Information contained in 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 for the retrieval costs. These costs will vary depending on the complexity of the request, 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. If requests for data conflict with ongoing Forest Inventory and Analysis work, they will be scheduled so as to minimize the impact on the work unit.

Requests for unpublished information may be directed to:

Burton L. Essex
Forest Inventory and Analysis Project
North Central Forest Experiment Station
1992 Folwell Avenue
St. Paul, Minnesota 55108
Phone: (612) 642-5275

Area served: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, eastern South Dakota, Wisconsin.

FOREWORD

Forest Inventory and Analysis (FIA) is a continuing endeavor as mandated by the Renewable Forest and Rangeland Resources Planning Act of 1974. Prior 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, and volume of timber, growth, and depletions. Up-to-date resource information is essential to frame intelligent 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 resource evaluation in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, eastern South Dakota, and Wisconsin.

Fieldwork for the Wisconsin Statewide forest inventory was begun in the summer of 1981 and completed in late 1983. Reports on the three previous inventories of Wisconsin's timber resource are dated 1936, 1956, and 1968.

More accurate survey information was obtained during the 1983 survey than otherwise would have been feasible because of intensified field sampling. Such sampling was made possible by additional funding and field personnel provided the North Central Station by the Wisconsin State Legislature through the Department of Natural Resources. Data from the Departments' canvass of all primary wood-using plants in the State was used to help estimate the quantity of timber products harvested in Wisconsin.

Aerial photos used in the Southeast Unit Forest Inventory were furnished by the Wisconsin Department of Natural Resources and the USDA Agricultural Stabilization and Conservation Service.

TIMBER RESOURCE OF WISCONSIN'S SOUTHEAST SURVEY UNIT, 1983

John S. Spencer, Jr., *Principal Resource Analyst*

HIGHLIGHTS

Forest Area

- Forest land amounted to 937 thousand acres in 1983 (12 percent of the land area), compared with 930 thousand acres in 1968.
- Commercial forest land increased from 904 thousand acres in 1968 to 909 thousand acres in 1983.
- Nonindustrial private owners account for 89 percent of the commercial forest area.
- Productive-reserved forest land increased from 11 to 25 thousand acres between 1968 and 1983--primarily because of the addition of State-owned natural and scientific areas and county parks.
- The oak-hickory forest type is the most extensive with 293 thousand acres, followed by the maple-birch and elm-ash-soft maple types with 234 and 200 thousand acres, respectively.
- The red pine and white pine types nearly tripled in area between 1968 and 1983, but the aspen and paper birch types declined by more than one-third.
- Door County contained the largest area of commercial forest, 106 thousand acres--up 10 percent from the 96 thousand acres in 1968.
- Sawtimber stands predominate with 54 percent of the commercial area, up 30 percent from the 1968 area.
- The area of seedling-sapling stands declined 34 percent between inventories, but poletimber stands remained at about the same level, as the outgrowth of trees into sawtimber size almost equaled the ingrowth from sapling-seedlings.
- Average site index for commercial forest land is 63 feet at age 50.
- Average basal area per acre of growing-stock trees is 83 square feet.
- Plantations, primarily red pine and white pine, occupy 32 thousand acres.

Timber Volume

- Volume of growing stock increased from 664[1] to 908 million cubic feet between 1968 and 1983, a 37-percent gain.
- Hardwoods (772 million cubic feet) account for 85 percent of the growing-stock volume; softwoods (136 million cubic feet) account for 15 percent.
- Softwood growing-stock volume increased 75 percent between surveys, and hardwood volume gained 32 percent.
- The white oaks led all other species groups in 1983 in growing-stock volume with 110 million cubic feet, followed by select red oaks (77 million), northern white-cedar (75 million), white and green ash (72 million), and hard maple (69 million).
- Average growing-stock volume per acre in 1983 was 999 cubic feet, compared with 734 cubic feet in 1968.
- The volume of rough and rotten trees (148 million cubic feet), short-log trees (56 million), and salvable dead trees (14 million), together with the volume of growing-stock trees (908 million), total 1,126 million cubic feet.
- Sawtimber volume amounted to 2,774 million board feet[2] in 1983.
- Door County had the largest growing-stock volume (120 million cubic feet), but Dane County had the largest sawtimber volume (323 million board feet).
- Two-thirds of the sawtimber volume is in trees with grade 3 butt logs.
- Nonindustrial private parties own 89 percent of the growing-stock and sawtimber volumes.

Stand Conditions

- Net annual growth of growing stock on commercial forest land amounted to 23.4 million cubic feet in 1982, a 28 percent increase from the 18.3 million cubic feet in 1967.[3]

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[1] *1968 growing-stock volumes have been adjusted from those published after the 1968 survey to conform to 1983 volumes because of changes in volume equations.*

[2] *International ¼-inch rule.*

[3] *1967 growth figures have been adjusted from those published after the 1968 survey to conform to 1982 volumes because of changes in Survey procedures and volume equations.*

- Average growth rate in 1982 was 2.6 percent of growing-stock inventory, compared with 2.8 percent in 1967.
- Growing-stock growth per acre averaged 25.7 cubic feet in 1982, compared with 20.3 cubic feet in 1967.
- Annual mortality of growing stock amounted to 9.3 million cubic feet in 1982 (1.0 percent of inventory).
- The mortality rate for softwoods, with generally younger trees, is 0.5 percent of inventory, but the hardwood rate is 1.1 percent.
- Disease accounted for the largest share of the known causes of mortality.
- Diseases of elm, chiefly Dutch elm disease, were responsible for 89 percent of the disease-caused mortality.

Timber Use

- Timber removals from growing stock totaled 8.1 million cubic feet in 1982, compared with 9.1 million cubic feet in 1967.
- Softwood removals were 43 percent greater in 1982 than in 1967, but hardwood removals were 15 percent lower.
- The oaks accounted for 38 percent of total removals in 1982.
- Eighty-one percent of total growing-stock removals was harvested for roundwood products--chiefly saw logs and fuelwood. Another 13 percent was "other" removals and the remaining 6 percent was logging residue.
- The volume of wood residue from primary wood-using plants in 1981 was 2.4 million cubic feet, 99 percent of which was used.

Biomass

- Greatest yields of live tree biomass are in the oak-hickory forest type (80 green tons per acre), the maple-birch type (79 tons) and the red pine type (70 tons).
- Live tree biomass (trees larger than 1-inch d.b.h.) totaled 62 million green tons in 1983, an average of 68 tons per acre. Almost half of this is in the boles of growing-stock trees.

APPENDIX

Accuracy of Survey

Forest Inventory and Analysis information is based on a sampling procedure designed to provide reliable statistics at the State and 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 Southeast Unit in 1983, 908.2 million cubic feet, has a sampling error of ± 5.88 percent (± 53.4 million cubic feet). The growing-stock volume from a 100-percent inventory would be expected to fall between 961.6 and 854.8 million cubic feet (908.2 ± 53.4), there being a one in three chance that this is not the case.

The following tabulation shows the sampling errors for the 1983 Southeast Unit Forest Inventory:

Item	Unit totals	Sampling error
Growing stock	(Million cubic feet)	(Percent)
Volume	908.2	5.88
Growth	23.4	9.10
Removals	8.1	38.74
Sawtimber	(Million board feet)	
Volume	2,774.4	6.69
Growth	77.3	9.77
Removals	27.9	43.09
Commercial forest	(Thousand acres)	
land	909.2	0.42

As survey data are broken down for areas smaller than a Survey Unit, the sampling error increases. For example, the sampling error for growing-stock volume in a particular county is higher than that for total growing-stock volume in the Unit (table 66 shows the sampling errors for estimates smaller than Unit totals).

Survey Procedures

We used a two-phase sampling design for the 1983 Wisconsin survey. This sampling scheme and associated estimators are similar to sampling with partial replacement (SPR) in that randomly located plots were available for remeasurement and new randomly located plots were established and measured. Major improvements in the new Wisconsin design were stratification for disturbance on the old sample and use of a growth model to improve regression estimates made on the old undisturbed forest plots. The growth model used was the Stand and Tree Evaluation and Modeling System (STEMS).[4]

The major steps in the new survey design were as follows:

1. The first phase of the survey was to interpret aerial photos. In this phase two sets of random points were located on current aerial photographs: a set of

[4] *For more information on STEMS, see: Belcher, D. L.; Holdaway, M. R.; Brand, G. J. 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; 1981. 18 p.*

new photo points and a set of relocated old photo points (ground plot locations from the previous inventory). In all, 45,454 1-acre points, including old ground sample locations, were systematically distributed across aerial photos of the entire Unit. These points were classified into land classes as shown below to make a preliminary estimate of forest area. Next, a total of 5,703 of these points were stereoclassified as to stand-size class and density. Finally, 3,118 points were examined on the ground to correct the preliminary area estimate for errors in classification and for actual changes in land use since the photos were taken.

Land class	Photo points classified	Photo points stereo-classified	Inventory plots checked
Forest land	5,432	5,432	374
Unproductive/reserved			
forest land	208	208	27
Nonforest land			
with trees	63	63	1
without trees	38,052	0	2,639
Water	1,699	0	77
Total	45,454	5,703	3,118

2. The second phase of the survey was to sample ground plots. The plot selection and measurement procedures are outlined in figure 1.

From the new photo points, a random sample of ground plots was established and land use, volume, mortality, and cutting were recorded. At each forest ground plot location, variable-radius plots (basal area factor 37.5) were established at 10 points uniformly

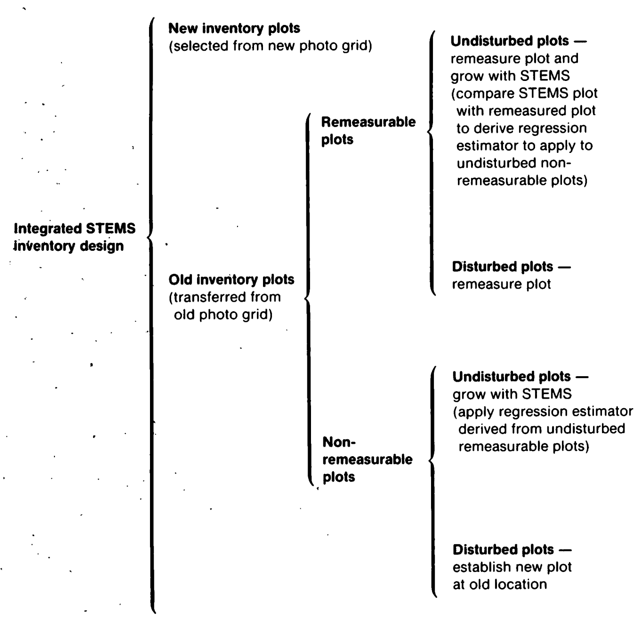

Figure 1.—*Logic structure for the 1983 Wisconsin sample design.*

placed over the sample acre. These locations were permanently marked for future remeasurement.

We used a somewhat different procedure on the old inventory photo points (old plot locations). Old plots were either remeasurable (permanently marked) or nonremeasurable (not marked and thus difficult to relocate). Within both of these groups, old plots were additionally identified as undisturbed or disturbed. The remeasurable old inventory photo points that are classified as forest undisturbed were remeasured on the ground to obtain current land use, volume, growth, and removals data. Additionally, all forest undisturbed remeasurable plots were projected to the current time using STEMS to estimate current volume and growth. Comparing the projected and observed values on these plots provided regression estimators to adjust the projected values of the undisturbed nonremeasurable plots. All disturbed remeasurable plots were remeasured on the ground to assess changes since the last inventory.

Disturbance as used here 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, regeneration, and land use change.

The nonremeasurable forest points are those that were not permanently marked during the 1968 inventory but played a crucial role in the new survey design. The nonremeasurable undisturbed forest points were visited on the ground at the time of the last survey and, following careful examination of both past and current photographs, it was determined that nothing happened that STEMS was unable to simulate. STEMS was then used to update the old plot and tree data. Thus, these points became ground plots even though the information was obtained without actually visiting the plot. The plot record for each updated plot was sent to the field for verification of current ownership information. For points classified as disturbed, a new ground plot was established as close to the old location as possible. This allowed information about land-use trends to be recorded even though the old plot could not be exactly relocated for remeasurement.

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 were remeasured or projected. A more detailed description of the sampling design is available in a separate publication.[5]

3. Statistics on timber utilization during 1981 were obtained from mill surveys. The Wisconsin Depart-

ment of Natural Resources canvassed resident sawmills, veneer mills, and other primary wood-using plants. The North Central Forest Experiment Station canvassed out-of-State sawmills, pulpmills, and veneer mills to determine their use of Wisconsin timber. Fuelwood and fencepost output was based on a random sample of households and loggers to determine their production of fuelwood and fenceposts. Estimates of primary mill residue used for fuelwood were obtained from the canvass of Wisconsin primary wood-using plants.

4. More than 2,500 felled trees on 133 active logging operations were measured throughout the State during 1981-1982 to develop wood-utilization factors for converting timber products output to timber removals for saw logs and pulpwood. Factors for all other products were obtained during the 1966-1967 Wisconsin utilization study.

5. Field data were sent to St. Paul, Minnesota, to be processed and analyzed.

COMPARING WISCONSIN'S FOURTH INVENTORY WITH THE THIRD INVENTORY

Data from new forest inventories are often compared with data from earlier inventories to determine trends in forest resources. However, changes in procedures and definitions between surveys often make it necessary to adjust earlier survey data so that they are comparable to data from the new survey. A consistency check was made for each Survey Unit in Wisconsin to ensure that the changes observed between inventories reflect actual changes in the resource and not changes in definitions or procedures.

Identifying and Correcting Procedural Changes

Between the 1968 and 1983 inventories of Southeast Wisconsin some procedural changes were made in the method of deriving annual mortality estimates and determining forest type, and revised volume equations were used.

Mortality figures for the 1968 inventory were based on field estimates from nonremeasurement plots. Information gathered on remeasurement plots during the current inventory was used to adjust the 1968 mortality figures. This adjustment, together with the new volume equations, also changed the estimate of net growth for the 1968 inventory. Additionally, the old spruce-fir forest type was separated into two distinct types for the new inventory--white spruce and balsam fir. Comparisons with old data may be made by adding the two new types together.

The difference in volume equations resulted in a 2.8 percent decrease in reported growing-stock volume for 1968.

Checking for Consistency

A test was made to ensure that it was possible to move from the adjusted 1968 resource statistics to the 1983 values by means of Timber Resource Analysis System (TRAS), a USDA Forest Service computer program for updating, backdating, and projecting timber volume, growth, mortality, and removals. Using the adjusted 1968 numbers of softwood and hardwood trees by 2-inch diameter class and applying 1983 cubic feet per tree estimates, volumes were generated for the 1968 inventory that are comparable to 1983 volumes. Then, using growth rates, mortality rates, and removal rates for the period between the two surveys, TRAS projected the inventory from 1968 to 1983. The program prints out volumes by diameter class for softwoods and hardwoods for selected years in the period. Thus, inconsistencies in volume, growth, mortality, and removals were identified and resolved.

TRAS generates an estimate of what total removals had to be for the inventory to have changed as it did between surveys, given the volume, growth, and mortality data. Estimates of removals for products and for logging residues, two of the three components of total timber removals, were available from an independent utilization study. An estimate of "other" removals (see Definition of Terms in Appendix), the third component of total removals, was made by subtracting the first two removals components from the TRAS-generated total removals estimate. This estimate of "other" removals was compared with findings from remeasurement plots and new plots (stump counts and land use change) to check its validity. When necessary, TRAS was rerun and adjusted until other removals were compatible with the estimate from field data.

LOG GRADE

In Wisconsin's Southeast Unit the butt log of every sawtimber tree on every full permanent sample plot was graded for quality.

Butt logs were graded on the basis of external characteristics as indicators of quality. Hardwood species were graded according to "Hardwood Log Grades for Standard Lumber."[6] The best 12-foot section of the

[5]*Hahn, J. T.; Hansen, M. H. A sampling procedure incorporating a growth simulator. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. (Manuscript in process).*

lowest 16-foot hardwood log, or the best 12-foot upper section if the butt log did not meet minimum log-grade standards, was graded as follows:

Forest Service standard grades for hardwood factory saw logs

Grading factors		Specifications							
		Log grade 1			Log grade 2				Log grade 3
Position in tree		Butts only	Butts and uppers		Butts and uppers				Butts and uppers
Scaling diameter, inches		13-15[1]	16-19	20+	11+[2]	12+			8+
Length without trim, feet			10+		10+	8-9	10-11	12+	8+
Required clear cuttings[3] of each of three best faces[4]	Min. length, feet	7	5	3	3	3	3	3	2
	Max. number	2	2	2	2	2	2	3	No Limit
	Min. proportion of log length required in clear cutting	5/6	5/6	5/6	2/3	3/4	2/3	2/3	1/2
Maximum sweep and crook allowance	For logs with less than one-fourth of end in sound defects	15 percent			30 percent				50 percent
	For logs with more than one-fourth of end in sound defects	10 percent			20 percent				35 percent
Maximum scaling deduction		40 percent[5]			50 percent[6]				50 percent

[1]Ash and basswood butts can be 12 inches if they otherwise meet requirements for small #1's.
[2]Ten-inch logs of all species can be #2 if they otherwise meet requirements for small #1's.
[3]A clear cutting is a portion of a face, extending the width of the face, that is free of defects.
[4]A face is one-fourth of the surface of the log as divided lengthwise.
[5]Otherwise #1 logs with 41-60 percent deductions can be #2.
[6]Otherwise #2 logs with 51-60 percent deductions can be #3.

[6]*Vaughn, C. L.; Wollin, C. A.; McDonald, K. A.; Bulgrin, E. H. Hardwood log grades for standard lumber. Res. Pap. FPL-63. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory; 1966. 52 p.*

Forest Service standard specifications for hardwood construction logs (tie and timber logs)[1]

Position in tree		Butt and upper
Min. diameter, small end		8 inches +
Min. length, without trim		8 feet
Clear cuttings		No requirements.
Sweep allowance, absolute		One-fourth of the diameter at the small end for each 8 feet of length.
Sound surface defects	Single knots	Any number, if no one knot has an average diameter above the callus in excess of one-third of log diameter at point of occurrence.
	Whorled knots	Any number if sum of knot diameters above the callus does not exceed one-third of log diameters at point of occurrence.
	Holes	Any number provided none has a diameter over one-third of log diameter at point of occurrence, and none extends over 3 inches into included timber.[2]
Unsound surface defects		Same requirements as for sound defects if they extend into included timber.[2] No limit if they do not.
End defects	Sound	No requirements.
	Unsound	None allowed; log must be sound internally, but will admit one shake not to exceed one-fourth of the scaling diameter and will admit a longitudinal split not extending over 5 inches into the contained timber.

[1]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, then it may be necessary to subdivide the class into grades.
[2]Included timber is always square, and dimension is judged from small end.

Softwood species were graded according to the following specifications: