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# Illinois's Forest Resources in 2001

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ABSTRACT.—The North Central Research Station's Forest Inventory and Analysis program began fieldwork for the fifth forest inventory of Illinois in 2001. This initiates a new annual inventory system. This Research Note contains estimates of the forest resources of Illinois derived from data gathered during the first year of the inventory.

KEY WORDS: Annual inventory, forest land, forest type, growing-stock volume, Illinois.

## BACKGROUND

The North Central Research Station's Forest Inventory and Analysis (NCFIA) program began fieldwork for the fifth forest inventory of Illinois in 2001, in partnership with the Illinois Department of Natural Resources. This inventory initiates a new annual inventory system in the State. One-fifth of the field plots in Illinois are measured each year under this system. As a result, the current inventory of the State's forest resources will not be fully implemented until 2005. However, because each year's sample is a systematic sample of the entire State and because timely information is needed about forest resources in Illinois, estimates have been prepared from data gathered during the first year of the inventory. Due to the limited number of field plots measured, future estimates using data from this report are subject to change when ensuing annual inventories are completed and data compiled. The results presented are estimates based on sampling techniques. As additional inventories are completed, the precision of the estimates will increase and additional data will be released.

Reports of previous inventories of Illinois are dated 1948, 1962, 1985, and 1998. Data from new inventories are often compared with data from earlier inventories to determine trends in forest resources. However, for the comparison 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 been made since the last inventory of Illinois in 1998 (Schmidt *et al*. 2000). Some of these changes make it inappropriate to directly compare portions of the 2001 data with those published for earlier inventories.

## RESULTS

The area that is Illinois was once a mix of tall grass prairie and eastern deciduous forest. At the time of initial Euro-American settlement, forests occupied an estimated 14 million acres, or about 40 percent of the land area that is Illinois (Illinois State Natural Survey Division 1960). Over a 150-year period—from 1800 to the mid-20th century—forest land area in Illinois declined to 3.9 million acres, or to about 11 percent of the State's total land area. Forests were removed to make way for agricultural, industrial, and urban developments.

Since 1948, timberland[1] area in Illinois has remained relatively stable (fig. 1). The stability of timberland area—during a period of profound population growth and urban development—reflects landowner and public interest in forests. In 1994, there were 115,000 private timberland owners in Illinois (Birch 1996). Since then, the number of timberland owners has increased. One estimate places the present number of Illinois private forest landowners at 169,000 (Illinois Department of Natural Resources 2002).

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[1] Timberland, a subset of forest land, is capable of growing trees at a minimum level (20 cubic feet per acre per year) and is not restricted from harvest.

Private forest landowners have been instrumental in the conservation and propagation of forests. For example, landowners have used governmental programs such as the Federal Conservation Reserve Program, the Illinois Forestry Development Cost-Share Program, and the Illinois Conservation Reserve Enhancement Program to idle marginal agricultural lands or to retire frequently flooded lands. These programs have resulted in some lands reverting to forest and others staying in forest. Individual families have intentionally protected forest lands, often for generations. Family forest landowners increasingly use legal actions designed to preserve forest, such as conservation easements. The FIA program, through the National Woodland Owner Survey, will provide more definitive information about forest landowners' use of conservation easements in the State. Also, the estimated 18 percent of total forest land area that is in public ownership in Illinois ensures that people will have access to outdoor recreation opportunities, that wildlife habitat is maintained, and that forests remain a vital component of the landscape. In Illinois, public forest lands are mostly within the Shawnee National Forest, State parks, county forest preserves, and park districts. We caution that the increase in timberland area between 1998 and 2001 should be viewed with the caveat that the 2001 estimate of timberland area is based on a partial inventory and therefore has a higher sampling error as shown in figure 1.

There is increasing concern, among Illinois forestry officials and others, that the division and sale of larger forested tracts in Illinois threatens forest ecosystem values and functions (Illinois Department of Natural Resources 2002). Whether the area of timberland remains stable is problematical because the construction of housing in rural areas is likely to continue. For instance, in some areas near cities, suburban and rural housing developments are consuming former agriculture lands at a substantial rate. For example, the American Farmland Trust (2002) reports that in Illinois, between 1992 and 1997, 161 thousand acres of prime farmland was lost to development. Ensuing annual forest inventories will provide more detailed information about land use change in Illinois.

Forest stands in Illinois are predominately hardwoods; about 97 percent of total area of timberland is classified in hardwood forest type groups (fig. 2). The primary hardwood forest type groups in Illinois are oak/hickory—51 percent of area; maple/beech/birch—23 percent of area; and elm/ash/cottonwood—19 percent of area. Virtually all hardwood stands are of natural origin.

In 2001, conifers (softwoods) represented only 3 percent of the total timberland area in Illinois. Almost 90 percent of the conifer area is pine. White pine stands are generally found in the northern portion of the State. Shortleaf pine stands are generally found in the southern reaches of the State. The remaining conifer forest area is mostly eastern redcedar. Eighty-six percent of the conifer area is planted. Most of the planted conifer acres—60 percent—are on public timberland.

As forests in Illinois mature and are affected by natural and human-caused events, they take on certain stand-size characteristics. Stand-size class is a measure of the average diameter of the dominant trees in a stand. There are three stand-size classes: sawtimber—large trees, softwoods at least 9 inches in diameter at breast height (d.b.h.) and hardwoods at least 11 inches d.b.h.; poletimber—medium trees, trees 5 inches in d.b.h. to sawtimber size; and sapling/seedling—small trees, trees 1 to 5 inches in d.b.h.

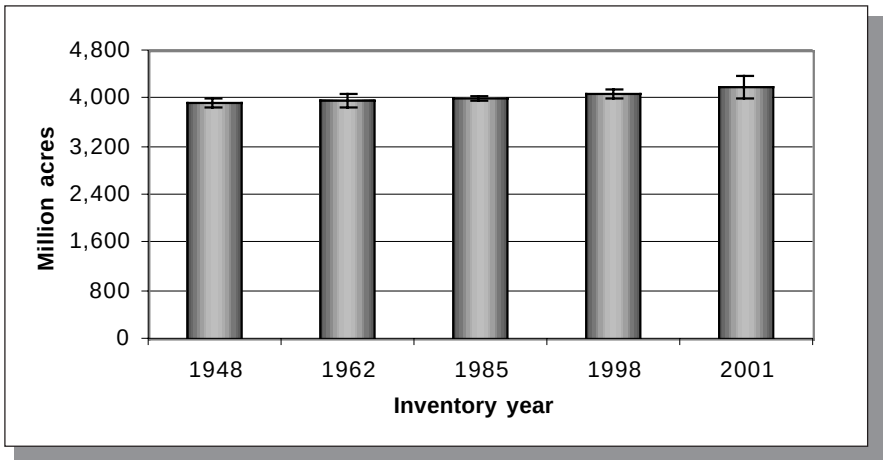


Figure 1.—*Area of timberland, Illinois, 1948-2001 (Note: the sample error associated with each inventory is represented by the vertical line at the top of each bar).*

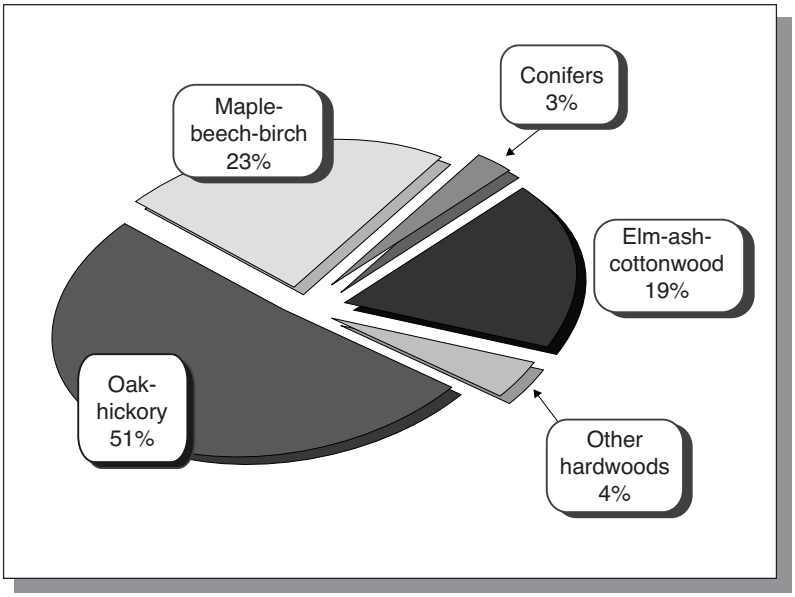


Figure 2.—*Area of forest land by forest type, Illinois, 2001.*

Between 1998 and 2001, the area of larger trees—sawtimber-size trees—remained virtually unchanged, accounting for 72 percent of timberland area (fig. 3). The substantial area of sawtimber-size stands points to a maturing forest. The area in poletimber-size trees declined as some stands grew into the sawtimber-size stands. The area in sapling-seedling-size stands increased, but those stands occupy less than 10 percent of timberland area. The smaller area of sapling-seedling stands may be related to how timber is harvested in much of the State. Often, mature timber is removed either as single scattered trees or in small groups. The lack of significant disturbances in hardwood stands may not open stands to progressive seedling development. Smaller trees in the understory are dominated by larger trees. However, the increase in area of sapling-seedling stands between 1998 and 2001 may point toward an emergence of conifers (softwoods) in the State's forests. Ensuing panels of the fifth Illinois inventory will provide more definitive information about change in stand-size class.

In 2001, growing-stock volume in Illinois totaled 6.6 billion cubic feet. Growing-stock volume is the amount of solid wood in timberland trees meeting quality standards that are greater than 5 inches diameter at breast height (d.b.h.), from

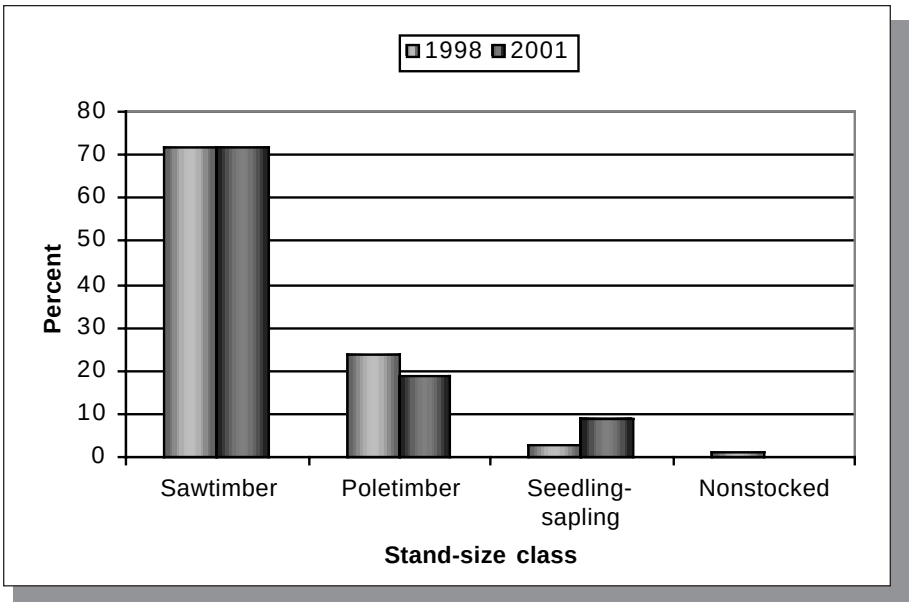


Figure 3.—*Stand-size class as a percentage of total timberland area, Illinois, 1998 and 2001.*

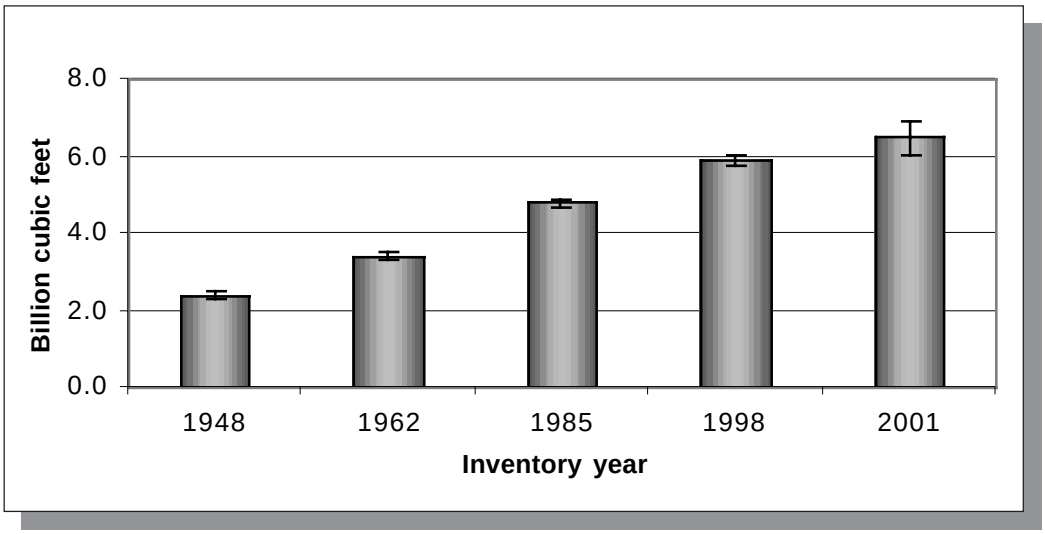


Figure 4.—*Growing-stock volume, Illinois, 1948-2001 (Note: sampling errors associated with each inventory are represented by vertical lines at the top of each bar).*

1 foot above the ground to a minimum 4-inch top diameter. Growing-stock volume increased between 1998 and 2001, from 5.9 to 6.6 billion cubic feet. Total growing-stock volume has increased in every inventory since 1948 (fig. 4).

In summary, data from the 2001 inventory of Illinois forest resources indicate that timberland area is holding steady, as it did throughout the second half of the 20th century. Softwoods, especially eastern redcedar, appear to be increasing. Growing-stock volume continues to increase as the forest matures. These findings are presented with the caveat that data are not yet sufficient to make definitive statements about how forest resources in Illinois have changed in the 3 years since the previous inventory. As additional data become available under the annual inventory system, a clearer picture of the status and direction of forests in Illinois will emerge.

## INVENTORY METHODS

### Changes Between Inventories

Since the 1998 inventory of Illinois, several changes have been made in the NCFIA inventory methods to improve the quality of the inventory as well as meet the increasing demands for timely forest resource information. The most significant change between the inventories has been the change from periodic inventories to annual inventories. Historically, NCFIA inventoried each State on a cycle that averaged about 15 years. However, the need for timely and consistent data across large geographical regions, combined with national legislative mandates, resulted in NCFIA's implementation of an annual inventory system. The annual inventory system began in Illinois in 2001.

With an annual inventory system, approximately one-fifth of all field plots are measured in any single year. After 5 years, the entire inventory will be completed. After the initial 5-year period, NCFIA will report and analyze results as a moving 5-year average. For example, NCFIA will be able to generate inventory results for 2001 through 2005 or for 2002 through 2006. While there are great advantages for an annual inventory, one difficulty is reporting on results in the first 4 years. With the 2001 inventory, only 20 percent of all field plots have been measured. Sampling estimates for the 2001 inventory are 4.51 percent for timberland area and 7.38 percent for growing-stock volume. Thus, caution should be used when drawing conclusions based on this limited data set. As ensuing measurements are completed, we will have additional confidence in our results due to the increased number of field plots measured. As each measurement year is completed, the quantity and quality of the results will expand.

Other significant changes between inventories include the implementation of new remote sensing technology, implementation of a new field plot design, and gathering of additional remotely sensed and field data. The use of new remote sensing technology since the previous inventory has

allowed NCFIA to use computer-assisted classifications of Multi-Resolution Land Characterization (MRLC) data and other available remote sensing products to stratify the total area of the State and to improve estimates. Previous inventories used manual interpretation of aerial photographs to stratify the sample.

Volume equations developed by Hahn and Hansen (1991) are used to estimate the growing-stock and sawtimber volumes. As additional annual inventories are implemented and comparisons between the current inventory and previous inventory become possible, FIA will update the 1998 inventory.

New algorithms were used in 2001 to assign forest type and stand-size class to each condition observed on a plot. These algorithms are being used nationwide by FIA to provide consistency from state to state and will be used to reassign the forest type and stand-size class of every plot in the 2001 inventory when it is updated. This will be done so that changes in forest type and stand-size class will reflect actual changes in the forest and not changes due to algorithms. The list of recognized forest types, groupings of these forest types for reporting purposes, equations used to assign stocking values to individual trees, definition of nonstocked (stands with a stocking value of less than 10 percent for all live trees), and names given to the forest types changed with the new algorithms.

Another change with the current inventory is the determination of the exact plot location of every ground plot in the new inventory. For plots that are visited in the field, this is done using a global positioning system (GPS) device at plot center. For plots not visited in the field, the plot location is determined by transferring the old plot location from aerial photography to an unclassified, geo-corrected remotely sensed image. Both procedures provide an accurate location that is used to link the ground plots to the classified remotely sensed data used for stratification.

## PROCEDURES

The 2001 Illinois survey used a two-phase sample for stratification that included remeasuring inventory plots from the 1998 inventory and measuring new field plots. Two-phase sampling, also called double sampling, consists of a phase 1 sample used to estimate area by strata and a phase 2 sample used to estimate the average value of parameters of interest within the strata. The estimated population total is the sum across all strata of each stratum's estimated area multiplied by its estimated mean per unit area. The only land that could not be sampled was private land where field personnel could not obtain permission to measure a phase 2 plot. These denied access plots were rare in Illinois (about 1 percent of the total plots statewide), and the methods used in the preparation of this report made the necessary adjustments to account for sites where access was denied.

### Phase 1

Phase 1 and phase 2 plots were placed systematically across the entire State without regard to specific land characteristics. All lands have the same probability of being sampled under this inventory system. The 2001 inventory used a computer-assisted classification of satellite imagery. FIA used the imagery to form two initial strata—forest and nonforest. Pixels within 60 m (2 pixel widths) of a forest/nonforest edge formed two additional strata—forest/nonforest and nonforest/forest. Forest pixels within 60 m of the boundary on the forest side were classified as forest/nonforest. Pixels within 60 m of the boundary on the nonforest side were classified as nonforest/forest. An overlay of national forest land ownership was used to identify all lands owned by the Shawnee National Forest. National forest lands were treated separately but were also stratified into one of the above four strata. Stratification and estimation were conducted at the State level for national forest lands and at the FIA Inventory Unit level for other lands. Final estimation of area by stratum was based on these five strata—national forest, forest, forest/nonforest, nonforest/forest, and nonforest for all lands.

In the 1998 inventory, aerial photographs were assembled into township mosaics and a systematic grid of 121 one-acre photo-plots (each plot representing approximately 190.4 acres on the ground) was overlaid on each township mosaic. Each of these photo plots was stereoscopically examined by aerial photo interpretation specialists and classified based on land use, forest type, and stand-size density. From these photo plots, a systematic sample of plots (without regard to their aerial photo classification) was selected as ground plots and further examined by survey crews to verify the classification and to make further measurements. These 1998 ground plots formed the basis for the remeasured ground plots in the 2001 inventory. Additional information related to the procedures for the 1998 inventory can be found in Schmidt *et al.* (2000).

The move to satellite imagery changed NCFIA's phase 1 sample from being based on one photo plot for every 190.4 acres to a sample based on a classified pixel every 0.22 acres. The increased intensity of the phase 1 sample greatly improved estimates of the area within each stratum, particularly at the county level. Also, because the classification was conducted using a computer-assisted algorithm across the entire State, biases in the photo plot sampling method that resulted from differences in photo quality, age of photography, and experience of the photo interpreter were eliminated and classification was consistent across the entire State.

## Phase 2

Phase two of the inventory consisted of the measurement of and annual sample of field plots in Illinois. Current FIA precision standards for annual inventories require a sampling intensity of one plot for every 5,937 acres. To satisfy this requirement, the geographical hexagons established for the Forest Health Monitoring (FHM) program were divided into 27 smaller NCFIA hexagons, each of which contained 5,937 acres (McRoberts 1999). A grid of field plots was established by selecting one plot from each of the smaller hexagons based on the following rules: (1) if an FHM plot fell within a hexagon, it was selected as the grid plot; (2) if no FHM plot fell within the hexagon, the existing FIA plot nearest the hexagon center was selected as the grid plot; and (3) if neither FHM nor existing NCFIA plots fell within the hexagon, a new NCFIA plot was established in the hexagon (McRoberts 1999). This grid of plots is designated the Federal base sample and is considered an equal probability sample; its measurement in Illinois is funded by the Federal government.

The total Federal base sample of hexagonal grid plots was systematically divided into five interpenetrating, non-overlapping subsamples or panels. Each year the plots in a single panel are measured with panels selected on a 5-year, rotating basis (McRoberts 1999). For estimation purposes, the measurement of each panel of plots may be considered an independent random sample of all lands in a State. Field crews measured vegetation on plots in the forested and straddler (nonforest/forest and forest/nonforest) categories; plots classified as non-forested were checked to ensure correct classification.

NCFIA has two categories of field measurements—phase 3 (formerly FHM plots) and phase 2 field plots to optimize our ability to collect data when available for measurement. It is imperative that each type of plot be uniformly distributed both geographically and temporally. Phase 3 plots are measured with the full array of vegetative and health variables collected (Mangold 1998) as well as the full suite of measures associated with phase 2 plots. Phase 3 plots must be measured between June 1 and August 30 to accommodate measurement of non-woody understory vegetation, ground cover, and other variables. We anticipate that in Illinois the complete 5-year annual inventory will involve about 381 phase 3 plots. On the remaining plots, only variables that can be measured throughout the entire year are collected. In Illinois, the complete 5-year annual inventory is expected to involve about 5,684 phase 2 forested plots.

The new national 4-point cluster plot design was used for data collection (fig. 5) in 2001 and will be used in subsequent years. For all remeasured field plots in the Federal base sample, the new 4-point cluster plot was established and measured at the old plot (1998) location. In addition, the first five subplots of the old 10-point (subplot) cluster were also remeasured in 2001 to estimate change. All trees previously measured on these plots were remeasured or otherwise accounted for on these five subplots. These measurements form the basis for change estimates between

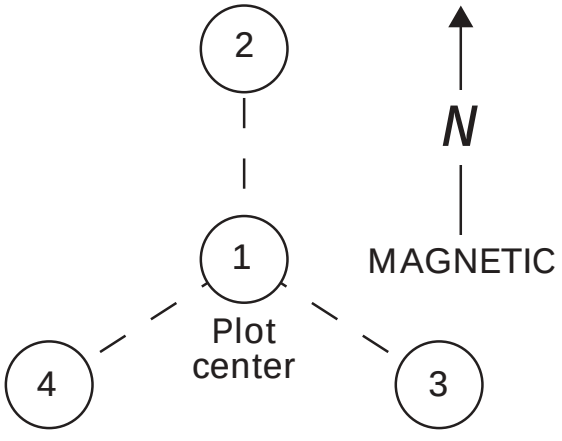


Figure 5.—*Current NCFIA field plot design.*

the 1998 and 2001 inventories for characteristics such as average annual net growth, mortality, and removals. Thus, until a complete cycle of annual inventories for Illinois has been accomplished, both the new 4-point cluster plots and part of the old 10-point cluster plots will be measured. If the anticipated 20-percent of the State is sampled each year, by the sixth year of annual inventories in Illinois, the new 4-point cluster plots will begin to be remeasured and the former plot design will be abandoned. The national plot design also requires mapping forest conditions on each plot. Due to the small sample size (20 percent) each year, the precision associated with change factors such as mortality will be relatively low. Consequently, change estimates will not be reported until at least three annual inventories have been completed, and even then we anticipate that estimates of change will be limited in detail. When the complete annual inventory has been implemented in 2005, the full range of change variables will be available.

The overall plot layout for the new design consists of four subplots spaced 120 feet apart in a triangular arrangement. Subplots 2, 3, and 4 are spaced 120 degrees apart. The center of the new plot is located at the same point as the center of the previous plot if a previous plot existed within the sample unit. All trees less than 5.0 inches in diameter at breast height (d.b.h., or 4.5 feet above ground level) are measured on a 6.8-foot-radius (1/300 acre) circular microplot located 12.0 feet due east of the center of each of the four subplots. Trees with diameters 5 inches and larger are measured on a 24-foot-radius (1/24 acre) circular subplot. The forest condition of each subplot is recorded. Factors that can determine a change in forest condition from subplot 1 are changes in forest type, stand-size class, land use, ownership, and density. Each condition that occurs anywhere on one of the subplots is identified, described, and mapped if the condition in total meets or exceeds 1 acre in size (the 1-acre minimum size for a condition to be identified could include land off the subplot). Each condition is assigned a condition number, and condition information is recorded.

Field plot measurements are combined with phase 1 estimates in the compilation process. As additional annual inventories are completed, tables will be generated for publication. In year 5, all statewide inventory summary tables will be available in both printed and electronic formats.

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