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Cover photo of Kansas oaks; photo used with permission by Mike Blair, Kansas Department of Wildlife and Parks.

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Foreword

This report is the result of the most recent inventory of the forests of Kansas. The inventory was a cooperative effort between the U.S. Forest Service, Northern Research Station Forest Inventory and Analysis (FIA) Program, and the Kansas Forest Service, a unit of Kansas State University. The results show that Kansas forests continue to increase in acreage with each inventory cycle dating back to 1936. Today, the State supports 2.1 million acres of forest land, or about 4 percent of the total land area. Because forest lands only cover a small portion of the land base, they are considered critical components of the natural resource of Kansas.

Most of our forest land is in private ownership. These forests produce high-quality hardwoods such as black walnut, a variety of oaks and ash that favorably compete in the market place and add to the economy of Kansas. Our forests are growing more wood than is being harvested, providing tremendous opportunities for landowners to receive income while applying sound management practices and thus improving the health and productivity of our forest lands.

Our forests, however, are valued for more than wood production. They provide a host of environmental benefits to Kansans, for example: clean water, quality wildlife habitat for both game and nongame species, stream bank stabilization, recreational opportunities, and beautiful landscapes. These important values often are overlooked or otherwise taken for granted.

To keep our forests healthy and productive, we must be vigilant with respect to potential threats. Kansas forests, like those of more heavily forested states, are being threatened by nonnative invasive species, loss of forest to development and other uses, and fragmentation of forests into smaller units making them more difficult to manage. This report provides a forum with which to address these threats and will help us make informed decisions about the future management of our forest lands.

Ray Aslin, State Forester

Contents

Highlights

On the Plus Side

- Forest land area increased from 1.5 million acres in 1994 to 2.1 million acres in 2005, and now represents roughly 4 percent of Kansas total land area.
- Softwood forests make up almost 5 percent of the total timberland area. Oak/hickory forest types make up 56 percent of the total hardwood timberland area of 2.0 million acres. Elm/ash/cottonwood forest types account for more than 32 percent of timberland area.
- The proportion of Kansas timberland with trees 19 inches and larger has remained at 38 percent over the last 40 years.
- Kansas forests continue to increase in volume. In 2005, the net volume of growing stock on timberland was an estimated 1.5 billion cubic feet compared to 0.5 billion cubic feet in 1965.
- Live-tree aboveground biomass on timberland in Kansas amounted to 70.8 million dry tons in 2005. More than 5 percent was in trees 1 to 5 inches, 50 percent was in growing-stock trees, and 45 percent was in nongrowing-stock trees.
- Almost 95 percent of Kansas forest land is held by private landowners.

Areas of Concern

- Kansas forests are increasing in density in certain locations. The number of trees per acre has increased by 106 percent since 1965.
- Since 1965, oak growing-stock volume has increased by 231 percent, hickories by 224 percent, and maples by 231 percent. Eastern redcedar volume has increased by 23,000 percent, which presents an opportunity for forest products but also concerns about woody encroachment into grasslands and changing wildlife habitat.
- Cull trees (rough, short log, and rotten) constitute 46 percent of all of the live-tree volume in Kansas' timberland.
- While cottonwood growing-stock volume has increased by nearly 50 percent since 1981, cottonwood regeneration has declined dramatically over the same period.
- Since the emerald ash borer (EAB), an Asian wood-boring insect, was identified in Detroit, Michigan, in 2002, more than 50 million ash trees are estimated to have been killed by the insect. Natural spread is about 0.5 mile each year. However, human activity such as transporting firewood has increased the area infected and some experts believe it is only a matter of time before EAB arrives in Kansas.

Forest Features

Black walnut plantation located at Kansas State University's Tuttle Creek Forestry Research Station near Manhattan, KS. Photo used with permission by Robert Atchison, Kansas Forest Service.

Attributes of Kansas Forest Resources

Although we think of Kansas as a prairie state, Kansas forests are a valuable part of the State's natural resource wealth. Providing shelter and food for wildlife, clean water for drinking and recreation, scenery for enjoyment, and wood products for consumption, construction, and fuel, Kansas forest resources have played a vital role in the ecological, economic, and social well-being of its residents.

This is a report of Kansas' first 5-year forest inventory covering 2001 through 2005. Under the new inventory design, about 20 percent of the State's plots are measured each year, resulting in total coverage over a 5-year period. This new design ensures that all parts of the State are sampled with equal probability. Kansas is divided into three inventory units based somewhat on ecological characteristics: Northeastern, Southeastern, and Western (Fig. 1).

Dennis Carlson, Kansas Forest Service District Forester, provides timber management recommendations to Leonard Ellis, at the city of Florence's Tree Farm, Marion County. Photo used with permission by Robert Atchison, Kansas Forest Service.

Figure 1.—Kansas inventory units and counties. All maps are courtesy of W. Keith Moser unless otherwise indicated.

Background

Climate and geology

Kansas' climate is on the arid side of a temperate, humid continental climate and is characterized by extreme fluctuations. The average mean temperature is 55 °F with a record high of 121 °F and low of –40 °F. Annual precipitation ranges from slightly more than 40 inches in the southeast to as little as 16 inches in the west (Fig. 2). About 70 to 77 percent of the precipitation falls between 1 April and 30 September. Drought, extreme temperature fluctuations, and storms all affect forest health. Dodge City is said to be the windiest city in the United States, with an average wind speed of 14 mph.

Kansas hosts a variety of landscapes, shaped by geologic processes and recent human activities, such as farming and mining. Based on landscape features and geological history, Kansas has 11 different regions (Fig. 3). Each physiographic province tells a unique story about the State's geology. Much of Kansas was once an inland sea, which is why sedimentary limestone rock dominates much of the landscape. Tree leaf fossils that are 100 million years old document the presence of ancient forests.

History[1]

One can only speculate what the historic forests of Kansas must have looked like. Prior to human settlement, forests covered an estimated 8 percent of the State's land area (Ware and Smith 1939). The original forests of Kansas were located predominantly in the eastern third of the State where the central hardwood forests of the United States transitioned into the Great Plains and precipitation was adequate for tree growth. There, forests existed on rich alluvial bottomlands and on moist upland sites. Moving east to west across the State, forest land was more and more confined to river valleys or riparian areas that offered some protection from fire, a dominant force in limiting trees from invading the prairie. According to public land surveys that began in 1854 when the office of Surveyor General was established, there is a mistaken perception that there were no trees in the western part of the state prior to settlement. According to West (1998), the scarcity of riparian forests in these surveys results from some of the most rapid and dramatic changes experienced by the Great Plains beginning in the mid-to-late 1850s. This included the spread of horses in conjunction with the rise of the Plains Indian population, the Colorado Gold Rush, westward movement across overland trails, the rise of agriculture, and the settlement of Kansas. The result was that by the 1900s, most riparian woodlands had been harvested. West also documented the existence of the "Big Timbers," viewed by Zebulon Pike in 1806, where the Arkansas River intersects the modern day boundaries of Colorado and Kansas. Pike reported: "Abundant stands of cottonwood were found at that point to about 60 miles upstream." The Big Timbers are one of three unique forested ecosystems documented. Another was located on the Smoky Hill River in Wallace County and the third on the

[1] This section was adapted from Leatherberry EC, Schmidt TL, Strickler JK, Aslin RG. 1999.

Republican River south of present-day McCook, Nebraska. Because of the changes to the Kansas landscape before 1843, West questioned the reliability of using public land survey data to accurately describe presettlement plant communities.

In areas, such as the Red Hills region of south-central Kansas (Fig. 3), eastern redcedar *(Juniperus virginiana)* trees were found scattered savanna-like over the prairie. There were groves of deciduous trees and shrubs in valley bottoms and on north-facing slopes throughout much of the region (Küchler 1974). Over the past several hundred years, humans have had an accelerating influence on the nature and extent of forest land in Kansas. The Kansa and Osage Indians were among the first settlers in the region, and were active in shaping the structure and extent of forest land. In eastern Kansas, they cleared forest in river valleys for agricultural activities. On the prairies and plains, tribal groups such as the Pawnee and Kiowa, used fire to prepare range land for spring grazing by the American bison and pronghorn antelope. Those periodic, human-caused fires, along with lightning-caused fires, limited forest expansion.

The first European settlers in the region were attracted to the 4.5 million acres of forest land in what is now Kansas. Those settlers, most of whom were from the eastern United States or northwestern Europe, believed that only forest land could be farmed successfully. The timber-covered alluvial valleys of the rivers in eastern Kansas were the first lands to be settled by European-Americans (Ware and Smith 1939). Those settlers cleared much of the land of its original forest cover, not only for agriculture but also for building material, fencing, and fuel. By about 1860, many of the counties in eastern Kansas had reached populations of more than 10,000 residents (Edmondson and Miller 1997). Those counties were settled rapidly because they were places where field crops could grow without irrigation.

As settlement expanded onto the prairie, State and Federal governments established tree-planting initiatives. For example, the Kansas legislature passed laws providing financial incentives for any person who planted and cultivated 5 or more acres of trees (Ware and Smith 1939). The Timber Culture Act of 1873 dispensed Federal land to settlers and included tree planting as an enticement. Government tree-planting initiatives were intended to increase tree cover to modify the climate and provide much needed supplies of lumber, fence posts, and fuel. In addition, many people who established homesteads on the prairie brought seedlings and other plantings with them to recreate remnants of forest environments they were familiar with (Schaefer et al. 1987). For many settlers, trees provided psychological relief from the harsh climate and unending space of the Great Plains (Sutton 1985). However, periodic drought as well as a lack of management took a toll on the trees that were planted (Ware and Smith 1939).

As agriculture expanded and more virgin sod was plowed, periodic crop failures and the resultant severe wind erosion contributed to the well known Dust Bowl era. This period of severe drought during the 1930s accentuated the importance of trees to dry land agriculture on the Great Plains. Subsequently, the Federal government established programs by which thousand of acres of tree windbreaks were planted in Kansas. The windbreaks proved a necessary and vital part of dry land agriculture because they minimized soil loss from high winds.

By 1936, forest land in Kansas had been reduced to approximately 1.2 million acres (Ware and Smith 1939). Most of the forest land in Kansas occurred naturally but some was in plantations or field plantings such as farmstead windbreaks, farm woodlots, and rural school plantings. Between 1936 and 1965, forest land increased by about 112,000 acres, or 9 percent, to 1.3 million acres. The increase was due largely to natural tree regeneration on idle pasture and cropland rather than artificial reforestation (Chase and Strickler 1968). Controlling and suppressing wildfires also led to an increase in forest land area. Wildfire control was more effective after World War II as excess Federal property was made available for use in rural volunteer fire districts. The Kansas Forest Service played a significant role in organizing fire districts and in distributing critically needed equipment.

Between 1965 and 1981, forest land increased by 8,900 acres to more than 1.4 million acres. Forest land accounted for 3 percent of the State's total land area. The greatest single impact on the forest land between 1965 and 1981 was the death of many American elms *(Ulmus americana)* from Dutch elm disease (Spencer et al. 1984).

Planted windbreaks and natural wooded strips, the latter found mostly along rivers and streams, are important components of the landscape. However, most wooded strips and windbreak plantings do not qualify as forest land under the FIA definition because of their narrow, linear nature. Nonetheless, they have played an important role in Kansas history. For example, in some areas, "living fences" of Osage-orange *(Maclura pomifera)* were planted. It is estimated that farmers in Kansas planted 34,000 miles of single-row Osage-orange hedges between the middle of the 19th and middle of the 20th centuries (Stoeckeler and Williams 1949). Many of these hedgerows exist today. In 1965, the total area of wooded strips was estimated to be 215,000 acres (Chase and Strickler 1968). In 1981, wooded strips and windbreaks combined occupied 333,000 acres (Spencer et al. 1984). In some parts of the State, the area of wooded strips and windbreaks has declined. For instance, Sorenson and Marotz (1977) reported a 20 percent decrease in wooded strips between the late 1950s and early 1970s for a 13-county area in central Kansas. It is difficult to draw conclusions about the area of wooded strips and windbreaks because of differences in survey definitions and area covered. At any given time, the area of wooded strips and windbreaks was dependent on the attitude of landowners toward them. In 1994, forest land in Kansas totaled more than 1.5 million acres, up 13 percent from the nearly 1.4 million acres in 1981.

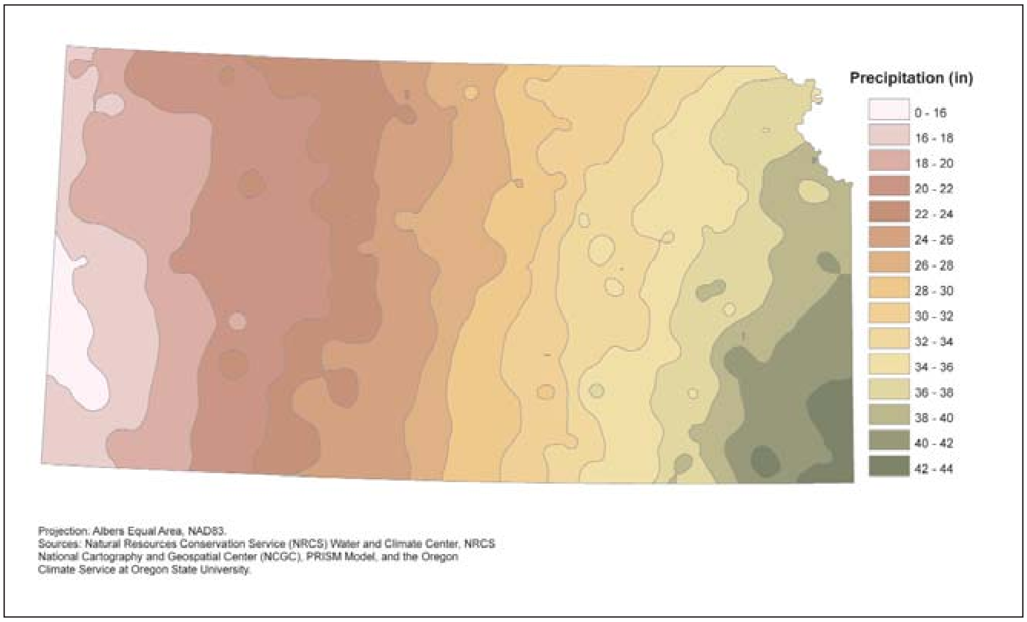


Figure 2.—Average yearly precipitation in Kansas, in inches. Map Source: USDA Natural Resource Conservation Service, Salina, KS.

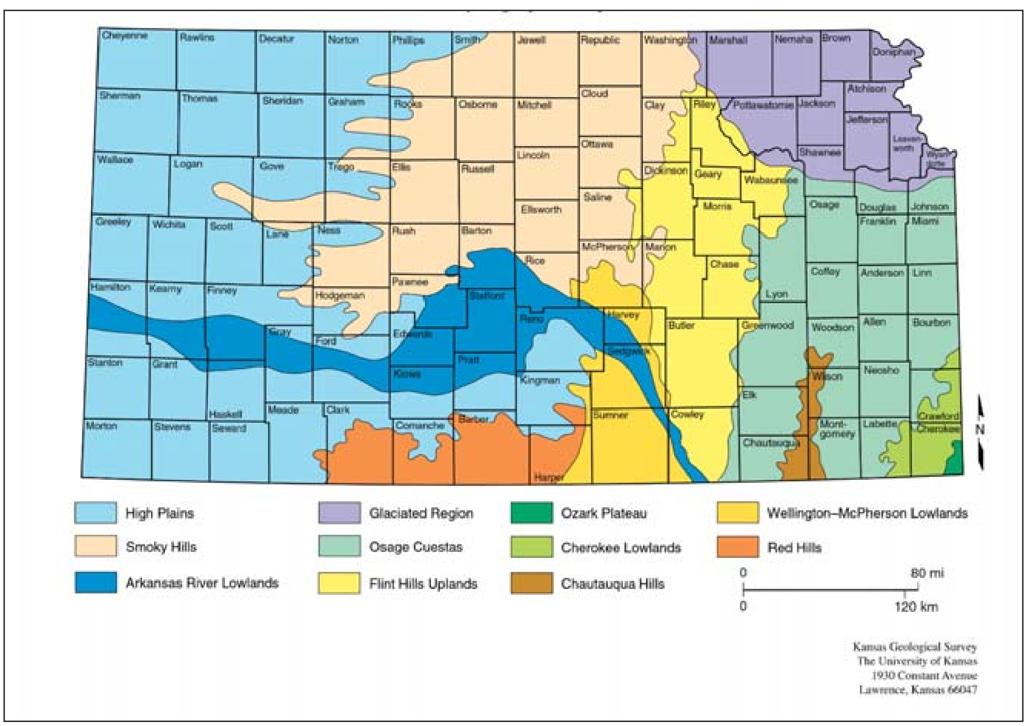


Figure 3.—Physiographic regions of Kansas. Map Source: Kansas Geological Survey, Lawrence, KS.

Forest Land Area

Background

Kansas plays host to the transition of the central hardwood forests of the eastern United States to the prairies of the Great Plains. Largely dominated by agricultural grasses and croplands, Kansas forests tend to be linear in shape, following streams and rivers. Because the State's forests are comparatively scarce, evaluating change in status and condition is important. Although forest land has increased by 56 percent since 1965, the State's human population has grown even more, placing increasing pressure on the forest resource for recreation, wildlife habitat, and other goods and services.

The FIA protocol defines forest land precisely: a minimum of 1 acre in area, 120 feet across at the narrowest width, and at least 10 percent stocking or capable of 10 percent stocking. In states with a large amount of agricultural land, prairie, and/or highly manipulated or disturbed forests, not all treed land is included in such a definition. In fact, a significant portion of Kansas trees likely is NOT included.

What we found

Four percent of Kansas land area of more than 52 million acres currently is in forest land (Fig. 4). At 2.1 million acres, Kansas forest land area is the highest amount in recent times. Most of this land is dominated by various hardwood forest types. Only 5 percent of the forest land is covered by softwood forest types such as eastern redcedar or ponderosa pine (Table 1).

To better estimate the extent of trees on Kansas landscape, NRS-FIA combined inventory data with spatial data from other sources to estimate treed land in the State. Figure 5 includes estimates of additional treed land by major watershed. In some regions, treed land approaches or even exceeds FIA estimate of forest land. These additional acreages are not trivial. In one watershed in northeast Kansas, additional estimated treed land exceeded 260,000 acres.

What this means

The increase in forest land continues a trend that began in 1936 of expanding with each successive inventory. The increase in forest land area between 1994 and 2005 is due primarily to trees becoming established on abandoned croplands and pastures. Although planting trees has been an important activity since the mid-1800s, nearly all of the forest land in Kansas is naturally occurring. Although the area of plantations is small, the overall area of land planted to trees in Kansas is much larger. In 1994, more than 2,000 acres of land was planted to trees (Moulton et al. 1995). Most of land planted to trees in Kansas is classified as nonforest land with trees primarily because the plantings do not meet the minimum FIA requirements to qualify as forest land.

Kansas forest land makes up a far smaller percentage of the State's total land area than states farther east. Yet precisely because of the relatively small size, forested areas play a disproportionate role in providing wildlife habitat and human recreation opportunities. They are an important component of the State's biodiversity and ecosystem health. FIA estimates of treed land takes into account the varied nature of the Kansas wooded landscape. In the sections that follow, we explore these factors with respect to forest species, size, age, ownership, and diversity.

Forest land located in western Kansas at Lake Scott State Park. Photo used with permission by Robert Atchison, Kansas Forest Service.

Figure 4.—Distribution of forest land area by percent of total area, Kansas 2005.

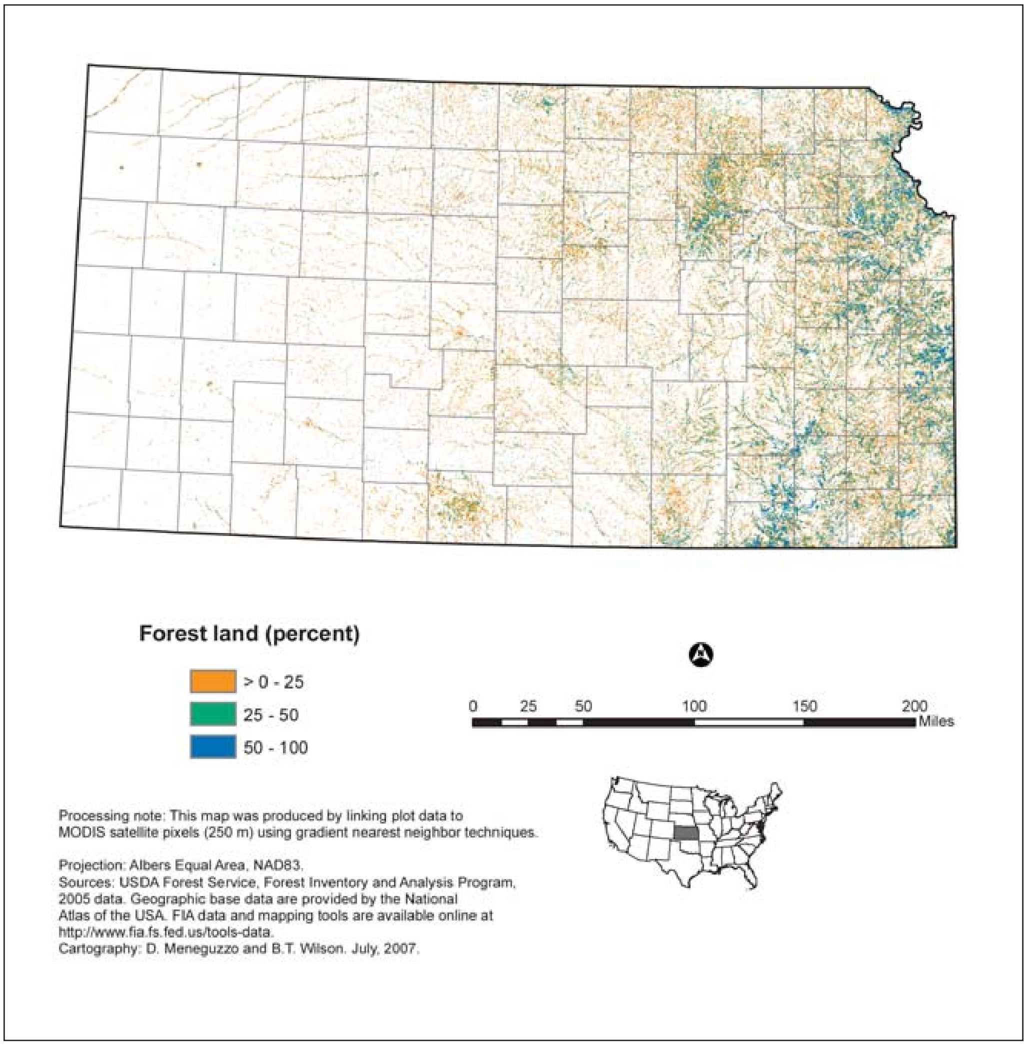
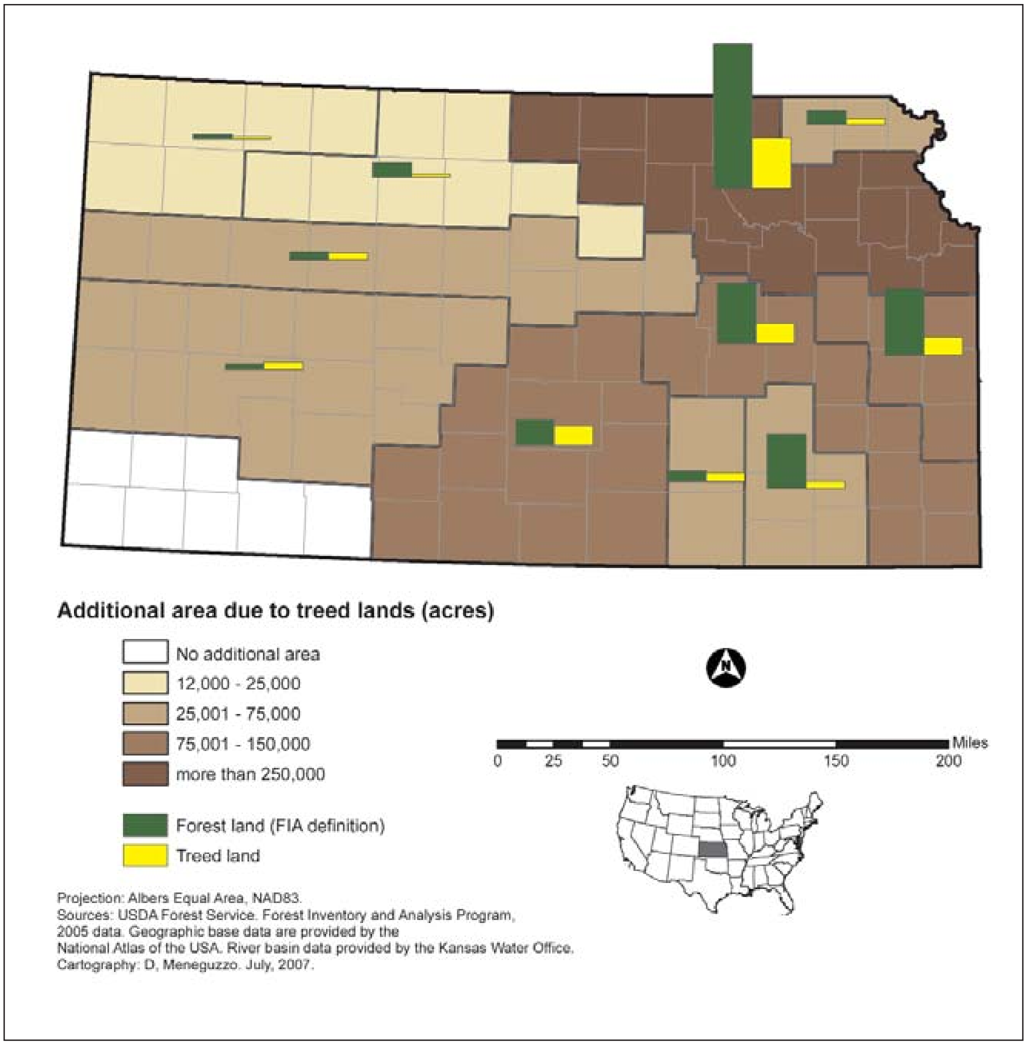


Table 1.—Area of forest land by forest type, Kansas 2005.

Forest type	Acres
Softwood	
Eastern redcedar	93,640
Ponderosa pine and other pines	10,231
Softwood total	**103,871**
Hardwood	
Eastern redcedar/hardwood	69,613
Post oak/blackjack oak	135,030
White oak/red oak/hickory	263,280
Northern red oak	11,043
Sassafras/persimmon	6,439
Bur oak	40,046
Black walnut	29,789
Mixed upland hardwoods	638,525
Swamp chestnut oak/cherrybark oak	5,222
Elm/ash/cottonwood group	1,499
Black ash/American elm/red maple	678
River birch/sycamore	30,228
Cottonwood	96,470
Willow	13,092
Sycamore/pecan/American elm	35,938
Sugarberry/hackberry/elm/green ash	409,057
Silver maple/American elm	11,537
Cottonwood/willow	23,744
Sugar maple/beech/yellow birch	41,432
Elm/ash/locust	80,336
Deciduous oak woodland	1,410
Other exotic hardwoods	27,861
Hardwood total	1,972,266
Nonstocked[a]	29,381
Total	**2,105,519**

[a.] Nonstocked lands have less than 10 percent of potential full stocking of live trees.

Figure 5.—Estimated additional area due to treed lands, Kansas 2005 (dark lines denote county groupings based on watersheds).



Timberland Area

Background

Using two criteria – productive/unproductive and reserved/unreserved – FIA defines three components of forest land: 1) Timberland – forest land not restricted from harvesting by statute, administrative regulation, or designation and capable of growing trees at a rate of 20 cubic feet per acre per year at maximum mean annual increment; 2) Reserved forest land – land restricted from harvesting by statute, administrative regulation, or designation (e.g., state parks, national parks, federal wilderness areas); and 3) Other forest land – low-productivity forest land not capable of growing trees at a rate of 20 cubic feet per acre per year. Timberland makes up 96 percent of Kansas forest land. The 0.1 million acres that are not timberland are important from an ecological point of view. Some of the area is reserved for nontimber uses such as recreation or wildlife. Other areas, perhaps due to low precipitation or soil productivity, do not support sufficient tree growth. Nonetheless, in an area in which forests are relatively scarce, all manner of forest land is important for biodiversity.

What we found

Timberland area has almost doubled since 1936 (Fig. 6). Nonetheless, timberland area in 2005, at 2.0 million acres, still was less than 4 percent of Kansas' 52.5 million acres of land. The State's timberland was dominated by hardwoods (94 percent of total timberland acreage), particularly oak-hickory (1.1 million acres) and elm-ash-cottonwood (0.6 million acres) forest-type groups (Fig. 7). Of the forest land that was not timberland, there were 76,100 acres of unproductive forests and 1,500 acres of reserved forests.

What this means

Historical accounts have estimated that Kansas presettlement forests exceeded 4 million acres. Today's forests cover considerably less area but the recent increase in the timberland base suggests there might be more opportunities for the industries that rely on wood from Kansas. Although some factors in the definition of forest land are fixed for a particular site, e.g., maximum potential growth rate, others can be influenced by human activities. A landowner in Kansas can modify land use by allowing land to naturally seed into trees, plant the land with trees, or control fire that otherwise would eliminate any tree regeneration, thus increasing the amount of timberland. We suspect that all of these decisions have played a role in the increase in timberland acreage in Kansas since 1936. During the 1990s, change in definition by FIA that reclassified some wooded pastures as forest land likely contributed to the increase in area between 1994 and 2005.

Figure 6.—Area of timberland by inventory year, Kansas 1936–2005 (the sampling error associated with each inventory estimate represents a 67 percent confidence interval and is depicted by the vertical line at the top of each bar).

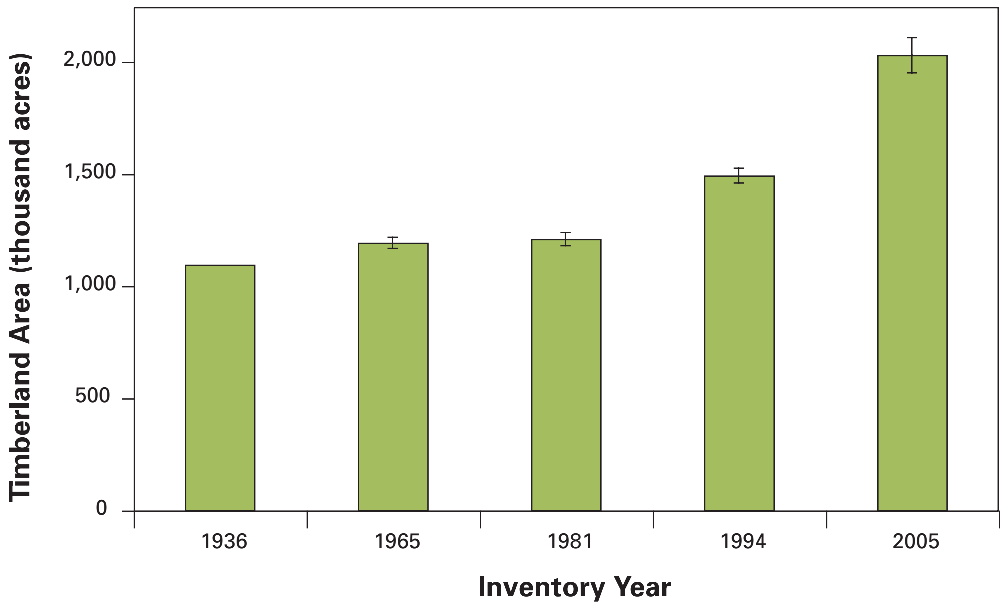
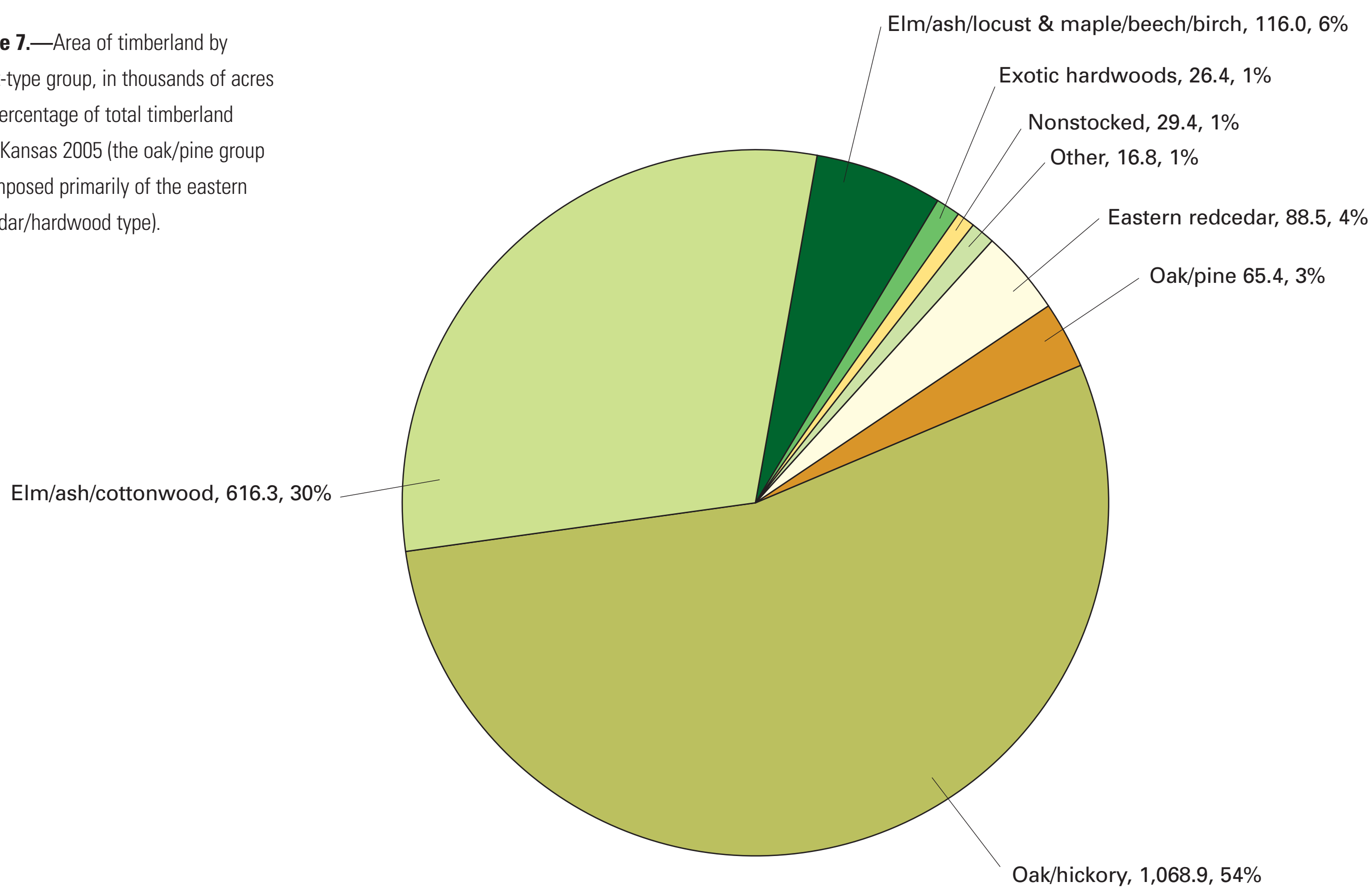


Figure 7.—Area of timberland by forest-type group, in thousands of acres and percentage of total timberland area, Kansas 2005 (the oak/pine group is composed primarily of the eastern redcedar/hardwood type).



Live-Tree Volume

Background

The volume of live trees on forest land represents both the accumulated growth of a tree since it was regenerated and the residual impact from past natural disturbances (e.g., weather, fire, or insects and disease) as well as from human activities (e.g., harvesting, conversion to another land use, or planting). To different users, tree volume represents wildlife habitat potential, measures of aesthetic beauty, potential for wood products, or stored carbon. Summarizing this elemental variable is the first step in understanding Kansas forests.

What we found

The volume of live trees has increased steadily since FIA measurements were first taken in the State. In 2005, live-tree volume on forest land in Kansas was an estimated 2.7 billion cubic feet. Softwoods on forest land made up 3 percent (85 million cubic feet) and hardwoods constituted 97 percent (2.7 billion cubic feet). On timberland, the net volume of live trees and salvable dead trees was 2.7 billion cubic feet (Fig. 8). Live trees were 99 percent of this total. Most of this volume was in the eastern half of the State (Fig. 9).

Of the 1.5 billion cubic feet of volume in growing-stock trees[2], 77 percent (1.1 billion cubic feet) was sawtimber size. Cull trees, at 1.2 billion cubic feet, made up 45 percent of live-tree volume on timberland. The cull-tree volume in softwoods in 2005 represented 32 percent of the total softwood live-tree volume, whereas hardwood cull trees represented 46 percent of the total hardwood volume.

[2] Growing-stock volume is defined as wood volume in standing trees of suitable species that are healthy, sound, reasonably straight, and greater than 5 inches in diameter at 4 1/2 feet above the ground. The difference between live-tree volume and growing-stock volume could result from many factors. For example, species may not be considered commercially exploitable, or individuals may be of poor form. A tree may have a defect like rot or its bole length might not meet minimum standards for length and soundness.

What this means

Although live-tree volume has increased steadily since 1965, a significant portion remains in cull trees (rough and rotten trees that are less desirable in the manufacture of forest products). Reducing the percentage of volume in cull trees will be difficult given their prominence on the landscape. This situation partly is the result of the historical structure of Kansas forests, where many stands, even those now with high density, developed in low-stocking conditions. The lack of large contiguous blocks of forest throughout the State means that a higher proportion of trees developed with edge effect, again creating branchiness and full-crown conditions. For example, denser forests increase the shading on branches, encouraging self-pruning and somewhat limiting any tendency toward multiple stems. Human intervention, harvesting cull trees and/or encouraging growing-stock trees, can influence cull proportions, yet there are limited markets for many of these cull trees. USDA programs like the Environmental Quality Incentives Program (EQIP) for Forest-land Health, provide forest-land owners with a financial incentive to remove cull trees. It should be noted that cull trees are a valuable source of wildlife habitat and aesthetic interest.

Hackberry in Marion County woodlands with lots of character but no commercial value. Photo used with permission by Robert Atchison, Kansas Forest Service.

Figure 8.—Net volume of live trees and salvable dead trees on timberland, by size class, tree class, and species group, Kansas 2005.

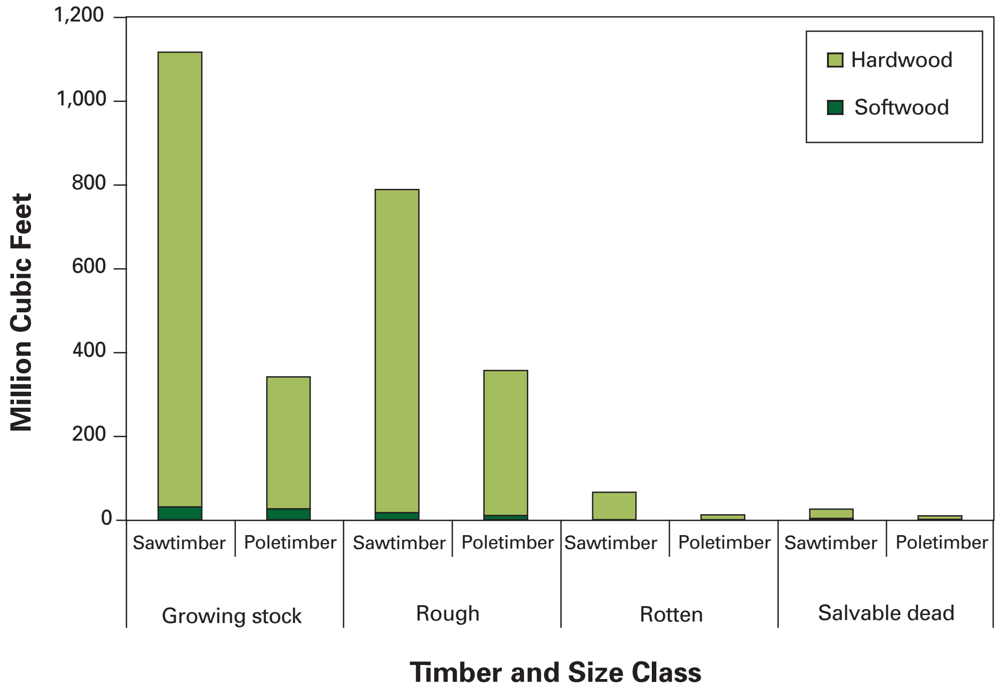
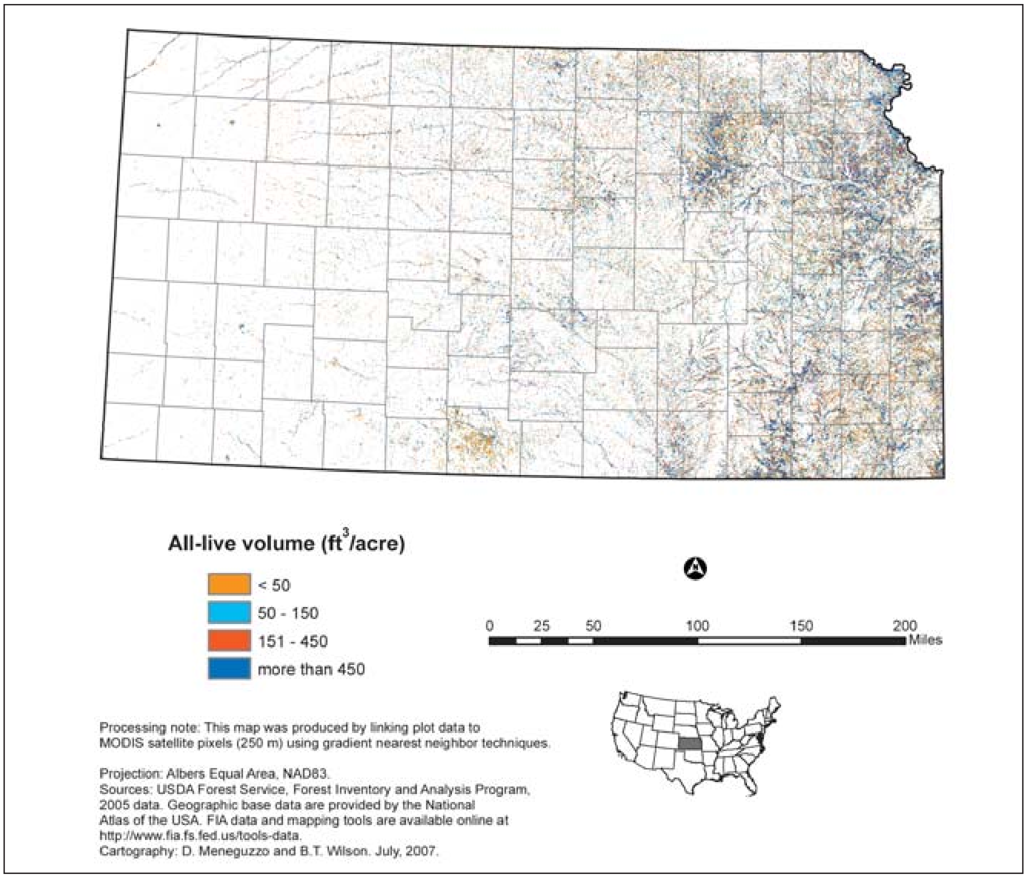


Figure 9.—Live-tree volume per acre on forest land, Kansas 2005.



Growing-stock Volume

Background

Historically, we measured growing-stock volume to get an idea of the potential resource for manufacturing wood-based products. Even as the inventory assumed a more ecosystem-based orientation, growing-stock volume still informs us about the sustainable use of Kansas forest resources. Growing-stock volume is defined here as wood volume in standing trees that are healthy, sound, reasonably straight, and greater than 5 inches in diameter at a height of 4.5 feet above the ground. The noticeable difference between live-tree volume and growing-stock volume is one of many factors that we evaluate to determine the ecological and economic health of Kansas forests.

What we found

Growing-stock volume was just under 1.5 billion cubic feet, a 16 percent increase since 1994 (Fig. 10), and a 197 percent increase since 1965. All of the major species groups showed a triple-digit increase in volume since 1965. Eastern redcedar showed an incredible 23,000 percent increase (Table 2). In 1981, Kansas timberland had no volume in overstocked stands. In contrast, there was 24 million cubic feet of overstocked volume in 2005. The volume in fully-stocked stands also jumped between 1981 and 2005, from 141 million cubic feet (18 percent of the total growing stock in 1981) to 444 million cubic feet in 2005 (30 percent of the total) (Fig. 11). More than 96 percent (1.4 billion cubic feet) of the total growing-stock volume on timberland was in hardwood species and 4 percent (56.7 million cubic feet) was in softwood species.

Looking at the State by inventory unit (Fig. 12), the Northeastern unit volume has increased steadily since 1981. The Southeastern and Western units increased in volume between 1981 and 1995 but have since shown no significant change. The bulk of Kansas timberland volume is in either oak-hickory or elm/ash/cottonwood forest type groups. In almost all cases, the contribution of softwoods to total growing-stock volume is minimal (Fig. 13).

What this means

Growing-stock volume has been increasing steadily in Kansas over the last 40 years. This rise coincides with a trend of increasing density on timberland in Kansas, with many stands transitioning from medium stocked to fully stocked. Harvesting in these denser stands might be more economically advantageous as loggers remove more wood at each location, thus reducing setup and transportation costs. As more and more forest stands reach full stocking, these increases in volumes probably will slow and we will not observe the dramatic gains observed so far.

Figure 10.—Volume of growing-stock trees by inventory year on timberland, Kansas 1981-2005 (the sampling error associated with each inventory estimate represents a 67 percent confidence interval and is depicted by the vertical line at the top of each bar).

Table 2.—Volume of growing-stock trees on timberland, Kansas 1965 and 2005, in thousand cubic feet.

Species group	1965	2005	Percent increase
Select white oaks	35,960	129,434	260
Select red oaks	25,340	88,443	249
Other white oaks	10,210	33,580	229
Other red oaks	18,930	48,733	157
All oaks	90,440	300,190	232
Hickories	20,590	66,895	225
Hard maple	2,200	7,944	261
Soft maple	8,770	31,736	262
Eastern redcedar	210	48,953	23,211

Figure 11.—Volume of growing-stock trees by stocking class, Kansas 1981, 1994, and 2005.

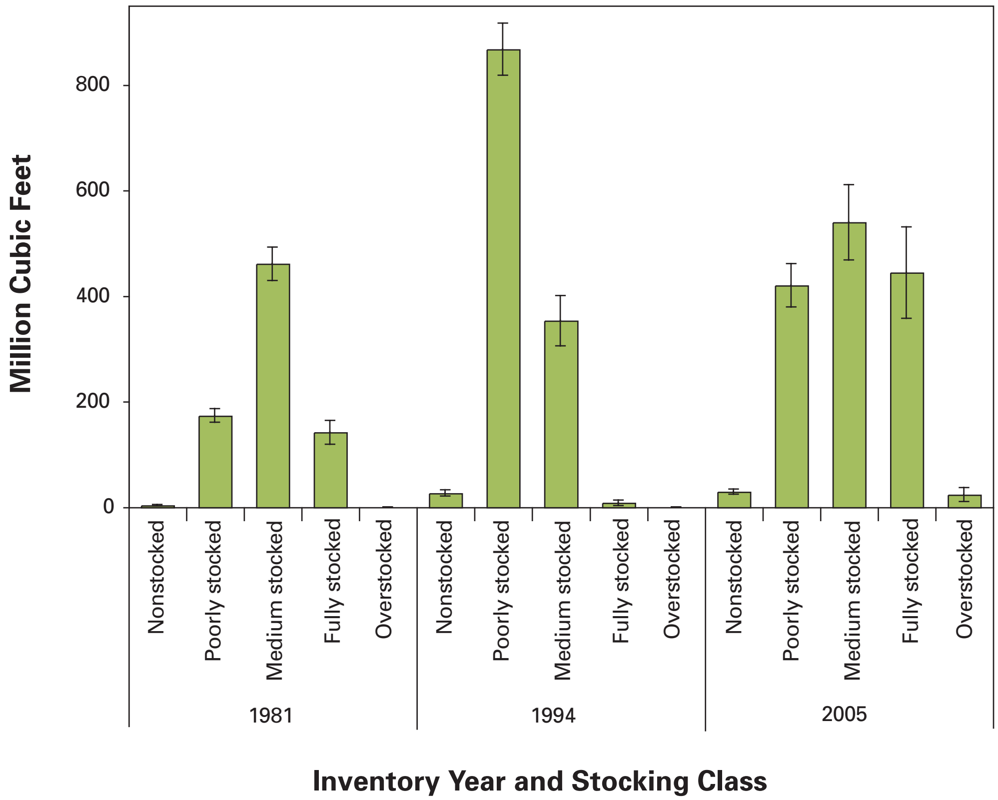


Figure 12.—Volume of growing-stock trees on timberland by inventory unit and inventory year, Kansas 2005.

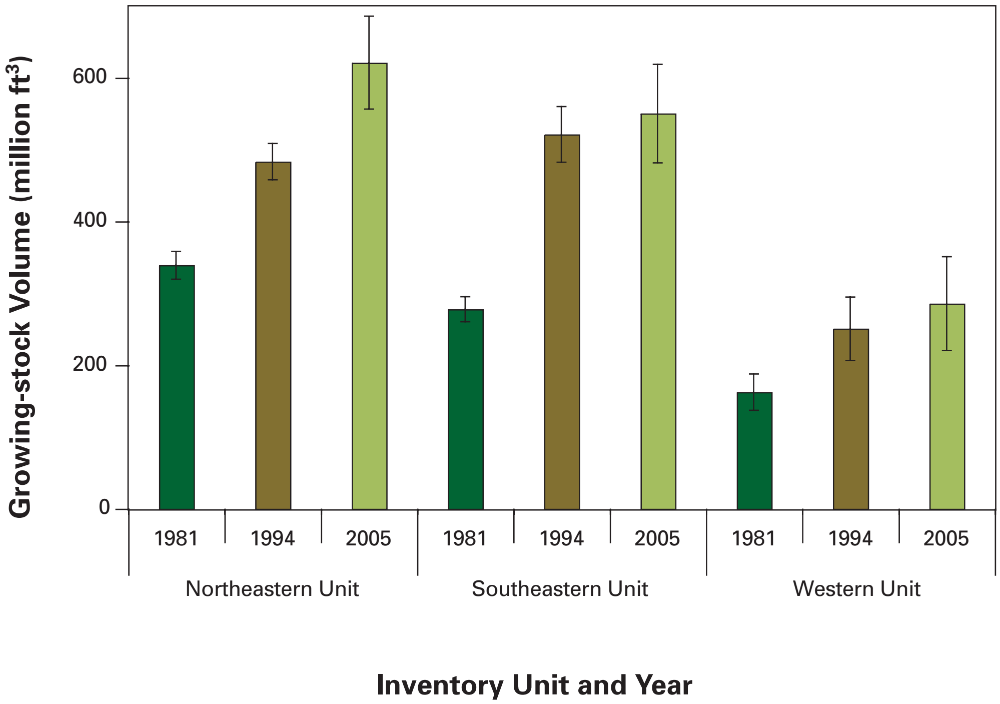
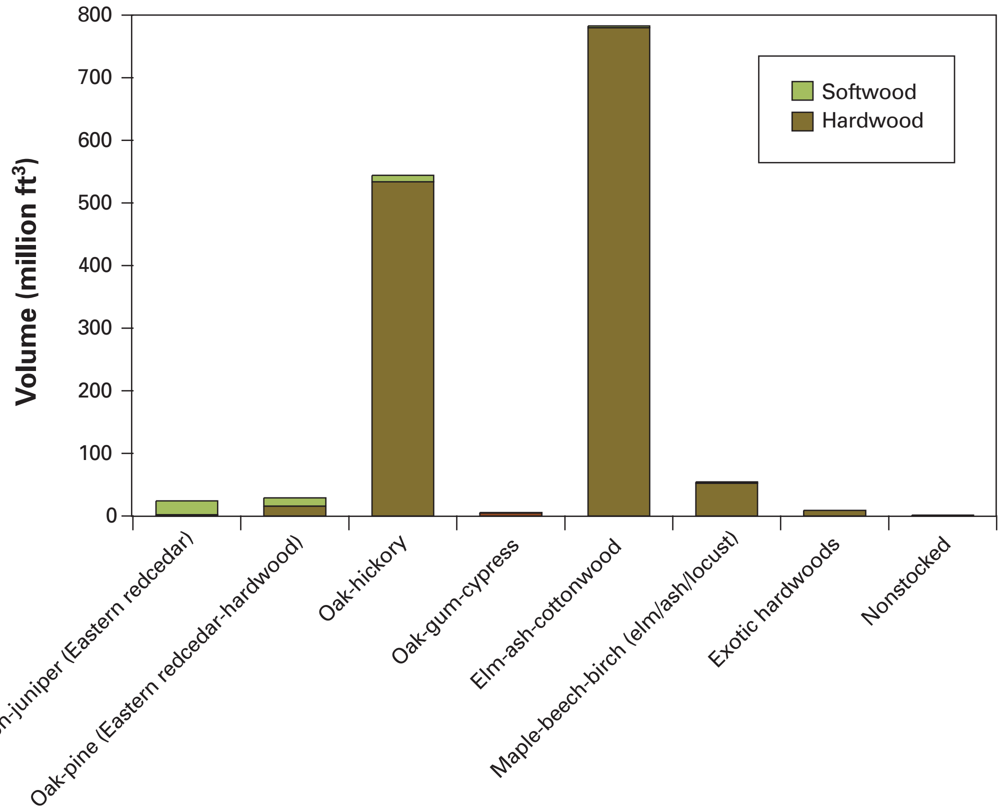


Figure 13.—Volume of growing-stock trees for selected forest type groups on timberland, Kansas 2005. The pinyon-juniper groups was primarily composed of the eastern redcedar type. The maple-beech-birch group was primarily composed of the elm-ash-locust type. The oak-pine group was primarily composed of the eastern redcedar/hardwood type.



Density

Background

Before European settlement, some portions of Kansas forests had a more widespread, open-woodland character with fewer but larger trees per acre than what we see today. As stated earlier, most of the presettlement forests were located in the eastern part of the State, which experienced sufficient rainfall to support tree growth and possessed good soils, either moist upland sites or rich alluvial bottom lands (Ware and Smith 1939). The farther west one traveled, the more forested areas were confined to riparian areas or steep or dry slopes. The former sites were moist enough to support forests while reducing the incidence and effect of wildfires; the latter sites did not produce sufficient fuels to carry fires frequently enough to burn out the trees.

Kansas forests have trees of nearly every size. To characterize average tree size in a stand, FIA looks for the plurality of stocking by stand size class: Small – less than 5 inches d.b.h. (diameter at breast height); Medium – 5 to 9 inches d.b.h. for softwoods and 5 to 11 inches d.b.h. for hardwoods; Large – more than 9 inches for softwoods and 11 inches for hardwoods. The FIA stand-size variable provides some indication of the stages of stand development (Oliver and Larson 1996), but the correlation with stand or tree age is less robust because the classification is based solely on tree diameter (McWilliams et al. 2002). There is no "right" mix of stand-size classes across the State; rather, particular combinations or trends might explain observations of forest health, growth, or change.

The distribution of basal area across Kansas in 2005 is shown in Figure 14. There is a long-term trend of increasing basal area on Kansas timberland (Fig. 15). Most of Kansas timberland was in the medium and large stand-size classes. In 2005, large-diameter acreage stood at 960,000 acres, or 47 percent of the total timberland acreage. The proportion of small size-class stands was 16 percent, or 319,000 acres (Fig. 16). Small size-class acreage increased dramatically between 1965 and 1981 (Fig. 17). From 1981 to 1994, medium size-class timberland acreage increased, likely because some of the previously small-diameter trees grew into the larger size classes. Large size-class timberland did not show a substantial percentage increase during any period, reflecting the large acreage already in that size class. The nonstocked area greatly increased on a percentage basis between 1994 and 2005, but this reflects a small base so the actual acreage increase was not substantial.

The number of trees in Kansas forests is increasing, particularly in the larger diameter classes (Fig. 18). In 2005, we estimated there were 718.5 million live trees in Kansas. Less than 8 percent, or 56.8 million trees, were softwoods; the remaining 661.6 million trees were hardwoods. If we look only at growing-stock trees on timberland, the total number drops to 394.9 million trees. The softwood portion of growing stock increases to 12 percent, or 48.8 million trees, and the hardwood portion decreases to 88 percent, or 346.1 million trees. The percent change in the number of trees is shown in Figure 19. There were dramatic gains from 1965 to 1981 and a smaller increase from 1994 to 2005.

Looking at the stand density index (larger values indicate higher density; [Reineke 1933, Woodall and Miles 2006]), we also found a long-term trend of increasing density (Fig. 20), apparently occurring primarily in riparian forests (Fig. 21).

Density is not merely a function of the horizontal occupancy of trees but also of the vertical space occupied by the forest. Growing-stock volume per acre in 2005, though declining slightly since 1994, still is 11 percent more than in 1981 (Fig. 22) and more than twice as large as in 1965. Along with the increase in the number of growing-stock trees has been a 69 percent increase in the average volume of a live tree and a 37 percent increase in the average volume per growing-stock tree since 1981 (Fig. 23).

What this means

In many areas, Kansas forests are denser now than in the past. On average, individual trees are larger in the latest inventory than in previous ones. The combination of more and larger trees suggests increased opportunities for utilization. Density increases also suggest that forest health problems are on the horizon. Overstocking combined with a high volume of cull suggests great opportunities for timber stand improvement that can be subsidized through programs like EQIP. The smaller rate of increase in growing-stock volume per acre between 1994 and 2005 compared to the earlier interval (1981-94) suggests more of the available growing space is being occupied by trees and that the trees, being larger (and presumably older) are slowing in volume growth.

We do not speak of a particular level of forest stocking as good or bad. In some cases, higher density means more competition for available resources of light, water, and nutrients. Competition is a natural ecological process. Trees that “lose” this competition are at risk for attack by insects and diseases. However, low-density stands provide suitable habitat for some wildlife, though these trees tend to be branchy and less useful as wood products. Managing this mix of high, medium, and low densities is a challenge for Kansas forest-land owners given limited utilization opportunities.

Figure 14.—Basal area of live trees in Kansas 2005.

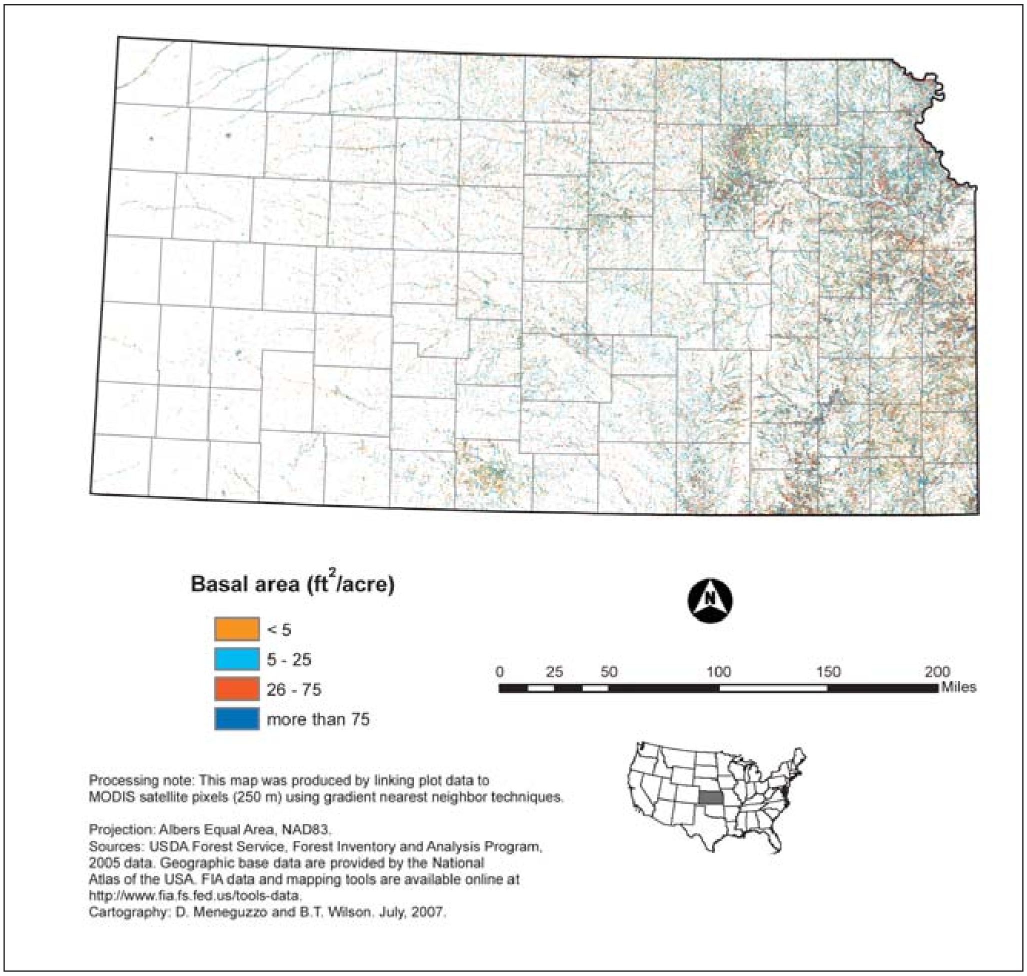


Figure 15.—Timberland acreage by live-tree basal-area category, Kansas 1981-2005.

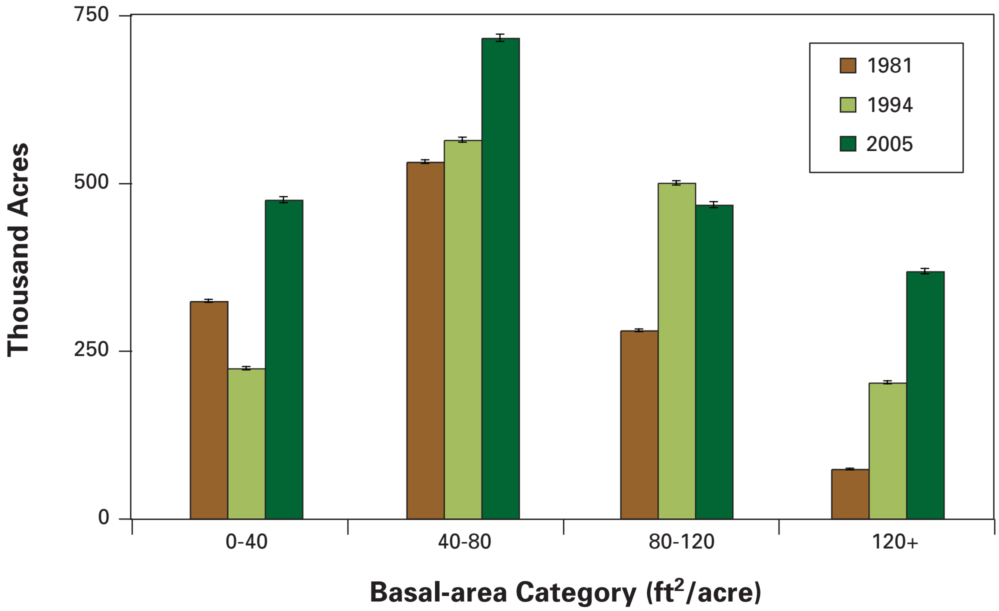


Figure 16.—Area of timberland by stand-size class, Kansas 1965-2005.

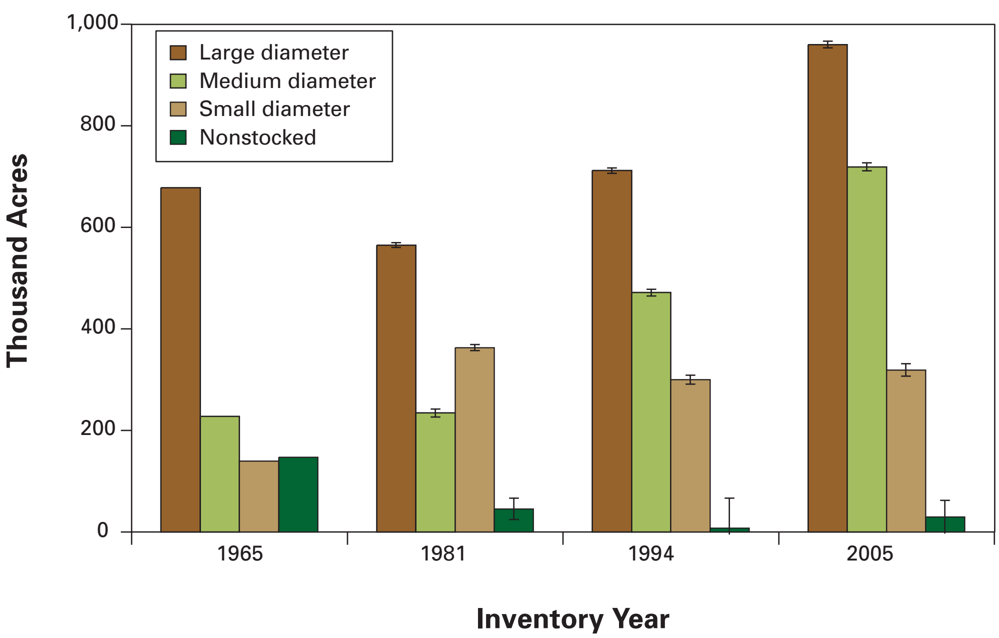


Figure 17.—Annual percent change in timberland area, by stand-size class, Kansas 1965-2005.

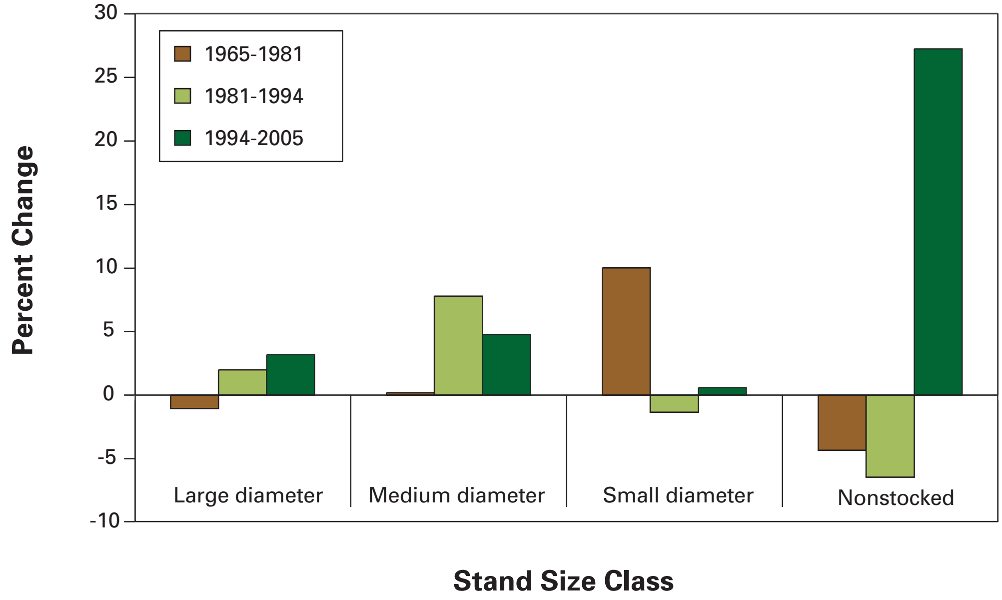
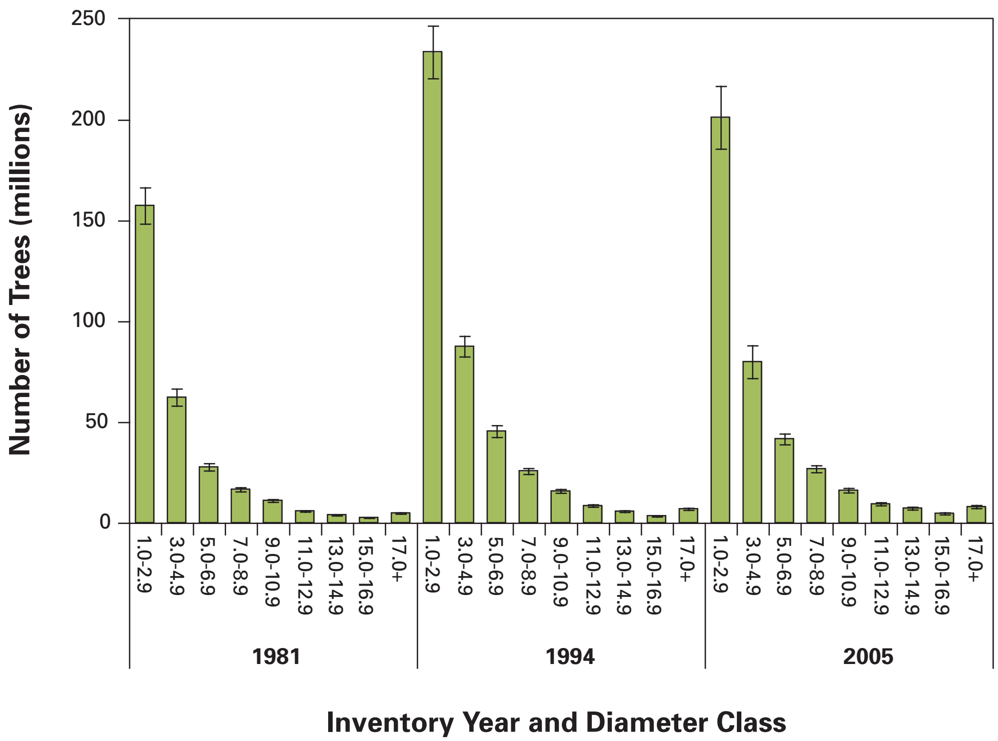


Figure 18.—Number of growing-stock trees on timberland by diameter class (in inches), Kansas 1981, 1994, and 2005.



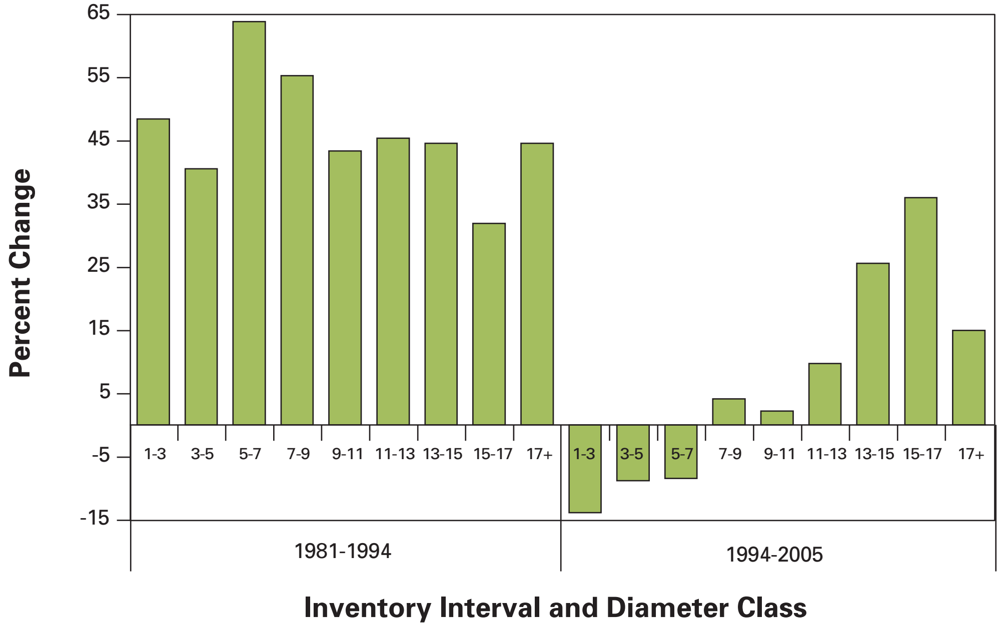


Figure 19.—Percent change in number of growing-stock trees on timberland by diameter class (in inches), Kansas 1981-2005.

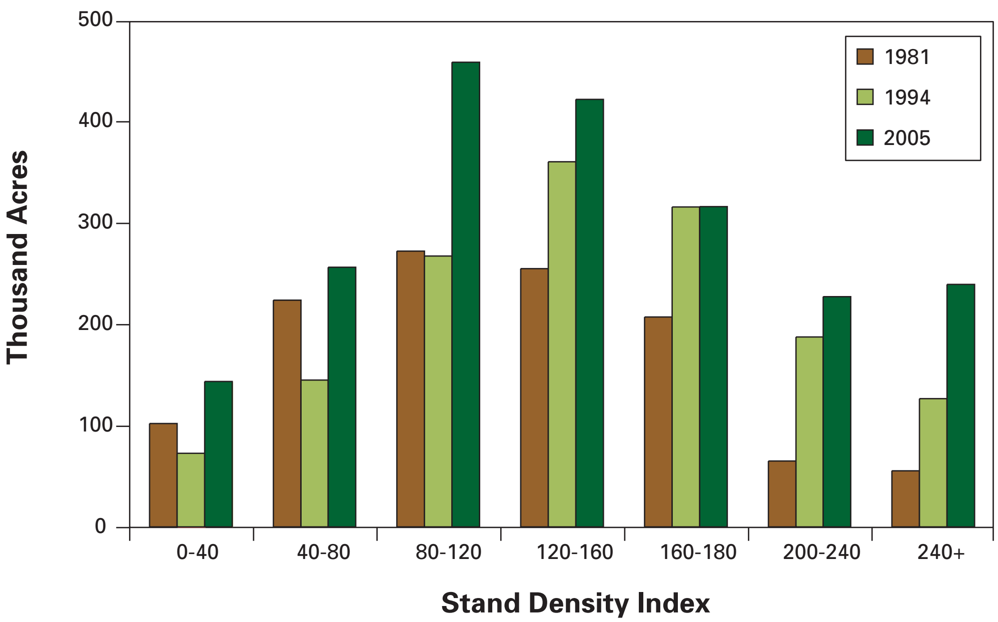


Figure 20.—Stand density index of timberland, Kansas 1981-2005.

Figure 21.—Stand density index of all trees on timberland, Kansas 2005.

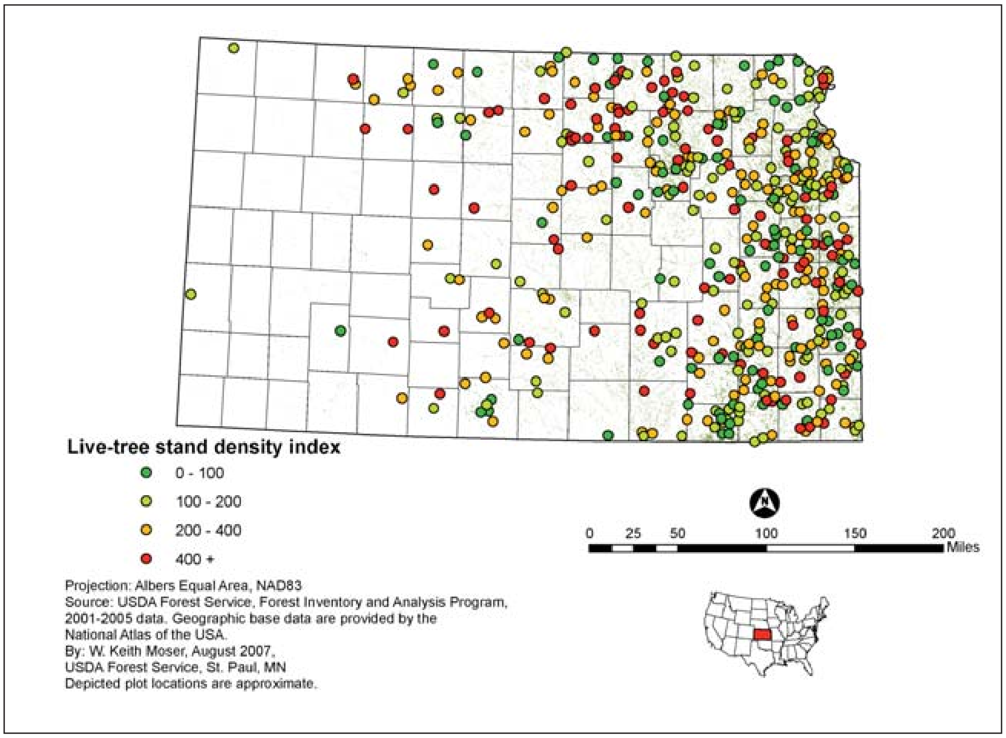


Figure 22.—Growing-stock volume (VPA) and growing-stock trees (TPA), 5 inches and larger in diameter, per acre of timberland, Kansas 1981-2005.

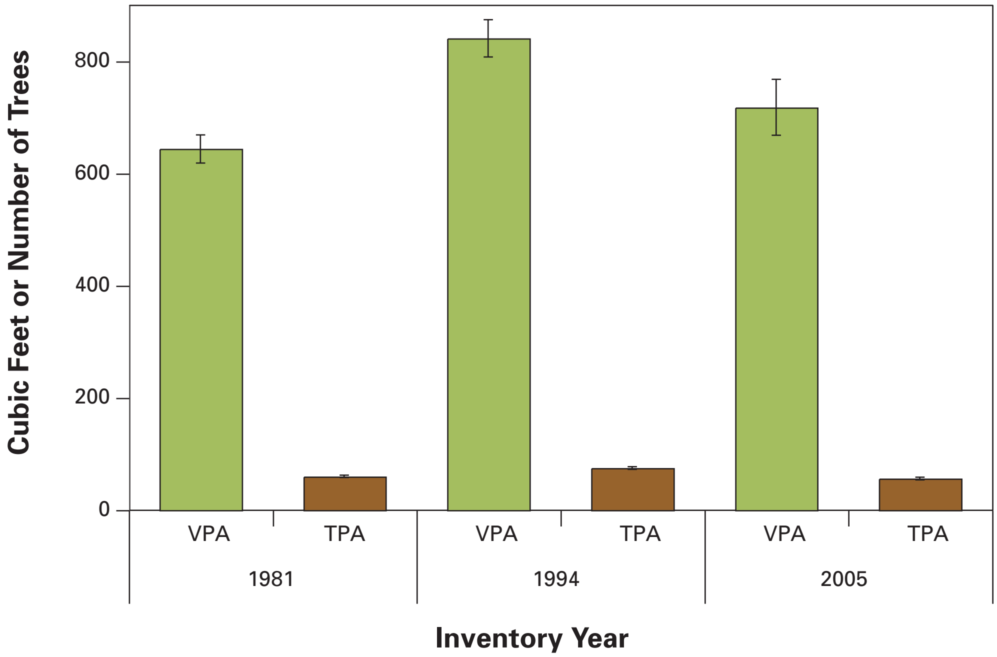


Figure 23.—Per-tree volume of live and growing-stock trees on timberland, Kansas 1981-2005.

Biomass

Background

FIA defines tree biomass as the weight of all aboveground components of forest trees, usually expressed on a dry-weight basis. This total includes stumps, boles, limbs, and tops. The most important part of the tree has been the bole because that is what farmers and other harvesters of timber used. But our understanding of forest biomass is changing. Today, forest product companies are using more of the tree and are moving to the whole-tree mass as a measure of product. On the horizon, we may see newer industries based on biocomposites and biofuels that can use Kansas forest biomass more completely. Finally, Kansas trees are recognized for their value as providers of ecological services and carbon storehouses.

What we found

In 2005, there were 72.3 million (dry) tons of live-tree biomass on forest land in Kansas, largely concentrated in the eastern part of the State (Fig. 24). Of this total, nearly 97 percent (more than 1.4 billion pounds or 70.1 million tons) was on timberland. Almost 5 percent of the timberland total (3.8 million tons) was in 1- to 5-inch trees, 50 percent (34.9 million tons) was in growing-stock trees, and 45 percent of total aboveground biomass (31.3 million tons) was in nongrowing-stock trees greater than 5 inches in diameter. Private landowners held almost 95 percent (66.3 million tons of biomass on timberland) and public owners held the remainder (3.8 million dry tons).

Biomass in 2005 was 34 percent greater than that in 1994 and 124 percent greater than in 1981 (Fig. 25). Our data show a steady increase in total and merchantable biomass over the last 25 years (Fig. 26). There are several factors influencing this trend. Volume has increased, both due to growth of the trees present in Kansas forests in 1981 and in-growth of new trees. In addition, a redefinition of forest land in the 1990s resulted in the addition of wooded lands not previously considered as forest. The proportion of biomass considered merchantable has also increased over the years (Table 3). Some of this increase was due to adding new wooded lands, but a substantial portion of the increase in merchantable percentage was due to growth into larger size classes.

In the Northeastern unit (which, coincidentally, has the largest proportion of the State's population), both total and merchantable biomass have increased the most over the last 25 years, followed by the Southeastern and Western units. The proportion of total biomass considered merchantable also has increased over time across the State.

What this means

Biomass includes more of the woody material than forest volume. It also is a good indicator of trends in carbon sequestration, forest health, and management. The bulk of Kansas forest biomass was in the eastern part of the State. The addition of wooded lands to the forest land category in the 1990s was instrumental to the biomass increase, as was overall volume growth. It is interesting that the area with the greatest total biomass and the largest increase since 1981 also is the most populated part of the State. Finally, the amount of biomass considered merchantable benefitted from the progression of individual trees into larger diameter classes. Although only a fraction of this biomass will be utilized commercially, the presence of increasingly large trees could result in lower harvesting and processing costs per unit volume.

American sycamore, Finney County, Kansas. Photo used with permission by Robert Atchison, Kansas Forest Service.

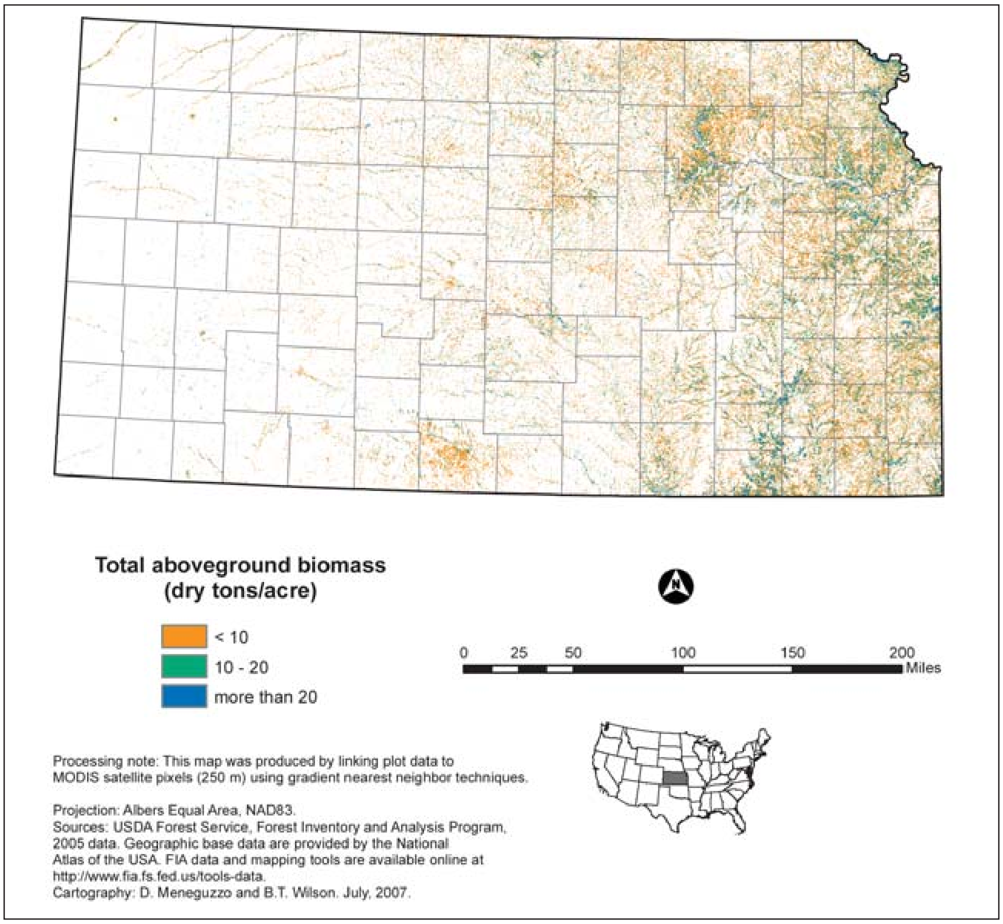


Figure 24.—Gross aboveground biomass per acre on timberland, Kansas 2005.

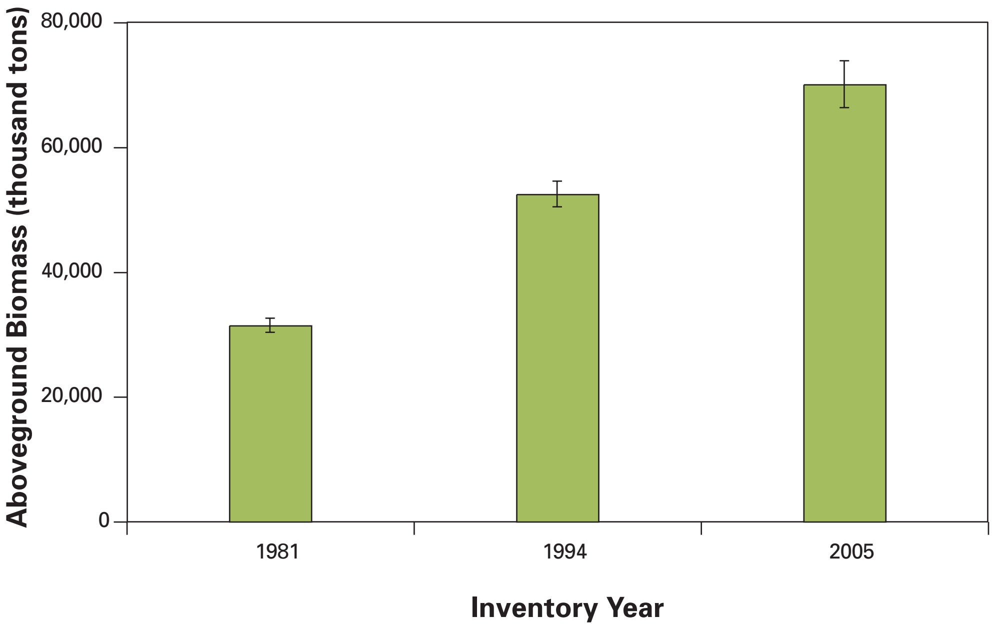


Figure 25.—Total aboveground biomass on Kansas timberland by inventory year.

Figure 26.—Total and merchantable aboveground biomass on timberland by inventory unit and year, Kansas 1981 - 2005.

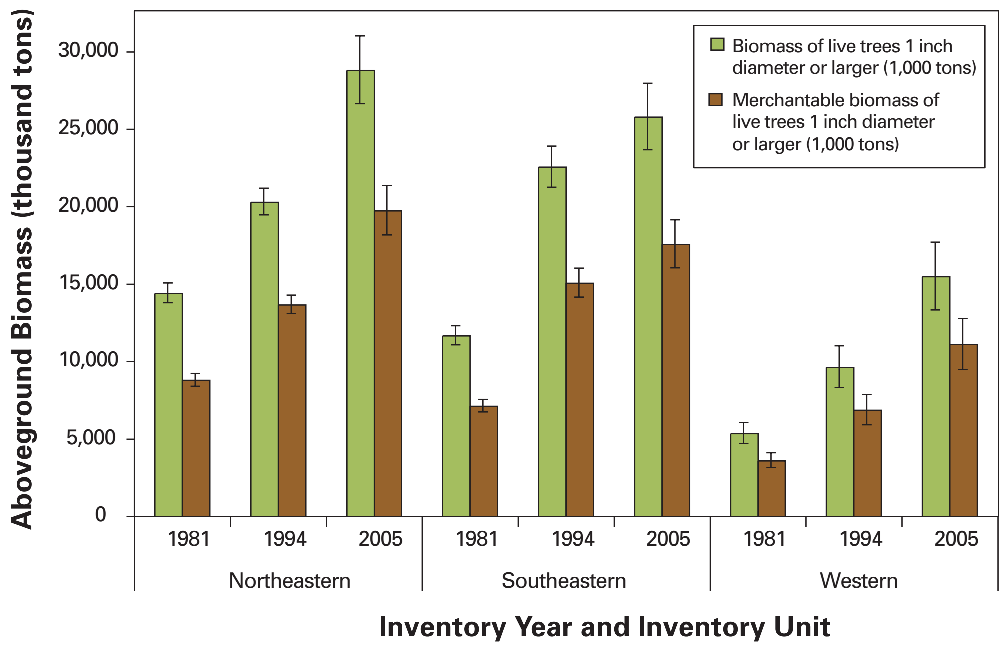


Table 3.—The percentage of total dry biomass considered merchantable, Kansas 1981-2005.

Inventory unit	1981	1994	2005
Northeastern	61	67	69
Southeastern	61	67	68
Western	67	71	72

Riparian Forests in Kansas

Background

Riparian areas are zones along water bodies that exist in the transitional margin between aquatic and terrestrial ecosystems. Examples include floodplains, stream- and riverbanks, and lake shores. Riparian zones can be identified by vegetation that reflects available soil moisture, soils that experience intermittent flooding, and the direct influence of a nearby water body. In the Great Plains states like Kansas, riparian areas tend to be linear and often are more productive than the adjacent land due to the availability of water (Fig. 27). The contrast with the drier uplands, particularly in the western part of Kansas, usually is quite dramatic.

There are an estimated 23,731 miles of perennial streams and rivers in Kansas. The riparian forests that follow these corridors provide valuable ecological services to the people of Kansas by stabilizing streambanks and reducing sedimentation and pollution of reservoirs that supply water to over half the state's population. Riparian forests often are the most productive timber sites as they provide valuable habitat for threatened and endangered species like the bald eagle, silverband shiner, spring peeper, redbelly snake, and eastern spotted skunk. Riparian forests also provide a variety of recreational opportunities.

What we found

NRS-FIA divides physiographic class into three broad categories: xeric, mesic, and hydric. Most of the plots in Kansas are in the mesic category (Fig. 28). Combining the mesic (with the exception of flatwoods, rolling uplands, and moist coves and slopes) and hydric physiographic classifications provides a rough estimate of 562,000 acres of riparian timberland in Kansas, or nearly 27 percent of total timberland area (Table 4).

Another type of analysis summarizes the pixels on the National Land Cover Dataset (NLCD)[3] for 2001 by cover class. Using this analysis, we estimate there are 1.9 million acres in deciduous, coniferous, and mixed forests, 402,400 acres in woody wetlands, and 223,900 in shrub/scrub habitat. Although the totals do not exactly match the summaries using FIA data, they provide evidence of the importance of forested wetlands to the Kansas landscape.

[3] The National Land Cover Dataset (http://www.epa.gov/mrlc/nlcd-2001.html) is a remote-sensing-derived estimate of different types of land cover in the United States. The NLCD 2001 is the latest product from this analysis. Andrew Lister, NRS-FIA, Newtown Square, PA, provided the analysis of NLCD 2001 for this report. The definitions of the different categories are available at http://www.epa.gov/mrlc/definitions.html#2001.

What this means

Unlike other states with extensive upland forests, riparian and other waterside forests make up a high percentage of Kansas wooded lands. Over one-quarter of the timberland in Kansas is associated with lakes, streams and rivers. Significant portions of riparian corridors in the State are incised and in need of riparian forest restoration and protection. Although nearly all riparian forests are privately owned, they provide important public benefits to the people of Kansas, such as reducing sediment entry into reservoirs that serve as the source of water for two-thirds of the State.

Riparian forests also are important to ecological health. They stabilize streambanks and remove excess nutrients and sediment from surface runoff, helping keep the State's waters clean. They shade the streams, thus reducing water temperature and providing better environment for Kansas aquatic inhabitants. Riparian forests, particularly in the drier, western part of the State, provide valuable wildlife habitat. Yet this benefit comes from a vulnerable resource as human activities and fluctuations in water supply can affect the health of forests in riparian zones. Floods can kill trees whose roots become starved for oxygen, but also replenish the site's productivity through deposition of rich soil. Floods can create new habitats that are quickly colonized by cottonwoods and willows. Most dramatically, the principal source of riparian forest degradation is conversion to other uses by humans, whether for roads and bridges, farm fields, or industrial sites. Logging and channel modification also impact riparian ecosystems. Faced with cycles of good and bad times, riparian forests in Kansas exist precariously.

Kansas riparian forests reduce sediment entry into reservoirs that provide drinking water. Photo used with permission by Kansas Biological Survey.

Figure 27.—Riparian forests in Kansas based on data from the Natural Resources Conservation Service.

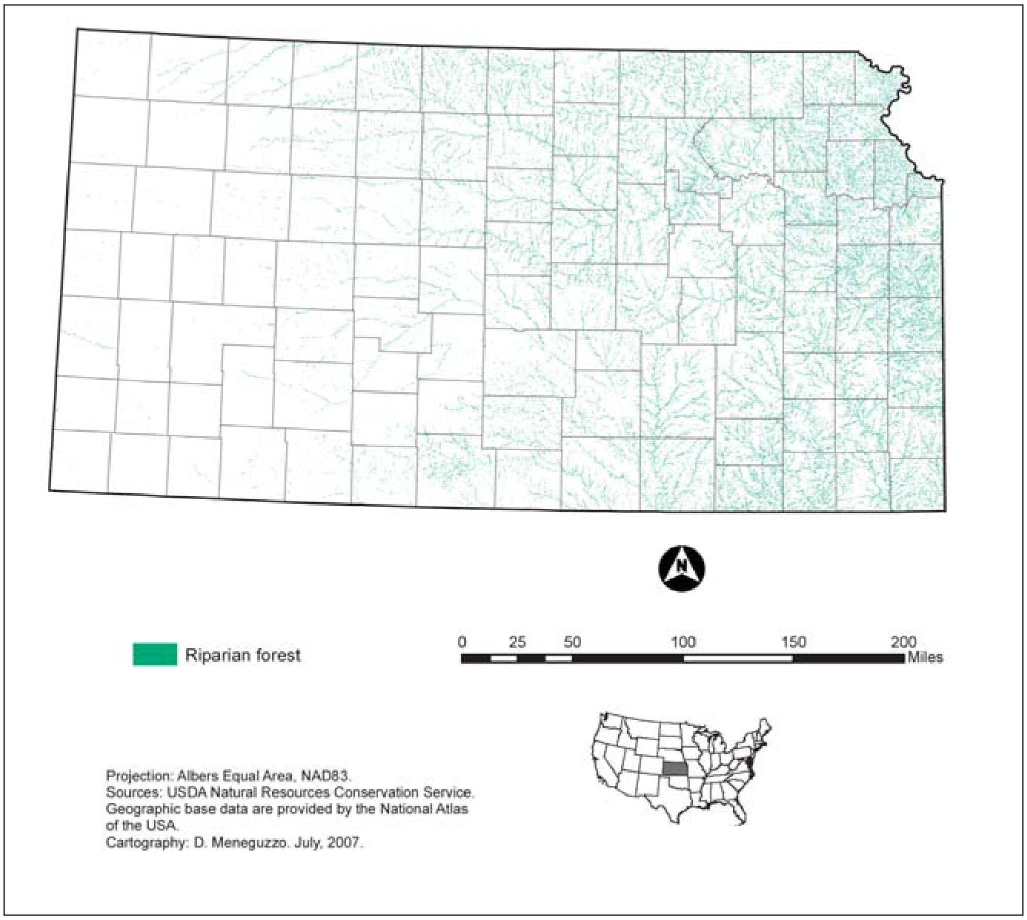


Figure 28.—Distribution of NRS-FIA plots by physiographic class category, Kansas 2005.

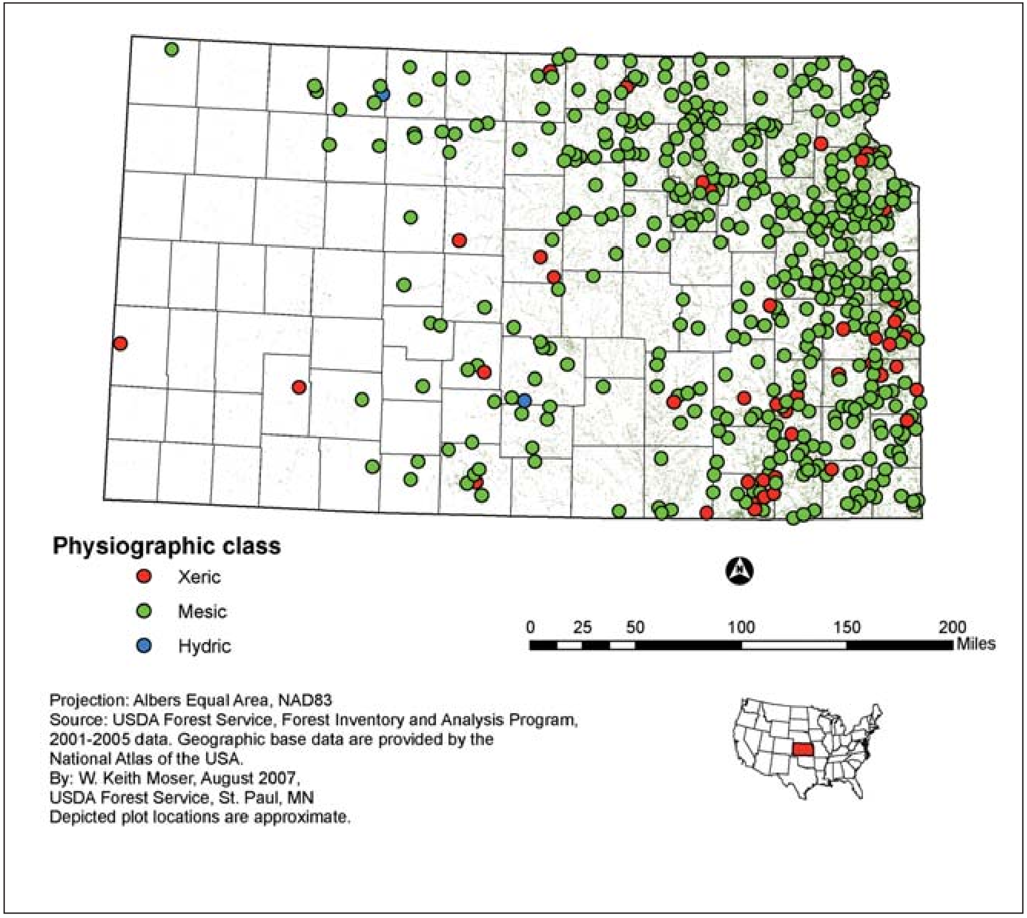


Table 4.—Area of forest land and timberland (in acres) by physiographic class, Kansas 2005,

Physiographic class	Forest land	Timberland
Dry tops	51,218	43,389
Dry slopes	185,523	154,854
Deep sands	13,969	8,170
Flatwoods	159,078	152,826
Rolling uplands	1,083,230	1,055,955
Moist slopes and coves	50,347	50,347
Narrow floodplains / bottomlands	377,273	377,273
Broad floodplains / bottomlands	174,791	174,791
Other mesic	5,222	5,222
Small drains	4,868	4,868
Total	**2,105,519**	**2,027,694**

Who Owns Kansas Forests?

FIA conducts the National Woodland Owner Survey (NWOS) (Butler et al. 2005) to increase our understanding of who owns the forest, why they own it, and what they intend to do with it. It serves as the social complement to our inventory of biophysical forest resources and gives us a better understanding of the forest resources and the factors affecting them. Data presented here are based on survey responses from 106 randomly selected families and individuals who own forest land in Kansas. As with most elements of the FIA program, the NWOS is implemented on an annual basis. For additional information pertaining to the NWOS, visit: http://www.fia.fs.fed.us/nwos.

General Ownership Patterns

Most of the forest land in Kansas, 1.9 million acres or 91 percent, is owned by families and individuals (Fig. 29). An additional 88,000 acres are owned by other private groups (corporations, tribes, etc.). Collectively, private owners control 95 percent of the State's forests. Any report or program that is purported to analyze or is designed to influence the forest resources of Kansas must consider this important, diverse, and dynamic group of forest owners.

Public agencies control 110,000 acres, or 5 percent of Kansas forest land. Most of the public land is controlled by the U.S. Army Corp of Engineers, Kansas Department of Wildlife and Parks, U.S. Department of Defense, Bureau of Reclamation, National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, state universities, counties, and municipalities.

Family Forests

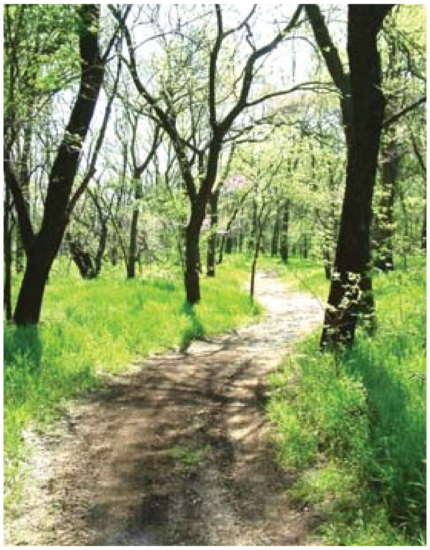
There are an estimated 117,000 families and individuals who collectively own 1.9 million acres of forest land in Kansas. They are by far the dominant land ownership group in the State. Although 65 percent of family forest owners hold fewer than 10 acres of forest land, 65 percent of the family forest land is owned by people with landholdings of 10 to 99 acres; an additional 25 percent of the family forest land is owned by people with holdings of 100 acres or more (Table 5).

Family forest owners have diverse ownership and forest management objectives. The most common reason for owning forest land is related to the land being part of a farm (Table 6). Sixty-eight percent of the family forest land is associated with farms. Other common reasons for ownership include family legacy, aesthetics, nature protection, privacy, hunting, and as an investment.

The most common forest-land activity is private recreation with 26 percent of the owners, who hold 57 percent of the forest land, reporting having done so in the past 5 years (Table 7). About one in five owners (17 percent of the family forest owners, who hold 27 percent of the family forest land) have harvested trees within the past 5 years. Over the course of their ownership tenure, 34 percent of the family owners, who hold 53 percent of the family forest land, have harvested trees from their land. Less than 10 percent of the owners, who hold 4 percent of the family forest land, reported having a written forest management plan, but 15 percent, who own 17 percent of the family forest land, have received management advice (Table 8).

Undesirable plants and trespassing are the greatest concerns reported by the family forest owners of Kansas (Table 9). Other concerns cited included the ability to pass on land to heirs, vandalism, dumping and other misuses of their woodland, and property taxes.

Although most family forest owners in Kansas plan to do relatively little with their land in the next 5 years, nearly one in 10 acres is owned by someone who plans to transfer his or her land to an heir or sell it (Table 10). This finding is related in part to the ages of the current owners. Twelve percent of the family forest land is owned by people 75 years old or older; an additional 27 percent of the family forest land is owned by people between 65 and 75 years of age (Table 11). This large-scale intergenerational shift will change the characteristics of the State's family forest owners, influence how owners view, interact with, and relate to their land, and alter future forest characteristics.



Marty Schroeder's Tree Farm, Sedgwick County, near Viola, Kansas.
Photo used with permission by Robert Atchison, Kansas Forest Service.

Figure 29.—Forest ownership, Kansas 2005 (total does not add to 100% due to rounding).

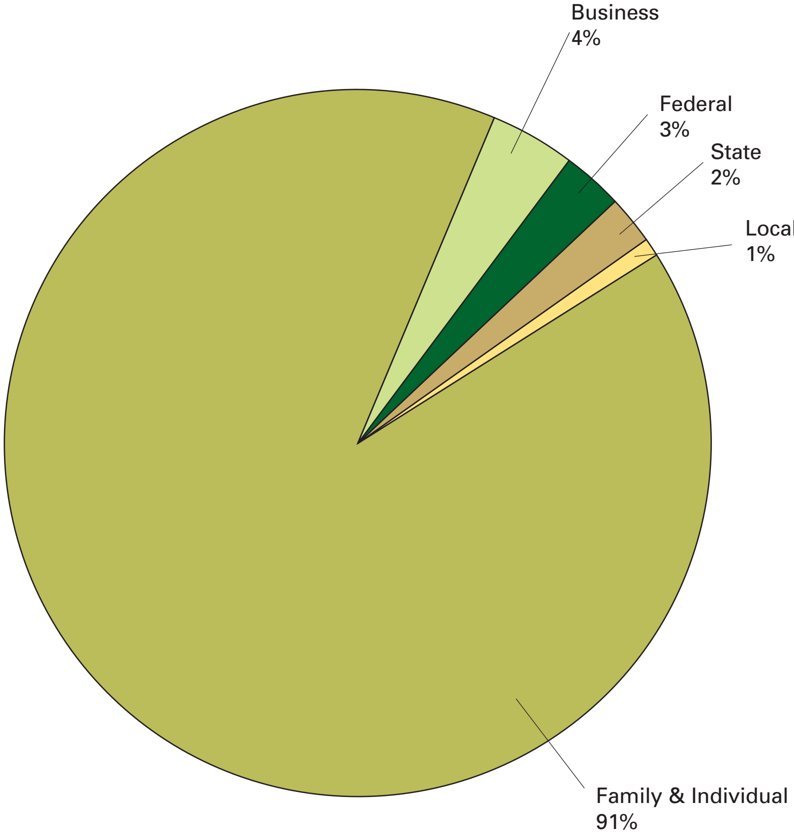


Table 5.—Area and number of family-owned forests by size of forest holdings, Kansas 2005.

Size of forest land holdings (acres)	Area		Ownerships	
	Acres (thousands)	Sampling error (percent)	Number (thousands)	Sampling error (percent)
1-9	198	49	76	38
10-49	665	18	29	15
50-99	575	20	10	16
100-499	378	28	3	22
500+	90	130	< 1	71
Total	**1,906**	**4**	**117**	**28**

Table 6.—Area and number of family-owned forests by reason for owning forest land, Kansas 2005. The area and number of ownerships in each category is the total of all respondents who ranked each objective as very important (1) or important (2) on a seven-point Likert scale.

	Area		Ownerships	
Reason for owning forest land [a]	Acres (thousands)	Sampling error (percent)	Number (thousands)	Sampling error (percent)
Part of farm	1,166	11	43	30
Family legacy	1,043	12	63	33
Aesthetics	989	12	46	28
Nature protection	953	13	41	28
Privacy	809	15	36	31
Hunting or fishing	809	15	23	19
Land investment	737	16	30	33
Part of home, or cabin [b]	486	23	42	50
Other recreation	468	24	20	47
Firewood production	342	31	14	31
Non-timber forest products	198	49	7	37
Timber production	144	64	8	48
No Answer	36	227	19	96

[a] Categories are not exclusive.

[b] Includes primary and secondary residences.

Table 7.—Area and number of family-owned forests by recent (past 5 years) forestry activity, Kansas 2005.

	Area		Ownerships	
Activity [a]	Acres (thousands)	Sampling error (percent)	Number (thousands)	Sampling error (percent)
Timber harvest	508	25	20	46
Collection of NTFPs [b]	127	75	13	102
Site preparation	126	72	12	74
Tree planting	216	45	19	56
Fire hazard reduction	162	58	9	67
Application of chemicals	270	37	12	53
Road/trail maintenance	252	40	8	60
Wildlife habitat improvement	234	42	11	56
Posting land	919	14	25	24
Private recreation	1,076	12	30	28
Public recreation	359	31	6	30
Cost share	72	119	11	82
Conservation easement [c]	36	227	9	98

[a] Categories are not exclusive.

[b] NTFPs = nontimber forest products

[c] Not limited to past 5 years.

Table 8.—Area and number of family-owned forests by management plan, advice received, and advice source, Kansas 2005.

	Area		Ownerships	
	Acres (thousands)	Sampling error (percent)	Number (thousands)	Sampling error (percent)
Written management plan				
Yes	72	119	11	84
No	1,780	5	104	26
No answer	54	155	2	65
Received advice				
Yes	324	32	17	56
No	1,547	7	99	27
No answer	36	227	2	71
Advice source [a]				
State forestry agency	216	45	15	61
Extension	36	227	9	96
Other state agency	54	155	1	66
Federal agency	144	64	11	80
Other landowner	54	155	1	67

[a] Categories are not exclusive.

Note: Data may not add to totals due to rounding.

Table 9.—Area and number of family-owned forests by landowners' concerns, Kansas 2005. Numbers include landowners who ranked each issue as a very important (1) or important (2) concern on a seven-point Likert scale.

	Area		Ownerships	
Concern [a]	Acres (thousands)	Sampling error (percent)	Number (thousands)	Sampling error (percent)
Undesirable plants	1,017	13	42	37
Trespassing	991	14	37	41
Family legacy	813	17	40	38
Dumping	788	17	59	50
Property taxes	737	18	60	48
Lawsuits	635	20	35	43
Fire	635	20	28	46
Air or water pollution	610	21	33	46
Storms	559	23	24	55
Land development	534	24	40	43
Insects/diseases	534	24	24	56
Harvesting regulations	457	27	22	60
Timber theft	432	28	21	61
Endangered species	330	35	18	72
Noise pollution	330	35	25	61
Wild animals	330	35	23	61
Regeneration	254	43	24	63
Domestic animals	229	46	17	77

[a] Categories are not exclusive.

Table 10.—Area and number of family-owned forests by landowners' future (5 year) plans for their forest land, Kansas 2005.

	Area		Ownerships	
Future plans[a]	Acres (thousands)	Sampling error (percent)	Number (thousands)	Sampling error (percent)
No activity	414	26	62	44
Minimal activity	468	24	20	39
Harvest firewood	719	17	25	29
Harvest sawlogs or pulpwood	144	64	3	40
Collect NTFPs[b]	102	91	1	57
Sell all or part of land	36	227	0	87
Transfer all or part of land to heirs	144	64	6	73
Buy more forest land	90	97	4	82
Land use conversion (forest to other)	54	155	3	89
Land use conversion (other to forest)	54	155	4	84
No current plans	324	32	19	42
No answer	18	443	1	100

[a] Categories are not exclusive.
[b] NTFPs = Nontimber forest products.

Table 11.—Area and number of family-owned forests by age of owner, Kansas 2005.

	Area		Ownerships	
Age (years)	Acres (thousands)	Sampling error (percent)	Number (thousands)	Sampling error (percent)
<35	102	91	1	61
35-44	127	75	15	67
45-54	432	28	20	65
55-64	483	26	11	32
65-74	508	25	15	44
75+	229	46	55	66
No answer	25	321	< 1	113

Note: Data may not add to totals due to rounding.

Characteristics of Major Forest Types in Kansas

Diversity

A forest composed of a variety of tree species, tree sizes, and heights can provide diverse habitats for wildlife and a range of recreation and aesthetic experiences. A diverse forest, while not completely free of forest health problems, is less likely to be devastated by an insect or disease that attacks a single species or a narrow group of species. Diverse forests also may be more resilient in the face of severe weather disturbances or climate variations.

The Shannon Diversity Index for species measures a combination of the number of species and the evenness or relative distribution of those species (Magurran 1988). A forest with 10 species in which 90 percent of the area is occupied by one species will have a lower Shannon Index than a forest with 10 species in which each species occupies a roughly equal proportion of the forest area.

What we found

We can see pockets of high and low tree-species diversity in Kansas forests (Fig. 30), with lower-diversity plots more prominent in the western part of the State. Over time, the Shannon Index has held steady in some units and decreased in others (Fig. 31). Looking at individual forest types, the Southeastern unit generally had the highest average Shannon value and the Western unit had the lowest (Fig. 32); the Northeastern unit had higher diversity in the most prominent forest types.

What this means

Climatic and site-productivity factors and other natural disturbances, such as storms, can influence the number of species on a particular site. Overstory diversity decreases in the drier portions of the State. Diversity also is influenced by the competitive abilities of each tree, the collective associations of tree species (who is next to whom), and human attempts to direct a forest toward a particular structure or species mix. Forests with greater species, age, or structural diversity are more resilient in the face of a forest-health threat that targets a single species or age category.

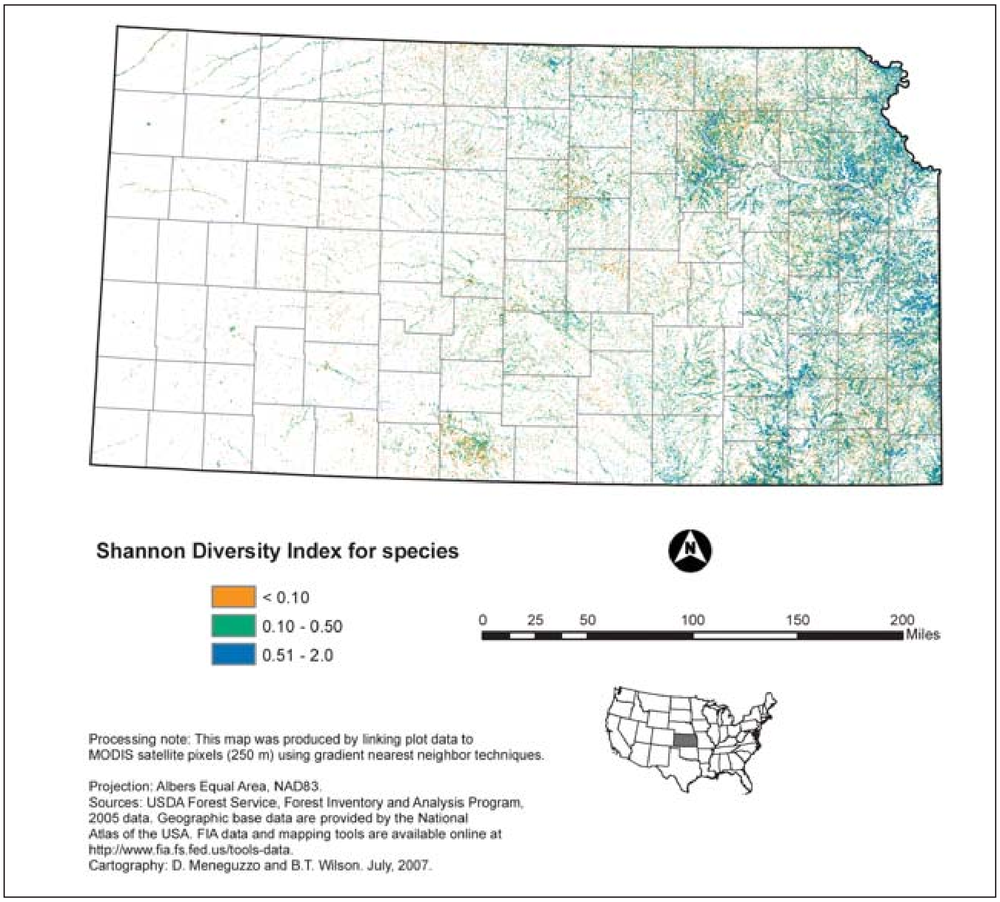


Figure 30.—Estimated tree species diversity (Shannon Diversity Index) of live trees on timberland, Kansas 2005.

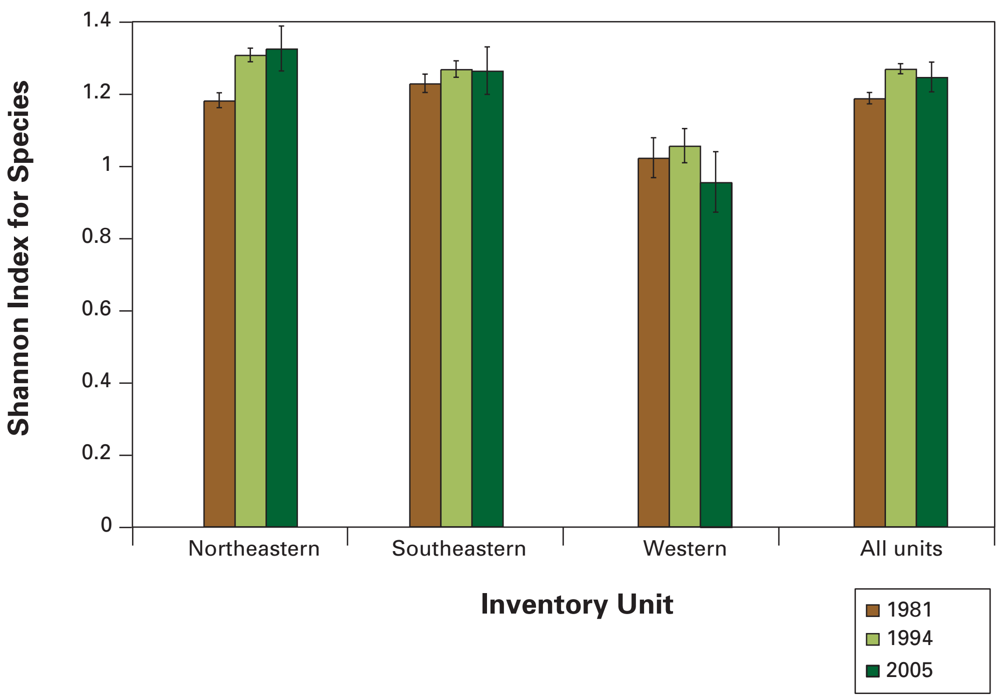
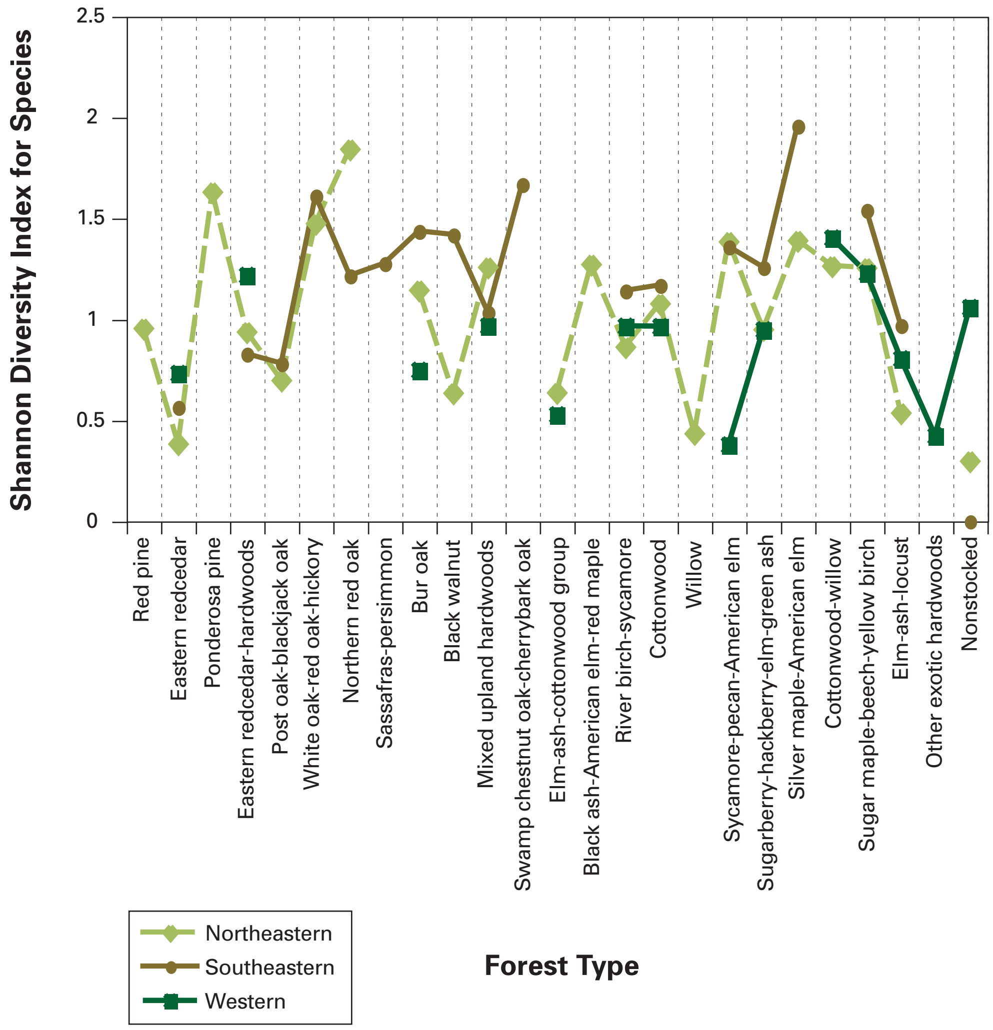


Figure 31.—Calculated Shannon Diversity Index for live trees on timberland, Kansas 1981, 1994, and 2005, by inventory unit.

Figure 32.—Calculated Shannon Diversity Index for species of live trees on timberland, Kansas 2005, by forest type and inventory unit.



Kansas Forests are Getting Younger

The age of a forest can determine its growth, suitability for a particular species of wildlife, or potential for economic use. Forest age can help us determine whether a past disturbance was caused by weather, insects, disease, or humans. It also can help us predict the forest's susceptibility and response to disturbance. On FIA plots, age is estimated by taking core samples from dominant or codominant trees in the overstory of a stand.

What we found

A substantial portion of the age-class distribution of our plots is less than 40 years old (Fig. 33). The volume and the number of trees 1 inch and larger and 5 inches and larger that are less than 60 years old has increased dramatically since 1981 (Fig. 34). When we look at the percentage of total volume or total numbers of trees (Fig. 35), the 25-year trends are even more dramatic. The bulk of the trees and volume is in the 30- to 59-year age group (Fig. 36).

What this means

An increasing proportion of the total volume of Kansas forest lands is in the younger age classes. There are several causes for this trend, most of which are disturbance-related. A change in the definition of forest land resulted in the inclusion of forested strips and large windbreaks, many of which were planted no more than 60 years ago. There were dramatic flood events in 1993 and 1995, altering some river courses and creating new growing space for trees. Areas with a few large trees might not have made the stocking minimums on their own, but if the post-flood regeneration resulted in new areas being classified as forest when they were not previously, we would expect to see both tree number and volume jump dramatically. In areas where grazing and/or burning has been reduced, we are seeing afforestation by species such as eastern redcedar. In the oak forests of eastern Kansas, a lack of such disturbances as fire provides opportunities for younger shade-tolerant species to become established, often at the expense of oak regeneration. Although this new cohort can increase overall stand diversity, as fewer young oaks survive to move up into the canopy, wildlife species that depend upon oak mast for food could decline.

Young hardwood forest. Photo used with permission by Robert Atchison, Kansas Forest Service.

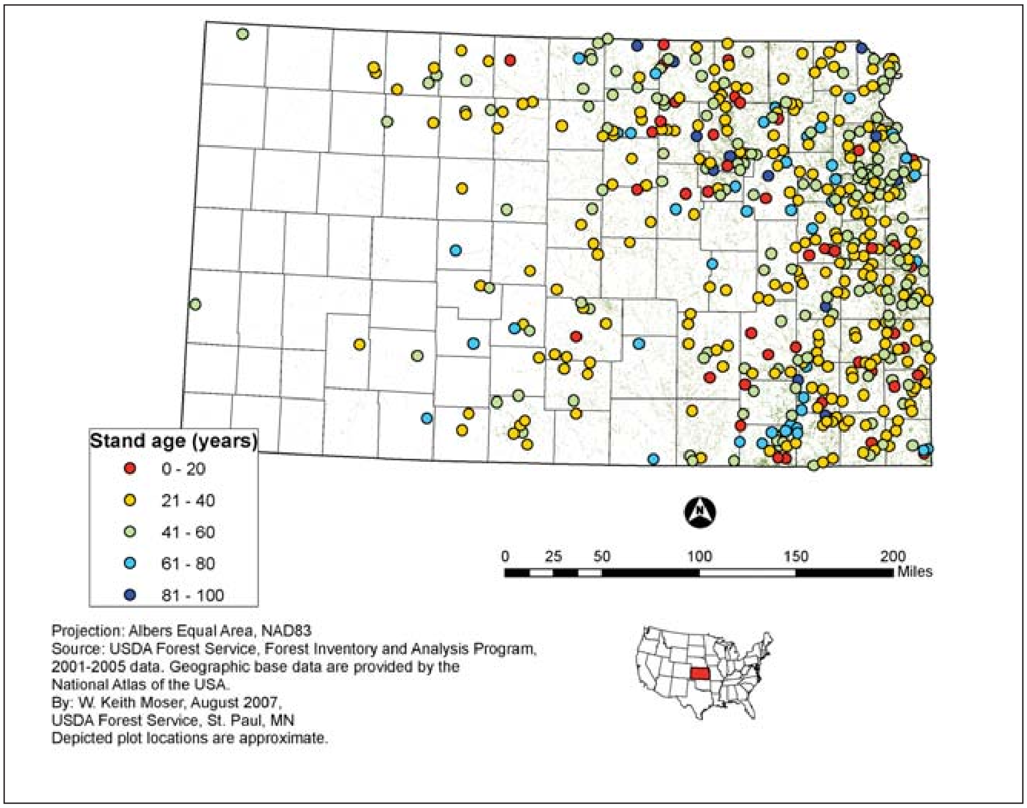


Figure 33.—Stand age on timberland, Kansas 2005.

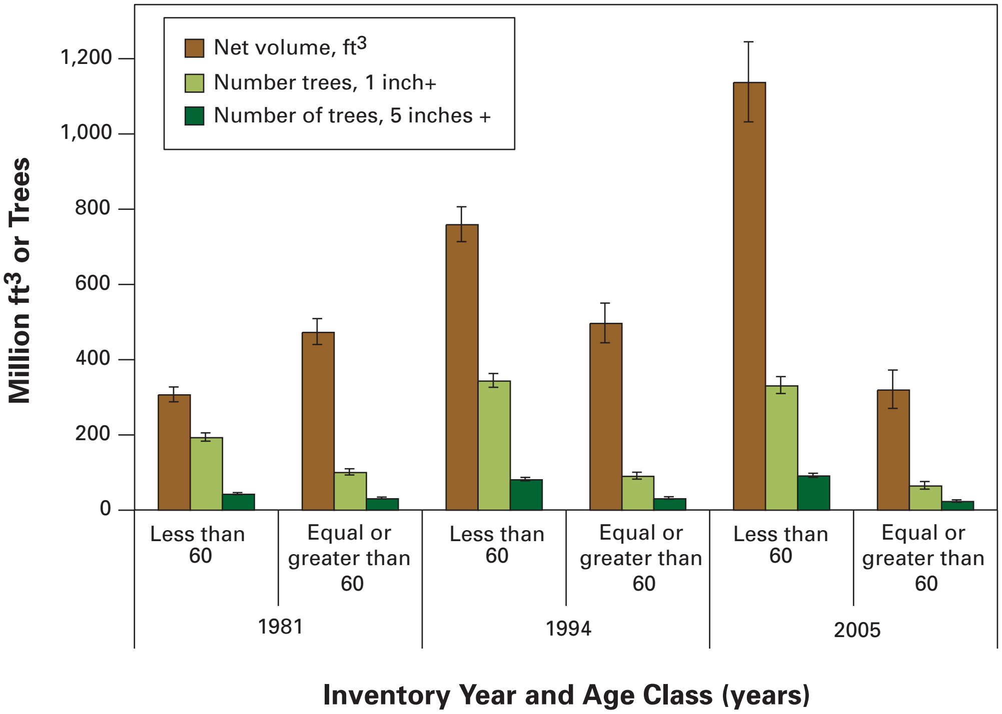


Figure 34.—Net volume and number of growing stock trees by age group, Kansas 1981-2005.

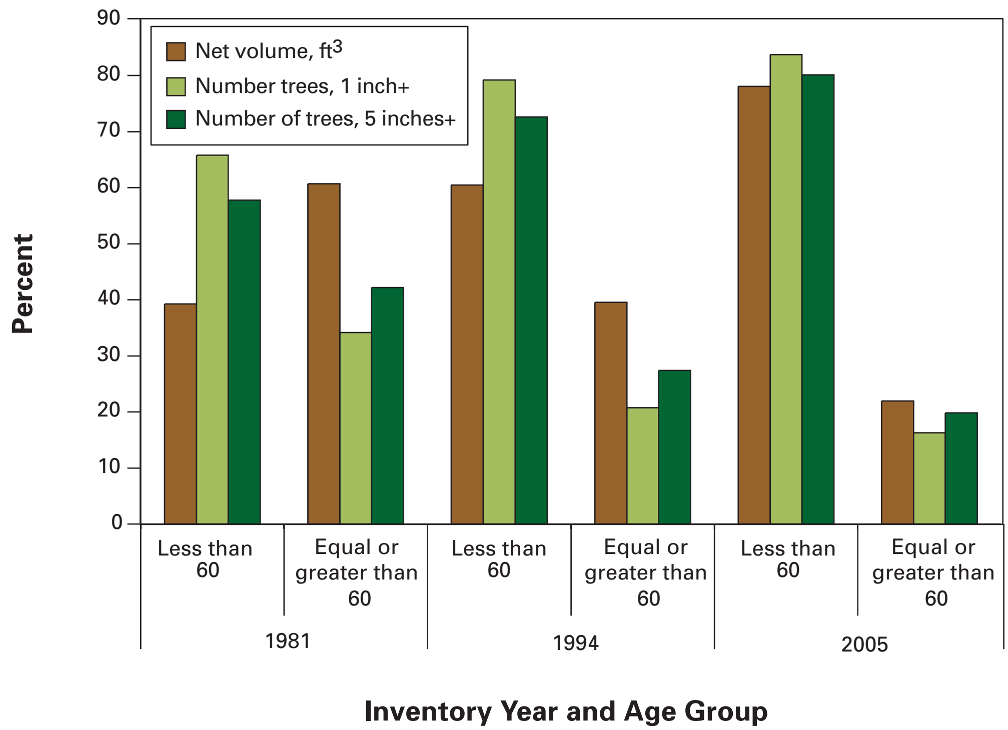


Figure 35.—Percentage of net volume and number of growing-stock trees by age group, Kansas 1981-2005.

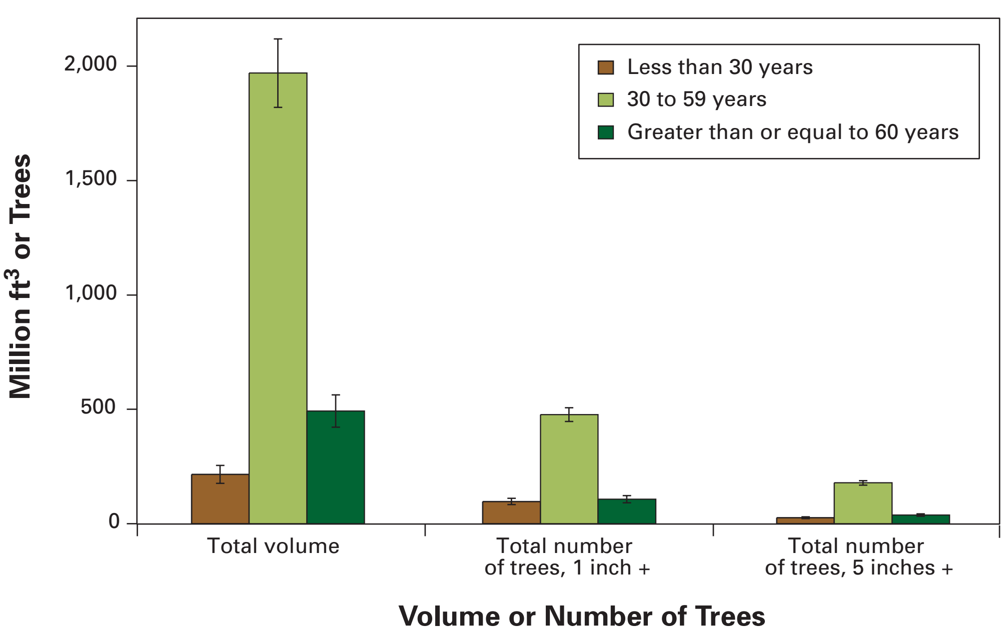


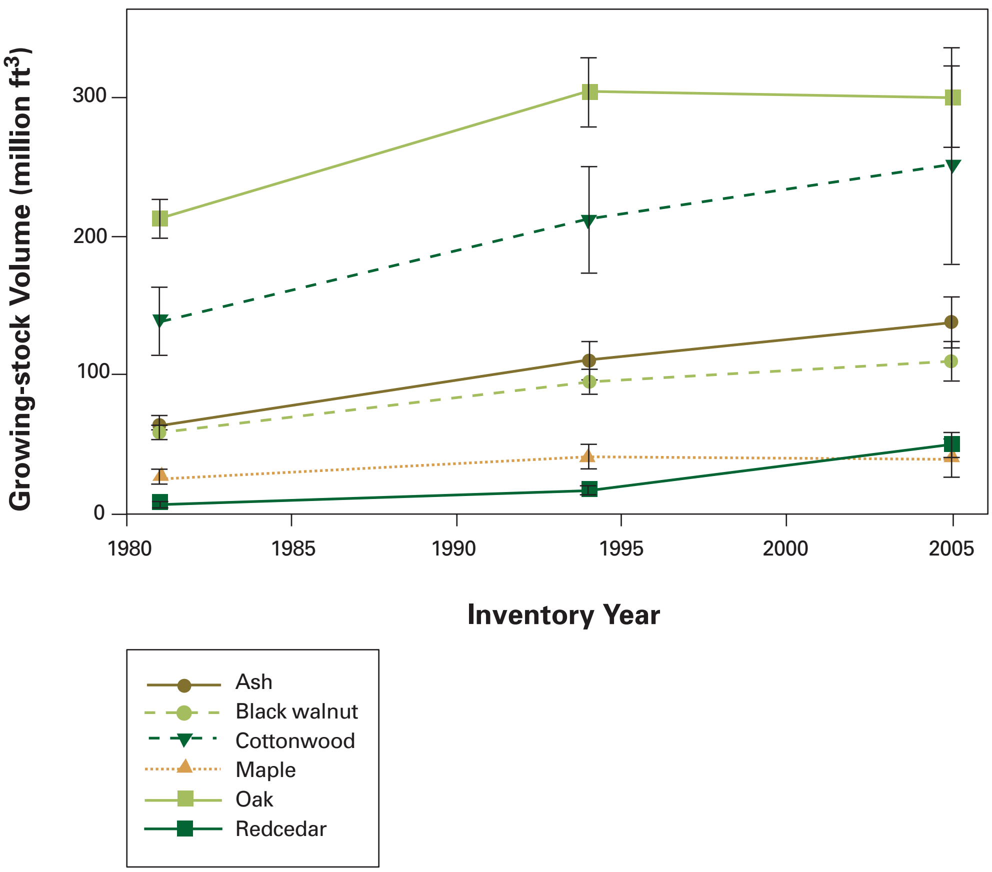
Figure 36.—Volume of live trees and number of trees on timberland, Kansas 2005.

Species Summary: Some are Up, Some are Down

Different disturbances and land-use histories favor some species and penalize others. In the following sections, we examine the trends of several prominent tree species in Kansas.

Reflecting overall trends in Kansas, the volume of all species except for ash and eastern redcedar increased at a lower rate between 1994 and 2005 than they did between 1981 and 1994 (Fig. 37).

Figure 37.—Volume of growing stock for selected species on timberland in Kansas, 1981-2005. The sampling error associated with each inventory estimate represents a 67 percent confidence interval and is depicted by the vertical line at the top of each bar.



Oaks across the Kansas Landscape

Background

Oak is one of the most prominent species in Kansas forests, both ecologically and economically. Red and white oaks are an important resource for the State's forest-products industry. Oaks provide habitat and food for a wide variety of mammals and birds. Oak forests are defined by the presence of *Quercus* species but contain significant numbers of other species as well.

What we found

As stated earlier, oak/hickory forests account for 54 percent of the timberland acreage in Kansas (Fig. 7). Oaks make up almost 19 percent of the total live-tree volume on forest land, but oak forest types contain 41 percent of the volume of live trees (Fig. 38). Since 1994, the proportion of total oak growing-stock volume in the medium and fully stocked categories has increased (Fig. 39). Oak species account for more than half of the trees in the State. Over the years, the number of oak trees has increased, first in the larger diameters then in the smaller ones (Fig. 40). After a pronounced decline in the number of oak trees between 1981 and 1994, Kansas saw a fairly dramatic across-the-board increase in oak trees over the next 11 years (Fig. 41).

We looked at the proportion of oak saplings vs. oak in the overstory to determine whether oak forests will be replaced by new oak forests in the future. Figure 42 shows the ratio of oaks as a percentage of all understory saplings vs. oak basal area in the overstory as a percentage of total basal area. Equal ratios of understory/overstory would produce an index of one (1). The majority of plots with oaks had a lower proportion of oaks in the understory than in the overstory.

What this means

Oak volume and tree numbers have increased, in some cases dramatically. Oak forests are increasing in density, yet it appears that oak forests in Kansas are not replacing themselves. The proportion of oaks in the regeneration layer is less than the proportion of oaks in the overstory. We cannot point to a single factor behind declining oak regeneration. Recurrent fire was important to maintaining oak stands in the past as it eliminated *Quercus*' competitors. With fire suppression, these other species are free to establish and thrive. As oaks face increasing competition in a denser (shadier) forest environment, we expect to see a lower proportion of oaks in future Kansas forests. Given the value of the species as a source of food and habitat, and the limited alternatives across much of the State, the failure to regenerate oaks could have serious impacts for wildlife in the future.

Figure 38.—Volume and number of trees in oak (by age class) and non-oak forest types, Kansas 2005.

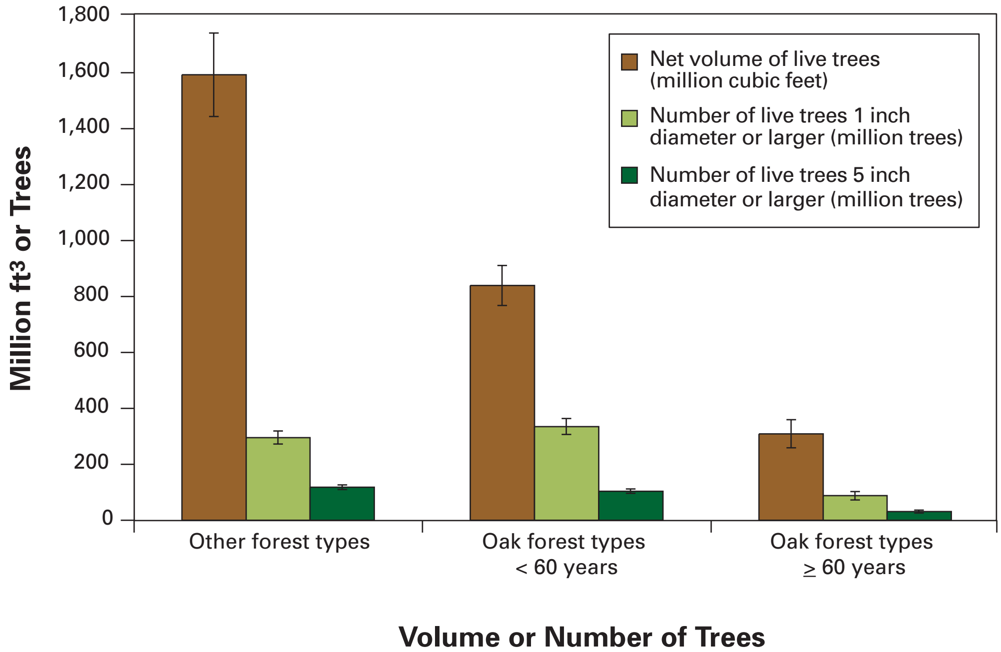
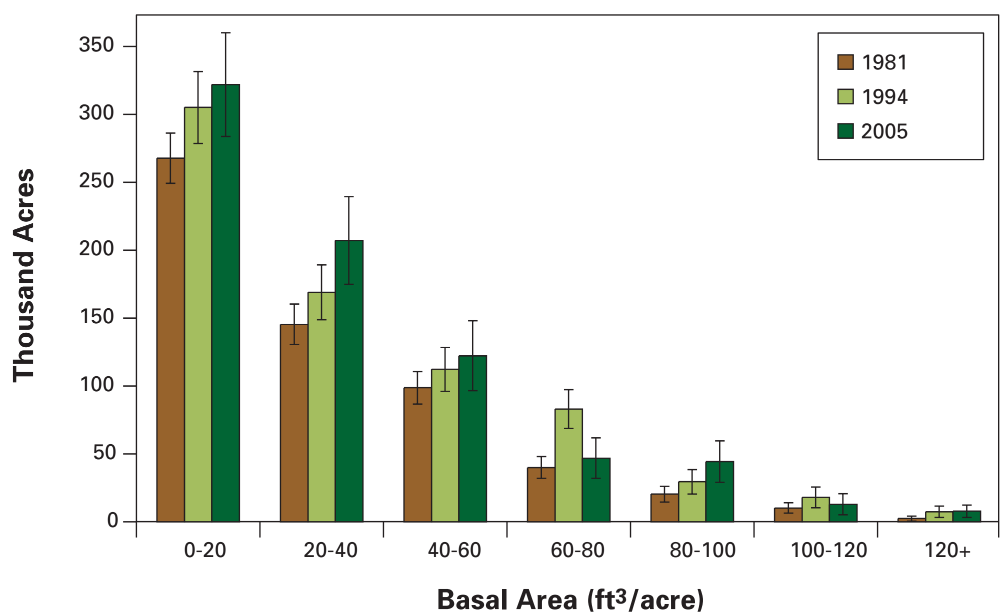


Figure 39.—Timberland acreage with oak species present, by basal area, Kansas 1981-2005.



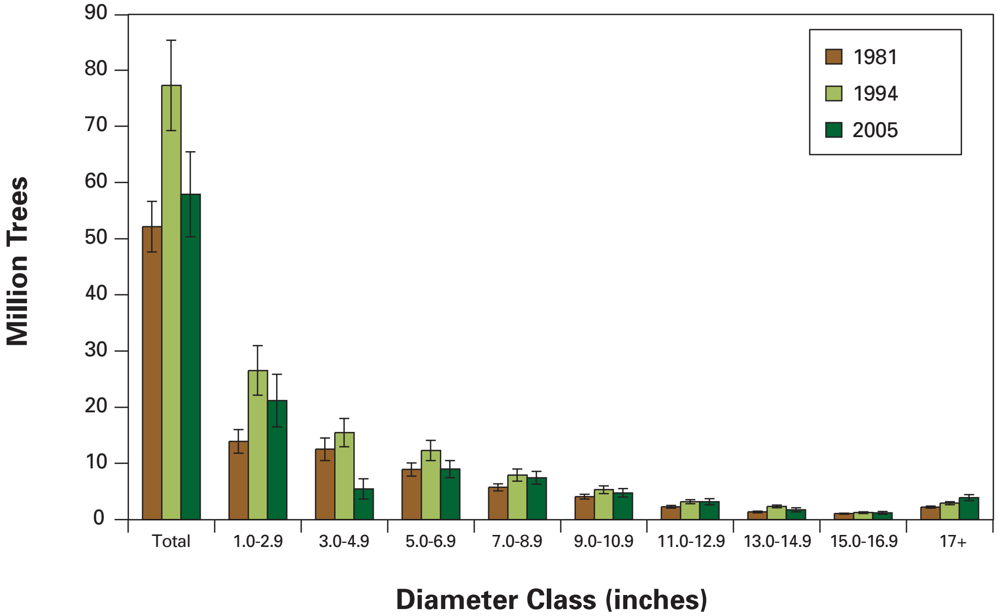


Figure 40.—Number of oak trees on timberland by inventory year and diameter class, Kansas 2005.

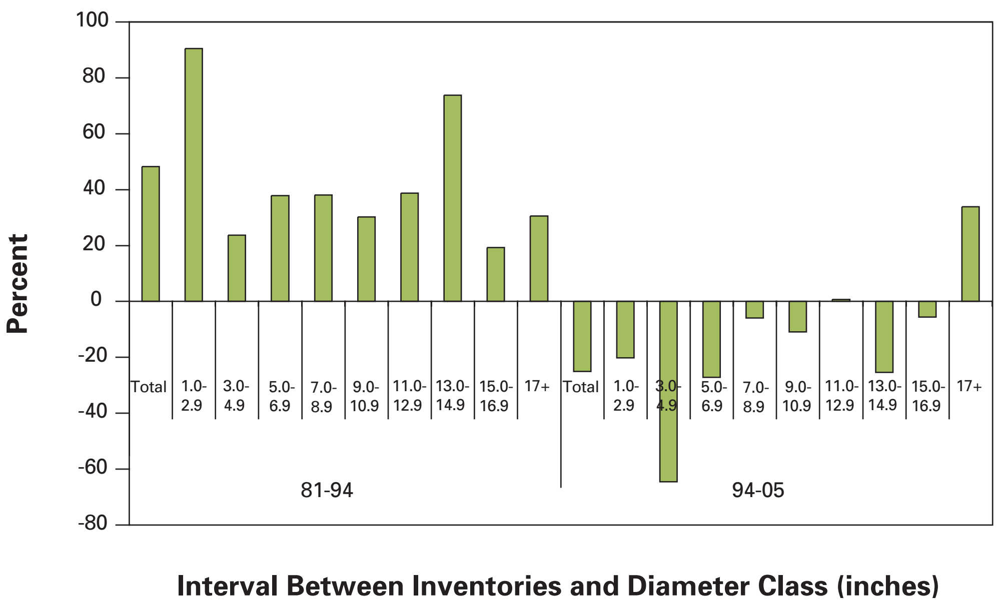
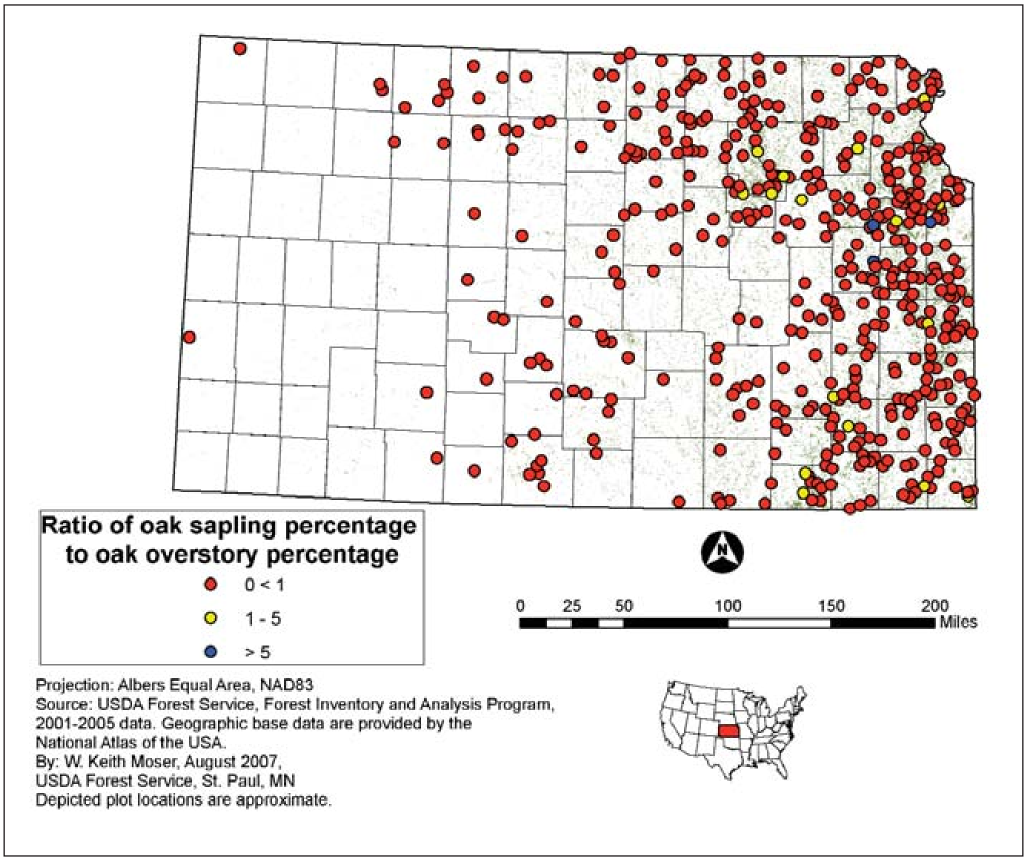


Figure 41.—Percent change in number of live oak trees on timberland, Kansas 1981-2005.

Figure 42.—Ratio of oak saplings as percentage of all saplings vs. oak overstory basal area as percentage of total growing-stock basal area. Numbers less than one (in red) mean that the proportion of all saplings that are oak saplings is less than the proportion of all overstory basal area that is oak basal area. Numbers equal to or greater than one (yellow or blue) mean that the sapling proportion in oaks is equal to or greater than the overstory proportion in oaks.



Black Walnut in Kansas

Background

Black walnut *(Juglans nigra)* is one of the most valuable hardwoods in Kansas. It is found throughout the eastern two-thirds of the State in small groups or as individuals. The fine wood from this species is prized for use in furniture and gunstocks. Black walnut has provided landowners with economic returns, and the presence of black walnut trees in a stand improves wildlife habitat. In the Midwest, it grows best on good sites in well drained bottoms (Williams 2000, Bruckerhoff 2005).

What we found

There was nearly 110 million cubic feet of black walnut growing stock in Kansas timberland in 2005. The black walnut forest type, which contains other species besides black walnut, contained 17 million cubic feet of growing-stock volume. Black walnut rarely is found in large, dense groves; many of the stands represented in Figure 43 had low basal areas in black walnut. Figure 44, however, shows that several plots had relatively high black walnut volumes due to the presence of large individual trees. The bulk of the plots containing black walnut are on "rolling uplands" sites (Fig. 45). Many of the other plots are located in floodplains. Table 12 shows that the wetter sites–floodplains and flatwoods–had the fewest black walnut trees per acre than the average for all plots with black walnut, whereas the comparatively drier rolling upland site had the most per acre. The difference was especially pronounced when one examines black walnut seedlings per acre. Here, rolling uplands had a much higher average, but dry slopes also had a higher average seedlings per acre than did the bottomland sites. More black walnut volume was found in fully stocked stands than in any other density category, although the difference with medium stocked stands was not significant (Fig. 46). It is notable that in the previous forest inventory, a much higher proportion of the volume was in medium and poorly stocked stands. Although there were twice as many trees in the black walnut forest types under 60 years old, this age class accounted for more than two-thirds of the volume (Fig. 47). Across all forest types, the top two grades of black walnut trees (1 and 2) are found primarily in poorly stocked and medium stocked stands, as are most of the small trees (Fig. 48).

What this means

Black walnut does not tolerate shade well, so it is a little surprising that half of the growing-stock volume was in fully stocked stands. One could speculate that these dense stands with black walnut only recently reached full stocking, and our data suggest that is the case. With increasing forest density over the long term, we would expect that there will be fewer black walnut trees in future Kansas forests. Being shade intolerant, black walnut not only has its best volume growth and survival in low to medium density stands but also apparently its best form. A discussion of stand density vs. tree form is important as black walnut did not respond well to pruning in Kansas (Shigo et al. 1978).

Figure 43.—Black walnut growing-stock density by plot location, Kansas 2005.

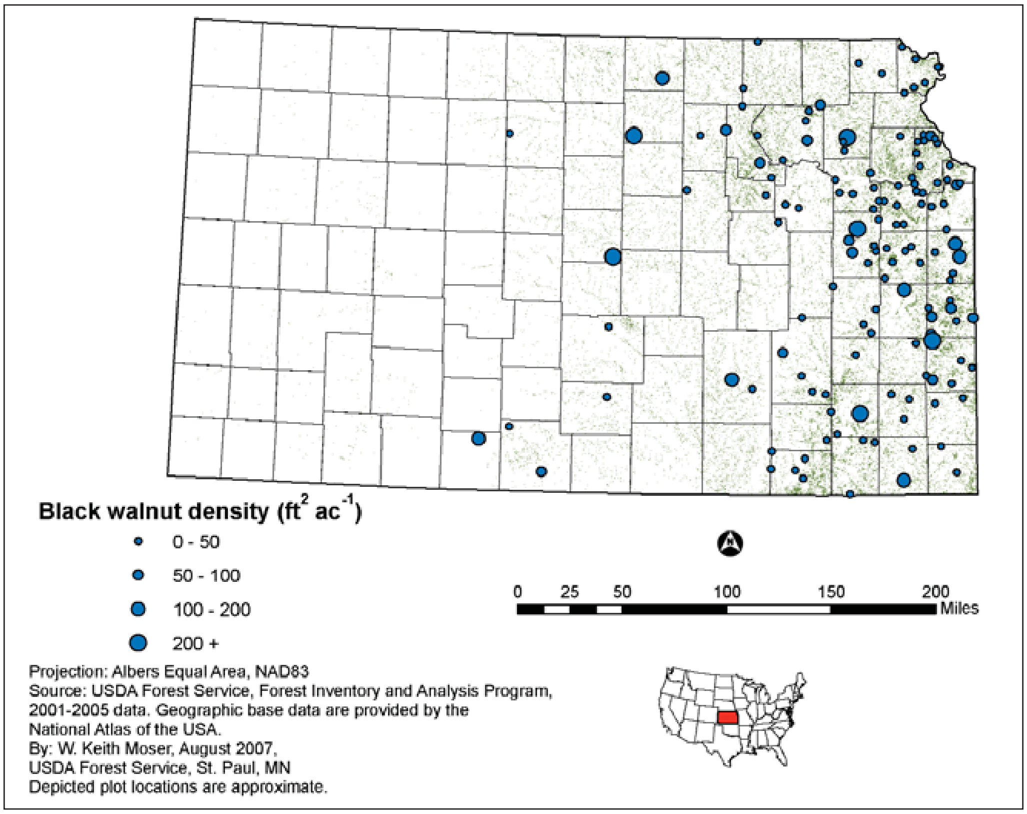


Figure 44.—Volume of black walnut growing stock on timberland, Kansas 2005.

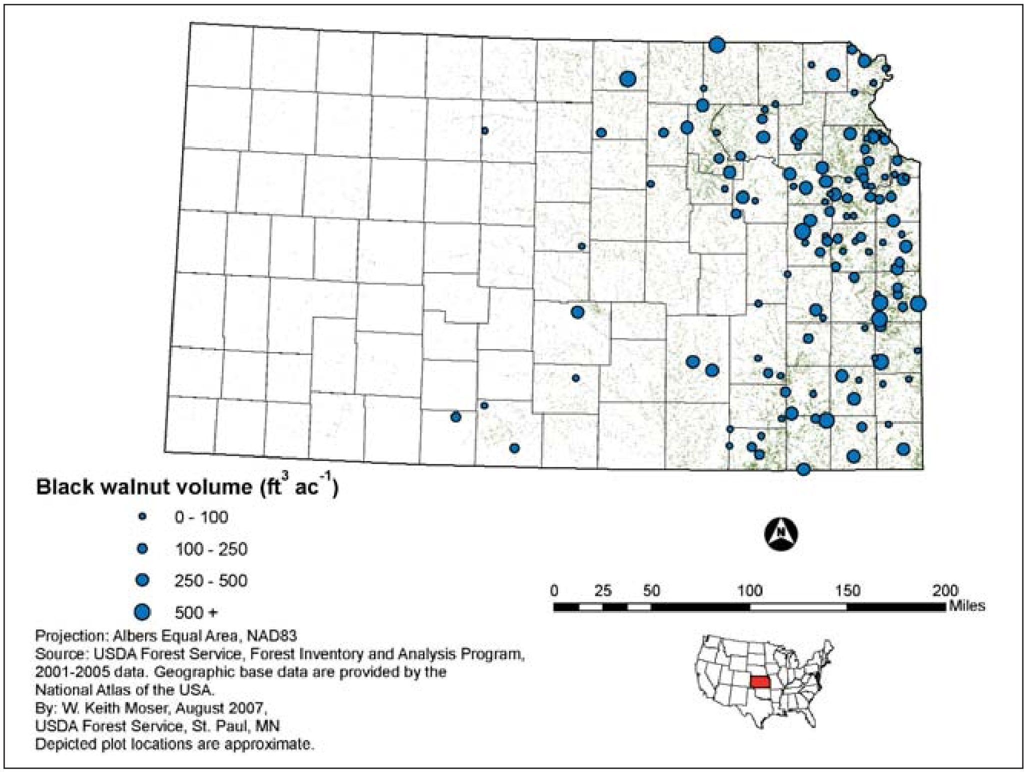


Figure 45.—Black walnut plots by physiographic class, Kansas 2005.

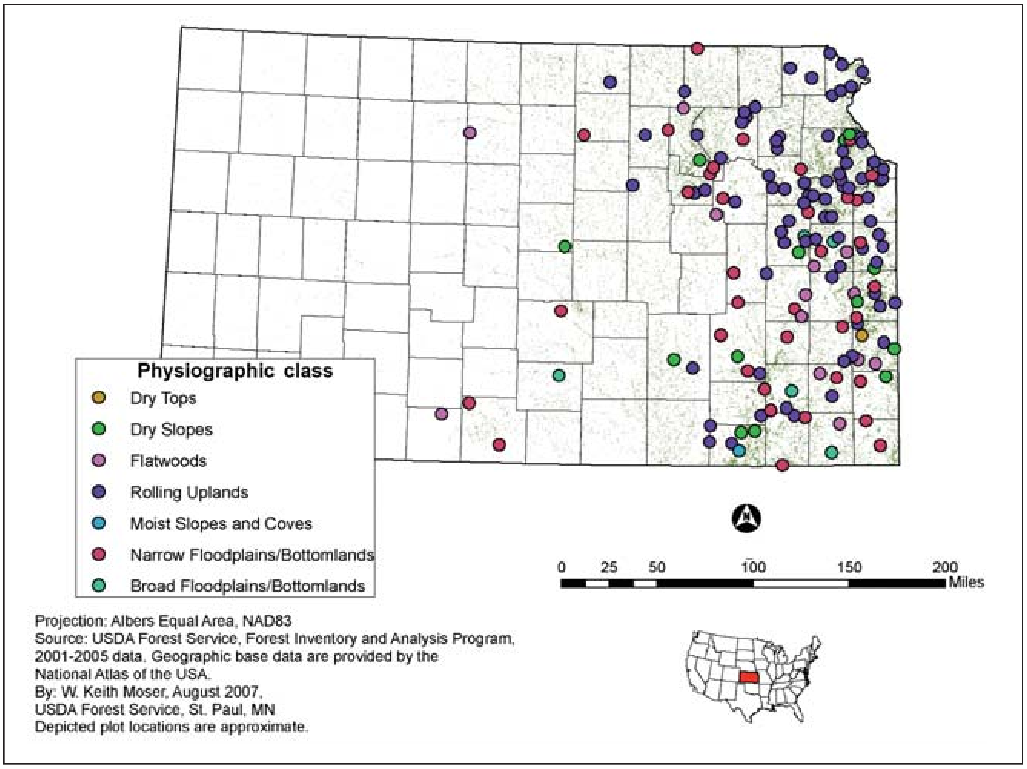


Table 12.—Black walnut trees per acre on plots where black walnut was present, by physiographic class, Kansas 2005.

Physiographic Class	Trees per acre	Seedlings per acre
Dry tops	0.0	75.0
Dry Slopes	17.6	149.9
Flatwoods	21.3	75.0
Rolling uplands	33.2	206.2
Moist slopes and coves	18.1	0.0
Narrow floodplains/bottomlands	20.0	107.1
Broad floodplains/bottomlands	25.8	112.4
All plots with black walnut	27.1	163.3

Figure 46.—Volume of black walnut growing stock on timberland by live-tree stocking code, Kansas 2005.

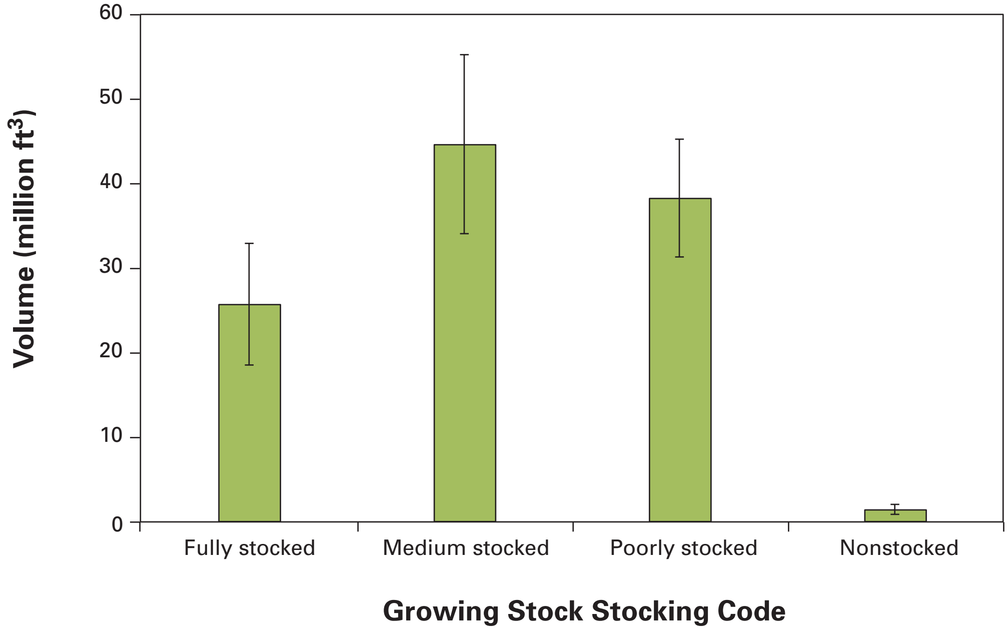
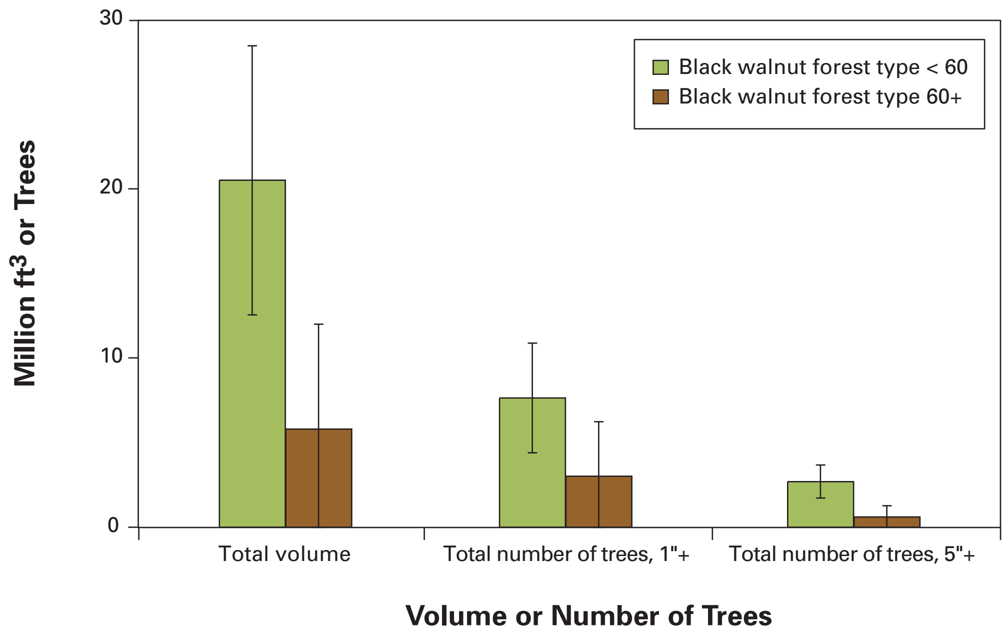


Figure 47.—Total volume and number of trees in black walnut forest types on timberland, Kansas 2005.



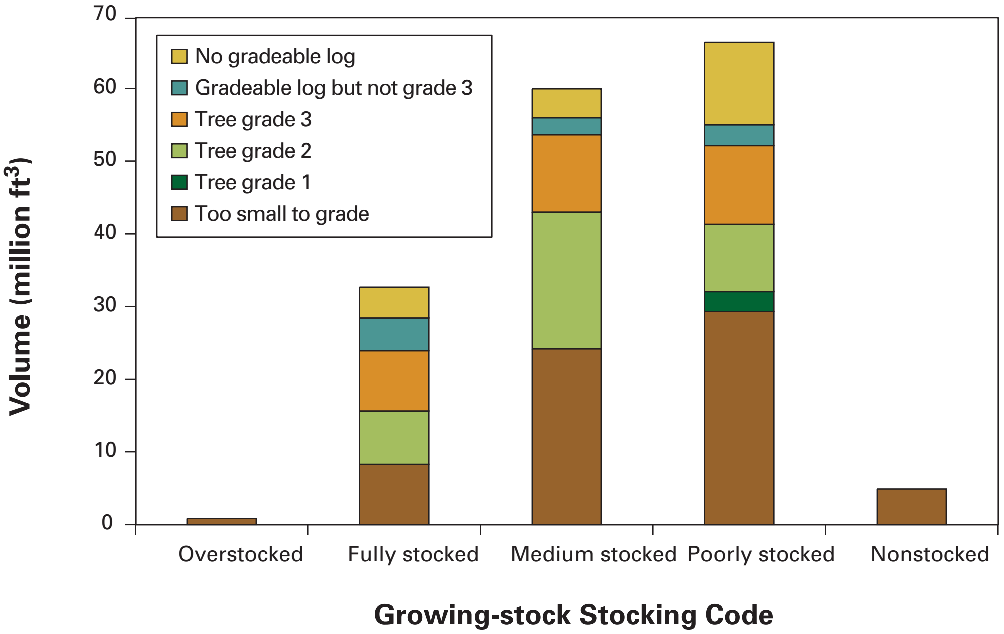


Figure 48.—Volume of live black walnut trees on forest land, by stocking and tree grade, Kansas 2005.

Cottonwood: King of the Rivers

Background

Cottonwood *(Populus deltoides)* is found throughout Kansas. While it grows best on humid sites in the Mississippi River alluvial bottomlands farther east (Fowells 1965), in Kansas this species finds sufficient moisture to survive in riparian areas. Germination in particular requires a moist seedbed, such as found on streambanks. It is probably the juvenile site requirements that limit survival, rather than water stress subsequent to establishment. Cottonwood is intolerant of shade and tends to grow in pure stands; otherwise, it becomes suppressed and dies. Cottonwood is an important species for riparian areas, especially in western Kansas.

What we found

While there are individual cottonwood trees at many locations in Kansas (Fig. 49), in some locations the basal area (Fig. 50) and volume (Fig. 51) are substantial. The number of large (13+ inches) cottonwood trees has increased since 1981 (Fig. 52). We observed a dramatic rise in the number of trees 17 inches and larger. Equally striking was the decline in the number of smaller trees from 1981 to 2005. Some of these size classes, particularly in the sapling (1 to 3 inches) and 5- to 7-inch diameter classes, were significantly smaller in 2005. Although there was a large percentage increase in the smallest diameter class between 1994 and 2005 (Fig. 53), the 1994 base was very small, so the increase was not really as dramatic as it first appears. Most of the volume as well as the plurality of the number of trees lies in the 30- to 60-year age class (Fig. 54).

What this means

As flood-control structures and prolonged drought change flooding regimes, cottonwood seeds find fewer suitable sites for germination. As a result, the species is not regenerating in sufficient quantities to maintain the forest type. The introduction of irrigation in the 1970s also may be responsible for the significant die-off of mature species along major rivers in western Kansas due to declining water tables. Cottonwood is not a particularly long-lived tree and makes its greatest volume growth in the second 30 years of its life (Van Haverbeke 1990). In order to compensate for natural patterns of mortality, particularly for a short-lived species like cottonwood, forest managers like to see many more seedlings and saplings across the landscape than mature trees. How much more depends upon the species' characteristics, but the lower quantities of the smaller diameter classes is worrisome to those concerned about cottonwood's future.

Figure 49.—Cottonwood trees per acre, Kansas 2005.

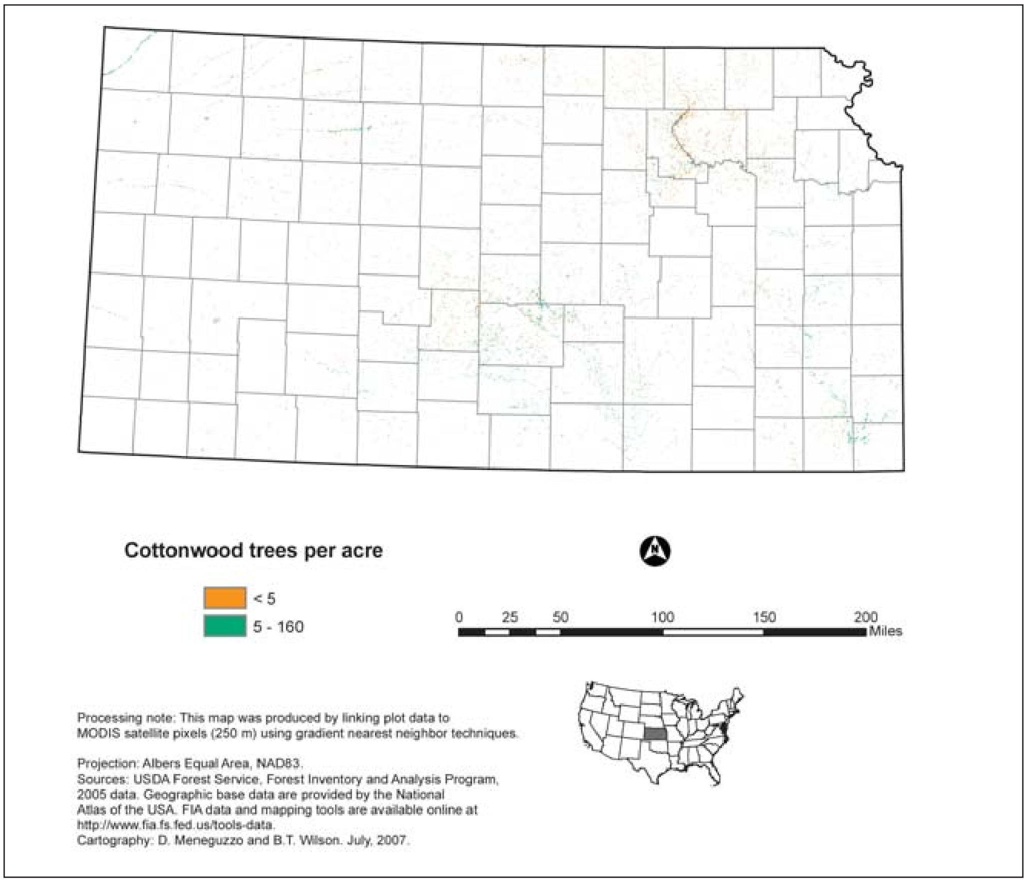
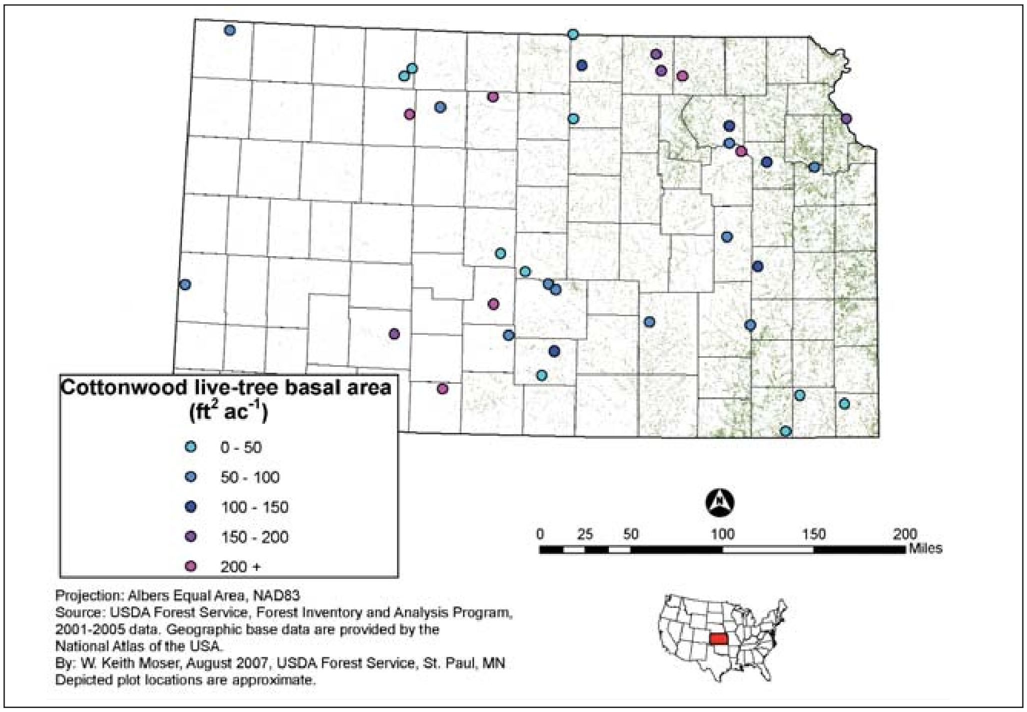


Figure 50.—Cottonwood basal area, Kansas 2005.



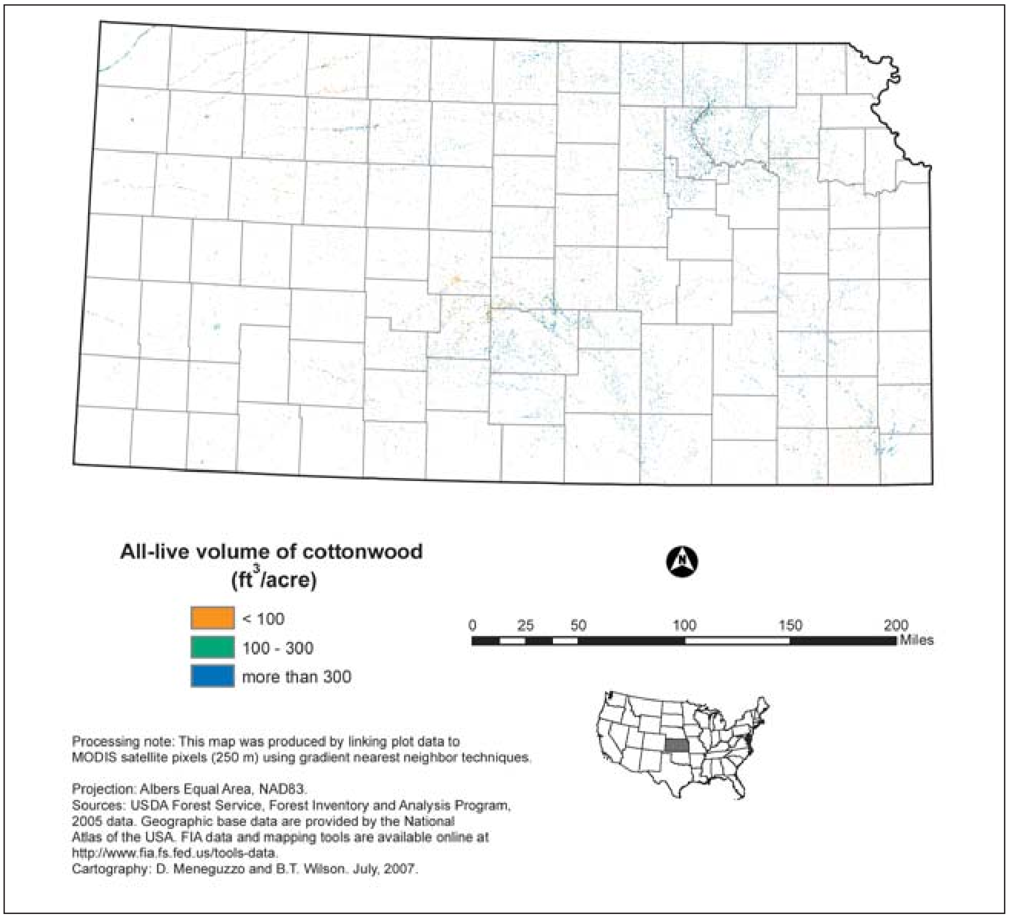


Figure 51.—Live-tree volume of cottonwood per acre, Kansas 2005.

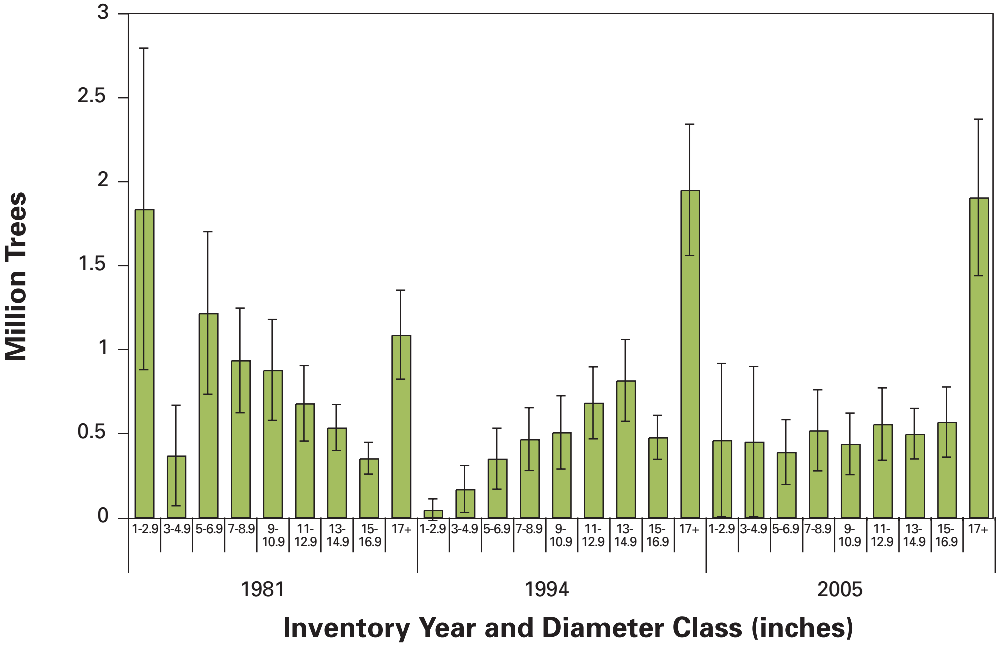


Figure 52.—Number of cottonwood trees on timberland, by inventory year and diameter class, Kansas 1981-2005.

Figure 53.—Percent change in number of live cottonwood trees on timberland, Kansas 1981-2005.

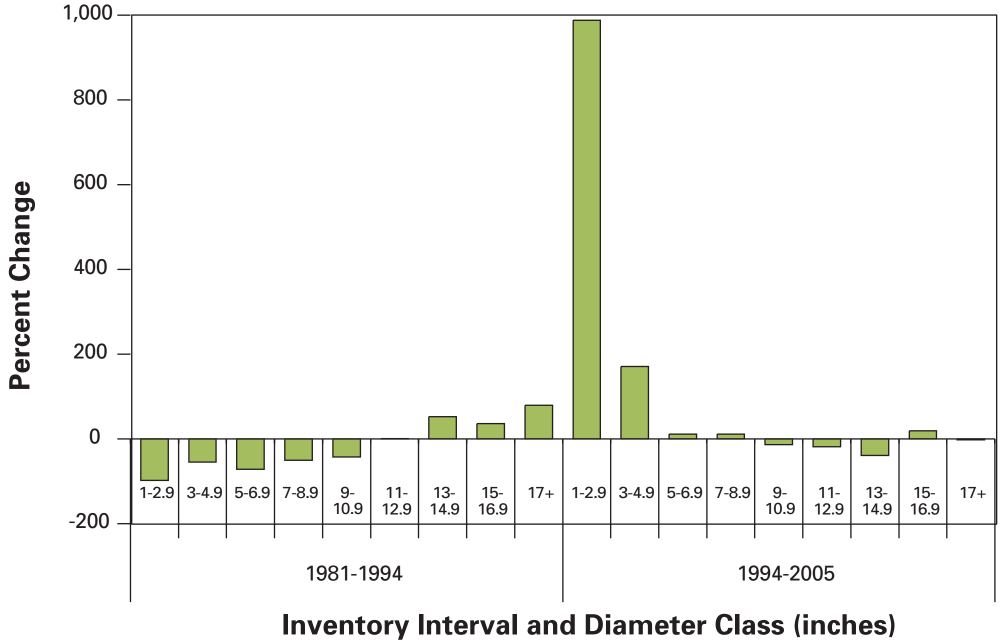
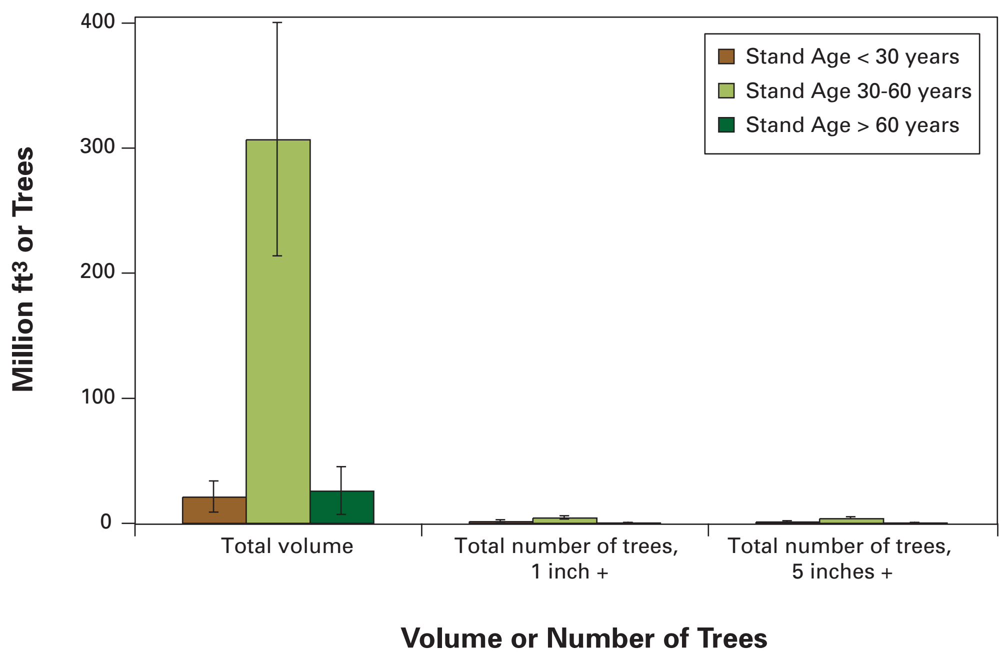


Figure 54.—Total net volume and number of cottonwood trees 1 inch and larger and 5 inches and larger across all forest types, by age class, Kansas 2005.



Eastern Redcedar: Coming on Strong

Eastern redcedar *(Juniperus virginiana)* is a coniferous species common to the eastern United States and capable of growing under different climatic conditions (Fowells 1965). Historically limited to areas with infrequent fires, this species is a vigorous colonizer of such open spaces as low density woodlands and abandoned agricultural lands. A common invader of old-field and pasture sites, eastern redcedar is the source of many specialty wood products. These two characteristics create opportunities both for forest products and for wildlife species that require dense cover but threaten grazing land health and wildlife species that rely on grassland habitat.

Good seed crops occur every 2 or 3 years, with dispersal depending heavily on birds and small mammals that eat and later distribute the seeds. On deeper soils, coinvaders can quickly outcompete redcedar. On wooded sites, redcedar occurs with blackjack oak, post oak, and white ash. If fire is suppressed, these species may be replaced by the more shade-tolerant hackberry and elm (Read and Walker 1950, Krusekopf 1963). Stands formed through invasion of old fields may begin to break up at around 60 years of age as hardwoods or other competing species become established.

What we found

Eastern redcedar grows throughout Kansas forests, particularly in the central and southern regions. Although redcedar can be found in extremely dense stands, the bulk of the populations in Kansas are in relatively low-density stands (Fig. 55). Consistent with the observation of redcedar basal area, we found that the majority of our plots have a relatively low number of redcedar trees per acre (Fig. 56) and low volume (Fig. 57). The bulk of the volume of eastern redcedar was in the 30- to 59-year age class (Fig. 58). We expected that result, but what was surprising was the relatively low number of trees in the under-30 age group. The acreage with eastern redcedar trees increased dramatically over the years (Fig. 59). This figure actually understates the extent of redcedar presence in 2005, as we did not include 50,000 acres with eastern redcedar seedlings but not trees over 1 inch in diameter, because we did not record similar data in the 1981 and 1994 inventories.

What this means

Eastern redcedar is expanding throughout the Midwest (Schmidt and Piva 1996). The suppression of fire and a reduction in grazing on pastureland have resulted in an expansion of redcedar in Kansas as never before seen. This species is one of the first to invade old fields (Arend 1947), largely as a result of fire suppression (Beilmann and Brenner 1951).

The preponderance of redcedar volume is in trees established 30 to 60 years ago. The much smaller proportion of trees in the younger age class would suggest a decline in the rate of land-use change, such as abandoned pasture, or the presence of vigorous grass and woody species competition that inhibits the establishment and growth of this species. Some of this density-dependent competition was reflected in the higher stocking of redcedar stands in the most recent inventory. However, the 50,000 acres of timberland with eastern redcedar seedlings but no large trees suggests a future expansion of this species.

Although dense stands of redcedar provide good wildlife cover, that density can reduce understory diversity and plant growth. The establishment of a redcedar stand will change the character of the forest landscape, encouraging some wildlife communities while limiting others. Dense eastern redcedar stands are highly susceptible to fire; an increase in such stands will increase the danger of wildfires absent effective fire management programs.

Figure 55.—Basal area of eastern redcedar, Kansas 2005.

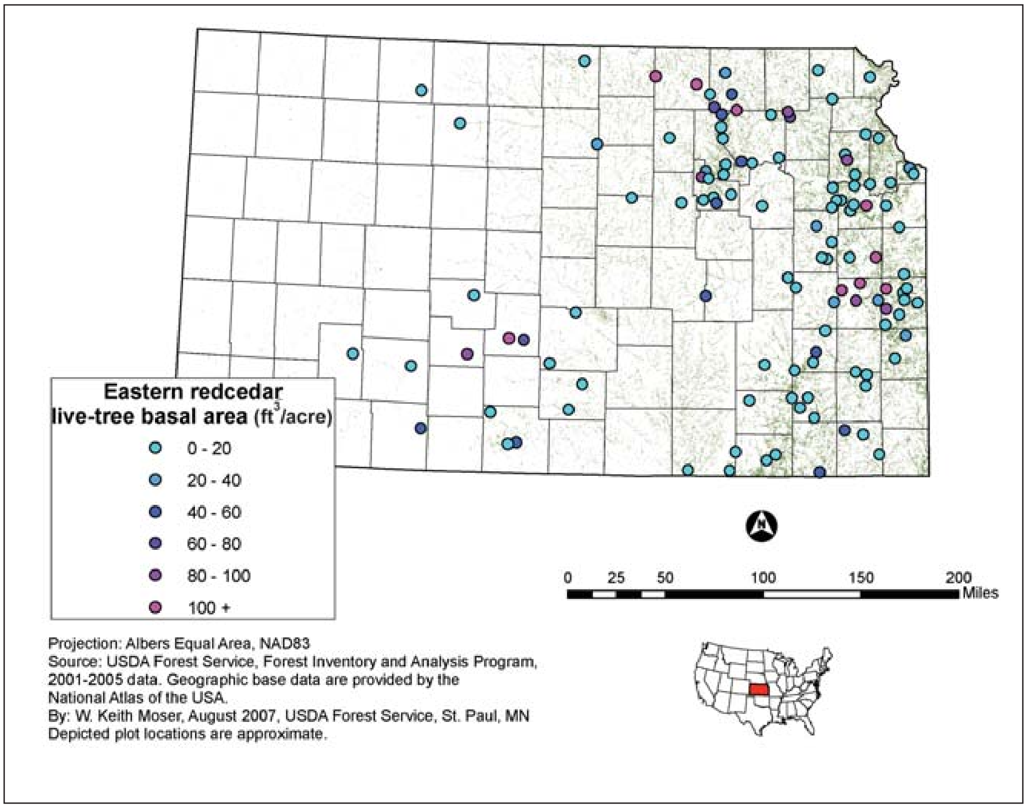


Figure 56.—Eastern redcedar trees per acre, Kansas 2005.

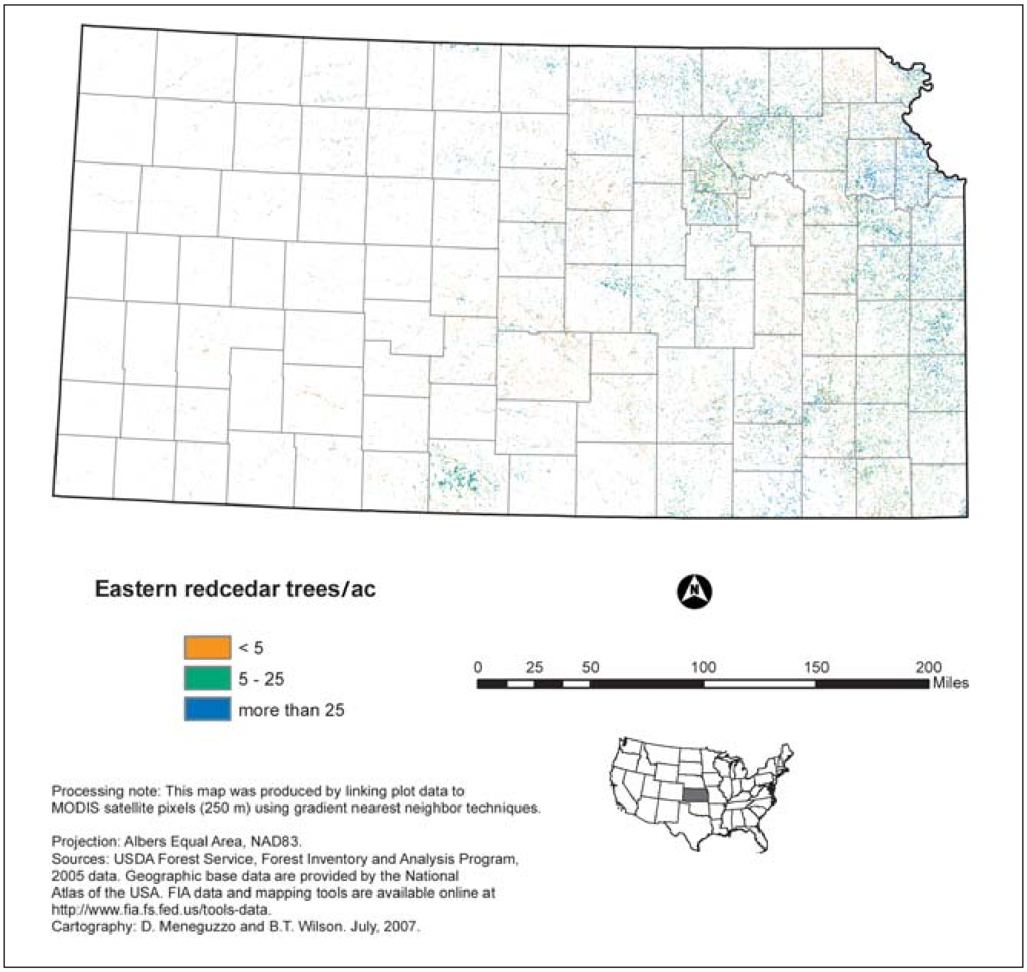


Figure 57.—Volume of eastern redcedar trees, Kansas 2005.

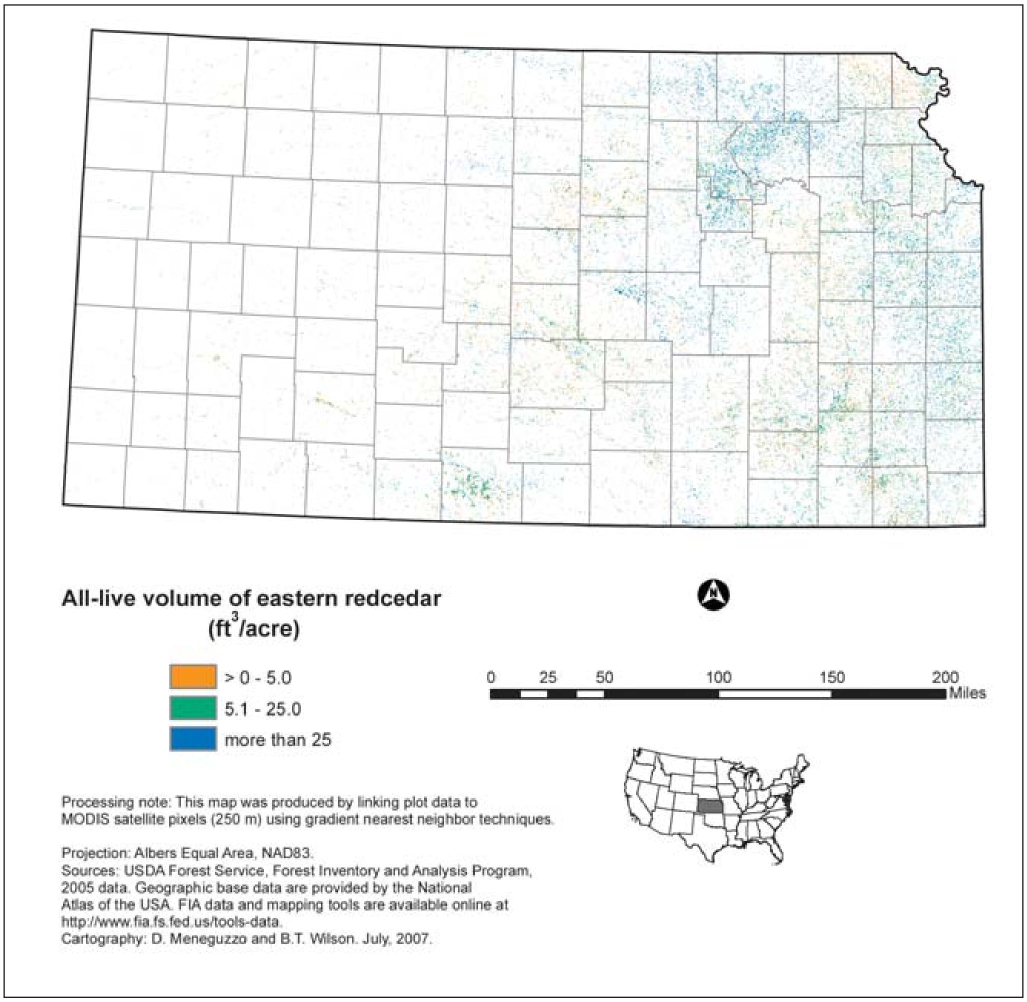


Figure 58.—Total net volume and number of eastern redcedar trees 1 inch and larger and 5 inches and larger across all forest types, by age class, Kansas 2005.

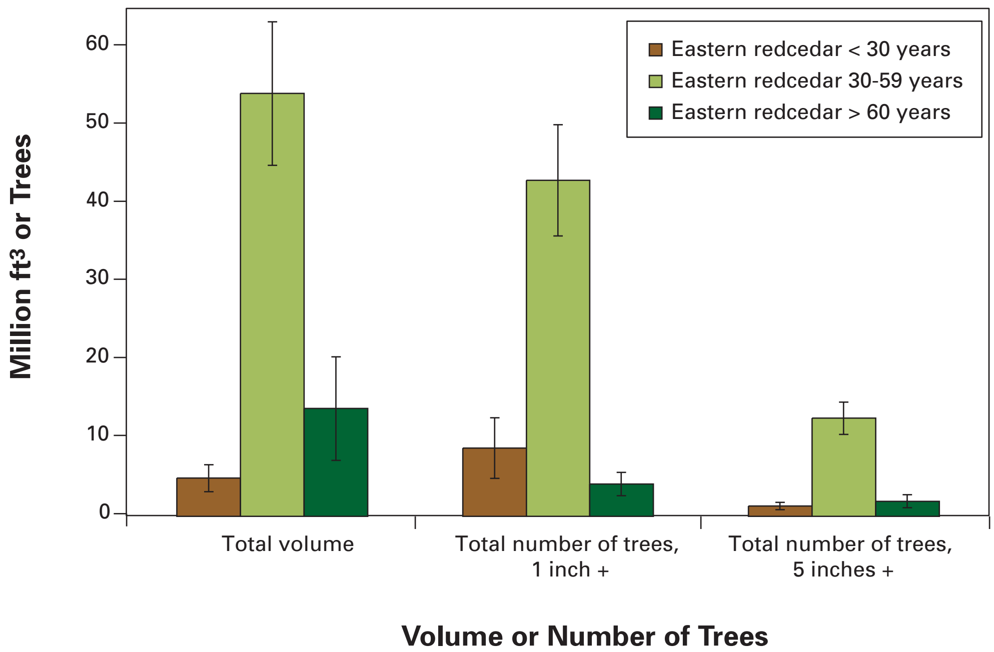
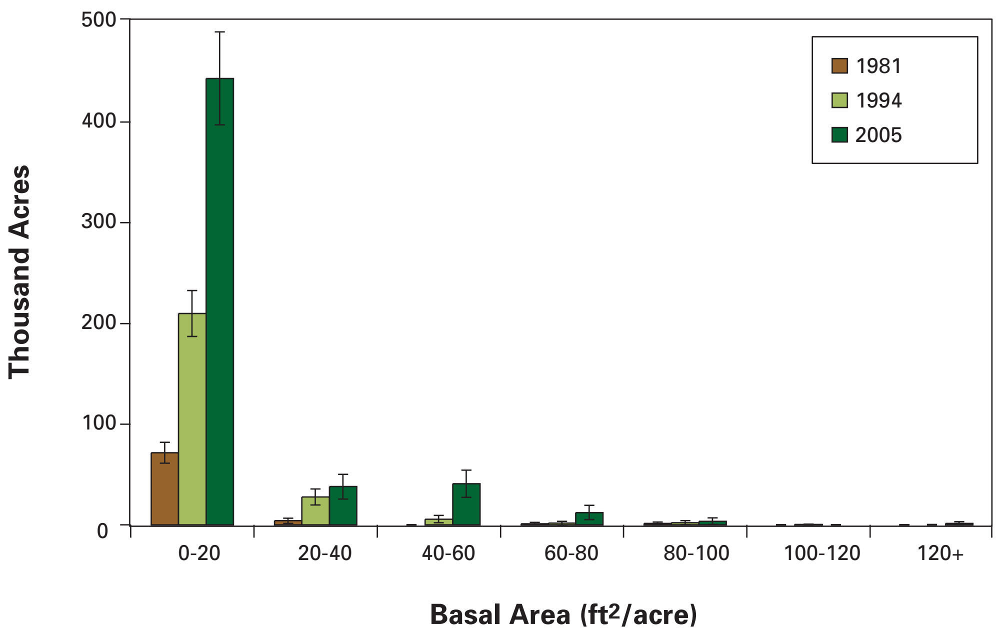


Figure 59.—Timberland acreage with eastern redcedar present, by basal-area category, Kansas 1981-2005.



Utilization and Forest Products

Timber in Miami County, Kansas. Photo used with permission by Robert Atchison, Kansas Forest Service.

Why so Much Cull? Tree Volume and Grade

Introduction

Kansas historically had high percentages of its live-tree volume in cull. Cull volume represents trees that are unsuitable for sawtimber but might have volume that can be used for such products as wood chips for oriented stand board, parquet flooring, and pulp.

What we found

Cull volume, defined as rough, short-log, and rotten, is nearly 46 percent of Kansas' live-tree volume on timberland. We broke down the estimated volume of trees 5 or more inches in diameter into growing stock and the three cull categories (Fig. 60). Rough cull is a high percentage of the volume of Kansas' trees more than 5 inches in diameter. In Kansas, many merchantable logs are sold in 8-foot lengths, which FIA defines as cull. In our data, though, short logs are not as prominent a component of cull volume. Figure 61 shows the transition from largely poorly stocked and lower-quality stands in 1994 (reflecting the recent inclusion of wooded pasture in the definition of forest land) to higher densities in 2005. Apparently, many of the smaller, ungraded trees in 1994 became low quality trees in 2005, likely due to their initial development in low density stands.

We observed two trends. The first was the transition from largely low and medium stocked stands to a higher proportion of fully stocked and overstocked stands. Earlier, we discussed the increase in forest-land density in Kansas (Figs. 22-23). This transition in stocking levels has been underlined by the data in Figure 61. We also observed an increase in lower tree grades, particularly in the 2005 inventory. Even in the higher stocking levels, volume increased in lower tree grades.

Why this matters

Increasing density is a recurring theme in this report. As stated earlier, increased forest density brings both benefits and costs. What seems paradoxical is the increase in low quality volumes even in higher stocking. In dense stands, at least one source of low quality stems—branchiness—should be reduced by shading, so we would expect to see fewer low quality stems in dense stands. What we have observed makes sense, however, when we consider ingrowth in lower density stands of low quality stems has led to higher density stands. The self-shading that usually occurs in dense stands was too late to improve stem quality; the branches already were too large and/or too low on the trunk.

Figure 60.—Volume of live trees 5 or more inches in diameter by tree class code, Kansas 2005.

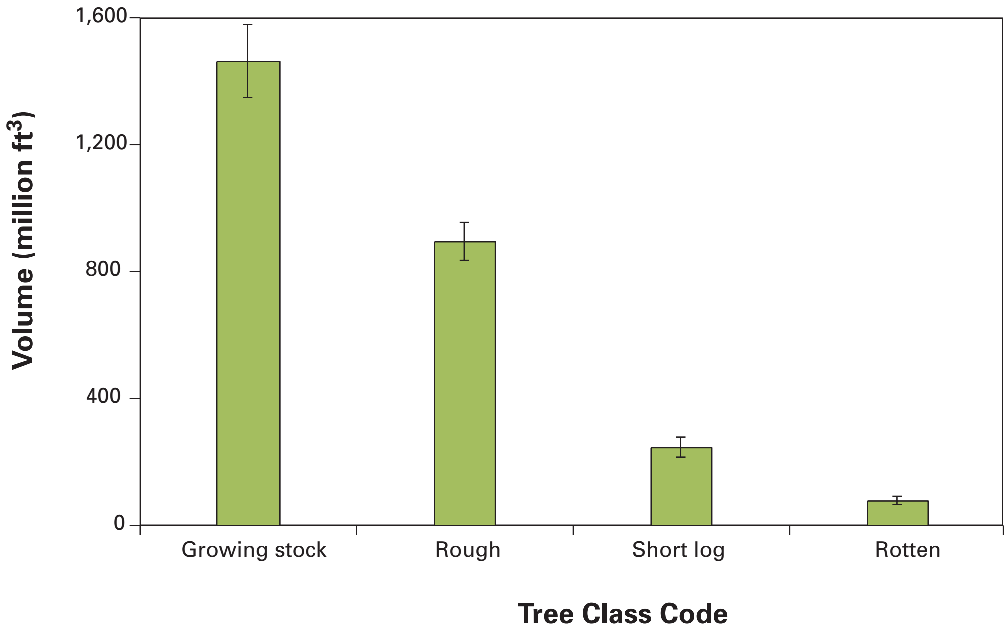
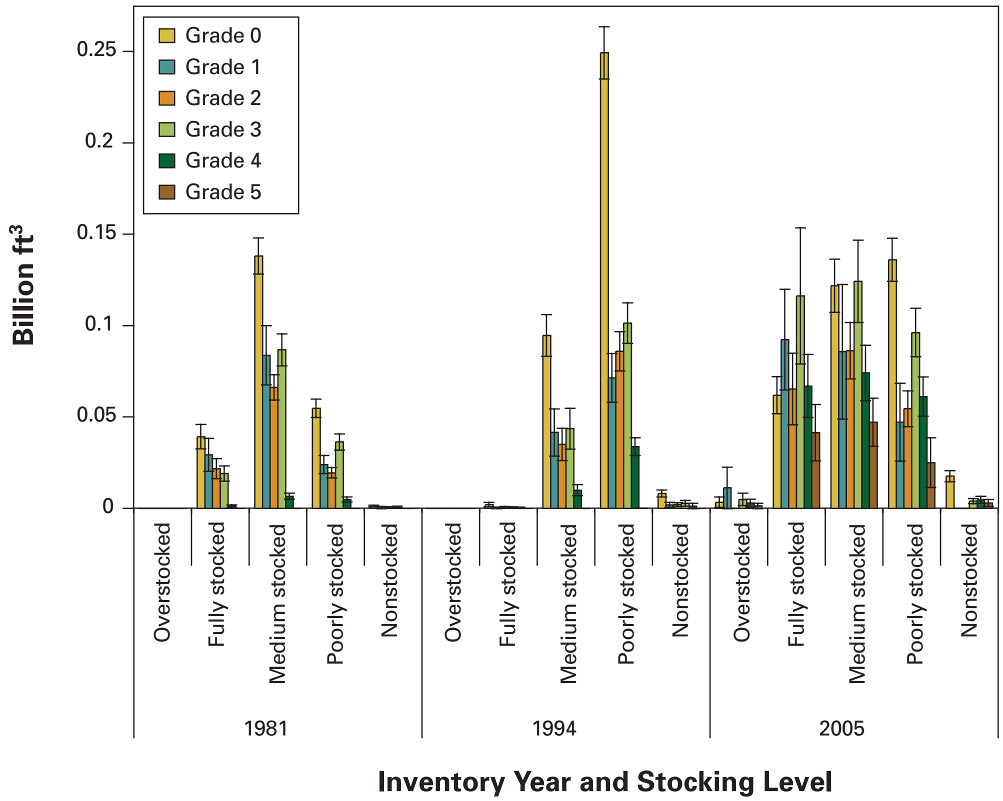


Figure 61.—Volume of growing stock on timberland, by inventory year, stocking level, and tree grade, Kansas 1984-2005.



Sawtimber Volume

Background

Sawtimber volume is the volume of wood in the saw log portion of a tree (the section of a tree's bole between the stump and the saw log top, expressed in board feet). Sawtimber volume represents the highest value for wood in a tree or the amount of usable product that might be manufactured. When saw logs are sawn into pieces by sawmills, the pieces are converted to products such as lumber, veneer, and furniture stock.

What we found

In 2005, Kansas had 5.4 billion board feet of sawtimber, a 22 percent increase over the 1994 inventory and a 123 percent increase over the 1981 inventory. Cottonwood (1.2 billion board feet) and hackberry (736.0 million) were particularly prominent on the Kansas landscape (Fig. 62). Select red and white oaks totaled 1.0 billion board feet. Important species in this category were bur oak (369 million board feet) and northern red oak (380 million). Black walnut totaled 388 million board feet.

There was a large increase in sawtimber volume among species groups between 1981 and 1994, but most of these same species groups increased much less (or even declined) between 1994 and 2005 (Fig. 63). When we look at the percentage increase (Fig. 64), the rapid accretion of sawtimber between 1981 and 1994 is in stark contrast to the (at best) smaller increases occurring from 1994 to 2005.

What this means

Eastern redcedar exhibited a phenomenal increase in sawtimber volume between 1994 and 2005 of 353 percent. Black walnut and select red oaks had the next largest percentage increases (42 and 34, respectively) from 1994 to 2005. Black walnut is highly prized for high quality forest products, particularly furniture, so this result should be heartening to Kansas' landowners and mill operators. Two riparian species–cottonwood and hackberry

Marty Hewins, logger and consulting forester, harvests timber in Doniphan County, Kansas.
Photo used with permission by Robert Atchison, Kansas Forest Service.

(the largest component of "other eastern soft hardwoods" in Kansas)–also showed dramatic increases in sawtimber volume since the last inventory, though the cottonwood increase was not statistically significant. The continued growth of Kansas' trees results in more volume in sawtimber-size trees. Larger trees present opportunities for both forest-products manufacturers and wildlife species that rely on maturing forests. However, such species as cottonwood are short-lived, so large trees now do not necessarily portend large trees in the future unless there are many trees to continually replenish the large diameter classes.

Figure 62.—Sawtimber volume (million board feet) for selected species, Kansas 2005.

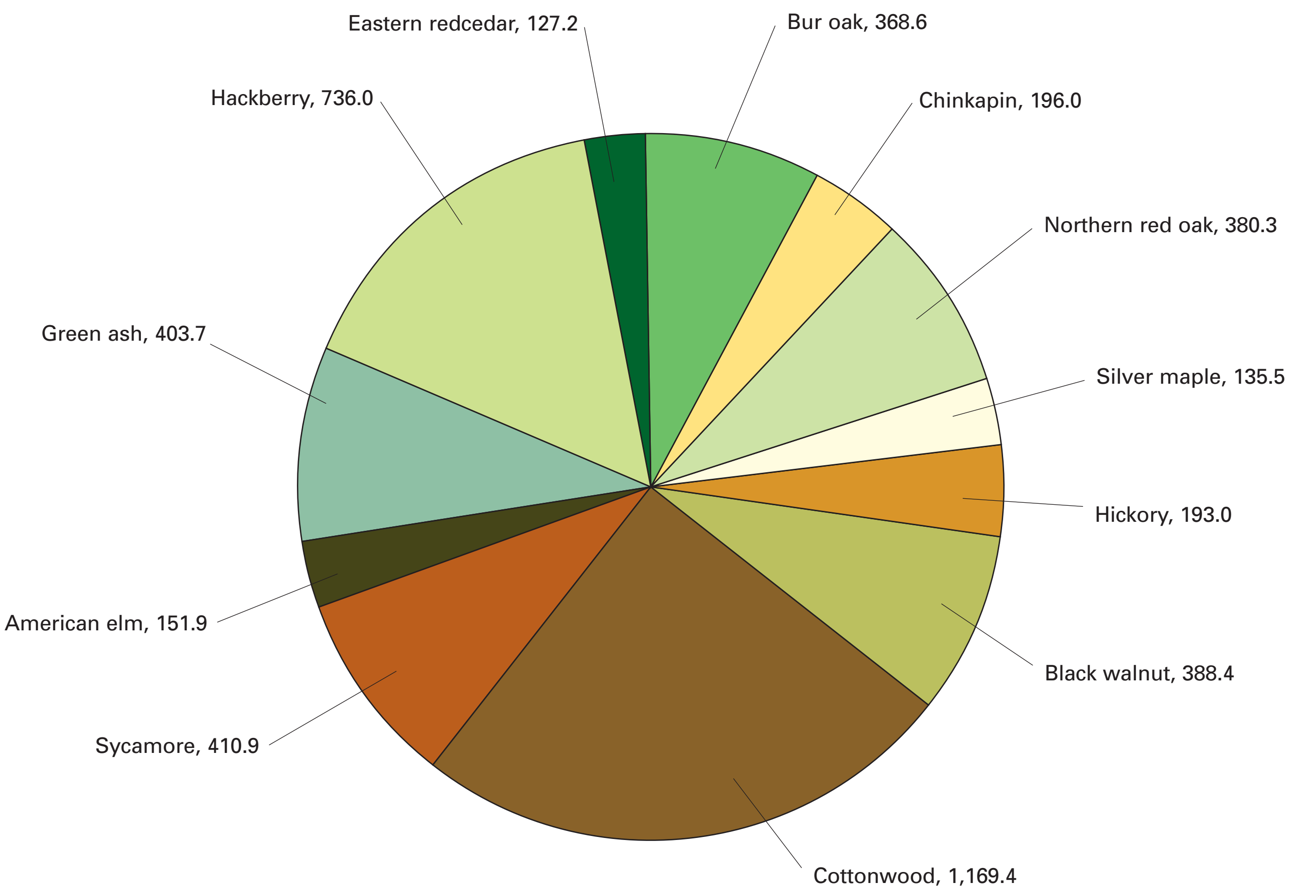


Figure 63.—Sawtimber volume of selected species groups, Kansas 2005.

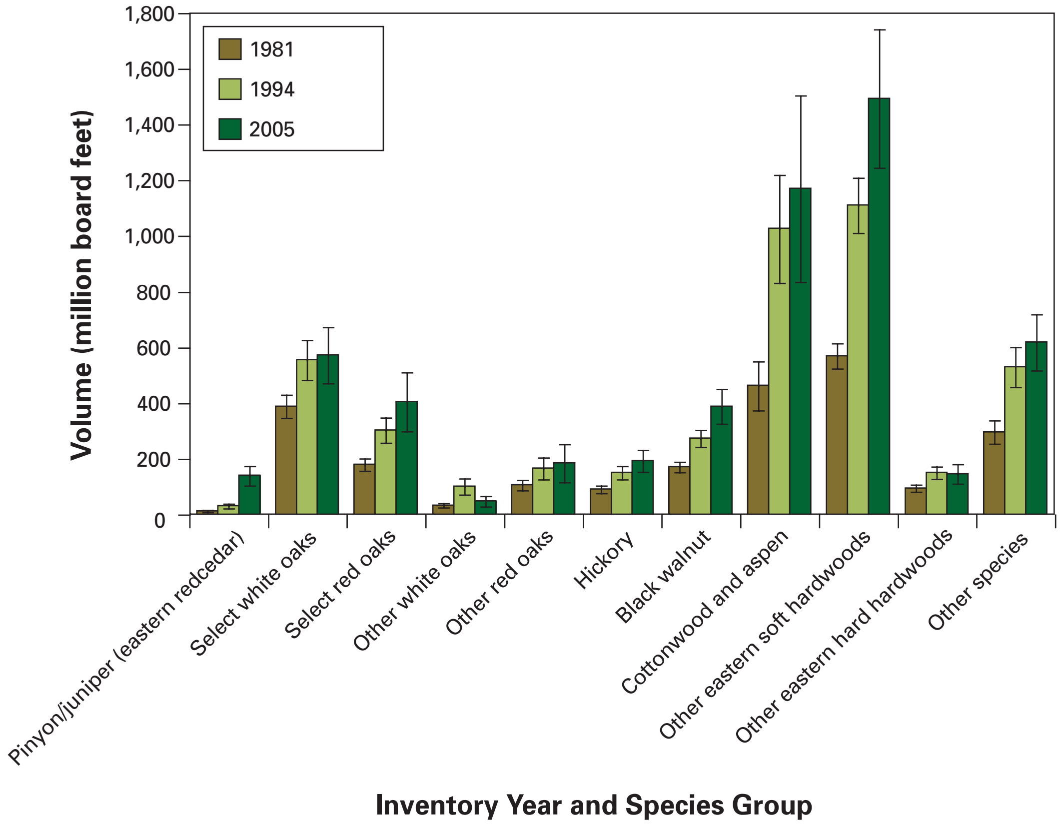
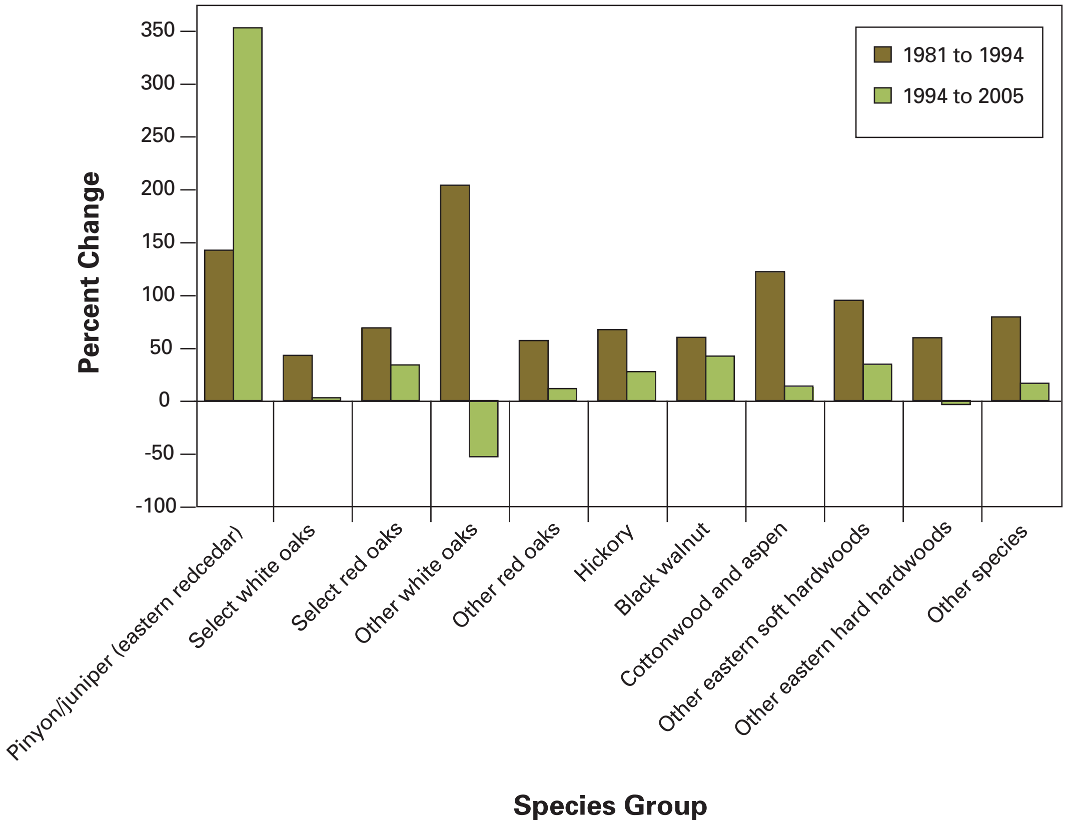


Figure 64.—Percent change in sawtimber volume between inventories, Kansas 1981-1994 and 1994-2005.



Timber Products Output

Background

Timber harvesting in Kansas is a small component of the State's economy. FIA periodically conducts surveys of wood-processing mills (called timber products output or TPO studies) in Kansas to generate an estimate of the amount of wood volume that is processed into products. The last survey was conducted in 2003 (Reading and Bruton 2007). In 2003, the State's economy supported one large sawmill (receipts greater than 1,000 thousand board feet/year), two medium sawmills (100 to 1,000 thousand board feet/year), and 37 small sawmills (less than 100 thousand board feet/year) (Fig. 65). The 2002 economic census estimated that the primary roundwood processing sector had receipts of $355 million and employed 2,494 people (U.S. Census Bur. 2005 a,b). These figures equate to less than 1 percent of the total manufacturing receipts for Kansas and slightly more than 1 percent of manufacturing employees. Despite its small size, Kansas' timber industry is important to those employed by it and to landowners who sell stumpage to it. Therefore, it is important to understand the characteristics of the timber being harvested and where it is being harvested, and how this may affect Kansas' forests.

What we found

Nearly 3.3 million cubic feet of industrial roundwood was harvested from Kansas' forests in 2003. Nearly all of this was in the form of sawlogs going to sawmills. Sawlog production changed by 2 percent from the 1998 survey, increasing from 19.8 to 20.2 million board feet in 2003. Most of this roundwood (77 percent) went to Kansas mills. The remainder went to Missouri (12 percent), Nebraska (10 percent) and states outside the 24-state FIA region of the Northern Research Station (2 percent). Although the harvesting of Kansas' forests increased slightly, the receipts of roundwood by the State's mills decreased by 16 percent during the same period. Ninety-seven percent of the roundwood processed by Kansas mills came from forests within the State. The remainder was supplied by Missouri and Oklahoma.

The regional harvest of sawlogs is not well correlated with the regional inventory estimates of standing sawtimber. The Southeastern unit produced 58 percent of the sawlogs harvested in 2003 while the Northeastern and Western units produced 24 and 18 percent, respectively (Fig 66). The 2005 inventory estimated that the Southeastern unit contains 37 percent of the standing sawtimber, the Northeastern unit 42 percent, and the Western unit 21 percent (Fig. 67).

The five most heavily harvested species in Kansas are: cottonwood, comprising 28 percent of the harvest; white oak (18 percent), soft maple (16 percent), black walnut (14 percent), and ash (9 percent) (Fig 68). Notable changes in harvest levels from the previous TPO survey are ash, which increased in share from 4 to 9 percent; black walnut, which increased from 7 to 14 percent; hackberry, which decreased from 9 to 4 percent; and white oak, which decreased from 23 to 18 percent. Of these species, only black walnut showed a significant change in inventory volume at the State level from 1994 to 2005. The statewide inventory volume of black walnut increased by 42 percent despite a 107 percent increase in harvest volume from the 1998 to 2003 TPO surveys.

At the unit level, only ash showed a significant change between the 1994 and 2005 inventories. Ash inventories in the Western unit increased by 136 percent. Between the 1998 and 2003 TPO surveys, ash harvest volume decreased by 87 percent.

What this means

The closure of several large- and medium-size mills since the last survey period has resulted in a statewide reduction in wood-products manufacturing capacity. This loss is concentrated in the Northeastern unit, where the closing of one large- and one medium-capacity sawmill was probably responsible for a sawlog production decrease of 27 percent in that unit. In 2003, 0.21 percent of standing sawtimber was harvested in the Northeastern unit, 0.60 percent in the Southeastern unit, and 0.35 percent in the Western unit. With respect to forest products, these percentages suggest that the Northeastern unit's forests are being underutilized compared to the rest of the State.

The only significant changes in sawtimber inventory volume for the five most heavily harvested species are increases at the unit or State level. In the case of black walnut, harvest levels have increased, as have inventory levels. Ash harvest levels have decreased while inventories have decreased. Apparently there is no consistent relationship between inventory levels and harvest levels at the unit or State level. This disconnect is probably due to the low intensity of sawtimber harvest at both levels. The temporal changes in Kansas' forest industry and its sawtimber harvesting activities probably are based more on the quality of sawtimber available and its competitive position in the market compared to that of other states such as Missouri and Indiana, both of which are large producers of hardwood sawtimber.

Figure 65.—Primary wood-using mills by capacity (thousand board feet = MBF) , Kansas 2003.

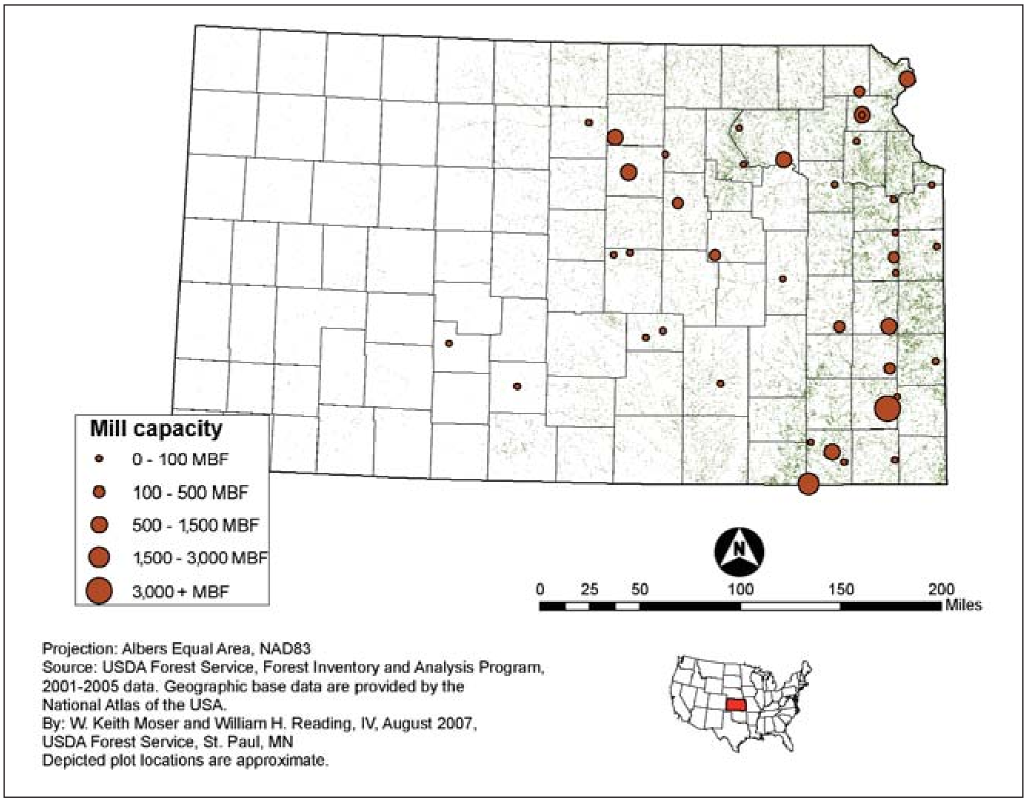


Figure 66.—Distribution of sawtimber production by forest inventory unit, Kansas 2003.

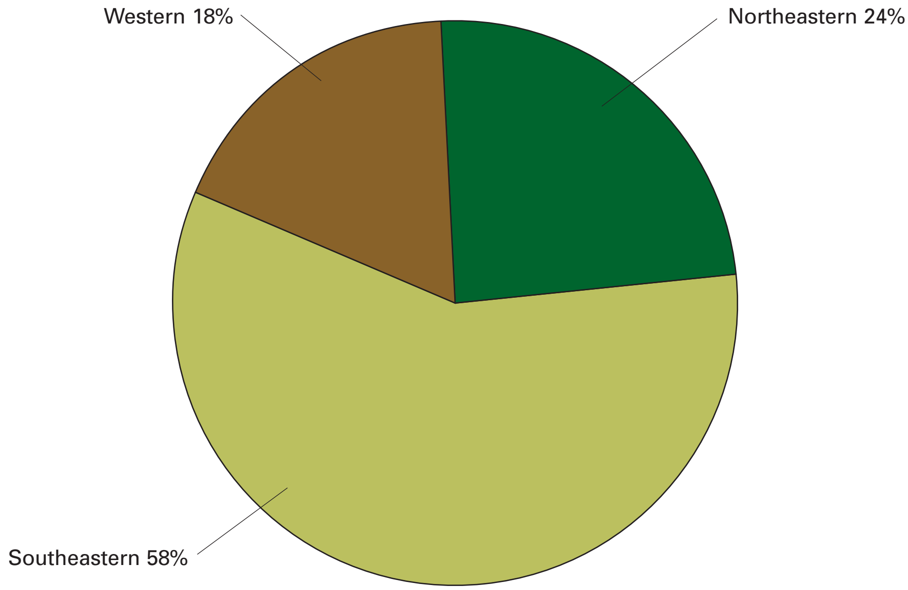


Figure 67.—Distribution of sawtimber on timberland by forest inventory unit, Kansas 2005.

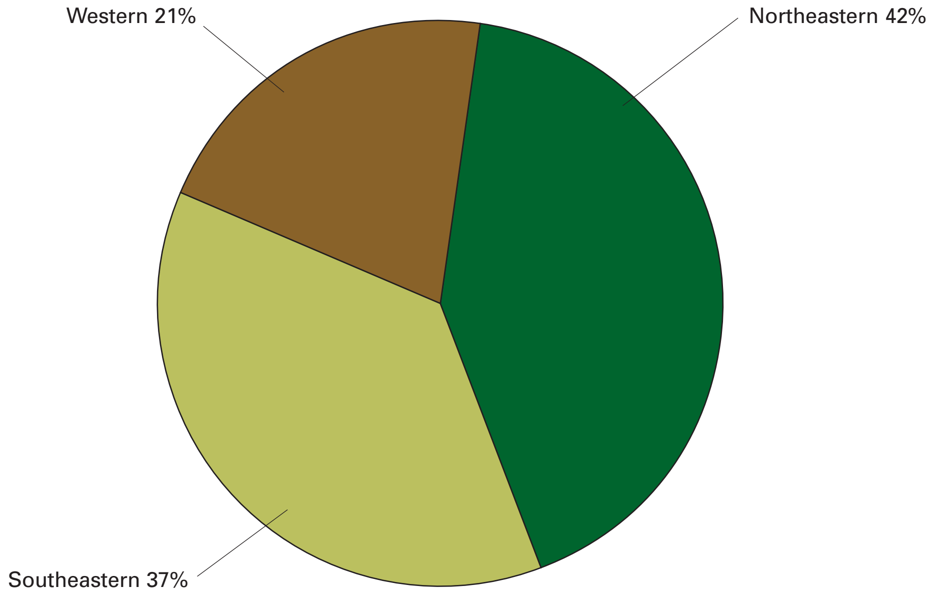
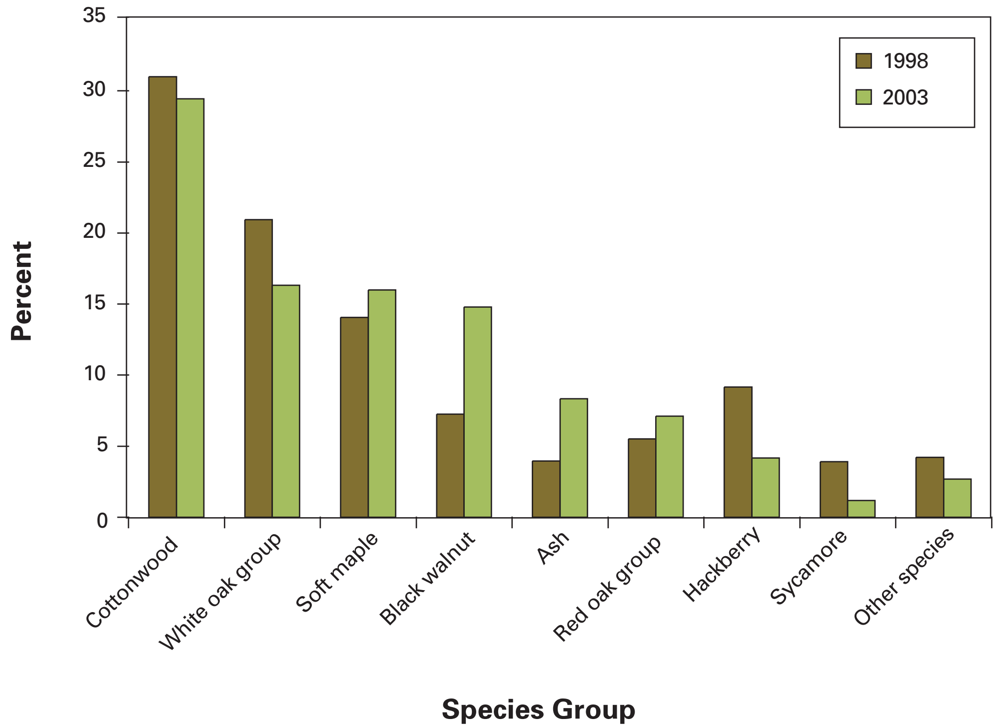


Figure 68.—Percentage of saw log production by species group, Kansas 1998 and 2003.



Wildlife Habitat

Background

Only 4 percent of all land in Kansas is forested, yet these forests are critical for wildlife habitat. Forests are valuable refuges for woodland birds, mammals, reptiles, amphibians, and invertebrates. Both upland and bottomland or riparian forests are important to Kansas wildlife. Fifty percent of the State's breeding birds use forests and woodlands for breeding or foraging; 14 and 16 species, respectively, of State-protected animals rely on upland and riparian forests for habitat. The population of these species often is directly proportional to the amount of forested habitat available (Leatherberry et al. 1999). Land management has intentionally and unintentionally altered the structure of wildlife habitat across Kansas (SWAP 2005), including the State's forests. We address selected components of wildlife habitat that are related to forest composition, structure, and spatial arrangement.

What we found

Standing dead trees provide nesting and roosting sites for many species of birds, small mammals, and even reptiles. FIA provides estimates of these snags (dead trees at least 5 inches in diameter, at least 4.5 feet tall, and not leaning by more than 45 degrees). Most of the higher values for snags per acre were recorded in riparian zones (Fig. 69). Twenty-five percent of Kansas' forest land was less than 500 feet from the road, whereas nearly 43 percent was between 1,000 feet and 0.5 mile from the road (Fig. 70). Only 9 percent was more than 0.5 mile from a road, reflecting the fact that the bulk of Kansas' forest land is in the more heavily populated (and roaded) eastern portion of the State. The distance of the forest land from roads and low Shannon Index diversity values (Figs. 31-32) are important in determining the quality of the wildlife habitat.

All states, including Kansas, have produced a Wildlife Action Plan, based on guidance provided by the U.S. Congress, USDI Fish and Wildlife Service, and International Association of Fish and Wildlife Agencies. The Kansas plan, known as Kansas' Comprehensive Wildlife Conservation Plan (CWCP), addresses habitat for 315 species of fish and wildlife with the greatest conservation need in the State (Wasson et al. 2005). In the Kansas CWCP, FIA is specifically named as a tool for monitoring the deciduous forests and deciduous floodplain habitats of the eastern tallgrass prairie conservation region, which comprises the eastern third of the State. Using the Kansas CWCP definitions, deciduous forest habitat is composed of the maple/basswood forest, oak/hickory forest, deciduous forest-mined land, mixed oak ravine, oak savanna, and deciduous woodland habitats. Theses six habitats, in turn, make up the deciduous floodplain habitat.

Kansas' deciduous forest and deciduous floodplain habitats contain 51 and 79 species, respectively, of mammals, birds, reptiles, amphibians, and invertebrates with the greatest conservation need. Of these, there are 13 State-listed endangered and threatened species within the deciduous forest and 14 within the deciduous floodplain (Fig. 71). For example, the threatened broad-headed skink (*Eumeces laticeps*), the largest skink in Kansas, inhabits mature oak woodlands in eastern counties and climbs trees to occupy cavities or woodpecker holes.

Of the Kansas CWCP issues listed for deciduous forest habitats, the following have been tabulated by the FIA program: amount of timber harvest (or lack thereof), spread of "weedy-woodys" and other invasive species, the predominance of such shade-tolerant tree species such as hackberry, and effects of urbanization and agricultural practices (forest land-use change).

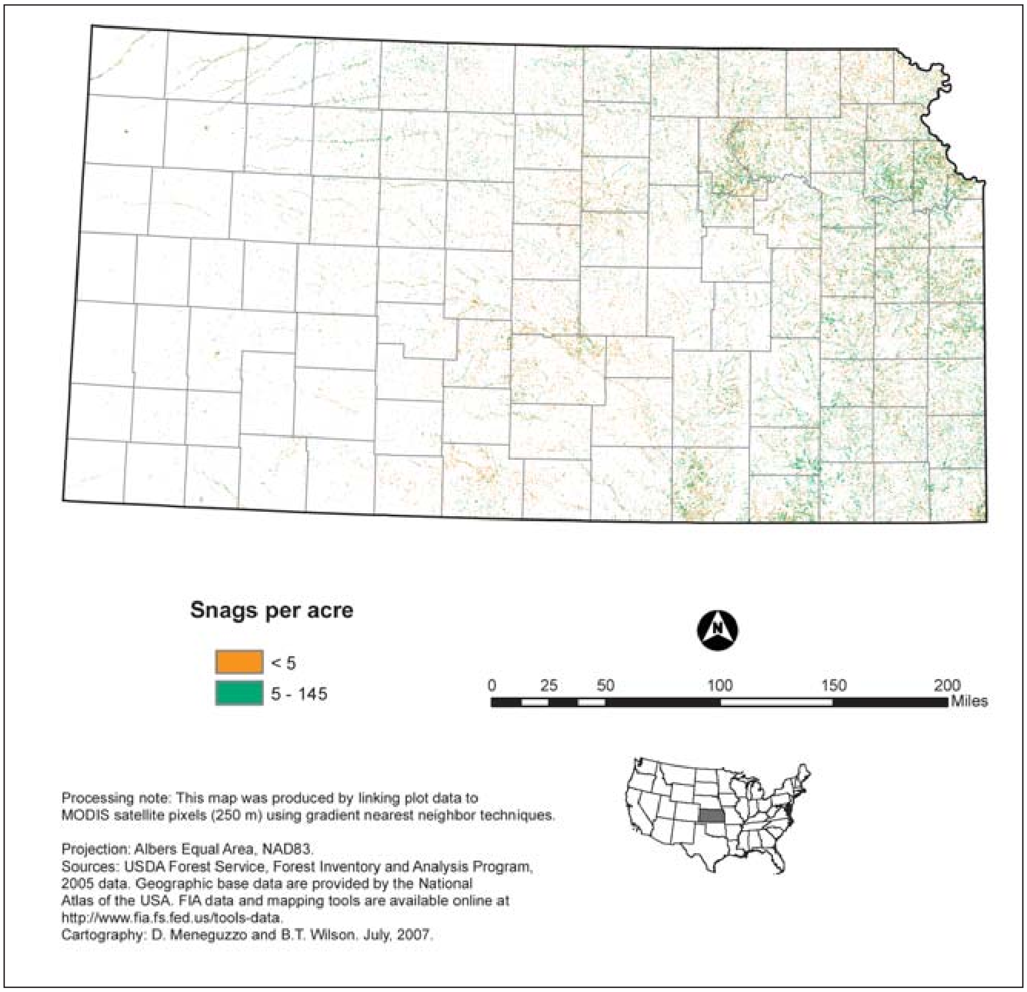
What this means

Snags play an important role in Kansas' forested ecosystems. Woodlands in the central and western portion of the State have numerous snags per acre that constitute a valuable resource for wildlife in this open landscape. The presence of snags in the future, however, will depend on successful regeneration and growth of new trees.

Anthropogenic changes to Kansas' forest land will continue to reduce the quality of wildlife habitat and the threatened and endangered species that benefit from forests. The lack of oak and cottonwood regeneration could adversely affect species that depend on oak mast as a primary food source and on cottonwood for nesting. Areas with low Shannon Index values are potential targets for manipulating species and structural diversity to improve wildlife habitat.

Cottonwood provide important perching and nesting sites for the bald eagle. Photo used with permission by Bob Gress, Great Plains Nature Center, Wichita, KS.

Figure 69.—Number of snags per acre, Kansas 2005.



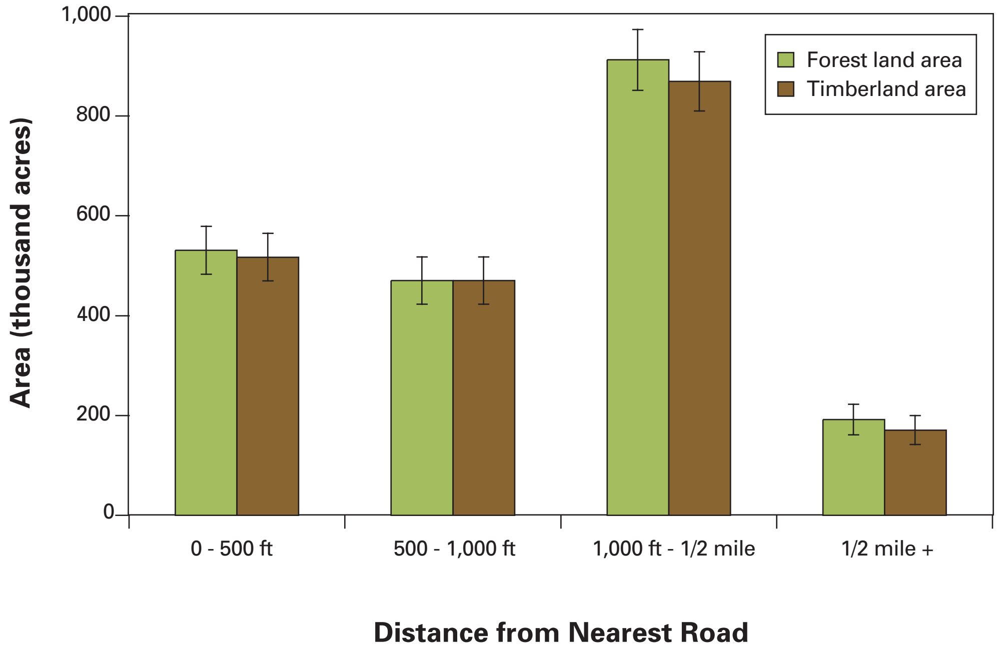


Figure 70.—Area of forest land and timberland vs. distance from road, Kansas 2005.

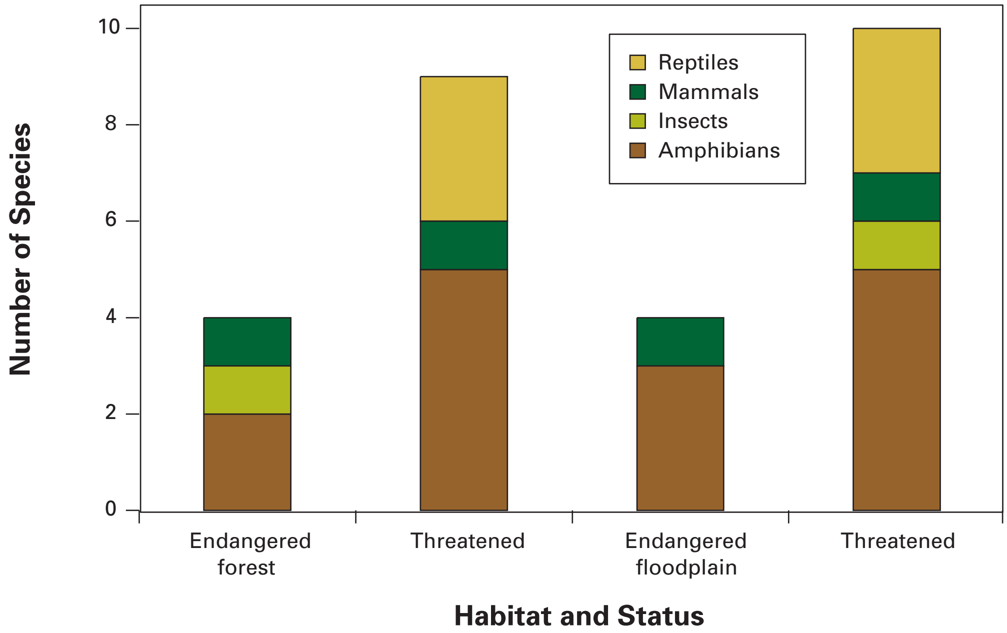


Figure 71.—Number of State-listed endangered and threatened species within deciduous forest and deciduous floodplain habitats, eastern tallgrass prairie conservation region, Kansas 2005.

Forest Health in Kansas

Soils: The Foundation of Forest Productivity

Background

Rich soils are the foundation of productive forest land. Inventory and assessment of the forest-soil resource provides critical baseline information on forest health and productivity, especially in the face of continued natural and human disturbance. When we understand what a soil is capable of providing, we begin to understand what a forest is capable of producing. Organic matter in the soil holds soil moisture and provides food for bacteria that make nutrients available for plants. Nitrogen availability is linked to organic matter, and this element is an important factor in tree growth. Species such as northern red oak and white oak are tolerant of nitrogen-deficient soils whereas species such as white ash and yellow-poplar, are more nitrogen-demanding and grow poorly in soils that are low in nitrogen (Mitchell and Chandler 1939). Potassium, another critical element, aids in the opening and closing of stomates, that part of the plant that regulates photosynthesis and transpiration. Think of the stomates as a kind of faucet that lets in carbon dioxide and lets out water vapor.

What we found

Field data were collected from 2005, but we are reporting the chemical analysis from 2001 to 2004. Only forest-type groups with more than five samples are considered. The forest floor is thicker under the oak/hickory group than under elm/ash/cottonwood (0.88 inch (2.16 cm) and 0.73 inch (1.8 cm), respectively (Fig. 72), but the thinner forest floor under the elm/ash/cottonwood forest type group is more carbon-rich than under oak/hickory (33.0 and 23.6 percent, respectively). There was no significant difference in mean coarse fraction or bulk density among these forest-type groups (Fig. 73). The pH of the surface mineral soil is slightly higher under the elm/ash/cottonwood group than that found under oak/hickory. Exchangeable sodium levels are higher under oak/hickory stands than under elm/ash/cottonwood stands (Table 13). This difference is significant in the 4- to 8 inch (10- to 20-cm) soil sample (40.62 and 8.85 mg Na/kg soil, respectively). Measurable aluminum levels were observed on only three plots in the entire State (all in oak/hickory), but the levels generally were low. Molar Ca:Al ratios, a measure of aluminum toxicity, were in healthy ranges. Aluminum concentrations were significant on one plot in southeastern Kansas. The Ca:Al ratio on this plot was 0.3, indicating a high risk of negative impacts on tree growth and nutrition (Cronan and Grigal 1995).

Soil Quality Index (SQI) is designed to combine the distinct physical and chemical properties of the soil into a single, integrative assessment (Amacher et al. 2007). SQI values in Kansas are comparable to those observed in Nebraska and South Dakota. North Dakota has higher SQI values but few samples from which to draw conclusions (Fig. 74).

What this means

Most soils in Kansas developed in a prairie ecosystem. Since there is less rainfall in Kansas than in states farther east, there is generally less leaching of the soil. According to Bailey (1976): “Soils of the prairies are Mollisols, which have black, friable, organic surface horizons and a high base content. Bases brought to the surface by plant growth are released on the surface and restored to the soil, perpetuating fertility. These soils are the most productive of the great soil groups.”

Given the few plots and forest-type groups sampled in the FIA soil inventory, it is difficult to make broad generalizations for Kansas. The data illustrate the manner in which the forests interact with and modify their local environment, but no significant impediments to forest productivity were identified. A regional analysis will be completed when 5 full years of data are available. In the interim, a few conclusions can be drawn. The differences in forest floor thickness likely are related to the greater amount of moisture available to support decomposition in elm/ash/cottonwood stands. There also may be differences in tissue quality. Hill et al. (1992) observed that cottonwood leaves decayed more quickly than the oak species they sampled.

The differences in sodium levels also may be related to the location of the plots in the landscape. Sodium salts can be brought to the surface by upward-moving water in the soil profile (Brady 1990), for example, by deeply rooted oaks seeking water during dry times of the year. Similarly, salts can be flushed from the soil profile by deep infiltration of excess water, for example, overbank flow adjacent to streams where elms and cottonwood often grow.

Figure 72.—Forest-floor thickness and depth to subsoil by forest-type group with more than five samples, in inches, Kansas 2005.

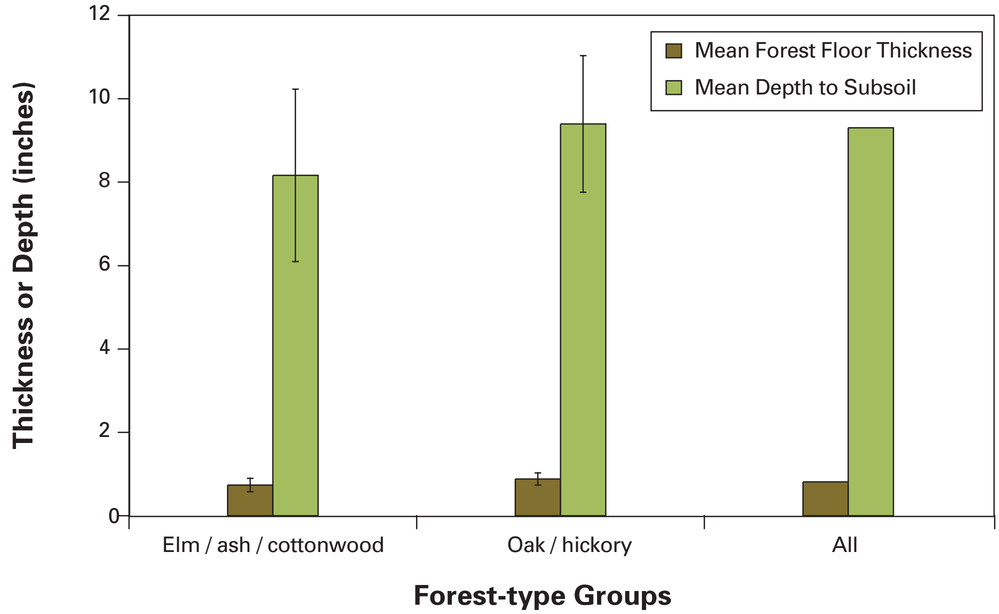


Figure 73.—Mean coarse fraction and mean bulk density of forest soils for select forest-type groups, Kansas 2005. MIN_1 and MIN_2 refer to the mineral soil layer collected at depths of 0-4 inches and 4-8 inches, respectively (See Table 13).

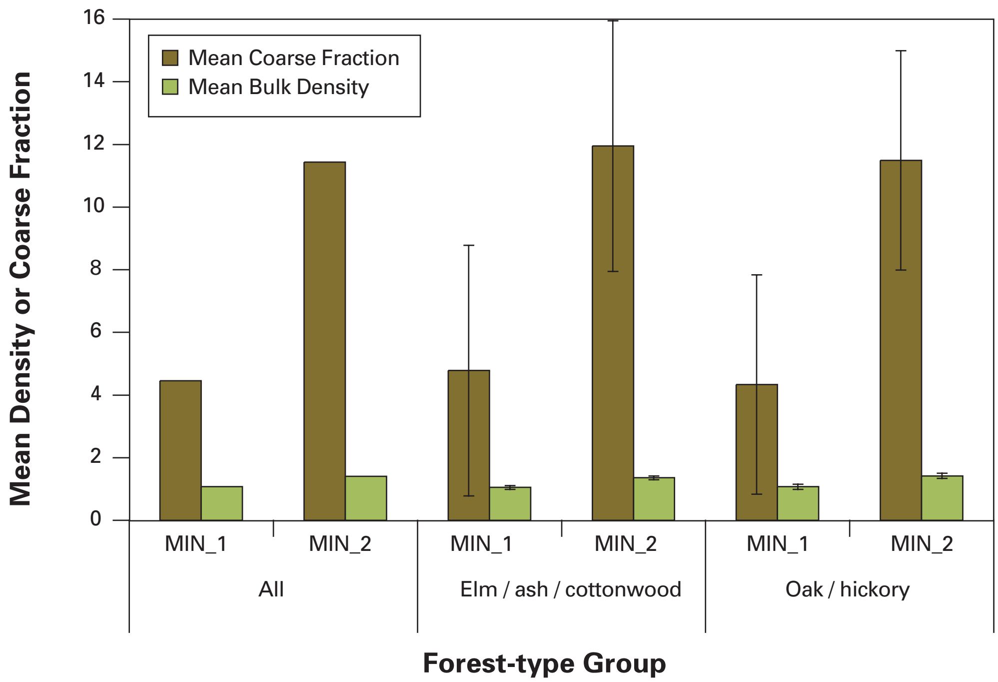


Table 13.—Selected chemical properties of the mineral soil, Kansas 2005. Units for P (phosphorus), Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Al (aluminum), and S (sulphur) are in mg per kg of soil. Units for ECEC (effective cation exchange capacity) is in $cmol_c$ per kg of soil.

Soil layer and forest-type group	Number of samples	P	Na	K	Ca	Mg	Al	ECEC	S
Mineral (0-4 inches [0-10 cm])									
Elm/ash/cottonwood	6	15.09	6.74	271.49	3,149.73	329.98	0	19.15	8.83
Exotic hardwoods	2	2.25	7	884	1,736	475.5	0	14.87	3.35
Maple/beech/birch	1		18	470	3,214	351	0	20.21	27.5
Oak/hickory	9	20.47	17.53	356.79	3,740.41	290.54	13.23	22.19	9.08
Pinyon/juniper (Eastern redcedar)	1		5	294	3,774	269	0	21.82	6.8
Mineral (4-8 inches [10-20 cm])									
Elm/ash/cottonwood	6	7.74	8.85	215.59	3,318.03	298.98	0	19.6	7.81
Exotic hardwoods	2	1.05	5.5	381	1,755	312	0	12.32	2.15
Maple/beech/birch	1		21	206	2,843	353	0	17.71	32.2
Oak/hickory	9	12.75	40.62	272.08	3,601.06	310.31	13.02	21.54	5.62

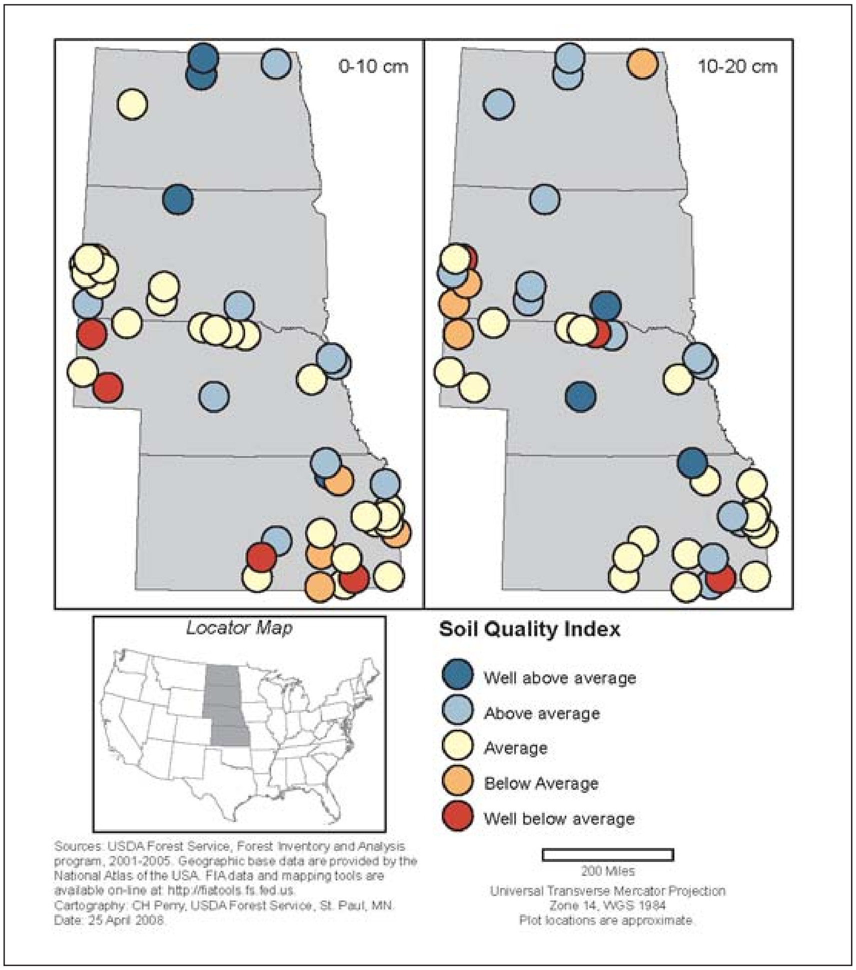


Figure 74.—A Soil Quality Index (Amacher et al. 2007) highlights differences in the overall chemical and physical condition of the soil.

Down Woody Materials

Background

Down woody materials in the form of fallen trees and branches fulfill a critical ecological niche in Kansas forests. They provide fish with valuable habitat in the form of coarse woody debris and potentially contribute to forest fire hazards via surface woody fuels. Down woody materials also contribute to logjams in rivers, especially those associated with reservoirs.

What we found

The fuel loadings of down woody materials (time-lag fuel classes) are not exceedingly high in Kansas (Fig. 75). Compared to Nebraska and Missouri, Kansas' fuel loadings of all time-lag fuel classes are not significantly different (see Woodall and Williams 2005). The size-class distribution of coarse woody debris (CWD) seems heavily skewed (88 percent) toward pieces less than 8 inches in diameter at point of intersection with plot sampling transects (Fig. 76A). The distribution of CWD by stages of decay seems fairly uniform across the State, except for decay class 3 logs (47 percent) (Fig. 76B). Decay class 3 pieces are typified by moderately decayed logs that remain structurally sound but have lost most of their bark due to extensive sapwood decay. There is no strong trend in CWD volumes per acre among classes of live-tree density (basal area/acre). However, stands with the highest volumes of CWD more often were those with the greatest standing live-tree density (Fig. 77).

What this means

Only in times of extreme drought would these low fuel amounts pose a hazard across the State. Of all down woody components, the amounts of 100-hr and 1,000+-hr fuels[4] were the largest. Volumes of CWD still were relatively low and were represented by small, moderately decayed pieces. This lack of CWD resources probably also indicates a lack of wildlife habitat. Overall, because fuel loadings are not exceedingly high across Kansas, possible fire dangers are outweighed by the benefits of woody materials to wildlife habitat and carbon sinks.

[4] Fuel-hour classes are defined by the amount of time (time-lag) it takes for moisture conditions to fluctuate. Larger woody debris will inherently take longer to dry out than the smallest fine woody pieces (small FWD=1-hour, medium FWD=10-hours, large FWD=100-hours, CWD=1,000+-hours, Burgan 1988).

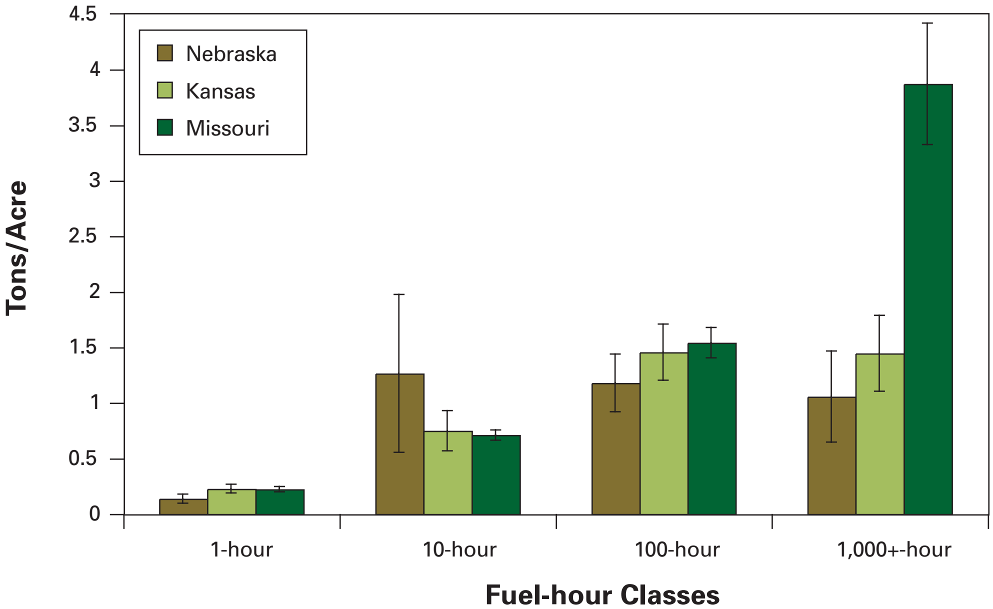
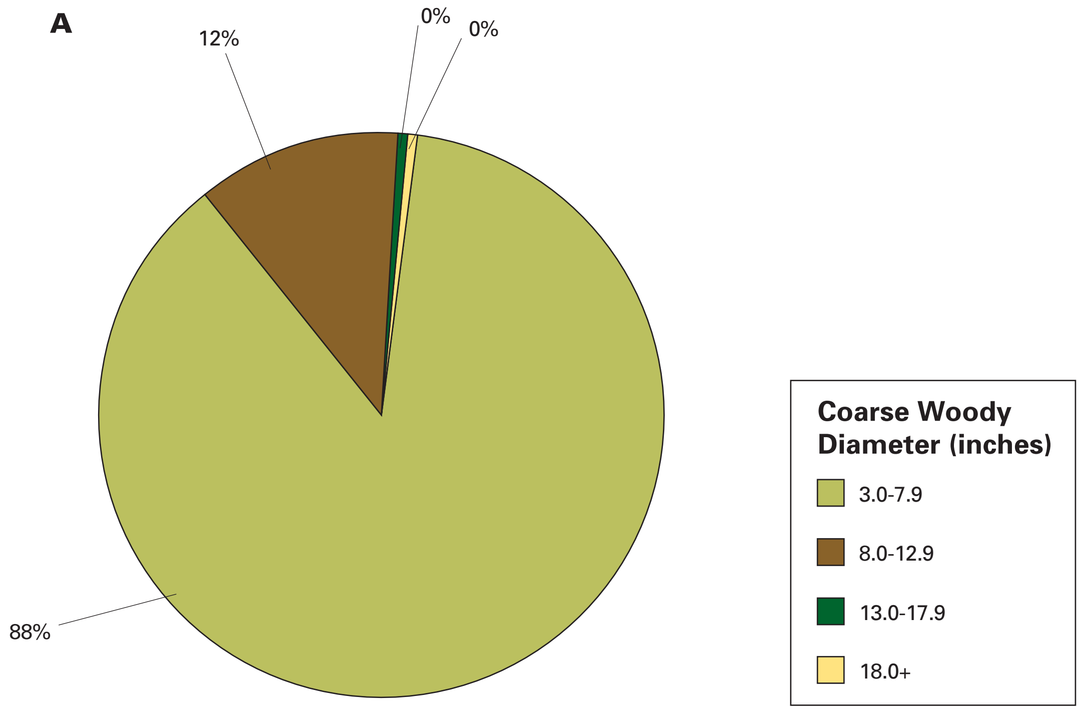


Figure 75.—Means and associated standard errors of fuel loadings (tons/acre, time-lag fuel classes) on forest land in Kansas and neighboring states, 2005.

Figure 76.—Mean proportions of coarse woody debris total pieces per acre by (A) transect diameter (inches) and (B) decay classes on forest land, Kansas 2005.



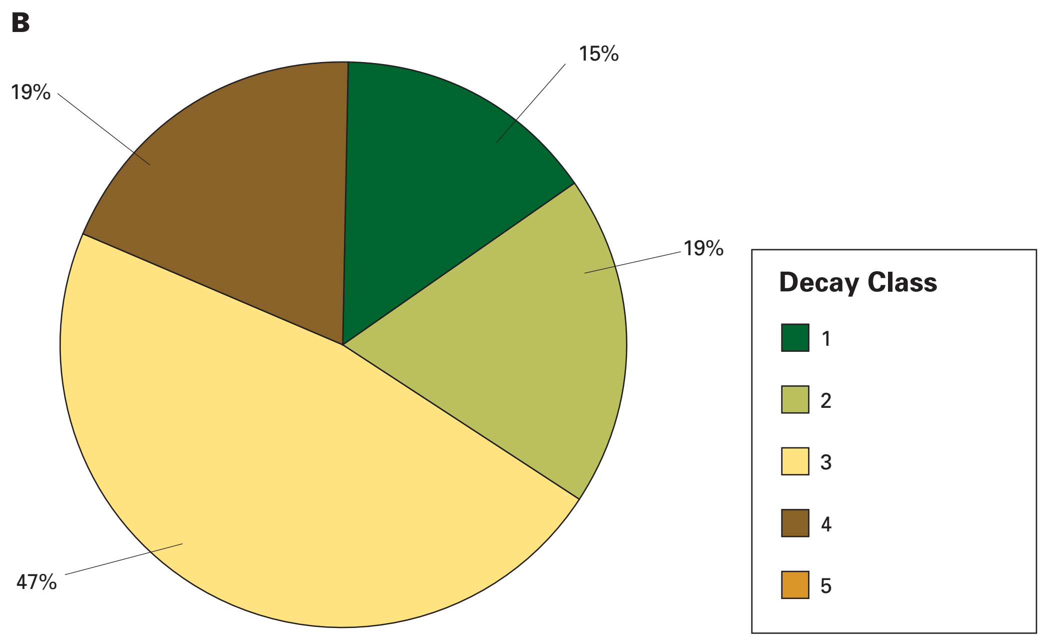
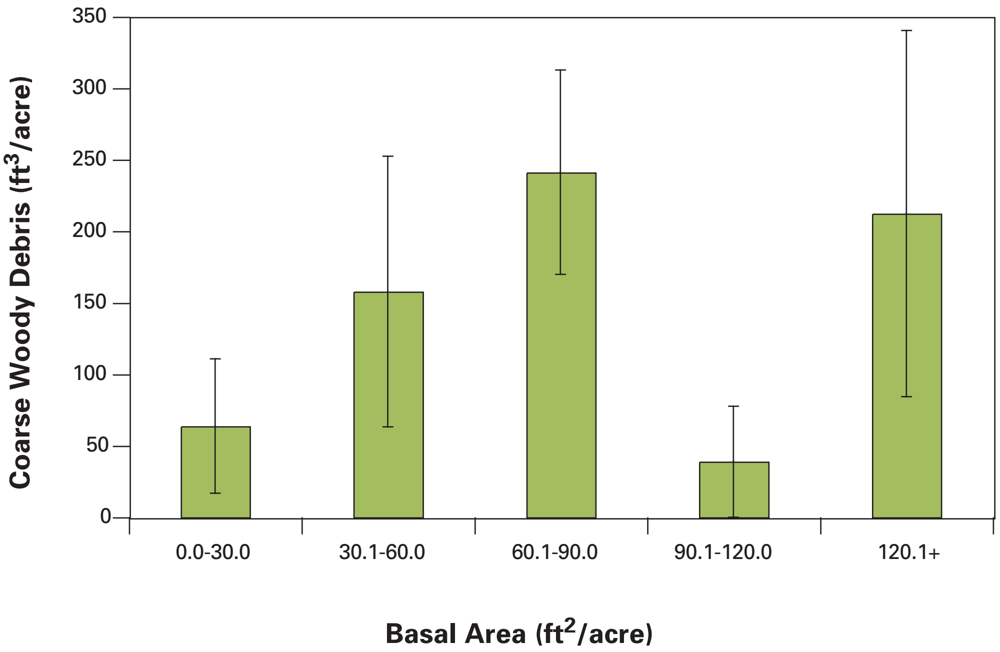


Figure 77.—Means and associated standard errors for volumes of coarse woody debris (ft3/acre) on forest land, Kansas, 2005.



Understory Vegetation in Kansas Forests

Background

Understory vegetation is an important component of most forested ecosystems. The total number of species and their relative proportions are the result of past stand history, including natural disturbances and human influences. By looking at diversity and abundance of vascular plant species, we may see indications of stresses such as pollution or forest-site degradation. Another indicator of disturbance is an increase in the amount of exotic plants, many of which are early colonizers. FIA assessed understory vegetation in two ways in Kansas. First, we examined all vascular plants on subplots in Phase 3 (P-3) plots in 2001-03, approximately 1/16th of the total forested plots in the State. Second, we looked for evidence of the 25 most prominent nonnative invasive plant species in the region on all Phase 2 (P-2) forested plots in 2005 and estimated their percent cover.[5]

What we found

According to Craig Freeman of the Kansas Biological Survey, the five plant communities with the most forest and woodland taxa include 36 percent (186) of the State's introduced (since Euro-American settlement) taxa. They are Asteraceae (sunflower family), 9 percent (45 taxa); Rosaceae (rose family), 9 percent (44 taxa); Poaceae (grass family), 7 percent (38 taxa); Cyperaceae (sedge family), 6 percent (31 taxa); and Fabaceae (legume family), 5 percent (28 taxa).

There were 419 species of vascular plants on P-3 plots in Kansas. The top eight families of vascular plants are the grass (Poaceae), sunflower (Asteraceae), legume (Fabaceae), sedge (Cyperaceae), rose (Roseaceae), spurge (Euphorbiaceae), elm (Ulmaceae), and grape (Vitaceae) (Fig. 78). The legume family had the highest proportion of occurrences that were nonnative invasive species (Fig. 79). Forbs and herbs are the most prevalent growth habit, followed by graminoids and trees (Fig. 80). (For definitions of growth habit, visit http://plants.usda.gov/growth_habits_def.html). Vines, shrubs, and subshrubs are the growth habits with the highest proportion of nonnative invasive species, albeit with few occurrences in the State. Virginia wild rye and brome grasses are among the common grasses in Kansas forests. Common forbs include snakeroot, ironweed, and threeseed mercury. Vine/shrub and vine/subshrub growth habits had the highest proportion of total occurrences that were nonnative invasive species, though there were relatively few occurrences (Fig. 81).

[5] See pages 118 and 119 for an explanation of FIA plot descriptions.

What this means

Kansas forests are home to hundreds of vascular plant species. As a State with an historically high amount of land in prairie and currently high acreage in agricultural production, it is not surprising that herbs and forbs were the predominant growth habit in Kansas' forests. Historically, eastern Kansas was considered oak/hickory bluestem parkland or oak/hickory prairie ecoregions (Bailey 1976). The western part of the State is classified as prairie. According to Bailey (1976), prairie vegetation is primarily tall grasses and associated subdominant broadleaved herbs. The grasses from almost continuous cover and flower in spring and early summer, whereas the herbs begin appearing in late summer.

Spring flowering in Kansas woodlands, Marion County, Kansas. Photo used with permission by Robert Atchison, Kansas Forest Service.

Figure 78.—Occurrence of understory plants on Phase 3 plots for the top 25 families, by native, nonnative invasive, or both (by genuses), Kansas 2001-2003.

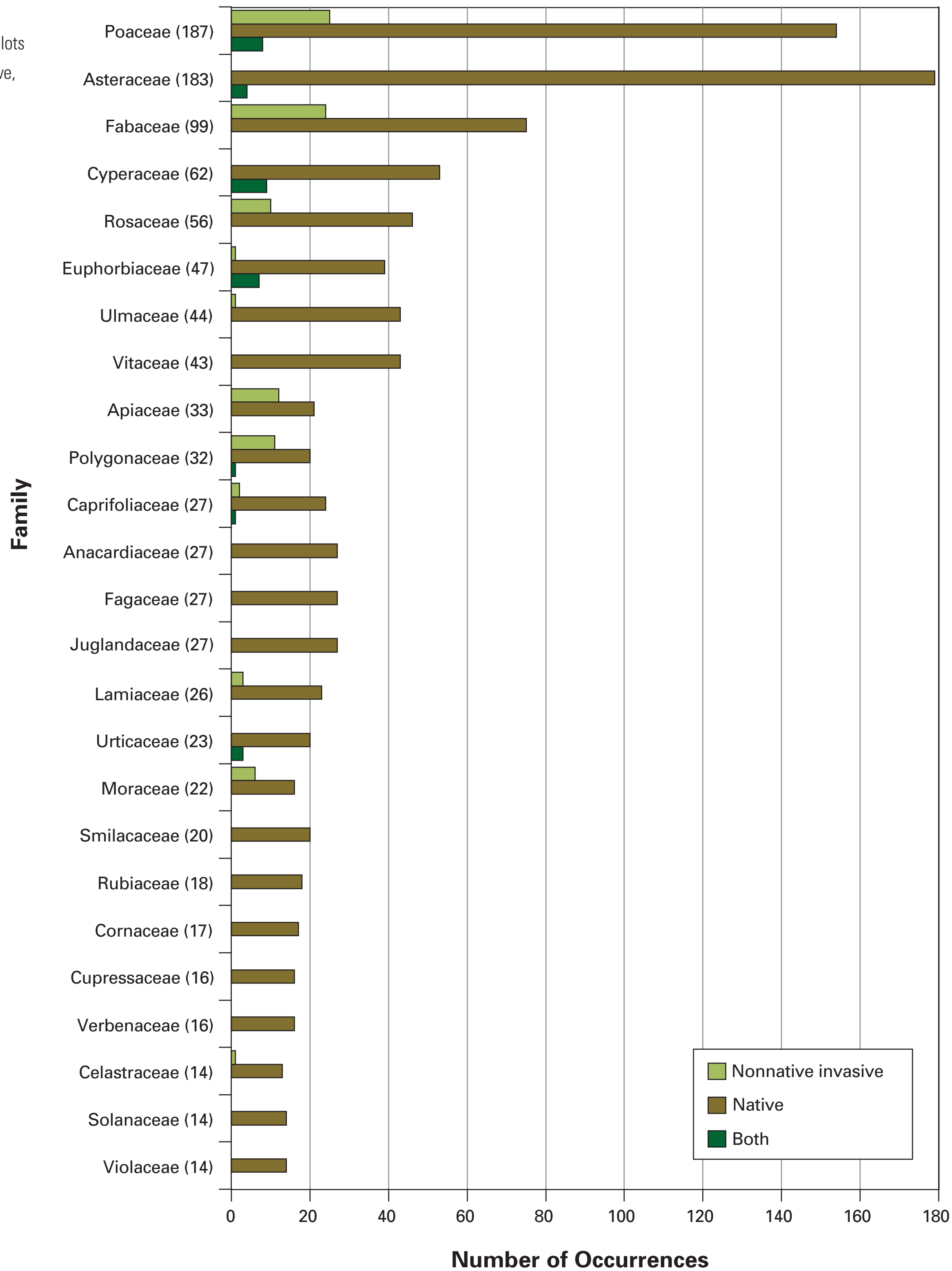


Figure 79.—Percent occurrence of top 25 families of understory plants with native, nonnative invasive, or both, Kansas 2001-03 (numbers in parentheses are total occurrences for each family.

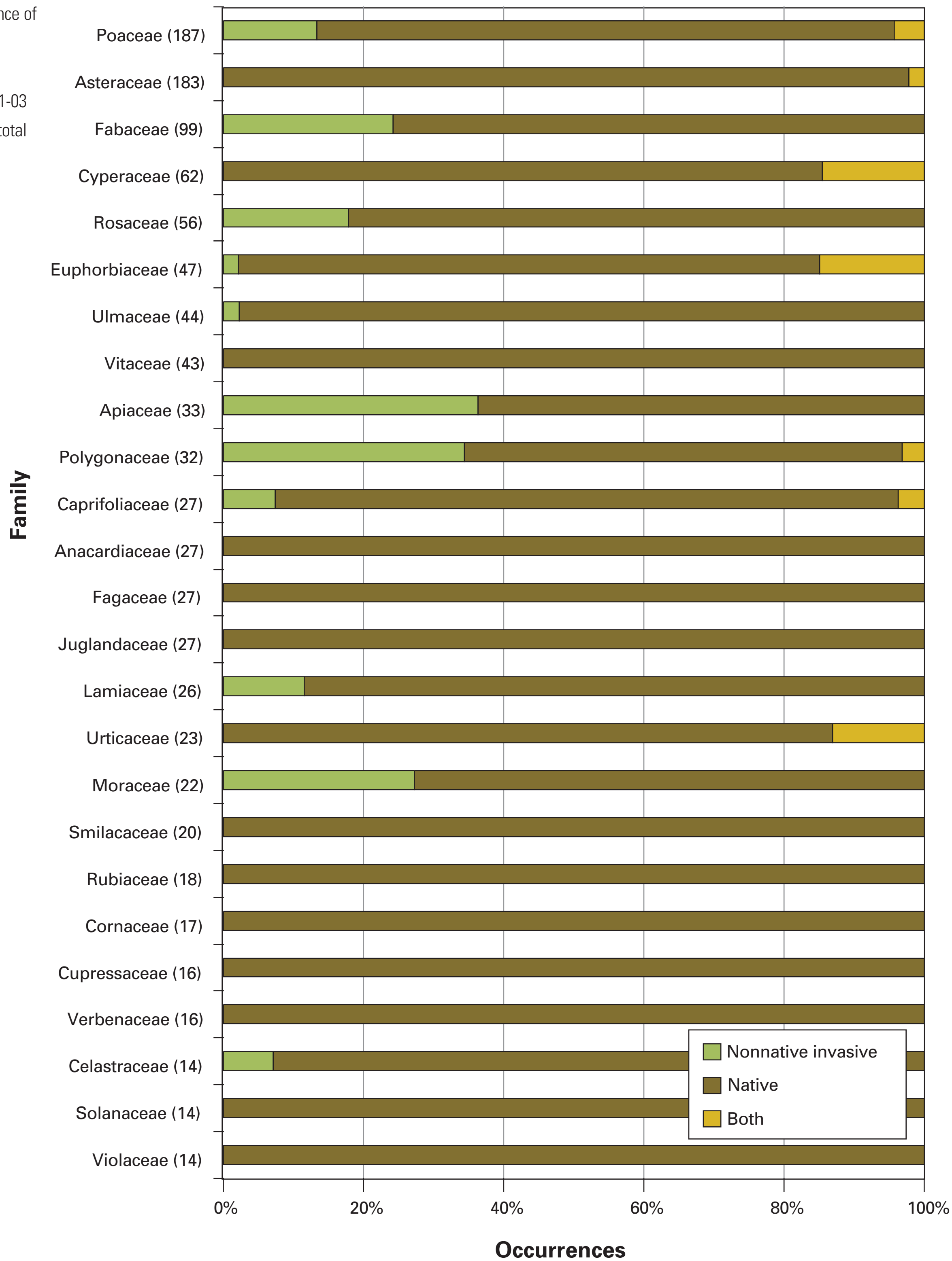


Figure 80.—Occurrence of native and invasive species on Phase 3 plots, by growth habit, Kansas 2001-03.

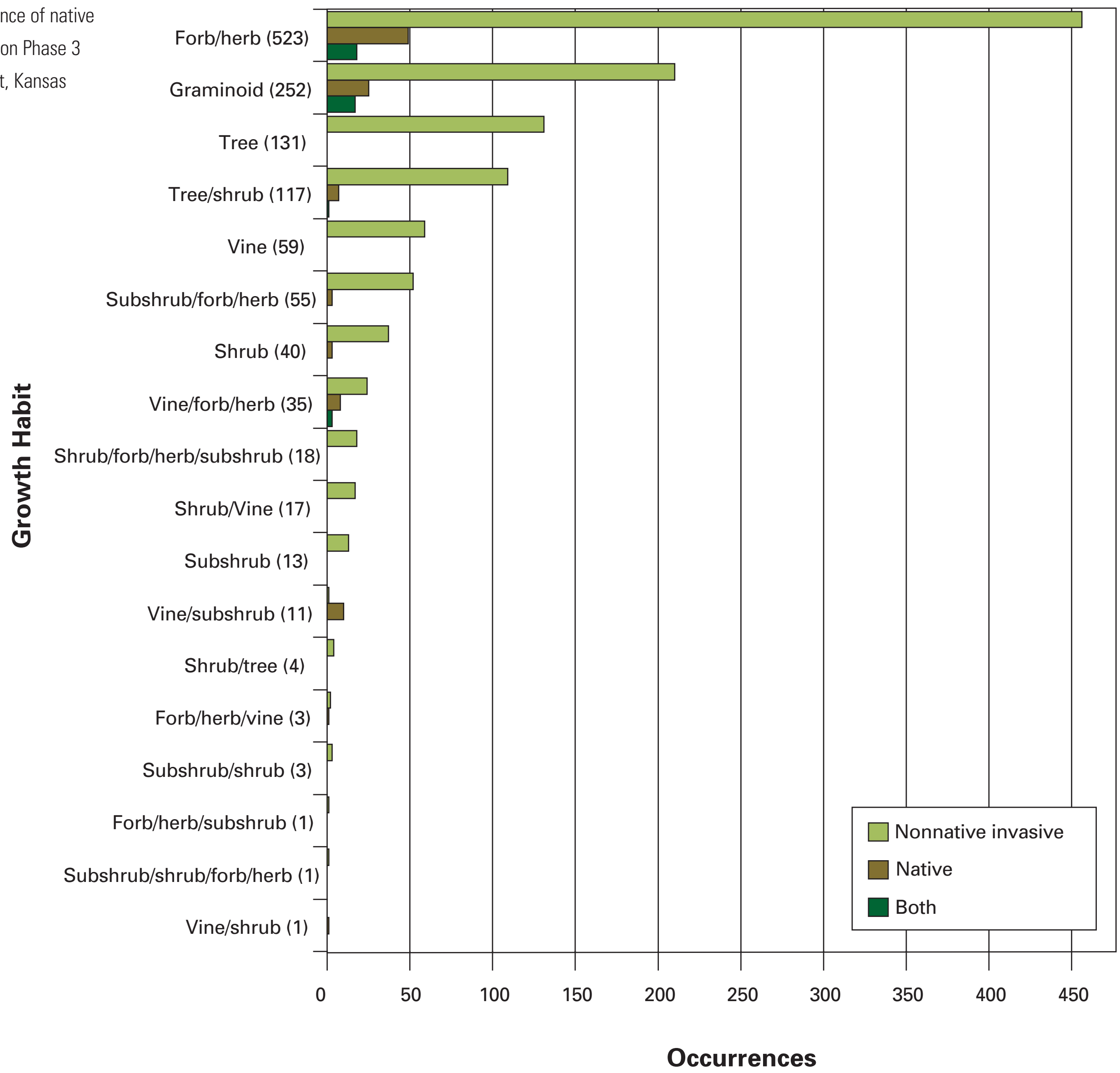
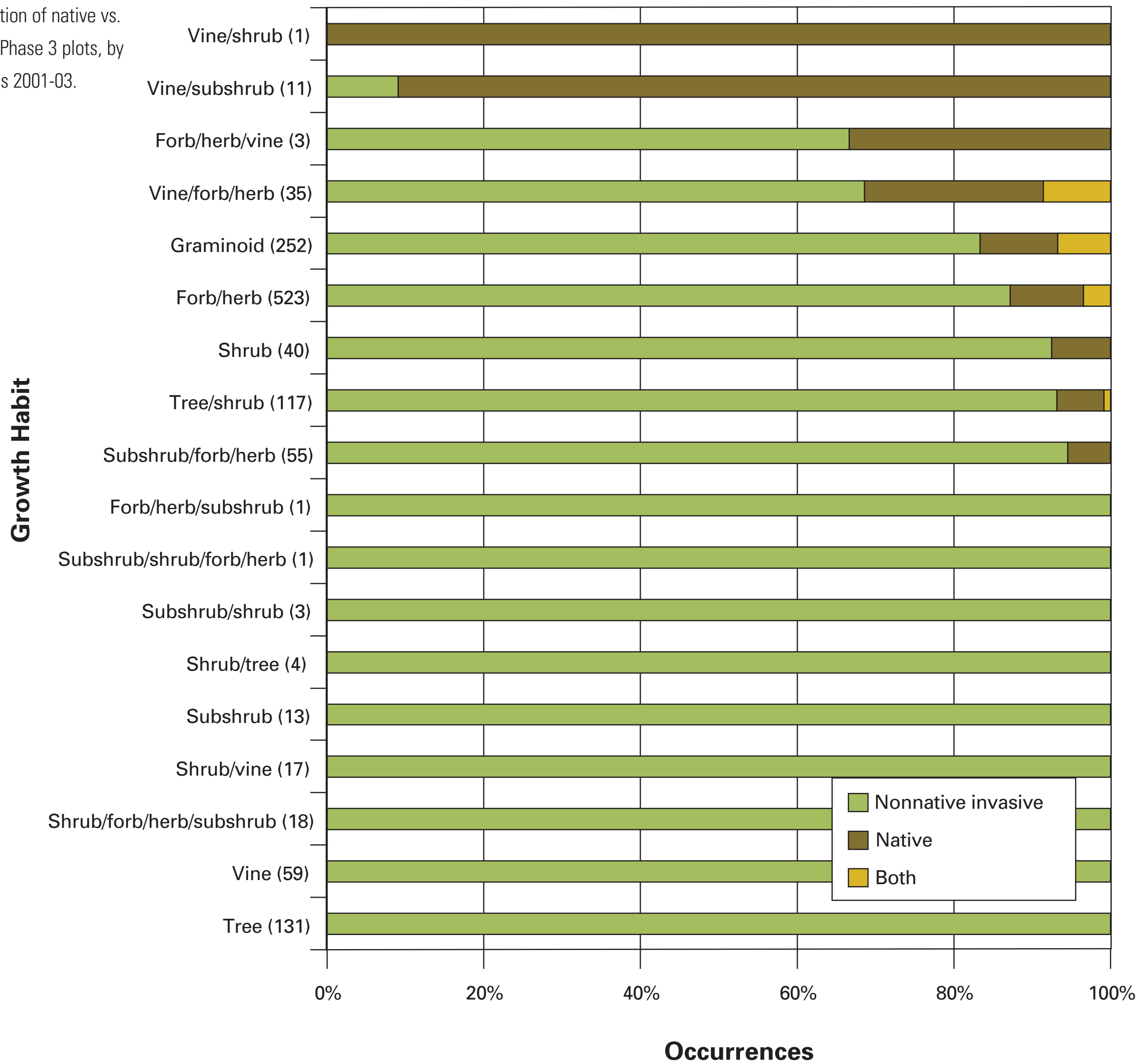


Figure 81.—Proportion of native vs. invasive species on Phase 3 plots, by growth habit, Kansas 2001-03.



Invasive Plants on Phase 2 Plots

Background

Nonnative invasive plant species threaten ecosystems across our country, and Kansas is no exception. Invasive species reduce ecosystem diversity and wildlife habitat by displacing native plants. During 2005, 100 percent of P-2 forested plots were assessed for the presence and cover of any of 25 invasive plant species (Table 14). If a species on the list was found, the percent cover was estimated and placed into one of seven codes, ranging from 1 (trace) to 7 (76 to 100 percent) (Table 15). Where a nonnative invasive species was found on a plot but had not previously been reported in that State, a specimen was collected and sent to the Northern Research Station for identification.

What we found

Of the 83 plots sampled that year, we found 26 occurrences of five nonnative invasive species on 23 plots (Table 16). Multiflora rose, a woody species, and garlic mustard, an herb, were predominant invasive species. Like the forest land itself, most of the invasive species were found in eastern Kansas (Fig. 82).

What this means

Invasive species are found in most Kansas forests. Their negative effect on forest health varies and can be difficult to measure. For example, although bush honeysuckle (generally Amur, *Lonicera maackii*) was found on only two invasive plots, where it occurs in eastern Kansas, it tends to dominate the forest understory, making it difficult for native plants to thrive. Garlic mustard outcompetes native plants by aggressively monopolizing light, water, nutrients, and space. It is a particular threat to species that complete their life cycles in the spring. Multiflora rose was the most common invasive, though its negative impact on forest health in Kansas has not been documented.

Morel mushrooms and invasive garlic mustard, Riley County, Kansas. Photo used with permission by Robert Atchison, Kansas Forest Service.

Table 14.—Nonnative invasive plants surveyed on Phase 2 plots in the Upper Midwest, 2005.

Common Name	Scientific Name	Common Name	Scientific Name
Woody species		**Grasses**	
Multiflora rose	*Rosa multiflora*	Reed canary grass	*Phalaris arundiacea*
Japanese barberry	*Berberis thunbergii*	Phragmites, Common reed	*Phragmites australis*
Common buckthorn	*Rhamnus cathartica*	Nepalese browntop, Japanese stiltgrass	*Microstegium vimineum*
Glossy buckthorn	*Frangula alnus*	**Herbaceous**	
Autumn olive	*Elaeagnus umbellata*	Garlic mustard	*Alliaria petiolata*
Nonnative bush honeysuckles	*Lonicera* spp.	Leafy spurge	*Euphorbia esula*
European privet	*Ligustrum vulgare*	Spotted knapweed	*Centaurea bierbersteinii*
Vines		Dame's rocket	*Hesperis matronalis*
Kudzu	*Pueraria montana*	Mile-a-minute weed, Asiatic tearthumb	*Polygonum perfoliatum*
Porcelain berry	*Ampelopsis brevipendunculata*	Common burdock	*Arctium minus*
Asian bittersweet	*Celastrus orbiculatus*	Japanese knotweed	*Polygonum cuspidatum*
Japanese honeysuckle	*Lonicera japonica*	Marsh thistle	*Cirsium palustre*
Chinese yam	*Dioscorea oppositifolia*		
Black swallowwort	*Cynanchum louiseae*		
Wintercreeper	*Euonymus fortunei*		

Table 15.—Cover codes and ranges of percent cover of nonnative invasive plants used in recording invasive species on FIA plots, Kansas 2005.

Cover code	Range of percent cover
1	< 1 (trace)
2	1 to 5
3	6 to 10
4	11 to 25
5	26 to 50
6	51 to 75
7	76 to 100

Table 16.—Prominent nonnative invasive species on FIA plots in Kansas (2005 panel only).

Species	Plots (no.) Where found	Where most prominent
Multiflora rose	12	10
Garlic mustard	10	9
Nonnative bush honeysuckles	2	2
Japanese honeysuckle	1	1
Reed canary grass	1	1
Total	**26**	**23**

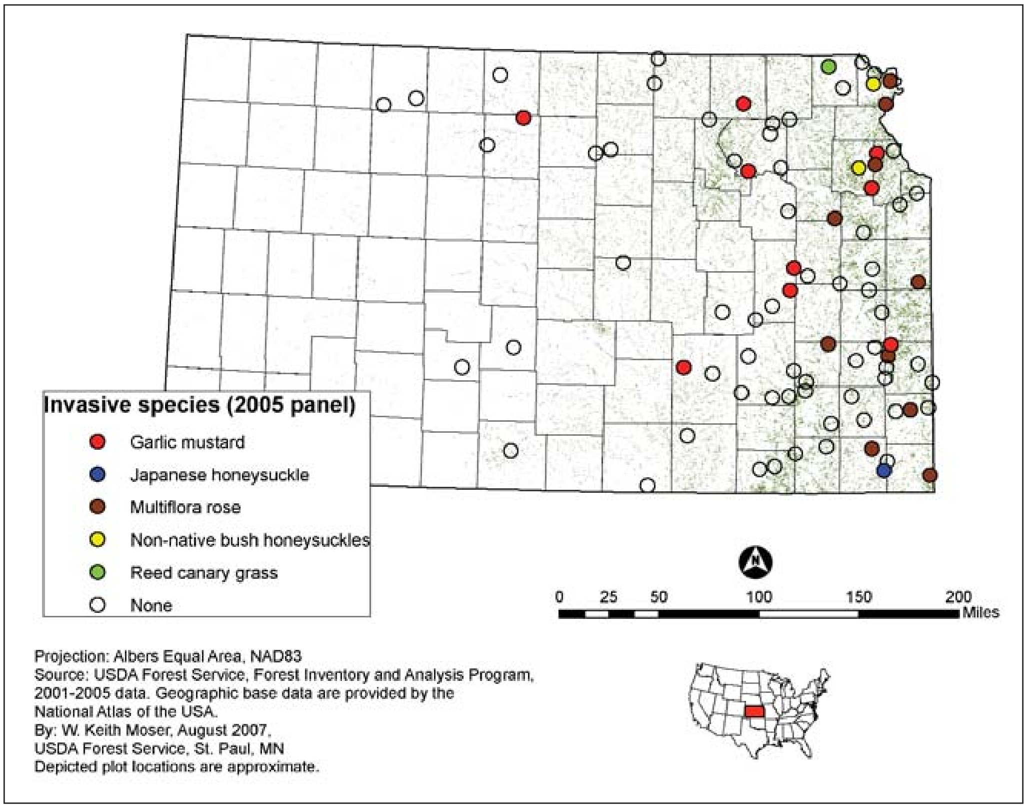


Figure 82.—Plots on which nonnative invasive ground vegetation species were detected in Kansas (2005 panel only).

Emerald Ash Borer: An Invader on the Horizon

Background

In 2002, a previously undetected exotic beetle, the emerald ash borer (EAB) (*Agrilus planipennis*) was discovered in southeastern Michigan and neighboring Ontario, Canada. It originated in Asia and probably came to North America in packing material (Haack et al. 2002, Russell et al. 2003). Adult insects feed on tree leaves but cause little permanent damage. The larvae of this species bore into the bark and destroy the organs that transport water and nutrients, killing the tree. In the United States, infested ash trees usually die within 3 years, though death can occur in 1 to 2 years if borer populations are at outbreak levels (Ohio State Univ. 2007). Although ash is not a dominant species in Kansas forests, ash species are not uncommon in the State.

What we found

Ash trees are found on 680,000 acres, or approximately 32 percent of total forest land. Ash is rarely the most prominent species in a stand. It generally accounts for less than 25 percent of total live-tree basal area (Fig. 83). There are nearly 218 million cubic feet of ash volume in Kansas not including urban areas where both green and white ash are abundant. Of these 44 million ash trees, most are on mesic and hydric sites in the eastern part of the State (Fig. 84). Over the past three inventories, an increasing proportion of ash trees, both number of trees and volume, are in stands 60 years of age or younger (Fig. 85). Young or old, all of these trees are threatened by the EAB. The USDA Cooperative Agricultural Pest Survey and the Kansas Department of Agriculture are coordinating detection efforts in Kansas by periodically inspecting firewood sold in the State for the presence of EAB.

What this means

If EAB is detected in Kansas, aggressive efforts will be made to quarantine and eradicate the insect. Currently, EAB is found in several states in the Upper Midwest and Northeastern United States and Canada (Coop. Emerald Ash Borer Proj. 2008). EAB could affect the ash population in the same way that Dutch elm disease has devastated American and red elms. Since most ash trees are in riparian areas, these ecosystems would be damaged the most should ash species be eradicated by EAB. Ash is a prominent tree in urban environments in Kansas and the potential economic and aesthetic loss would be substantial.

Adult Emerald Ash Borer feeding on a leaf. Photo used with permission by D. Cappaert, MSU, ForestryImages.org

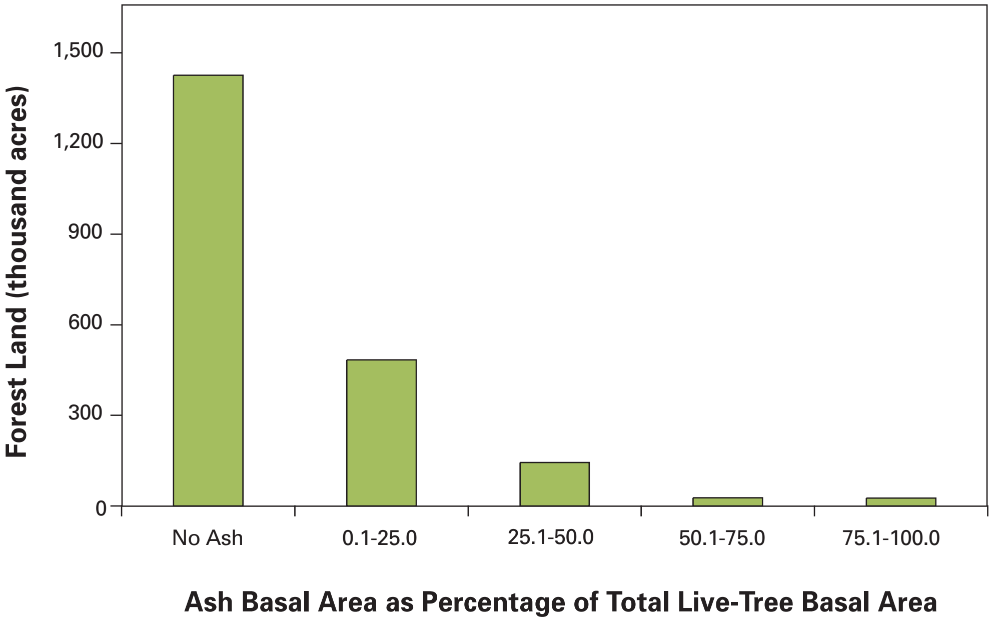


Figure 83.—Presence of ash on forest land, expressed as a percentage of stand basal area (ash BA per acre/total live BA per acre), Kansas, 2005.

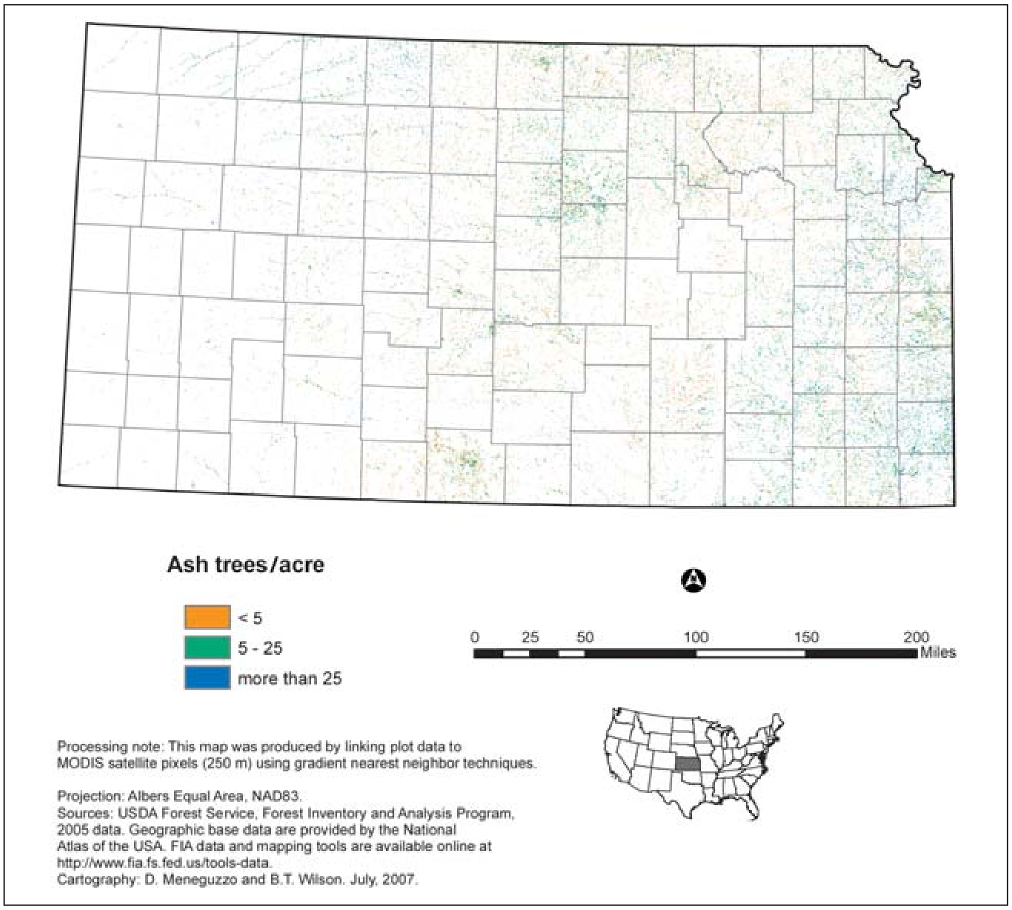
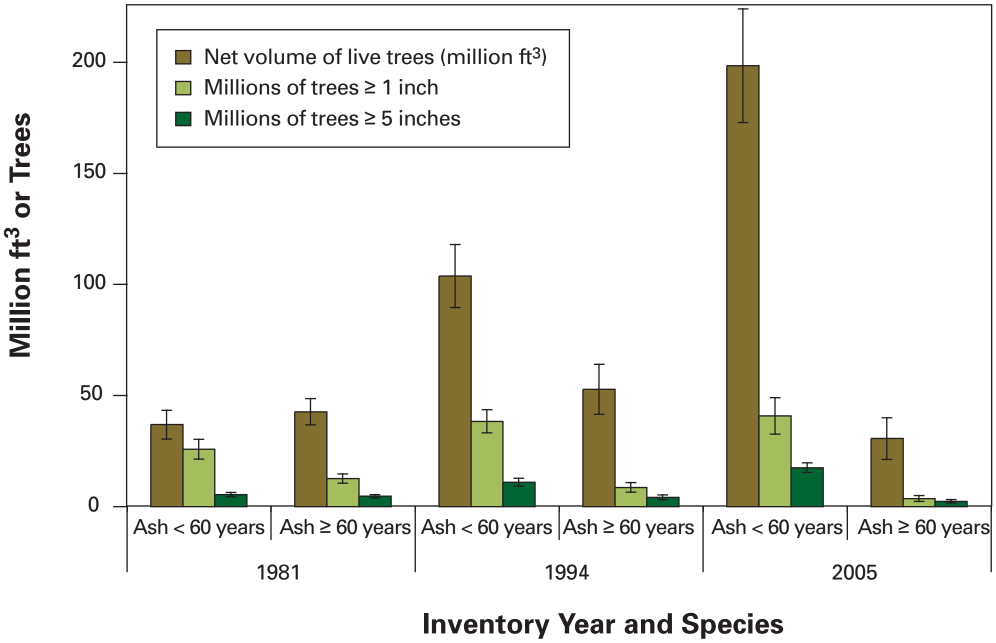
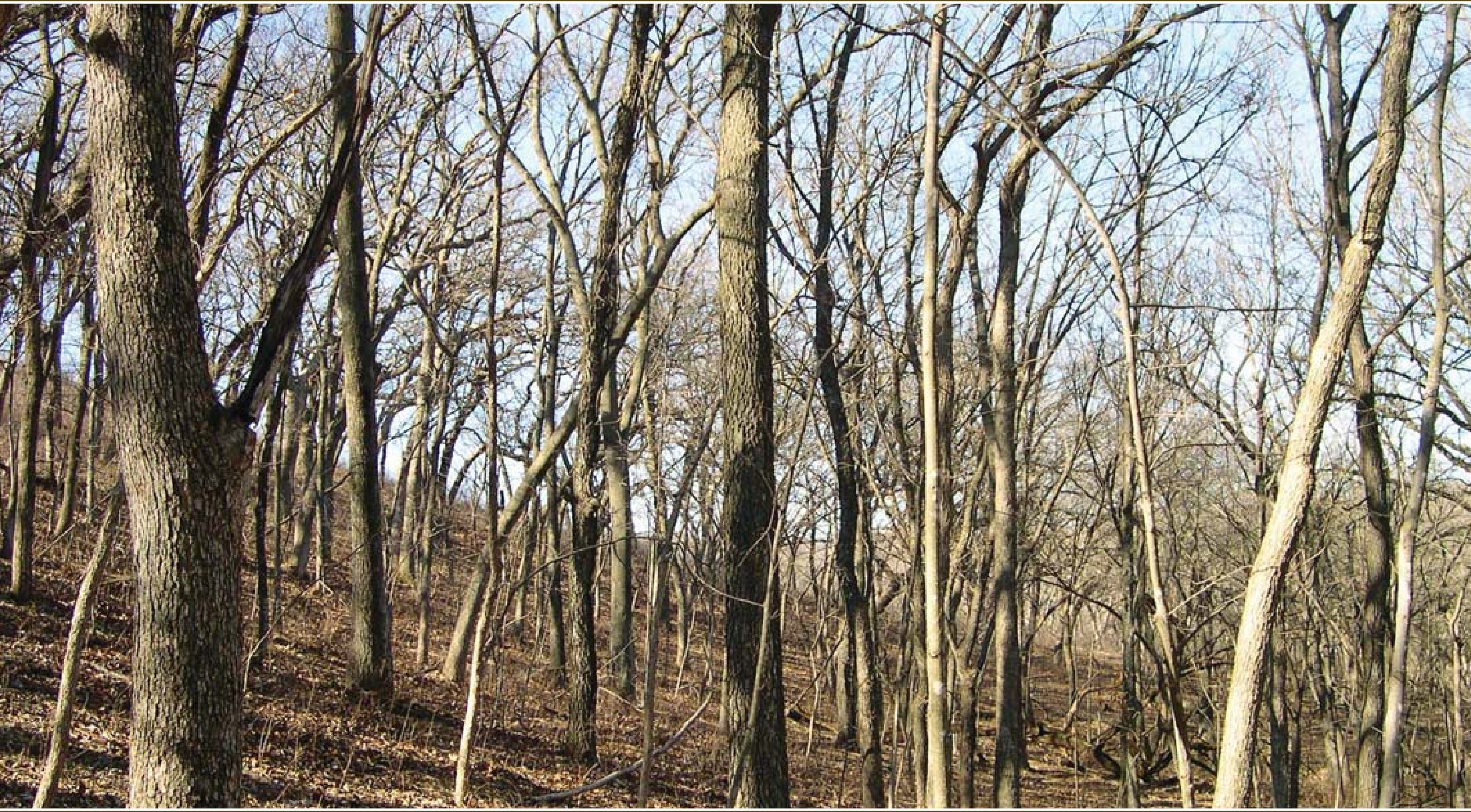


Figure 84.—Ash trees per acre, Kansas 2005.

Figure 85.—Total live-tree volume and total number of ash trees 1 inch and larger and 5 inches and larger on timberland, Kansas 1981, 1994, and 2005.



Data Sources and Techniques



Bur & chinkapin oak stand in Riley County, Kansas. Photo used with permission by Robert Atchison, Kansas Forest Service.

Forest Inventory

The Northern Research Station's Forest Inventory and Analysis (NRS-FIA) program began fieldwork for the fifth inventory of Kansas' forest resources in 2001. This inventory launched the new annual inventory system in which one-fifth of the field plots (considered one panel) in the State are measured each year. In 2005, NRS-FIA completed measurement of the fifth and final panel of inventory plots in Kansas. Now that all panels have been measured, each will be remeasured approximately every 5 years. Previous inventories of Kansas are dated 1936, 1965, 1981, and 1994 (Kansas State College 1939, Chase and Strickler 1968, Spencer et al. 1984, Raile and Spencer 1984, Leatherberry et al. 1999).

Data from new inventories often are compared with data from earlier inventories to determine trends in forest resources. However, for the comparisons to be valid, the procedures used in the two inventories must be similar. As a result of our ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have been made since the last Kansas inventory in 1994 (Leatherberry et al. 1999). Although these changes will have little effect on statewide estimates of forest area, timber volume, and tree biomass, they may significantly affect plot classification variables such as forest type and stand-size class. For estimating growth, removals, and mortality, the 1994 inventory (Leatherberry et al. 1999) was processed using estimation/summary routines for the 2005 inventory. Although these changes allow limited comparison of inventory estimates among separate inventories in this report, it is inappropriate to directly compare all portions of the 2005 data with those from earlier inventories.

The 2005 Kansas forest inventory was completed in three phases. During the first phase, NRS-FIA used a computer-assisted classification of satellite 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 on the forest side of a forest/nonforest boundary were classified into a forest-edge stratum. Pixels within 60 m of the boundary on the nonforest side were classified into a nonforest-edge stratum. The estimated population total for a variable is the sum across all strata of the product of each stratum's estimated area and the variable's estimated mean per unit area for the stratum.

The second phase of the forest inventory consisted of the actual field measurements. Current NRS-FIA precision standards for annual inventories require a sampling intensity of one plot for approximately every 6,000 acres. The entire area of the United States is divided into nonoverlapping hexagons, each of which contains 5,937 acres (McRoberts 1999). The total Federal base sample of plots was systematically divided into five interpenetrating, nonoverlapping subsamples or panels. The Kansas Forest Service (KFS) contributed its services to the inventory. Each year, the plots in a single panel are measured, and panels are selected on a 5-year, rotating basis (McRoberts 1999). For estimation purposes, the measurement of each panel of plots may be considered an independent systematic sample of all land in a state. Field crews measure vegetation on plots forested at the time of the last inventory and on plots currently classified as forest by photointerpreters using aerial photos or digital orthoquads.

NRS-FIA has two categories of field plot measurements: Phase 2 field plots (standard FIA plots) and Phase 3 plots (forest health plots) to optimize our ability to collect data when available for measurement. A suite of tree and site attributes are measured on Phase 2 plots, and a full suite of forest health variables are measured on Phase 3 plots. Both types of plots uniformly are distributed both geographically and temporally. The 2005 annual inventory results represent field measurements on 4,632 Phase 2 forested plots and 220 Phase 3 plots.

The overall Phase 2 plot layout consists of four subplots. The centers of subplots 2, 3, and 4 are located 120 feet from the center of subplot 1. The azimuths to subplots 2, 3, and 4 are 0, 120, and 240 degrees, respectively. Trees 5 inches and larger in d.b.h. are measured on a 24-foot-radius (1/24-acre) circular subplot. All trees less than 5 inches d.b.h. are measured on a 6.8-foot-radius (1/300-acre) circular microplot located 12 feet east of the center of each of the four subplots. Forest conditions on each of the four subplots are recorded. Factors that differentiate forest conditions are changes in forest type, stand-size class, land use, ownership, and density. For details on the sample protocols for Phase 2 variables and all Phase 3 indicators, visit http://fia.fs.fed.us/library/fact-sheets/.

Timber Products Inventory

This study was a cooperative effort of the Northern Research Station and the Kansas Forest Service (KFS). Using questionnaires supplied by NRS-FIA and designed to determine the size and composition of the State's primary wood-using industry, its use of roundwood (round sections cut from trees), and its generation and disposition of wood residues, KFS personnel visited all known primary wood-using mills within the State. This allowed for a 100-percent response rate. Completed questionnaires were forwarded to the Northern Research Station for editing and processing.

As part of data editing and processing, all reported industrial roundwood volumes were converted to standard units of measure using regional conversion factors. Timber removals by source of material and harvest residues generated during logging were estimated from standard product volumes using factors developed from logging utilization studies previously conducted by the Northern Research Station. Finalized data on Kansas' industrial roundwood receipts were loaded into regional timber removals database where they were supplemented with data on out-of-state uses in Kansas roundwood to provide a complete assessment of the State's timber-product output.

National Woodland Owner Survey

This survey of private woodland owners is conducted annually by the Forest Service to increase our understanding of these owners–the critical link between forests and society. Each year, NWOS personnel use a mail-based survey to contact about 6,500 randomly selected private landowners from across the United States. The results in this report are based on responses from 106 forest-land owners in Kansas. These responses represent 52.9 percent of the questionnaires sent out to Kansas landowners. For additional information on the intent and methods of the NWOS, see Butler et al. 2005.

NLCD Imagery

Derived from Landsat Thematic Mapper satellite data (30-m pixel), the National Land Cover Data (NLCD) is a 21-class land-cover classification scheme applied consistently across the United States by the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (EPA). NLCD was developed from data acquired by the Multi-Resolution Land Characterization (MRLC) Consortium, a partnership of Federal agencies that produce or use land-cover data. Partners include the USGS (National Mapping, Biological Resources, and Water Resources Divisions), EPA, U.S. Forest Service, and National Oceanic and Atmospheric Administration.

Mapping Procedures

Maps in this report were created by one of three methods. In the first method, categorical coloring of major watersheds is used according to various forest attributes, e.g., forest land area. These are known as choropleth maps. In the second method, a variation of the k-nearest-neighbor (KNN) technique is used to apply information from forest inventory plots to remotely sensed MODIS imagery (250-m pixel size) based on the spectral characterization of pixels and additional geospatial information. In the third method, colored dots or dots of different sizes are used to represent plot attributes at approximate plot locations.

Data Sources

Unless specifically cited, maps in this publication have the following data sources:

Political boundaries: ESRI™ Data and Maps, 2002
Forest/nonforest cover: MRLC Consortium National Land Cover Database, 2001
Tree biological data: Forest Inventory and Analysis Database

Maps produced by:

Forest Inventory and Analysis (FIA)
Northern Research Station
U.S. Forest Service

Literature Cited

Amacher, M.C.; O'Neil, K.P.; Perry, C.H. 2007. **Soil vital signs: a new Soil Quality Index (SQI) for assessing forest soil health.** Res. Pap. RMRS-RP-65WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 12 p.

Arend, J.L. 1947. **An early eastern red cedar plantation in Arkansas.** Journal of Forestry. 45: 358-360.

Bailey, R.G. 1976. **Ecoregions of the United States (map).** Ogden, UT: U.S. Department of Agriculture, Forest Service.

Beilmann, A.P.; Brenner, L.G. 1951. **The recent intrusion of forests in the Ozarks.** Annals of the Missouri Botanical Garden. 38: 261-282.

Brady, N.C. 1990. **The nature and properties of soils.** 10th ed. New York: Macmillan. 621 p.

Bruckerhoff, D.N. 2005. **Improving black walnut stands.** Leaflet. L-718. Manhattan, KS: Kansas State University Agricultural Experiment Station and Cooperative Extension Service. 2 p.

Burgan, R.E. 1988. **1988 Revisions to the 1978 National Fire-Danger Rating System.** Res. Pap. SE-273. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 39 p.

Butler, B.J.; Leatherberry, E.C.; Williams, M.S. 2005. **Design, implementation, and analysis methods for the National Woodland Owner Survey.** Gen. Tech. Rep. NE-GTR-336. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 43 p.

Chase, C.D.; Strickler, J.K. 1968. **Kansas woodlands.** Resour. Bull. NC-4. St. Paul, MN: Department of Agriculture, Forest Service, North Central Research Station. 50 p.

Cooperative Emerald Ash Borer Project 2008. **A multistate effort in Michigan, Illinois, Indiana, Maryland, Ohio, Pennsylvania, and Wisconsin (uninfested) to bring you the latest information about emerald ash borer.** http://www.emeraldashborer.info/. [Accessed 1 August 2008]

Cronan, C.S.; Grigal, D.F. 1995. **Use of calcium/aluminum ratios as indicators of stress in forest ecosystems.** Journal of Environmental Quality. 24(2): 209-226.

Edmondson, B.; Miller, B. 1997. **How the West was settled.** American Demographic. 19(8): 16-17.

Fowells, H.A. 1965. **Silvics of forest trees of the United States.** Agric. Handb. 271. Washington, DC: U.S. Department of Agriculture. 762 p.

Haack, R.A.; Jendek, E.; Liu, H.; Marchant, K.R.; Petrice, T.R.; Poland, T.M.; Ye, H. 2002. **The emerald ash borer: a new exotic pest in North America.** Newsletter of the Michigan Entomological Society. 47(3-4): 1-5.

Hill, B.H.; Gardner, T.J.; Ekisola, O.F.; Henebry, G.M. 1992. **Microbial use of leaf litter in prairie streams.** Journal of the North American Benthological Society. 11(1): 11-19.

Kansas State College 1939. **Woodlands of Kansas.** Bull. 285. Manhattan, KS: Kansas State College Agricultural Experiment Station. 42 p.

Kuchler, A.W. 1974. **A new vegetation map of Kansas.** Ecology. 55(3): 586-604.

Krusekopf, H.H. 1963. **Forest soil areas in the Ozark Region of Missouri.** Res. Bull. 818. Columbia, MO: Missouri Agricultural Experment Station.

Leatherberry, E.C.; Schmidt, T.L.; Strickler, J.K.; Aslin, R.G. 1999. **An analysis of the forest resources of Kansas.** Res. Pap. NC-334. St. Paul, MN: U.S. Department of Agriculture Forest Service, North Central Research Station. 114 p.

Magurran, A.E. 1988. **Ecological diversity and its measurement.** Princeton, NJ: Princeton University Press. 192 p.

McRoberts, R.E. 1999. **Joint annual forest inventory and monitoring system, the North Central perspective.** Journal of Forestry. 97(12): 27-31.

McWilliams, W.H.; O'Brien, R.A.; Reese, G.C.; Waddell, K.L. 2002. **Distribution and abundance of oaks in North America.** In: McShea,W.J.; Healy, W.H., eds. Oak forest ecosystems: ecology and management for wildlife. Baltimore, MD: Johns Hopkins Press: 13-32.

Mitchell, H.L.; Chandler, R.F. 1939. **The nitrogen nutrition and growth of certain deciduous trees of northeastern United States.** Black Rock Forest Bulletin 11. Cornwall, NY: Corwall Press. 94 p.

Moulton, R.J.; Lockhart, F.: Snellgrove, J.D. 1995. **Tree planting in the United States 1994.** Washington, DC: U.S. Department of Agriculture, Forest Service, State and Private Forestry. 18 p.

Ohio State University. 2007. **Ash alert. Emerald ash borer: Frequently asked questions.** http://ashalert.osu.edu/faq.asp?pageview=faq. [Accessed 6 July 2007].

Oliver, C.D.; Larson, B.C. 1996. **Forest stand dynamics.** Update edition. New York: J. Wiley. 544 p.

Raile, G.K.; Spencer, J.S. 1984. **Kansas forest statistics, 1981.** Resour. Bull. NC-70. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 124 p.

Read R.A.; Walker L.C. 1950. **Influence of eastern redcedar on soil in Connecticut pine plantations.** Journal of Forestry 48: 337-339.

Reading, W.H; Bruton, D.L. 2007. **Kansas timber industry – an assessment of timber product output and use, 2003.** Resour. Bull. NC-269. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 73 p.

Reineke, L.H. **Perfecting a stand-density index for even-aged stands.** Journal of Agricultural Research. 46: 627-638.

Russell, H.; McCullough, D.; Sklapsky, M. 2003. **Emerald ash borer: biology and control options.** East Lansing, MI: Michigan State University Diagnostic Facts. April. 4 p.

Schaefer, P.R.; Sheridan, D.; Erickson, D. 1987. **Windbreaks: a Plains legacy in decline.** Journal of Soil and Water Conservation. 42(4): 180-183.

Schmidt, T.L.; Piva, R.J. 1996. **An annotated bibliography of eastern redcedar.** Res. Bull. NC-166. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Experiment Station. 93 p.

Shigo, A.L.; Rogers, N.F.; McGinnes, E.A., Jr.; Funk, D.T. 1978. **Black walnut on Kansas strip mine spills: some observations 25 years after pruning.** Res. Pap. NE-383. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 16 p.

Sorenson, C.J.; Marotz, G.A. 1977. **Changes in shelterbelt mileage statistics over four decades in Kansas. Journal of Soil and Water Conservation.** 32(6): 276-281.

Spencer, J.S.; Strickler, J.K.; Moyer, W.J. 1984. Res. Bull. NC-83. **Kansas forest inventory, 1981.** St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 134 p.

Stoeckeler, J.H.; Williams, R.A. 1949. **Windbreaks and shelterbelts**. In: Stefferud, A., ed. Trees, the yearbook of agriculture. Washington, DC: U.S. Department of Agriculuture: 191-199.

Sutton, R.K. 1985. **Relict rural plantings in Eastern Nebraska.** Landscape Journal. 4(2): 106-115.

U.S. Census Bureau 2005. **2002 economic census, Kansas, manufacturing by industry.** http://www.census.gov/econ/census02/data/ks/KS000_31.htm. [Accessed 9 March 2007]

U.S. Census Bureau 2005. **2002 economic census, nonemployer statistics manufacturing Kansas.** http://www.census.gov/epcd/nonemployer/2002/ks/KS000_31.htm. [Accessed 9 March 2007]

Van Haverbeke, D.F. 1990. **Populus deltoides var. occidentalis Rydb: Plains Cottonwood.** In: Burns, R.M.; Honkala, B.H., tech. coords. Silvics of North America: hardwoods. Vol. 2. Agric. Handb. 645. Washington, DC: U.S. Department of Agriculture, Forest Service: 535-543.

Ware, E.R., Smith, L.F. 1939. **Woodlands of Kansas.** Bull. 285. Manhattan, KS: Kansas State College of Agriculture and Applied Science. 42 p.

Wasson, T.; Yasui, L.; Brunson, K.; Amend, S.; Ebert,V. 2005. **A future for Kansas wildlife, Kansas' comprehensive wildlife conservation strategy.** Topeka, KS: Kansas Department of Wildlife and Parks. In cooperation with Dynamic Solutions, Inc. 170 p.

West, E. 1998. **The contested Plains, Indians, goldseekers, and the rush to Colorado.** Lawrence, KS: University of Kansas Press: 422 p.

Williams, R.D. 1990. ***Juglans nigra* L.: black walnut.** In: Burns, R.M.; Honkala, B.H., tech. coords. Silvics of North America: hardwoods. Vol. 2. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 391-399.

Woodall, C.W.; Miles, P.D. 2006. **New method for determining the relative stand density of forest inventory plots.** In: McRoberts, R.E.; Reams, G.A.; Van Deusen, P.C.; McWilliams, W.H., eds. Proceedings of the sixth annual forest inventory and analysis symposium; 2004 September 21-24; Denver, CO. Gen. Tech. Rep. WO-70. Washington, DC: U.S. Department of Agriculture, Forest Service: 105-110.

Woodall, C.W.; Williams, M.S. 2005. **Sampling protocol, estimation, and analysis procedures for down woody materials indicator of the FIA program.** Gen. Tech. Rep. NC-256. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 47 p.

Moser, W. Keith; Hansen, Mark H.; Atchison, Robert L.;, Brand, Gary J.; Butler, Brett J.; Crocker, Susan J.; Meneguzzo, Dacia M.; Nelson, Mark D.; Perry, Charles H.; Reading, William H. IV; Wilson, Barry T.; Woodall, Christopher W. 2008. Kansas forests 2005. Resour. Bull. NRS-26. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 125 p.

The first completed annual inventory of Kansas forests reports 2.1 million acres of forest land, roughly 4 percent of the total land area in the State. Softwood forests account for nearly 5 percent of the total timberland area. Oak/hickory forest types make up 56 percent of the total hardwood forest land area. Elm/ash/cottonwood accounts for more than 30 percent of the timberland area. The proportion of Kansas' timberland with trees 19 inches and larger remained about the same over the last 40 years (38 percent in 1965 versus 38 percent today). Kansas' forests have continued to increase in volume. In 2005, net volume of growing stock on timberland was an estimated 1.5 billion cubic feet compared with 0.5 billion cubic feet in 1965. Live-tree biomass on forest land in Kansas amounted to 72.3 million dry tons in 2005. More than 3 percent was in small stands, 26 percent was in medium-size stands, and 71 percent was in large stands. Oak species account for nearly 15 percent. About 95 percent of Kansas forest land is held by private landowners.

KEY WORDS: forest area, forest health, completed annual inventory.

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