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

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

BACKGROUND

The North Central Research Station's Forest Inventory and Analysis (NCFIA) program began fieldwork for the fourth forest inventory of Nebraska in 2001, in partnership with the Nebraska Forest Service, University of Nebraska, Lincoln. This inventory initiates a new annual inventory system in the State. One-fifth of the field plots in Nebraska are measured each year under this system. As a result, the current inventory of Nebraska'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 Nebraska's 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 Nebraska are dated 1955, 1983, 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 occurred since the last Nebraska inventory in 1994 (Schmidt and Wardle 1998). Some of these changes make it inappropriate to directly compare portions of the 2001 data with those published for earlier inventories.

RESULTS

Nebraska is perhaps best known as a land of grains and grasses, with fertile agricultural soils and extensive prairies (Stone and Bagley 1961). However, it is also a State with an expanding and productive forest resource. Nebraska's forests are unique in that they combine aspects of eastern hardwood, western coniferous, and northern boreal forests. Forests in the eastern third of Nebraska are dominated by deciduous species that extend across nearly all soil types, landforms, and physiographic classes (Schmidt and Wardle 1998). Towards the west, the area of forest land declines sharply. The majority of western forests are dominated by stands of ponderosa pine associated with escarpments of the Pine Ridge. Although the soils themselves are nutrient-rich and productive, the distribution and extent of forest species in the central and western portions of the State are limited by the harsh continental climate and the availability of moisture. Native forests are located primarily along water corridors and in lowland sites; more than five times as many native woody species are found in eastern Nebraska as compared to the western part of the State (Schmidt and Wardle 1998).

Despite the dominance of prairie and agricultural lands today, Nebraska was once covered by a forest of boreal white spruce (*Picea glauca*) following the retreat of the Pleistocene ice sheets approximately 10,000 years ago (Wright 1970). Evidence of these prehistoric boreal forests can still be found today in the stands of paper birch (*Betula papyrifera*) and aspen (*Populus tremuloides*) scattered across the northern part of Nebraska. Changing climate and the extensive use of fire by Native Americans eventually pushed the edge of these early forests eastward, leaving trees primarily along the natural firebreaks formed by rivers and streams (Schmidt and Wardle 1986).

Following the arrival of European settlers, government programs designed to promote settlement in the Great Plains often encouraged forestry as well. For example, the Timber Culture Act of 1873 provided 160 acres of land free to settlers who planted 40 acres of trees as part of their homestead (Schmidt and Wardle 1986). Some of these plantings are still evident today. The ecological and economic importance of Nebraska's forested lands later came into sharp focus during the Dust Bowl of the 1930s, during which a legacy of aggressive agricultural practices and an extended drought combined to produce vast dust storms that covered homes and buildings with drifts of eroded topsoil (Croker 1991). In response to the enormity of this disaster, Franklin Roosevelt instituted the Prairie States Forestry Project, a system of shelterbelts stretching from Texas to the Canadian border that included more than 4,100 miles of windbreaks in Nebraska alone (Stone and Bagley 1961).

Yet, despite Nebraska's early nickname, the "Tree Planter's State," increasing settlement and the high value of agricultural soils led to a general decline in forest land for much of the time since European settlement. Between the first (1955) and second (1983) inventories of Nebraska's forests, a period of just 18 years, the area of timberland in the State decreased by 49 percent as commercial forest lands were shifted to agricultural uses (Schmidt and Wardle 1998, Raile 1986). This downward trend made a dramatic turnaround in the latter part of the 20th century, with a 67 percent increase in the area of timberland (from 538 to 898 thousand acres) between the 1983 and 1994 inventories (Schmidt and Wardle 1998). The 2001 data are consistent with this increase, with the area of timberland currently estimated at 1,098,000 acres or 2.4 percent of the State's total land area (fig. 1). However, caution needs to be taken in comparing these estimates, due to a definitional change of "forest land." In previous inventories, forest lands that had been grazed or used as shelterbelts were classified as "nonforest with trees." In the 2001 inventory, these lands are classified as forest land if they meet the definitional standards for size, width, and stocking. This may account for a portion of the increase in forest land since 1994.

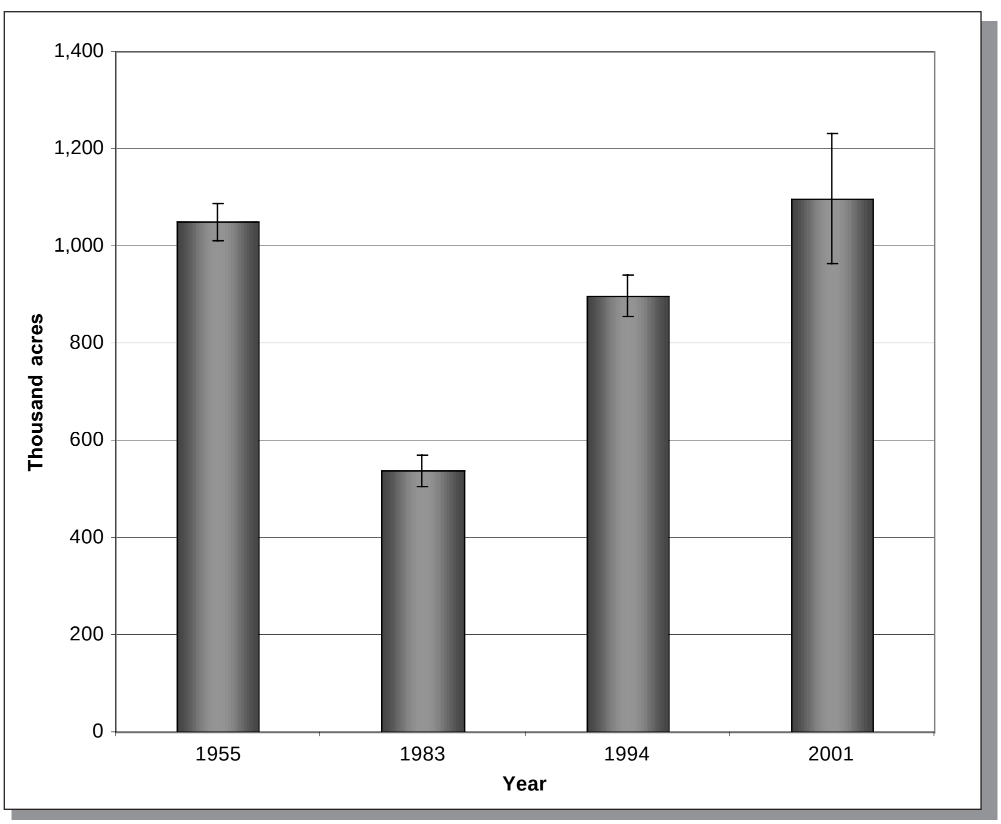

Figure 1.—*Area of timberland, Nebraska, 1955-2001. (Note: The sample error associated with an inventory is represented by the vertical line at the top of its bar.)*

Nebraska is one of the few States to have both eastern hardwoods and western softwoods within its borders (Stone and Bagley 1961). Hardwood stands occupy 742,900 ± 113,400 acres, or 63 percent of all forest land within the State (fig. 2). The majority of hardwood stands are associated with the elm-ash-cottonwood group (251,600 ± 66,000 acres), followed by the maple-beech-birch (193,100 ± 57,800 acres) and oak-hickory groups (189,300 ± 57,300 acres). Forests in the western part of the State are largely dominated by conifers, with ponderosa pine found on nearly 250 thousand acres in northwestern Nebraska, accounting for 22 percent of all forest land. Nearly 9 out of every 10 acres of forest land (87 percent) and timberland (89 percent) are held by private landowners.

The distribution of Nebraska's timberland area by stand-size class generally agrees with that of the 1994 inventory, with the majority of timberland dominated by trees in larger size classes. Initial estimates based on the 2001 inventory indicate that sawtimber stands occupy 614,500 ± 99,800 acres, or more than half (56 percent) of all timberland (fig. 3). Sawtimber refers to a live tree that is 11.0 inches d.b.h. for hardwoods or 9.0 inches d.b.h. for conifers and contains at least a 12-foot saw log or two non-contiguous saw logs 8 feet or longer. An additional one-quarter (23 percent) of timberlands is classified in the next largest size class, poletimber, which consists of trees at least 5.0 inches d.b.h. Seedlings and sapling stands (seedlings at least 12 inches tall up to 1 inch d.b.h. and young trees between 1.0 and 5.0 inches d.b.h.) account for less than 12 percent of timberland area. The greatest difference in timberland area between the 1994 and 2001 inventories is in the percentage of timberland classified as nonstocked. Nonstocked timberland is land that has forests as its primary land use but that did not have a sufficient number of trees present during the inventory to be classified into a specific forest type. Between 1994 and 2001, the area of timberland classified as nonstocked increased from 1.3 to 9.2 percent. The magnitude of this increase may be due in part to the limited sample size of the 2001 inventory, and this percentage may decline as more timberlands are sampled.

The increase in timberland area between 1983 and 2001 is reflected in the estimated increase in growing-stock volume of both hardwood and softwood species. Growing-stock volume refers to the amount of solid wood on timberland in trees 5 inches d.b.h. or greater, from 1 foot above the ground to a minimum 4-inch top diameter, with deductions made for poor form or defect. Hardwood stands represent 82 percent of the total growing-stock volume on timberland, with the majority of the growing-stock volume in the elm-ash-cottonwood species groups (39.1 percent), followed by the maple-beech-birch group (19.2 percent), and the oak-hickory group (17.4 percent) (fig. 4). More than 80 percent of total softwood volume (203.2 ± 93.9 million cubic feet or 14.4 percent of total growing-stock volume) is associated with ponderosa pine stands (fig. 5). For hardwood species, estimated growing-stock volume increased by more than 300 percent, from 285.8 ± 31.1 million cubic feet in 1984 to 1,155.3 ± 224.1 million cubic feet in 2001. During this same time period, growing-stock volume of softwood species showed an increase of 44 percent.

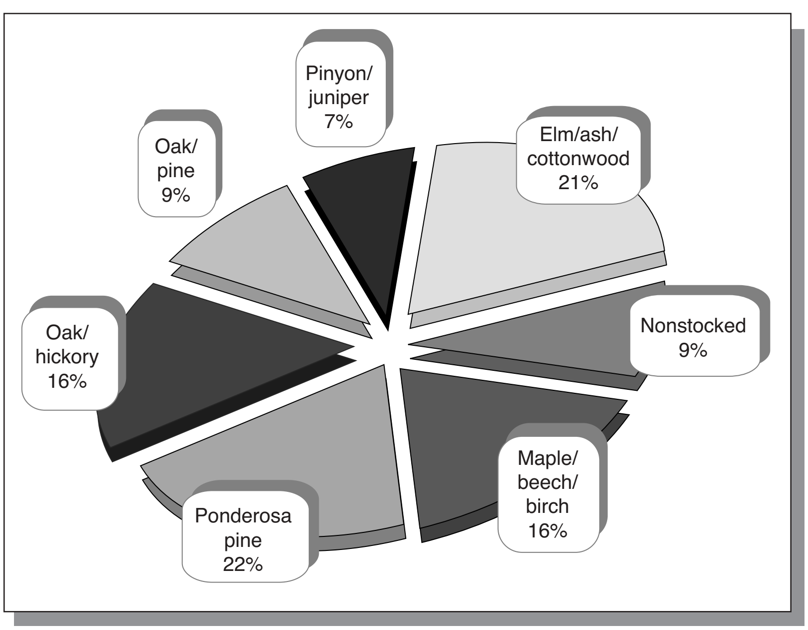

Figure 2.—*Area of forest land by forest type, Nebraska, 2001.*

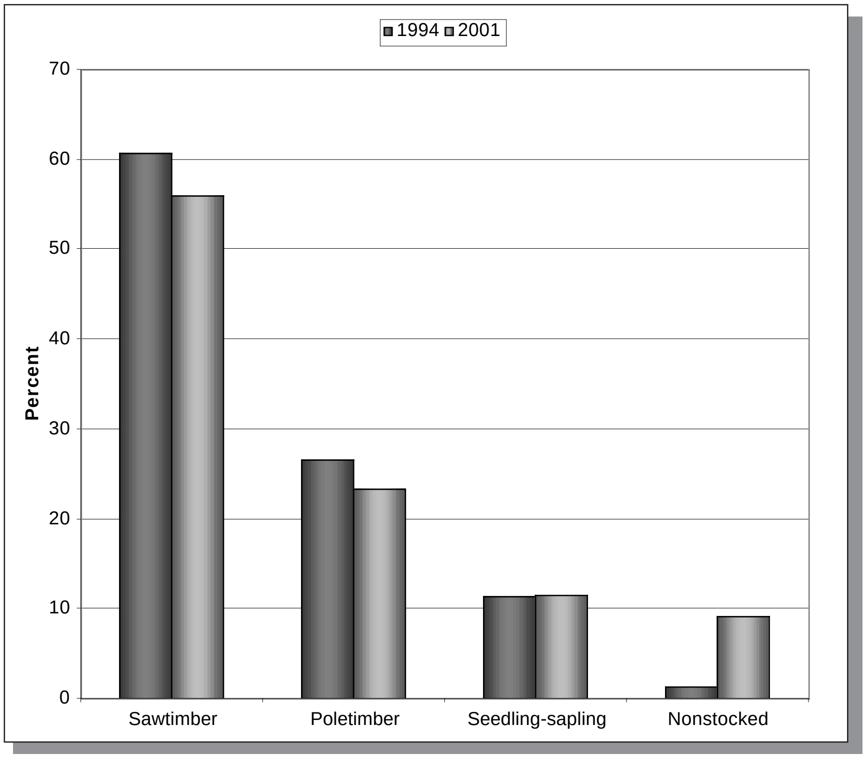

Figure 3.—*Stand-size class as a percentage of total timberland area, Nebraska, 1994 and 2001.*

In summary, results from the initial year of the annual inventory of Nebraska completed in 2001 generally agree with the trend of increasing forest land and increasing growing-stock volume observed throughout the second half of the 20th century. However, due to the small sample size in the first year of the annual inventory system, there are insufficient data at present to state with statistical certainty how Nebraska's forest resources have changed since the 1994 inventory. As additional data become available under the annual inventory system, a clearer picture of the status and direction of Nebraska's forests will emerge. Until that time, the 1994 inventory remains the best source of data on Nebraska's forest resources.

INVENTORY METHODS

Changes Between Inventories

Since the 1994 inventory of Nebraska, 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, the 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 Nebraska 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 12.15 percent for timberland area and 17.6 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

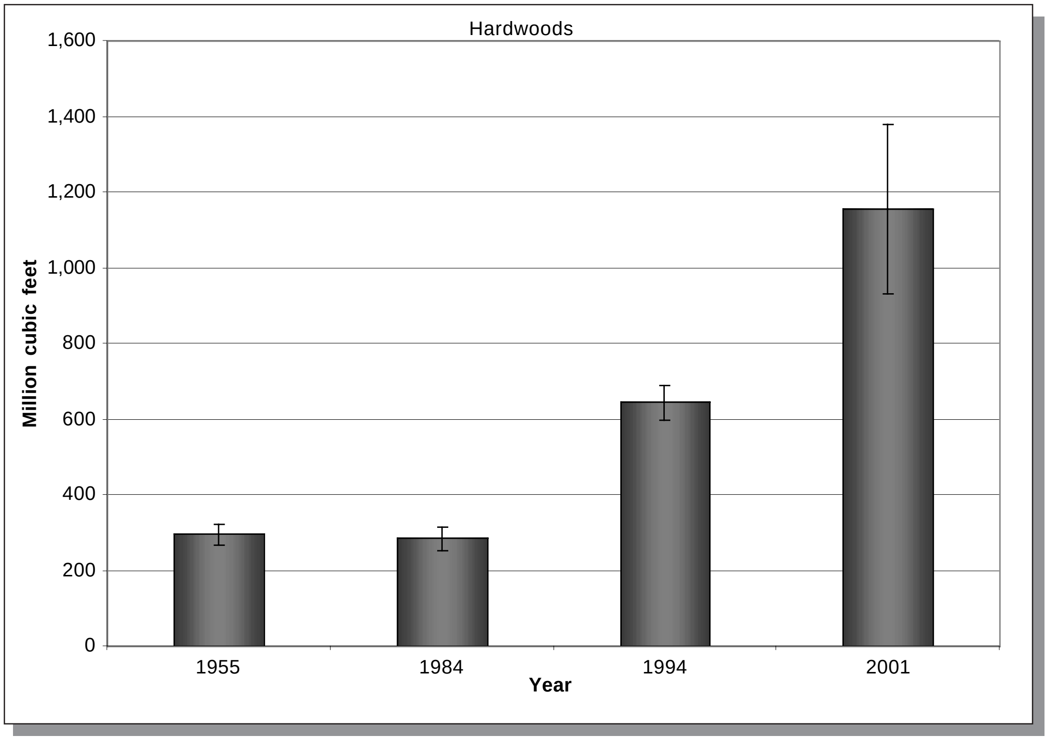

Figure 4.—*Hardwood growing-stock volume, Nebraska, 1955-2001. (Note: The sampling error associated with an inventory is represented by the vertical line at the top of its bar.)*

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.

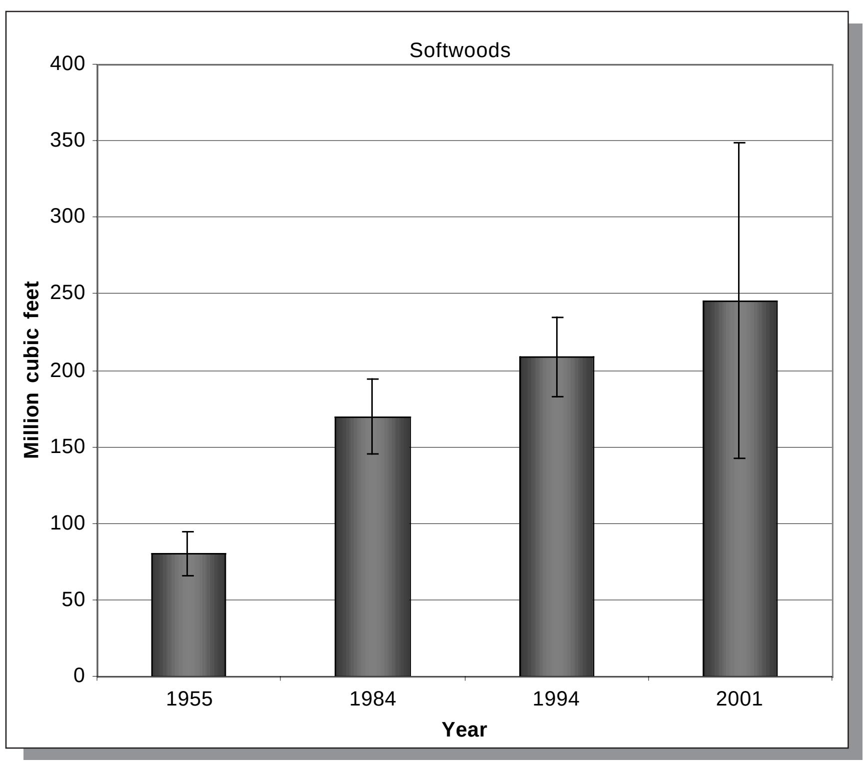

Figure 5.—*Softwood growing-stock volume, Nebraska, 1955-2001. (Note: The sampling error associated with an inventory is represented by the vertical line at the top of its bar.)*

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 Nebraska 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 Nebraska (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 into the nonforest/forest strata. In Nebraska, 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 Schmidt and Wardle (1998).

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 Nebraska. 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 Nebraska is funded by the Federal government. The State of Nebraska 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, nonoverlapping 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 Nebraska the complete 5-year annual inventory will involve about 519 phase 3 plots. On the remaining plots, only variables that can be measured throughout the entire year are collected. In Nebraska, the complete 5-year annual inventory is expected to involve about 7,116 phase 2 plots.

The new national 4-point cluster plot design was used for data collection (fig. 6) in 2001 and will be used in subsequent years. In Nebraska, 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 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.

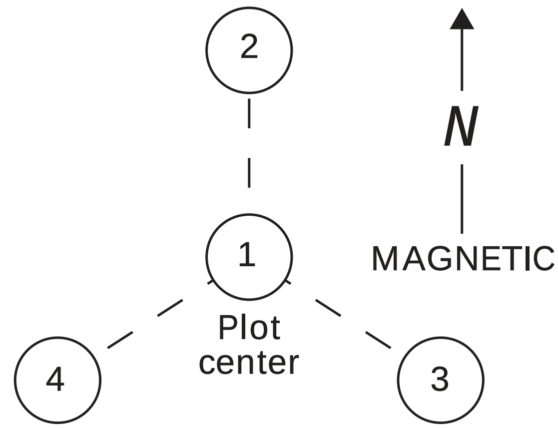

Figure 6.—*Current NCFIA field plot design.*

When the complete second five-panel cycle of the annual inventory has been implemented in 2009, (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. 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 5.0 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, change 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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