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Kansas'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 Kansas in 2001. This initiates a new annual inventory system. This Research Note contains estimates of the forest resources of Kansas derived from data gathered during the first year of the inventory.

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

BACKGROUND

The North Central Research Station's Forest Inventory and Analysis (NCFIA) program began fieldwork for the fifth forest inventory of Kansas in 2001, in partnership with the Kansas Forest Service, Kansas State University. This inventory initiates a new annual inventory system in Kansas. One-fifth of the field plots in the State are measured each year under this system. As a result, the current inventory of Kansas's forest resources will not be fully implemented until 2005. However, because each year's sample is a systematic sample of the State's forest and because timely information is needed about forest resources, 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.

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Reports of previous inventories of Kansas are dated 1936, 1965, 1981, and 1994. 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 Kansas in 1994 (Leatherberry *et al.* 1999). Some of these changes make it inappropriate to directly compare portions of the 2001 data with those published for 1994. When comparisons are made or estimates presented from past inventories in this report, data from previous inventories are recomputed using current methods to ensure that comparisons are valid.

RESULTS

Before Euro-American settlement, forests covered about 4.5 million acres, or about 9 percent of land area in Kansas (Ware and Smith 1939). Between the mid-1800s and 1936, forest land area in Kansas declined by an estimated 3.4 million acres to about 1.1 million acres. Forests were lost as settlers converted the rich alluvial bottom forest and the moist upland forest to agricultural uses. During most of the 20th century, timberland[1] area remained relatively stable at around 1 to 1.5 million acres (fig. 1). Topography and climate play a role in the general stability of timberland area in Kansas. In eastern Kansas, where precipitation is adequate to support tree growth, land that was too hilly or rugged for row crops tended to remain forest. In western Kansas, tree growth is limited by low precipitation and the sometimes harsh and extreme weather. There, forests are confined to small groves and forest islands or to sheltered areas such as

[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.

coves and ravines. Between 1994 and 2001, forest land area expanded in Kansas to 2.2 million acres. However, the magnitude of the increase was due, mostly, to a definitional change. Previously, forest lands that were being grazed or that provided shelter from the wind were classed as nonforest with trees; now such lands are classed as forest land if they meet the definitional standards for size, width, and stocking. Also, the increase in forested lands between 1994 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 than prior inventories (fig. 1). The 2001 estimate indicates that forest land area continues to expand as it has since the 1930s. An increase in forest land area is noteworthy considering the relative scarcity of trees in a State known for its vast expanse of prairies.

In Kansas, the vast majority of timberland is privately owned. Birch (1997) reported an estimated 39,300 private ownerships holding timberland in Kansas. Timberland gives owners many benefits including protection from wind, wildlife habitat, watershed protection, timber and non-timber products, recreation opportunities, soil erosion protection, and visual diversity/aesthetics. In a place where forest is relatively scarce and public ownership is low, privately owned forest provides the critical link between forests and people. Also, forest management will depend largely on the attitudes of private owners.

Most of the timberland in Kansas is of natural origin. Only an estimated 39 thousand acres are planted. Those planted stands are exclusively hardwoods and probably contain more economically valued species such as black walnut. Although plantations are few, there is a long history of tree planting in Kansas. Early settlers brought seedlings and other plantings with them in an attempt to re-create remnants of forest environments they were familiar with. Up until the early 1900s, government tree planting initiatives were widely used. However, periodic drought, as well as lack of management, took a toll on the trees planted (Ware and Smith 1939).

Timberland in Kansas supports mostly hardwood stands. The maple/beech/birch forest type group is the most extensive forest type in Kansas, occupying an estimated 36 percent of the State's timberland area (fig. 2). In Kansas, the maple/beech/birch forest type group comprise mostly elm, ash, and locust trees. The elm/ash/cottonwood group occurs on about 29 percent of timberland area, followed by the oak/hickory forest type group that occurs on about 27 percent of the State's timberland area. The pinyon/juniper forest type group, in Kansas eastern redcedar, makes up the softwood forest. The area of eastern redcedar expanded in Kansas between 1994 and 2001, nearly doubling to 136.7 thousand acres. The expansion of eastern redcedar in Kansas mirrors patterns of expansion occurring in neighboring Missouri, Nebraska, and Oklahoma.

As forests 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. Although area of timberland expanded between 1994 and 2001, the proportion of area in each of the stand-size classes remained unchanged (fig. 3). Sawtimber-size stands predominate. Starting with the 1936

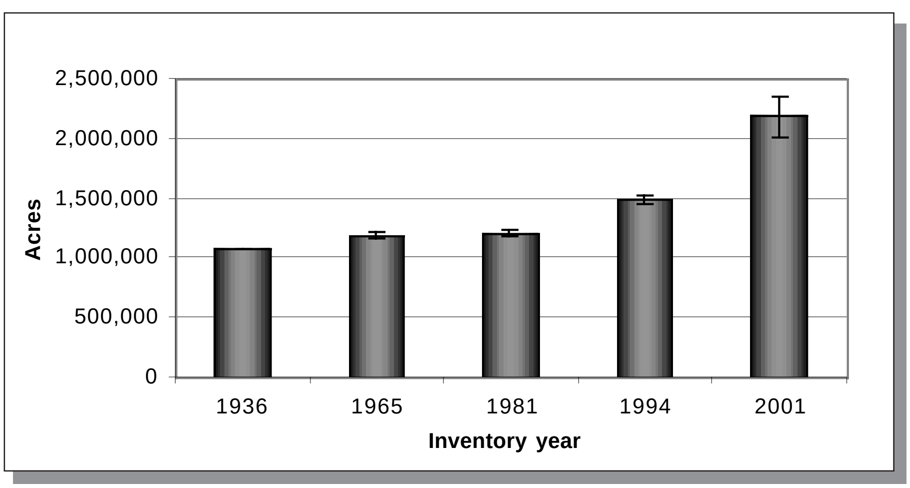

Figure 1.—*Area of timberland, Kansas, 1936-2001 (Note: the sampling error associated with each inventory is represented by the vertical line at the top of each bar).*

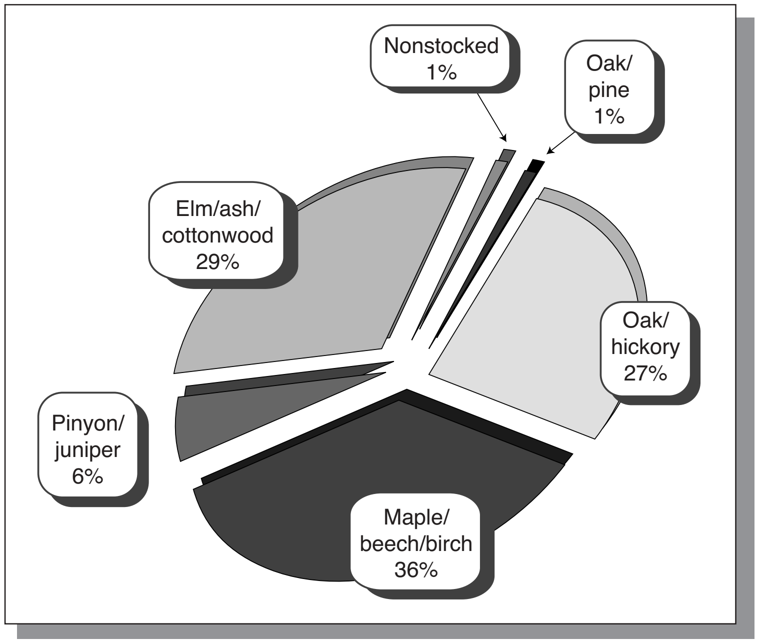

Figure 2.—*Area of forest land by forest type group, Kansas 2001.*

inventory and in each succeeding inventory, sawtimber stands have accounted for roughly half the State's timberland area (1,049.7 thousand acres). As noted, the Kansas forest is largely hardwood with an increasing presence of eastern redcedar. Indicative of the rapid expansion of eastern redcedar is the change that occurred between 1994 and 2001 in the proportion of eastern redcedar and the proportion of pinyon juniper forest type groups in sapling-seedling stands. In 1994, nearly half of the acres (33.5 thousand acres) in the eastern redcedar forest type group were sapling-seedling stands. In 2001, two-thirds of all acres (85.7 thousand acres) in pinyon/juniper (i.e., eastern redcedar) stands were sapling-seedling stands.

Growing-stock volume on Kansas timberland totals 1.7 billion cubic feet. Growing-stock volume is the amount of solid wood in timberland trees meeting quality standards that are greater than 5 inches d.b.h. from 1 foot above ground to a minimum 4-inch top diameter. In Kansas, growing-stock volume is largely found in hardwood trees.

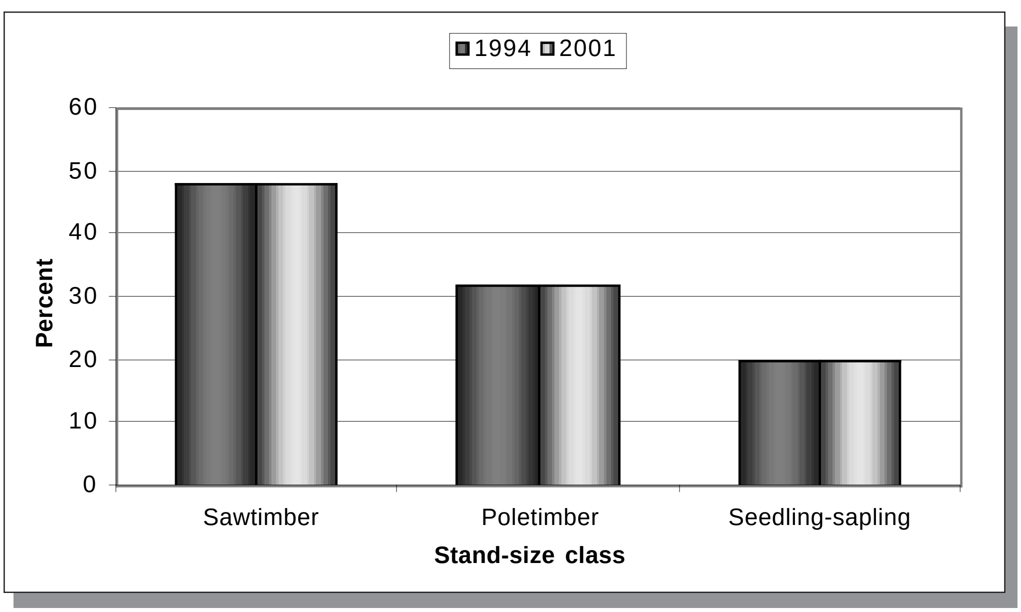

Figure 3.—*Stand-size class as a percentage of total timberland area, Kansas, 1994 and 2001.*

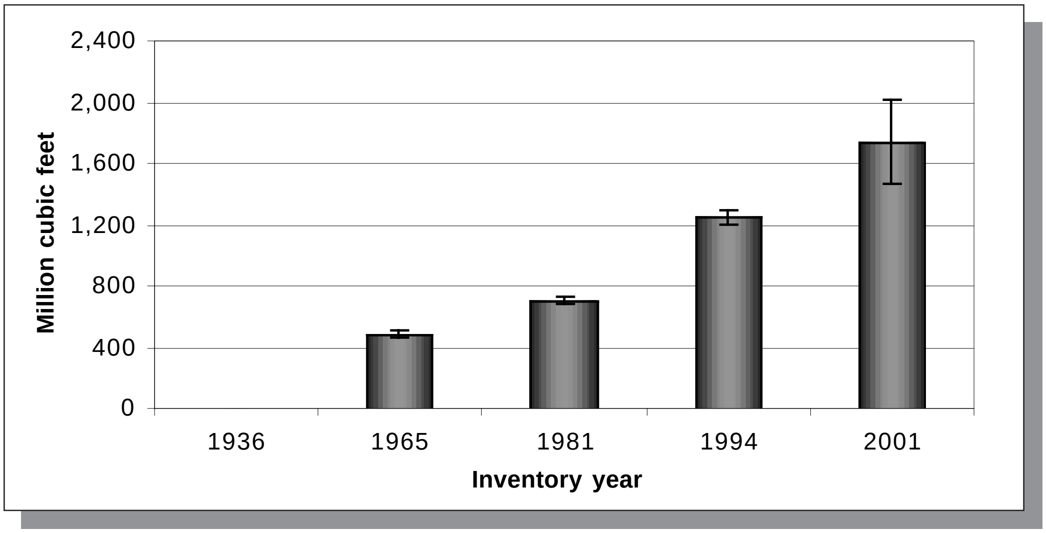

Figure 4.—*Growing-stock volume, Kansas, 1965-2001 (Note: the sampling error associated with each inventory is represented by the vertical line at the top of each bar).*

Before 1994, there was virtually no softwood growing-stock volume in the State. The 1994 inventory reported only 16.6 million cubic feet of softwood growing-stock volume, which accounted for only 1 percent of the State's total growing-stock volume. Between 1994 and 2001, softwood growing-stock volume more than doubled to 34 million cubic feet, or nearly 2 percent of total growing-stock volume. Total growing-stock volume in Kansas has increased in every inventory since 1965 (fig. 4). Between each inventory, the increase in growing-stock volume has been rather substantial, indicative of steady to increasing timberland area and a maturing forest.

In summary, data from the 2001 inventory of forest resources in Kansas indicate the likely direction of change in the State's forest resources. Both timberland area and growing-stock volume increased between 1994 and 2001. Although Kansas has mostly a hardwood forest, softwood growing-stock volume continues to increase as eastern redcedar expands. These findings are presented with the caveat that data are not yet sufficient to make more definitive statements about how Kansas forest resources have changed since the 1994 inventory. As additional data become available under the annual inventory system, a clearer picture of the direction of forests in Kansas will emerge.

INVENTORY METHODS

Changes Between Inventories

Since the 1994 inventory of Kansas, 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 Kansas 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 error estimates for the 2001 inventory are 7.97 percent for timberland area and 15.86 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 1994 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. In the northern Great Plains States (Kansas, Nebraska, South Dakota—outside the Black Hills National Forest, and North Dakota), all field plots are newly established. For each newly established field plot, the exact location is determined by using a global positioning system (GPS) device at the plot center. For plots not visited in the field, the plot location is identified on 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 Kansas survey used a two-phase sample for stratification. 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 Kansas (less than 1 percent of the total number of 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. In Kansas, final estimation of area by stratum was based on three strata—nonforest, nonforest edge, and forest plus forest edge.

In the 1994 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 take further measurements. Additional information related to the procedures for the 1994 inventory can be found in Leatherberry *et al*. (1999).

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 2 of the inventory consisted of the measurement of an annual sample of field plots in Kansas. 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 establishing a new permanent FIA plot in each of the smaller hexagons. This grid of plots is designated the Federal base sample and is considered an equal probability sample; its measurement in Kansas is funded by the Federal government. The Kansas Forest Service provides additional support for the inventory measurements by supplying field crews.

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 Kansas the complete 5-year annual inventory will involve about 551 phase 3 plots. On the remaining plots, only variables that can be measured throughout the entire year are collected. In Kansas, the complete 5-year annual inventory is expected to involve about 8,317 phase 2 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. In Kansas, because all plots in the annualized inventory are newly established, remeasurement data will not be available until the sixth year of the annual inventory. Those measurements will form the basis for change estimates between the first five-panel cycle and the second five-panel cycle for characteristics such as average annual net growth, mortality, and removals. 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

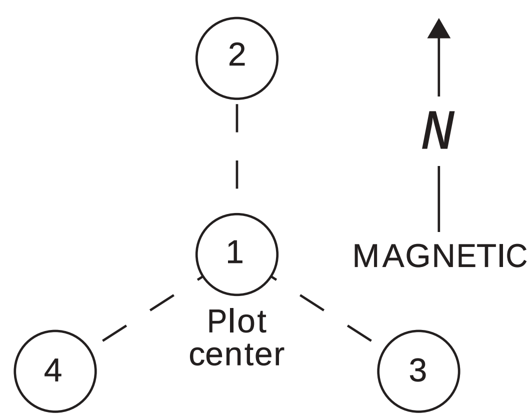

Figure 5.—*Current NCFIA field plot design.*

reported until at least three annual inventories have been completed in the second five-panel cycle, and even then we anticipate that estimates of change will be limited in detail. When the complete second five-panel cycle of the annual inventory has been implemented in 2010, (if the anticipated 20 percent of the State is sampled each year), 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. 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, statewide inventory summary tables will be available in both printed and electronic formats. However, changing factors such as growth, mortality, and removals will not be reported until at least three annual inventories have been completed in the second five-panel cycle.

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