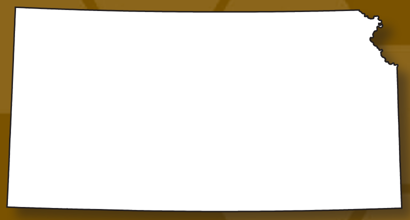
Kansas' Forests 2010



Resource Bulletin
NRS-85

USDA United States Department of Agriculture

Forest Service

Abstract

The second completed annual inventory of Kansas' forests reports 2.4 million acres of forest land, roughly 5 percent of the total land area in the State. Softwood forests account for 4.4 percent of the total timberland area. Oak/hickory forest types make up 55 percent of the total hardwood forest land area. Elm/ash/cottonwood accounts for more than 32 percent of the timberland area. Kansas' forests have continued to increase in volume. In 2010, net volume of growing stock on timberland was an estimated 1.45 billion cubic feet compared with 0.5 billion cubic feet in 1965. Live-tree biomass on forest land in Kansas amounted to 82.5 million dry tons in 2010. More than 6 percent was in trees less than 5 inches in diameter. About 94 percent of Kansas' forest land is held by private landowners.

Acknowledgments

The authors would like to thank those who contributed both to the inventory and to the analysis of Kansas' forest resources. Data management personnel included Mark Hatfield, Gary Brand, Jay Solomakos, and James Blehm. Field crew and QA staff over the 2006-2010 field inventory cycle included David Bruton, Joshua Carron, John Klempa, Connie Robinson-Clemons, Greg Pugh, Glenda Hefty, Nicole Ricci, Todd Bixby, Dave Bruckerhoff, Thomas Goff, Joel Topham, Melissa Powers, Cassandra Asleim, Matt Hake, Earl Sheehan, Robert Paro, and Thad Rhodes.

Cover: Chase-Riat black walnut plantation, Dickinson County. Kansas. Photo used with permission of Robert Atchison, Kansas Forest Service.

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Foreword from the State Forester

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 2.4 million acres of forest land by FIA definition, or about 4 percent of the total land area. Because forest lands cover only 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 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 will provide a forum in which to address these threats and will help us make informed decisions about the future management of our forest lands.

Larry Biles
State Forester

Contents

Highlights

On the Plus Side

- Forest land area increased from 1.5 million acres in 1994 to more than 2.4 million acres in 2010, representing almost 5 percent of Kansas' total land area.

- Softwood forests, made up almost entirely of eastern redcedar, comprise 4.4 percent of the total timberland area and softwood species make up 3.4 percent of all live trees on timberland by volume. Oak/hickory forest types make up 55 percent of the total hardwood timberland area of almost 2.3 million acres. Elm/ash/cottonwood forest types account for 31 percent of hardwood timberland area.

- Kansas' forests continue to increase in volume. In 2010, the net volume of growing stock on timberland was an estimated 1.45 billion cubic feet compared to 0.5 billion cubic feet in 1965.

- Live-tree aboveground biomass on forest land in Kansas amounted to 82.5 million dry tons in 2010. More than 6.2 percent was in trees less than 5 inches d.b.h. Of trees 5 inches and greater, 45 percent was in growing-stock trees and 55 percent was in nongrowing-stock trees.

- Almost 94 percent of Kansas' forest land is held by private landowners.

Areas of Concern

- Cull trees constitute 51.5 percent of all live-tree hardwood volume and 65.8 percent of all live-tree softwood volume on timberland in Kansas.

- Emerald ash borer, an Asian wood-boring insect first identified in Michigan in 2002, was confirmed in Kansas City, KS, by USDA's Animal Plant Health and Inspection Service in August 2012. Now, more than 255 million cubic feet of ash species on Kansas' forest land are in peril because of this exotic insect.

- Thousand cankers disease, a fungus that afflicts black walnut, is approaching the State from the west. This disease threatens fully 186 million cubic feet of black walnut live trees on forest land, Kansas' most valuable tree for forest products.

Baldwin Woods. Photo by Kansas Forest Service, used with permission.

Introduction

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

The mental picture most Americans hold of the Great Plains, and states within that area such as Kansas, is of long vistas of grasslands and agricultural fields. Yet, within Kansas' 52 million acres are 2.4 million acres of forests that provide wildlife habitat, recreation opportunities, clean water, and wood products for consumption, construction, and fuel.

This report summarizes Kansas' second 5-year forest inventory covering the years 2006 through 2010 (Fig. 1). This second inventory provided the Northern Research Station's Forest Inventory and Analysis Program (NRS-FIA or FIA) with the opportunity to remeasure plots from the first annual inventory cycle (2001-2005) (Moser et al. 2008) and generate change (growth, mortality, and removals) data.

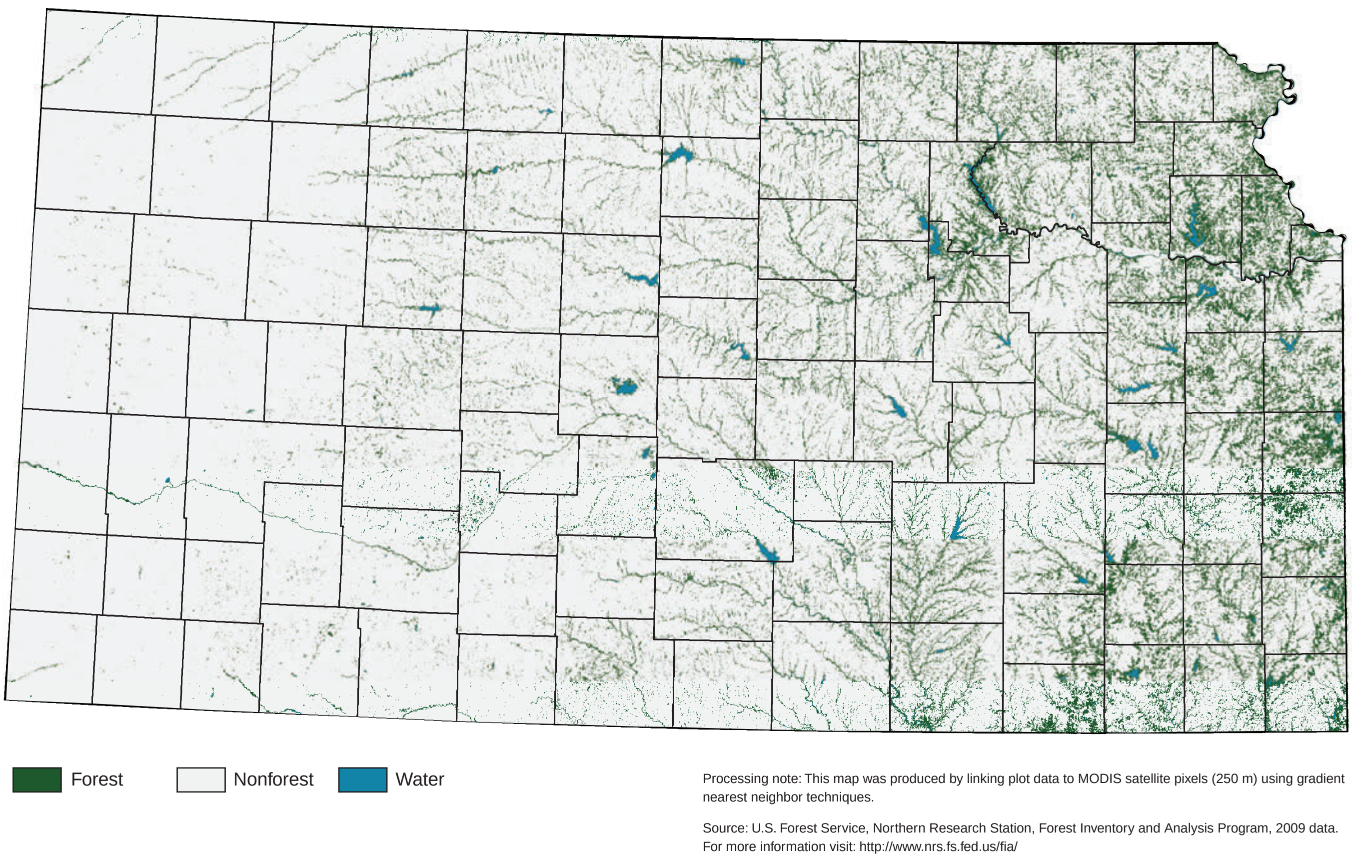
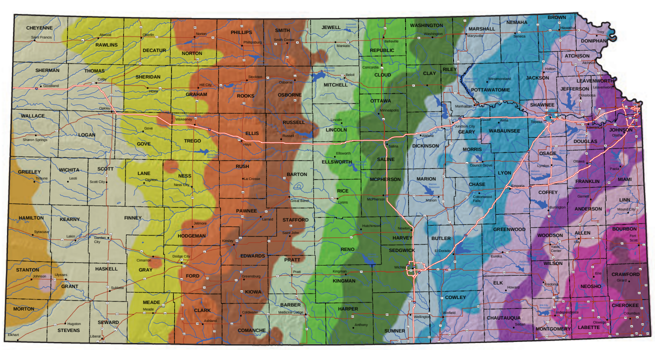


Figure 1.—Forest land in Kansas. Map courtesy of B.T. Wilson, NRS FIA.

Climate and Geology

Kansas is situated in the central part of the Great Plains, and its climate reflects this location. At this warmer, drier end of a temperate, humid climate, the average mean daily temperature is 55 °F. The temperature can range from a record high of 121 °F to a record low of -40 °F. As it stretches from the western edge of the Central Hardwood region to the foothills of the Rocky Mountains in Colorado, Kansas experiences a wide range in precipitation, from 40 inches per year in the southeast part of the State to 16 inches per year in the High Plains region of the west (Fig. 2).



Average Annual Precipitation 1971-2000 (inches per year)

0-16	22-24	30-32	38-40
16-18	24-26	32-34	40-42
18-20	28-30	34-36	42-44
20-22	26-28	36-38	44-46

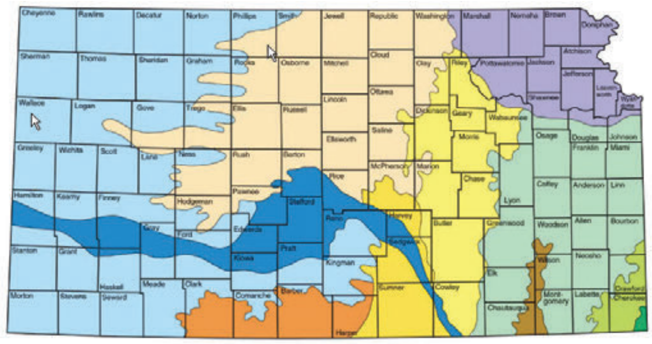
Data Sources: NOAA Cooperative Station Normals (1971-2000) climate observations, NRCS SNOTEL Station Normals, and supplemental data provided by regional and state climatologists and designated reviewers.

Digital Elevation Model: The Digital Elevation Model is derived from the 30 meter National Digital Elevation Dataset.

October 18, 2007 - Resource Conservation Staff - Salina, KS

Figure 2.—Average yearly precipitation in Kansas, in inches. Map source: USDA, Natural Resources Conservation Service.

More than two-thirds of this annual total falls between April and September. This climate occurs over a highly varied landscape and geology, shaped by the State's past life as an inland sea, which explains the widespread presence of sedimentary limestone rock. Kansas has 11 different regions (Fig. 3), each with an individual geologic story and all with significant impacts on the types of vegetation cover that can grow there.



- High Plains
- Smokey Hills
- Arkansas River Lowlands
- Glaciated Region
- Osage Cuestas
- Flint Hills Uplands
- Ozark Plateau
- Cherokee Lowlands
- Chatauqua Hills
- Wellington-McPherson Lowlands
- Red Hills

0 80 Miles

Kansas Geological Survey, The University of Kansas
1930 Constant Avenue, Lawrence, Kansas 66047

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

History[1]

Kansas' forests were believed to encompass 4.5 million acres[2] before European settlement. The river valleys were the first areas settled and the timber there was removed for agriculture and for building materials. By the time of the first forest inventory in 1936, forest land in Kansas was reduced to 1.2 million acres. The area under forest began to increase after that due more to forest encroachment on idle pasture and agricultural land than to active forest management and establishment. Although Kansas' forest land has steadily increased since 1936, there have been some setbacks, including the lingering effects of the drought-impacted 1930s and the devastating impact on elms in the 1970s caused by the Dutch elm disease. Approaching forest health problems such as thousand cankers disease of black walnut and emerald ash borer will make managing Kansas' future forests a continuing challenge.

1 This section was adapted from Leatherberry et al. (1999).

2 This estimate comes from Ware and Smith (1939). The actual report it references, U.S. Department of Agriculture (1928), is based on Senate Resolution 311 from the Second Session of the 66th Congress (U.S. Forest Service 1920), which suggests the figure comes from Census estimates of land area. Andreas (1883) actually provides estimates of percent of counties timbered based on 1883 Government Land Office survey records. These records suggest about 4.1 percent of the land area was forested.

A Beginners Guide to Forest Inventory[3]

What is a tree?

We know a tree when we see one and we can agree on some common tree attributes. Trees are perennial woody plants with central stems and distinct crowns. In general, the Forest Inventory and Analysis (FIA) program of the U.S. Department of Agriculture, Forest Service defines a tree as any perennial woody plant species that can attain a height of 15 feet at maturity. In Kansas, the problem is in deciding which species should be classified as shrubs and which should be classified as trees. A complete list of the tree species measured in this inventory can be found in Kansas' Forests 2010: Statistics, Methods, and Quality Assurance on the CD in the inside back cover pocket of this bulletin.

What is a forest?

We all know what a forest is, but where does the forest stop and the prairie begin? It's an important question. The gross area of forest land or rangeland often determines the allocation of funding for certain State and Federal programs. Forest managers want more land classified as forest land; range managers want more land classified as prairie. Somewhere you have to draw the line.

FIA defines forest land as land that is at least 10 percent stocked by trees of any size or formerly having had such tree cover and not currently developed for nonforest use. The area with trees must be at least 1 acre in size, and roadside, streamside, and shelterbelt strips must be at least 120 feet wide to qualify as forest land.

What is the difference between timberland, reserved forest land, and other forest land?

From an FIA perspective, there are three types of forest land: timberland, reserved forest land, and other forest land. In Kansas, almost 96 percent of the forest land is timberland, with the remainder in reserved forest land and other forest land.

- Timberland is unreserved forest land that meets the minimum productivity requirement of 20 cubic feet per acre per year at its peak.

- Reserved forest land is land withdrawn from timber utilization through legislation or administrative regulation.

- Other forest land, in Kansas, is commonly found on low-lying sites with poor soils where the forest is incapable of producing 20 cubic feet per acre per year at its peak.

Before 2001, only trees on timberland plots were measured in Kansas. Therefore, while we can report volume on timberland for those inventories, we cannot report volume on forest land (although the difference between the two categories was and is admittedly quite small in this State). Under the new annual inventory system trees were measured on all forest land therefore forest volume estimates can be produced. Because these annual plots have been re-measured upon completion of the second annual inventory in 2010, we are now able to report growth, removals and mortality on all forest land, whereas for prior inventories we could report only growth, removals, and mortality on timberland.

3 This section was adapted from Miles et al. 2011.

4 During the 2010 inventory of Kansas (from 2006 to 2010), we measured a sixth-acre plot for approximately every 6,000 acres of forest land.

How many trees are in Kansas?

There are approximately 803 million trees on Kansas' forest land, with approximately 280 million of them at least 5 inches in diameter as measured at 4.5 feet above the ground. We do not know the exact number because we measured only about 1 out of every 36,000 trees.[4] In all, 7,093 trees 5 inches and larger were sampled on 556 forested plots.

How do we estimate a tree's volume?

FIA has typically expressed volumes in cubic feet. But, forest products industries measure wood more commonly as cords (a stack of logs 8 feet long, 4 feet wide, and 4 feet high). A cord has approximately 79 cubic feet of solid wood and 49 cubic feet of bark and air.

Volume can be precisely determined by immersing a tree in a pool of water and measuring the amount of water displaced. Less precise, but much cheaper, was the method used by the North Central Research Station (which later merged with the Northeastern Research Station to become the Northern Research Station). Several hundred cut trees were measured by taking detailed diameter measurements along their lengths to accurately determine their volumes (Hahn 1984). Regression lines were then fit to these data by species group. Using these regression equations, we can produce individual-tree volume estimates based on species, diameter, and tree site index.

The same method was used to determine sawtimber volumes. FIA reports sawtimber volumes in ¼-inch International board-foot scale. Conversion factors for converting to Scribner board-foot scale are also available (Smith 1991).

How much does a tree weigh?

The U.S. Forest Service's Forest Products Laboratory and others developed specific gravity estimates for a number of tree species (Miles and Smith 2009). These specific gravities were then applied to tree volume estimates (Hahn 1984) to derive estimates of merchantable tree biomass (the weight of the bole). To estimate live biomass, we have to add in the stump, limbs, and bark (Heath et al. 2009). We do not currently report the live biomass of roots or foliage.

Forest inventories report biomass as green or oven-dry weight. Green weight is the weight of a freshly cut tree; oven-dry weight is the weight of a tree with zero percent moisture content. On average, 1 ton of oven-dry biomass is equal to 1.9 tons of green biomass.

How do we estimate all the forest carbon pools?

FIA does not measure the carbon in standing trees, let alone carbon in belowground pools. FIA assumes that half the biomass in standing live/dead trees consists of carbon. The remaining carbon pools (e.g., soil, understory vegetation, belowground biomass) are modeled based on stand/site characteristics (e.g., stand age and forest type).

How do we compare data from different inventories?

Data from new inventories are often compared with data from earlier inventories to determine trends in forest resources. This is certainly valid when comparing the 2005 inventory to the 2010 inventory. But comparisons with inventories conducted before 1999, are problematic because procedures for assigning stand characteristics like forest type and stand size have changed as a result of FIA's ongoing efforts to improve the efficiency and reliability of the inventory. Several changes in procedures and definitions have occurred since the 1994 Kansas inventory. Although these changes will have little impact on statewide estimates of forest area, timber volume, and tree biomass, they may have significant impacts on plot classification variables such as forest type and stand-size class. Some of these changes make it inappropriate to directly compare the 2010 and 2005 annual inventory tables with periodic inventories published for 1936, 1965, 1981, and 1994, The biggest change in inventories was the change in plot design. In an effort toward national consistency, a new national plot design was implemented by all five regional FIA units in 1999. The old North Central plot design used in the 1994 Kansas inventory consisted of variable-radius subplots. The new national plot design used in the 2005 and 2010 inventories used fixed-radius subplots. Both designs have their strong points, but they often produce different classifications for individual plot characteristics.

A word of caution on suitability and availability…

FIA does not attempt to identify which lands are suitable or available for timber harvesting, particularly because such suitability and availability are subject to changing laws, economic/market constraints, physical conditions, adjacency to human populations, and ownership objectives. The classification of land as timberland does not necessarily mean it is suitable or available for timber production.

FIA endeavors to be precise in definitions and implementation. The program tries to minimize changes to these definitions and to collection procedures, but that is not always possible or desirable in a world of changing values and objectives. Although change is inevitable, we hope that through clarity and transparency forest inventory data will be of use to analysts for decades to come.

Forest Features

Baldwin Woods. Photo by Robert Atchison, Kansas Forest Service, used with permission.

Forest Land and Timberland Area

Background

Kansas is situated at the western edge of the Central Hardwood region where it changes to the prairies of the Great Plains. Within the State, there is a forest land transition, too: the eastern third of Kansas contains most of the forest land and the western two-thirds possesses much less wooded area, largely restricted to riparian zones (Fig. 1).

As stated earlier, 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 canopy cover. Many trees in the State are in linear features, such as riparian forests or windbreaks, features that are not considered forest land under FIA definitions and, therefore, no trees are measured. The Great Plains Initiative (in a later section) was the first attempt to capture these trees.

FIA defines three components of forest land by asking two questions: (1) Is the land productive, defined as capable of growing trees at a rate of 20 cubic feet per acre per year at maximum mean annual increment? and (2) Is the land reserved, i.e., statutorily or administratively prohibited from harvesting? The answers to these two questions allow FIA to place Kansas forest land into one of three categories: (1) Timberland–productive forest land not restricted from harvesting by statute, administrative regulation, or designation; (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.

What we found

Kansas forest land acreage in 2010 exceeds 2.4 million acres. All stand-size classes of forest have increased since the previous inventory. During the 1990s, a change in definition by FIA that reclassified some wooded pastures as forest land likely contributed to the increase in area between 1994 and 2010. Some of this pattern is due to ingrowth of young stands on previously nonforested land. Fire suppression and reduced grazing can result in conversion of pasture or range to forest land due to eastern redcedar colonization. Ninety-six percent of Kansas forest land is categorized as timberland. Timberland area has more than doubled since 1936 (Fig. 4). Nonetheless, timberland area in 2010, at more than 2.3 million acres, still does not exceed 5 percent of Kansas' 52.5 million acres of land. Of the forest land that was not timberland, the entire 107,000 acres was considered to be in unproductive forests. Hardwood forest types are the most prominent forest cover on the land. Less than 8 percent of the forest land is covered by softwood forest types such as eastern redcedar or ponderosa pine (Fig. 5).

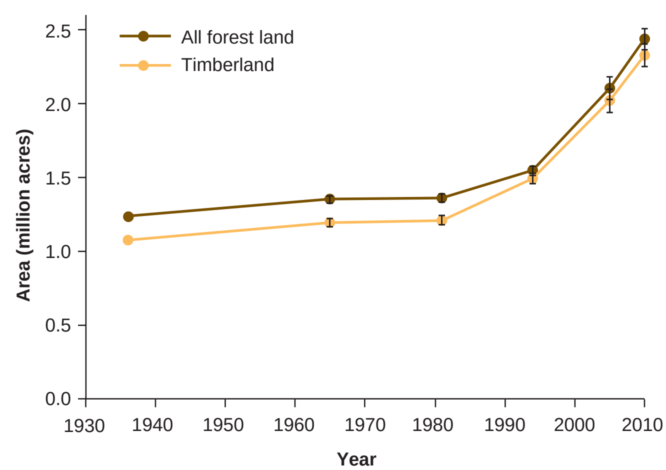


Figure 4.—Forest land and timberland area in Kansas, 1936-2010.

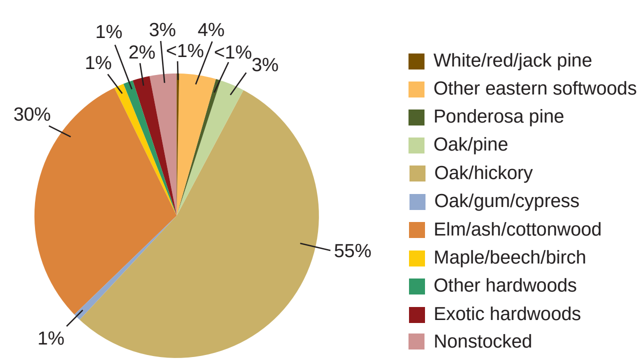


Figure 5.—Area of forest land by forest-type group, in acres, Kansas, 2010.

FIA characterizes forests by forest types, which are defined by an algorithm comprised of species, number of trees, and size of trees (Table 1). To simplify reporting at larger scales, these forest types are combined into forest-type groups. Oak/hickory was the predominant forest-type group on Kansas' forest lands at 1.35 million acres or 55 percent of the total forest land. The elm/ash/cottonwood forest-type group was the second-largest, with almost 736,000 acres or 30 percent. These relative rankings have changed little over the years. When compared to previous reports (Leatherberry et al. 1999, Moser et al. 2008, Raile and Spencer 1984), a change is evident among the lesser forest types and forest-type groups, e.g., the rise in eastern redcedar and eastern redcedar/hardwoods acreage.

The State's largest individual forest types were elm/ash/black locust at 587,000 acres, sugarberry/hackberry/elm/green ash at 470,000 acres, and white oak/red oak/hickory at 262,000 acres. Like much of the Great Plains, Kansas lacks mountainous terrain such as the Ozark Plateau to the east or the Rockies to the west. But that does not mean that the State lacks variation in topography. About 42 percent of the FIA plots are on sites with no appreciable slope. The first two of the abovementioned types (elm/ash/black locust and sugarberry/hackberry/elm/green ash) had a higher percentage of area on level land than the State average, likely reflecting their primarily riparian locations. The white oak/red oak/hickory forest type was predominantly situated on slopes, with only 23 percent of its area on level ground. The largest proportion of this forest type was situated on north-facing slopes. For most forest types in Kansas, the predominant non-level location was on north-facing or east-facing slopes, perhaps reflecting the greater likelihood that these slopes have high soil moisture levels, an important resource in the Great Plains region.

Table 1.—Area of forest land by forest type and aspect, in thousand acres, Kansas, 2010.

Forest type	Total area	North	East	South	West	None	Percent on non-level sites
Black walnut	56.9	7.5	8.2	12.4	13.3	15.4	72.9
Bur oak	62.8	12.6	9.9	7.7	16.4	16.3	74.1
Cottonwood	90.6	1.3	10.0	1.9	10.8	66.7	26.5
Cottonwood/willow	37.3		5.0			32.2	13.5
Eastern redcedar	103.9	16.1	17.3	14.8	20.0	35.7	65.6
Eastern redcedar/hardwood	73.2	6.7	5.7	16.8	16.2	27.7	62.1
Elm/ash/black locust	587.1	63.7	80.7	66.3	70.7	305.6	47.9
Mixed upland hardwoods	223.8	32.6	45.9	32.1	34.6	78.5	64.9
Northern red oak	25.7	1.7	11.0	7.3	4.2	1.5	94.1
Other exotic hardwoods	41.1	2.5	2.7	5.7	5.8	24.3	40.9
Other hardwoods	31.0	3.4		3.0	3.0	21.6	30.3
Post oak/blackjack oak	109.0	38.8	24.0	12.5	9.7	24.0	78.0
River birch/sycamore	30.5	7.4	4.6	11.1	4.0	3.5	88.5
Sugarberry/hackberry/elm/green ash	470.4	69.8	45.4	58.7	42.5	254.0	46.0
Sycamore/pecan/American elm	70.4	5.1	10.1	4.8	1.9	48.4	31.2
White oak/red oak/hickory	262.0	76.9	47.6	27.1	52.0	58.5	77.7
Willow	24.4		3.0		1.5	20.0	18.3
Other	71.5	6.4	15.9	6.9	13.9	28.4	60.3
Nonstocked[a]	65.7	9.6	4.3	9.6	9.1	33.1	49.6
Total	**2,437.4**	**362.0**	**351.3**	**298.7**	**329.8**	**1,095.5**	**55.1**

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

On average, the trees in Kansas' forests are getting bigger. The area of large stand-size forests has increased by 67 percent since 1965, while the area in medium stand-size forests has increased by 226 percent since 1965 (Fig. 6). Most of this change has occurred since 1994 (Fig. 7). A little more than half, 54 percent, of forest land area is within 1,000 feet of a road (Fig. 8), roughly the same amount as in 2005 (Moser et al. 2008).

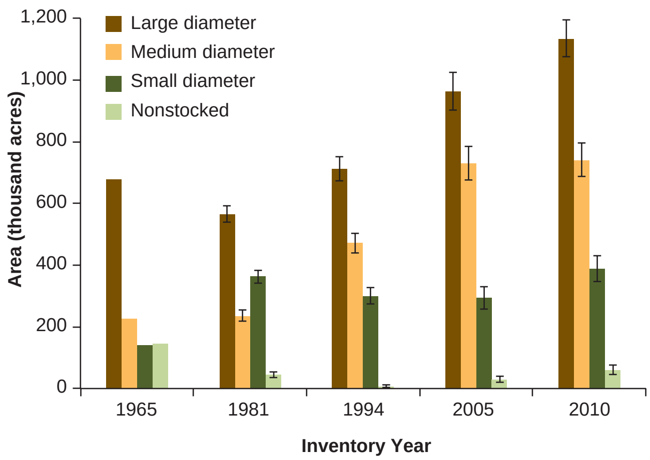


Figure 6.—Timberland area by stand-size class, Kansas, 1965-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

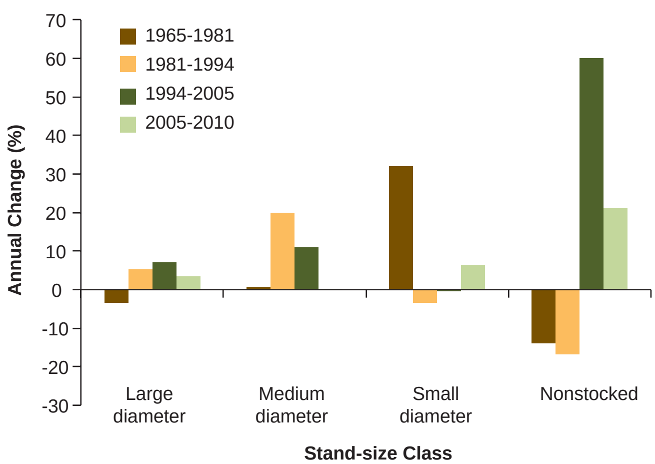


Figure 7.—Percentage change in timberland area by stand-size class, Kansas, 1965-2010.

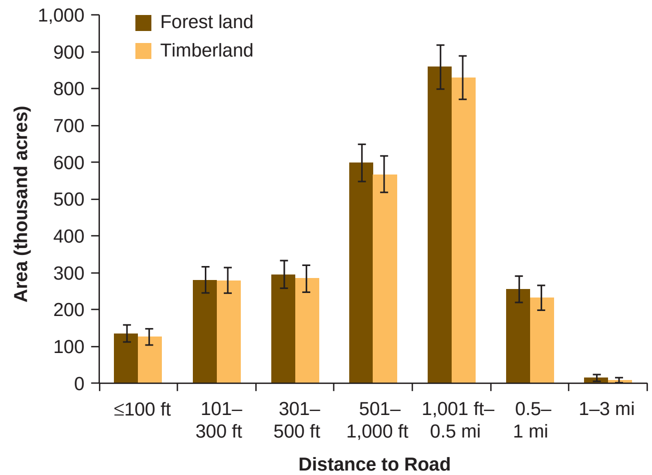


Figure 8.—Acreage of forest land and timberland, by distance to road, Kansas, 2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

What this means

The initial survey of Kansas timberland occurred in 1936 (Kansas State College 1939). Since then, forest land has increased, particularly after 1981. Part of this more recent increase was due to the reclassification of wooded pastures as forest land (Leatherberry et al. 1999), but a substantial portion of the increase resulted from forest encroachment on formerly open lands due to a reduction in agricultural usage or cessation of some other type of human-caused disturbance.

Because Kansas' forest land constitutes a relatively small proportion of the State's total land base, the forested areas that do exist play an important role in providing recreational opportunities and habitat for many forms of wildlife (see the later section on various aspects of wildlife habitat). FIA attempts to capture the various components of Kansas' forests with its inventory, and this report will summarize these attributes in the sections that follow.

Land Use Change

Background

Land use is heavily influenced by the underlying geology and soil productivity and by the short-term and long-term climate of the region. Rapid or severe changes in the weather can cause changes in the vegetative cover. Yet, human activity is the primary influence on the type of vegetation that appears on Kansas' landscapes. Through our actions or inaction, different vegetation grows or is harvested, is burned or is not, is cleared for agriculture or abandoned to reforestation.

What we found

As stated earlier, Kansas' forest land makes up a small proportion of the State's total land base (Fig. 9). Timberland, productive forest land with no restrictions on harvesting, comprises the vast majority of forested acreage. The relatively low proportion of non-timberland forest land has not changed significantly over the last several decades.

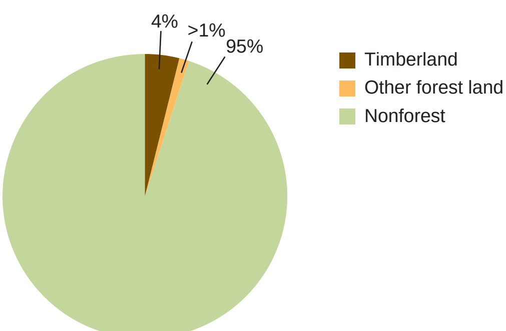


Figure 9.—Land cover, by forest and nonforest types, in acres, Kansas, 2010.

Of the current forest land in Kansas in 2010, a little less than one-fifth was in nonforest condition (mainly agricultural) in the previous inventory (Fig. 10). Because the forest land acreage has increased slightly since 2005 (see Fig. 4), this result suggests that a great many acres also changed from forest in 2005 to nonforest in 2010.

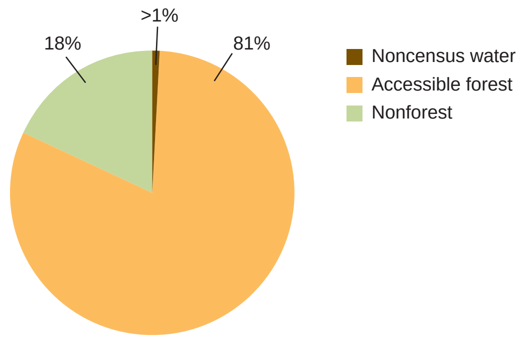


Figure 10.—Previous use of 2010 forest land, in acres, in Kansas.

What this means

Land use change is dynamic and never ending. Although statewide totals may follow gross trends, individual localities may experience increases in forest land while others face decreases, losing woodlands to other uses such as agriculture or development.

Live-tree Volume

Background

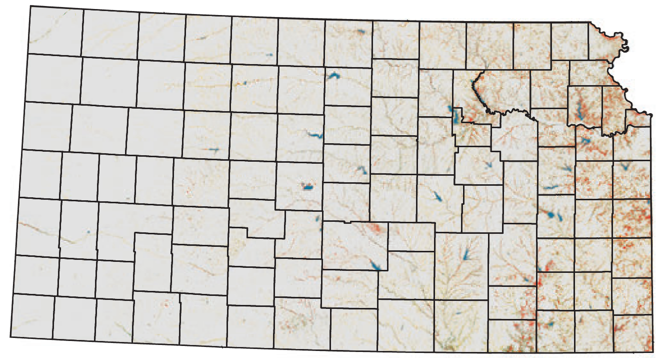
Live-tree volume is the sum of past net growth, influenced by disturbances—natural and human-made—along the way. If we consider trees to be the "skeleton" of Kansas forests, then the size and shape of this skeleton determines the body of benefits—aesthetic, biological, and economic—that Kansans receive. Usable volume in Kansas used to be limited by the minimum size necessary to produce solid wood products. With no nearby pulp mills and few chip mills in the region, landowners had few opportunities to market their small or deformed trees. The recent development of markets for biomass harvesting and renewable energy generation has given landowners more opportunities for income generation. This report will summarize biomass information in a later section.

What we found

The volume of live trees has increased steadily since FIA measurements were first taken in the State. In 2010, live-tree volume on forest land in Kansas was 3.1 billion cubic feet. Softwoods on forest land made up 3.4 percent (106 million cubic feet) and hardwoods constituted 96.6 percent (3.0 billion cubic feet). Most of this volume was in the eastern part of the State (Fig. 11) and in sawtimber-size stands (Fig. 12). Of this total live-tree volume on forest land, 48 percent or 1.49 billion cubic feet, was categorized as growing-stock trees.[5] Rough cull, at 1.50 billion cubic feet, and rotten cull, at almost 105 million cubic feet, made up the remainder.

What this means

Live-tree volume has doubled since 1981. However, a significant portion of total volume remains in cull trees (rough and rotten trees that are less desirable in the manufacture of forest products), a result of the historical development of these forests from low-density woodlands or the fragmented nature causing many trees to be influenced by forest edges resulting in increased branchiness. Of course, cull trees are economic categories, not ecological ones. Cull trees can still store carbon and have value as wildlife habitat or aesthetic features. Forest landowners seeking income from their land may or may not find these "character trees" an impediment to income generation. In making forest management decisions, a landowner can balance the cost of timber stand improvement against the potential future value of an economically improved stand and the change in other non-economic values. These results suggest that there are opportunities for additional woodland management and highlight the need to create additional markets for local wood other than pallets and dunnage.



Processing note: This map was produced by linking plot data to MODIS satellite pixels (250 m) using gradient nearest neighbor techniques.

Source: U.S. Forest Service, Northern Research Station, Forest Inventory and Analysis Program, 2009 data.

Figure 11.—Live-tree volume per acre on forest land, Kansas, 2006.

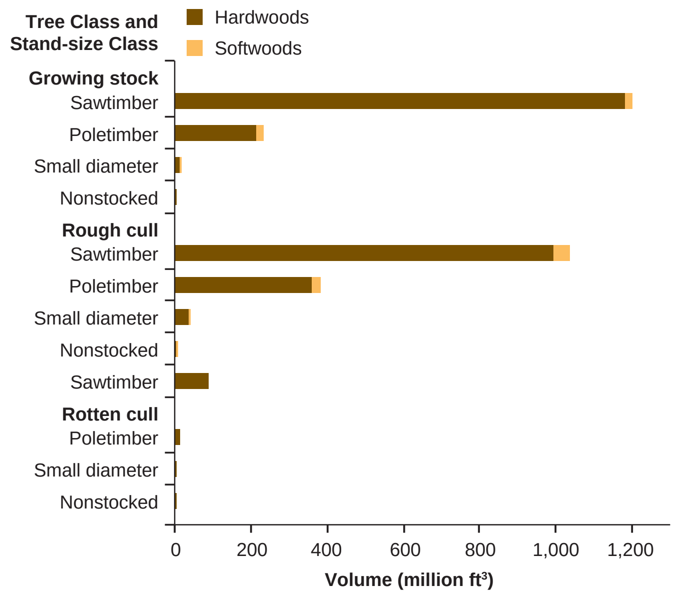


Figure 12.—Net volume of live trees on timberland, by stand-size class, tree class, and major species group, Kansas, 2010.

5 Growing-stock volume is defined as wood volume in standing trees of suitable species that are healthy, sound, reasonably straight, and more than 5 inches in diameter at 4.5 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 such as rot or its bole length might not meet minimum standards for length and soundness.

Growing-stock Volume

Background

Since the beginning of continuous forest inventory in Kansas in 1936, growing-stock volume has been estimated to evaluate the potential resource for manufacturing wood-based products. Even as the inventory developed a more ecosystem-oriented focus, growing-stock estimates still provide Kansans with a measure of sustainable use, both potential and actual. Growing-stock volume is defined 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 difference between live-tree volume and growing-stock volume is a measure that Kansans can use to evaluate the economic potential of the State's forests. The increasing potential for using trees to produce biomass energy blurs this historical distinction.

What we found

Growing-stock volume has remained steady since 2005, at 1.45 billion cubic feet, an 86-percent increase since 1981 (Fig. 13). Since 1965, all of the major species groups have shown a triple-digit percent increase in volume, with eastern redcedar expanding by more than 15,000 percent (Table 2). In 2010 almost 98 percent of growing-stock volume (1.41 billion cubic feet) was in hardwood species, with the remainder (35 million cubic feet) in softwoods.

Table 2.—Volume of growing-stock trees of selected species groups on timberland in thousand cubic feet, Kansas, and the percent increase between the two inventory years, 1965 and 2010.

Species group	1965	2010	Percent increase
All oaks	90,440	270,816	199
Select white oaks	35,960	110,057	206
Select red oaks	25,340	85,292	237
Other white oaks	10,210	27,371	168
Other red oaks	18,930	48,097	154
Hickories	20,590	70,645	243
Hard maple	2,200	8,317	278
Soft maple	8,770	21,395	144
Eastern redcedar	210	31,884	15,083

Looking at the State by inventory unit (Fig. 14), the Northeastern unit has the largest volume, followed by the Southeastern and Western units. Statewide, volume in the middle diameter classes seems to be making the highest percentage gains over the recent inventories (Fig. 15).

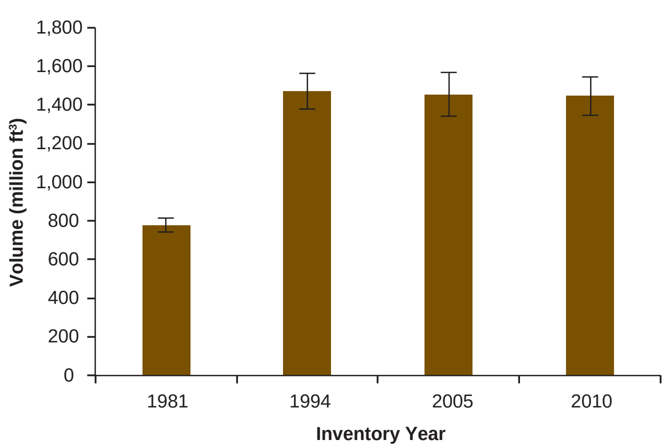


Figure 13.—Volume of growing-stock trees by inventory year on timberland, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

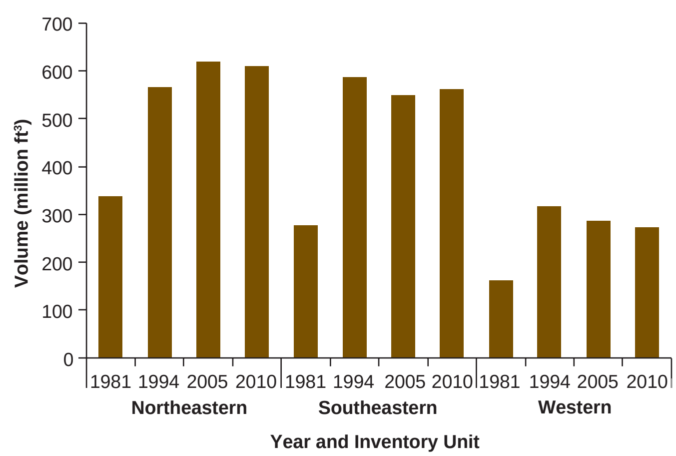


Figure 14.—Growing-stock volume on timberland by inventory unit, Kansas 1981–2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

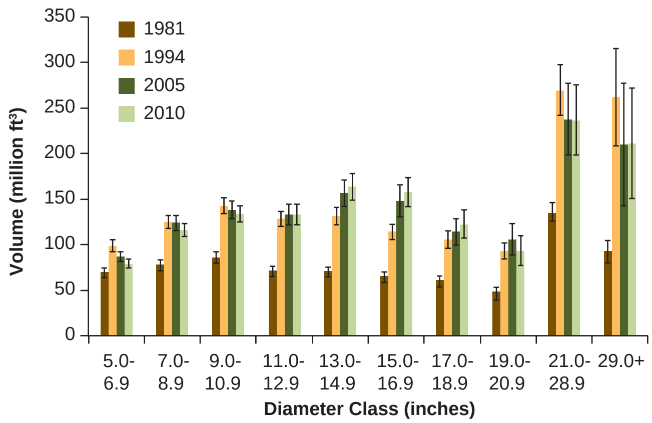


Figure 15.—Growing-stock volume on timberland by diameter class, Kansas, 1981–2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

What this means

Growing-stock volume on timberland has increased since 1981; however, the rate of increase is declining. Future patterns of this forest measure will likely reflect the countervailing influences of increasing density per acre in Kansas and the reduced rate of increase or even a decrease in timberland acreage. At that point, barring any change in harvesting patterns, we may see increased concentration of volume in the larger diameter class.

Density

Background

Before the arrival of Euro-Americans, the forests of the region were more open in character than are many forests today (Beilmann and Brenner 1951). Many forests in the region were shaped by the fires set by Native Americans, thus maintaining the open understory for grazing and hunting.

What we found

To classify a forest stand by constituent tree sizes, FIA estimates 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 can be related to the stages of stand development for particular forest types, but the relationship with age is not as strong.

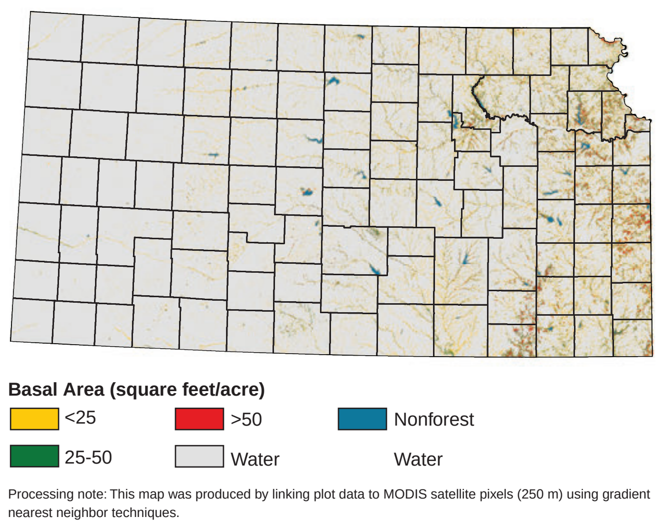


Figure 16.—Basal area of live trees in Kansas, 2006.

The distribution of basal area across Kansas is shown in Figure 16. Over the past four inventories, Kansas' forests have exhibited increasing density, although in the latest inventory there was a significant increase in acreage of the lowest basal area class, perhaps reflecting an increase in newly established forested acres on former range, pasture, or agricultural land (Fig. 17).

Most of Kansas' timberland was in the medium and large stand-size classes. In 2010, large stand-size acreage stood at 1.135 million acres, or 48.8 percent of the total timberland acreage. Medium stand-size acreage was 741,300 acres or 31.9 percent of the total timberland

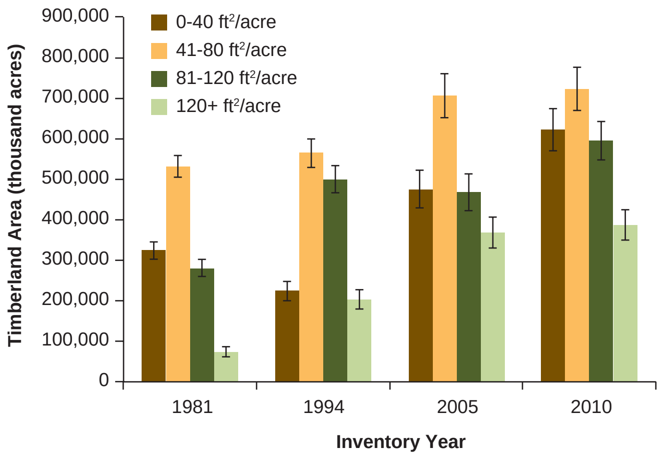


Figure 17.—Timberland acreage by live-tree basal area category, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

acreage. The area of small size-class stands was 389,400 acres, not much larger than the 1981 estimate for this size class (363,000 acres), but a far smaller percentage (16.7 percent) of total timberland area than the comparable 1981 figure (30 percent) (Fig. 18).

The number of trees on Kansas' timberland has increased since 2005, although most of the gains at the lower diameter classes likely reflect the afforestation of formerly open land by pioneer species, such as eastern redcedar (Fig. 19). The increase in larger diameter classes that was detailed in the 2005 report (Moser et al. 2008) has not continued through the latest inventory.

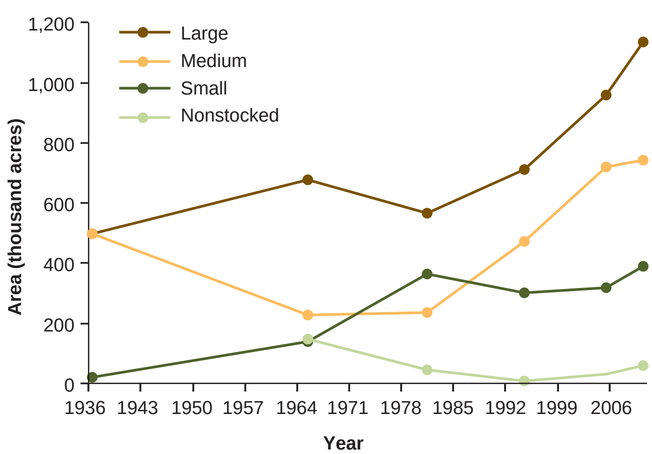


Figure 18.—Area of timberland in Kansas by stand-size class, Kansas, 1936–2010.

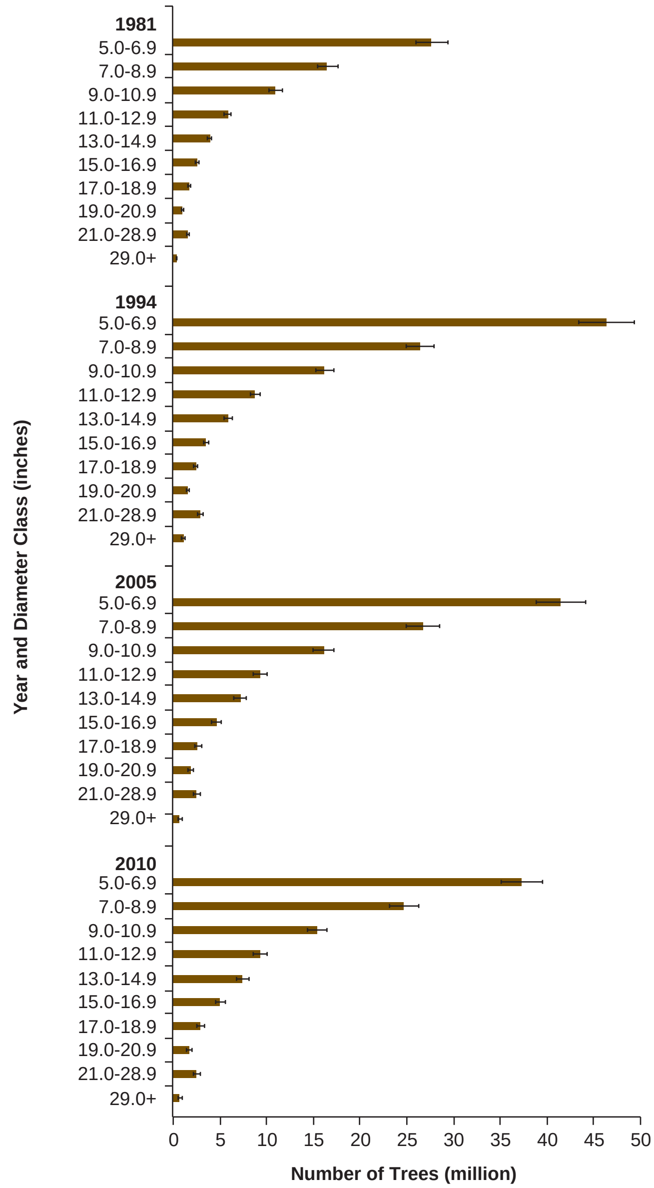


Figure 19.—Number of growing-stock trees on timberland by diameter class, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

Density can also be measured as volumes per unit area. In this report, we examined volume per acre (VPA) of timberland since 1981. After a peak in 1994, volume per acre declined to the point where the 2010 VPA was less than that of 1981 (Fig. 20). As many older stands increased in density, the overall decline in VPA is probably due to new forests on formerly open lands.

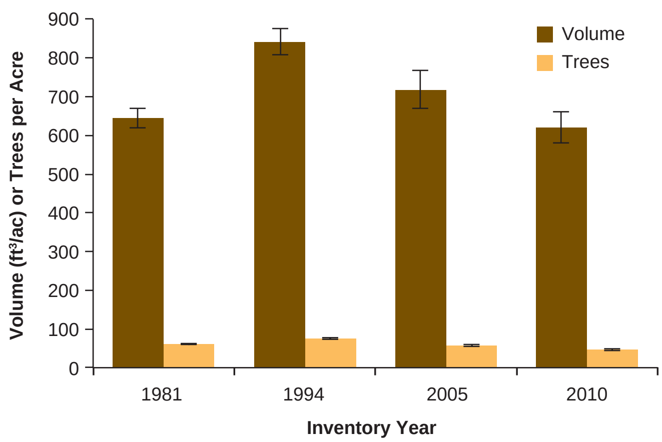


Figure 20.—Volume (VPA) and number (TPA) of growing-stock trees per acre on timberland, Kansas 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

There are other ways of measuring forest density, including total basal area per acre and growing-stock stocking class. Basal area is a purely quantitative measure whereas stocking class makes some assumptions about "appropriate" levels of density based on the biology of the component tree species and the capabilities of the sites. For some analyses of wildlife habitat, these density measures can help determine the potential for shelter and food sources (Moser and Palmer 1997). Figure 21, which subsets growing-stock volume by growing-stock stocking levels, portrays the previously mentioned dampening of any statewide change in density, where the denser, older stands are counterbalanced by newer low-density forests.

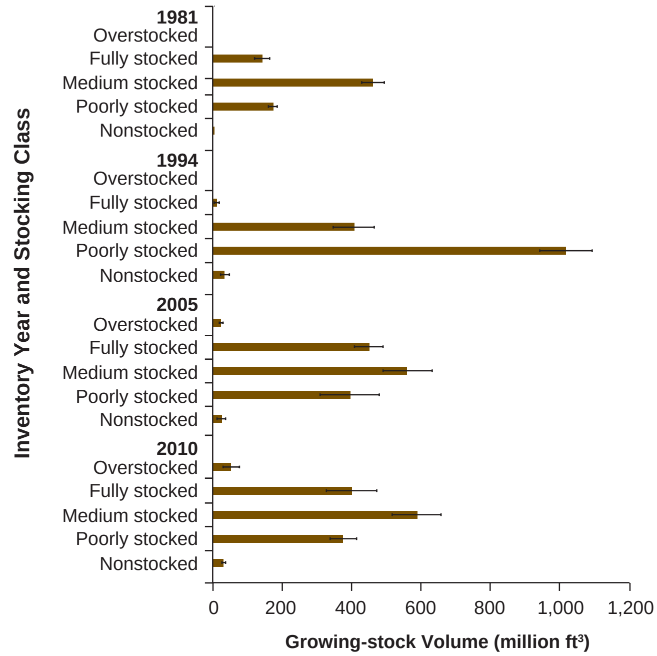


Figure 21.—Growing-stock volume on timberland by growing-stock stocking class, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

What this means

A particular forest stocking level is not necessarily desirable or undesirable. Resource managers frequently compare density to what was present historically. Changes from this historical condition represent opportunities and costs that must be taken into account, given one's point of view. Lower density stands may provide habitat for certain plants and animals yet may not be economically operable due to poor tree quality or lower volume per acre. Higher density forests can be more acceptable economically, but not create the habitat or recreational opportunities that a more open stand might. How landowners deal with these choices depends upon their goals and objectives.

Age

Background

Knowing a forest's age is critical to understanding the processes behind the forest's structure and composition. Once resource managers know the age of a forest, they can determine if a forest should be thinned or harvested completely, if the forest is prone to health problems, how it would respond to natural or human-caused disturbances, or if it is appropriate habitat for particular wildlife species. FIA estimates the age of each of its forested plots by taking core samples from dominant or codominant trees in the overstory.

What we found

While the trends up to 2005 appeared to support the hypothesis that Kansas' forests were getting younger (Moser et al. 2008), this latest inventory finds a cohort of plots moving through the age-class distribution (Fig. 22). These stands, apparently established between the 1950s and 1980s, represent a substantial proportion of Kansas' forest land. Some ingrowth of the younger age classes is likely due to afforestation of previously nonforested lands. These area-based results are mirrored by analysis based on the number of trees (Fig. 23). When we examine age-class distribution by forest type (Fig. 24), upland oak forest types appear to have a higher proportion of older stands than do other forest types in the State.

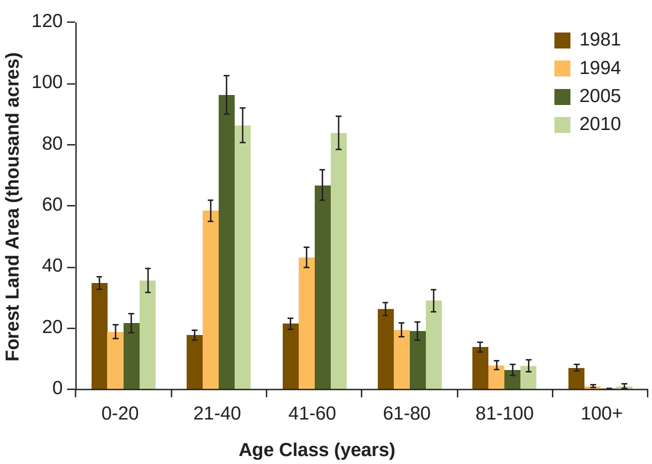


Figure 22.—Forest land area by age class, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

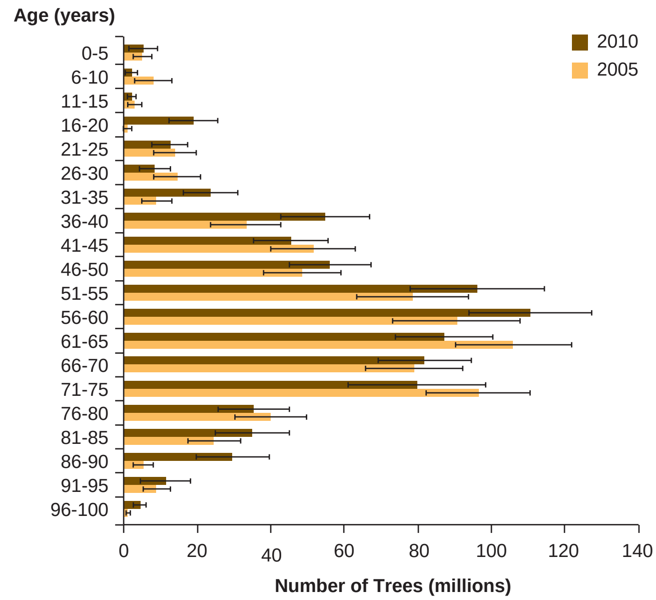


Figure 23.—Number of live trees on forest land by age group, Kansas, 2005 and 2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

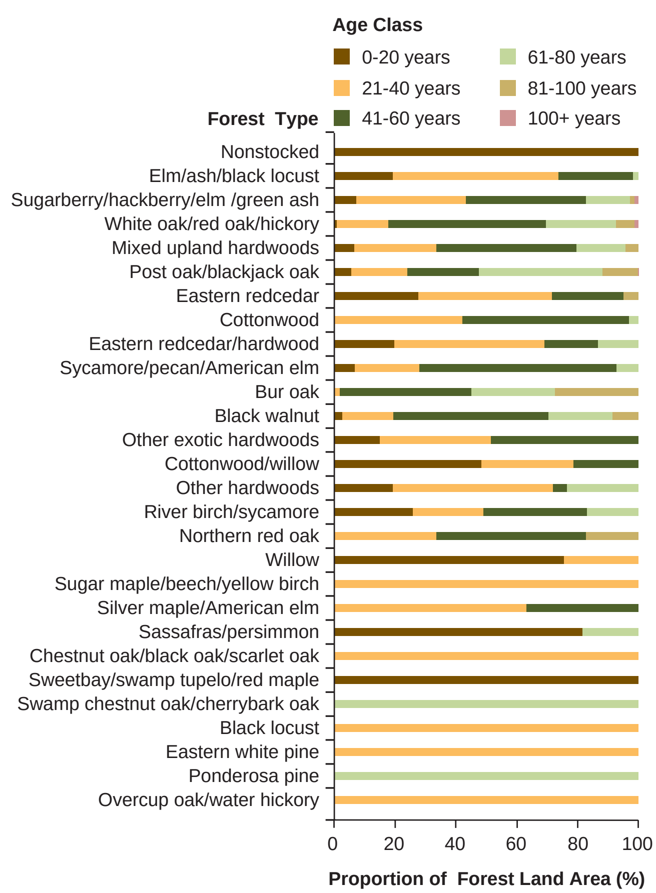


Figure 24.—Proportion of total land area, by forest type and age class, Kansas, 2010.

What this means

Although the FIA-estimated age of a plot does not mean that every tree is that age, the increasing age of the dominant and codominant trees in the stand helps determine the forest's character. Increasingly older (and, presumably, larger) forest trees could eventually provide acceptable habitat for black bears (*Ursus americanus*) that might disperse from neighboring Missouri and Arkansas, for example. A large proportion of Kansas' forest land appears to have been established 30 to 60 years ago. If the younger forests are not predominantly oak as are the older forests, the benefits for wildlife and other users of the forest (including humans) will undergo a profound change as time goes by.

Diversity

The diversity of a forest may be defined by a variety of factors, including differences in overstory tree species or size, diversity of understory species, and/or some variation in spacing. Each of these factors provides some sort of habitat for wildlife and can provide a variety of recreational opportunities. A diverse forest has the potential to be more resilient in the face of disturbances.

The Shannon Diversity Index for species measures a combination of species number and the relative distribution of those species (Magurran 1988). For example, in this report, the Shannon Diversity Index was applied to the overstory trees for the entire State, then broken out by inventory unit and by individual forest types within the inventory units.

What we found

Statewide, we can see pockets of high and low tree-species diversity in Kansas' forests, as shown in this map from the 2005 report (Fig. 25, Moser et al. 2008), with lower diversity plots more prominent in the western part of the State. Across the State, the inventory data suggest there has been a decline in overstory species diversity over time (Fig. 26), perhaps reflecting the increasing age of Kansas' forests (Figs. 22-24). Looking at species diversity by forest type, the data suggest that there is less overstory diversity in western Kansas than in the east. Notable exceptions to this observation include eastern redcedar, a much more drought-tolerant species, and cottonwood/willow forests, whose primary habitats are in riparian areas and thus are less influenced by lower rainfall levels in the upland portions of western Kansas (Fig. 27).

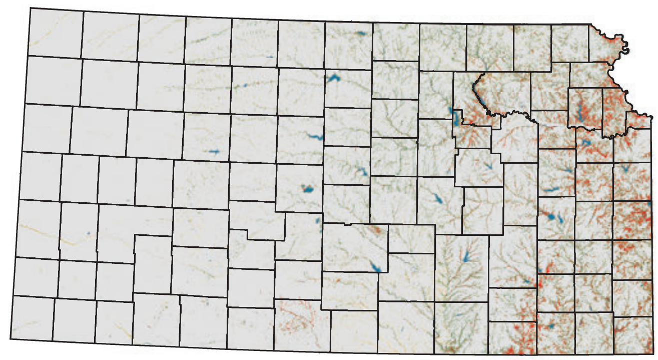


Figure 25.—Estimated tree species diversity (Shannon Diversity Index) of live trees on timberland, Kansas, 2005 (Moser et al. 2008).

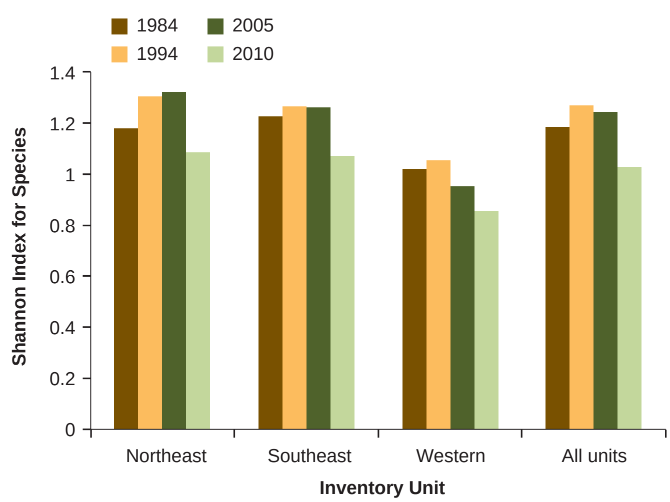


Figure 26.—Calculated Shannon Diversity Index for live trees on timberland, by inventory unit, Kansas, 1981–2010.

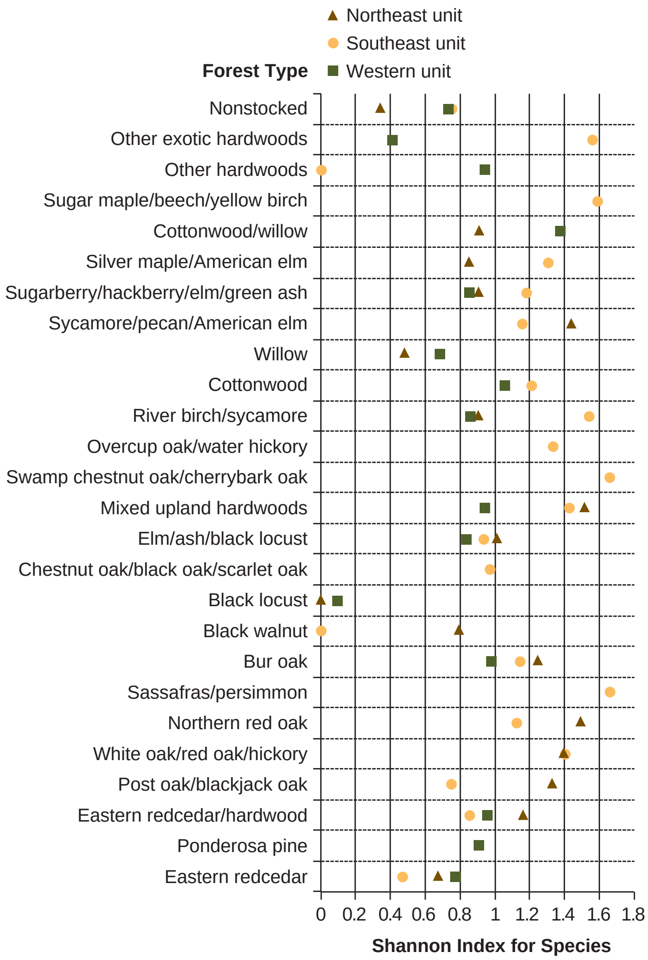


Figure 27.—Calculated Shannon Diversity Index for species of live trees on timberland, by forest type and inventory unit, Kansas, 2010.

What this means

Climatic and site-productivity factors and natural disturbances, such as storms, can influence the number of species on a particular site. Decreasing soil moisture not only limits the potential for moisture-loving species to even exist on a site, but also impacts species that can tolerate such extremes by reducing their total potential productivity. Thus, we see less basal area and/or volume on drier sites in the west (see Figs. 4 and 15), as well as fewer species of trees in the overstory.

Who Owns Kansas' Forests?

Background

The owners of the forest land ultimately control its fate and decide if and how it will be managed. By understanding forest owners, the forestry and conservation communities can better help the owners meet their needs, and in so doing, help conserve the region's forests for future generations. FIA conducts the National Woodland Owner Survey (NWOS) to better understand who owns the forests, why they own them, and how they use them (Butler 2008).

What we found

Almost all of Kansas' forests, 95 percent, are privately owned (Fig. 28). Of these private acres, 96 percent are owned by families, individuals, and other unincorporated groups, collectively referred to as family forest owners.

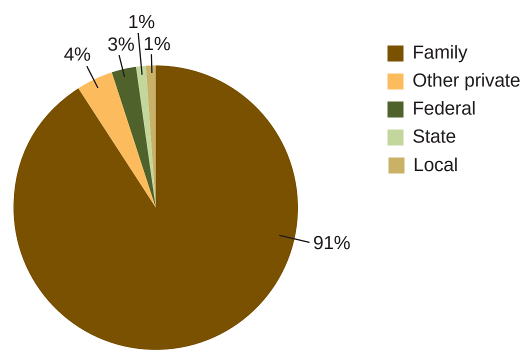


Figure 28.—Forest ownership, Kansas, 2006.

A total of 101,000 family forest owners control 1.9 million forested acres across Kansas. More than half (60 percent) of these owners have between 1 and 9 acres of forest land, but more than half (55 percent) of the forest land is in holdings of 50 acres or more (Fig. 29). The average holding size is 19 acres. The primary reasons for owning forest land are related to the land being part of their farm, aesthetics, family legacy, and protection of nature (Fig. 30).

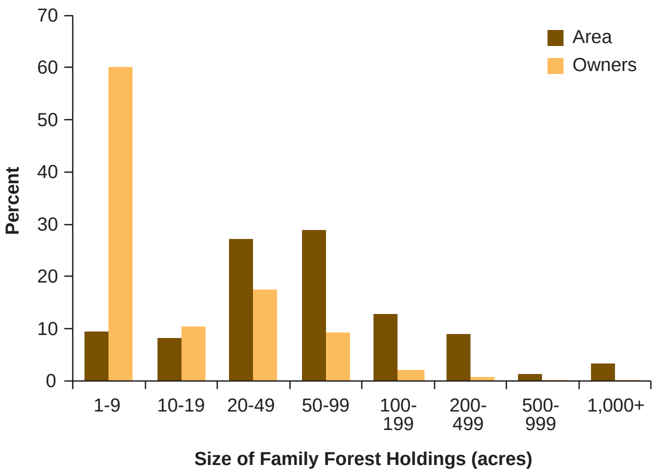


Figure 29.—Size of family forest holdings, Kansas, 2006.

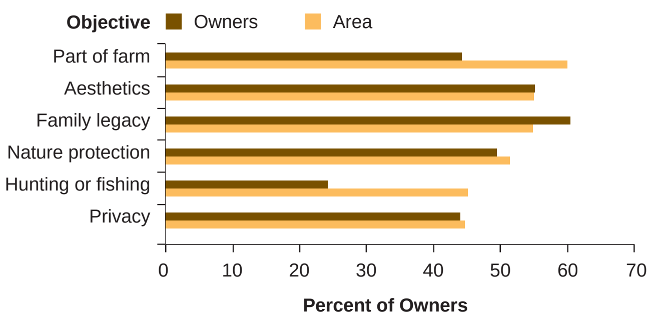


Figure 30.—Primary ownership objectives of family forest owners, Kansas, 2006.

Although timber production is not a primary ownership objective for most forest owners across Kansas, 22 percent of the family forest land is owned by people who have commercially harvested trees. Three percent of the land is owned by people who have a written management plan, and 20 percent of the land is owned by people who have received management advice.

What this means

Much of the forest land in Kansas will soon be changing hands. One in nine acres is owned by someone who plans to pass the land onto heirs or sell it in the near future. Family legacy is a major ownership objective and it is also a major concern. What can be done to help the forest owners and the land? Timber production is clearly not on the forefront of forest owners' minds, but many owners are not adverse to harvesting and other activities in the woods. It is important to provide programs that meet the owners' needs.

Elements of Change

Ecological systems do not stand still. In most forests, change is a constant factor. Growth and mortality are processes whereby a forested ecosystem both prepares for the future and adjusts to the opportunities and limitations of site, climate, and disturbance. Removals, resulting from either timber harvesting or land use change, is also a measure of change that must be taken into account when evaluating Kansas' forests.

Growth

Background

Growth is a function both of the productivity of the land and the potential of the trees standing on the site. Up to a point, larger trees can produce more growth than smaller trees, although the percent increase may be higher in the smaller trees. Where there are larger trees that are not growing as much as expected, such a result may indicate changes in precipitation over the preceding period, a mature age-class structure, or perhaps some forest health problem.

What we found

Average net growth of all live trees on forest land in Kansas from 2006 through 2010 was 79.4 million cubic feet per year. Net growth of growing-stock trees on timberland was 36.6 million cubic feet per year, representing a substantial increase since the last two periodic inventories where growth was calculated (1981 and 1994) (Fig. 31).

Different species exhibit different growth patterns depending on their individual life history strategies, competition from other species, or their ability to use available soil resources. Forest types are associations of such species that coexist because of the ability of the component species to integrate their needs in the face of disturbance patterns and site productivity.

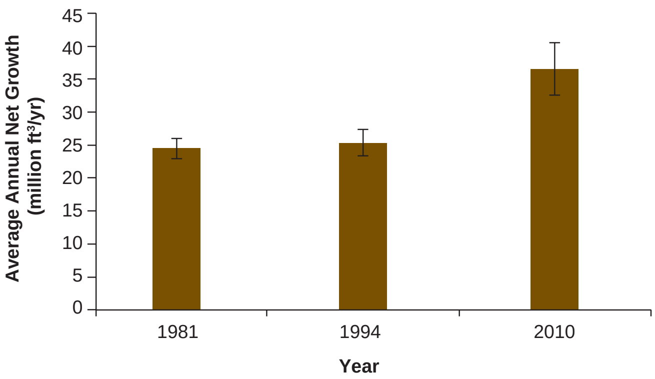


Figure 31.—Net growth of growing stock on timberland in Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

What we found

Based on this productivity, the elm/ash/locust forest type displayed the highest average annual growth of any forest type in Kansas (Fig. 32). The largest component of this type's growth occurred in the 21- to 40-year age class, reflecting the relatively short-lived, early successional component species. The sugarberry/hackberry/elm/green ash forest type exhibited the second highest amount of growth with the increase spread more evenly across the first 80 years of stand age than elm/ash/black locust. Hackberry, a more shade tolerant species, is able to maintain growth even in less open conditions than would other, more shade-intolerant species, such as black locust or cottonwood.

Although some species are present only in pure (often shade-intolerant) stands, many species in Kansas can survive and even thrive in mixed-species forests. In Figure 33, there are both types of species in the top 10 species with the most statewide growth for the 2006–2010 inventory, with many, but not all, being relative shade-intolerant. Hackberry and Osage-orange, shade-tolerant and shade-intolerant species, respectively, tied as the species with the most growth. The expansion of these two species represents significant shifts in the Kansas landscape. Hackberry is beginning to dominate many of the State's denser forests. Osage-orange, like eastern redcedar, is spreading into grasslands that will eventually qualify as forests.

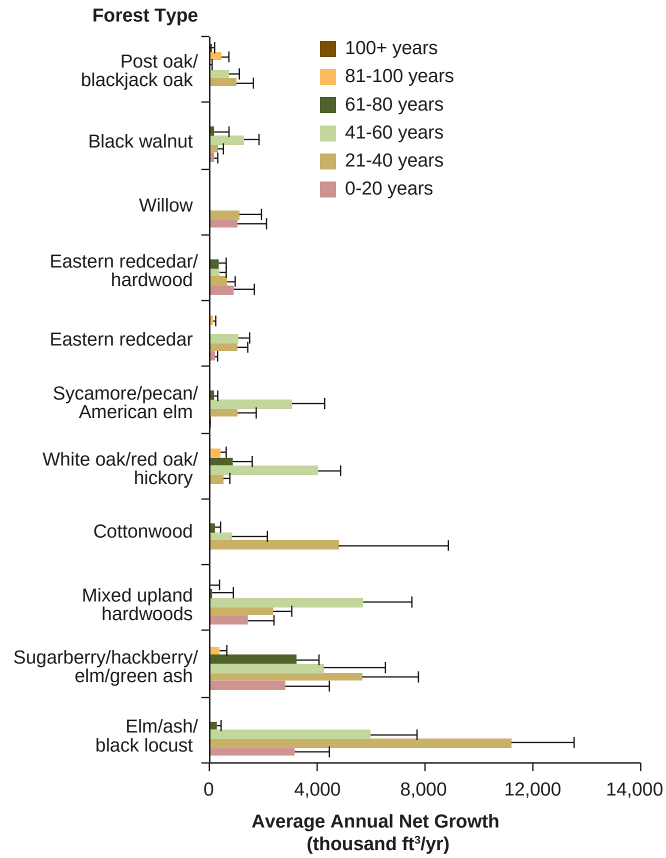


Figure 32.—Average annual net growth of all live species on forest land, by selected forest types, Kansas, 2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

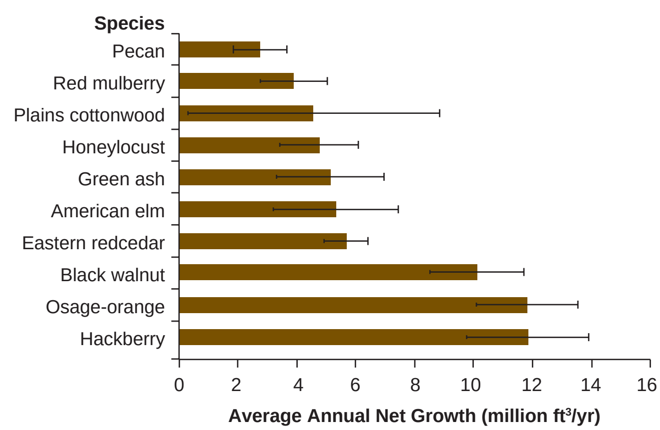


Figure 33.—Live-tree average annual net growth of top 10 species on forest land, Kansas, 2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

Removals

Removals can result from forest land taken out of forest use or actual timber harvests on timberland. To separate these two situations, FIA produces estimates of harvest removals and other (usually land use change) removals. In most states, including Kansas, timber harvest removals is the largest component of total removals, although in some local areas, such as counties in or near a major metropolitan area, land use change removals may be in the majority.

What we found

Reflecting its abundance and particularly its high value and popularity, black walnut had the highest amount of harvest removals over the past 5 years (Fig. 34). This disparity with the other species' harvest estimates is all the more remarkable given that black walnut does not have the highest estimated inventory in either all live trees or growing stock.

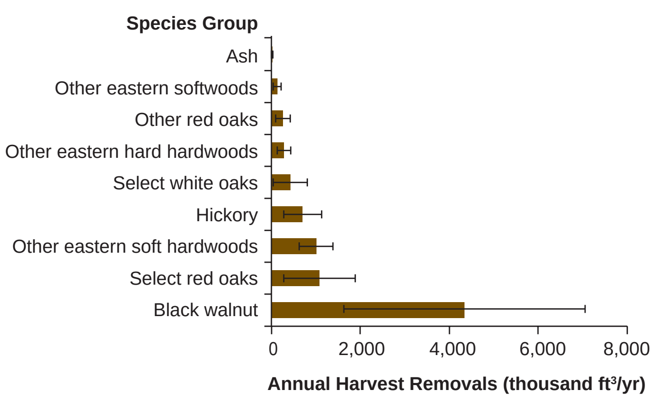


Figure 34.—Average annual harvest removals of growing stock on timberland, by species group, Kansas, 2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

Likely reflecting the age-class structure of Kansas' forests, the bulk of the harvest removals occurred in stands where the stand age was in the 41- to 60-year range (Fig. 35). For some species, such as black walnut, this suggests that harvests are occurring before financial maturity of the species. Also influencing this harvest pattern was the apparent preference of Kansas harvesters for those species that were early-successional or mid-successional in ecological status. In contrast to the 2005 inventory (Moser et al. 2008), cottonwood was not among the top nine species groups in terms of volume harvested, perhaps reflecting the recent economic downturn and the reduction in the number of pallet and dunnage mills in the State. Future inventories will evaluate whether the cohort of cottonwood trees established during the major flood events of the mid-1990s will reach a point where the species will make up a more significant proportion of total harvest removals.

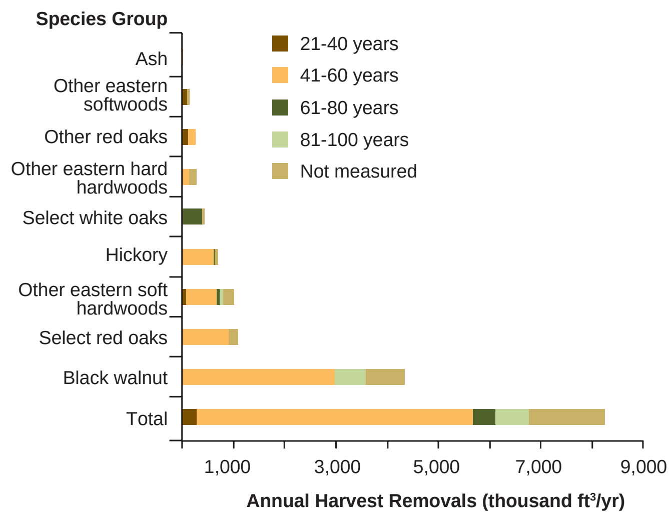


Figure 35.—Average annual harvest removals of growing stock on timberland, by species group and age class, Kansas, 2010.

What this means

Harvest removals reflect economic activity in Kansas' forests. Although this activity will be explored in greater depth in the Timber Products Output section, these data suggest incapacity or an unwillingness to use any species other than black walnut. While proposed biomass-to-energy activities may provide an opportunity to monetize a more broad section of forest assets, that opportunity is not available to most forest land owners in Kansas at this time. The State might also benefit from local markets and wood industries that process a variety of local hardwoods.

Mortality

Background

As stated above, mortality is a normal part of any ecological process. It is important not to confuse high vs. low mortality with “good” vs. “bad.” One technique that puts mortality into context is to estimate historical levels of mortality and determine if current values deviate from those levels. Even then, particular circumstances may explain a dramatic increase or decrease in mortality. For example, a species such as cottonwood that was established after a flood 50 to 60 years ago may have greater mortality than a bur oak forest of similar age. Interpretation of mortality estimates should consider the whole of the ecological story.

What we found

Sugarberry/hackberry/elm/green ash forests had the highest mortality, more than 12 million cubic feet per acre per year, followed by cottonwood and elm/ash/black locust forest types (Fig. 36). Despite their substantial volumes in Kansas’ forests, bur oak and black walnut had much less mortality than other forest-type groups; white oak/red oak/hickory did not have much more. Density had some apparent influence on mortality (Fig. 37). More than half of cottonwood mortality occurred in stands that were fully stocked or overstocked; almost half of sugarberry/hackberry/elm/green ash and elm/ash/black locust mortality occurred in these more dense stands.

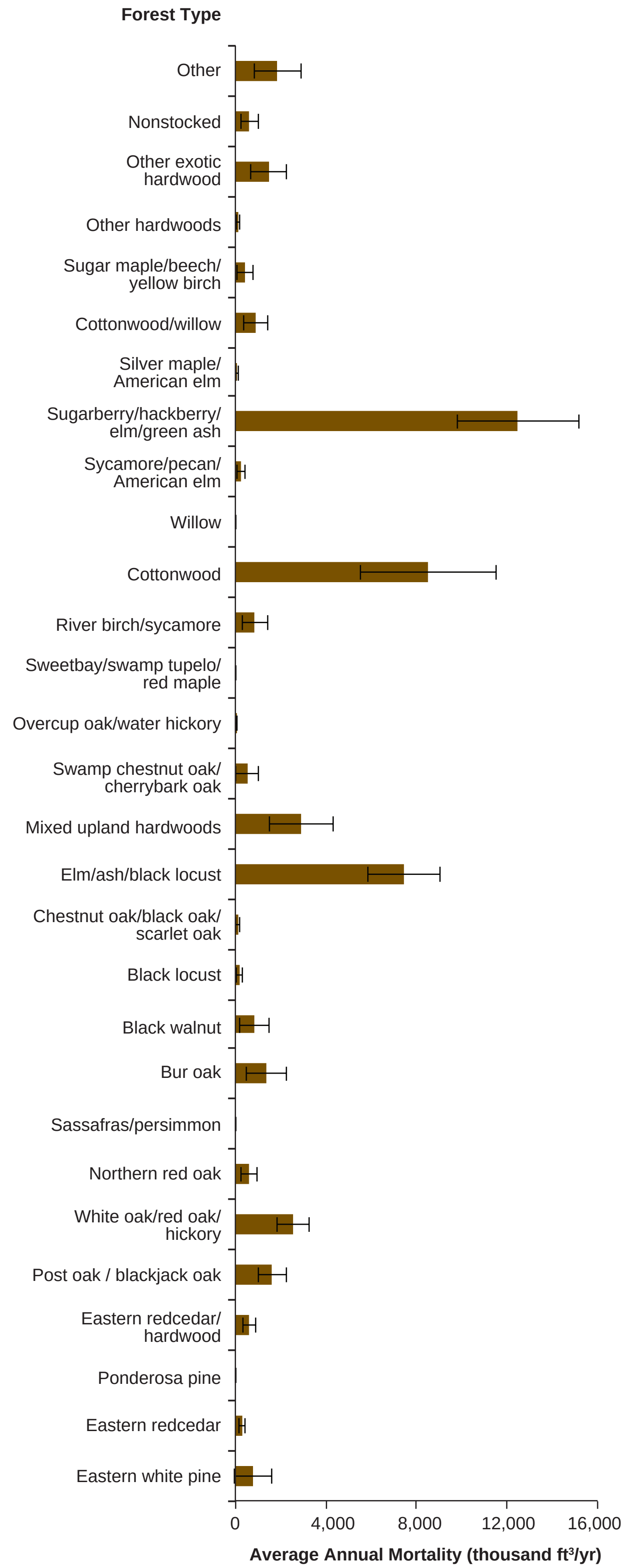


Figure 36.—Average annual mortality of trees (at least 5 inches d.b.h.), by forest type on forest land, Kansas, 2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

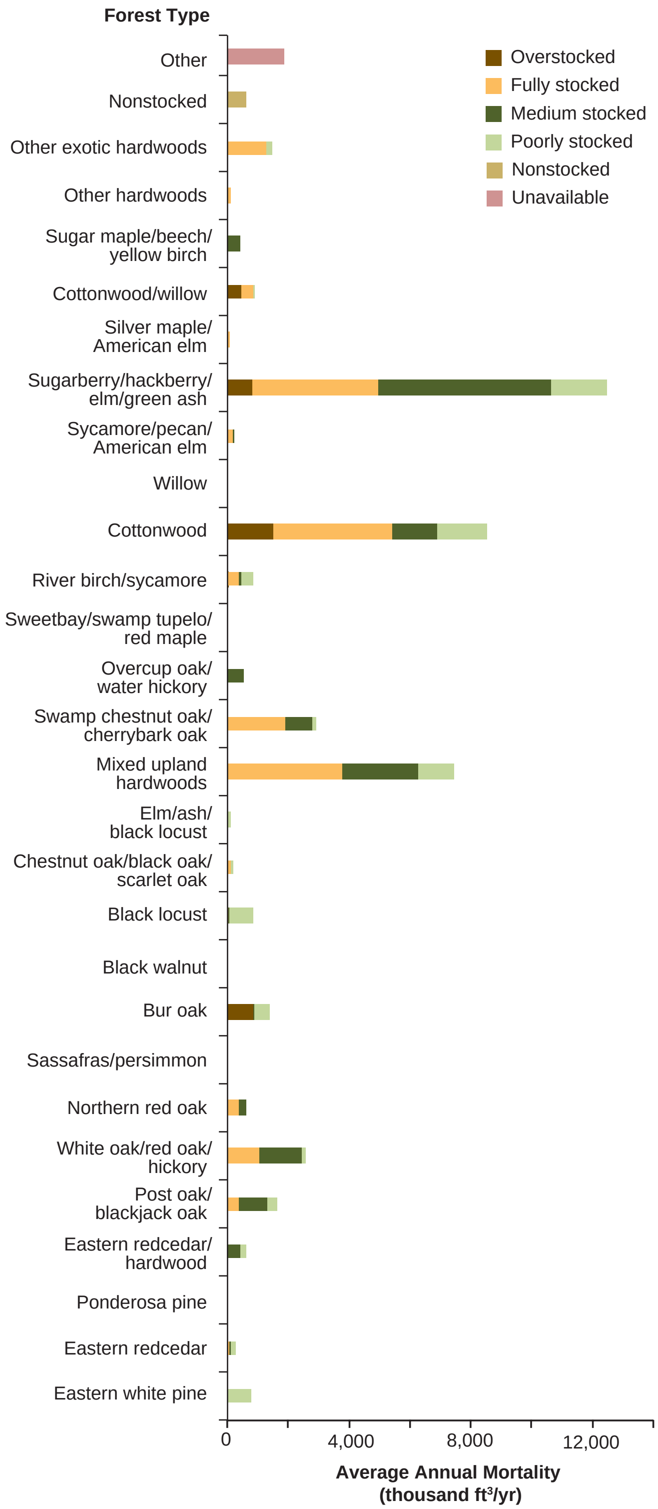


Figure 37.—Average annual mortality of trees (at least 5 inches d.b.h.), by forest type and growing-stock stocking class on forest land, Kansas, 2010.

Characteristics of Major Species in Kansas

In the following section, we highlight selected species of interest in Kansas. Each of these species is valuable to Kansans for wildlife habitat and food, potential wood products, and the ability to impact ecological change and succession. These species are not always the most dominant in every situation, but they have significant roles in Kansas' forests.

Hackberry: An Increasing Forest Resource

Background

Hackberry is a species common to riparian zones and other moist sites in Kansas. In this report, we will call all *Celtis* species found in Kansas "hackberry." Krajicek and Williams (1990) stated that hackberry and sugarberry (*Celtis laevigata*) are difficult to differentiate, but that sugarberry is more likely located on bottomlands and hackberry on uplands. Hackberry is a shade-tolerant species with limited commercial utility. Its wood is heavy but not hard and is occasionally used for inexpensive furniture.

What we found

The growing-stock volume of hackberry in 2010 was 250 million cubic feet, an almost 14-percent increase from 2005 and a 149-percent increase from the 1981 values (Fig. 38). Most of the volume in recent years has been concentrated in the oak/hickory and elm/ash/cottonwood forest-type groups (Fig. 39), the two principal hardwood groups in Kansas. The number of hackberry trees has increased across the diameter distribution, most prominently in the lower diameter classes (Fig. 40). The distribution of sawtimber volume is bimodal (Fig. 41), perhaps reflecting the presence of existing large relict trees in the riparian zones along with a cohort of smaller (and possibly younger) trees moving through the system.

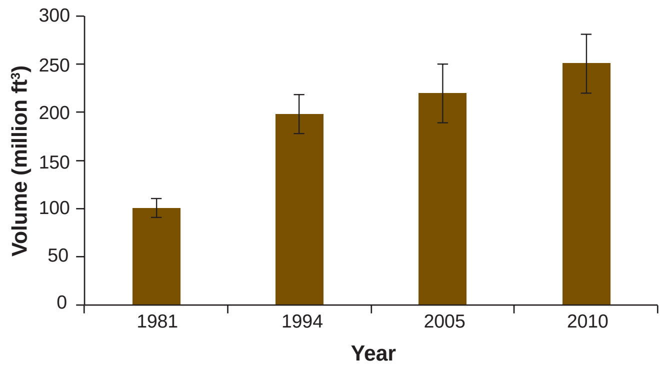


Figure 38.—Growing-stock volume on timberland of hackberry, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

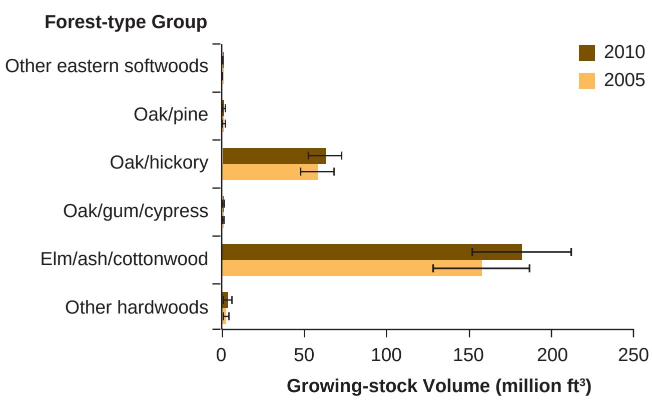


Figure 39.—Hackberry and sugarberry growing-stock volume on timberland by forest-type group, Kansas, 2005-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

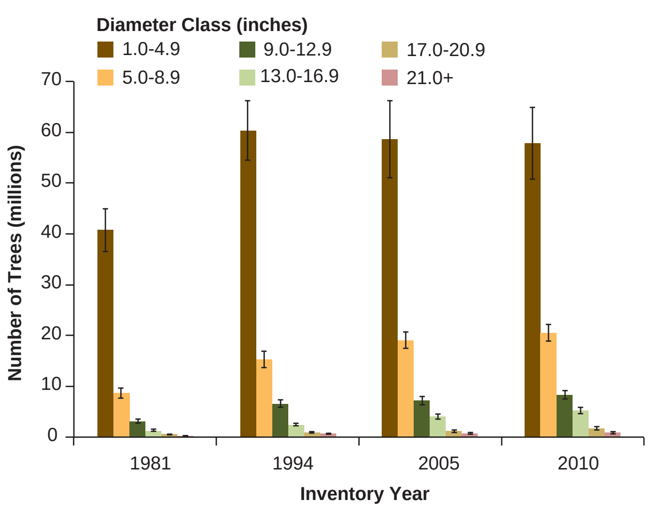


Figure 40.—Number of live hackberry trees on timberland by diameter class, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

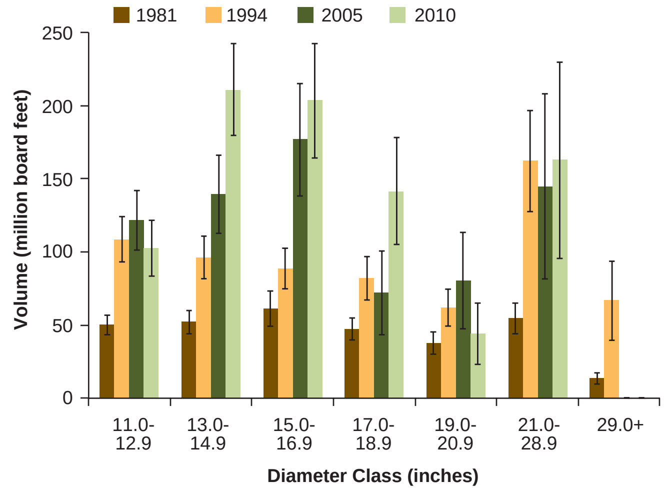


Figure 41.—Sawtimber volume of hackberry species, by diameter class, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

What this means

Hackberry had the most growing-stock volume of any species in Kansas in 2010. This species, while not as commercially popular as some in Kansas, could provide an opportunity for future forest utilization.

Oaks: An Important Component of Kansas' Forests

Kansas lies at the western end of the oak/hickory forest complex that stretches east all the way to the Atlantic Ocean. Long a source of wood products and fuel for Kansas settlers and their descendants, oak forests are also a valuable source for food and habitat for wildlife. Oaks are the dominant species in their forest types, but many other tree species can be present.

Because oak is a heavy-masted species, its presence in the overstory is critical to the establishment of oak regeneration in the understory. Generally, oak forests need only 100 oak seedlings per acre to make it into the canopy to maintain the forest type (Johnson et al. 2009). Attrition due to competition-caused mortality and herbivores necessitates a cushion of excess seedlings to ensure that at least 100 remain. Managing oak regeneration is a balancing act, because the overstory cannot be so dense that saplings cannot get enough sunlight, water, and nutrients to grow into the overstory. Disturbances, such as windstorms, fire, or harvest (complete or partial), may provide enough opportunity for seedlings to establish in the understory and progress into the overstory.

What we found

Oak/hickory forests account for 55 percent of the timberland acreage in Kansas (Fig. 5). In recent years, the proportion of total oak growing-stock volume in the medium and fully stocked categories has increased (Fig. 42). Although overall oak growing-stock volume has decreased in recent years; it is still almost 28 percent higher than in 1981 (Fig. 43). More than half of the trees in Kansas are oaks.

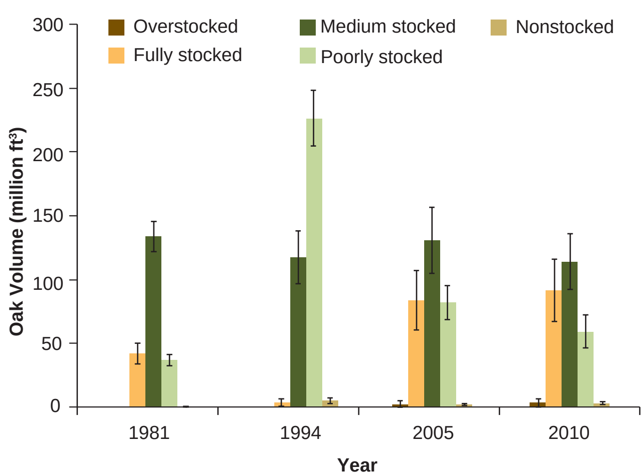


Figure 42.—Growing-stock volume of oak species, by growing-stock stocking category, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

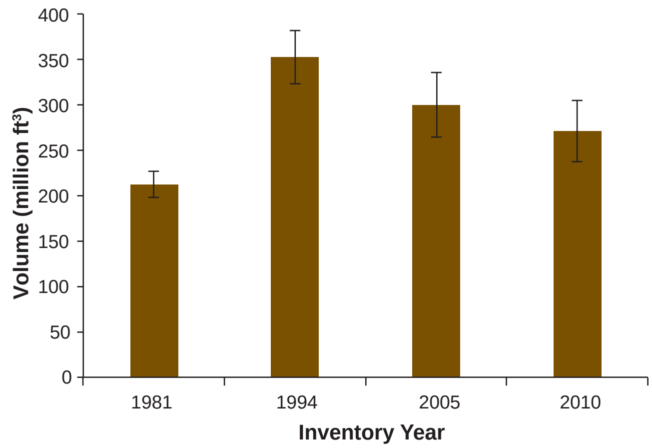


Figure 43.—Growing-stock volume of oak species on Kansas' timberland, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

Having oaks in the overstory was positively correlated with oak seedling presence in the understory. In Figure 44, the oak proportion of 20 to 50 percent was the most productive of oak seedlings and had many plots with hundreds of seedlings per acre. Few plots had a low proportion of oak in the overstory and yet high oak seedling densities in the understory. As the proportion of oak in the overstory increased, we did observe a slight increase in the number of plots with higher seedling densities.

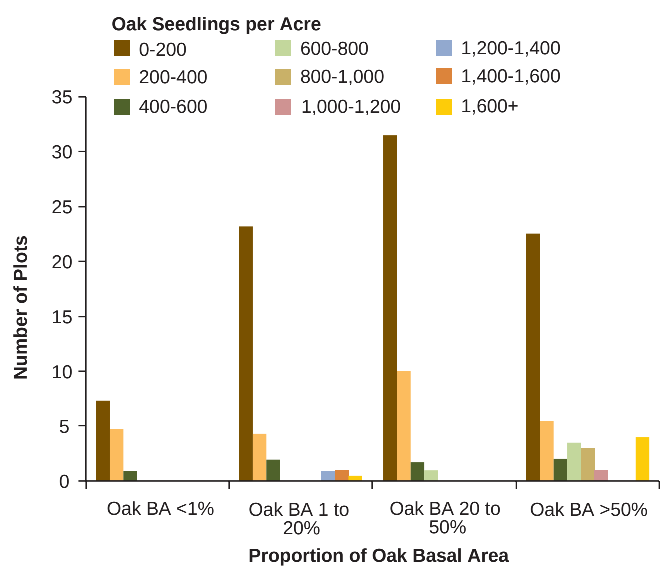


Figure 44.—Oak species seedlings in oak forests, by proportion of oak basal area, Kansas, 2006-2010.

Examining oak sapling data on Kansas' forested plots, we found that the number of saplings was considerably less than the seedling number (Fig. 45). The value of higher oak overstory proportions is not as evident, however, suggesting that perhaps the current overstory conditions were not the same as those when the understory oaks became established.

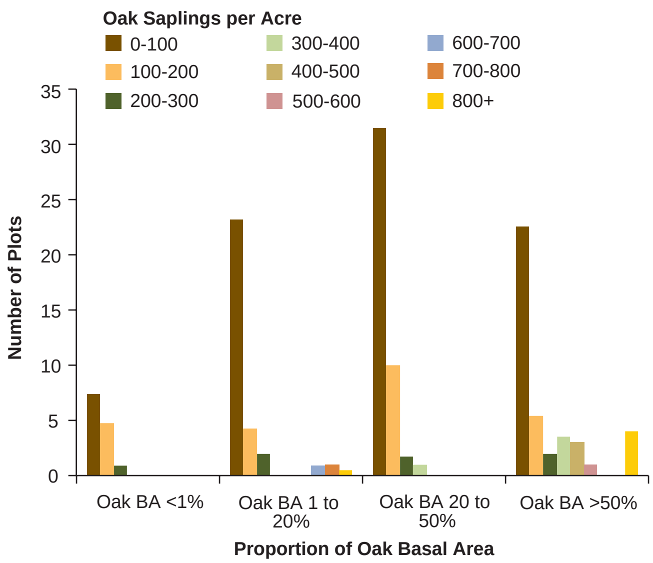


Figure 45.—Oak species saplings in oak forests, by proportion of oak basal area, Kansas, 2006-2010.

Finally, we analyzed the interactions between total overstory density and oak species proportion. Figure 46 suggests that oak proportion was the more influential factor in terms of sapling numbers. One might conclude that even if overstory conditions had changed since oak germination, perhaps the correlation between current and previous stand conditions and the more open canopies in oak-dominated forests contributed to oak survival in the understory.

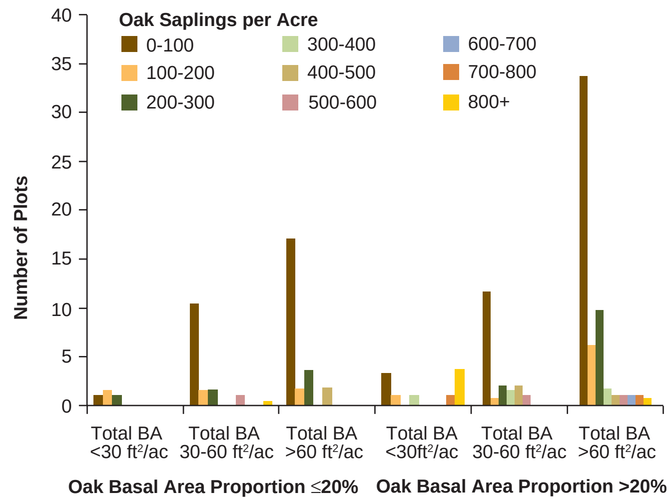


Figure 46.—Oak saplings per acre with two levels of oak proportion in overstory and three total basal area ranges, Kansas, 2010.

What this means

Initially, both the number of oak trees and their volume increased, but since the latest inventory these numbers have declined. The density of oak forests has increased since 1994. It is valuable to consider oak regeneration when managing forests with oak in the overstory, because the presence of oak overstory was correlated with higher numbers of oak regeneration. After establishing oak regeneration, Kansas forest landowners may want to consider releasing these seedlings and saplings so that they use the newly available growing space to develop into the overstory. A lack of any kind of disturbance, natural or human-caused, will favor more shade-intolerant species and may result in less acreage in oak-dominated forests in the future.

Black Walnut in Kansas: A Valuable Tree at Risk

Background

Black walnut (*Juglans nigra*) is a highly valuable tree found primarily in the eastern two-thirds of Kansas. Generally situated on moist sites, this shade-intolerant species grows best in low- to medium-density stands (Bruckerhoff 2005, Williams 1990). Because of its value, even a few trees can become a valuable source of income for forest landowners in Kansas.

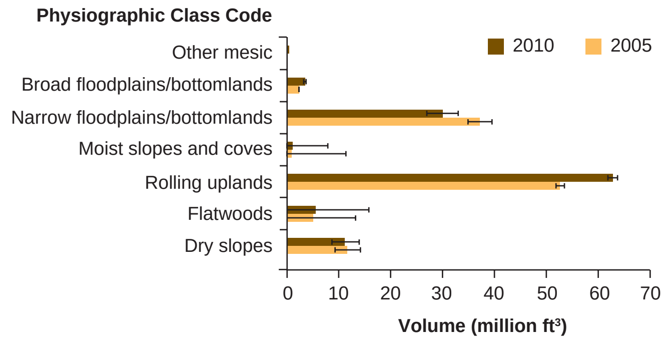


Figure 48.—Growing-stock volume of black walnut on timberland, Kansas, 2005-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

What we found

Black walnut volume has increased by about 95 percent since 1981, although the rate of increase has declined in recent years (Fig. 47). The species has rarely been found in pure stands in Kansas (Moser et al. 2008). The bulk of the plots containing black walnut are on either rolling uplands or moist slopes/coves sites (Fig. 48). The average black walnut tree is getting larger in diameter (Fig. 49); the volume in the 5- to 10.9-inch diameter class has declined since 1994 and the volumes in the larger diameter classes have increased.

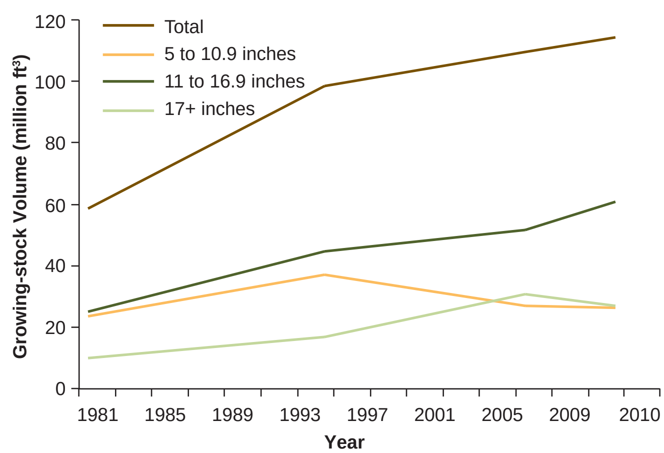


Figure 49.—Growing-stock volume of black walnut, by diameter group, Kansas, 1981-2010.

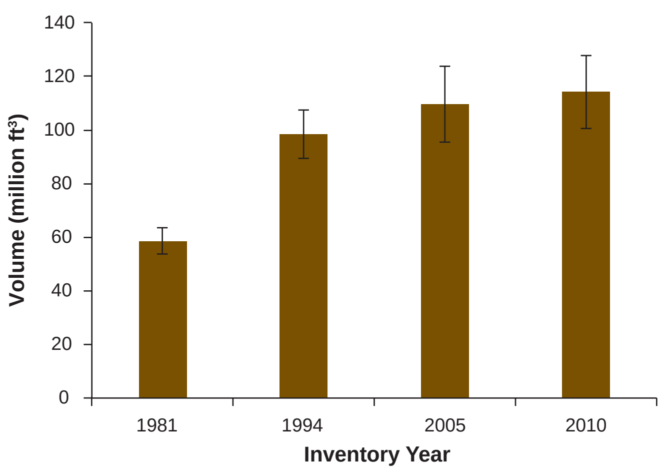


Figure 47.—Growing-stock volume of black walnut trees on timberland, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

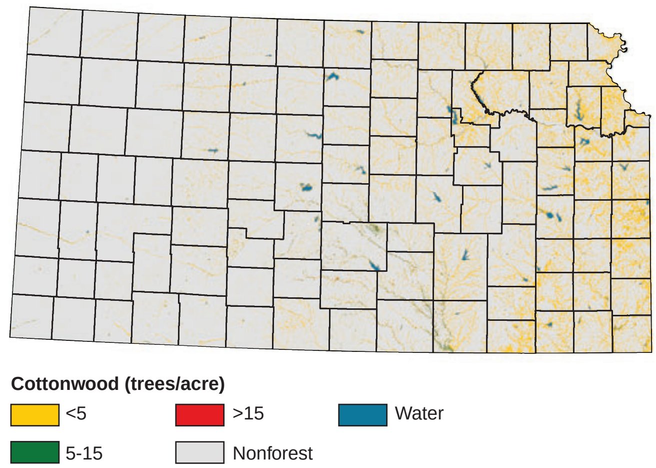
What this means

Black walnut faces an uncertain future with the impending arrival of thousand cankers disease (TCD). Although growing-stock volume has increased since 1981, these gains could be wiped out by TCD. Although black walnut is a popular product for utilization, the increase in average growing-stock tree size suggests that there will be even more economic opportunity for Kansas' forest landowners. However, with the high proportions of growing stock on rolling upland sites, we might question the type of quality that will come from black walnut trees on this physiographic class.

Cottonwood: A Riparian Giant with a Mixed Future

Background

Cottonwood is an iconic species in the Great Plains and an important component of riparian forests in Kansas. Shade intolerant, cottonwood establishes and grows best in monocultures on newly established sites. It is not particularly long lived and makes its greatest volume growth in the second 30 years of its life (Van Haverbeke 1990). Given its sensitivity to competition and its pioneering nature, cottonwood regenerates best on newly established sites on sandbars and floodplain zones along Kansas' rivers.



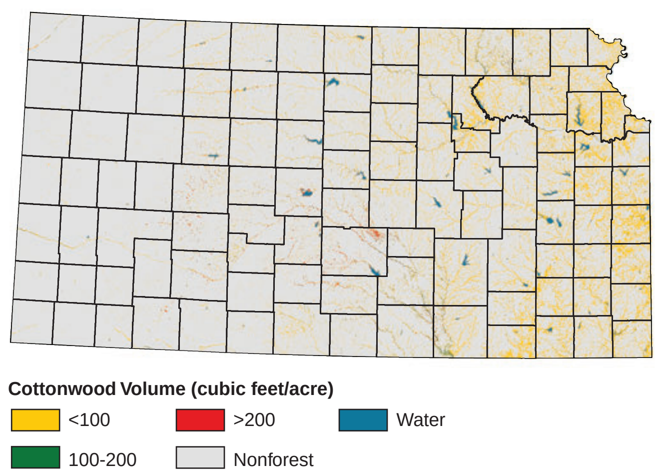
Processing note: This map was produced by linking plot data to MODIS satellite pixels (250 m) using gradient nearest neighbor techniques.

Source: U.S. Forest Service, Northern Research Station, Forest Inventory and Analysis Program, 2009 data.

Figure 50.—Cottonwood trees per acre, Kansas, 2006.

What we found

Both the number of cottonwood trees per acre (Fig. 50) and cubic feet per acre (Fig. 51) were concentrated in lowland areas of the State, particularly on or near riparian areas. The number of cottonwood trees increased between 2005 and 2010. The number of cottonwood trees per diameter class has been fairly similar across diameters and inventory years (Fig. 52). However, the bulk of sawtimber volume is concentrated in the largest diameter classes (Fig. 53). There is a trend where the middle diameter classes have declined in sawtimber volumes, suggesting that the survival and ingrowth of smaller trees are not occurring at the same rates as historically.



Processing note: This map was produced by linking plot data to MODIS satellite pixels (250 m) using gradient nearest neighbor techniques.

Source: U.S. Forest Service, Northern Research Station, Forest Inventory and Analysis Program, 2009 data.

Figure 51.—Live-tree volume of cottonwood per acre, Kansas, 2006.

What this means

The major flood events of the 1990s resulted in the creation of sites suitable for cottonwood establishment. The lack of similar events since then limits the opportunity for establishing new cottonwood stands. Because flood events are neither predictable nor desirable, future cottonwood forests may require proactive efforts on the part of resource managers to establish cottonwood regeneration now.

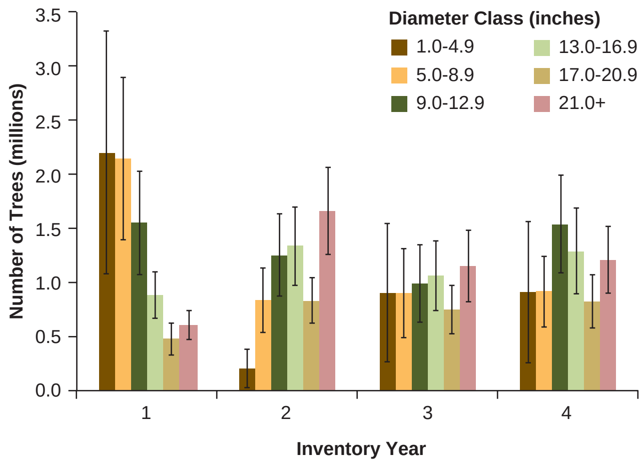


Figure 52.—Number of live cottonwood trees on timberland, by inventory year and diameter class, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

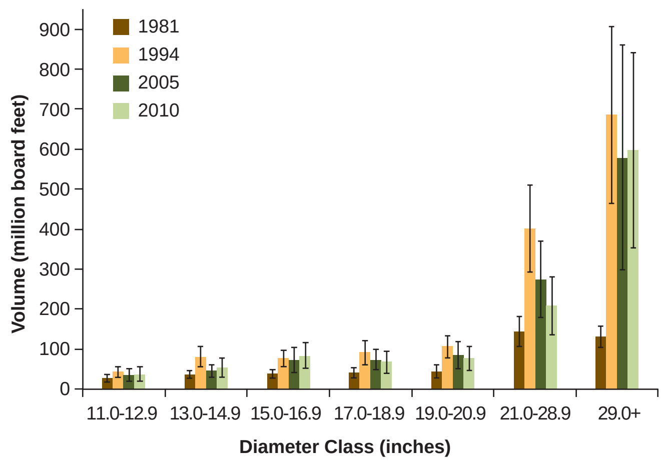


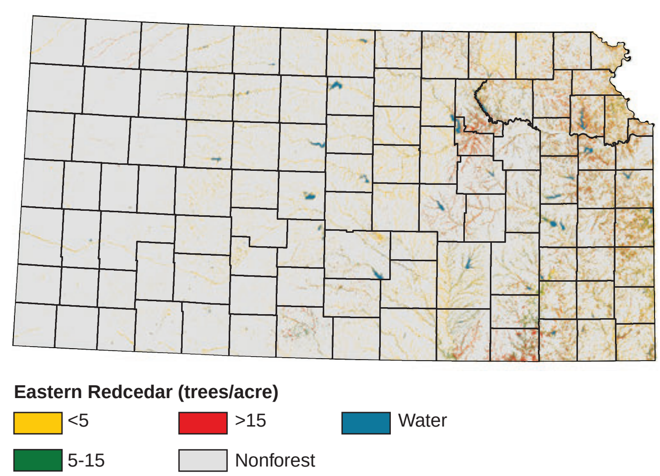
Figure 53.—Sawtimber volume of cottonwood trees, by diameter class, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

Eastern Redcedar: Invader of Open Lands and Stands

Eastern redcedar (*Juniperus virginiana*) is a vigorously-colonizing conifer common to the eastern half of the United States (Fowells 1965). The species is a common invader of open lands in the Midwest. Once established, particularly on better sites, other species can outcompete redcedar. Eventually, hardwoods can take over a decrepit redcedar stand. (Krusekopf 1963, Read and Walker 1950).

What we found

Eastern redcedar is found throughout Kansas, but it is most prominent in the eastern part of the State (Figs. 54, 55). Although it can grow in dense stands, the bulk of redcedar today can be found in poorly stocked, low-density stands (Fig. 56). Many FIA plots have redcedar seedlings and many plots have larger diameter redcedar, but considerably fewer plots contain small, sapling-size redcedar (Fig. 57). Where the species is a prominent component of the overstory, redcedar seedlings do not appear to thrive (Fig. 58).



Processing note: This map was produced by linking plot data to MODIS satellite pixels (250 m) using gradient nearest neighbor techniques.

Source: U.S. Forest Service, Northern Research Station, Forest Inventory and Analysis Program, 2009 data.

Figure 54.—Eastern redcedar trees per acre, Kansas, 2006.

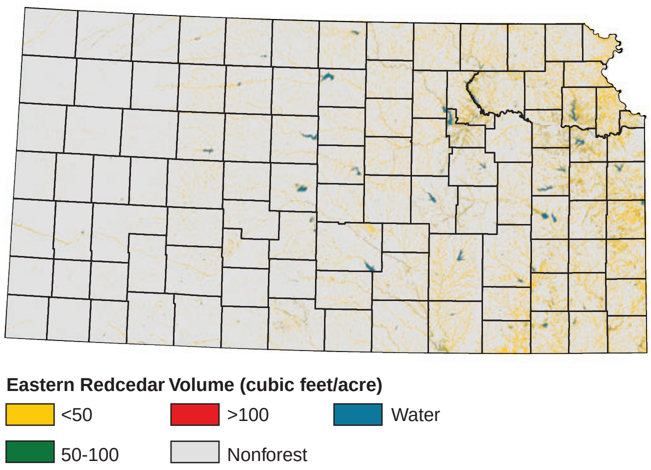


Figure 55.—Volume of eastern redcedar trees, Kansas, 2006.

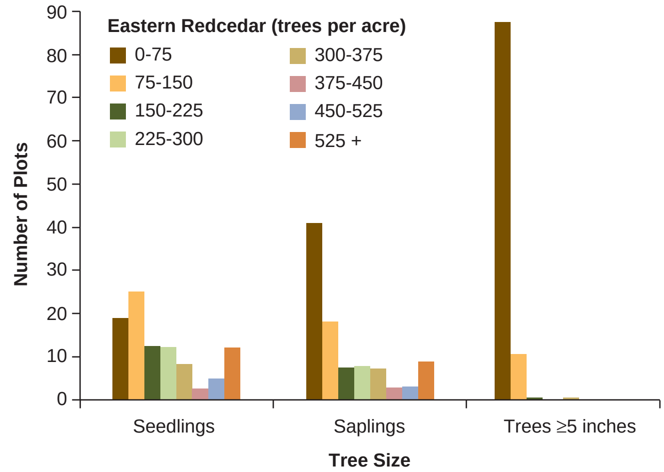


Figure 57.—Comparison of the number of trees per acre of eastern redcedar on forest land plots in Kansas for seedlings, saplings, and trees >5 inches d.b.h., respectively, 2006-2010. Each plot represents roughly 6,000 acres.

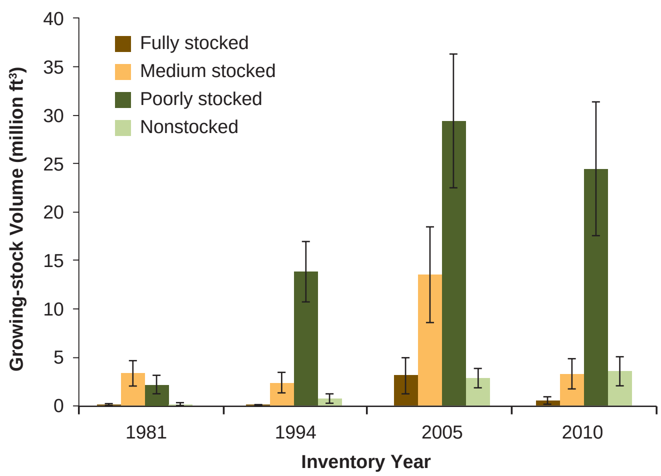


Figure 56.—Growing-stock volume of eastern redcedar, by growing-stock stocking class, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

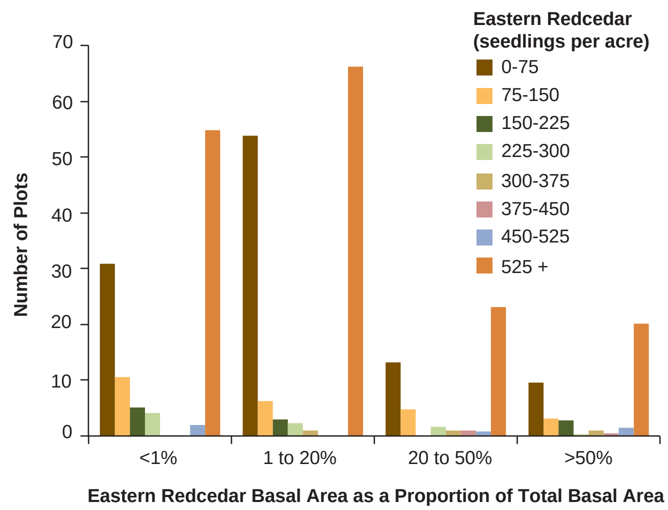


Figure 58.—Comparison of the number of eastern redcedar seedlings per acre on forest land plots in Kansas by proportion of total basal area in eastern redcedar, 2006-2010.

Eastern redcedar seedlings represent the future cedar forest in non-cedar stands. Kansas has many FIA plots where redcedar presence in the overstory is negligible, yet the seedling count is high. Above 20 percent of total basal area, however, the number of plots with significant numbers of redcedar seedlings drops off. This trend has not yet carried over to eastern redcedar saplings. Because saplings are somewhat better situated to capture light, we do find them in stands with higher eastern redcedar overstory basal area. The previous section outlined a trend where eastern redcedar is expanding its numbers in disturbance-free environments. One of the interactions we examined was how much ERC was showing up in oak stands. On many FIA plots, eastern redcedar seedlings are showing up under hardwood overstories, but when the oak overstory basal area increases, the number of eastern redcedar seedlings present declines sharply (Fig. 59). These trends have not appeared yet in the sapling class (Fig. 60).

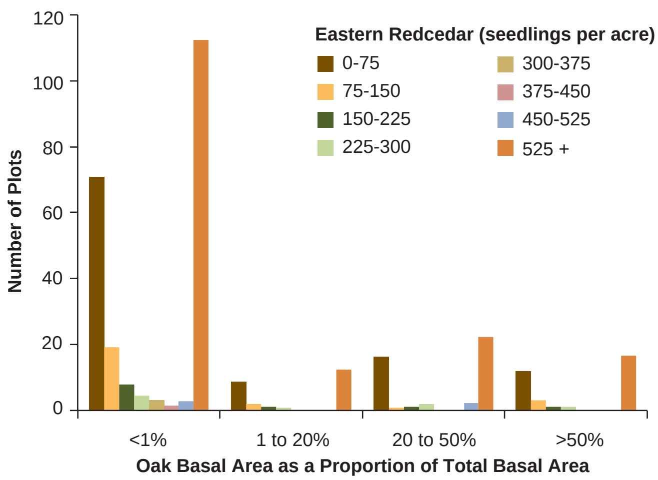


Figure 59.—Eastern redcedar seedlings in oak forests, by proportion of total basal area in oak species, Kansas, 2006-2010.

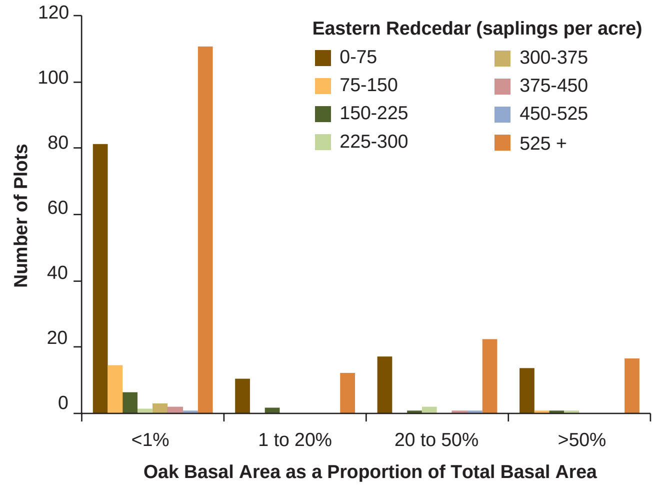


Figure 60.—Eastern redcedar saplings in oak forests, by proportion of oak basal area, Kansas, 2006-2010.

What this means

Eastern redcedar has long been recognized as an aggressive invader throughout the Midwest (Schmidt and Piva 1996). Without disturbance, eastern redcedar will colonize open lands such as pastures and fields. Given an adequate seed source, however, we see evidence of redcedar colonizing non-cedar forested lands in Kansas. Seedling numbers are quite high in non-redcedar stands, but drop off dramatically in stands with high eastern redcedar basal area, likely reflecting the lower available light levels at the forest floor. Sapling numbers are not as high, yet they appear to survive better than seedlings under higher eastern redcedar overstory densities. The lower level of eastern redcedar saplings under non-eastern redcedar overstories may reflect a timing issue. Given the amount of seedlings we found in similar environments, future remeasurements might find more saplings than there are at present.

Wildlife Habitat

Forest Habitats

Forests, woodlands, and savannas provide habitats for many species of Kansas' birds (126), mammals (48), and amphibians and reptiles (59) (NatureServe: Lists of Vertebrate Species in the Contiguous U.S., February 17, 2011). Different forest types at different structural stages provide natural communities (habitats) at a coarse filter scale of conservation. Rare, imperiled, or wide-ranging wildlife species may not be fully served at this scale, so a fine filter approach is used to identify species-specific conservation needs. Representing an intermediate or meso-filter scale of conservation are specific habitat features (e.g., snags, riparian forest strips), which may meet particular habitat requirements for multiple species.

Like all states, Kansas has developed a State Wildlife Action Plan (SWAP), based upon guidance provided by Congress, the U.S. Fish and Wildlife Service, and the International Association of Fish and Wildlife Agencies. Known as the "Kansas' Comprehensive Wildlife Conservation Plan, A Future for Kansas Wildlife," the plan addresses habitat for 315 species of fish and wildlife having the greatest conservation need in the State (Wasson et al. 2005). FIA is specifically named in the plan as a tool for monitoring the deciduous forests and deciduous flood plain habitats, containing 51 and 79 species, respectively, of mammals, birds, reptiles, amphibians, and invertebrates having greatest conservation need in Kansas. Of these species, 13 are state-listed endangered and threatened species within deciduous forest and 14 within deciduous floodplain. This report characterizes Kansas' forest and woodland habitats at the coarse-filter scale (forest age/size) and meso-filter scale (standing dead trees).

Forest Age/Size

Background

Some species of wildlife depend upon early successional forests comprised of smaller, younger trees, while others require older, interior forests containing large trees with complex canopy structure. Yet other species inhabit the ecotone (edge) between different forest stages, and many require multiple structural stages of forests to meet different phases of their life history needs. Abundance and trends in these structural and successional stages serve as indicators of population carrying capacity for wildlife species (Hunter et al. 2001). Historical trends in Kansas' forest habitats are reported for timberland, which makes up more than 95 percent of all forest land in the State. For current habitat conditions, estimates are reported for all forest land.

What we found

The area of large-diameter and medium-diameter stand-size classes has increased steadily in Kansas since 1981, while small-diameter stand-size class has remained fairly stable (Fig. 61). Since 1965, timberland area under 40 years of age has increased dramatically. Between 1965 and 1981, 41- to 60-year-old timberland decreased in abundance, but has since increased substantially. The timberland area in the 61- to 100-year age class has fluctuated over past decades, but appears to be increasing in recent years. In Kansas, timberland older than 100 years has been consistently uncommon during the past half century, and currently makes up less than 1 percent of all timberland area (Fig. 62).

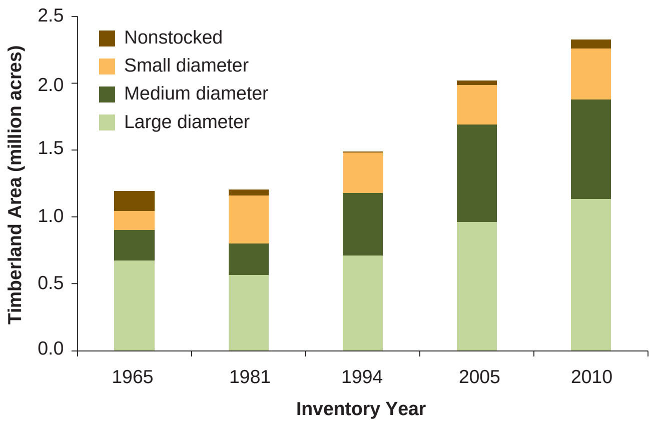


Figure 61.—Timberland area, by growing-stock stocking class, Kansas, 1965-2010.

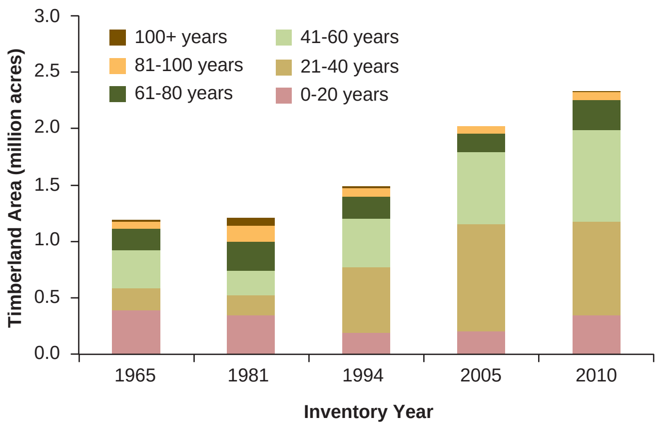


Figure 62.—Timberland area, by age class, Kansas, 1965-2010.

In Kansas, all three stand-size classes contain forests of multiple ages. As expected, small-diameter forest is comprised predominately of young forests, with sharply decreasing abundance for stand ages over 40 years (Fig. 63). Medium stand-size class is comprised predominately of forests of 21 to 60 years of age, with lower abundance of both young and old forest. Forests 41 to 60 years of age make up the largest proportion of large diameter stand-size class. Somewhat surprisingly for this stand-size class is that forests of 21 to 40 years are nearly twice as abundant as forests of 61 to 80 years of stand age.

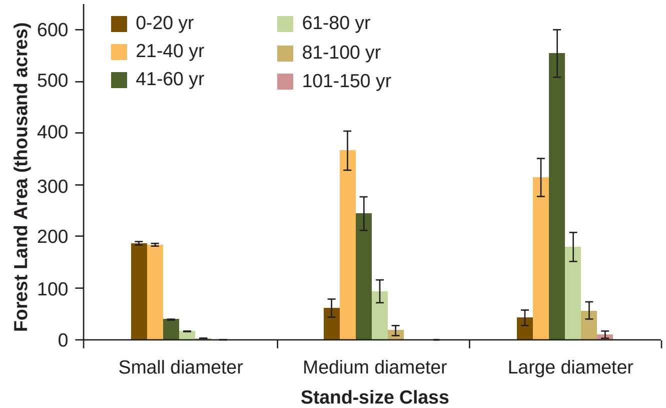


Figure 63.—Forest land area, by stand-size class and age, Kansas, 2010.

What this means

Although area of timberland in the large-diameter stand-size class has nearly doubled during the past three decades, timberland more than 80 years of age has actually declined since 1981. Of the large-diameter class, 94 percent is less than 80 years of age and less than 1 percent is older than 100 years. Current abundance of the small-diameter stand-size class is similar to that in the 1980s, but is now increasing. Stand-size class and stand-age class are indicators of forest structural/successional stage. Note the presence of small-diameter forest in older stand ages and the occurrence of large-diameter forest in younger stand ages. The latter combination can occur when a few huge trees and numerous smaller trees occur in the same vicinity, although rare coding anomalies also may result in unexpected combinations. Such mixtures of different ages and sizes of trees provide a vertical diversity of vegetation structure that can enhance habitat conditions for wildlife species. Although seemingly contradictory, there is a need to maintain forest conditions in both smaller and larger structural stages to maintain both early and late successional habitats for all forest-associated species. The trend of increasing forest land area is generally interpreted as a positive conservation outcome, but encroachment of woody invasive species into historically nonforest habitats may have negative effects on prairie and grassland dependent wildlife. Managing for both forest and nonforest habitats across a variety of compositional and structural conditions will promote healthy wildlife populations in Kansas.

Standing Dead Trees

Background

Specific habitat features such as nesting cavities and standing dead trees provide critical habitat components for many forest-associated wildlife species. Standing dead trees that are large enough to meet habitat requirements for wildlife are referred to as snags. According to one definition in the Dictionary of Forestry (2008), "…for wildlife habitat purposes, a snag is sometimes regarded as being at least 10 in (25.4 cm) in diameter at breast height [d.b.h.] and at least 6 ft (1.8 m) tall." Examples of snag size preferences by Kansas' wildlife include red-headed and pileated woodpeckers (20-inch d.b.h.), American kestrel and flying squirrel (10- to 20-inch d.b.h.) (Achison 2007) and black-capped chickadee and eastern bluebird (8- to 10-inch d.b.h.). Standing dead trees serve as important indicators of wildlife habitat and past mortality events. Standing dead trees also store carbon and are sources of down woody material (discussed later in this report), which also provides habitat features for wildlife. The number and density of standing dead trees, together with decay classes, species, and sizes, define an important wildlife habitat feature across Kansas' forests.

What we found

FIA collects data on standing dead trees (at least 5 inches d.b.h.) for all species and sizes in varying stages of decay. According to current inventory data (2006-2010), more than 26 million standing dead trees are present on Kansas' forest land. This total equates to an overall density of 11.2 standing dead trees per acre of forest land, with slightly higher densities on public (13.2) than on private (11.1) forest land. Seven species groups each contributed more than one million standing dead trees, with the top group, other eastern soft hardwoods, exceeding 7.6 million, (Fig. 64), more than 5 million of which were American elm trees. Relative to the total number of live trees in each species group, five species groups exceeded 10 standing dead trees per 100 live trees (at least 5 inches d.b.h.), with the cottonwood and aspen species group topping the list at more than 28 standing dead trees per 100 live trees (Fig. 65). Most (78 percent) standing dead trees were smaller than 11 inches d.b.h.; 41 percent were smaller than 7 inches d.b.h. (Fig. 66). Nearly 72 percent of standing dead trees showed intermediate decay, a pattern consistent across most diameter classes.

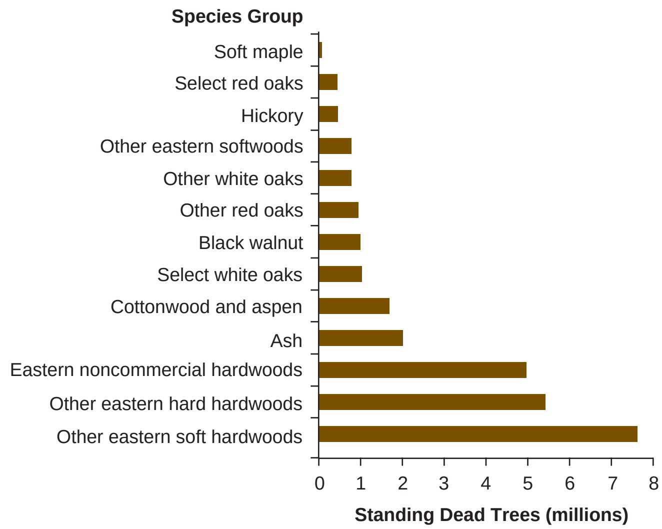


Figure 64.—Number of standing dead trees, by species group, Kansas, 2010.

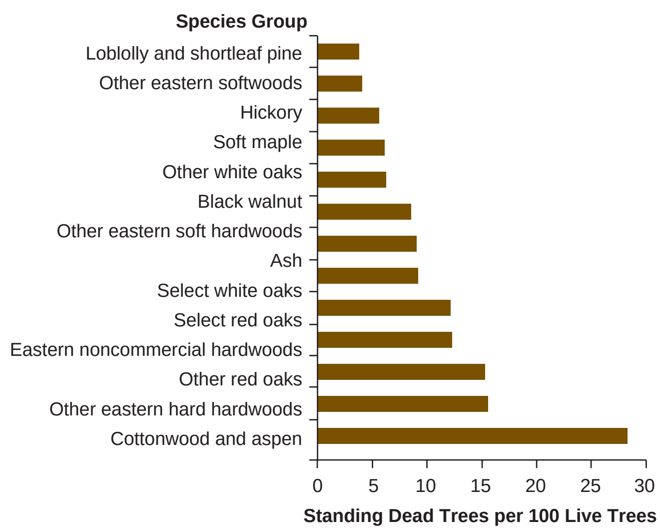


Figure 65.—Ratio of number of standing dead trees per 100 live trees, at least 5 inches in diameter, Kansas, 2010.

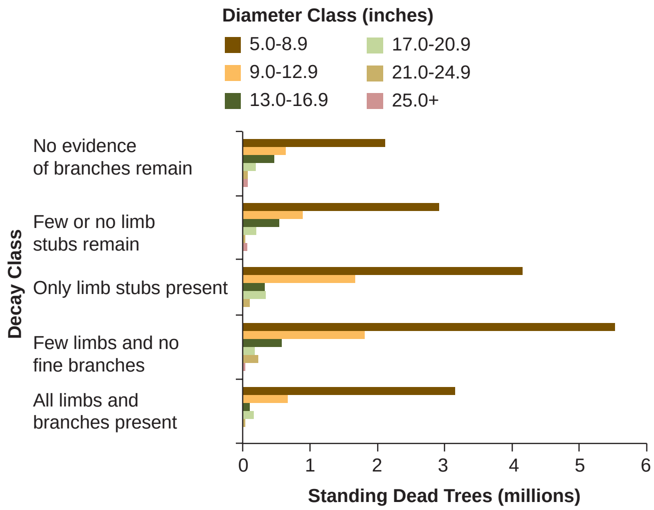


Figure 66.—Number of standing dead trees at least 5 inches in diameter, by diameter class and decay class, Kansas, 2010.

What this means

Snags and smaller standing dead trees result from a variety of potential causes, including diseases and insects, weather damage, fire, flooding, drought, competition, and other factors. Other eastern soft hardwoods species groups contained the largest total number of standing dead trees, predominately elms, but the cottonwood and aspen species group had the highest density of standing dead trees per 100 live trees in Kansas. Compared to the number of live trees, the number of standing dead trees is relatively small, but they typically contain significantly more cavities per tree than occur in live trees (Fan et al. 2003). Standing dead trees provide areas for foraging, nesting, roosting, hunting perches, and cavity excavation for wildlife, from primary colonizers such as insects, bacteria, and fungi to birds, mammals, and reptiles. For example, Kansas' broad-headed skink (*Eumeces laticeps*), a state-threatened species, inhabits mature oak woodlands in eastern Kansas counties and climbs trees to occupy cavities or woodpecker holes. Most cavity nesting birds are insectivores that help control insect populations. The availability of very large snags may be a limiting habitat feature for some species of wildlife. Providing a variety of forest structural stages and retaining specific features such as snags on both private and public lands are ways that forest managers can maintain the abundance and quality of habitat for forest-associated wildlife species in Kansas.

Forest Health Indicators

Harold Rush tree farm. Photo by Robert Atchison, used with permission.

Down Woody Materials

Background

Down woody materials, including fallen trees and branches, fill a critical ecological niche in Kansas' forests. They provide valuable wildlife habitat in the form of coarse woody debris, contribute to forest fire hazards via surface woody fuels, and carbon stocks in the form of slowly decaying large logs.

What we found

The fuel loadings and subsequent fire hazards of dead and down woody material in Kansas' forests are relatively low, especially when compared with the nearby states of Nebraska and Missouri (Fig. 67). The size distribution of coarse woody debris (diameter larger than 3 inches) is overwhelmingly dominated (82 percent) by pieces less than 8 inches in diameter (Fig. 68A). Moderately decayed coarse woody pieces (decay classes 2, 3, and 4) constituted 79 percent of the decay class distribution (Fig. 68B). The carbon stocks of coarse woody debris appear to be uniformly distributed (≈ 1 ton/acre) across classes of live-tree basal area, but with tremendous variability (Fig. 69).

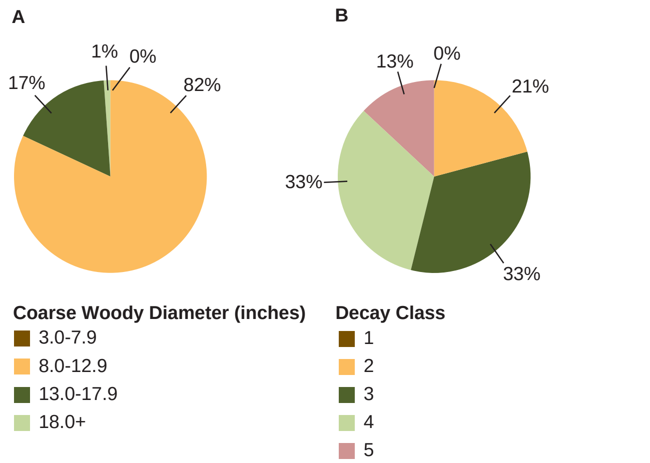


Figure 68.—(A) Proportion of coarse woody debris, by transect diameter class (inches) and (B) decay class on forest land, Kansas, 2004-2008.

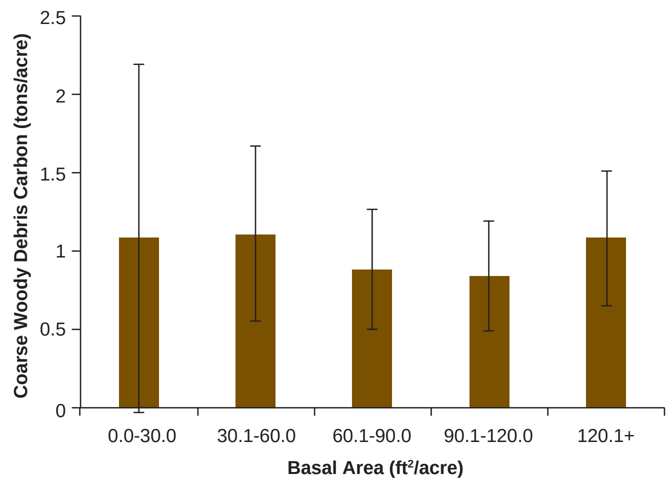


Figure 69.—Mean carbon stock of coarse woody debris on forest land in Kansas, 2004-2008. Error bars represent a 68-percent confidence interval around the mean.

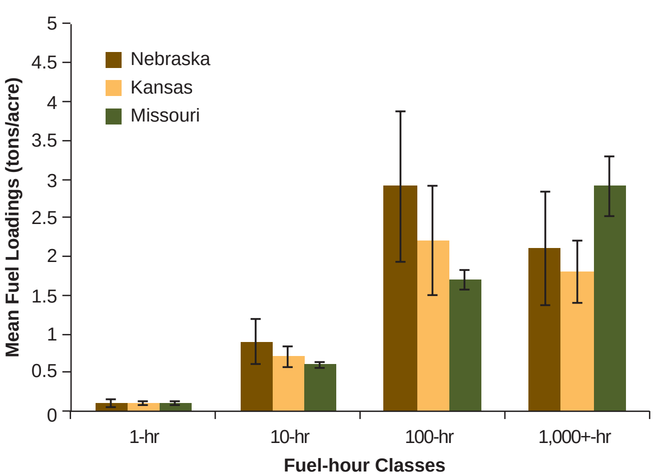


Figure 67.—Mean fuel loadings on forest land in Kansas and the surrounding states of Nebraska and Missouri, 2004-2008. Error bars represent a 68-percent confidence interval around the mean.

What this means

The fuel loadings of down woody material can be considered a forest health hazard only in times of drought or in isolated stands with excessive tree mortality. The ecosystem services (e.g., habitat for fauna or shade for tree regeneration) provided by down woody materials exceed any negative forest health aspects. The population of coarse woody debris across Kansas consists mostly of small pieces that are moderately decayed. Therefore, coarse woody debris constitutes a small, but important carbon stock and source of wildlife habitat across Kansas' forests. Given that the coarse woody debris carbon stocks were uniformly distributed across class of live-tree basal area, it appears that disturbances do not play a role in dead wood accumulation. Finally, the distribution of down dead fuel loadings in Kansas' forests appears consistent with those in nearby states.

Carbon Stocks

Background

Collectively, forest ecosystems represent the largest terrestrial carbon sink on Earth. The accumulation of carbon in forests through sequestration helps to mitigate emissions of carbon dioxide to the atmosphere from sources such as forest fires and burning of fossil fuels. FIA does not directly measure forest carbon stocks in Kansas. Instead, a combination of empirically derived carbon estimates (e.g., standing live trees) and models (e.g., carbon in soil organic matter is based on stand age and forest type) are used to estimate Kansas' forest carbon stocks. Estimation procedures are detailed by Smith et al. (2006).

What we found

Kansas' forests currently contain more than 156 million tons of carbon. Soil organic matter (SOM) represents the largest forest ecosystem carbon stock in the State at more than 87 million tons, followed by live trees and saplings at more than 49 million tons (Fig. 70). Within the live tree and sapling pool, merchantable boles contain the bulk of the carbon (~ 30 million tons) followed by roots (~ 8 million tons) and tops and limbs (~ 7 million tons). The majority of Kansas' forest carbon stocks are found in relatively young stands aged 21 to 60 years (Fig. 71). Early in stand development, most forest ecosystem carbon is in the SOM and belowground tree components. As forest stands mature, the ratio of aboveground to belowground carbon shifts, and by the 100+ age class the aboveground components represent the majority of ecosystem carbon. This trend continues well into stand development as carbon accumulates in live and dead aboveground components. A look at carbon by forest-type group on a per unit area basis found that 7 of the 11 groups have between 50 and 85 tons of carbon per acre (Fig. 72). Despite the similarity in per acre estimates, the distribution of forest carbon stocks by forest type is quite variable. In the ponderosa pine group, for example, 43 percent (~ 22 tons) of the forest carbon is in live biomass; in the other exotic softwoods group, only 15 percent is in live biomass.

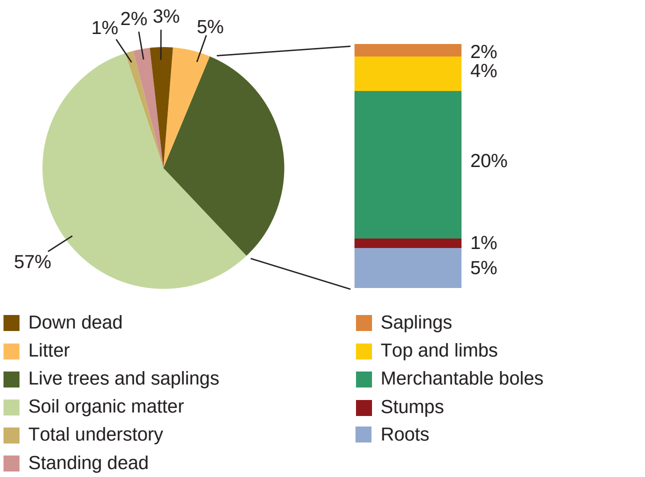


Figure 70.—Estimated total carbon stocks on forest land, by forest ecosystem component, Kansas, 2006-2010.

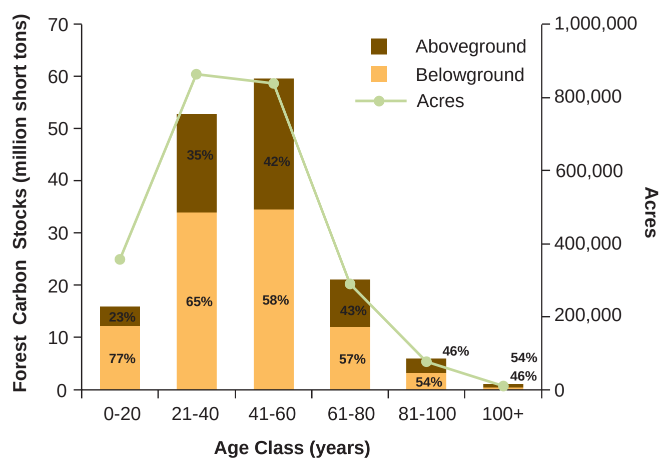


Figure 71.—Estimated aboveground and belowground carbon stocks on forest land, by stand-age class, Kansas, 2006-2010.

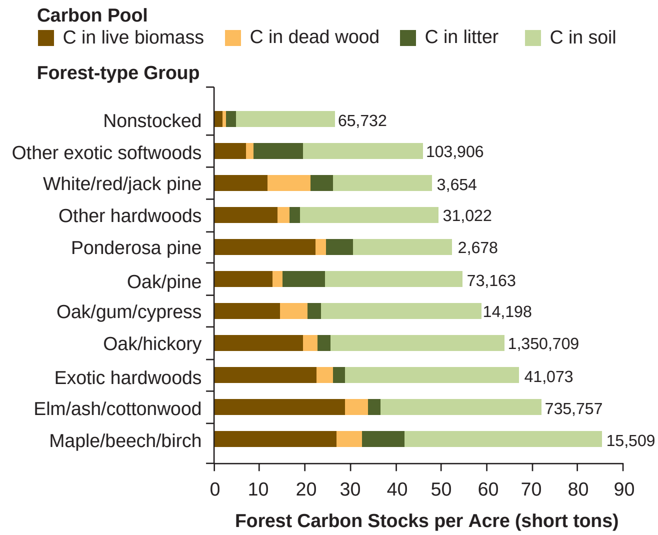


Figure 72.—Estimated carbon stocks on forest land, by forest-type group and carbon pool per acre, Kansas, 2006-2010.

What this means

Carbon stocks in Kansas' forests have increased substantially over the last several decades. The majority of forest carbon in the State is found in relatively young stands dominated by moderately long-lived species. This finding suggests that Kansas's forest carbon will continue to increase as stands mature and accumulate carbon in aboveground and belowground components. Given the age-class structure and species composition of forests in Kansas there are many opportunities to increase forest carbon stocks. That said, managing for carbon in combination with other land management objectives will require careful planning and creative silviculture beyond simply managing to maximize growth and yield.

Understory Vegetation in Kansas' Forests

Background

The diversity of plant life is an important characteristic of terrestrial forest ecosystems. Some fauna are species specific and require the presence of a certain species or group of species to survive (e.g., various butterflies and moths). Because plants are able to convert the sunlight into food (carbohydrates), animals (including humans) are dependent on plants, directly or indirectly, as a source of energy. Plants can also help stabilize soil, regulate the temperature, filter pollutants, sequester carbon, and influence nutrient availability. Indicator plants offer important environmental information about air quality (e.g., ozone). A survey of the plant community is an important management tool and can provide information about diversity, disturbance, soil moisture, nutrient availability, and the flora and fauna that it may be able to support. In Kansas, Phase 3 (P3) vegetation data have been collected on about 6.25 percent of field plots since 2007, resulting in a complete vegetation survey on 36 plots. Because Kansas has a low number of P3 plots, the results should be interpreted with caution. The data are presented to provide an overview of what was found on the plots but may not represent overall statewide trends.

What we found

Kansas' forests support many plant species. From 2007 through 2010, 459 identifiable species were found on P3 plots. Of the species recorded, the largest percentage was classified as forb/herbs (48 percent, Fig. 73), based on the USDA Natural Resources Conservation Service's PLANTS Database. Graminoids also made up a significant proportion (23 percent) of the species observed on P3 plots. Of the species recorded, 84 percent were native to the United States and 13 percent were introduced (Fig. 74).

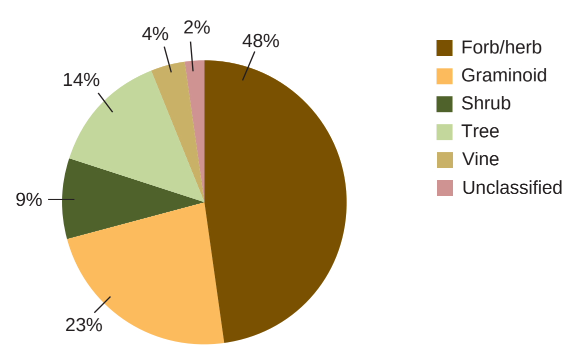


Figure 73.—Percentage of species on P3 plots, by growth habit category (per PLANTS Database, USDA Natural Resources Conservation Service), Kansas, 2007-2010.

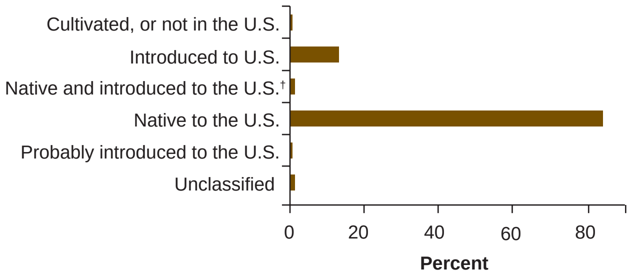


Figure 74.—Origin of species found on Kansas P3 plots (per PLANTS Database, USDA Natural Resources Conservation Service), 2007-2010. †A category in the USDA PLANTS database where some infra-taxa are considered native and others as introduced in the lower 48 states.

On P3 plots, the number of species and genera recorded ranged from 14 to 83 per plot, with an average of 50 (Fig. 75). The 16 most frequently observed species are listed in Table 3, all of which are native. Coralberry (*Symphoricarpos orbiculatus*) was observed on the greatest number of plots (33; 92 percent). Eastern poison ivy (*Toxicodendron radicans*), common hackberry (*Celtis occidentalis*), bristly greenbrier (*Smilax tamnoides*), and Virginia creeper (*Parthenocissus quinquefolia*) are other species that were found on 75 percent or more of the plots inventoried.

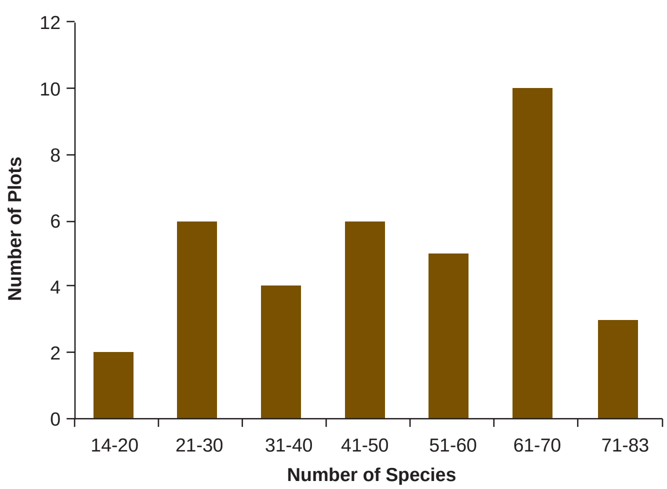


Figure 75.—Number of species observed per plot on P3 plots, Kansas, 2007-2010.

Table 3.—The 16 most commonly found plant species on P3 plots in Kansas listed by the number of observances and the percentage of plots where the species occurred, 2007-2010.

Species	Number of observances	Percentage of plots
Coralberry	33	91.7
Eastern poison ivy	32	88.9
Common hackberry	30	83.3
Bristly greenbrier	29	80.6
Virginia creeper	27	75.0
Eastern woodland sedge	26	72.2
American elm	26	72.2
Virginia wildrye	26	72.2
Roughleaf dogwood	23	63.9
White avens	23	63.9
Common blue violet	20	55.6
Great ragweed	20	55.6
Osage orange	20	55.6
Honeylocust	20	55.6
Eastern redcedar	18	50.0
Baldwin's ironweed	17	47.2

Table 4.—The 16 most commonly found nonnative plant species on P3 plots in Kansas listed by the number of observances and the percentage of plots where the species occurred, 2007-2010.

Species	Number of observances	Percentage of plots
Smooth brome	14	38.9
Meadow fescue	11	30.6
White mulberry	10	27.8
Multiflora rose	8	22.2
Green bristlegrass	7	19.4
Buckwheat	7	19.4
Spreading hedgeparsley	7	19.4
Canada bluegrass	6	16.7
Common dandelion	6	16.7
Lambsquarters	6	16.7
Sweetclover	6	16.7
Kentucky bluegrass	5	13.9
Johnsongrass	5	13.9
Red clover	5	13.9
Toothed spurge	5	13.9
Amur honeysuckle	5	13.9

Despite occurring on fewer plots than the native plant species, several nonnative species were encountered. The presence of nonnative plant species in the forest community requires the attention of landowners and managers. Differing from invasive plant species, which can be native or nonnative and are discussed in the next section of this report, the list of nonnative plant species is comprised of those species that have been introduced. The most frequently observed nonnative plant species was smooth brome (*Bromus inermis*; 14 plots), closely followed by meadow fescue (*Lolium pratense*; 11 plots), and white mulberry (*Morus alba*; 10 plots; Table 4). Forb/herbs and graminoids were the two dominate growth forms.

What this means

According to the data gathered on FIA plots, Kansas' forests support fewer species (467) than neighboring Missouri (584; Moser et al. 2011). However, comparing the plant diversity across states must be done with caution due to differing sample sizes. Missouri had nearly 2.5 times more plots inventoried than Kansas. Both native and nonnative species were found on the P3 plots in Kansas. The presence of nonnative plants within the forest community is problematic because they have the potential to displace the native plants upon which fauna depend. The invasive plants are a particular concern because they have characteristics, such as high seed production (e.g., purple loosestrife, *Lythrum salicaria*) and rapid growth (e.g., Princesstree, *Paulownia tomentosa*), which allow them to quickly spread through the forest understory.

Gathering data on the vegetation communities provides key information on site quality, species distribution, and diversity. Obtaining future survey data on the presence and abundance of the plants within Kansas will provide us with information on changes in species composition. This information will allow us to monitor species of concern and help determine the factors that influence the presence of species of interest.

Invasive Plants on Phase 2 and Phase 3 Plots

Background

Invasive plant species (IPS) are a global concern. Within ecosystems they can displace native plant species by reducing light (e.g., common buckthorn, *Rhamnus cathartica*) and altering nutrient availability (e.g., black locust, *Robinia pseudoacacia*). Economically, these species cost billions of dollars due to inspection, education, monitoring, and eradication efforts. In the United States, IPS annually cost $35 billion and impact 3.0 million acres (Czarapata 2005). Invasive plants can also be detrimental to agriculture crops. Common buckthorn serves as an alternate host for the soybean aphid (*Aphis glycines*) while common barberry (*Berberis vulgaris*) is an alternate host for wheat stem rust (*Puccinia graminis*), affecting wheat, barley, oats, and other grasses (Royer and Dickinson 1999). To facilitate their spread, invasive plants can rapidly infest an area by establishing from vegetative propagules (e.g., multiflora rose, *Rosa multiflora*) and seed. Areas closest to edges, where there is greater exposure to people, livestock, and various other disturbances, are more vulnerable to invasion. To help understand the distribution and abundance of these plant species, FIA has been collecting IPS data on Kansas' P2 Invasive plots. From 2007 through 2010, IPS data were collected on 100 forested plots, about 20 percent of the P2 field plots.

What we found

The list of IPS that NRS-FIA has selected to monitor is shown in Table 5. Data from Kansas' P2 Invasive plots suggest that IPS are present throughout the State. Of the 43 species monitored, 14 were present on the P2 Invasive plots. Those invasive plants present on two or more plots are shown in Table 6. The species recorded on the greatest number of plots was multiflora rose (16 plots). This invasive spreads quickly, and in the NRS region from 2005 through 2010, it was the most commonly found IPS of those monitored (Kurtz 2013). Garlic mustard was also found on many plots (11). Additional

Table 5.—Invasive plant species target list for NRS-FIA P2 Invasive plots, 2007 to present.

Tree Species
Norway maple *(Acer platanoides)*
Tree-of-heaven *(Ailanthus altissima)*
silktree *(Albizia julibrissin)*
Russian olive *(Elaeagnus angustifolia)*
Punktree *(Melaleuca quinquenervia)*
Chinaberry *(Melia azedarach)*
Princesstree *(Paulownia tomentosa)*
Black locust *(Robinia pseudoacacia)*
Saltcedar *(Tamarix ramosissima)*
Tallow tree *(Triadica sebifera)*
Siberian elm *(Ulmus pumila)*
Vine Species
Oriental bittersweet *(Celastrus orbiculatus)*
English ivy *(Hedera helix)*
Japanese honeysuckle *(Lonicera japonica)*
Woody Species
Japanese barberry *(Berberis thunbergii)*
Common barberry *(Berberis vulgaris)*
Autumn olive *(Elaeagnus umbellata)*
Glossy buckthorn *(Frangula alnus)*
European privet *(Ligustrum vulgare)*
Showy fly honeysuckle *(Lonicera x.bella)*
Amur honeysuckle *(Lonicera maackii)*
Morrow's honeysuckle *(Lonicera morrowii)*
Tatarian bush honeysuckle *(Lonicera tatarica)*
Common buckthorn *(Rhamnus cathartica)*
Multiflora rose *(Rosa multiflora)*
Japanese meadowsweet *(Spiraea japonica)*
European cranberrybush *(Viburnum opulus)*
Herbaceous Species
Garlic mustard *(Alliaria petiolata)*
Spotted knapweed *(Centaurea biebersteinii)*
Canada thistle *(Cirsium arvense)*
Bull thistle *(Cirsium vulgare)*
Black swallow-wort *(Cynanchum louiseae)*
European swallow-wort *(Cynanchum rossicum)*
Leafy spurge *(Euphorbia esula)*
Dames rocket *(Hesperis matronalis)*
Creeping jenny *(Lysimachia nummularia)*
Purple loosestrife *(Lythrum salicaria)*
Japanese knotweed *(Polygonum cuspidatum)*
P. cuspidatum/P. sachalinense hybrid *(Polygonum x.bohemicum)*
Giant knotweed *(Polygonum sachalinense)*
Grass Species
Nepalese browntop *(Microstegium vimineum)*
Reed canarygrass *(Phalaris arundinaceae)*
Common reed *(Phragmites australis)*

IPS that were observed but are not listed in Table 6 are autumn olive (*Elaeagnus umbellata*), black locust (*Robinia pseudoacacia*), Canada thistle (*Cirsium arvense*), dames rocket (*Hesperis matronalis*), Oriental bittersweet (*Celastrus orbiculatus*), reed canarygrass (*Phalaris arundinacea*), and saltcedar (*Tamarix ramosissima*).

Table 6.—The seven most commonly found invasive plant species on Kansas P2 Invasive plots, the number of observances, and percentage of plots where each species was observed, 2007-2010.

Species name	Number of observances	Percentage of plots
Multiflora rose	16	16
Garlic mustard	11	11
Amur honeysuckle	6	6
Siberian elm	5	5
Japanese honeysuckle	4	4
Bull thistle	3	3
Russian olive	2	2

The distributions of IPS on P2 Invasive plots in Kansas are shown in Figures 76 and 77. Figure 76 shows the statewide distribution of the two most commonly observed IPS, garlic mustard and multiflora rose. Garlic mustard was primarily observed in the eastern half of Kansas with a few observances of this species in the western part of the State. However, it is important to remember that the eastern half of the State is also where the greatest number of plots are monitored because there is more forest land there. A similar trend was found for multiflora rose although there were no observances of this species on plots in the western half of the State. The approximate locations of all observances of the selected IPS are shown in Figure 77.

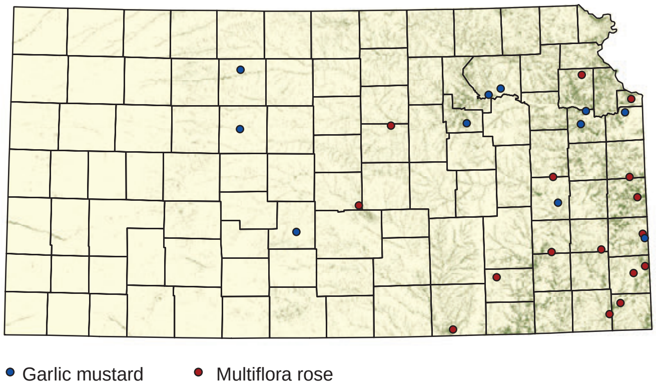


Figure 76.—Observations of garlic mustard (*Alliaria petiolata*) and multiflora rose (*Rosa multiflora*) on FIA P2 Invasive plots in Kansas, 2007-2010; approximate plot locations depicted.

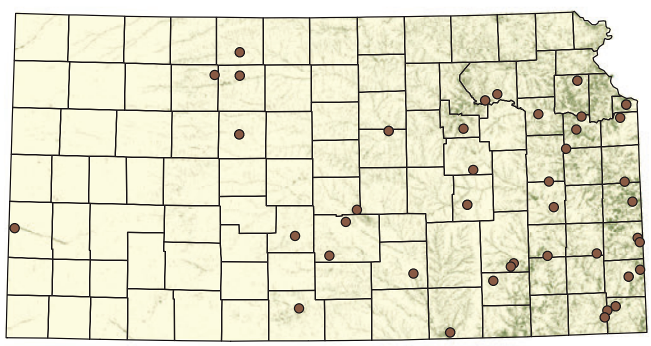


Figure 77.—Observances of invasive plants species monitored by NRS-FIA on P2 Invasive plots in Kansas, 2007-2010; approximate plot locations depicted.

What this means

Kansas had a larger number of IPS detected (14) than neighboring Missouri (8; Moser et al. 2011). Forty-one percent of the plots in Kansas had one or more of the selected IPS present, with an average of 1.4 per plot (ranging from 1 to 4 IPS per plot). The FIA data suggest that IPS may be a threat to the forest ecosystems of Kansas. These plants can degrade the quality of the forest by reducing forage and biodiversity, as well as changing nutrient and hydrologic properties. By transforming ecosystems, the entire food web is affected because of the changes in the plant community that is required by the fauna.

Aside from the ecological damage IPS cause, they can also have economic impacts through lost revenues that would have been derived from the displaced native species and through the costs of management and remediation. Gathering data on IPS helps individuals and land managers understand the abundance and distribution of these species. By continuing to monitor invasive plants in future inventories, FIA can aid further understanding of how they impact the forest community and allow managers to observe trends in abundance and spread with an eye toward reducing their extent and mitigating their impact.

Emerald Ash Borer: An Invader on the Horizon

Background

The emerald ash borer (*Agrilus planipennis*; EAB), a wood-boring beetle native to Asia, was first detected in the U.S. in southeastern Michigan in 2002 (Poland and McCullough 2006). In North America, EAB has been identified only as a pest of ash and at least 16 native species appear to be susceptible (Cappaert et al. 2005, McCullough and Siegert 2007). Trees and branches as small as 1 inch in diameter have been attacked, and while stressed trees may be initially preferred, healthy trees are also susceptible (Cappaert et al. 2005). In areas with a high density of EAB, tree mortality generally occurs 1 to 2 years after infestation for small trees and 3 to 4 years after infestation for large trees (Poland and McCullough 2006). Spread of EAB has been facilitated by human transportation of infested material. EAB was not found in Kansas during the 2010 inventory, but was recently discovered in Wyandotte County in Kansas City, KS, in August 2012.

What we found

With an estimated 53.5 million trees (more than 1 inch in diameter) and 255.2 million cubic feet of live volume (in trees more than 5 inches in diameter), ash is the fifth most abundant species group by number and ranks fourth by live-tree volume (Fig. 78). Ash is distributed across much of Kansas; however, the majority of ash is concentrated in the central and southeastern portions of the State (Fig. 79). Present on approximately 804,000 acres, or 33 percent of forest land, ash generally makes up less than 25 percent of total live-tree basal area (Fig. 80).

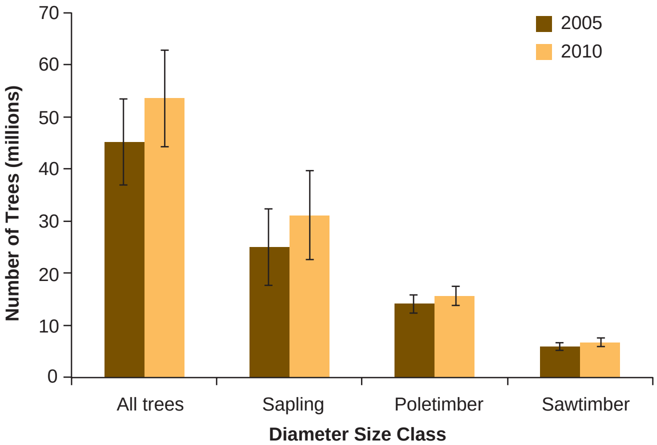
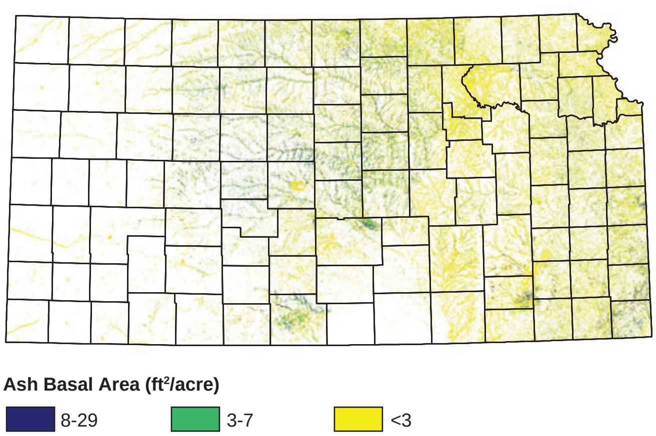


Figure 78.—Number of ash trees on forest land by inventory year and diameter size class, Kansas, 2005 and 2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.



Processing note: This map was produced by linking plot data to MODIS satellite pixels (250 m) using gradient nearest neighbor techniques.

Figure 79.—Ash density on forest land, Kansas, 2010.

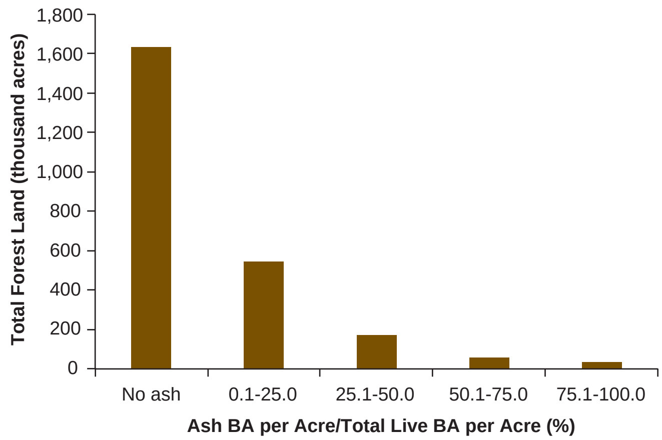


Figure 80.—Presence of ash on forest land, as a percentage of total live-tree basal area (BA), Kansas, 2010.

What this means

Ash is an important component of Kansas' treed landscape. Because EAB has caused extensive decline and mortality of ash throughout the northern United States, it represents a significant threat to the forested and urban ash resource across Kansas. Continued monitoring of ash resources will help identify the long-term impacts of EAB in forested settings. Efforts to slow the spread of EAB would be enhanced by setting quarantines and controlling the transportation of firewood, nursery stock, logs, branches, and other woody materials in infected areas and implementing state and community response plans.

Thousand Canker Disease and Black Walnut[6]

Beginning in the 1990s, planted black walnut along the Front Range of Colorado has been dying in great numbers. The trees are dying due to the presence of a fungus, *Geosmithia morbida*, which infests the phloem and xylem of black walnut (*Juglans nigra*) trees, blocking the flow of water and nutrients. The fungus is carried by the walnut twig beetle (*Pityophthorus juglandus*), which can bore thousands of small holes up and down the bark (hence the name of the disease). Much like oak wilt, the early symptoms include yellowing and thinning of the upper crown, followed by death of smaller branches and then progressively larger branches. Reports indicate that the trees die within 3 years of the first observable symptoms.

6 The following section was adapted from Treiman et al. 2010.

One analysis (Treiman et al. 2010) estimated that more than $111 million dollars would be lost into the future due to lost payments to landowners and loggers and lost value added at the sawmill. Further costs from lost nut production, removal and replacement of community trees, as well as the lost landscape value, results in a 2008 dollar loss of more than $160 million. The analysis also suggested that up to 50 jobs would be lost in Kansas due to the decimation of this species.

There are no known controls for TCD at this time. The adult walnut twig beetles are quite active, and it is uncertain how well insecticide would work in such a situation. The only known treatment at this time is rapid detection, removal, and quarantine.

Utilization and Forest Products

Loading walnut logs after harvesting near Emporia, Kansas. Photo by Kansas Forest Service, used with permission.

Sawtimber Volume

Background

Sawtimber volume is a traditional measure of the economic value of the wood in a tree. It is defined as 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 can be thought of as 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.

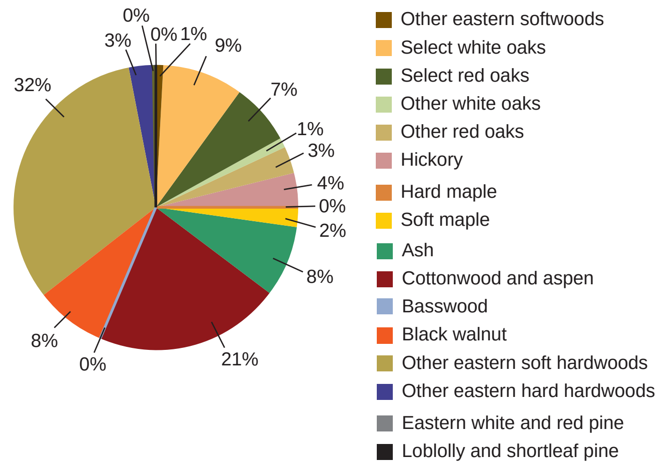


Figure 82.—Proportion of total sawtimber volume, by species group, Kansas, 2010.

What we found

In 2010, Kansas had 5.4 billion board feet of sawtimber, a slight decrease from the 1994 inventory but still a 125-percent increase over the 1981 inventory (Fig. 81).

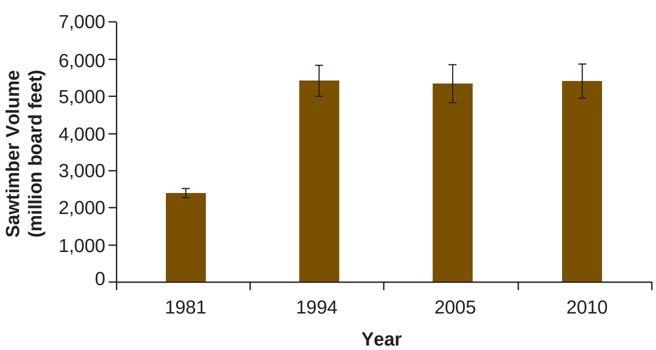


Figure 81.—Sawtimber volume on Kansas timberland, 1981-2010.

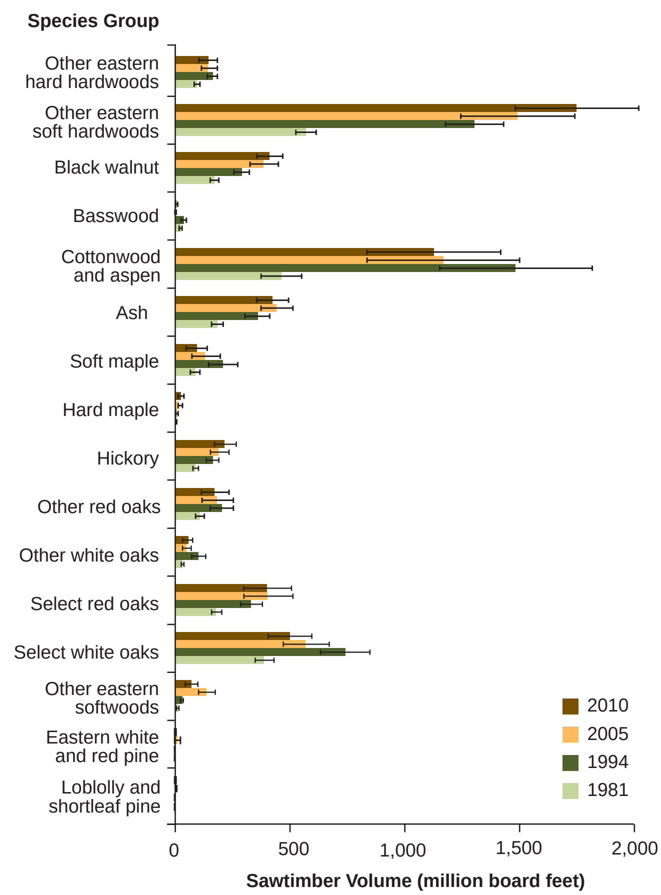


Figure 83.—Sawtimber volume on timberland, by species group, Kansas 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

Cottonwood and aspen (1.125 billion board feet) and other eastern soft hardwoods (primarily hackberry) (1.75 billion board feet) were the species groups with the greatest sawtimber volume on Kansas timberlands (Fig. 82). Select red and white oaks totaled 900 million board feet. Sawtimber volumes increased dramatically between 1981 and 1994. Subsequently, many of the species groups declined between 1994 and 2010; the other eastern soft hardwoods group was a notable exception (Fig. 83). There is also evidence of a slight increase in black walnut sawtimber volume since 2005. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

What this means

Total sawtimber volume has remained flat since the 1994 inventory, likely reflecting the maturing forests, the complete occupancy of growing space, and the reduced rate of conversion of formerly open lands to forests. What is most striking about the latest inventory is the continued ascension of sawtimber volume in forests with hackberry as a principal component. Black walnut, greatly desired for high quality forest products, has continued to increase since 1994. We are starting to see a decline in cottonwood sawtimber volume, perhaps the result of mortality, utilization and reduced ingrowth from smaller diameter classes.

Timber Products Output

Background:

The harvesting and processing of timber products creates a stream of income shared by timber owners, managers, marketers, loggers, truckers, and processors. In 2007, the wood products and paper manufacturing industries (NAICS codes 321 and 322) in Kansas employed 4,900 people, with an average annual payroll of $178.9 million, and total value of shipments of $1,066.6 million (U.S. Census Bureau 2007). To better manage Kansas' forests, it is important to know the species, amounts, and locations of timber being harvested.

What we found

Surveys of Kansas' wood-processing mills are conducted periodically to estimate the amount of wood volume that is processed into products. These estimates are supplemented with the most recent surveys conducted in surrounding states that processed wood harvested from Kansas. In 2009, there were 45 active primary wood-processing mills that were surveyed to determine what species were processed and where the wood material came from. These mills processed 1.1 million cubic feet of saw logs into lumber and pallets.

In 2009, 1.7 million cubic feet of industrial roundwood were harvested from Kansas' forest land. Primary wood-processing mills in Kansas processed 55 percent of the industrial roundwood that was harvested in Kansas (Fig. 84). Missouri mills received 31 percent of the industrial roundwood; Iowa mills, 12 percent; Nebraska mills, less than 1 percent; and 2 percent was shipped to other countries. Black walnut accounted for more than 40 percent of the industrial roundwood harvest in 2009 (Fig. 85). Other important species groups harvested were cottonwood, red and white oaks, soft maple, and ash.

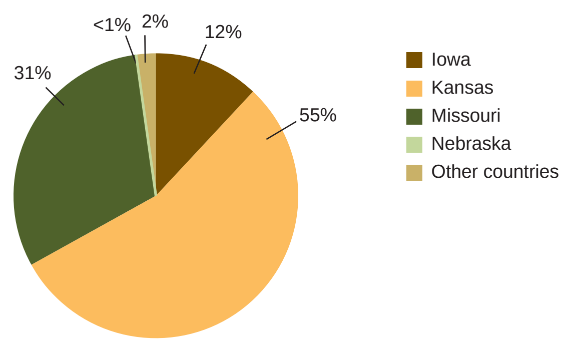


Figure 84.—Destination of industrial roundwood harvested from Kansas, 2009.

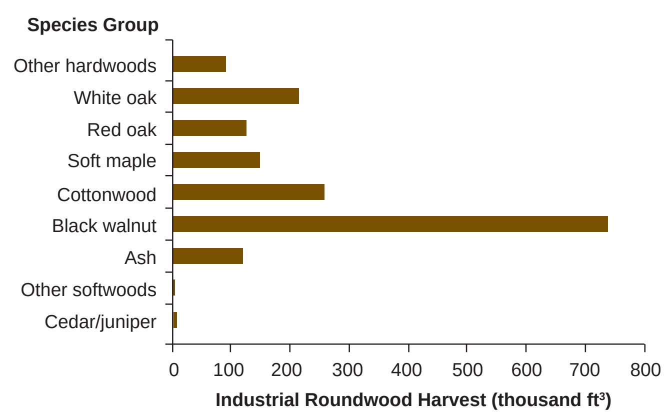


Figure 85.—Industrial roundwood harvested by species group, Kansas, 2009.

In the process of harvesting industrial roundwood, 663,700 cubic feet of harvest residues were left on the ground (Fig. 86). Nearly two-thirds of the harvest residues came from non-growing-stock sources such as crooked or rotten trees, tops and limbs, and dead trees. The processing of industrial roundwood in Kansas' primary wood-using mills generated 16,600 green tons of wood and bark residues. Eighty percent of the mill residues generated were used for mulch, livestock bedding, and other miscellaneous uses. Only 11 percent of the mill residues were used for industrial fuelwood or residential fuelwood. Nine percent of the mill residues were not used for other products (Fig. 87).

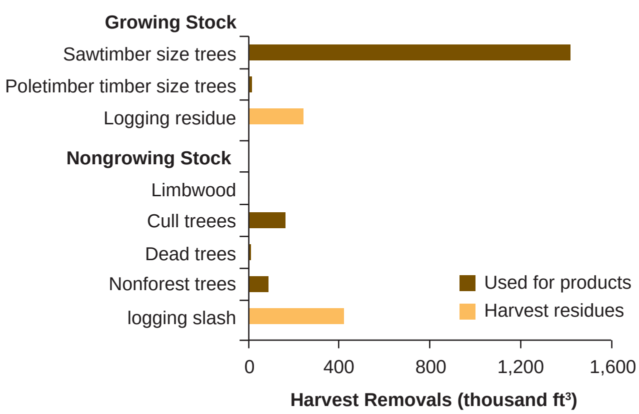


Figure 86.—Total harvest removals from industrial roundwood harvesting, by growing stock and nongrowing stock, and used for product and harvest residue, Kansas, 2009.

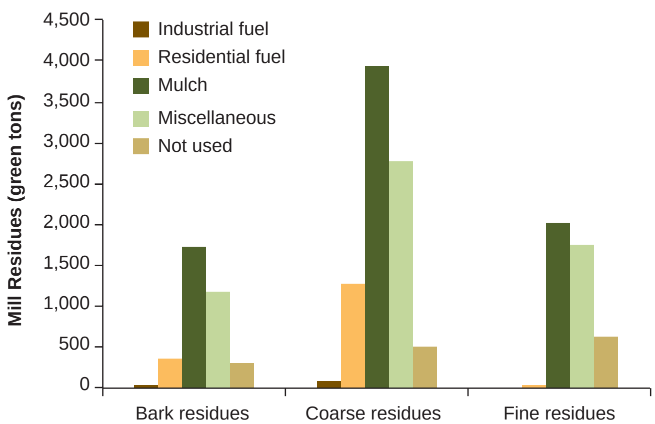


Figure 87.—Disposition of mill residues generated by primary wood-using mills, Kansas, 2009.

What this means

The poor economy has led to the idling and closure of an increased number of primary wood-processing facilities. An important consideration for the future of the primary wood-products industry is its ability to retain industrial roundwood processing facilities. The loss of processing facilities is important not only because of the number of jobs lost, but also because it makes it harder for landowners to find markets for the timber harvested from management activities on their forest land.

A third of the harvest residue generated during the harvest is from growing-stock sources (wood material that could be used for products). In addition, nearly 10 percent of the mill residues that are produced are currently not being used for other secondary products. Industrial fuelwood or wood pellets could be possible markets for this unused material, and thus, could lead to better utilization of the forest resource.

Focus Issues

Spring flowers in Kansas woodland. Photo by Robert Atchison, Kansas Forest Service, used with permission.

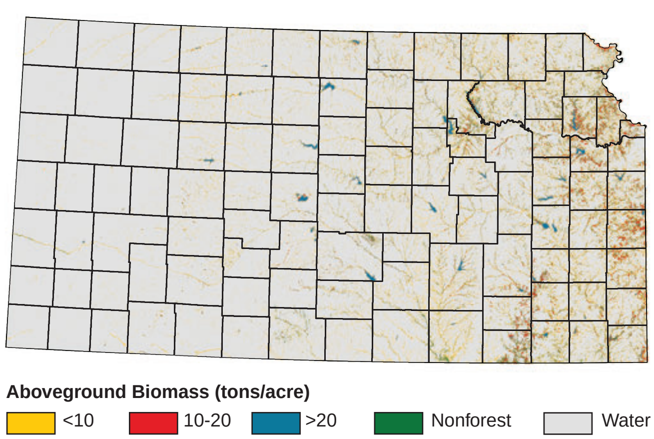
Biomass

Background

Current fuel prices and lack of available alternatives have increased public interest in forest woody biomass as a source of fuels, either burned directly for energy generation or a future source of ethanol for vehicles. FIA defines aboveground tree biomass as the weight of stumps, boles, limbs, and tops, but not foliage, usually expressed on a dry weight basis. Historically, those who harvested trees concentrated their efforts on the bole, and FIA still estimates that portion of total biomass. But with these newer needs for forest biomass, the other aboveground components are attracting increasing interest.

What we found

In 2010, Kansas had almost 80.1 million dry tons of aboveground live-tree biomass, mainly in the eastern part of the State (Fig. 88). The statewide total for dry weight biomass of merchantable boles on live trees was 58.1 million tons. The total aboveground biomass in 2010 was 13 percent greater than in 2005 and 53 percent greater than that in 1994 (Fig. 89). Among the three inventory units in Kansas (Fig. 90), the Northeastern unit had the most biomass (both aboveground live tree and merchantable bole) but the Southeastern unit had rapidly increased since 2005 and the two unit totals were not significantly different from each other.



Processing note: This map was produced by linking plot data to MODIS satellite pixels (250 m) using gradient nearest neighbor techniques.

Source: U.S. Forest Service, Northern Research Station, Forest Inventory and Analysis Program, 2009 data.

Figure 88.—Gross aboveground biomass per acre on timberland, Kansas, 2006.

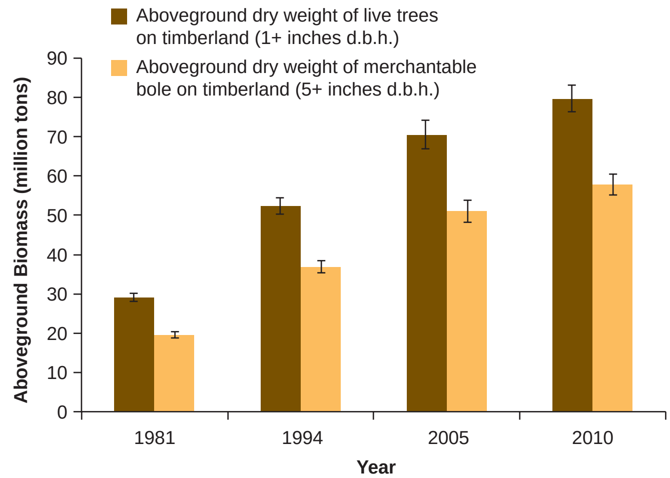


Figure 89.—Total aboveground dry weight and merchantable bole dry weight of biomass on timberland, by inventory year, Kansas 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

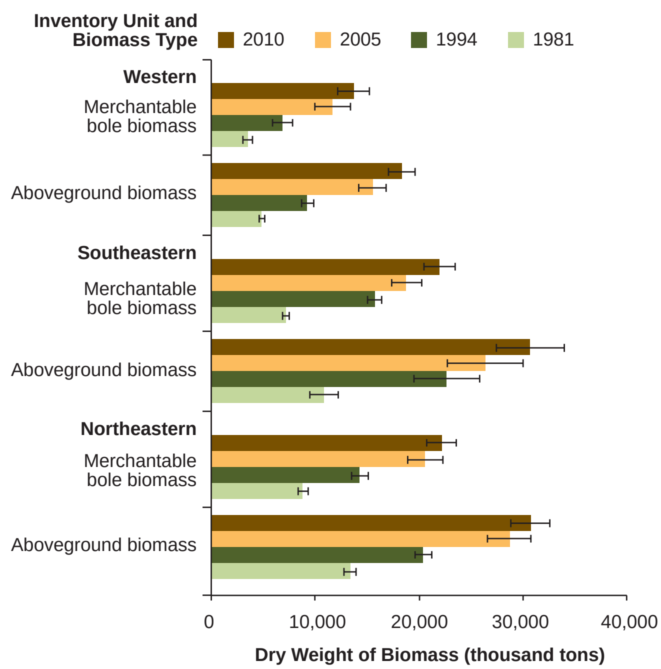
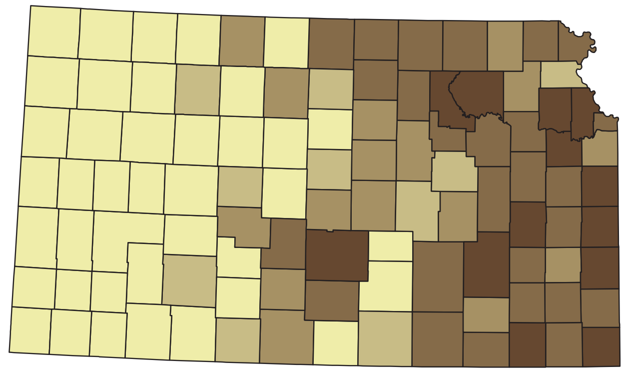


Figure 90.—Total and merchantable aboveground biomass on timberland, by inventory unit and year, Kansas, 1981-2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

What this means

Aboveground live-tree biomass includes all of the woody material of a tree, not just the bole volume. It is a good indicator of trends in carbon sequestration and total biological productivity. The bulk of Kansas' live-tree biomass continues to lie within the eastern part of the State. The proportion of biomass considered merchantable benefited from the progression of individual trees into larger diameter classes.



Projection: Albers Equal Area, NAD83
Source: USDA Forest Service, Forest Inventory and Analysis Program, 2010 data.
Geographic base data are provided by the National Atlas of the USA.
Cartography: W. Keith Moser, April 2012,
USDA Forest Service, St. Paul, MN

Figure 91.—Total aboveground biomass on forest land, by county, Kansas, 2010.

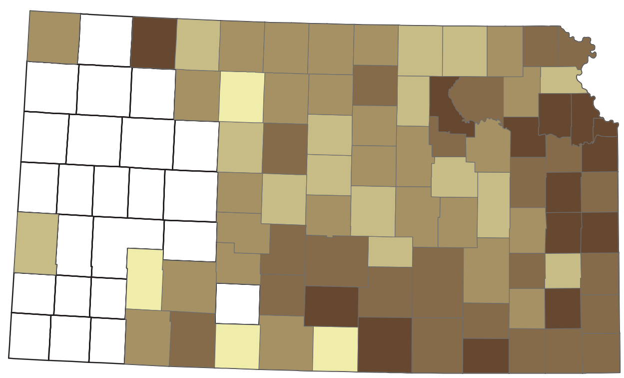
Biomass by County and Hardwoods/Softwoods

Background

Knowing how much biomass is at the county level is helpful when considering where to locate a biomass utilization facility, such as one for energy generation or even biofuels.

What we found

Total aboveground live-tree biomass on forest land is concentrated in the eastern part of Kansas (Fig. 91). Linn, Miami, Pottawatomie, Leavenworth, and Douglas Counties were the top five counties in terms of all live-tree biomass on forest land in 2010. In the previous (2005) inventory, Leavenworth, Linn, Douglass, Miami, and Pottawatomie Counties had the most biomass. In terms of merchantable bole biomass, the 2010 order of the top five counties changes slightly to Linn, Miami, Pottawatomie, Douglas, and Greenwood. Merchantable bole biomass as a percentage of total biomass gives us an indication of the potential for economical utilization, because the more biomass in the merchantable bole, the more likely the biomass will be used. By this measure, the order of the counties changes dramatically; the top five are Stafford, Ford, Comanche, Graham, and Rooks. The average aboveground biomass per forest land acre for all of Kansas was 33.8 tons per acre. The top five counties with the highest average biomass per acre of forest land were Stafford, Graham, Cheyenne, Pratt, and Edwards (Fig. 92). When evaluating these statistics, we must remember that counties in the western part of Kansas certainly have less forest land and, hence, less forest biomass on forest land.



*Note from SW: I've changed these number from original and added "thousands" to legend title
Projection: Albers Equal Area, NAD83
Source: USDA Forest Service, Forest Inventory and Analysis Program, 2010 data.
Geographic base data are provided by the National Atlas of the USA.
Cartography: W. Keith Moser, April 2012,
USDA Forest Service, St. Paul, MN

Figure 92.—Average aboveground biomass per acre of forest land, by county, Kansas, 2010.

What this means

Use of all biomass on a piece of land requires specific equipment and specific utilization facilities. Merchantable biomass harvesting and utilization can be accomplished with standard logging equipment. It is possible that smaller, less specialized operators would be more competitive in stands with higher merchantable biomass ratios than in stands with a lower percentage of merchantable biomass. However, a more important measure of potential economic viability would be the presence of sufficient forest biomass resource in a county to sustain economically viable utilization over the long term.

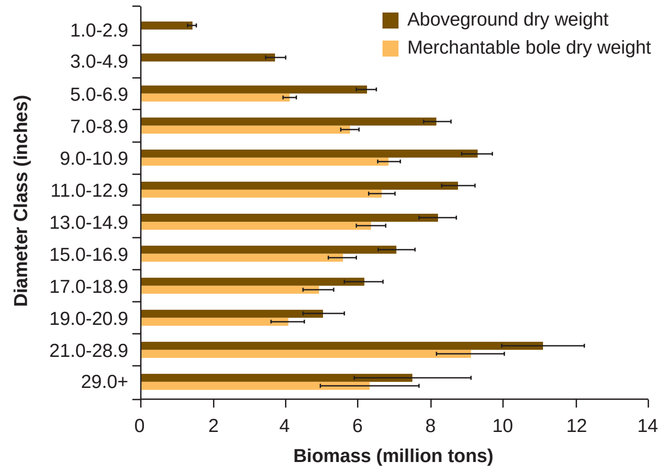


Figure 93.—Aboveground and merchantable bole dry weight biomass on Kansas' forest land, 2010. The sampling error associated with each inventory estimate represents a 68-percent confidence interval and is depicted by the vertical line at the top of each bar.

Biomass: Size Class/ Economics of Removal and Utilization

Background

Following up on the previous section, a natural question to ask is how the biomass is distributed by tree size. Given operating costs, it is more profitable to remove larger trees. Smaller operators, however, may not have large specialized equipment and may actually prefer smaller sawtimber-size trees.

What we found

For both all-live and merchantable bole biomass categories, the most biomass was found in the 21- to 28.9-inch diameter class (Fig. 93). The second and third highest amounts were found in the 9- to 10.9-inch and 11- to 12.9-inch diameter categories, respectively. Reordering the biomass by diameter (Fig. 94), we find that, for example, 50 percent of the merchantable bole biomass in Kansas is 15 inches d.b.h. or larger, and that 75 percent of all aboveground biomass is 9 inches or larger in diameter.

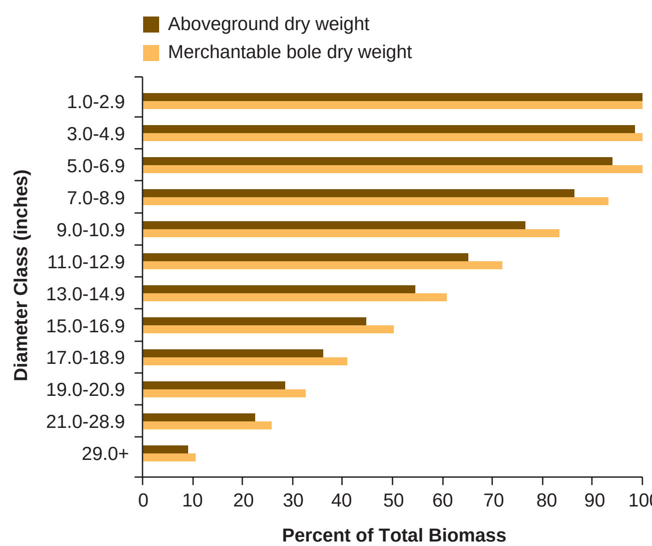


Figure 94.—Cumulative percent of total biomass, by diameter class of aboveground and merchantable bole biomass, Kansas, 2010.

What this means

Like biomass per acre, biomass as a function of tree size is a determinant of the feasibility and operability of biomass utilization. Kansas has considerable biomass in the larger size classes, particularly in cottonwood stands. As the forests get older and different species assume dominance, the mix of biomass and size class will likely change.

When is a Tree Not in a Forest? The Great Plains Initiative

Background

Kansas is approximately 5 percent forest (Smith et al. 2004) and consists mostly of agricultural and grassland vegetation communities. Although FIA collects detailed information on trees in areas meeting its definition of forest, some of its users have recognized the lack of available information on the nonforest tree (NFT) resource and speculate whether this knowledge gap might hinder wise management of these areas. The U.S. Forest Service periodically assesses forest health in the Plains States and has identified a number of concerns, including flood damage, ice storms, invasive species encroachment, and various insect and other plant diseases (U.S. Forest Service 2009a, b, c, d). Of particular concern is the spread of the EAB, which, since being identified in 2002 near Detroit, MI, has been found in Connecticut, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Minnesota, Missouri, Ohio, New York, Pennsylvania, Tennessee, and Wisconsin, and as far north as Quebec and Ontario Canada. It was detected in Kansas City, KS, in August 2012.

In response to these concerns, state forestry agencies in the Plains States, with funding assistance from the U.S. Forest Service's State and Private Forestry, began a project called the Great Plains Tree and Forest Invasives Initiative (GPI) (Lister et al. 2011). Objectives of the GPI include a characterization of the existing NFT resource with an inventory, identification of EAB mitigation needs and utilization opportunities, and development of educational materials to help land managers and landowners cope with potential EAB impacts (Nebraska Forest Service 2007). To meet the first objective, FIA's National Inventory and Monitoring Applications Center (NIMAC) helped design the inventory, process the data, and create a reporting tool to provide information that will characterize the NFT resource and supplement the information that FIA collects on the tree resource in forested areas. Data from 199 urban and 289 rural plots were collected in Kansas during 2008 and 2009.

What we found

One of the goals of the Great Plains Initiative was to assess the ash resource in nonforest portions of the Plains States. In Kansas, GPI data revealed an estimated 14.3 million ash trees potentially at risk to EAB in nonforest areas. Ash, which was planted aggressively (Ball et al. 2007), is a relatively strong component of both forest and nonforest areas with trees. Based on the FIA data, American elm is the most abundant tree species in forested areas, with an estimated 116 million elm trees that are 1-inch diameter or greater. GPI data suggest that in nonforest areas, elm species are also a significant component, with approximately 19.2 million trees being found there. GPI findings indicate that Osage-orange is the most abundant tree species in nonforest areas in Kansas, with an estimated 33 million trees. Table 7 shows the top 10 most abundant species in Kansas in both forested areas (from FIA data) and nonforested areas (from GPI data), with a breakdown of the nonforest information by urban and rural classification. These data suggest that the species compositions of forest and nonforest areas (with respect to species abundance) are somewhat similar. Not surprisingly, nonnative, invasive species such as Siberian elm are relatively more abundant (10.4 million trees) in nonforest areas in Kansas than in forested areas, as are species that grow along stream banks, like willow.

The Kansas GPI inventory data suggest differences in species composition when comparing urban and non-urban nonforest areas (Table 7). Elm emerges as a strong component of urban areas, likely due to ornamental plantings. Several of the species that are relatively abundant in urban areas are not commonly planted, which might seem counterintuitive, but the definition of "urban" used in the GPI study was a minor modification to the U.S. Census Bureau's "urban places" definition (U.S. Census Bureau 1994), which includes places with at least 2,500 inhabitants. There can thus be large natural areas surrounding some of the smaller population centers designated by the U.S. Census Bureau as urban places.

In addition to data on the 2.4 million acres of forest land in Kansas, the Great Plains Initiative provided data on

Table 7.—Counts of Kansas trees greater than 1 inch in diameter, from the 10 most abundant species, in different land uses classes: forest, total nonforest, rural nonforest, and urban nonforest; the forest land data come from FIA, and the nonforest data come from the Kansas GPI inventory.

Forest land	
Species	**count**
American elm	116,006,072
hackberry	95,524,011
Osage-orange	95,082,950
eastern redcedar	68,859,085
green ash	49,443,556
honeylocust	36,330,919
red mulberry	33,322,071
eastern redbud	27,064,005
black walnut	25,091,058
post oak	22,434,983
Nonforest Land	
Osage-orange	32,931,145
hackberry spp.	28,526,841
redcedar/juniper spp.	21,864,467
elm spp.	19,273,319
ash spp.	14,306,127
Siberian elm	10,432,276
Unknown hardwood	7,552,488
honeylocust spp.	7,485,171
cottonwood and poplar spp.	7,174,006
willow spp.	5,770,110
Rural nonforest land	
Osage-orange	31,244,565
hackberry spp.	25,276,342
redcedar/juniper spp.	19,257,935
elm spp.	14,336,241
ash spp.	12,772,873
Siberian elm	8,899,021
honeylocust spp.	6,626,549
cottonwood and poplar spp.	6,530,039
willow spp.	5,371,464
mulberry spp.	4,237,580
Urban nonforest	
elm spp.	4,937,078
unknown hardwood	3,403,824
hackberry spp.	3,250,499
redcedar/juniper spp.	2,606,532
maple spp.	2,238,551
walnut spp.	1,778,575
Osage-orange	1,686,580
ash spp.	1,533,254
Siberian elm	1,533,254
white oak	1,471,924

2.9 million acres of rural, nonforest treed land, including windbreaks, riparian forests, and isolated trees that do not qualify as forestland but provide important benefits to the people of Kansas. Of the trees found in rural nonforest areas, 78 million (53 percent) perform some kind of a windbreak function; approximately 76 percent of these windbreak trees are associated with farming or livestock. The remaining windbreak trees are in either riparian areas, wildlife plantings, or other natural or semi-natural wooded strips. Species compositions of windbreak and non-windbreak areas are similar, with some notable exceptions (Fig. 95).

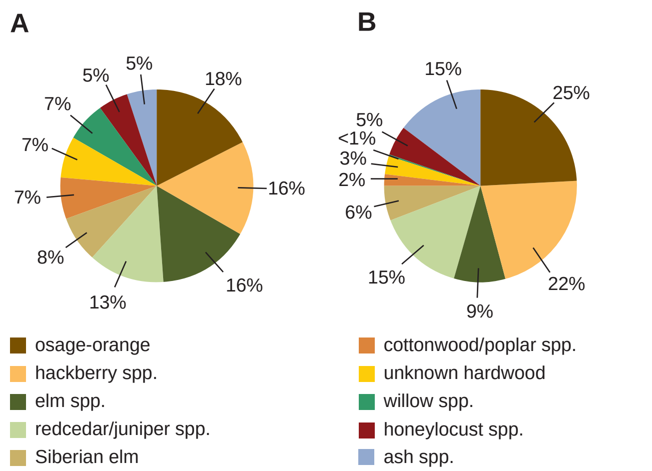


Figure 95.—Percentages of the top 10 tree species in windbreak areas found outside of or inside windbreaks. Percentages are those of trees in each windbreak category; for example, ash represents 14 percent of the total number of trees in the top 10 species found in windbreaks.

Differences in species composition are likely due to a combination of chance, historic land use, and the effects of natural factors such as proximity to streams. For example, there is a much higher percentage of Osage-orange and ash trees in windbreaks, largely because they were planted extensively for this purpose. Relative amounts of willow, on the other hand, are higher in non-windbreak areas due to their occurrence around streams and in wet areas less commonly associated with windbreaks.

The 2.9 million acres of rural nonforest land with trees identified by GPI photointerpreters in Kansas (2.1 million acres of which have nonforest trees greater than 5 inches in diameter at a density of at least 6 trees per acre) are divided among several land uses (Fig. 96). Agriculture is the primary land use associated with nonforest trees greater than 5 inches in diameter.

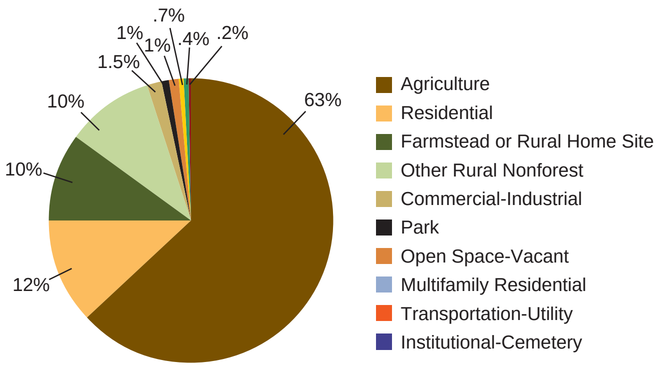


Figure 96.—Proportions of uses of nonforest land with trees (nonforest areas with trees greater than 5 inches in diameter). "Other Rural Nonforest" includes idle farmland, windbreaks, shelterbelts, or other similar areas.

The U.S. Department of Agriculture periodically conducts an agricultural census and generates maps of estimates of the occurrence of different types of agricultural land use. This map product, called the Cropland Data Layer (CDL) (U.S. Department of Agriculture 2006), was combined with the nonforest tree plots in a GIS to produce summaries of nonforest tree data by type of surrounding agricultural use. Figure 97 suggests that, of the nine CDL categories with the highest nonforest tree abundance, grassland areas in Kansas contain the largest numbers of nonforest trees. Areas surrounding sorghum, corn, soybeans, and other crops have fewer trees.

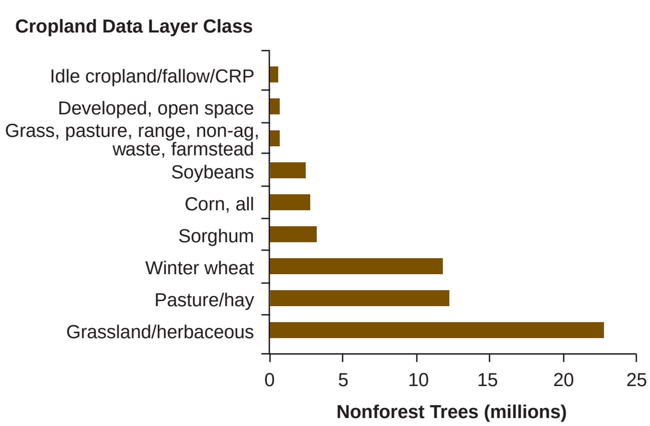


Figure 97.—Number of nonforest trees greater than 5 inches in diameter, by type of surrounding agricultural use.

Of the 289,577 nonforest treed acres with farmstead, field, or livestock windbreaks in Kansas, nearly half are adjacent to the grassland and pasture/hay CDL cover types, with the majority of the remainder surrounding wheat, corn, sorghum, or soybean fields. Areas adjacent to other minor crops, Cropland Reserve Program (CRP) areas, and other non-crop lands represent only about 12,000 acres of nonforest treed windbreaks.

What this means

FIA provides valuable information on various site variables across all lands, as well as information about tree and more detailed site variables on lands meeting its definition of forest. However, until the GPI, little was known about trees in nonforest areas. The GPI data indicate that species composition differs dramatically between forested and nonforested areas of the State, and thus different management approaches should apply.

Although knowledge of the differences in general is useful, the practical usefulness of the information relates to management of some of the ecosystem services that trees in these areas provide. The information obtained from GPI can be used to promote wise windbreak stewardship and renovation of older windbreaks. Practices might include monitoring windbreaks for EAB infestation, removing dead or dying trees, and replacing them with non-susceptible species to prolong the function of the windbreaks. A clear understanding of differences in urban and rural tree species composition can help guide managers in their efforts to design sustainable landscapes that offer multiple benefits, which can include support for wildlife populations, windbreak functions, energy savings, and forest product industry development. GPI data also enable the estimation of economic and conservation benefits of windbreaks for crop yields, livestock operations, soil conservation, and energy savings for farmsteads.

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DVD Contents

Kansas' Forests 2010 (PDF)

Kansas' Forests: Statistics, Methods, and Quality Assurance (PDF)

Kansas' Forests 2005 (PDF)

Kansas Inventory Database (CSV file)

Kansas Inventory Database (Access file)

Field guides that describe inventory procedures (PDF)

Database User Guides (PDF)

Moser, W. Keith; Hansen, Mark H.; Atchison, Robert L.; Butler, Brett J.; Crocker, Susan J.; Domke, Grant; Kurtz, Cassandra M.; Lister, Andrew; Miles, Patrick D.; Nelson, Mark D.; Piva, Ronald J.; Woodall, Christopher W. 2013. **Kansas' Forests 2010.** Resour. Bull. NRS-85. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 63 p.

The second completed annual inventory of Kansas' forests reports 2.4 million acres of forest land, roughly 5 percent of the total land area in the State. Softwood forests account for 4.4 percent of the total timberland area. Oak/hickory forest types make up 55 percent of the total hardwood forest land area. Elm/ash/cottonwood accounts for more than 32 percent of the timberland area. Kansas' forests have continued to increase in volume. In 2010, net volume of growing stock on timberland was an estimated 1.45 billion cubic feet compared with 0.5 billion cubic feet in 1965. Live-tree biomass on forest land in Kansas amounted to 82.5 million dry tons in 2010. More than 6 percent was in trees less than 5 inches in diameter. About 94 percent of Kansas' forest land is held by private landowners.

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

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