pine.—Forests in which white pine makes up a plurality of the stocking. Species commonly associated with the white pine forest type in Indiana include red pine, yellow-poplar, Virginia pine, and shortleaf pine.

Shortleaf-Virginia pine.—Forests in which shortleaf and Virginia pine, singly or in combination, make up a plurality of the stocking. Species commonly associated with the shortleaf-Virginia pine forest type in Indiana include yellow-poplar, hard maple, sycamore, and black cherry.

Eastern redcedar.—Forests in which eastern redcedar makes up a plurality of the stocking. Species commonly associated with the eastern redcedar forest type in Indiana include yellow-poplar, red oaks, and black cherry.

Eastern redcedar-hardwoods.—Forests in which hardwoods make up a plurality of the stocking but in which eastern redcedar makes up between 25 and 50 percent of the stocking. Hardwood species commonly associated with the hardwood portion of this forest type in Indiana include ash, hickories, hard maple, white oaks, red oaks, and yellow-poplar.

Oak-pine.—Forests in which oaks and hickories, singly or in combination, make up a plurality of the stocking but where pines or eastern redcedar makes up 25 to 50 percent of the stocking. Species commonly associated with the oak-pine forest type in Indiana include yellow-poplar, cottonwood, river birch, and sycamore.

Oak-hickory.—Forests in which upland oaks and hickories, singly or in combination, make up a plurality of the stocking. Species commonly associated with the oak-hickory forest type in Indiana include yellow-poplar, ash, black cherry, cottonwood, and black walnut.

Oak-gum-cypress.—Forests in which tupelo, blackgum, sweetgum, oaks, or cypress, singly or in combination, make up a plurality of the stocking. Species commonly associated with the oak-gum-cypress forest type in Indiana include yellow-poplar, cottonwood, ash, and sycamore.

Elm-ash-cottonwood.—Forests in which lowland elm, ash, red maple, silver maple, and cottonwood, singly or in combination, make up a plurality of the stocking. Species commonly associated with the elm-ash-cottonwood forest type in Indiana include sycamore, yellow-poplar, red oak, and black walnut.

Maple-beech.—Forests in which hard maple, beech, American elm, and red maple, singly or in combination, make up a plurality of the stocking. Species commonly associated with the maple-beech forest type in Indiana include white oaks, red oaks, hickories, yellow-poplar, and ash.

Cherry-ash-yellow poplar.—Forests in which black cherry, white ash, and yellow-poplar, singly or in combination, make up a plurality of the stocking. Species commonly associated with the cherry-ash-yellow poplar forest type in Indiana include black walnut, American elm, white oak, and hard maples.

Aspen-birch.—Forests in which quaking aspen, bigtooth aspen, and paper birch, singly or in combination, make up a plurality of the stocking. Species commonly associated with the aspen-birch forest type in Indiana include red oaks and yellow-poplar.

Growing-stock tree

A live tree of commercial species that meets specified standards of size, quality, and merchantability. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume

Net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a minimum 4.0-inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs.

Hard hardwoods

Hardwood species with an average specific gravity greater than 0.50 such as oaks, hard maple, hickories, and ash.

Hardwoods

Dicotyledonous trees, usually broad-leaved and deciduous. (See definitions for Soft hardwoods and Hard hardwoods.)

Improved pasture

Land currently improved for grazing by cultivating, seeding, irrigating, or clearing trees or brush and less than 16.7 percent stocked with trees.

Industrial wood

All roundwood products except residential fuelwood.

Land

(a) Bureau of the Census.—Dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains, (omitting tidal flats below mean high tide); streams, sloughs, estuaries, and canals less than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

(b) Forest Inventory and Analysis.—The same as the Bureau of the Census, except minimum width of streams, etc., is 120 feet and minimum size of lakes, etc., is 1 acre.

Live trees

Growing-stock, rough, and rotten trees 1.0 inch d.b.h. and larger.

Log grade

A log classification based on external characteristics as indicators of quality or value. Log grade was assigned to a sample of softwood sawtimber trees throughout the State during the 1998 inventory. Also see Tree grade in definitions. (See appendix for specific grading factors used.)

Logging residue

The unused portions of cut trees, plus unused trees killed by logging.

Marsh

Nonforest land that characteristically supports low, generally herbaceous or shrubby vegetation, and that is intermittently covered with water.

Merchantable

Refers to a pulpwood or saw log section that meets pulpwood or saw log specifications, respectively

Miscellaneous Federal land

Federal land other than national forest and land administered by the Bureau of Land Management or Bureau of Indian Affairs.

National forest land

Federal land that has been legally designated as national forest or purchase units, and other land administered by the USDA Forest Service.

Net volume

Gross volume less deductions for rot, sweep, or other defect affecting use for timber products.

Noncommercial species

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

Nonforest land

Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, active Christmas tree plantations as indicated by annual shearing, orchards, nurseries, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land.) If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area to qualify as nonforest land.

Nonforest land without trees.—Nonforest land with no live trees present.

Nonforest land with trees.—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Nonstocked land

Timberland less than 10 percent stocked with all live trees.

Other forest land

Forest land not capable of producing 20 cubic feet per acre per year of industrial wood crops under natural conditions and not associated with urban or rural development. Many of these sites contain tree species that are not currently used for industrial wood production or trees of poor form, small size, or inferior quality that are unfit for most industrial products. Unproductivity may be the result of adverse site conditions such as sterile soil, dry climate, poor drainage, high elevation, and rockiness. This land is not withdrawn from timber use.

Other removals

Growing-stock trees removed but not used for products, or trees left standing but “removed” from the timberland classification by land-use change. Examples are removals from cultural operations such as timber stand improvement work and land clearing, and the standing volume on land classified originally as timberland but later designated as reserved from timber harvesting (such as a newly established State park).

Ownership size class

The amount of timberland owned by one owner, regardless of the number of parcels.

Pasture

Land presently used for grazing or under cultivation to develop grazing.

Physiographic class

A measure of soil and water conditions that affect tree growth on a site. The physiographic classes are:

Xeric sites.—Very dry soils where excessive drainage seriously limits both growth and species occurrence. Example: eastern redcedar barrens.

Xeromesic sites.—Moderately dry soils where excessive drainage limits growth and species occurrence to some extent. Example: dry oak ridge.

Mesic sites.—Deep, well-drained soils. Growth and species occurrence are limited only by climate. Example: well-drained terraces of loamy soil.

Hydromesic sites.—Moderately wet soils where insufficient drainage or infrequent flooding limits growth and species occurrence to some extent. Example: moderately drained bottomland hardwood sites.

Hydric sites.—Very wet sites where excess water seriously limits both growth and species occurrence. Example: frequently flooded river bottoms.

Plant byproducts

Plant residues used for products such as mulch, pulp chips, and fuelwood.

Plantation

An artificially reforested area sufficiently productive to qualify as timberland. The planted species is not necessarily predominant. Christmas tree plantations, which are considered cropland, are not included.

Plant residues

Wood and bark materials generated at manufacturing plants during production of other products.

Poletimber stand

(See Stand-size class.)

Poletimber tree

A live tree of commercial species at least 5.0 inches d.b.h., but smaller than sawtimber size.

Potential productivity class

A classification of forest land in terms of inherent capacity to grow crops of industrial wood. The class identifies the potential growth in merchantable cubic feet/acre/year at culmination of mean annual increment of fully stocked natural stands.

Private individual land

Privately owned land not owned by forest industry. This class includes the formerly used farmer and miscellaneous private classes.

Reserved forest land

Forest land withdrawn from timber use through statute, administrative regulation, or designation. Note: Historically, Christmas tree plantations were classified as reserved forest land. However, Christmas tree plantations are now classified as cropland.

Rotten tree

Live trees of commercial species that do not contain at least one 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of rot; that is, when more than 50 percent of the cull volume in a tree is rotten.

Rough tree

(a) Live trees of commercial species that do not contain at least one merchantable 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of roughness or poor form, and

(b) all live trees of noncommercial species.

Roundwood products

Logs, bolts, or other round sections (including chips from roundwood) cut from trees for industrial or consumer uses. (Note: Includes saw logs, veneer logs, and bolts; cooperage logs and bolts; pulpwood; fuelwood; pilings; poles; posts; hewn ties; mine timbers; and various other round, split, or hewn products.)

Salvable dead tree

A standing or down dead tree considered merchantable by regional standards.

Sapling

A live tree 1.0 to 5.0 inches d.b.h.

Sapling-seedling stand

(See Stand-size class.)

Saw log

A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight and with a minimum diameter outside bark (d.o.b.) for softwoods of 7.0 inches (9.0 inches for hardwoods) or other combinations of size and defect specified by regional standards.

Saw log portion

That part of the bole of sawtimber trees between the stump and the saw log top.

Saw log top

The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber stand

(See Stand-size class.)

Sawtimber tree

A live tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d.b.h. Hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume

Net volume of the saw log portion of live sawtimber in board feet, International 1/4-inch rule (unless specified otherwise), from stump to a minimum 7.0 inches top d.o.b. for softwoods and a minimum 9.0 inches top d.o.b. for hardwoods.

Seedling

A live tree less than 1.0 inch d.b.h. that is expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Short-log (rough tree)

A sawtimber-size tree of commercial species that contains at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

Shrub

A woody, perennial plant differing from a perennial herb in its persistent and woody stem(s) and less definitely from a tree in its lower stature and/or the general absence of a well-defined main stem. For this report, shrubs were separated somewhat arbitrarily into tall and low shrubs as follows:

Tall shrubs.—Normally taller than 1.6 to 3.2 feet

Low shrubs.—Normally shorter than 1.6 to 3.2 feet (0.5 to 1.0 m). (Woody perennial vines, such as grape, were included with low shrubs.)

Shrub and tree seedling biomass

The total aboveground weight of trees less than 1.0 inch in diameter and all shrubs.

Site index

An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Soft hardwoods

Hardwood species with an average specific gravity less than 0.50, such as cottonwood, red maple, basswood, and willow.

Softwoods

Coniferous trees, usually evergreen, having needles or scale-like leaves.

Stand

A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-age class

A classification based on age of the main stand. Main stand refers to trees of the dominant forest type and stand-size class.

Stand-size class

A classification of stocked (see Stocking) forest land based on the size class of live trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

Sawtimber stands.—Stands with half or more of live tree stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Poletimber stands.—Stands with half or more of live tree stocking in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

Sapling-seedling stands.—Stands with more than half of the live tree stocking in saplings and/or seedlings.

State land

Land owned by the State of Indiana or leased to it for 50 years or more.

Stocking

The degree of occupancy of land by live trees, measured by basal area and/or the number of trees in a stand by size or age and spacing, compared to the basal area and/or number of trees required to fully use the growth potential of the land; that is, the stocking standard. A stocking percent of 100 indicates full use of the site and is equivalent to 80 square feet of basal area per acre in trees 5.0 inches d.b.h. and larger. In a stand of trees less than 5 inches d.b.h., a stocking percent of 100 would indicate that the present number of trees is sufficient to produce 80 square feet of basal area per acre when the trees reach 5 inches d.b.h.

Stands are grouped into the following stocking classes:

Overstocked stands.—Stands in which stocking of live trees is 100 percent or more.

Fully stocked stands.—Stands in which stocking of live trees is from 60 to 99 percent.

Medium stocked stands.—Stands in which stocking of live trees is from 35 to 59 percent.

Poorly stocked stands.—Stands in which stocking of live trees is from 10 to 34 percent.

Nonstocked areas.—Timberland on which stocking of live trees is less than 10 percent.

Timber products output

All timber products cut from roundwood and byproducts of wood manufacturing plants. Roundwood products include logs, bolts, or other round sections cut from growing-stock trees, cull trees, salvable dead trees, trees on nonforest land, noncommercial species, sapling-size trees, and limbwood. Byproducts from primary manufacturing plants include slabs, edgings, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and screenings of pulpmills that are used as pulpwood chips or other products.

Timberland

Forest land that is producing, or is capable of producing, more than 20 cubic feet per acre per year of industrial wood crops under natural conditions, that is not withdrawn from timber use, and that is not associated with urban or rural development. Currently inaccessible and inoperable areas are included. (Timberland was formerly called commercial forest land.)

Tree

A woody plant usually having one or more erect perennial stems, a stem diameter at breast height of at least 3 inches, a more or less definitely formed crown of foliage, and a height of at least 13 feet at maturity.

Tree biomass

The total aboveground weight (including the bark but excluding the foliage) of all trees from 1 to 5 inches in d.b.h., and the total aboveground weight (including the bark but excluding the foliage) from a 1-foot stump for trees more than 5 inches in diameter.

Tree grade

A classification of the lower 16 feet of the bole of standing trees based on external characteristics as indicators of the quality and quantity of lumber that could be produced from the tree. Tree grade was assigned to a sample of hardwood sawtimber trees during the 1998 inventory. Also see log grade in the definitions. (See appendix for specific grading factors used.)

Tree size class

A classification of trees based on diameter at breast height, including sawtimber trees, poletimber trees, saplings, and seedlings.

Upper stem portion

That part of the bole of sawtimber trees above the saw log top to a minimum top diameter of 4.0 inches d.o.b. or to the point where the central stem breaks into limbs.

Urban and other areas

Areas within the legal boundaries of cities and towns; suburban areas developed for residential, industrial, or recreational purposes; school yards; cemeteries; roads; railroads; airports; beaches; powerlines and other rights-of-way; or other nonforest land not included in any other specified land use class.

Urban forest land

Land that would otherwise meet the criteria for timberland, but that is in an urban-suburban area surrounded by commercial, industrial, or residential development and not likely to be managed for the production of industrial wood products on a continuing basis. Wood removed would be for land clearing, fuelwood, or esthetic purposes. Such forest land may be associated with industrial, commercial, residential subdivision, industrial parks, golf course perimeters, airport buffer strips, and public urban parks that qualify as forest land.

Water

(a) *Bureau of the Census*.—Permanent inland water surfaces, such as lakes, reservoirs, and ponds at least 40 acres in area; and streams, sloughs, estuaries, and canals at least one-eighth of a statute mile wide.

(b) *Noncensus*.—Permanent inland water surfaces, such as lakes, reservoirs, and ponds from 1 to 39.9 acres in area; and streams, sloughs, estuaries, and canals from 120 feet to one-eighth of a statute mile wide.

Wooded pasture

Improved pasture with more than 16.7 percent stocking in live trees, but less than 25 percent stocking in growing-stock trees. Area is currently improved for grazing or there is other evidence of grazing.

Wooded strip

An acre or more of natural continuous forest land that would otherwise meet survey standards for timberland except that it is less than 120 feet wide.

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TABLE TITLES

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Table 17.—*Average annual net growth and average annual removals of growing stock and sawtimber (Doyle rule) on timberland by species group, Hoosier National Forest, Indiana, 1986-1997*

Table 18.—*Average annual mortality of growing stock and sawtimber (International 1/4-inch rule) on timberland by species group, Hoosier National Forest, Indiana, 1986-1997*

Table 19.—*Average annual mortality of growing stock and sawtimber (Doyle rule) on timberland by species group, Hoosier National Forest, Indiana, 1986-1997*

TABLES

Table 1. -- *Area of land by county and major land-use class, Hoosier National Forest, Indiana, 1998*

(In thousand acres)

County	Total land area [1]	Forest land				Other land
		Total forest	Timberland	Reserved forest land	Other forest land	
Martin	9.0	8.2	8.2	--	--	0.7
Brown	17.4	17.1	15.8	1.3	--	0.3
Crawford	18.0	17.6	17.6	--	--	0.4
Dubois	0.4	0.4	0.4	--	--	--
Jackson	22.5	22.5	22.5	--	--	--
Lawrence	15.8	15.8	15.8	--	--	--
Monroe	18.9	18.9	4.1	14.9	--	--
Orange	29.4	29.2	29.2	--	--	0.2
Perry	57.9	56.3	56.3	--	--	1.6
All counties	189.3	186.0	169.8	16.2	--	3.4

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

[1] From U.S. Bureau of the Census, 1990.

Table 2. -- *Area of timberland by forest type group/local type and stand-size class, Hoosier National Forest, Indiana, 1998*

(In thousand acres)

Forest type group and local type	All stands	Stand-size class			
		Sawtimber	Poletimber	Sapling-seedling	Non-stocked
White-red-jack pine					
White pine	2.8	2.6	0.2	--	--
Total	2.8	2.6	0.2	--	--
Loblolly-shortleaf pine					
Shortleaf-Virginia pine	8.2	5.1	3.1	--	--
Total	8.2	5.1	3.1	--	--
Oak-pine					
Eastern redcedar	0.3	0.3	--	--	--
Eastern redcedar-hardwood	4.3	4.3	--	--	--
Oak-pine	4.9	3.2	1.7	--	--
Total	9.5	7.8	1.7	--	--
Oak-hickory					
Oak-hickory	91.1	81.1	6.7	3.3	--
Total	91.1	81.1	6.7	3.3	--
Elm-ash-cottonwood					
Elm-ash-cottonwood	12.3	8.8	3.5	--	--
Total	12.3	8.8	3.5	--	--
Maple-beech-birch					
Maple-beech	38.5	32.9	5.6	--	--
Cherry-ash-yellow poplar	5.1	2.0	1.1	2.1	--
Total	43.6	34.9	6.6	2.1	--
Aspen-birch					
Aspen-birch	2.0	2.0	--	--	--
Total	2.0	2.0	--	--	--
Nonstocked					
Other	0.3	--	--	--	0.3
Total	0.3	--	--	--	0.3
Nonstocked	0.3	--	--	--	0.3
All types	169.8	142.3	21.8	5.4	0.3

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

Table 3. -- *Number of all live trees on timberland by species group and diameter class, Hoosier National Forest, Indiana, 1998*

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height)											
		1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
White pine	1,740	667	442	89	174	132	132	62	30	12	--	--	--
Shortleaf pine	1,661	147	143	178	297	330	358	154	55	--	--	--	--
Virginia pine	130	15	--	12	59	44	--	--	--	--	--	--	--
Eastern redcedar	2,282	1,274	282	350	182	64	60	39	10	10	10	--	--
Total softwoods	5,812	2,104	867	629	712	571	549	255	94	22	10	--	--
Hardwoods													
Select white oak	4,567	1,780	147	567	301	281	340	307	358	200	156	121	10
Other white oak	2,065	282	675	176	139	148	174	159	141	113	37	21	--
Select red oak	370	--	--	54	35	10	28	56	36	37	29	85	--
Other red oak	3,277	807	540	373	278	187	270	236	190	197	65	134	--
Select hickory	1,720	1,143	191	85	70	39	57	37	80	19	--	--	--
Other hickory	2,733	1,358	147	232	217	274	173	106	134	54	10	28	--
Basswood	98	87	--	--	--	12	--	--	--	--	--	--	--
Beech	4,330	2,813	945	192	81	68	41	28	46	15	21	75	5
Hard maple	19,881	13,263	4,038	965	699	386	176	135	88	71	28	32	--
Soft maple	10,372	8,689	360	507	300	168	137	65	37	60	23	23	2
Elm	5,036	4,418	240	228	105	29	--	--	15	--	--	--	--
White & green ash	2,887	1,713	444	258	137	143	110	40	20	10	--	12	--
Sycamore	1,556	549	489	106	144	20	33	53	45	41	42	33	--
Cottonwood	8	--	8	--	--	--	--	--	--	--	--	--	--
Hackberry	706	669	17	--	10	--	9	--	--	--	--	--	--
Bigtooth aspen	613	323	135	10	69	17	20	8	16	8	--	8	--
River birch	289	--	45	160	47	28	--	8	--	--	--	--	--
Sweetgum	49	--	--	10	--	29	--	--	--	--	10	--	--
Tupelo	4,489	3,601	477	187	73	77	30	27	9	--	--	8	--
Black cherry	2,398	2,065	--	171	35	68	22	22	15	--	--	--	--
Black walnut	298	--	--	87	112	37	35	17	--	10	--	--	--
Butternut	95	--	--	83	12	--	--	--	--	--	--	--	--
Yellow-poplar	5,059	1,703	1,587	490	379	248	275	67	127	44	78	61	--
Other hardwoods	28,220	19,786	6,978	976	276	104	42	10	30	10	8	--	--
Total hardwoods	101,116	65,050	17,463	5,919	3,519	2,371	1,971	1,380	1,387	889	507	642	17
Noncommercial species	8,714	8,062	584	68	--	--	--	--	--	--	--	--	--
All species	115,642	75,217	18,914	6,615	4,231	2,942	2,520	1,635	1,481	911	516	642	17

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the number of trees round to less than 1 thousand trees. Columns and rows may not add to their totals due to rounding.

Table 4. -- *Number of growing-stock trees on timberland by species group and diameter class, Hoosier National Forest, Indiana, 1998*

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height)											
		1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
White pine	1,740	667	442	89	174	132	132	62	30	12	--	--	--
Shortleaf pine	1,661	147	143	178	297	330	358	154	55	--	--	--	--
Virginia pine	110	15	--	12	47	36	--	--	--	--	--	--	--
Eastern redcedar	2,170	1,274	282	278	162	55	60	39	10	--	10	--	--
Total softwoods	5,680	2,104	867	557	680	553	549	255	94	12	10	--	--
Hardwoods													
Select white oak	3,957	1,277	147	503	301	281	331	307	332	200	148	121	10
Other white oak	1,994	282	675	143	130	136	166	150	141	113	37	21	--
Select red oak	362	--	--	46	35	10	28	56	36	37	29	85	--
Other red oak	3,228	807	540	356	278	165	270	226	190	197	65	134	--
Select hickory	1,720	1,143	191	85	70	39	57	37	80	19	--	--	--
Other hickory	2,705	1,358	147	213	217	274	173	106	134	54	10	19	--
Basswood	98	87	--	--	--	12	--	--	--	--	--	--	--
Beech	4,082	2,735	945	152	59	58	25	28	38	15	18	10	--
Hard maple	19,261	12,960	3,873	882	660	376	176	115	88	71	28	32	--
Soft maple	10,102	8,689	360	408	270	108	93	45	25	60	23	18	2
Elm	4,972	4,403	240	209	75	29	--	--	15	--	--	--	--
White & green ash	2,748	1,696	426	183	117	133	110	40	20	10	--	12	--
Sycamore	1,517	549	489	97	134	20	33	43	45	41	32	33	--
Cottonwood	8	--	8	--	--	--	--	--	--	--	--	--	--
Hackberry	36	17	--	--	10	--	9	--	--	--	--	--	--
Bigtooth aspen	613	323	135	10	69	17	20	8	16	8	--	8	--
River birch	289	--	45	160	47	28	--	8	--	--	--	--	--
Sweetgum	49	--	--	10	--	29	--	--	--	--	10	--	--
Tupelo	4,278	3,411	477	187	73	77	10	27	9	--	--	8	--
Black cherry	2,366	2,065	--	161	25	56	22	22	15	--	--	--	--
Black walnut	283	--	--	87	96	37	35	17	--	10	--	--	--
Butternut	42	--	--	42	--	--	--	--	--	--	--	--	--
Yellow-poplar	4,577	1,703	1,146	481	364	240	267	67	127	44	78	61	--
Other hardwoods	24,249	19,778	3,480	691	197	43	30	--	20	10	--	--	--
Total hardwoods	93,536	63,284	13,324	5,105	3,227	2,168	1,854	1,302	1,331	889	477	563	12
All species	99,217	65,388	14,191	5,661	3,907	2,721	2,403	1,557	1,425	901	487	563	12

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the number of trees round to less than 1 thousand trees. Columns and rows may not add to their totals due to rounding.

Table 5. -- *Net volume of all live trees* [1] *greater than 5 inches in diameter at breast height on timberland by species group and diameter class, Hoosier National Forest, Indiana, 1998*

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height)									
		5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
White pine	8,064	219	1,057	1,469	2,233	1,493	986	607	--	--	--
Shortleaf pine	16,883	493	1,666	3,311	5,705	3,659	2,048	--	--	--	--
Virginia pine	760	21	270	469	--	--	--	--	--	--	--
Eastern redcedar	4,371	690	716	485	813	686	278	296	407	--	--
Total softwoods	30,078	1,424	3,710	5,733	8,751	5,839	3,312	903	407	--	--
Hardwoods											
Select white oak	55,889	1,271	1,517	2,663	5,098	6,900	11,025	8,202	8,448	9,472	1,294
Other white oak	20,301	385	662	1,217	2,528	3,208	4,244	4,454	1,922	1,680	--
Select red oak	15,836	119	163	107	501	1,262	1,209	1,558	1,696	9,220	--
Other red oak	43,155	851	1,506	1,742	4,349	5,393	5,993	8,621	3,579	11,122	--
Select hickory	6,754	213	397	414	939	968	2,901	921	--	--	--
Other hickory	20,974	526	1,218	2,797	2,843	2,837	4,870	2,724	676	2,482	--
Basswood	108	--	--	108	--	--	--	--	--	--	--
Beech	12,296	395	393	653	562	677	1,344	709	1,260	5,673	630
Hard maple	28,672	2,449	3,801	3,979	3,140	3,429	3,282	3,499	1,801	3,292	--
Soft maple	15,890	1,114	1,564	1,540	2,169	1,534	1,251	2,686	1,401	2,241	389
Elm	1,663	449	449	255	--	--	510	--	--	--	--
White & green ash	7,673	605	769	1,438	1,861	1,005	616	481	--	898	--
Sycamore	14,381	285	912	227	654	1,414	1,765	2,340	2,779	4,005	--
Hackberry	201	--	63	--	138	--	--	--	--	--	--
Bigtooth aspen	2,597	26	457	147	366	162	558	326	--	554	--
River birch	1,023	370	224	269	--	160	--	--	--	--	--
Sweetgum	839	31	--	267	--	--	--	--	541	--	--
Tupelo	3,287	365	333	685	363	706	243	--	--	592	--
Black cherry	2,289	331	160	483	336	487	492	--	--	--	--
Black walnut	2,199	188	485	322	445	327	--	431	--	--	--
Butternut	198	154	44	--	--	--	--	--	--	--	--
Yellow-poplar	34,548	1,327	2,243	2,659	4,927	1,826	5,287	2,323	5,904	8,052	--
Other hardwoods	5,692	1,778	1,164	695	522	102	806	406	220	--	--
Total hardwoods	296,466	13,233	18,524	22,666	31,742	32,398	46,396	39,679	30,229	59,284	2,313
Noncommercial species	134	134	--	--	--	--	--	--	--	--	--
All species	326,812	14,791	22,234	28,399	40,494	38,237	49,707	40,583	30,635	59,284	2,313

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

[1] Net volume of all live trees 5 inches d.b.h. and larger from a 1-foot stump to a 4-inch top diameter outside bark.

Table 6. -- *Net volume of all live trees and salvable dead trees on timberland by class of timber and major species group, Hoosier National Forest, Indiana, 1998*

(In thousand cubic feet)

Class of timber	All species	Major species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Live trees					
Growing stock trees					
Sawtimber					
Saw-log portion	225,288	19,615	2,349	55,148	148,176
Upper stem portion	28,767	2,303	250	6,624	19,591
Total	254,055	21,918	2,599	61,771	167,767
Poletimber	55,381	3,679	1,235	21,060	29,408
All growing stock trees	309,436	25,597	3,834	82,831	197,175
Cull trees					
Short-log trees	4,928	--	69	1,652	3,207
Rough trees[1]					
Sawtimber size	3,984	62	296	1,280	2,346
Poletimber size	3,781	--	110	2,199	1,473
Total	7,766	62	406	3,479	3,818
Rotten trees[1]					
Sawtimber size	4,019	--	--	688	3,330
Poletimber size	529	49	61	279	140
Total	4,547	49	61	967	3,470
All live cull trees	17,241	111	537	6,098	10,496
All live trees	326,678	25,707	4,371	88,929	207,670
Salvable dead trees					
Sawtimber size	2,338	889	--	424	1,026
Poletimber size	2,058	281	102	701	974
All salvable dead trees	4,397	1,170	102	1,125	2,000
All classes	331,074	26,877	4,474	90,054	209,670

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

[1] Includes noncommercial species.

Table 7. -- *Net volume of growing stock on timberland by species group and forest type group/local type, Hoosier National Forest, Indiana, 1998*

(In thousand cubic feet)

		Forest type group/local type													
		White-red-jack pine	Loblolly-shortleaf pine	Oak-pine				Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch			Aspen-birch	Non-stocked
Species group	All types	White pine	Shortleaf-Virginia pine	Total	Eastern redcedar	Eastern redcedar-hardwood	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Total	Maple-beech	Cherry-ash-yellow poplar	Aspen-birch	Non-stocked
Softwoods															
White pine	8,064	4,049	--	3,343	--	606	2,737	--	--	--	672	672	--	--	--
Shortleaf pine	16,883	421	13,174	2,538	--	1,435	1,104	569	--	180	--	--	--	--	--
Virginia pine	650	313	286	--	--	--	--	51	--	--	--	--	--	--	--
Eastern redcedar	3,834	--	134	2,566	451	1,907	208	906	--	--	229	179	50	--	--
Total	29,431	4,783	13,594	8,447	451	3,948	4,049	1,525	--	180	901	851	50	--	--
Hardwoods															
Select white oak	54,626	--	--	238	--	238	--	47,749	--	606	6,032	6,032	--	--	--
Other white oak	19,859	--	--	--	--	--	--	19,859	--	--	--	--	--	--	--
Select red oak	15,825	--	--	--	--	--	--	7,830	--	43	7,952	7,952	--	--	--
Other red oak	42,828	--	108	1,931	--	1,412	519	39,544	--	310	934	934	--	--	--
Select hickory	6,754	--	117	--	--	--	--	3,230	--	256	3,150	3,150	--	--	--
Other hickory	20,043	--	434	510	--	510	--	15,747	--	462	2,890	2,890	--	--	--
Basswood	108	--	--	--	--	--	--	--	--	--	108	108	--	--	--
Beech	5,989	--	--	40	--	--	40	2,407	--	--	3,543	3,528	14	--	--
Hard maple	27,836	125	526	497	--	497	--	6,712	--	798	19,178	19,051	127	--	--
Soft maple	13,163	--	406	431	--	--	431	4,115	--	7,824	387	334	53	--	--
Elm	1,541	167	54	54	--	54	--	86	--	216	965	900	65	--	--
White & green ash	7,390	--	104	88	--	--	88	2,975	--	280	3,943	3,943	--	--	--
Sycamore	13,549	--	--	--	--	--	--	697	--	11,347	1,505	1,505	--	--	--
Hackberry	201	--	--	--	--	--	--	138	--	--	63	63	--	--	--
Bigtooth aspen	2,597	--	--	--	--	--	--	2,262	--	335	--	--	--	--	--
River birch	1,023	115	--	--	--	--	--	--	--	908	--	--	--	--	--
Sweetgum	839	--	--	--	--	--	--	81	--	--	757	757	--	--	--
Tupelo	3,071	--	--	589	--	148	441	1,943	--	--	538	457	82	--	--
Black cherry	2,145	--	--	165	--	165	--	340	--	167	1,473	1,473	--	--	--
Black walnut	2,150	--	--	--	--	--	--	491	--	435	1,224	1,072	152	--	--
Butternut	58	--	58	--	--	--	--	--	--	--	--	--	--	--	--
Yellow-poplar	34,312	2,225	357	4,371	--	90	4,281	9,030	--	80	18,248	11,620	6,628	--	--
Other hardwoods	4,101	154	358	189	--	16	174	2,733	--	183	485	464	21	--	--
Total	280,006	2,786	2,522	9,103	--	3,131	5,972	167,969	--	24,250	73,376	66,233	7,143	--	--
All species	309,436	7,569	16,116	17,550	451	7,078	10,022	169,495	--	24,430	74,277	67,084	7,192	--	--

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

Table 8. -- *Net volume of growing stock on timberland by species group and diameter class, Hoosier National Forest, Indiana, 1998*

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height)									
		5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
White pine	8,064	219	1,057	1,469	2,233	1,493	986	607	--	--	--
Shortleaf pine	16,883	493	1,666	3,311	5,705	3,659	2,048	--	--	--	--
Virginia pine	650	21	222	407	--	--	--	--	--	--	--
Eastern redcedar	3,834	565	670	416	813	686	278	--	407	--	--
Total softwoods	29,431	1,299	3,615	5,602	8,751	5,839	3,312	607	407	--	--
Hardwoods											
Select white oak	54,626	1,164	1,517	2,663	4,991	6,900	10,366	8,202	8,057	9,472	1,294
Other white oak	19,859	332	616	1,148	2,422	3,042	4,244	4,454	1,922	1,680	--
Select red oak	15,825	108	163	107	501	1,262	1,209	1,558	1,696	9,220	--
Other red oak	42,828	830	1,506	1,594	4,349	5,235	5,993	8,621	3,579	11,122	--
Select hickory	6,754	213	397	414	939	968	2,901	921	--	--	--
Other hickory	20,043	494	1,218	2,797	2,843	2,837	4,870	2,724	676	1,582	--
Basswood	108	--	--	108	--	--	--	--	--	--	--
Beech	5,989	315	282	555	343	677	1,186	709	1,083	839	--
Hard maple	27,836	2,268	3,614	3,890	3,140	3,051	3,282	3,499	1,801	3,292	--
Soft maple	13,163	918	1,462	1,059	1,510	1,099	875	2,686	1,401	1,764	389
Elm	1,541	421	354	255	--	--	510	--	--	--	--
White & green ash	7,390	472	677	1,379	1,861	1,005	616	481	--	898	--
Sycamore	13,549	257	872	227	654	1,210	1,765	2,340	2,219	4,005	--
Hackberry	201	--	63	--	138	--	--	--	--	--	--
Bigtooth aspen	2,597	26	457	147	366	162	558	326	--	554	--
River birch	1,023	370	224	269	--	160	--	--	--	--	--
Sweetgum	839	31	--	267	--	--	--	--	541	--	--
Tupelo	3,071	365	333	685	147	706	243	--	--	592	--
Black cherry	2,145	307	115	408	336	487	492	--	--	--	--
Black walnut	2,150	188	436	322	445	327	--	431	--	--	--
Butternut	58	58	--	--	--	--	--	--	--	--	--
Yellow-poplar	34,312	1,319	2,190	2,586	4,825	1,826	5,287	2,323	5,904	8,052	--
Other hardwoods	4,101	1,372	900	362	426	--	636	406	--	--	--
Total hardwoods	280,006	11,830	17,396	21,242	30,236	30,955	45,033	39,679	28,880	53,072	1,683
All species	309,436	13,129	21,010	26,844	38,987	36,793	48,345	40,286	29,287	53,072	1,683

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

Table 9. -- *Net volume of growing stock on timberland by forest type group/local type and major species group, Hoosier National Forest, Indiana, 1998*

(In thousand cubic feet)

Forest type group/ local type	All species	Major species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Softwood type groups					
White-red-jack pine					
White pine	7,569	4,783	--	2,521	265
Total	7,569	4,783	--	2,521	265
Loblolly-shortleaf pine					
Shortleaf-virginia pine	16,116	13,460	134	1,249	1,273
Total	16,116	13,460	134	1,249	1,273
Oak-pine					
Eastern redcedar	451	--	451	--	--
Eastern redcedar-hardwood	7,078	2,041	1,907	457	2,674
Oak-pine	10,022	3,841	208	5,398	574
Total	17,550	5,882	2,566	5,855	3,248
All softwood types	41,235	24,124	2,700	9,625	4,786
Hardwood type groups					
Oak-hickory					
Oak-hickory	169,495	620	906	23,774	144,195
Total	169,495	620	906	23,774	144,195
Elm-ash-cottonwood					
Elm-ash-cottonwood	24,430	180	--	21,340	2,909
Total	24,430	180	--	21,340	2,909
Maple-beech-birch					
Maple-beech	67,084	672	179	21,242	44,991
Cherry-ash-yellow poplar	7,192	--	50	6,850	293
Total	74,277	672	229	28,092	45,284
All hardwood types	268,201	1,472	1,134	73,206	192,389
Nonstocked	--	--	--	--	--
All forest types	309,436	25,597	3,834	82,831	197,175

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

Table 10. -- *Net volume of growing stock on timberland by species group, Hoosier National Forest, Indiana, 1986 and 1998*

(In thousand cubic feet)

Species group	1986	1998
Softwoods		
White pine	3,110	8,064
Shortleaf pine	13,471	16,883
Virginia pine	12	650
Eastern redcedar	2,200	3,834
Total softwoods	18,792	29,431
Hardwoods		
Select white oak	50,192	54,626
Other white oak	16,460	19,859
Select red oak	10,938	15,825
Other red oak	33,894	42,828
Select hickory	7,612	6,754
Other hickory	18,121	20,043
Basswood	122	108
Beech	4,528	5,989
Hard maple	15,726	27,836
Soft maple	2,578	13,163
Elm	1,131	1,541
White & green ash	8,910	7,390
Sycamore	3,865	13,549
Hackberry	--	201
Bigtooth aspen	3,271	2,597
River birch	51	1,023
Sweetgum	824	839
Tupelo	3,000	3,071
Black cherry	1,740	2,145
Black walnut	693	2,150
Butternut	--	58
Yellow-poplar	21,664	34,312
Other hardwoods	5,435	4,101
Total hardwoods	210,753	280,006
All species	229,545	309,436

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

Table 11. -- *Net volume of sawtimber (International 1/4-inch rule) on timberland by species group, Hoosier National Forest, Indiana, 1986 and 1998*

(In thousand board feet)[1]

Species group	1986	1998
Softwoods		
White pine	6,541	31,209
Shortleaf pine	33,864	74,540
Virginia pine	- -	1,930
Eastern redcedar	6,531	12,800
Total softwoods	46,936	120,479
Hardwoods		
Select white oak	192,262	229,688
Other white oak	70,512	89,100
Select red oak	43,097	74,189
Other red oak	136,238	188,432
Select hickory	26,976	27,580
Other hickory	43,889	77,740
Basswood	37	- -
Beech	13,230	23,960
Hard maple	40,531	86,428
Soft maple	5,101	42,162
Elm	603	2,310
White & green ash	16,666	22,552
Sycamore	7,937	58,589
Hackberry	- -	645
Bigtooth aspen	9,714	9,524
River birch	107	732
Sweetgum	3,260	2,398
Tupelo	8,471	7,572
Black cherry	4,086	5,998
Black walnut	2,442	5,834
Yellow-poplar	92,456	148,449
Other hardwoods	7,190	6,662
Total hardwoods	724,804	1,110,544
All species	771,740	1,231,023

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand board feet. Columns and rows may not add to their totals due to rounding.

[1] International 1/4-inch rule.

Table 12. -- *Net volume of sawtimber (Doyle rule) on timberland by species group, Hoosier National Forest, Indiana, 1986 and 1998*

(In thousand board feet)[1]

Species group	1986	1998
Softwoods		
White pine	2,453	16,753
Shortleaf pine	14,515	38,058
Virginia pine	- -	667
Eastern redcedar	2,811	7,145
Total softwoods	19,779	62,623
Hardwoods		
Select white oak	118,636	148,261
Other white oak	39,750	53,962
Select red oak	30,106	55,862
Other red oak	84,141	123,002
Select hickory	15,953	15,402
Other hickory	23,325	45,137
Basswood	16	- -
Beech	8,181	15,254
Hard maple	23,163	52,939
Soft maple	2,898	27,664
Elm	308	1,359
White & green ash	9,264	12,457
Sycamore	4,366	40,955
Hackberry	- -	269
Bigtooth aspen	6,157	5,848
River birch	55	375
Sweetgum	1,723	1,722
Tupelo	6,171	4,596
Black cherry	2,394	3,095
Black walnut	1,367	3,088
Yellow-poplar	58,251	99,176
Other hardwoods	3,681	3,711
Total hardwoods	439,905	714,133
All species	459,684	776,756

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand board feet. Columns and rows may not add to their totals due to rounding.

[1] Doyle rule.

Table 13. -- *Net volume of sawtimber (International 1/4-inch rule) on timberland by species group and diameter class, Hoosier National Forest, Indiana, 1998*

(In thousand board feet) [1]

Species group	All classes	Diameter class (inches at breast height)							
		9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
White pine	31,209	6,531	10,112	6,918	4,631	3,017	--	--	--
Shortleaf pine	74,540	16,199	28,746	18,819	10,776	--	--	--	--
Virginia pine	1,930	1,930	--	--	--	--	--	--	--
Eastern redcedar	12,800	2,306	4,141	3,355	1,267	--	1,730	--	--
Total softwoods	120,479	26,966	42,999	29,092	16,675	3,017	1,730	--	--
Hardwoods									
Select white oak	229,688	--	24,673	33,405	49,405	38,482	36,906	41,537	5,280
Other white oak	89,100	--	12,247	15,335	21,382	22,443	9,773	7,921	--
Select red oak	74,189	--	2,471	6,267	6,024	7,744	8,342	43,340	--
Other red oak	188,432	--	21,410	25,813	29,492	42,225	17,366	52,126	--
Select hickory	27,580	--	4,500	4,660	13,976	4,444	--	--	--
Other hickory	77,740	--	14,192	14,222	24,336	13,668	3,386	7,935	--
Basswood	--	--	--	--	--	--	--	--	--
Beech	23,960	--	1,736	3,414	5,941	3,509	5,318	4,042	--
Hard maple	86,428	--	15,148	14,813	15,841	16,851	8,667	15,108	--
Soft maple	42,162	--	6,557	4,819	3,853	11,768	6,134	7,524	1,508
Elm	2,310	--	--	--	2,310	--	--	--	--
White & green ash	22,552	--	8,434	4,662	2,889	2,287	--	4,280	--
Sycamore	58,589	--	2,977	5,745	8,375	11,262	10,840	19,389	--
Hackberry	645	--	645	--	--	--	--	--	--
Bigtooth aspen	9,524	--	1,748	780	2,823	1,649	--	2,524	--
River birch	732	--	--	732	--	--	--	--	--
Sweetgum	2,398	--	--	--	--	--	2,398	--	--
Tupelo	7,572	--	674	3,204	1,114	--	--	2,580	--
Black cherry	5,998	--	1,539	2,214	2,244	--	--	--	--
Black walnut	5,834	--	2,147	1,587	--	2,101	--	--	--
Yellow-poplar	148,449	--	24,090	9,408	27,999	12,503	32,134	42,314	--
Other hardwoods	6,662	--	1,945	--	2,896	1,822	--	--	--
Total hardwoods	1,110,544	--	147,134	151,080	220,901	192,758	141,264	250,619	6,788
All species	1,231,023	26,966	190,133	180,172	237,576	195,775	142,993	250,619	6,788

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand board feet. Columns and rows may not add to their totals due to rounding.

[1] International 1/4-inch rule.

Table 14. -- *Net volume of sawtimber (Doyle rule) on timberland by species group and diameter class, Hoosier National Forest, Indiana, 1998*

(In thousand board feet) [1]

Species group	All classes	Diameter class (inches at breast height)							
		9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
White pine	16,753	2,256	4,833	4,145	3,199	2,319	--	--	--
Shortleaf pine	38,058	5,597	13,741	11,276	7,444	--	--	--	--
Virginia pine	667	667	--	--	--	--	--	--	--
Eastern redcedar	7,145	797	1,979	2,010	875	--	1,483	--	--
Total softwoods	62,623	9,317	20,554	17,432	11,519	2,319	1,483	--	--
Hardwoods									
Select white oak	148,261	--	10,293	17,097	29,060	25,279	26,498	34,041	5,992
Other white oak	53,962	--	5,109	7,848	12,577	14,743	7,017	6,668	--
Select red oak	55,862	--	1,031	3,208	3,543	5,087	5,990	37,003	--
Other red oak	123,002	--	8,932	13,211	17,347	27,737	12,469	43,304	--
Select hickory	15,402	--	1,878	2,385	8,220	2,919	--	--	--
Other hickory	45,137	--	5,921	7,279	14,314	8,979	2,431	6,212	--
Basswood	--	--	--	--	--	--	--	--	--
Beech	15,254	--	724	1,747	3,495	2,305	3,818	3,164	--
Hard maple	52,939	--	6,320	7,581	9,318	11,069	6,223	12,428	--
Soft maple	27,664	--	2,736	2,466	2,266	7,730	4,404	6,350	1,712
Elm	1,359	--	--	--	1,359	--	--	--	--
White & green ash	12,457	--	3,518	2,386	1,699	1,502	--	3,351	--
Sycamore	40,955	--	1,242	2,940	4,926	7,398	7,783	16,664	--
Hackberry	269	--	269	--	--	--	--	--	--
Bigtooth aspen	5,848	--	729	399	1,661	1,083	--	1,976	--
River birch	375	--	--	375	--	--	--	--	--
Sweetgum	1,722	--	--	--	--	--	1,722	--	--
Tupelo	4,596	--	281	1,640	655	--	--	2,020	--
Black cherry	3,095	--	642	1,133	1,320	--	--	--	--
Black walnut	3,088	--	896	812	--	1,380	--	--	--
Yellow-poplar	99,176	--	10,050	4,815	16,469	8,213	23,072	36,556	--
Other hardwoods	3,711	--	811	--	1,703	1,197	--	--	--
Total hardwoods	714,133	--	61,384	77,323	129,934	126,623	101,427	209,738	7,704
All species	776,756	9,317	81,938	94,754	141,453	128,942	102,910	209,738	7,704

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand board feet. Columns and rows may not add to their totals due to rounding.

[1] Doyle rule.

Table 15. -- *Average annual net growth of growing stock on timberland by species group and forest type group/local type, Hoosier National Forest, Indiana, 1986-1997*

(In thousand cubic feet)

		Forest type group/local type														
		White-red-jack pine	Loblolly-shortleaf pine	Oak-pine				Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch			Aspen-birch	Non-stocked
Species group	All types	White pine	Shortleaf-Virginia pine	Total	Eastern redcedar	Eastern redcedar-hardwood	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Total	Maple-beech	Cherry-ash-yellow poplar	Aspen-birch	Non-stocked
Softwoods															
White pine	343	108	--	216	--	12	204	--	--	--	10	10	--	--	10
Shortleaf pine	497	36	349	88	--	56	32	21	--	--	3	--	3	--	--
Virginia pine	19	--	19	--	--	--	--	0	--	--	--	--	--	--	--
Eastern redcedar	129	--	1	116	15	81	20	2	--	--	9	9	--	--	--
Total	989	144	369	420	15	149	255	24	--	--	23	19	3	--	10
Hardwoods															
Select white oak	1,391	--	--	30	--	30	--	1,012	--	6	343	315	27	--	--
Other white oak	387	--	--	0	--	0	--	384	--	--	4	4	--	--	--
Select red oak	381	--	--	10	--	1	9	253	--	--	118	118	--	--	--
Other red oak	1,266	-1	11	171	--	86	85	994	--	70	20	12	8	--	--
Select hickory	155	--	3	5	--	4	0	61	--	1	85	83	2	--	--
Other hickory	538	--	30	26	--	8	17	398	--	12	72	72	--	--	--
Basswood	19	--	--	--	--	--	--	--	--	--	19	19	--	--	--
Beech	166	--	--	--	--	--	--	118	--	2	45	45	0	--	--
Hard maple	901	11	14	28	--	25	3	315	--	26	509	509	0	--	--
Soft maple	439	--	16	17	--	--	17	210	--	183	13	13	--	--	--
Elm	38	1	-1	--	--	--	--	14	--	12	11	11	--	--	--
White & green ash	191	--	--	10	--	2	8	122	--	8	51	51	--	--	--
Sycamore	446	--	1	13	--	--	13	26	--	249	158	158	--	--	--
Hackberry	8	--	--	--	--	--	--	--	--	--	8	8	--	--	--
Bigtooth aspen	146	--	--	--	--	--	--	114	--	32	--	--	--	--	--
River birch	72	--	--	--	--	--	--	11	--	50	11	11	--	--	--
Sweetgum	21	--	--	--	--	--	--	-1	--	--	22	22	--	--	--
Tupelo	99	--	--	--	--	--	--	70	--	8	20	8	12	--	--
Black cherry	173	--	--	18	--	11	6	48	--	16	91	64	27	--	--
Black walnut	47	--	--	--	--	--	--	23	--	9	15	15	--	--	--
Butternut	5	--	5	--	--	--	--	--	--	--	--	--	--	--	--
Yellow-poplar	1,076	21	21	228	--	19	209	461	--	44	300	187	114	--	--
Other hardwoods	101	6	13	8	--	-4	11	52	--	7	15	14	1	--	--
Total	8,067	38	113	561	--	183	378	4,688	--	738	1,929	1,739	191	--	--
All species	9,055	182	482	981	15	332	633	4,712	--	738	1,952	1,758	194	--	10

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic feet.
Columns and rows may not add to their totals due to rounding.

Table 16. -- *Average annual net growth and average annual removals of growing stock and sawtimber (International 1/4-inch rule) on timberland by species group, Hoosier National Forest, Indiana, 1986-1997*

Species group	Growing stock		Sawtimber	
	Average annual net growth	Average annual removals	Average annual net growth	Average annual removals
	(In thousand cubic feet)		(In thousand board feet)[1]	
Softwoods				
White pine	343	--	1,554	--
Shortleaf pine	497	10	2,731	50
Virginia pine	19	--	67	--
Eastern redcedar	129	--	709	--
Other softwoods	--	--	--	--
Total softwoods	989	10	5,060	50
Hardwoods				
Select white oak	1,391	447	6,644	1,827
Other white oak	387	16	1,499	--
Select red oak	381	21	1,959	85
Other red oak	1,266	47	5,862	167
Select hickory	155	14	610	--
Other hickory	538	--	3,195	--
Basswood	19	--	225	--
Beech	166	--	1,075	--
Hard maple	901	--	3,487	--
Soft maple	439	--	1,423	--
Elm	38	1	-3	--
White & green ash	191	--	1,287	--
Sycamore	446	--	2,140	--
Cottonwood	--	--	--	--
Hackberry	8	--	--	--
Bigtooth aspen	146	--	511	--
Quaking aspen	--	--	--	--
River birch	72	--	179	--
Sweetgum	21	--	89	--
Tupelo	99	--	148	--
Black cherry	173	--	634	--
Black walnut	47	--	55	--
Butternut	5	--	--	--
Yellow-poplar	1,076	371	5,218	1,938
Other hardwoods	101	14	265	--
Total hardwoods	8,067	930	36,502	4,017
All species	9,055	940	41,562	4,067

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic or board feet. Columns and rows may not add to their totals due to rounding.

[1] International 1/4-inch rule.

Table 17. -- *Average annual net growth and average annual removals of growing stock and sawtimber (Doyle rule) on timberland by species group, Hoosier National Forest, Indiana, 1986-1997*

Species group	Growing stock		Sawtimber	
	Average annual net growth	Average annual removals	Average annual net growth	Average annual removals
	(In thousand cubic feet)		(In thousand board feet)[1]	
Softwoods				
White pine	343	--	697	--
Shortleaf pine	497	10	1,267	24
Virginia pine	19	--	23	--
Eastern redcedar	129	--	296	--
Other softwoods	--	--	--	--
Total softwoods	989	10	2,283	24
Hardwoods				
Select white oak	1,391	447	3,898	1,260
Other white oak	387	16	747	--
Select red oak	381	21	1,112	96
Other red oak	1,266	47	3,413	78
Select hickory	155	14	267	--
Other hickory	538	--	1,554	--
Basswood	19	--	101	--
Beech	166	--	564	--
Hard maple	901	--	1,882	--
Soft maple	439	--	787	--
Elm	38	1	-29	--
White & green ash	191	--	595	--
Sycamore	446	--	1,264	--
Cottonwood	--	--	--	--
Hackberry	8	--	--	--
Bigtooth aspen	146	--	263	--
Quaking aspen	--	--	--	--
River birch	72	--	81	--
Sweetgum	21	--	54	--
Tupelo	99	--	69	--
Black cherry	173	--	303	--
Black walnut	47	--	24	--
Butternut	5	--	--	--
Yellow-poplar	1,076	371	3,121	1,015
Other hardwoods	101	14	114	--
Total hardwoods	8,067	930	20,183	2,450
All species	9,055	940	22,466	2,474

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic or board feet. Columns and rows may not add to their totals due to rounding.

[1] Doyle rule.

Table 18. -- *Average annual mortality of growing stock and sawtimber (International 1/4-inch rule) on timberland by species group, Hoosier National Forest, Indiana, 1986-1997*

Species group	Growing stock average annual mortality	Sawtimber average annual mortality
	(In thousand cubic feet)	(In thousand board feet) [1]
Softwoods		
White pine	103	263
Shortleaf pine	84	139
Virginia pine	--	--
Eastern redcedar	12	--
Other softwoods	--	--
Total softwoods	199	402
Hardwoods		
Select white oak	142	67
Other white oak	125	239
Select red oak	184	625
Other red oak	415	672
Select hickory	114	218
Other hickory	87	191
Basswood	11	--
Beech	47	134
Hard maple	185	164
Soft maple	42	133
Elm	57	103
White & green ash	96	119
Sycamore	44	86
Cottonwood	--	--
Hackberry	--	--
Bigtooth aspen	22	65
Quaking aspen	--	--
River birch	--	--
Sweetgum	--	--
Tupelo	14	--
Black cherry	58	133
Black walnut	10	--
Butternut	2	--
Yellow-poplar	82	207
Other hardwoods	203	--
Total hardwoods	1,939	3,157
All species	2,138	3,558

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic or board feet. Columns and rows may not add to their totals due to rounding.

[1] International 1/4-inch rule.

Table 19. -- *Average annual mortality of growing stock and sawtimber (Doyle rule) on timberland by species group, Hoosier National Forest, Indiana, 1986-1997*

Species group	Growing stock average annual mortality	Sawtimber average annual mortality
	(In thousand cubic feet)	(In thousand board feet) [1]
Softwoods		
White pine	103	132
Shortleaf pine	84	48
Virginia pine	- -	- -
Eastern redcedar	12	- -
Other softwoods	- -	- -
Total softwoods	199	180
Hardwoods		
Select white oak	142	56
Other white oak	125	138
Select red oak	184	450
Other red oak	415	384
Select hickory	114	151
Other hickory	87	119
Basswood	11	- -
Beech	47	79
Hard maple	185	69
Soft maple	42	56
Elm	57	75
White & green ash	96	55
Sycamore	44	75
Cottonwood	- -	- -
Hackberry	- -	- -
Bigtooth aspen	22	47
Quaking aspen	- -	- -
River birch	- -	- -
Sweetgum	- -	- -
Tupelo	14	- -
Black cherry	58	73
Black walnut	10	- -
Butternut	2	- -
Yellow-poplar	82	172
Other hardwoods	203	- -
Total hardwoods	1,939	1,999
All species	2,138	2,179

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volumes round to less than 1 thousand cubic or board feet. Columns and rows may not add to their totals due to rounding.

[1] Doyle rule.


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The inventory of forest resources of the Hoosier National Forest reports 186 thousand acres of forest land, of which 169.8 thousand acres are timberland. This bulletin presents an analysis of forest resources, focusing on change in tree species composition, timber volume, growth, removals, and mortality.

KEY WORDS: Forest area, forest composition, timber volume, growth, removals, mortality.

The Forest Inventory and Analysis web site is:
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