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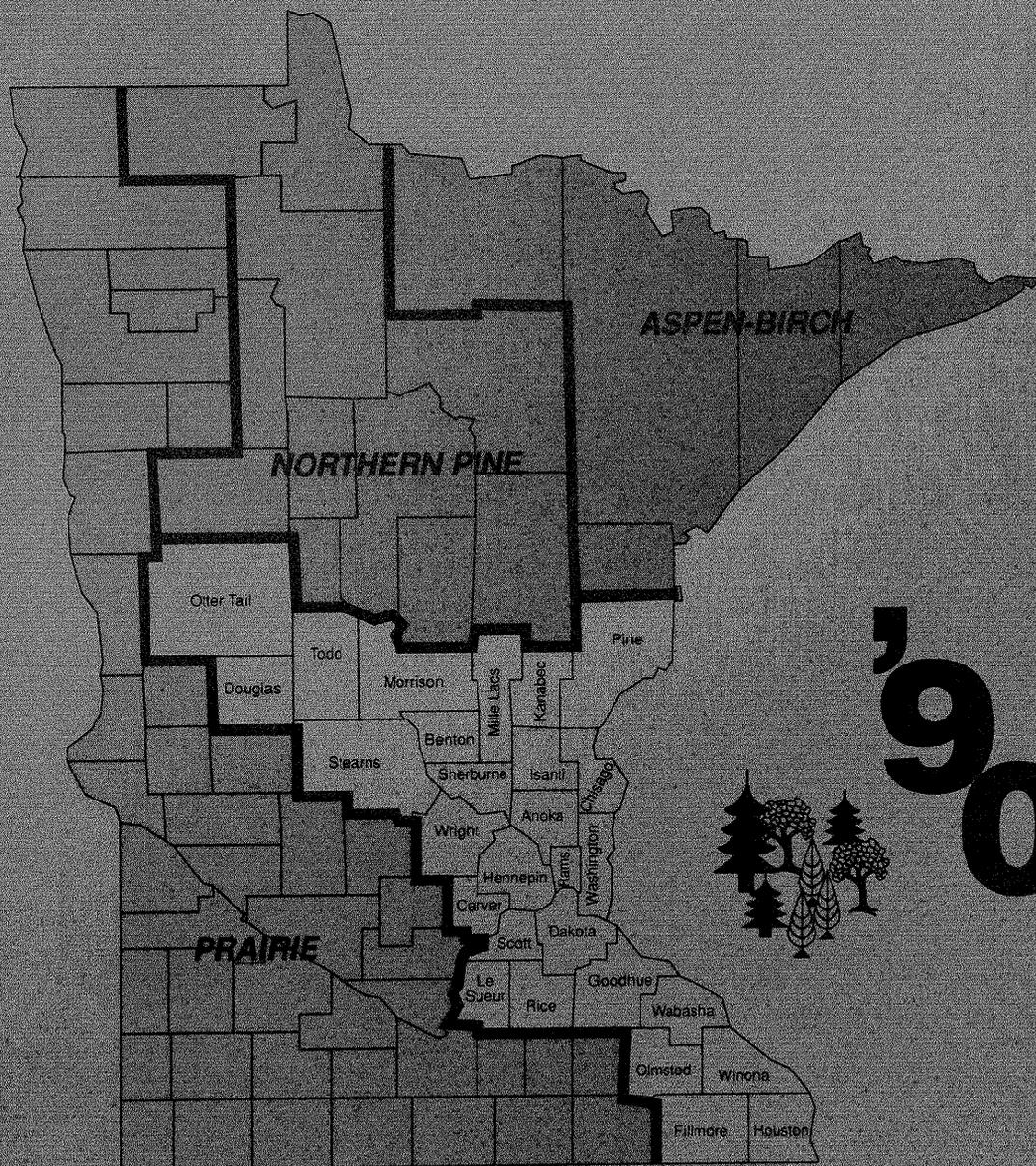
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# Forest Statistics for Minnesota's Central Hardwood Unit

Earl C. Leatherberry



# '90



This report includes the most commonly used Forest Inventory and Analysis statistics. However, additional forest resource data can be provided to interested users. Persons requesting additional information that can be provided from the raw inventory data are expected to pay the retrieval costs. These costs range from less than \$100 for a relatively simple request to \$2,000 for a complex retrieval involving the services of a Forest Inventory and Analysis computer programmer. Requests will be filled so as to minimize the impact on the Forest Inventory and Analysis Work Unit.

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## FOREWORD

Forest Inventory and Analysis (FIA) is a continuing endeavor mandated by the Renewable Forest and Rangeland Resources Planning Act of 1974. Prior to 1974, inventories were mandated by the McSweeney-McNary Forest Research Act of 1928. The objective of FIA is to periodically inventory the Nation's forest land to determine its extent, condition, volume of timber, growth, and removals. Up-to-date resource information is essential to frame forest policies and programs. USDA Forest Service regional experiment stations are responsible for conducting these inventories and publishing summary reports for individual States. The North Central Forest Experiment Station is responsible for forest inventory and analysis in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.

Fieldwork for the Minnesota Central Hardwood Unit forest inventory was begun in February 1990 and completed in February 1991. Reports of four previous inventories of Minnesota's timber resource are dated 1936, 1953, 1962, and 1977.

More accurate information was obtained during this survey than otherwise would have been feasible because of intensified field sampling. This sampling was made possible through the cooperation and assistance of the Minnesota Department of Natural Resources (MDNR). Data for the Central Hardwood Unit were collected by the North Central Forest Inventory field staff. To aid in determining current timber removals, the MDNR surveyed primary wood-using plants in the State.

Aerial photos used in the Central Hardwood Unit forest inventory were 1:40,000 scale black and white photos furnished by the USDA Agricultural Stabilization and Conservation Service (ASCS) and the MDNR. In addition, the North Central Forest Inventory project purchased 35mm true color prints at a scale of 1:15,840 for all 1977 forest plot locations. These were used for disturbance detection.

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Earl C. Leatherberry

## HIGHLIGHTS

**NOTE:** *Data from new forest inventories are often compared with data from earlier inventories to determine trends in forest resources. However, for the comparisons to be valid, the procedures used in the two inventories must be similar. As a result of our ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have occurred since 1977. Because some of these changes will make it inappropriate to directly compare the 1990 data with those published for 1977, data from the 1977 inventory have been reprocessed using the 1990 procedures. Please refer to the section labeled "Comparing Minnesota's Fifth Inventory With the Fourth Inventory" for more details. **The data in this report are subject to change when inventory data for the entire State have been compiled. It is expected that any such changes will be minor.***

## General

The Central Hardwood Survey Unit consists of 28 counties in central and southeastern Minnesota (see cover). This Unit contains the largest population in the State, including the 7-county

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Twin Cities metropolitan area. Forests are scattered and intermixed with large areas of urban and agricultural land. Forests in the Unit are primarily hardwood, changing to prairie to the west and to conifer forests to the north. In the north the aspen-birch forest type predominates, and in the south the oak-hickory and maple-basswood types prevail. Topography ranges from flat to rolling in the north to steep and rugged in the unglaciated hill country of extreme southeastern Minnesota. The Mississippi River traverses the length of the Unit.

## Forest Area

- The Central Hardwood Unit contains 11.9 million acres of land, of which 2.4 million acres were forest land in 1990. The area of forest land showed a modest increase since 1977 as a result of reversion of lands with some tree cover previously used for agriculture to forest.
- Seven counties in the northeast and southeast portions of the Central Hardwood (Kanabec, Mille Lacs, Morrison, and Pine in the northeast; Houston, Wabasha, and Winona in the southeast) are more than 20 percent forested. Pine County contains the largest area of forest land—521 thousand acres or 57 percent of the county's land area.
- Ninety-seven percent (2.3 million acres) of the forest land in the Unit is classified as timberland—forest land that is capable of producing in excess of 20 cubic feet per acre per year of industrial wood crops and is not withdrawn from timber harvesting.

- Softwood forest types represent a small portion of the area of timberland. Four hardwood types account for the largest area in the Unit—oak-hickory, aspen, maple-basswood, and elm-ash-soft maple (fig. 1). Area of the aspen type remained virtually unchanged between inventories, but the areas of elm-ash-soft maple, oak-hickory, and maple-basswood types increased between 20 and 30 percent.

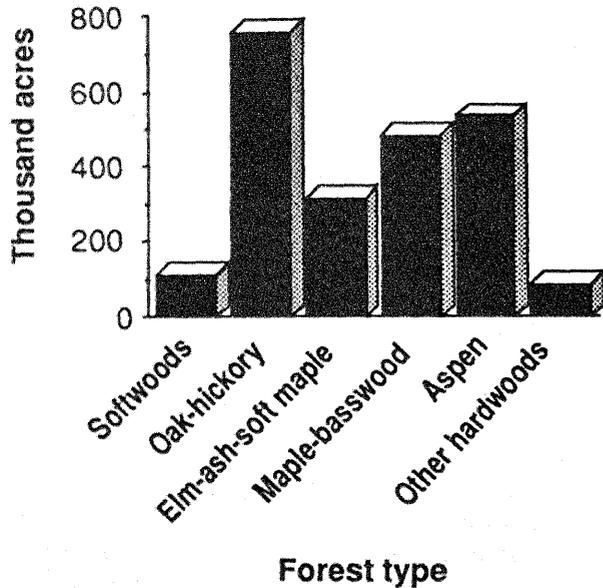


Figure 1.—Area of timberland by forest type, Central Hardwood Unit, 1990.

- Nonindustrial private owners account for 81 percent of the timberland area. Farmers alone own 1.1 million acres, and miscellaneous private owners hold another 793 thousand acres (fig. 2). The public, largely the State, owns 413 thousand acres.
- Sawtimber stands account for 50 percent of the timberland area, with 1.1 million acres. Poletimber stands account for 30 percent of the area with 686 thousand acres. Sapling-seedling stands account for 19 percent of the area with 431 thousand acres. And, the remaining 1 percent, or 20 thousand acres, is classified as nonstocked.

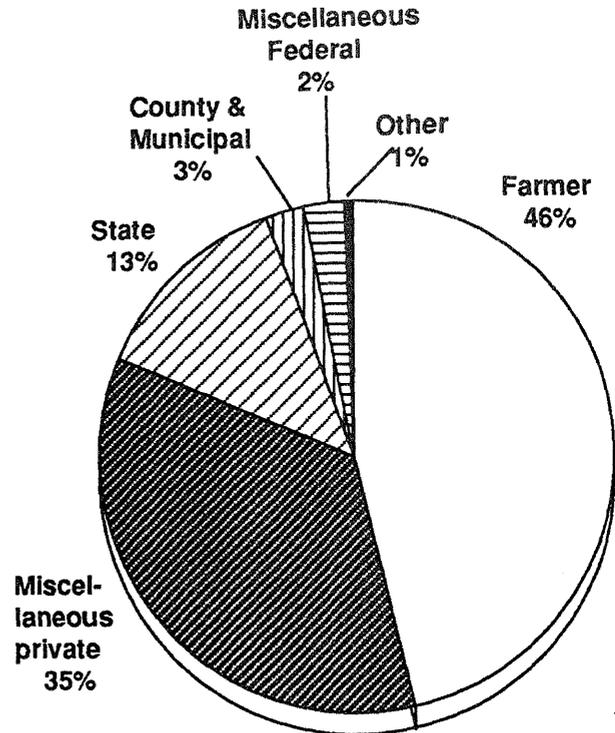


Figure 2.—Distribution of timberland in the Central Hardwood Unit by ownership class, 1990.

#### Volume

- The volume of growing stock in the Central Hardwood Unit in 1990 totaled 2.3 billion cubic feet, an increase of about a fourth since 1977. Growing-stock volume averaged 1,024 cubic feet per acre in 1990.
- Sawtimber volume in 1990 totaled 6.2 billion board feet per acre, up nearly a third since 1977. Sawtimber volume in 1990 averaged 2,714 board feet per acre.
- Oaks accounted for 34 percent of the growing-stock volume in 1990 (801 million cubic feet) (fig. 3). The aspens had the second largest volume with 438 million cubic feet, followed by basswood with 216 million cubic feet, and paper birch with 124 million cubic feet.
- Elm volume stood at 98.8 million cubic feet in 1990 and continues to decline as a result of Dutch elm disease.

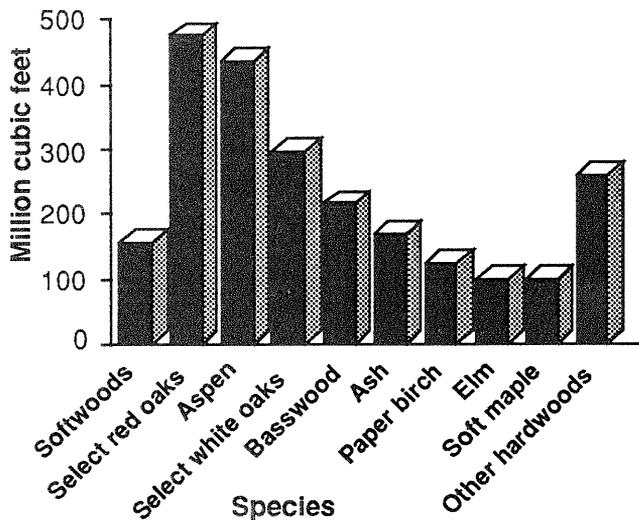


Figure 3.—Volume of growing stock on timberland in the Central Hardwood Unit by species group, 1990.

- Nonindustrial private owners hold 80 percent of the growing-stock volume (1.9 billion cubic feet) (fig. 4). Farmers own the largest portion (1.1 billion cubic feet), averaging 1,003 cubic feet per acre; followed by miscellaneous private owners (0.8 billion cubic feet), averaging 996 cubic feet per acre.
- The State owns the third largest volume of growing stock (0.3 billion cubic feet), averaging 1,059 cubic feet per acre.

#### Timber Growth, Mortality, and Removals

- Net annual growth of growing stock on timberland averaged 53.4 million cubic feet per year from 1977 through 1989 (fig. 5). This is an average of 25 cubic feet per acre per year, or 2.5 percent of the average inventory for the period.
- Hardwood growth averaged 47.9 million cubic feet from 1977 through 1989, or 2.4 percent of the average hardwood inventory for the period. Softwood growth averaged 5.5 million cubic feet, or 4.5 percent of the average softwood inventory for the period.

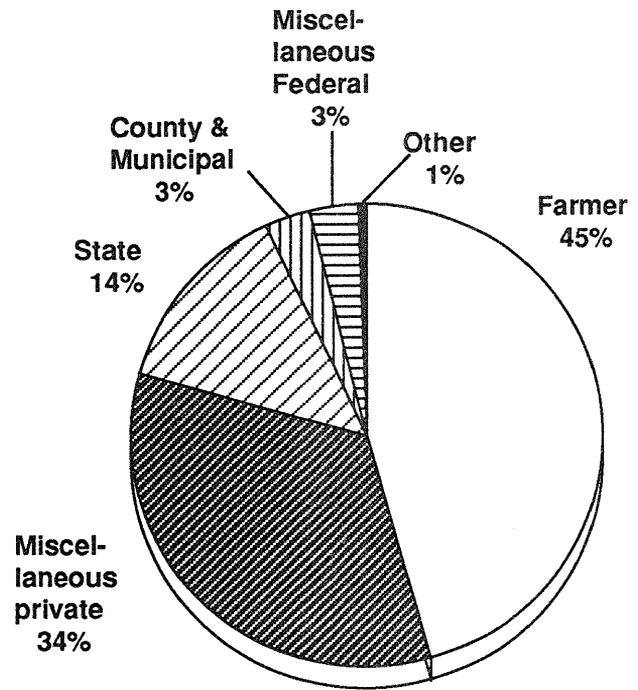


Figure 4.—Distribution of growing-stock volume on timberland in the Central Hardwood Unit by ownership class, 1990.

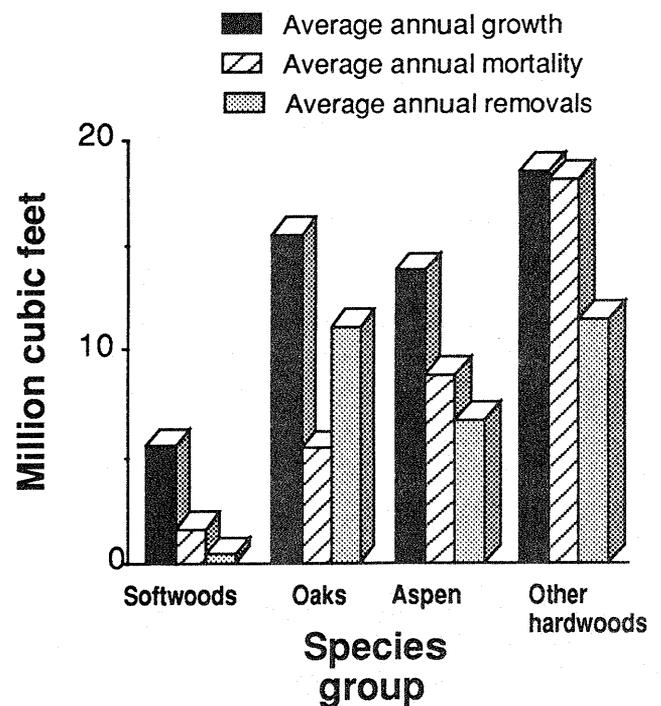


Figure 5.—Average annual growing-stock growth, removals, and mortality on timberland in the Central Hardwood Unit by species group, 1977-1989.

- Mortality of growing stock averaged 34 million cubic feet per year from 1977 through 1989. Elm mortality accounted for 11 million cubic feet—one-third of the total mortality volume.
- Average annual removals of growing stock from timberland was 29.8 million cubic feet per year from 1977 through 1989. This is 56 percent of average net annual growth. Hardwoods accounted for 98 percent of the removals.
- Current annual growth of growing stock on timberland was 75.4 million cubic feet in 1989. This amounts to 33.1 cubic feet per acre, or 3.2 percent of growing-stock inventory.
- Removals of growing stock in 1988 totaled 34.3 million cubic feet—46 percent of current (1989) annual growth.
- In 1989 current growth on red oaks (select and other red oaks) totaled 10.7 million cubic feet, compared with 1988 removals of 8.5 million cubic feet.
- Oak removals alone averaged 11.1 million cubic feet during 1977 to 1989, or 71 percent of oak average net annual growth. Removals of select red oak, which is in high demand, amounted to 8.2 million cubic feet per year compared with an average net annual growth of 9.5 million cubic feet.

## APPENDIX

### ACCURACY OF THE SURVEY

Forest Inventory and Analysis 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. These sampling errors mean that the chances are two out of three that if a 100-percent inventory had been taken, using the same methods, the results would have been within the limits indicated.

For example, the estimated growing-stock volume in the Unit in 1990, 2,330.9 million cubic feet, has a sampling error of  $\pm 2.30$  percent ( $\pm 53.6$  million cubic feet). The growing-stock volume from a 100-percent inventory would be expected to fall between 2,384.5 and 2,277.3 million cubic feet ( $2,330.9 \pm 53.6$ ), there being a one in three chance that this is not the case.

The following tabulation shows the sampling errors for the Central Hardwood Forest Inventory:

Item	Unit totals	Sampling error
Growing stock	(Million cubic feet)	(Percent)
Volume (1990)	2,330.9	2.30
Average annual growth (1977-1989)	53.4	5.49
Average annual removals (1977-1989)	29.8	10.42
Sawtimber	(Million board feet)	
Volume (1990)	6,174.6	3.01
Average annual growth (1977-1989)	213.8	5.22
Average annual removals (1977-1989)	96.3	11.54
Timberland	(Thousand acres)	
Area (1990)	2,275.4	1.02

**NOTE:** A standard FIA inventory is designed to provide sampling errors of 3 percent per million acres of timberland or an overall error on Minnesota's nearly 15 million acres of about 0.8 percent. The State of Minnesota provided funding to collect additional field data to reduce the sampling error by one-half. The overall goal was to provide a sampling error for total timberland area by county of less than 10 percent.

## SURVEY PROCEDURES

The sampling error within a county will depend on the size of the county and its total area of timberland. Many large, heavily forested counties in the State have sampling errors well below  $\pm 5$  percent. However, in counties where timberland area is less than 35,000 acres, sampling errors will generally exceed  $\pm 10$  percent. For this reason we combined the data for some counties in this report to provide reporting areas with sampling errors lower than  $\pm 10$  percent. The sampling error for total timber volume in a reporting unit containing 35,000 acres of timberland will be about  $\pm 20$  percent. Individual county data are provided only in Table 1 with the associated sampling error for timberland. Other data for individual counties are available from FLA by special request.

To estimate the sampling error for values smaller than Unit totals in this report, the following formula is used:

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

where:

E = sampling error in percent  
SE = Unit total error for area or volume

For example, to compute the error on the area of timberland in the elm-ash-soft maple in the Unit, proceed as follows:

The total area of elm-ash-soft maple type in the Unit from table 3 = 311,100 acres

The total area of all timberland in the Unit from table 3 = 2,275,400

The Unit total error for timberland area from the above tabulation = 1.02 percent

Using the above formula:

$$\begin{aligned} \text{Error} &= \frac{(1.02) \sqrt{2,275,400}}{\sqrt{311,100}} \\ &= \pm 2.76 \text{ percent} \end{aligned}$$

The 1990 Minnesota survey used a growth model-enhanced, two-phase sample design. Using this sampling scheme and associated estimators is similar to sampling with partial replacement (SPR), in that a set of randomly located plots is available for remeasurement and a random set of new plots is established and measured. A significant feature of the new Minnesota design is stratification for disturbance on the old sample and use of a growth model to improve regression estimates made on old undisturbed forest plots (fig. 6). Detailed descriptions of the sampling and estimation procedures are presented by Hansen<sup>1</sup>. The growth model used in the Minnesota survey design was the Lake States Stand and Tree Evaluation and Modeling System (STEMS)<sup>2</sup>.

These were the major steps in the new survey design:

### 1. Aerial photography (Phase 1)

In this phase two sets of random points were located on current aerial photography: a set of new photo plots and a set of relocated old ground plot locations from the 1977 inventory. Aerial photos used in the Central Hardwood Unit forest inventory were furnished by the USDA Agricultural Stabilization and Conservation Service (ASCS, 1:40,000 scale black and white) and the Minnesota Department of Natural Resources (1:15,840 scale black and white). In addition, the North Central Forest Inventory Project purchased 35mm true color prints at a scale of 1:15,840 of all of the 1977 ground plot locations. These 35mm prints were

<sup>1</sup> Hansen, Mark H. 1990. *A comprehensive sampling system for forest inventory based on an individual tree growth model*. St. Paul, MN: University of Minnesota, College of Natural Resources. 256 p. Ph.D. dissertation.

<sup>2</sup> Belcher, David W.; Holdaway, Margaret R.; Brand, Gary J. 1982. *A description of STEMS: the stand and tree evaluation and modeling system*. Gen. Tech. Rep. NC-79. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 18 p.

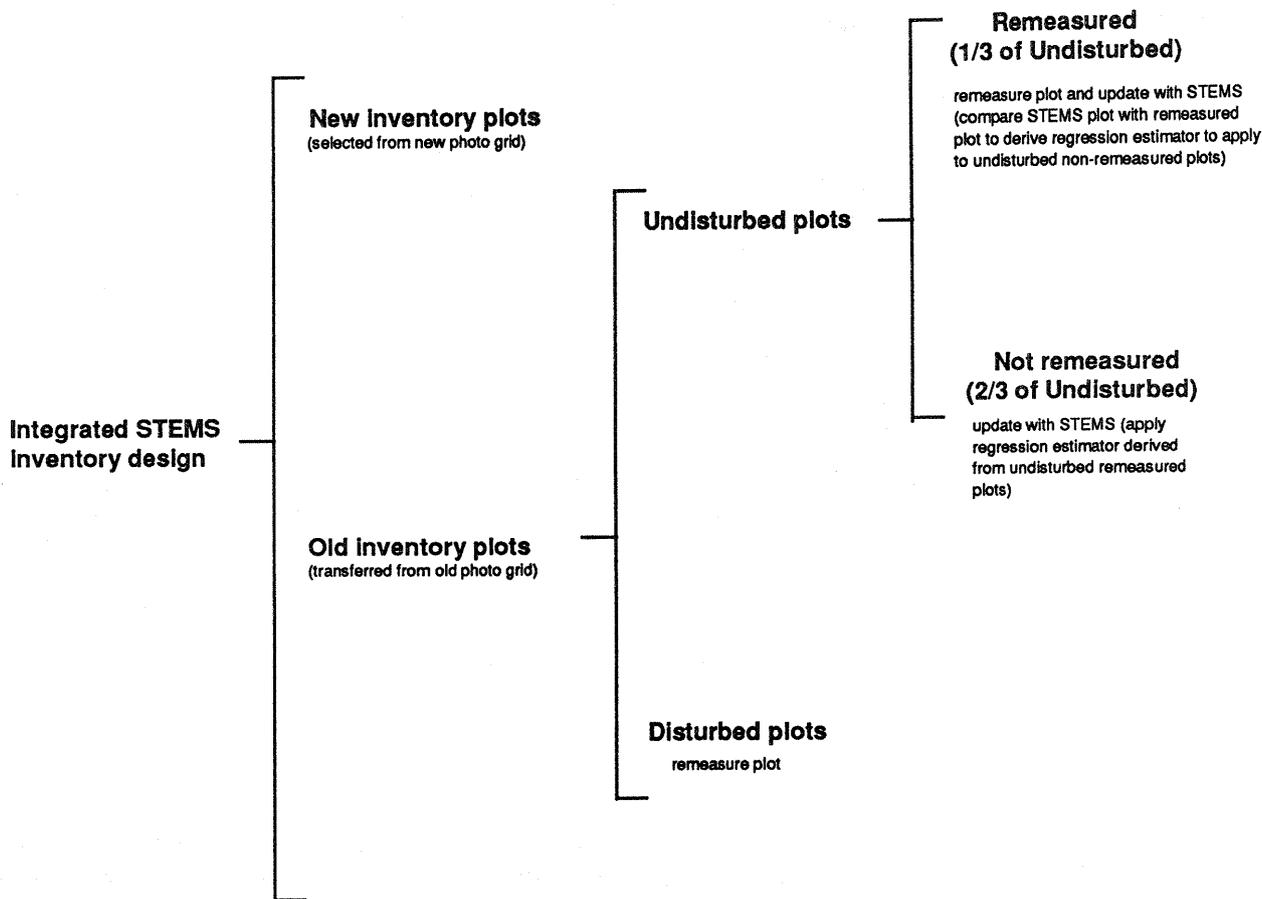


Figure 6.—Overview of the Minnesota sample design.

used in addition to the ASCS prints to help detect disturbances in the 1977 ground plot locations. The year of photography for each county in the Unit is shown below.

County	Date	
	ASCS or DNR	35mm
Anoka	1976 (DNR)	1988
Benton	1980 (ASCS)	1988
Carver	1980 (ASCS)	1988
Chisago	1983 (ASCS)	1988
Dakota	1979 (ASCS)	1988
Douglas	1982 (ASCS)	1988
Fillmore	1979 (ASCS)	1988
Goodhue	1980 (ASCS)	1988
Hennepin	1976 (DNR)	1988
Houston	1979 (ASCS)	1988

Isanti	1983 (ASCS)	1988
Kanabec	1984 (DNR)	1988
LeSueur	1980 (ASCS)	1988
Mille Lacs	1984 (DNR)	1988
Morrison	1980 (ASCS)	1988
Olmsted	1980 (ASCS)	1988
Otter Tail	1980 (ASCS)	1988
Pine	1982 (DNR)	1988
Ramsey	1977 (DNR)	1988
Rice	1979 (ASCS)	1988
Scott	1980 (ASCS)	1988
Sherburne	1980 (ASCS)	1988
Stearns	1980 (ASCS)	1988
Todd	1980 (ASCS)	1988
Wabasha	1980 (ASCS)	1988
Washington	1980 (ASCS)	1988
Winona	1979 (ASCS)	1988
Wright	1979 (ASCS)	1988

The locations of the plots used in the 1977 inventory were transferred to these new photographs. The photographs were then 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 photogrammetrists and classified stereoscopically based on land use. If trees were present, forest type and stand-size density class were recorded. All of the 1977 ground plot locations were also examined for disturbance (logging, fire, catastrophic mortality, etc.) with the aid of the 35mm photographs. After this examination, all the old "disturbed" sample locations, a one-third sample of the old "undisturbed" sample locations, and a sample of the new photo plots were sent to the field for survey crews to verify the photo classification and to take further measurements. All photo plot locations for the 1990 inventory were examined for the Central Hardwood Unit and were classified as shown in the following tabulation:

Photo land class	Photo plots
Timberland	12,294
Reserved forest land	326
Other forest land	146
Questionable	480
Nonforest with trees	1,404
Nonforest without trees	48,197
Water	3,285
All classes	66,132

## 2. Plot measurements (Phase 2)

On plots classified as timberland, wooded pasture, or windbreak (at least 120 feet wide), a ground plot was established, remeasured, or modeled. Old plots sent to the field for remeasurement that could not be relocated were replaced with a new plot at the approximate location of the old one. Each ground plot consists of a 10-point cluster covering approximately 1 acre. At each point, 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 measurement procedure for the new and old sample locations was as follows:

### a. New inventory plots

A random sample of the new photo plots was selected for field measurement. Ground plots were established; and measures of current classification such as land use, forest type, and ownership as well as size and condition of all trees on the plot were recorded. These locations were monumented for future remeasurement.

### b. Old inventory plots

These plots were established, monumented, and measured as part of the 1977 field inventory. The procedures for these old plot locations were different from those for the new plots. Old plots were classed as "undisturbed" or "disturbed" in the aerial photo phase of the sampling process. 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. All trees measured on these plots in 1977 were remeasured or otherwise accounted for, and all new trees were identified and measured.

All sample plots that were forested at the time of the 1977 inventory and determined to be undisturbed until this inventory were projected to the current time using STEMS. This procedure gives projected estimates of current volume and growth for these undisturbed plots. The comparison of the projected and observed values on the one-third sample of the undisturbed forest plots that were remeasured provided local calibration data 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<sup>3</sup>.

<sup>3</sup> Smith, W. Brad. 1983. *Adjusting the STEMS regional growth models to improve local predictions. Res. Note NC-297. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.*

The old sample plots that were not forested in 1977 and that were determined to be undisturbed until the current inventory (no evidence of conversion to another land use) were also sub-sampled (field checked) at the one-third rate. Any changes in land use to forest detected on these plots were used to adjust the two-thirds sample of these plots not field checked. The field check of these points in the Central Hardwood Unit indicated that no adjustment was necessary.

The undisturbed plots that were not re-measured play a crucial role in the new survey design. These plots, after careful examination comparing past and current aerial photography, 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, even though they were never visited. 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 re-measurement to assess and verify changes since the last inventory. Disturbance refers to any change on a plot that can be detected on aerial photos and that the STEMS growth processor cannot predict, such as catastrophic mortality, cutting, seedling stands, and land use change.

The estimation procedure for computing statistics from this sampling design was more complicated than the simple two-phase estimation procedure used in the past. In fact, this procedure yielded two independent samples, one coming from the new photo points and the other from the old photo points that are re-measured or modeled. The following tabulation summarizes the distribution of all ground plots for the new inventory design by type of plot:

Ground land use class	Old plots re-measured	Old plots updated	New plots	Total plots
Timberland	970	595	145	1,710
Reserved forest land	10	3	67	80
Other forest land	14	4	—	18
Nonforest with trees	213	31	39	283
Nonforest without trees	2,373	4,154	709	7,236
Water	143	255	67	465
Total	3,723	5,042	1,027	9,792

### 3. Area estimates

Area estimates were made using two-phase estimation methods. In this type of estimation, a preliminary estimate of area by land use is made from the aerial photographs (Phase 1) and corrected by the plot measurements (Phase 2). A complete description of this estimation method is presented by Loetsch and Haller<sup>4</sup>.

### 4. Volume estimates

Estimates of volume per acre were made from the trees measured or modeled on the 10-point plots. Estimates of volume per acre were multiplied by the area estimates to obtain estimates of total volume. Net cubic foot volumes are based on a modification of the method presented by Hahn<sup>5</sup> for use in the Lake States. For the Minnesota inventory, the merchantable height equation presented was used in conjunction with Stone's equation 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.

<sup>4</sup> Loetsch, F.; Haller, K.E. 1964. *Forest Inventory, Volume I, Statistics of forest inventory and information from aerial photographs*. BLV Verlagsgesellschaft Munch Basle Vienna. 436 p.

<sup>5</sup> Hahn, Jerold T. 1984. *Tree volume and biomass equations for the Lake States*. Res. Pap. NC-250. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 10 p.

The Forest Service reports all board foot volume in International 1/4-inch rule. In Minnesota, the Scribner log rule is commonly used. Scribner log rule conversion factors were derived from full tree measurements taken throughout the Lake States (Michigan, Wisconsin, and Minnesota) and an equation was developed by Wiant and Castenaeda<sup>6</sup>. The factors (multipliers) used here to convert board foot International volumes to the Scribner rule are shown in the following tabulation:

D.B.H. (inches)	Scribner rule conversion factor	
	Softwoods	Hardwoods
9.0-10.9	0.7830	—
11.0-12.9	0.8287	0.8317
13.0-14.9	0.8577	0.8611
15.0-16.9	0.8784	0.8827
17.0-18.9	0.8945	0.8999
19.0-20.9	0.9079	0.9132
21.0-22.9	0.9168	0.9239
23.0-24.9	0.9240	0.9325
25.0-26.9	0.9299	0.9396
27.0-28.9	0.9321	0.9454
29.0+	0.9357	0.9544

#### 5. Growth and mortality estimates

On remeasured plots, estimates of growth and mortality per acre come from the remeasured diameters of trees and from observation of trees that died between inventories. Growth reported as the average net annual growth between the two inventories (1977 and 1990) is computed from data on remeasurement plots and modeled plots using methods presented by VanDeusen *et al.*<sup>7</sup>. Mortality is also average net annual for the remeasurement period. On new plots, where

<sup>6</sup> Wiant, Harry V., Jr.; Castenaeda, Froylan. 1977. *Mesavage and Girard's volume tables formulated. BLM4. Denver, CO: U.S. Department of Interior, Bureau of Land Management, Denver Service Center: 1-4.*

<sup>7</sup> VanDeusen, P.C.; Dell, T.R.; Thomas, C.E. 1986. *Volume growth estimation from permanent horizontal points. Forest Science. 32: 415-422.*

trees were not remeasured, estimates of growth and mortality were obtained by using STEMS to project the growth and mortality of trees for 1 year. 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 estimates. Current annual growth for 1989 was computed by using the adjusted STEMS model to grow all current inventory plots for 1 year.

#### 6. Average annual removals estimates

Average annual growing-stock and sawtimber removals (1977 to 1989) were estimated only from the remeasured plots; new plots were not used to estimate removals. These estimates are obtained from trees measured in the last survey and cut or otherwise removed from the timberland base. Because remeasurement plots make up about one-half of the total ground plots, average annual removals estimates have greater sampling errors than volume and growth estimates.

### COMPARING MINNESOTA'S FIFTH INVENTORY WITH THE FOURTH INVENTORY

The following paragraphs highlight some of the procedural changes since the last inventory to assist the reader in analyzing data from this report:

A new volume estimation procedure was developed for the Lake States (see Survey Procedures section), and this procedure was used to compute the 1989 volumes and also to recompute the 1977 volume for growth calculations. Although the adjustment differs by Survey Unit and species, the recomputed 1977 growing-stock and board foot volumes are greater than those shown in the 1977 report.

Past surveys used only growing-stock trees to determine stand-size class. Current survey procedures require that stand-size class be determined on the basis of all live trees. Therefore, direct comparisons of current inventory data to old inventory data by stand-size class may be misleading.

The basic building block for estimating forest area and timber volume has been changed from the Survey Unit to the county. In the past, the statistics were developed at the Unit level and prorated back to the county on the basis of photo-interpretation points. Direct development of county-level data helps users interested in more precise local data, but can make the outcome of comparisons with past estimates uncertain.

### **TREE GRADE**

On approximately one-third of the sample plots in the Central Hardwood Unit of Minnesota, all sawtimber sample trees were graded for quality and assigned a tree grade. Tree grades are based on the classification of external characteristics as indicators of quality. The volume yield by tree grade for this sample was used to distribute the volume of the ungraded sample trees by species group.

Hardwood sawtimber trees were graded according to "Hardwood tree grades for factory lumber."<sup>8</sup> 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 in "A guide to hardwood log grading."<sup>9</sup>

Red pine and jack pine sawtimber trees were graded based on specifications described in "Forest Service Log Grades for Southern Pines".<sup>10</sup> White pine and other softwood sawtimber trees were graded according to specifications described in the circular "Log grades"<sup>11</sup> from the University of Wisconsin. For all softwoods, the first merchantable 16-foot log, or shorter lengths down to 12 feet, was used for grading.

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<sup>8</sup> Hanks, Leland F. 1976. *Hardwood tree grades for factory lumber. Res. Pap. NE-333. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 81 p.*

<sup>9</sup> Rast, Everette D.; Sonderman, David L.; Gammon, Glenn L. 1973. *A guide to hardwood log grading. Gen. Tech. Rep. NE-1. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 31 p.*

<sup>10</sup> Campbell, Robert A. 1964. *Forest service log grades for southern pine. Res. Pap. SE-11. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 17 p.*

<sup>11</sup> Peterson, Ted. 1965. *Log grades. Spec. Circ. 60. Madison, WI: University of Wisconsin, Extension Service, College of Agriculture. 4 p.*

## HARDWOOD TREE GRADES FOR FACTORY LUMBER

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 <sup>a</sup> (feet)	Best 12	Best 12	Best 12
DBH, minimum (inches)	16 <sup>b</sup>	13	11
Diameter, minimum inside bark at top of grading section (inches)	13 <sup>b</sup> 16 20	11 <sup>c</sup> 12	8
Clear cuttings (on the three best faces) <sup>d</sup>			
Length, minimum (feet)	7 5 3	3 3	2
Number on face (maximum)	2	2 3	e
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	9 <sup>f</sup>	50

<sup>a</sup> 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.

<sup>b</sup> In basswood and ash, d.i.b. at top of grading section must be 12 inches and d.b.h. must be 15 inches.

<sup>c</sup> Grade 2 trees can be 10 inches d.i.b. at top of grading section if otherwise meeting surface requirements for small grade 1's.

<sup>d</sup> 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.

<sup>e</sup> Unlimited.

<sup>f</sup> Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2, 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)<sup>1</sup>

Position in tree	Butts and uppers
Min. diameter, small end	8 inches +
Min. length without trim	8 feet
Clearcuttings	No requirements
Sweep allowance	One-fourth of the diameter at the small end for each 8 feet of length.
<b>Sound surface defects:</b>	
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 <sup>2</sup> .
Unsound surface defects :	Same requirements as for sound defects if they extend into included timber. No limit if they do not.

<sup>1</sup>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.

<sup>2</sup>Included timber is always square, and dimension is judged from small end.

## TREE GRADES FOR EASTERN WHITE PINE

Log grade	Minimum size <sup>1</sup>		Sweep or crook allowance	Total cull allowance including sweep	Maximum weevil injury	Allowable knot size (inches) <sup>2</sup> on three best faces or minimum clearness on four faces
	(Inches)	(Feet)	(Percent)	(Percent)	(Number)	(Inches)
1	12 & 13	8-16	20	50	0	Four faces clear full length
	14+	10-16	20	50	0	Two faces clear full length, or four faces clear 50 percent length (6 feet min. length) <sup>3</sup>
2	6+	8-16	30	50	0	Sound knots i.e. <sup>4</sup> D/6 and less than 3 inches <sup>5</sup>  Unsound knots: i.e. 1-1/2 inches and for: butt, logs i.e. D/12 upper logs i.e. D/10, or four faces clear 50 percent of length
3	6+	8-16	40	50	8-foot logs: 1 weevil	Sound knots i.e. D/3 and less than 5 inches
					10-foot+ logs: 2 weevils	Unsound knots i.e. D/6 and less than 2-1/2 inches
4	6+	8-16	50	50	No limit	No limit

<sup>1</sup>Plus trim.

<sup>2</sup>Disregard all knots less than 1/2-inch diameter in all grades.

<sup>3</sup>The sum of the diameter of sound knots plus twice the sum of the diameter of unsound knots (in inches) is less than or equal to half of the diameter of the log (inches).

<sup>4</sup>i.e. means less than or equal to.

<sup>5</sup>D means d.i.b. of log at location of knot.

## TREE GRADES FOR JACK PINE AND RED PINE

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- Grade 1:* Trees with three or four clear faces on the 16-foot grading section.<sup>1</sup>  
*Grade 2:* Trees with one or two clear faces on the 16-foot grading section.  
*Grade 3:* Trees with no clear faces on the 16-foot grading section.

After the tentative grade is established from above, the tree will be reduced one grade for each of the following, except that no tree can be reduced below grade 3, provided the total scaling deductions for sweep and/or rot do not exceed two-thirds of the gross scale of the tree.

1. *Sweep.* Degrade any tentative grade 1 or 2 tree one grade if sweep in the lower 12 feet of grading sections amounts to 3 or more inches and equals or exceeds one-fourth of the diameter at breast height.
2. *Heart rot.* Degrade any tentative grade 1 or 2 tree one grade if conk, punk knots, massed hyphae, or other evidence of advanced heart rot is found anywhere on the main tree stem.

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<sup>1</sup>A face is one-fourth of the circumference in width extending the full length of the grading section. Clear faces are those free of: knots measuring more than 1/2-inch in diameter, overgrown knots of any size, and holes more than 1/4-inch in diameter. Faces may be rotated to obtain the maximum number of clear ones on the grading section.

## TREE GRADES FOR ALL OTHER SOFTWOOD LOGS

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### *Grade 1*

1. Trees must be 16 inches in diameter <sup>A</sup> 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 <sup>B</sup> 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.

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A) Diameters are diameter inside bark (d.i.b.) at small end of grading section.

B) 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 MINNESOTA<sup>12</sup>**

**SOFTWOODS**

- Eastern white pine ..... *Pinus strobus*  
 Red pine ..... *Pinus resinosa*  
 Jack pine ..... *Pinus banksiana*  
 White spruce ..... *Picea glauca*  
 Black spruce ..... *Picea mariana*  
 Balsam fir ..... *Abies balsamea*  
 Tamarack ..... *Larix laricina*  
 Northern white-cedar ..... *Thuja occidentalis*  
 Other softwoods  
 Eastern redcedar ..... *Juniperus virginiana*  
 Scotch pine ..... *Pinus sylvestris*

**HARDWOODS**

- White oak<sup>13</sup>  
 White oak ..... *Quercus alba*  
 Bur oak ..... *Quercus macrocarpa*  
 Select red oak<sup>13</sup>  
 Northern red oak ..... *Quercus rubra*  
 Other red oak<sup>13</sup>  
 Northern pin oak ..... *Quercus ellipsoidalis*  
 Black oak ..... *Quercus velutina*

<sup>12</sup>The common and scientific names are based on: Little, Elbert L. 1981. Checklist of native and naturalized trees of the United States. Agric. Handb. 541. Washington, DC: U.S. Department of Agriculture, Forest Service. 385 p.

<sup>13</sup>This species or species group is considered a hard hardwood, with an average specific gravity greater than or equal to 0.50.

- Hickory<sup>13</sup>  
 Shagbark hickory ..... *Carya ovata*  
 Bitternut hickory ..... *Carya cordiformis*  
 Basswood<sup>14</sup> ..... *Tilia americana*  
 Yellow birch<sup>14</sup> ..... *Betula alleghaniensis*  
 Hard maple<sup>13</sup>  
 Black maple ..... *Acer nigrum*  
 Sugar maple ..... *Acer saccharum*  
 Soft maple<sup>14</sup>  
 Red maple ..... *Acer rubrum*  
 Silver maple ..... *Acer saccharinum*  
 Elm  
 American elm<sup>14</sup> ..... *Ulmus americana*  
 Slippery elm<sup>14</sup> ..... *Ulmus rubra*  
 Rock elm<sup>13</sup> ..... *Ulmus thomasi*  
 Ash<sup>13</sup>  
 White ash ..... *Fraxinus americana*  
 Black ash ..... *Fraxinus nigra*  
 Green ash ..... *Fraxinus pennsylvanica*  
 Cottonwood<sup>14</sup> ..... *Populus deltoides*  
 Black willow<sup>14</sup> ..... *Salix nigra*  
 Hackberry<sup>14</sup> ..... *Celtis occidentalis*  
 Balsam poplar<sup>14</sup> ..... *Populus balsamifera*  
 Aspen<sup>14</sup>  
 Bigtooth aspen ..... *Populus grandidentata*  
 Quaking aspen ..... *Populus tremuloides*  
 Paper birch<sup>13</sup> ..... *Betula papyrifera*  
 Black cherry<sup>14</sup> ..... *Prunus serotina*  
 Black walnut<sup>13</sup> ..... *Juglans nigra*  
 Butternut<sup>14</sup> ..... *Juglans cinerea*  
 Other hardwoods  
 Boxelder<sup>14</sup> ..... *Acer negundo*  
 Black locust<sup>13</sup> ..... *Robinia pseudoacacia*  
 Red mulberry<sup>14</sup> ..... *Morus rubra*  
 Honeylocust<sup>13</sup> ..... *Gleditsia triacanthos*  
 Northern catalpa<sup>13</sup> ..... *Catalpa speciosa*  
 Noncommercial species  
 Eastern hophornbeam ..... *Ostrya virginiana*  
 Apple ..... *Malus* spp.  
 American hornbeam ..... *Carpinus caroliniana*  
 Wild plum ..... *Prunus* spp.  
 Hawthorn ..... *Crataegus* spp.

<sup>14</sup>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 removals from growing stock.**—The average net growing-stock volume in growing-stock trees removed annually for forest products (including roundwood products and logging residues) and for other uses (see Other removals). Average annual removals of growing stock is reported for a period of several years (1977 to 1989 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 forest products (including roundwood products and other uses [see Other removals]). Average annual removals of sawtimber is reported for a period of several years (1977 to 1989 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

**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.)

**Commercial forest land.**—(See Timberland).

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

**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.

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

**Current annual 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. Current growth is based on an estimate of the current annual increment of each growing-stock tree in the inventory.

**Current annual 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. Current 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 forest products (including roundwood products and logging residues) and for other uses (see Other removals). Current annual removals of growing stock is reported for a single year (1988 in this report) and 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 forest products (including roundwood products and other uses [see Other removals]). Current annual removals of sawtimber is reported for a single year (1988 in this report) and 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 (d.b.h.). 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 (1.37m) 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.

**Farm.**—Any place from which \$1,000 or more of agricultural products were produced and sold during the year.

**Farmer-owned land.**—Land owned by farm operators whether part of the farmstead or not. (Note: Excludes land leased by farm operators from nonfarm owners, such as railroad companies and States.)

**Forest land.**—Land at least 16.7 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 shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas shall be classed as forest if less than 120 feet wide. (See Tree, Land, Timberland, Reserved forest land, Other forest land, Stocking, and Water.)

**Forest industry land.**—Land owned by companies or individuals that operate a primary wood-using plant.

**Forest type.**—A classification of forest land based on the species forming a plurality of live tree stocking. Major forest types in the State are:

*Jack pine.*—Forests in which jack pine comprises a plurality of the stocking. (Common associates include eastern white pine, red pine, aspen, birch, and maple.)

*Red pine.*—Forests in which red pine comprises a plurality of the stocking. (Common associates include eastern white pine, jack pine, aspen, birch, and maple.)

*White pine.*—Forests in which eastern white pine comprises a plurality of the stocking. (Common associates include red pine, jack pine, aspen, birch, and maple.)

*Balsam fir.*—Forests in which balsam fir and white spruce comprise a plurality of stocking with balsam fir the most common. (Common associates include aspen, maple, birch, northern white-cedar, and tamarack.)

*White spruce.*—Forests in which white spruce and balsam fir comprise a plurality of the stocking with white spruce the most common. (Common associates include aspen, maple, birch, northern white-cedar, and tamarack.)

*Black spruce.*—Forests in which swamp conifers comprise a plurality of the stocking with black spruce the most common. (Common associates include tamarack and northern white-cedar.)

*Northern white-cedar.*—Forests in which swamp conifers comprise a plurality of the stocking with northern white-cedar the most common. (Common associates include tamarack and black spruce.)

*Tamarack.*—Forests in which swamp conifers comprise a plurality of the stocking with tamarack the most common. (Common associates include black spruce and northern white-cedar.)

*Oak-hickory.*—Forests in which northern red oak, white oak, bur oak, or hickories, singly or in combination, comprise a plurality of the stocking. (Common associates include jack pine, elm, and maple.)

*Elm-ash-soft maple.*—Forests in which lowland elm, ash, red maple, silver maple, and cottonwood, singly or in combination, comprise a plurality of the stocking. (Common associates include birches, spruce, and balsam fir.)

*Maple-basswood.*—Forests in which sugar maple, basswood, yellow birch, upland American elm, and red maple, singly or in combination, comprise a plurality of the stocking. (Common associates include white pine, elm, and basswood.)

*Aspen.*—Forests in which quaking aspen or bigtooth aspen, singly or in combination, comprise a plurality of the stocking. (Common associates include balsam poplar, balsam fir, and paper birch.)

*Paper birch.*—Forests in which paper birch comprises a plurality of the stocking. (Common associates include maple, aspen, and balsam fir.)

*Balsam poplar.*—Forests in which balsam poplar comprises a plurality of the stocking. (Common associates include aspen, elm, and ash.)

**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 Soft hardwoods and Hard hardwoods.)

**Indian land.**—Land held in trust by the United States for the tribes or individual Indians.

**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.

**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.

**Miscellaneous private land.**—Privately owned land other than forest-industry and farmer-owned land.

**Mortality.**—The volume of sound wood in growing-stock and sawtimber trees that die annually.

**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 annual 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.

**Net annual 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.

**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, 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.)

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

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

**Nonstocked land.**—Forest land less than 16.7 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. These sites often contain tree species that are not currently utilized for industrial wood production or trees of poor form, small size, or inferior quality that are unfit for 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 utilization.

**Other removals.**—Growing-stock trees removed but not utilized 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, land clearing, and changes in land use.

**Poletimber stand.**—(See Stand-size class.)

**Poletimber tree.**—A tree of commercial species at least 5.0 inches d.b.h. but smaller than sawtimber size.

**Potential productivity class.**—A classification of forest lands 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.

**Reserved forest land.**—Forest land withdrawn from timber utilization through statute, administrative regulation, designation, or exclusive use for Christmas tree production, as indicated by annual shearing.

**Rotten tree.**—A tree that does not meet regional merchantability standards because of excessive unsound cull. May include noncommercial tree species.

**Rough tree.**—A tree that does not meet regional merchantability standards because of excessive sound cull. May include noncommercial tree species.

**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 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 inches top diameter outside bark (d.o.b.) for softwoods and a minimum 9 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).**—Sawtimber-size trees of commercial species that contain at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

**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 gum, yellow-poplar, 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-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.

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

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

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

**State land.**—Land owned by States or leased to them 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 utilize the growth potential of the land; that is, the stocking standard.

A stocking percent of 100 indicates full utilization 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 133 percent or more.

*Fully stocked stands.*—Stands in which stocking of live trees is from 100.0 to 132.9 percent.

*Medium stocked stands.*—Stands in which stocking of live trees is from 60.0 to 99.9 percent.

*Poorly stocked stands.*—Stands in which stocking of live trees is from 16.7 to 59.9 percent.

*Nonstocked areas.*—Timberland on which stocking of live trees is less than 16.7 percent.

**Timberland.**—Forest land that is producing or capable of producing in excess of 20 cubic feet per acre per year of industrial wood crops under natural conditions, that is not withdrawn from timber utilization, and that is not associated with urban or rural development. Currently inaccessible and inoperable areas are included.

**Tree.**—A woody plant usually having one or more perennial stems, a more or less definitely formed crown of foliage, and a height of at least 12 feet at maturity.

**Tree grade.**—A tree classification based on external characteristics of the butt log as an indicator of quality or value. Tree grades may be converted to lumber grade yields for individual species. (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 outside bark or to the point where the central stem breaks into limbs.

**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 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 1.--Area of land by county and major land-use class, Central Hardwood Unit, Minnesota, 1990

County	Land area	Forest land					Sampling error for timberland (SE)	Percent
		All forest land	Timberland	Timberland as a percent of land area	Other forest land	Reserved forest land		
		----- Thousand acres -----						
Anoka	275.1	38.9	34.2	12.4	1.6	3.1	8.3	
Benton	261.3	34.7	34.7	13.3	--	--	8.3	
Carver	224.6	19.2	19.2	8.5	--	--	11.1	
Chisago	267.0	48.6	48.6	18.2	--	--	7.0	
Dakota	367.6	13.5	12.4	3.4	--	1.1	13.8	
Douglas	411.8	32.0	31.6	7.7	--	0.4	8.7	
Fillmore	551.7	101.6	98.6	17.9	--	3.0	4.9	
Goodhue	488.3	69.4	69.4	14.2	--	--	5.8	
Hennepin	346.1	15.0	11.5	3.3	--	3.5	14.3	
Houston	361.0	135.7	133.9	37.1	1.8	--	4.2	
Isanti	281.5	54.1	54.1	19.2	--	--	6.6	
Kanabec	337.5	142.2	142.2	42.1	--	--	4.1	
Le Sueur	285.6	23.5	23.5	8.2	--	--	10.0	
Mille Lacs	369.9	145.2	138.4	37.4	0.9	5.9	4.1	
Morrison	719.2	167.4	166.4	23.1	--	1.0	3.8	
Olmsted	419.0	40.7	40.7	9.7	--	--	7.6	
Otter Tail	1,262.8	218.2	208.2	16.5	5.5	4.5	3.4	
Pine	909.5	520.7	486.4	53.5	0.6	33.7	2.2	
Ramsey	98.6	--	--	--	--	--	--	
Rice	320.6	20.0	19.8	6.2	--	0.2	10.9	
Scott	228.7	16.4	14.2	6.2	--	2.2	12.9	
Sherburne	278.2	52.6	50.7	18.2	1.9	--	6.8	
Stearns	856.4	69.2	69.2	8.1	--	--	5.8	
Todd	602.4	97.6	97.6	16.2	--	--	4.9	
Wabasha	343.6	67.9	67.9	19.8	--	--	5.9	
Washington	249.3	31.4	23.8	9.5	1.5	6.1	10.0	
Winona	403.3	130.2	127.7	31.7	--	2.5	4.3	
Wright	430.1	51.3	50.5	11.7	--	0.8	6.8	
All counties	11,950.7	2,357.2	2,275.4	19.0	13.8	68.0	1.02	

Table 2.--Area of timberland by county and ownership class, Central Hardwood Unit, Minnesota, 1990  
(In thousand acres)

County	Ownership class									
	All owners	Misc. federal	State	County & municipal	Indian	Forest industry	Farmer corporation	Misc. private corporation	Misc. private individual	
Anoka-Dakota-Ramsey-										
Washington	70.4	--	6.6	1.0	--	--	31.9	8.6	22.3	
Benton-Sherburne	85.4	18.2	8.6	--	--	--	35.5	1.3	21.8	
Carver-Hennepin-Scott	44.9	2.1	6.2	3.9	--	--	18.2	2.1	12.4	
Chisago-Isanti	102.7	--	7.5	3.7	--	--	45.7	3.7	42.1	
Douglas-Todd	129.2	6.9	6.1	1.6	--	--	69.3	3.1	42.2	
Fillmore-Olmsted	139.3	--	13.0	1.8	--	1.4	94.7	3.0	25.4	
Goodhue	69.4	3.1	6.2	0.8	--	--	48.1	3.2	8.0	
Houston	133.9	6.6	8.8	--	1.2	--	96.9	2.2	18.2	
Kanabec	142.2	--	14.9	7.8	--	--	41.6	1.3	76.6	
Le Sueur-Rice	43.3	--	3.2	0.9	--	--	24.0	--	15.2	
Mille Lacs	138.4	4.8	33.8	--	5.0	--	39.7	0.5	54.6	
Morrison	166.4	0.7	30.4	--	--	--	61.2	19.0	55.1	
Otter Tail	208.2	--	3.3	1.2	--	--	155.3	7.5	40.9	
Pine	486.4	3.1	111.5	32.3	1.4	2.6	112.2	24.8	198.5	
Stearns	69.2	--	--	0.9	--	--	37.1	3.2	28.0	
Wabasha	67.9	6.5	10.1	--	--	--	33.3	3.5	14.5	
Winona	127.7	3.3	25.2	2.0	--	--	78.3	5.6	13.3	
Wright	50.5	--	2.8	1.7	--	--	34.3	2.3	9.4	
All counties	2,275.4	55.3	298.2	59.6	7.6	4.0	1,057.3	94.9	698.5	

Table 3.--Area of timberland by county and forest type, Central Hardwood Unit, Minnesota, 1990  
(In thousand acres)

County	Forest type													All types		
	Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-soft maple	Maple-bass-wood	Aspen	Paper birch		Balsam poplar	Non-stocked
Anoka-Dakota-Ramsey-																
Washington	0.6	--	--	--	--	--	--	--	32.9	7.9	20.3	5.8	2.9	--	--	
Benton-Sherburne	3.6	2.4	--	--	--	--	--	--	58.3	10.3	5.4	5.4	--	--	--	
Carver-Hennepin-Scott	--	--	--	--	--	--	--	--	21.3	12.5	10.5	0.6	--	--	--	
Chisago-Isanti	0.4	3.2	--	--	0.2	2.4	--	2.8	39.7	20.0	19.5	11.2	2.2	--	1.1	
Douglas-Todd	1.1	--	--	--	--	--	--	3.8	47.1	28.3	21.3	23.3	2.0	1.2	1.1	
Fillmore-Olmsted	--	--	--	--	--	--	--	--	85.5	17.8	33.3	2.7	--	--	--	
Goodhue	69.4	--	--	--	--	--	--	--	24.5	14.5	16.3	8.9	4.6	--	0.6	
Houston	--	--	--	--	--	--	--	--	92.7	11.4	16.8	6.7	6.3	--	--	
Kanabec	142.2	--	--	--	--	2.2	--	1.6	27.5	16.3	31.4	54.2	4.1	1.1	3.8	
Le Sueur-Rice	43.3	--	--	--	--	--	--	--	4.4	11.7	25.2	0.8	--	--	1.2	
Mille Lacs	138.4	--	--	--	--	--	--	--	21.5	25.6	35.3	44.8	6.4	--	--	
Morrison	166.4	3.8	2.4	--	--	--	--	4.8	50.8	9.4	22.4	67.6	4.0	--	--	
Otter Tail	208.2	2.8	0.2	--	--	--	--	8.2	51.0	23.8	62.7	48.8	4.1	5.4	1.2	
Pine	486.4	8.3	3.1	2.0	8.3	24.1	--	14.1	28.9	52.3	76.1	245.6	18.8	3.6	1.2	
Stearns	69.2	--	--	--	--	--	--	1.5	21.5	19.2	23.0	--	--	2.4	1.6	
Wabasha	67.9	--	--	--	--	--	--	--	48.3	3.9	12.0	3.7	--	--	--	
Winona	127.7	--	--	--	--	--	--	--	91.3	15.4	17.9	1.0	1.0	--	1.1	
Wright	50.5	--	--	--	--	--	--	--	5.9	10.8	25.6	1.0	--	--	7.2	
All counties	2,275.4	18.8	12.5	4.6	8.3	0.2	28.7	40.8	753.1	311.1	475.0	532.1	56.4	13.7	20.1	

Table 4.--Area of timberland by county and stand-size class,  
Central Hardwood Unit, Minnesota, 1990

(In thousand acres)

County	All stands	Stand-size class			
		Sawtimber	Poletimber	Seedling & sapling	Nonstocked
Anoka-Dakota-Ramsey- Washington	70.4	47.6	19.6	3.2	--
Benton-Sherburne	85.4	49.5	19.8	16.1	--
Carver-Hennepin-Scott	44.9	28.5	6.0	10.4	--
Chisago-Isanti	102.7	46.4	28.9	26.3	1.1
Douglas-Todd	129.2	68.2	36.3	23.6	1.1
Fillmore-Olmsted	139.3	104.4	20.8	14.1	--
Goodhue	69.4	54.6	10.0	4.2	0.6
Houston	133.9	98.1	14.3	21.5	--
Kanabec	142.2	49.3	49.0	40.1	3.8
Le Sueur-Rice	43.3	28.9	3.5	9.7	1.2
Mille Lacs	138.4	51.1	59.7	27.6	--
Morrison	166.4	63.0	85.2	18.2	--
Otter Tail	208.2	96.3	67.0	43.7	1.2
Pine	486.4	131.4	210.4	143.4	1.2
Stearns	69.2	39.9	18.1	9.6	1.6
Wabasha	67.9	51.3	12.1	4.5	--
Winona	127.7	96.7	22.0	7.9	1.1
Wright	50.5	33.1	3.5	6.7	7.2
<b>All counties</b>	<b>2,275.4</b>	<b>1,138.3</b>	<b>686.2</b>	<b>430.8</b>	<b>20.1</b>

Table 5.--Area of timberland by county and potential productivity class,  
Central Hardwood Unit, Minnesota, 1990

(In thousand acres)

County	All classes	Potential productivity class (cubic feet of growth per acre per year)				
		165+	120-164	85-119	50-84	20-49
Anoka-Dakota-Ramsey- Washington	70.4	--	--	5.9	44.2	20.3
Benton-Sherburne	85.4	--	1.5	1.8	31.6	50.5
Carver-Hennepin-Scott	44.9	--	--	8.1	19.2	17.6
Chisago-Isanti	102.7	--	2.4	10.9	35.9	53.5
Douglas-Todd	129.2	--	--	18.0	45.1	66.1
Fillmore-Olmsted	139.3	--	1.1	23.0	40.5	74.7
Goodhue	69.4	--	--	21.3	23.9	24.2
Houston	133.9	--	3.1	16.4	58.3	56.1
Kanabec	142.2	1.0	1.2	38.1	53.9	48.0
Le Sueur-Rice	43.3	--	--	20.0	10.1	13.2
Mille Lacs	138.4	--	--	21.3	52.0	65.1
Morrison	166.4	--	1.3	33.8	67.1	64.2
Otter Tail	208.2	--	--	25.7	54.3	128.2
Pine	486.4	--	4.7	129.7	159.2	192.8
Stearns	69.2	--	--	2.8	17.5	48.9
Wabasha	67.9	0.3	2.3	11.2	28.3	25.8
Winona	127.7	--	1.0	13.1	51.6	62.0
Wright	50.5	--	--	4.7	27.6	18.2
All counties	2,275.4	1.3	18.6	405.8	820.3	1,029.4

Table 6.--Area of timberland by county and stocking class of growing-stock trees<sup>1</sup>,  
Central Hardwood Unit, Minnesota, 1990

(In thousand acres)

County	All classes	Stocking percent of growing-stock trees				
		Non-stocked	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Anoka-Dakota-Ramsey-Washington	70.4	--	24.7	39.2	6.5	--
Benton-Sherburne	85.4	3.7	37.0	36.0	5.5	3.2
Carver-Hennepin-Scott	44.9	1.7	15.0	18.7	8.5	1.0
Chisago-Isanti	102.7	1.1	51.9	35.4	11.9	2.4
Douglas-Todd	129.2	3.6	34.0	71.4	19.7	0.5
Fillmore-Olmsted	139.3	5.5	46.5	64.1	23.2	--
Goodhue	69.4	1.4	19.8	34.0	13.1	1.1
Houston	133.9	--	32.0	73.1	26.4	2.4
Kanabec	142.2	4.9	39.4	71.0	19.4	7.5
Le Sueur-Rice	43.3	1.2	7.9	30.7	3.5	--
Mille Lacs	138.4	3.2	37.8	58.2	30.3	8.9
Morrison	166.4	--	42.1	91.9	25.7	6.7
Otter Tail	208.2	5.7	82.6	92.1	23.0	4.8
Pine	486.4	2.4	141.7	207.0	105.4	29.9
Stearns	69.2	6.2	27.1	31.1	4.8	--
Wabasha	67.9	--	18.7	44.1	5.1	--
Winona	127.7	2.1	32.2	72.3	20.0	1.1
Wright	50.5	9.2	16.1	21.8	3.4	--
All counties	2,275.4	51.9	706.5	1,092.1	355.4	69.5

<sup>1</sup>This table is based on the stocking percent of growing-stock trees rather than that of all live trees. To use the definitions of stocking for this table, replace the term "all live" by "growing-stock."

Table 7.--Area of timberland by ownership class and stocking class of growing-stock trees<sup>1</sup>,  
Central Hardwood Unit, Minnesota, 1990

(In thousand acres)

Ownership class	All classes	Stocking percent of growing-stock trees				
		Non-stocked	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Miscellaneous federal	55.3	--	18.4	29.0	6.7	1.2
State	298.2	2.9	74.7	144.8	52.7	23.1
County and municipal	59.6	0.8	17.8	22.0	17.4	1.6
Indian	7.6	--	0.5	5.3	1.8	--
Forest Industry	4.0	--	0.6	2.0	1.4	--
Farmer	1,057.3	33.2	356.4	517.7	134.4	15.6
Miscellaneous private corporation	94.9	0.2	28.6	44.8	17.7	3.6
Miscellaneous private individual	698.5	14.8	209.5	326.5	123.3	24.4
<b>All owners</b>	<b>2,275.4</b>	<b>51.9</b>	<b>706.5</b>	<b>1,092.1</b>	<b>355.4</b>	<b>69.5</b>

<sup>1</sup>This table is based on the stocking percent of growing-stock trees rather than that of all live trees. To use the definitions of stocking for this table, replace the term "all live" by "growing-stock."

Table 8.--Area of timberland by forest type and ownership class, Central Hardwood Unit, Minnesota, 1990  
(In thousand acres)

Forest type	Ownership class									
	All owners	Misc. federal	State	County & municipal	Indian	Forest industry	Farmer corporation	Misc. private corporation	Misc. private individual	
Jack pine	18.8	--	3.3	--	--	--	5.0	1.7	8.8	
Red pine	12.5	--	2.2	--	--	--	1.3	0.8	8.2	
White pine	4.6	--	--	--	--	--	0.2	--	4.4	
Balsam fir	8.3	--	4.1	--	--	--	2.4	--	1.8	
White spruce	0.2	--	--	--	--	--	--	--	0.2	
Black spruce	28.7	--	15.0	1.1	--	--	4.2	--	8.4	
Northern white-cedar	--	--	--	--	--	--	--	--	--	
Tamarack	40.8	0.6	3.9	--	--	--	13.6	1.4	21.3	
Oak-hickory	753.1	31.1	83.7	7.7	1.2	0.6	423.7	28.4	176.7	
Elm-ash-soft maple	311.1	16.0	37.0	8.6	2.3	1.4	124.0	17.2	104.6	
Maple-basswood	475.0	4.7	47.6	13.7	4.1	1.4	238.6	23.1	141.8	
Aspen	532.1	1.2	94.1	27.1	--	--	194.3	21.2	194.2	
Paper birch	56.4	1.7	5.9	1.4	--	0.6	25.7	1.1	20.0	
Balsam poplar	13.7	--	--	--	--	--	11.1	--	2.6	
Nonstocked	20.1	--	1.4	--	--	--	13.2	--	5.5	
All types	2,275.4	55.3	298.2	59.6	7.6	4.0	1,057.3	94.9	698.5	

Table 9.--Area of timberland by forest type and stand-size class,  
Central Hardwood Unit, Minnesota, 1990

(In thousand acres)

Forest type	All stands	Stand-size class			
		Sawtimber	Poletimber	Seedling & sapling	Nonstocked
Jack pine	18.8	5.6	7.0	6.2	--
Red pine	12.5	4.8	7.7	--	--
White pine	4.6	4.6	--	--	--
Balsam fir	8.3	2.4	3.4	2.5	--
White spruce	0.2	--	--	0.2	--
Black spruce	28.7	1.5	9.9	17.3	--
Northern white-cedar	--	--	--	--	--
Tamarack	40.8	11.9	10.9	18.0	--
Oak-hickory	753.1	562.3	157.0	33.8	--
Elm-ash-soft maple	311.1	119.6	103.8	87.7	--
Maple-basswood	475.0	256.1	98.7	120.2	--
Aspen	532.1	150.9	247.4	133.8	--
Paper birch	56.4	15.1	32.3	9.0	--
Balsam poplar	13.7	3.5	8.1	2.1	--
Nonstocked	20.1	--	--	--	20.1
All types	2,275.4	1,138.3	686.2	430.8	20.1



Table 11.--Number of growing-stock trees on timberland by species group and diameter class, Central Hardwood Unit, Minnesota, 1990  
(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+				
<b>Softwoods</b>																	
Jack pine	8,081	5,011	991	699	700	489	153	30	8								
Red pine	10,007	1,293	1,656	2,996	2,801	731	313	100	42	31	19						
White pine	4,352	2,163	954	389	216	212	94	78	74	49	44	77	2				
White spruce	1,594	561	568	259	94	38	12	19	6	27	6	4					
Black spruce	20,535	9,477	8,266	2,319	429	38	--	6	--	--	--	--	--				
Balsam fir	7,460	2,820	2,296	1,191	733	302	75	29	11	--	--	3					
Tamarac	16,381	6,250	4,191	2,968	1,746	864	273	71	15	2	1	0					
Eastern redcedar	8,598	5,006	1,985	702	657	134	84	19	3	5	--	3					
Northern white-cedar	39		--	--	--	--	--	--	--	--	--	--					
Other softwoods	1,329	261	407	278	274	71	14	16	8								
<b>Total</b>	<b>78,376</b>	<b>32,881</b>	<b>21,314</b>	<b>11,801</b>	<b>7,650</b>	<b>2,879</b>	<b>1,018</b>	<b>368</b>	<b>167</b>	<b>108</b>	<b>82</b>	<b>106</b>	<b>2</b>				
<b>Hardwoods</b>																	
White oak	47,778	13,089	9,079	6,520	6,256	4,705	3,119	2,081	1,423	764	334	389	19				
Select red oak	43,043	8,916	3,767	4,708	6,254	6,624	4,476	3,046	2,251	1,367	802	776	56				
Other red oak	3,343	435	591	513	772	244	276	181	143	55	62	66	5				
Hickory	14,901	8,561	3,149	1,213	984	465	296	149	52	25	3	4	--				
Basswood	59,702	30,512	9,636	7,182	4,173	3,491	1,860	1,221	689	451	213	256	18				
Yellow birch	1,290	955	319	--	--	5	5	6	--	--	--	--	--				
Hard maple	45,522	25,747	9,438	5,495	1,938	1,095	815	433	253	151	69	83	5				
Soft maple	57,559	27,603	16,563	8,443	2,583	1,142	427	307	153	124	75	100	39				
Elm	70,875	42,360	15,004	7,122	2,987	1,330	984	460	260	145	115	100	8				
Black ash	47,679	23,151	10,543	7,028	3,795	1,731	777	405	143	63	32	11	--				
White and green ash	29,954	16,878	4,904	2,759	2,177	1,449	867	472	217	106	66	45	14				
Cottonwood	985	231	226	32	113	70	31	44	32	45	57	74	30				
Willow	1,327	708	--	110	102	138	66	80	45	59	8	7	4				
Hackberry	7,215	5,395	914	558	147	93	40	34	7	17	8	2	--				
Balsam poplar	4,473	1,832	813	497	577	440	169	90	41	8	6	--	--				
Bigtooth aspen	14,193	7,443	1,194	1,132	1,189	1,511	1,096	442	114	52	13	7	--				
Quaking aspen	168,436	99,650	24,512	15,739	12,335	8,602	4,534	2,140	704	176	34	10	--				
Paper birch	46,355	14,415	12,175	9,260	6,629	2,521	1,031	248	34	35	3	4	--				
Black cherry	17,269	13,835	1,849	635	489	214	144	57	23	19	4	--	--				
Butternut	1,645	525	335	73	334	86	98	74	66	38	7	9	--				
Black walnut	1,453	520	337	31	224	105	104	51	38	24	14	5	--				
Other hardwoods	25,021	16,485	4,296	1,987	959	768	251	143	76	26	26	3	--				
<b>Total</b>	<b>710,018</b>	<b>359,246</b>	<b>129,644</b>	<b>81,037</b>	<b>55,017</b>	<b>36,829</b>	<b>21,466</b>	<b>12,164</b>	<b>6,764</b>	<b>3,750</b>	<b>1,951</b>	<b>1,951</b>	<b>199</b>				
<b>All species</b>	<b>788,394</b>	<b>392,127</b>	<b>150,958</b>	<b>92,838</b>	<b>62,667</b>	<b>39,708</b>	<b>22,484</b>	<b>12,532</b>	<b>6,931</b>	<b>3,858</b>	<b>2,033</b>	<b>2,057</b>	<b>201</b>				

Table 12.--Net volume of timber on timberland by class of timber and species group,  
Central Hardwood Unit, Minnesota, 1990

(In thousand cubic feet)

Class of timber	All species	Species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Live trees					
Growing-stock trees					
Sawtimber	987,356	43,257	25,621	370,055	548,423
Saw-log portion	354,120	6,166	3,790	141,181	202,983
Upper stem portion					
Total	1,341,476	49,423	29,411	511,236	751,406
Poletimber	989,454	35,039	43,239	539,484	371,692
All growing-stock trees	2,330,930	84,462	72,650	1,050,720	1,123,098
Cull trees					
Short-log trees	114,764	423	271	33,271	80,799
Rough trees					
Sawtimber	244,495	1,444	1,847	76,183	165,021
Poletimber	183,415	989	2,357	86,029	94,040
Total	427,910	2,433	4,204	162,212	259,061
Rotten trees					
Sawtimber	59,873	371	403	31,814	27,285
Poletimber	11,935	62	41	8,162	3,670
Total	71,808	433	444	39,976	30,955
All cull trees	614,482	3,289	4,919	235,459	370,815
All live trees	2,945,412	87,751	77,569	1,286,179	1,493,913
Salvable dead trees					
Sawtimber	45,552	903	767	37,453	6,429
Poletimber	37,332	154	904	30,557	5,717
Total	82,884	1,057	1,671	68,010	12,146
All classes of timber	3,028,296	88,808	79,240	1,354,189	1,506,059

Table 13.--Net volume of growing-stock trees on timberland by species group and diameter class, Central Hardwood Unit, Minnesota, 1990

(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+									
<b>Softwoods</b>																				
Jack pine	13,908	1,599	3,998	4,817	2,522	680	292	--	--	--	--	--	--	--	--	--	--	--	--	--
Red pine	44,681	9,119	16,294	7,075	4,694	2,134	1,261	1,212	1,584	1,308	1,261	1,584	1,308	1,308	1,584	1,308	1,584	1,308	1,584	1,308
White pine	22,429	813	1,239	1,960	1,375	1,785	2,538	2,359	2,812	7,031	2,538	2,812	7,031	7,031	2,812	7,031	2,812	7,031	2,812	7,031
White spruce	4,265	601	597	422	175	423	205	1,194	343	305	205	343	305	305	343	305	343	305	343	305
Black spruce	9,190	6,229	2,421	368	--	172	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Balsam fir	13,245	3,364	4,349	3,000	1,234	720	389	--	--	189	389	--	--	189	--	--	--	--	--	--
Tamarack	36,620	8,746	11,263	9,348	4,789	1,790	549	87	48	--	549	87	48	--	--	--	--	--	--	--
Eastern redcedar	9,330	1,944	3,725	1,274	1,386	501	99	193	--	208	99	--	--	208	--	--	--	--	--	--
Northern white-cedar	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other softwoods	3,444	617	1,360	680	197	355	235	--	--	--	235	--	--	--	--	--	--	--	--	--
<b>Total</b>	<b>157,112</b>	<b>33,032</b>	<b>45,246</b>	<b>28,944</b>	<b>16,372</b>	<b>8,560</b>	<b>5,568</b>	<b>5,045</b>	<b>4,787</b>	<b>9,041</b>	<b>5,045</b>	<b>4,787</b>	<b>9,041</b>	<b>9,041</b>	<b>4,787</b>	<b>9,041</b>	<b>4,787</b>	<b>9,041</b>	<b>4,787</b>	<b>9,041</b>
<b>Hardwoods</b>																				
White oak	295,784	15,416	32,955	43,499	44,503	43,404	40,598	28,470	16,136	27,905	40,598	16,136	27,905	27,905	16,136	27,905	16,136	27,905	16,136	27,905
Select red oak	475,478	11,746	33,696	62,917	67,436	66,980	67,857	55,339	41,551	59,638	67,857	41,551	59,638	59,638	41,551	59,638	41,551	59,638	41,551	59,638
Other red oak	29,755	1,172	3,914	2,332	3,904	3,821	4,014	2,040	3,014	4,859	4,014	3,014	4,859	4,859	3,014	4,859	3,014	4,859	3,014	4,859
Hickory	23,951	3,013	5,155	4,458	4,723	3,367	1,800	1,048	147	240	1,800	147	240	240	147	240	147	240	147	240
Basswood	215,909	19,085	25,302	38,292	31,382	29,044	22,246	18,803	11,551	17,946	22,246	11,551	17,946	17,946	11,551	17,946	11,551	17,946	11,551	17,946
Yellow birch	270	--	--	60	88	122	--	--	--	--	122	--	--	--	--	--	--	--	--	--
Hard maple	89,881	14,591	12,411	11,951	14,102	10,640	8,276	6,711	3,993	6,345	8,276	3,993	6,345	6,345	3,993	6,345	3,993	6,345	3,993	6,345
Soft maple	98,223	21,793	15,820	12,426	7,714	8,072	5,347	5,735	4,397	9,133	5,347	4,397	9,133	9,133	4,397	9,133	4,397	9,133	4,397	9,133
Elm	98,853	15,704	16,167	12,855	15,475	10,520	7,853	5,720	5,852	7,549	7,853	5,852	7,549	7,549	5,852	7,549	5,852	7,549	5,852	7,549
Black ash	91,156	18,412	22,415	18,374	12,904	9,387	4,598	2,686	1,657	723	4,598	1,657	723	723	1,657	723	1,657	723	1,657	723
White and green ash	78,245	6,832	12,281	14,453	13,599	11,018	6,843	4,269	3,471	3,580	6,843	3,471	3,580	3,580	3,471	3,580	3,471	3,580	3,471	3,580
Cottonwood	21,623	113	443	674	553	1,007	1,000	1,896	2,890	6,158	1,000	2,890	6,158	6,158	2,890	6,158	2,890	6,158	2,890	6,158
Willow	10,075	209	587	1,180	976	1,702	1,308	2,348	393	616	1,308	393	616	616	393	616	393	616	393	616
Hackberry	5,741	1,320	815	838	600	857	192	628	377	114	857	377	114	114	377	114	377	114	377	114
Balsam poplar	16,904	1,428	3,524	4,680	2,838	2,472	1,367	314	281	--	1,367	281	--	--	281	--	--	--	--	--
Bigtooth aspen	67,268	3,556	8,416	17,217	19,305	11,215	3,920	2,278	851	510	3,920	851	510	510	851	510	851	510	851	510
Quaking aspen	370,404	43,006	74,463	92,586	75,358	51,853	22,827	7,669	1,879	763	22,827	1,879	763	763	1,879	763	1,879	763	1,879	763
Paper birch	123,985	26,561	42,671	27,608	17,749	6,221	1,112	1,622	185	256	1,112	185	256	256	185	256	185	256	185	256
Black cherry	12,913	1,895	3,019	2,367	2,461	1,436	774	777	184	--	774	184	--	--	184	--	--	--	--	--
Butternut	11,522	172	2,137	1,048	1,781	1,775	2,094	1,483	387	645	2,094	387	645	645	387	645	387	645	387	645
Black walnut	8,822	119	1,491	1,254	1,714	1,182	1,134	854	738	336	1,134	738	336	336	738	336	738	336	738	336
Other hardwoods	27,056	4,387	5,094	6,801	3,497	2,904	2,077	962	1,066	166	2,077	1,066	166	166	1,066	166	1,066	166	1,066	166
<b>Total</b>	<b>2,173,818</b>	<b>210,530</b>	<b>322,776</b>	<b>377,870</b>	<b>342,662</b>	<b>278,999</b>	<b>207,237</b>	<b>151,652</b>	<b>101,000</b>	<b>147,482</b>	<b>151,652</b>	<b>101,000</b>	<b>147,482</b>	<b>147,482</b>	<b>101,000</b>	<b>147,482</b>	<b>101,000</b>	<b>147,482</b>	<b>101,000</b>	<b>147,482</b>
<b>All species</b>	<b>2,330,930</b>	<b>243,562</b>	<b>368,022</b>	<b>406,814</b>	<b>359,034</b>	<b>287,559</b>	<b>212,805</b>	<b>156,697</b>	<b>105,787</b>	<b>156,523</b>	<b>156,697</b>	<b>105,787</b>	<b>156,523</b>	<b>156,523</b>	<b>105,787</b>	<b>156,523</b>	<b>105,787</b>	<b>156,523</b>	<b>105,787</b>	<b>156,523</b>



Table 16.--Net volume of growing-stock and sawtimber trees on timberland by county and species group, Central Hardwood Unit, Minnesota, 1990

County	Growing stock						Sawtimber					
	All species			Species group			All species			Species group		
	Pine	Other softwoods	Hard hardwoods	Pine	Soft hardwoods	Hard hardwoods	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	Soft hardwoods	Hard hardwoods
----- Thousand cubic feet -----												
Anoka-Dakota-Ramsey-												
Washington	62,436	849	233	19,924	41,430	185,664	1,080	222	45,553	138,809		
Benton-Sherburne	71,622	10,706	285	12,367	48,264	177,135	23,878	825	22,920	129,512		
Carver-Hennepin-Scott	46,493	--	441	14,569	31,483	168,121	--	966	51,013	116,142		
Chisago-Isanti	89,426	13,873	2,832	29,318	43,403	209,607	11,020	4,134	54,384	140,069		
Douglas-Todd	129,016	1,440	4,912	51,566	71,098	379,872	5,886	16,354	131,732	225,900		
Fillmore-Olmsted	163,447	1,026	2,212	39,923	120,286	543,733	5,553	5,186	111,035	421,959		
Goodhue	93,782	1,108	809	41,280	50,585	326,157	4,880	2,550	125,408	193,319		
Houston	153,188	1,517	1,931	50,082	99,658	509,615	7,328	2,843	153,090	346,354		
Kanabec	132,279	1,873	5,234	71,276	53,896	290,654	8,768	5,657	136,045	140,184		
Le Sueur-Rice	49,396	--	698	25,472	23,226	180,322	--	734	93,955	85,633		
Millie Lacs	144,213	491	2,109	78,027	63,586	298,341	--	3,125	159,617	135,599		
Morrison	197,856	18,729	4,873	100,603	73,651	424,254	64,351	8,579	156,860	194,464		
Other Tall	200,404	2,438	11,198	88,553	98,215	526,191	6,176	34,557	229,840	255,618		
Pine	462,896	29,004	30,192	303,767	99,933	869,993	110,917	56,147	510,503	192,426		
Stearns	61,795	--	2,770	29,890	29,135	173,954	--	5,946	83,086	84,922		
Wabasha	74,695	136	--	29,996	44,563	236,038	659	--	77,565	157,814		
Winona	157,509	1,272	747	44,250	111,240	533,245	6,521	2,424	119,049	405,251		
Wright	40,477	--	1,174	19,857	19,446	141,754	--	1,688	65,102	74,964		
All counties	2,330,930	84,462	72,650	1,050,720	1,123,098	6,174,650	257,017	151,937	2,326,757	3,438,939		

<sup>1</sup>International 1/4-inch rule.

Table 17.--Net volume of live and growing-stock trees on timberland by ownership class and species group, Central Hardwood Unit, Minnesota, 1990  
(In thousand cubic feet)

Ownership class	Live trees						Growing stock						
	All species	Species group			All species	Hard hardwoods	Pine	Other softwoods	Soft hardwoods	All species	Species group		
		Pine	Other softwoods	Soft hardwoods							Pine	Other softwoods	Soft hardwoods
Miscellaneous federal State	94,955	125	534	46,681	47,615	125	534	46,681	78,151	125	534	41,027	36,465
County and municipal	379,225	15,665	13,877	175,763	173,920	14,764	13,181	175,763	315,852	14,764	13,181	148,869	139,038
Indian	84,198	2,423	68	51,576	30,131	2,423	68	51,576	70,074	2,423	68	43,647	23,936
Forest industry	12,309	--	--	6,615	5,694	--	--	6,615	9,901	--	--	5,041	4,860
Farmer	6,067	30	--	1,557	4,480	--	--	1,557	5,899	--	--	1,557	4,342
Miscellaneous private corporation	1,391,050	17,240	34,265	529,363	810,182	17,022	31,426	529,363	1,060,435	17,022	31,426	417,319	594,668
Miscellaneous private individual	108,465	3,086	--	51,816	53,563	2,741	--	51,816	84,786	2,741	--	40,990	41,055
All owners	869,143	49,182	28,825	422,808	368,328	47,387	27,441	422,808	705,832	47,387	27,441	352,270	278,734
	2,945,412	87,751	77,569	1,286,179	1,493,913	84,462	72,650	1,286,179	2,330,930	84,462	72,650	1,050,720	1,123,098

Table 18.--Net volume of sawtimber trees on timberland by species group and tree grade,  
Central Hardwood Unit, Minnesota, 1990

(In thousand board feet)<sup>1</sup>

Species group	All grades	Tree grade			
		1	2	3	Tie and timber
<b>Softwoods</b>					
Jack pine	40,266	500	1,871	37,894	--
Red pine	101,347	6,058	5,743	89,546	--
White pine	108,158	8,557	51,965	34,516	13,120
White spruce	17,148	--	--	17,148	--
Black spruce	2,854	--	--	2,854	--
Balsam fir	27,344	--	--	27,344	--
Tamarack	85,046	--	2,803	82,243	--
Eastern redcedar	19,545	--	--	19,545	--
Northern white-cedar	--	--	--	--	--
Other softwoods	7,246	--	--	7,246	--
<b>Total</b>	<b>408,954</b>	<b>15,115</b>	<b>62,383</b>	<b>318,336</b>	<b>13,120</b>
<b>Hardwoods</b>					
White oak	923,806	19,096	137,602	353,995	413,113
Select red oak	1,691,411	98,875	426,558	629,399	536,579
Other red oak	104,113	6,066	13,286	22,555	62,207
Hickory	46,045	2,269	9,953	17,113	16,709
Basswood	623,850	140,394	220,310	239,443	23,703
Yellow birch	967	--	--	373	594
Hard maple	234,323	6,218	47,223	113,341	67,541
Soft maple	229,052	9,848	15,159	78,674	125,371
Elm	237,666	27,483	48,039	84,865	77,279
Black ash	146,609	9,954	33,858	76,123	26,674
White and green ash	203,685	46,745	35,233	67,352	54,356
Cottonwood	100,428	47,925	28,272	18,008	6,224
Willow	35,493	--	--	13,273	22,220
Hackberry	12,210	--	2,790	4,921	4,498
Balsam poplar	32,415	--	4,499	10,932	16,985
Bigtooth aspen	171,239	1,871	16,256	99,123	53,989
Quaking aspen	716,620	2,938	130,333	365,668	217,681
Paper birch	114,797	--	17,154	49,300	48,343
Black cherry	24,851	--	3,278	16,256	5,317
Butternut	39,148	--	24,068	6,556	8,523
Black walnut	28,136	--	--	7,244	20,892
Other hardwoods	48,832	--	--	24,115	24,717
<b>Total</b>	<b>5,765,696</b>	<b>419,681</b>	<b>1,213,871</b>	<b>2,298,627</b>	<b>1,833,517</b>
<b>All species</b>	<b>6,174,650</b>	<b>434,796</b>	<b>1,276,254</b>	<b>2,616,965</b>	<b>1,846,635</b>

<sup>1</sup>International 1/4-inch rule.

Table 19.--Average net annual growth of growing stock and sawtimber on timberland by county and species group, Central Hardwood Unit, Minnesota, 1977-1989

County	Growing stock										Sawtimber				
	All species					Species group					Species group				
	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species
	----- Thousand cubic feet -----										----- Thousand board feet <sup>1</sup> -----				
Anoka-Dakota-Ramsey-	2,214	21	924	1,272	6,556	111	31	1,464	4,950						
Washington	2,409	8	676	1,079	9,496	2,150	79	1,866	5,401						
Benton-Sherburne	1,214	33	603	578	5,332	--	50	1,793	3,489						
Carver-Hennepin-Scott	2,452	32	667	841	6,050	1,177	-125	867	4,131						
Chisago-Isanti	1,222	92	-267	1,405	9,163	60	693	1,404	7,006						
Douglas-Todd	2,982	36	731	2,065	14,269	209	214	2,588	11,258						
Fillmore-Olmsted	995	33	43	880	7,763	313	103	1,869	5,478						
Goodhue	3,112	73	864	2,126	15,750	407	263	3,959	11,121						
Houston	4,049	41	2,263	1,557	13,597	198	335	7,146	5,918						
Kanabec	1,151	--	382	730	3,075	--	37	871	2,167						
Le Sueur-Rice	3,887	40	2,034	1,726	12,600	--	185	6,951	5,464						
Mille Lacs	6,091	698	3,419	1,809	22,507	4,434	342	9,978	7,753						
Morrison	2,978	106	733	2,072	16,442	641	1,136	5,554	9,111						
Otter Tail	13,517	1,071	8,739	2,887	44,287	3,397	3,228	28,495	9,167						
Pine	493	17	-154	630	3,468	--	266	495	2,707						
Stearns	1,280	13	376	891	6,900	65	--	1,474	5,361						
Wabasha	2,795	43	383	2,350	14,020	286	96	1,936	11,702						
Winona	599	--	93	518	2,548	--	-48	435	2,161						
Wright															
All counties	53,440	3,701	22,509	25,416	213,823	13,448	6,885	79,145	114,345						

<sup>1</sup>International 1/4-inch rule.

Table 20.--Average annual removals of growing stock and sawtimber on timberland by county and species group, Central Hardwood Unit, Minnesota, 1977-1989

County	Growing stock						Sawtimber						
	All species		Pine		Other softwoods		Species group		Pine		Species group		
	Thousand cubic feet	Hard woods	Soft woods	hardwoods	hardwoods	hardwoods	Thousand board feet <sup>1</sup>	Other softwoods	Soft hardwoods	Hard hardwoods	hardwoods	hardwoods	
Anoka-Dakota-Ramsey-													
Washington	287				39	248	663			118	545		
Benton-Sherburne	769				261	455	2,352			983	1,369		
Carver-Hennepin-Scott	51				35	16	163			163	--		
Chisago-Isanti	1,130				473	521	4,255		744	1,490	2,021		
Douglas-Todd	888			14	645	190	2,928		102	2,209	543		
Fillmore-Olmsted	1,868				575	1,293	8,692			2,558	6,134		
Goodhue	1,796				1,031	765	6,981			3,905	3,076		
Houston	1,779				123	1,656	8,041			444	7,597		
Kanabec	2,018				1,408	610	4,812			2,857	1,955		
Le Sueur-Rice	443				363	80	1,098			696	402		
Mille Lacs	1,329				898	431	2,885			1,772	1,113		
Morrison	3,180				2,121	1,035	7,733			4,063	3,670		
Otter Tail	3,607				2,027	1,580	10,100			5,678	4,422		
Pine	5,486			75	4,045	1,236	13,314		403	8,148	4,500		
Stearns	664				391	273	2,245			1,203	1,042		
Wabasha	1,255				600	655	5,775			2,749	3,026		
Winona	2,735				231	2,504	12,796			1,095	11,701		
Wright	508				405	103	1,503			1,184	319		
All counties	29,793	382	89	15,671	13,651	96,336	1,249	337	41,315	53,435			

<sup>1</sup>International 1/4-inch rule.

Table 21.--Average net annual growth, mortality, and removals of growing stock and sawtimber on timberland by species group, Central Hardwood Unit, Minnesota, 1977-1989

Species group	Growing stock			Sawtimber		
	Net growth <sup>1</sup>	Mortality	Removals	Net growth <sup>1</sup>	Mortality	Removals
	----- Thousand cubic feet -----			----- Thousand board feet <sup>2</sup> -----		
<b>Softwoods</b>						
Jack pine	161	441	147	1,462	1,212	120
Red pine	2,608	16	30	6,441	54	--
White pine	757	109	205	4,609	558	1,129
White spruce	180	79	31	435	421	115
Black spruce	148	210	--	76	58	--
Balsam fir	444	194	44	1,561	420	148
Tamarack	657	478	14	3,901	1,133	74
Eastern redcedar	385	30	--	912	54	--
Northern white-cedar	--	--	--	--	--	--
Other softwoods	175	--	--	936	--	--
<b>Total</b>	<b>5,515</b>	<b>1,557</b>	<b>471</b>	<b>20,333</b>	<b>3,910</b>	<b>1,586</b>
<b>Hardwoods</b>						
White oak	5,608	380	2,625	28,690	1,289	9,785
Select red oak	9,508	4,724	8,178	53,843	13,992	34,310
Other red oak	431	303	288	2,922	1,113	999
Hickory	785	58	47	1,975	88	161
Basswood	5,397	1,092	2,647	19,456	3,604	10,440
Yellow birch	-10	15	10	2	18	--
Hard maple	2,213	228	1,243	7,589	450	4,984
Soft maple	4,056	383	577	9,015	530	922
Elm	-4,489	10,931	4,356	-16,340	29,773	15,431
Black ash	2,558	461	352	6,730	650	775
White and green ash	2,877	164	736	10,099	227	1,995
Cottonwood	482	58	52	2,612	334	273
Willow	172	147	210	1,044	424	620
Hackberry	209	70	--	208	248	--
Balsam poplar	437	442	206	1,359	817	140
Bigtooth aspen	2,208	749	956	10,197	1,076	1,659
Quaking aspen	11,659	8,176	5,738	41,792	14,330	10,337
Paper birch	1,462	3,384	654	5,710	1,945	789
Black cherry	383	50	222	1,305	67	449
Butternut	403	11	67	1,450	79	323
Black walnut	533	79	53	2,787	133	255
Other hardwoods	1,043	513	105	1,045	922	103
<b>Total</b>	<b>47,925</b>	<b>32,418</b>	<b>29,322</b>	<b>193,490</b>	<b>72,109</b>	<b>94,750</b>
<b>All species</b>	<b>53,440</b>	<b>33,975</b>	<b>29,793</b>	<b>213,823</b>	<b>76,019</b>	<b>96,336</b>

<sup>1</sup>An estimate of average gross growth may be computed by adding average mortality to average net growth.

<sup>2</sup>International 1/4-inch rule.

Table 22.--Average net annual growth and average annual removals of growing stock on timberland by ownership class and species group, Central Hardwood Unit, Minnesota, 1977-1989

(In thousand cubic feet)

Ownership class	Growth										Removals			
	All species	Species group			All species	Hard hardwoods	Soft hardwoods	Pine	Species group			Hard hardwoods		
		Other softwoods	Hard hardwoods	Soft hardwoods					Other softwoods	Soft hardwoods	Hard hardwoods			
Miscellaneous federal	1,517	13	626	64	876	--	2	--	--	--	64	--	--	64
State	7,747	302	3,832	2,235	2,967	63	646	63	11	1,860	301	11	1,860	301
County and municipal	1,366	6	791	552	537	39	32	39	--	125	388	--	125	388
Indian	245	--	89	--	156	--	--	--	--	--	--	--	--	--
Forest industry	107	--	36	34	50	31	21	31	--	--	3	--	--	3
Farmer	20,522	564	6,613	17,096	12,742	189	603	189	64	7,316	9,527	64	7,316	9,527
Miscellaneous private corporation	2,476	--	1,216	2,991	1,055	--	205	--	--	2,340	651	--	2,340	651
Miscellaneous private individual	19,460	929	9,306	6,821	7,033	60	2,192	60	14	4,030	2,717	14	4,030	2,717
All owners	53,440	1,814	22,509	29,793	25,416	382	3,701	382	89	15,671	13,651	89	15,671	13,651

Table 23.--Average net annual growth and average annual removals of sawtimber on timberland by ownership class and species group, Central Hardwood Unit, Minnesota, 1977-1989

(In thousand board feet)<sup>1</sup>

Ownership class	Growth										Removals			
	All species	Pine			Other softwoods			Species group hardwoods			All species	Species group		
		softwoods	hardwoods	hardwoods	hardwoods	softwoods	hardwoods	hardwoods	softwoods	hardwoods		hardwoods	softwoods	hardwoods
Miscellaneous federal	7,447	10	80	3,385	3,972	299	--	--	--	--	--	--	299	
State	29,081	2,274	697	12,397	13,713	4,482	220	--	--	3,707	555	--	555	
County and municipal	6,508	301	--	4,017	2,190	2,234	102	--	--	409	1,723	--	1,723	
Indian	715	--	--	200	515	--	--	--	--	--	--	--	--	
Forest industry	703	5	--	300	398	18	18	--	--	--	--	--	--	
Farmer	94,006	3,353	3,388	26,767	60,498	62,938	744	263	21,952	39,979	--	--	39,979	
Miscellaneous private corporation	9,818	1,756	--	4,014	4,048	8,155	--	--	6,048	2,107	--	--	2,107	
Miscellaneous private individual	65,545	5,749	2,720	28,065	29,011	18,210	165	74	9,199	8,772	--	--	8,772	
All owners	213,823	13,448	6,885	79,145	114,345	96,336	1,249	337	41,315	53,435	--	--	53,435	

<sup>1</sup>International 1/4-inch rule.

Table 24.--Current annual growth, mortality, and removals of growing stock and sawtimber on timberland by species group, Central Hardwood Unit, Minnesota, 1989

Species group	Growing stock			Sawtimber		
	1989 Net growth <sup>1</sup>	1989 Mortality	1988 Removals <sup>2</sup>	1989 Net growth <sup>1</sup>	1989 Mortality	1988 Removals <sup>2</sup>
	----- Thousand cubic feet -----					
Softwoods	----- Thousand board feet <sup>3</sup> -----					
Jack pine	171	479	358	2,301	868	800
Red pine	2,499	1	750	10,404	9	2,697
White pine	1,042	5	276	6,084	109	1,455
Spruce	550	265	50	2,272	93	160
Balsam fir	827	127	98	2,527	185	253
Tamarack	947	363	14	3,735	672	18
Cedar	520	3	27	1,801	19	13
Other softwoods	169	0	0	1,044	0	0
<b>Total</b>	<b>6,725</b>	<b>1,243</b>	<b>1,573</b>	<b>30,168</b>	<b>1,955</b>	<b>5,396</b>
Hardwoods						
White oak	6,853	127	3,053	29,697	1,510	10,139
Red oak	10,716	5,426	8,510	61,434	18,058	31,957
Basswood	6,384	1,121	2,812	24,536	4,140	12,538
Yellow birch	3	2	20	107	10	95
Hard maple	3,022	140	738	8,383	638	2,304
Soft maple	6,208	357	680	12,860	727	2,271
Elm	3,842	2,776	2,513	4,501	7,009	6,063
Ash	6,633	679	1,203	21,487	1,487	3,855
Cottonwood	595	38	354	3,166	217	1,739
Balsam poplar	485	363	339	2,807	676	884
Aspen	16,447	9,854	10,960	70,360	18,337	28,810
Paper birch	2,500	2,451	830	7,952	1,762	1,972
Other hardwoods	4,955	689	738	10,564	1,699	1,858
<b>Total</b>	<b>68,643</b>	<b>24,023</b>	<b>32,750</b>	<b>257,854</b>	<b>56,270</b>	<b>104,485</b>
<b>All species</b>	<b>75,368</b>	<b>25,266</b>	<b>34,323</b>	<b>288,022</b>	<b>58,225</b>	<b>109,881</b>

<sup>1</sup>An estimate of current gross growth may be computed by adding current mortality to current net growth.

<sup>2</sup>Based on data from a 1988 mill survey and a 1989-1990 logging utilization study, and on land use change estimates from the new inventory.

<sup>3</sup>International 1/4-inch rule.

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Forest Service, North Central Forest Experiment Station.  
46 p.

In 1990, the fifth inventory of Minnesota's Central Hardwood Unit found 11.9 million acres of land, of which 2.4 million acres are forested. This bulletin presents statistical highlights and contains detailed tables of forest area, as well as timber volume, growth, removals, mortality, and ownership.

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

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.

