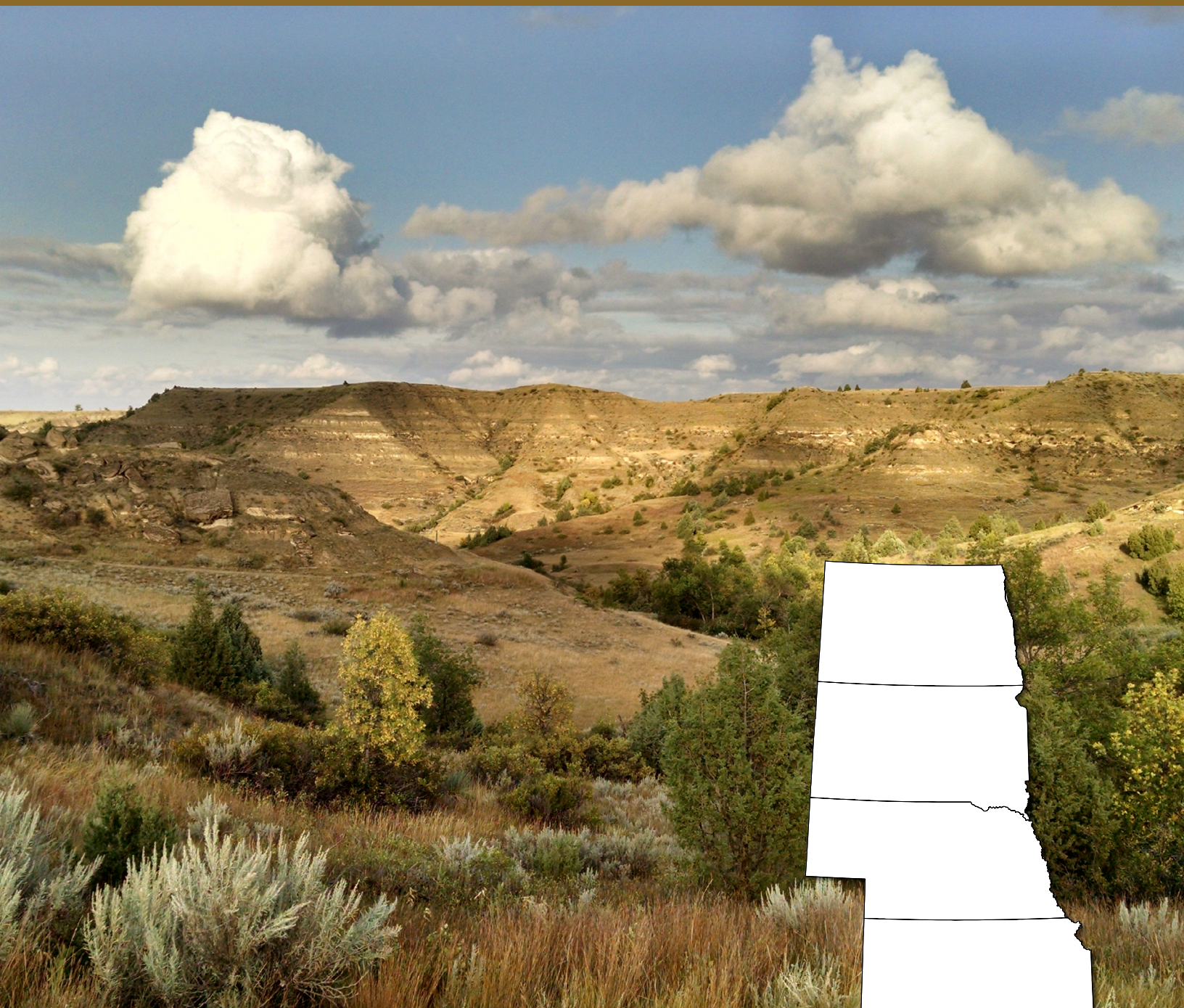




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Northern Great Plains Forests 2020



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Abstract

The 2020 inventory of the forests of the Northern Great Plains States (Kansas, Nebraska, North Dakota, and South Dakota) reports more than 6.6 million acres of forest land and more than 2.1 billion trees. Forest land is dominated by the ponderosa pine, sugarberry/hackberry/elm/green ash, and elm/ash/black locust forest types, which together occupy 43 percent of the total forest land area. The volume of growing stock on timberland currently totals 3.9 billion cubic feet. The average annual net growth of live trees from 2014 to 2020 was 162.5 million cubic feet per year. This report includes additional information on forest attributes, carbon, timber products, and forest health. The following supplemental information is available online at <https://doi.org/10.2737/NRS-RB-143>: (1) tables summarizing quality assurance, (2) a core set of tabular estimates for forest resources, and (3) user and database guides for Phase 2 and Phase 2+ protocols.

KEYWORDS: forest inventory, forest statistics, forest land, trees outside forests, volume, biomass, carbon, growth, removals, mortality, forest health, Kansas, Nebraska, North Dakota, South Dakota

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Cover photo: Little Missouri National Grassland, Medora, North Dakota. USDA Forest Service photo by Cory Engel.

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Summary tables available at: <https://doi.org/10.2737/NRS-RB-143>

User and database guides available at: <https://doi.org/10.2737/NRS-RB-143>

Highlights

- There are an estimated 6.6 million acres of forest land in the Northern Great Plains region, a decrease of approximately 200,000 acres since 2015.
- Pasture/rangeland was the largest recipient of forest losses and the largest provider of forest gains in all four States.
- Nonforest land with trees, an important ecological and economic resource, adds nearly 5.1 million acres of tree-covered land across the region.
- Urban tree cover is estimated at 27 percent and provides an estimated \$329 million per year in ecosystem services.
- More than two-thirds (69 percent) of the forest land across the Northern Great Plains is privately owned, most of which (4 million acres) are family forests. However, the largest changes in area of forest land by ownership group between 2013 and 2020 have been a 191,000 acre decrease in family forest land and a 157,000 acre increase in corporate forest land.
- There are approximately 2.1 billion live trees in the Northern Great Plains forests. The five most abundant species (ponderosa pine, eastern redcedar, green ash, hackberry, and American elm) make up more than half (53 percent) of all trees.
- Ponderosa pine and eastern cottonwood contain more than one-third (36 percent) of the total net merchantable bole wood volume of live timber species on forest land.
- The most common forest-type group is ponderosa pine, representing an estimated 1.2 million acres of forest land.
- Forest regeneration is impacted by herbivory, but the impact varies by State. Browse levels were higher in Nebraska and Kansas compared to the Dakotas.
- Net growth continued to decline while mortality continued to increase, although at a lower rate. Removals remained relatively stable. In terms of net growth rate as a percentage of sound total-stem volume, eastern redcedar had the highest net growth rate of 3.5 percent while ponderosa pine had the lowest at negative 1.2 percent.
- Seventeen different invasive plant species were observed in the Northern Great Plains and various species were found in all four States. The highest number of invasive plant species occurred in Nebraska, followed by Kansas, North Dakota, and South Dakota.
- Total carbon stocks on forest land in the Northern Great Plains States are an estimated 519 million tons: 215 million tons in Kansas, 106 million tons in Nebraska, 66 million tons in North Dakota, and 132 million tons in South Dakota. Overall, this represents a slight decline in stocks from 2015.
- The majority (85 percent) of the volume processed by Northern Great Plains States wood-processing mills came from the four States. Overall, industrial roundwood harvest in the Northern Great Plains States decreased by nearly 14 percent between 2014 and 2019; however, the decreases occurred in the Dakotas while Nebraska and Kansas reported small increases.



Sioux Ranger District, Custer Gallatin National Forest, South Dakota. USDA Forest Service photo.

Background



Cattle near a pond in Lyon County, Kansas. USDA photo by Preston Keres.

An Overview of Forest Inventory

What is this report?

This report summarizes findings of the 2020 inventories of forest resources in Kansas, Nebraska, North Dakota, and South Dakota, which are collectively referred to as the Northern Great Plains States in this report. Data for this survey were collected from 2014 through 2020 and are referred to as the 2020 inventory throughout this report. The inventory was conducted by the U.S. Department of Agriculture, Forest Service, [Forest Inventory and Analysis \(FIA\) program](#). Additional resource materials are available online at <https://doi.org/10.2737/NRS-RB-143>.

What is FIA?

The FIA program is often referred to as the Nation's forest census. FIA is a national program that conducts and maintains a comprehensive inventory of forest resources in the United States and its territories. Key definitions, data collection methods, and estimation procedures are summarized in the following paragraphs. For more detailed information about the statistics and quality assurance of the Northern Research Station FIA (NRS-FIA) program, see Gormanson et al. (2023).

Regional forest inventory

FIA conducted inventories in the Northern Great Plains region as early as 1935 (South Dakota). Prior to 1999, inventories were conducted periodically, or approximately once every 10 to 20 years. In 1999, an annual inventory system was implemented, wherein a percentage of plots were measured each year, and an entire inventory cycle was completed every 5 years. Table 1 lists the previous forest inventories for the Northern Great Plains States. In 2014, the Northern Great Plains States went from a 5-year cycle that measured 20 percent of the plots annually to a 7-year cycle measuring 14 percent of the plots annually. FIA maintains a 5-year reporting period and each report covers a full data measurement cycle. This creates an annual moving window with 5-year reporting periods composed of plots from a 7-year cycle, which are identified by the last year in a given full cycle. For this report, plots measured from 2014 through 2020 are collectively referred to as the 2020 inventory.

Table 1.—Previously published forest inventory reports for the Northern Great Plains States

State	Inventory year	Forest inventory report
Kansas	1936	Kansas State College 1939
	1965	Chase and Strickler 1968
	1981	Spencer et al. 1984
	1994	Leatherberry et al. 1999
	2005	Moser et al. 2008
	2010	Moser et al. 2013
	2015	Meneguzzo et al. 2018a
Nebraska	1955	Stone and Bagley 1961
	1983	Raile 1986
	1994	Schmidt and Wardle 1998
	2005	Meneguzzo et al. 2008
	2010	Meneguzzo et al. 2012
	2015	Meneguzzo et al. 2018a
North Dakota	1954	Warner and Chase 1956
	1980	Jakes and Smith 1982
	1994	Haugen et al. 1999
	2005	Haugen et al. 2009
	2010	Haugen et al. 2013
	2015	Meneguzzo et al. 2018a
South Dakota	1935	Ware 1936
	1962	Choate and Spencer 1969
	1977	Western South Dakota only; Green 1978
	1984	Collins and Green 1988
	1996	Forest land outside the Black Hills National Forest only; Leatherberry et al. 2000
	1999	Black Hills National Forest only; DeBlander 2002
	2005	Piva et al. 2009
	2010	Piva et al. 2013
	2015	Meneguzzo et al. 2018a

What is a tree?

The FIA program defines a tree as any perennial woody plant species with central stems and distinct crowns that can reach a height of 15 feet at maturity. A complete list of the tree species measured in this inventory can be found in Appendix 1. Throughout this report, the size of a tree is usually expressed as diameter at breast height (d.b.h.) or diameter at the root collar (d.r.c.) for woodland species, in inches. This is the diameter, outside the bark, at a point 4.5 feet above the ground (recorded as d.b.h.); for woodland species, d.r.c. is measured at the ground line or at the stem root collar, whichever is higher. Definitions for “tree” and many other terms in this report are available in the [FIA online glossary](#). Woodland species are identified with a “w” under the “Woodland” column on the tree species list (see Appendix 3+N of USDA Forest Service 2024). Rocky Mountain juniper is the only woodland species recorded in the 2020 Northern Great Plains States inventory.

What is a forest?

FIA defines forest land as land that has at least 10 percent canopy cover by live tally trees of any size or has had at least 10 percent cover in the past and is currently not developed or maintained for nonforest use. To qualify as forest land the area must be at least 1-acre in size and 120 feet in width, although exceptions exist for certain strips of trees separated from qualifying forest land by roads and streams (USDA Forest Service 2024).

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

Timberland is forest land that meets minimum productivity standards (capable of producing at least 20 cubic feet per acre per year of industrial wood) and is not withdrawn from harvesting due to legislative or administrative statutes. Inaccessible and inoperable areas are included.

Reserved forest land is forest land withdrawn by law prohibiting the management of land for the production of wood products (not merely controlling or prohibiting wood-harvesting methods). Some lands owned by State or local governments are considered reserved, even in the absence of specific laws covering them, if the agency mandate for that land designation precludes management to produce wood products (e.g., most state parks). All reserved forest land is publicly owned.

Other forest land is forest land that does not meet minimum productivity standards due to poor site conditions (i.e., degraded soil or excess water) and is not reserved.

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 is subject to changing laws, economic and 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. Forest inventory data alone are inadequate for determining the area of forest land available for timber production. Additional factors, such as those provided, need to be considered when estimating the timber base, and these factors may change with time.

How do we estimate a tree's volume?

To estimate a live tree's volume, NRS-FIA uses volume equations developed for each tree species group found within the northeastern United States. Individual tree volumes are based on species, diameter, and height. FIA reports volume in cubic feet and board feet (International ¼-inch rule). Board-foot volume measurements are applicable only for sawtimber-size trees. Some wood products are often measured and reported in cords (a stack of wood 8 feet long by 4 feet wide and 4 feet high). A cord of wood consists of about 79 to 85 cubic feet of solid wood; the remaining 43 to 49 cubic feet are bark and air.

How is forest biomass estimated?

The Forest Service has developed estimates of specific gravity for many tree species (Miles and Smith 2009). These specific gravities are applied to estimates of tree volume to estimate the biomass of merchantable trees (weight of the bole). Estimates of total aboveground tree biomass are calculated by adding top, limb, and stump biomass to bole biomass (Woodall et al. 2011). Currently, FIA does not report the biomass of foliage. FIA can 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 no moisture content; oven-dry weight is used to report biomass in this report. On average, 1.9 tons (2,000 pounds per ton) of green biomass equals 1 ton of oven-dry biomass.

How do we estimate all the forest carbon pools?

FIA does not directly measure the carbon in standing trees; it estimates forest carbon pools by assuming that half the biomass in standing live/dead trees consists of carbon. Additional carbon pools (e.g., soil, understory vegetation, belowground biomass) are modeled based on stand and site characteristics (e.g., stand age and forest type). For more information on carbon attributes and how FIA obtains population estimates of the various carbon pools, refer to chapter 6 in Westfall et al. (2022).

Major Components of the FIA Program

Forest inventory sample plots and design

For estimating forest attributes, such as forest area, forest composition, and forest structure, FIA has established a set of permanent inventory plots across the United States that are periodically revisited. Each plot consists of four 24-foot subplots for a total area of approximately one-sixth of an acre (Fig. 1). Each plot is randomly located within a hexagon that is approximately 6,000 acres in size. Therefore, each plot represents about 6,000 acres of land and can be used to generate unbiased estimates and associated sampling errors for attributes such as total forest land area. Full details of estimation procedures are available in Bechtold and Patterson (2005).

On the forested portions of each subplot, all trees that have diameters of at least 5.0 inches d.b.h./d.r.c. are tallied. Since the total area sampled is known, as is the number of trees counted in this area, estimates of number of trees can be made. Saplings, trees with a diameter between 1.0 and 4.9 inches d.b.h./d.r.c., and seedlings are inventoried on 6.8-foot radius microplots that are nested within each subplot. The estimation procedure is analogous to that described in the above paragraph.

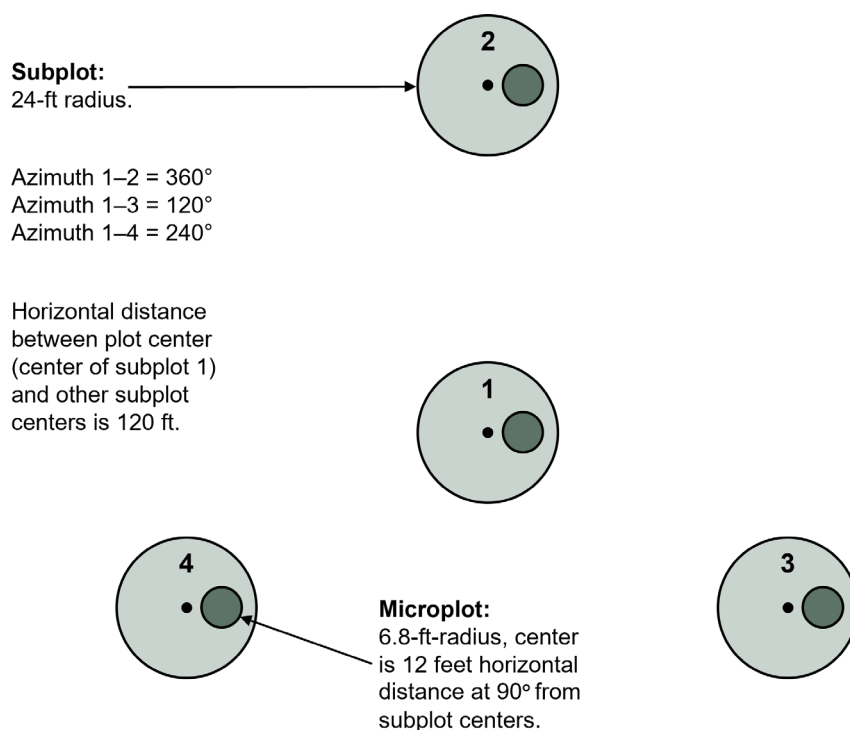


Figure 1.—Forest Inventory and Analysis program Phase 2 plot design used by the Northern Research Station.

What is P2+?

The Phase 2 plus (P2+) protocol for FIA was established to collect additional data specifically related to forest ecosystem function, condition, and health. This protocol utilizes a 12.5 percent subset of base field plots, visited during the leaf-on portion of the field season (May 1 through September 30). The suite of additional data collected includes an advanced tree seedling regeneration (ATSR) survey, vegetation profile (Veg), invasive plant species (Invasives) tally, down woody materials (DWM) measurements, and additional tree crown variables (Crowns) that pertain to tree health. Half of all P2+ plots (6.25 percent of all base plots) are also selected for soils measurements during the same leaf-on window.

What is the National Woodland Ownership Survey?

Information about family forest owners is collected annually through the Forest Service [National Woodland Owner Survey](#) (NWOS). The NWOS was designed to increase our understanding of owner demographics, concerns, and motivation. Individuals and private groups identified as woodland owners by FIA are invited to participate in the NWOS. Each year, questionnaires are mailed to 20 percent of private owners; more-detailed questionnaires are sent out in years 2 or 7 to coincide with national census, inventory, and assessment programs. Data presented here are based on survey responses from randomly selected families and individuals who own forest land in the Northern Great Plains States. For more detailed information about the sampling and estimation procedures for the base NWOS, refer to chapter 4 in Westfall et al. (2022).

What is the Timber Products Output Survey?

The Timber Products Output (TPO) survey (a component of the [National Resource Use Monitoring program](#)) is conducted by FIA to gain information on the amount of wood that is being processed. Information on the volumes and species being processed, where the materials originate, the types of products being manufactured, and the use of the residual materials are obtained through surveys of sawmills and other primary wood processing facilities throughout the region. For more detailed information about the sampling and estimation procedures used in the TPO survey, refer to chapter 5 in Westfall et al. (2022).

Forest Features



Hat Creek on the Oglala National Grassland in Montrose, Nebraska. USDA Forest Service photo by Sarlyn McCormick.

Forest Area and Land-use Change

Background

Periodic forest inventories within the Northern Great Plains States of Kansas, Nebraska, North Dakota, and South Dakota were conducted repeatedly from the 1930s up until the implementation of the annual inventory system in 2000. Annual inventories with permanent, remeasured inventory plots provide a wealth of information about recent trends in forest and other land uses (Fig. 2). Results in this report emphasize changes between the inventory period of 2009 through 2013 (referred to as the 2013 inventory) and remeasurements completed during 2014 through 2020 (referred to as the 2020 inventory).

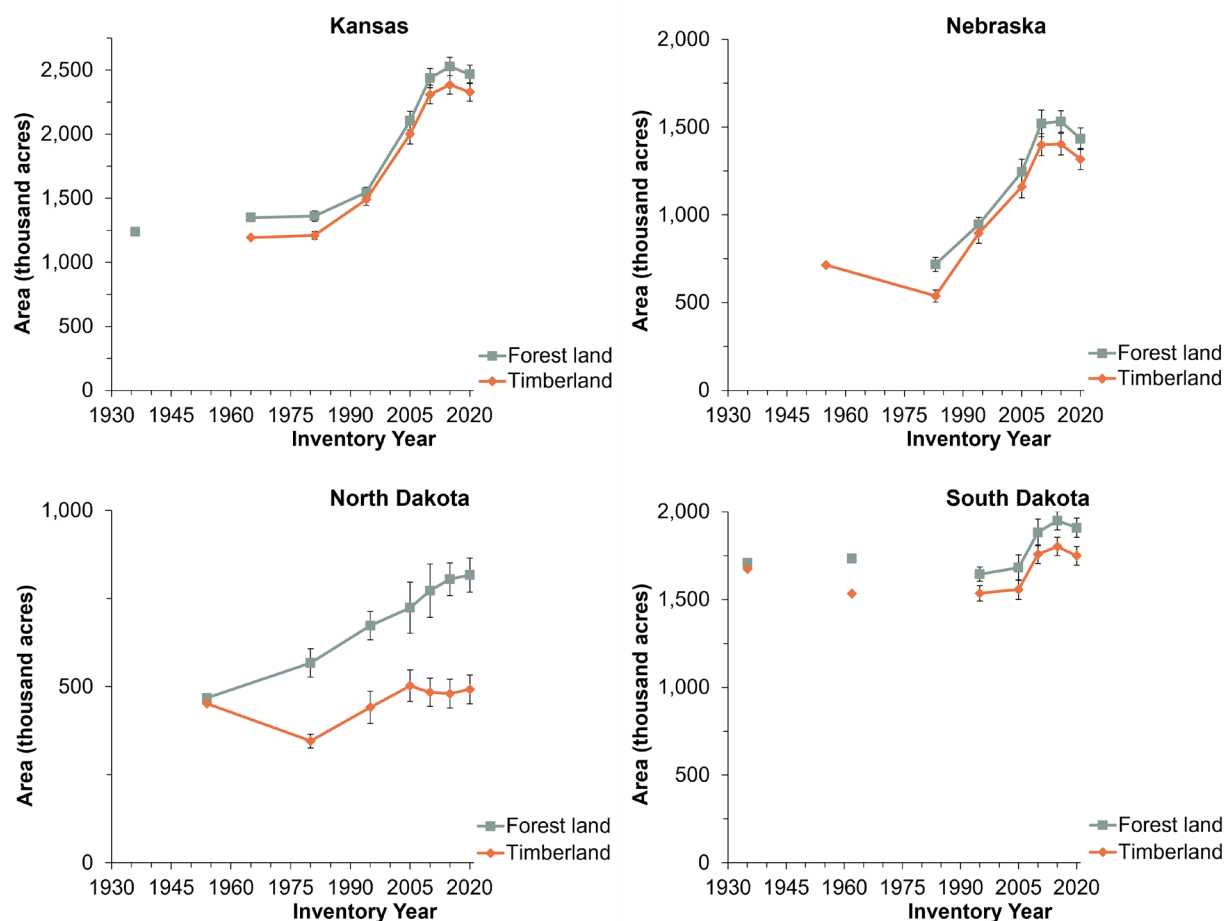


Figure 2.—Forest land and timberland area by inventory year, Northern Great Plains States. Error bars represent a 68 percent confidence interval. No error estimates are available from early periodic inventories.

The 2020 inventory reveals that forests cover about 6.6 million acres, or 3.4 percent, of land area in the Northern Great Plains States of Kansas (4.7 percent), Nebraska (2.9 percent), North Dakota (1.8 percent), and South Dakota (3.9 percent), providing a critical resource and offering a wide range of benefits. FIA further characterizes land area by using several land-use categories, which are aggregated for this report into agricultural, developed, forest, pasture/rangeland, water, and other land (undeveloped beaches, nonvegetated lands, persisting snow and ice) (Fig. 3).

The conversion of forest land to nonforest and water uses is referred to as gross forest loss (or diversion), and the conversion of nonforest land and water to forest is known as gross forest gain (or reversion). The magnitude of the difference between gross loss and gross gain is defined as net forest change. By comparing land use on current and previously measured inventory plots we can characterize forest land-use change dynamics. To better understand forest land dynamics, it is important to explore the underlying land-use changes. Understanding land-use change dynamics is essential for monitoring the sustainability of forest resources and helps land managers make informed policy decisions within the Northern Great Plains States.

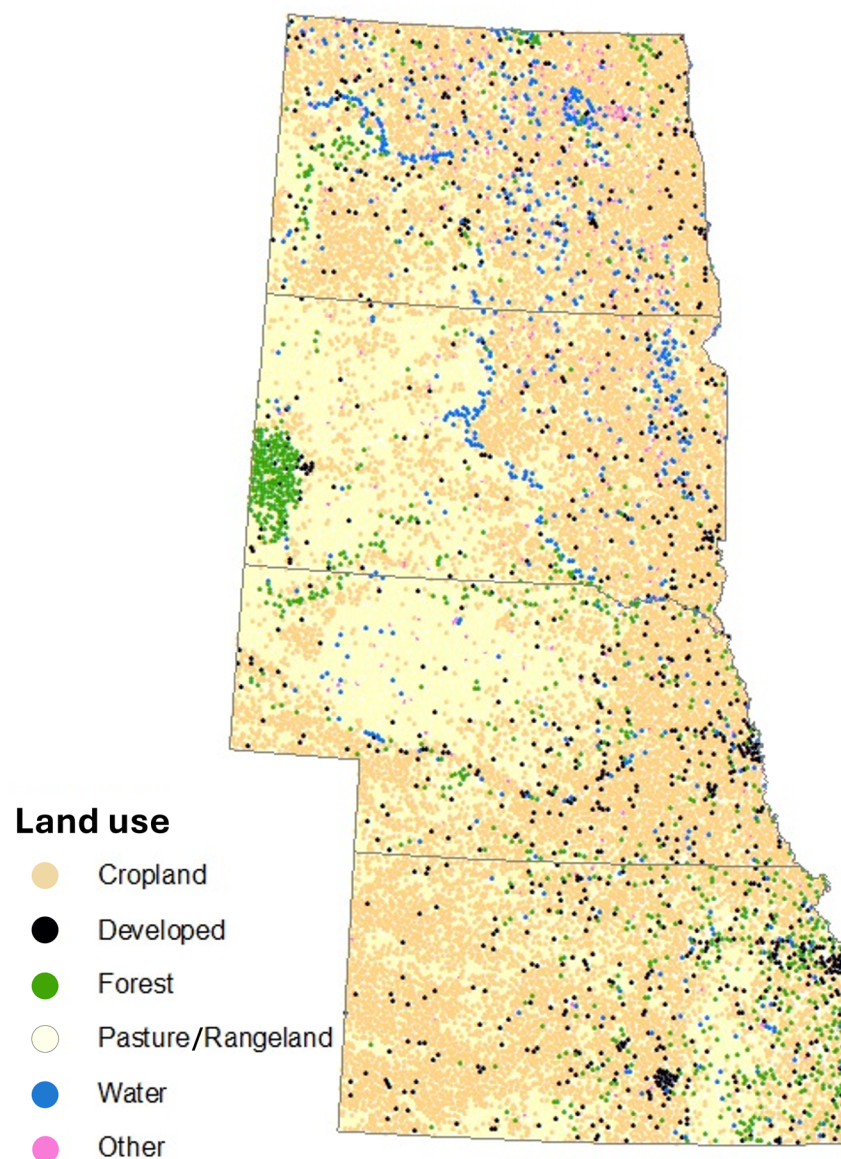


Figure 3.—Approximate locations of Forest Inventory and Analysis plots showing general land uses, Northern Great Plains States, 2020.

What we found

Forest land area in the Northern Great Plains States consists of about 6.6 million acres; other land uses cover over 190 million acres of the region's surface area. Estimates based on previous and current remeasurements indicate that 1.6 to 4.1 percent of area remained forested, 94.9 to 98.3 percent remained nonforest, and 0.1 to 1.1 percent of land area experienced change, with net totals of forest diversions and reversions varying slightly among the four States (Fig. 4). Change plots—for mapping purposes, defined as those remeasured plots having a land-use category gain or loss of at least 25 percent—are distributed throughout the Northern Great Plains States (Fig. 5). Pasture/rangeland was the largest recipient of forest losses and the largest provider of forest gains in all four States, followed by agriculture, developed land, and other land uses (Fig. 6).

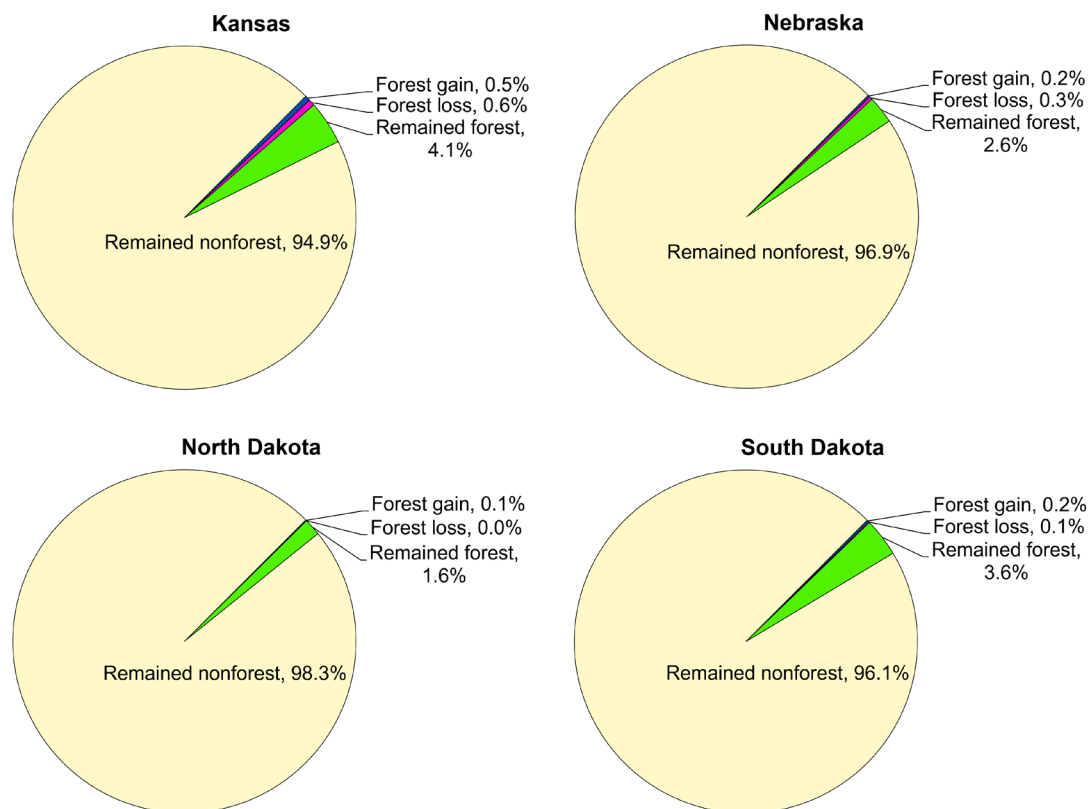


Figure 4.—Land-use dynamics showing percentage of unchanged land, forest loss, and forest gain by State, Northern Great Plains, 2020.

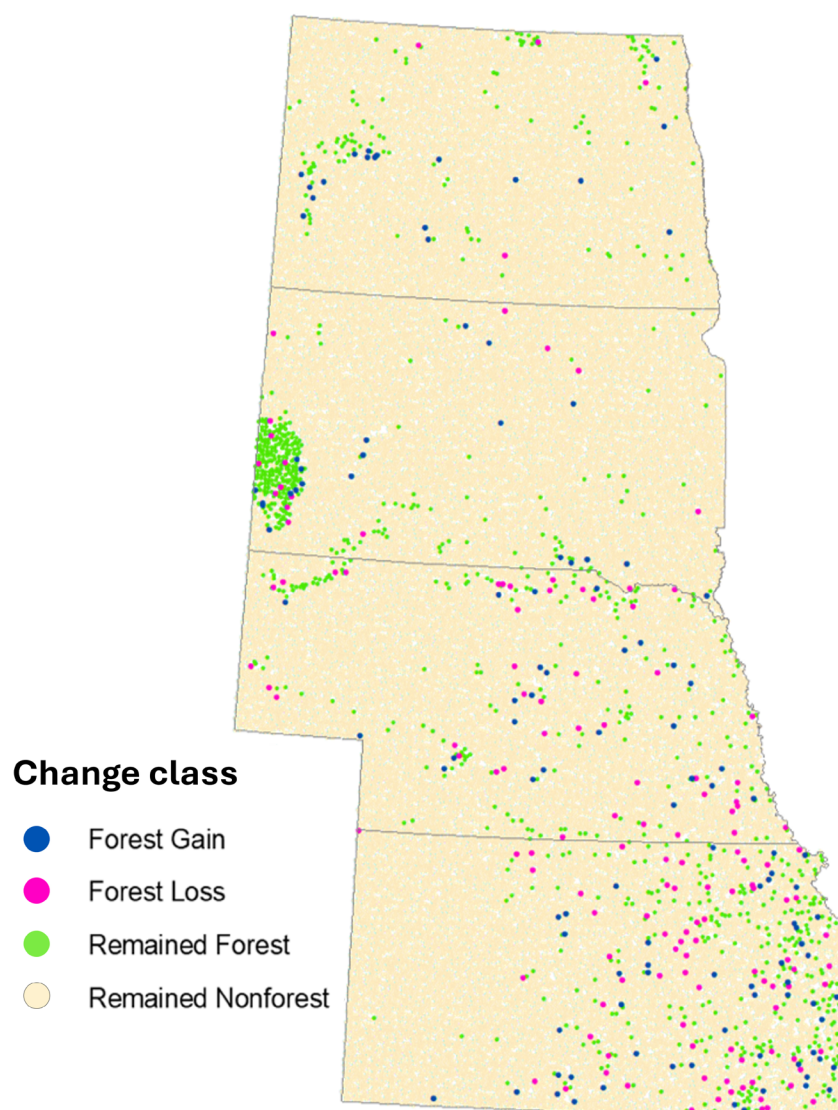


Figure 5.—Approximate locations of remeasured Forest Inventory and Analysis plots showing per-plot forest gain and forest loss of at least 25 percent and persisting forest and nonforest with less than 25 percent change, Northern Great Plains States, 2013 to 2020.

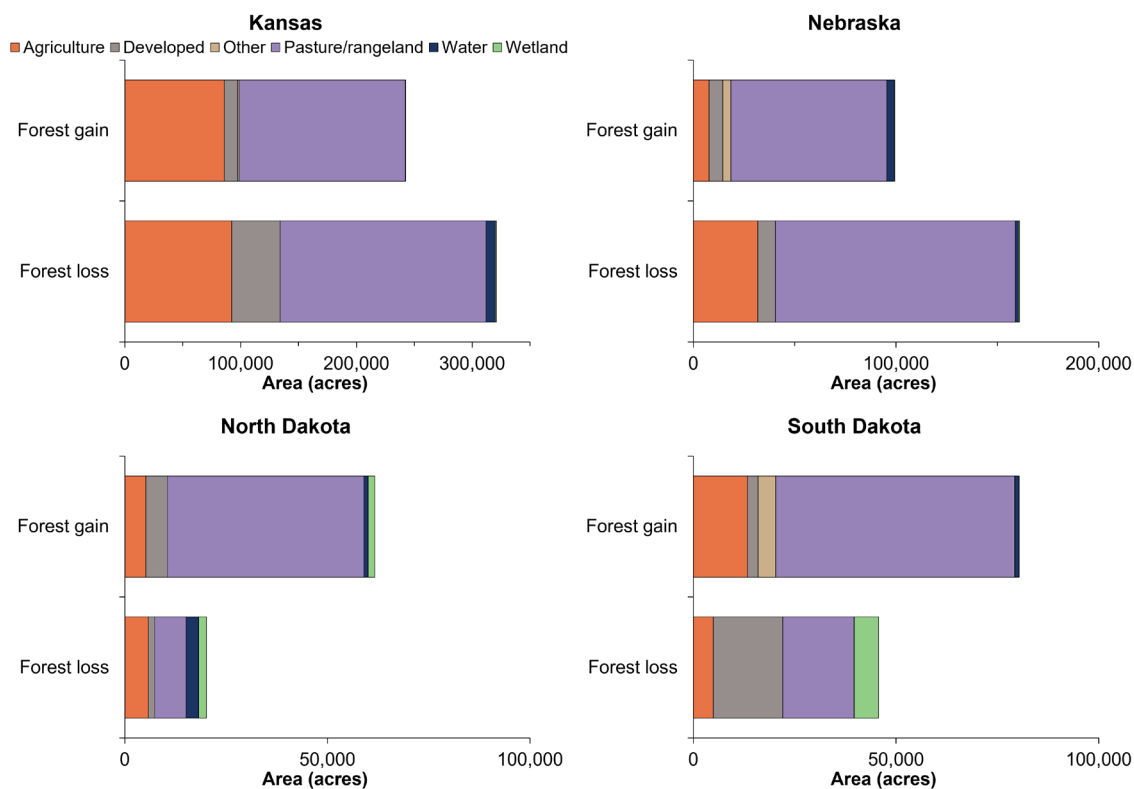


Figure 6.—Gross area forest gain and forest loss by land-use category and State, Northern Great Plains, 2013 to 2020.

What this means

Forest land gross losses exceeded gross gains in Kansas and Nebraska, resulting in a small net loss in forest land area. The reverse pattern was seen in North Dakota and South Dakota, resulting in small net gains in forest land area. Gains and losses from multiple causes are driving forest land-use change dynamics in the Northern Great Plains States.

Forest Type Distribution

Background

The composition of forests can be described at varying levels, from the numbers of individual species of seedlings, saplings, and trees, to a broader view of the resource categorizing land based on shared characteristics. The broad-scale delineation of forest land is expressed as forest types which consist of tree species that generally coexist together in a forested setting. Similar forest types are collectively known as forest-type groups.

What we found

There are 14 forest-type groups comprising 34 individual forest types across the four-State region of the Northern Great Plains. The oak/hickory forest-type group covers 31 percent of the total forest area, totaling 2.1 million acres, over 60 percent of which is in Kansas. Elm/ash/cottonwood is the second largest group with 21 percent of the total forest area, or 1.4 million acres.

The ponderosa pine forest type comprises 1.2 million acres, or 18 percent of the total forest land area across the Northern Great Plains (Fig. 7); the majority, 85 percent, is in South Dakota where it occupies more than half (54 percent) of forest land. Nebraska's 1.4 million acres of forest land has the most diversity with six groups having at least 5 percent of total area but no single group composing more than 25 percent. It is notable that Nebraska and South Dakota combined are over 9 percent nonstocked.

Although oak/hickory is the largest forest-type group, only one of the 11 forest types within that group, elm/ash/black locust, exceeded 10 percent of total forest area at 770,000 acres (Table 2). Sugarberry/hackberry/elm/green ash is the largest single type in the elm/ash/cottonwood group with 882,000 acres.

To investigate the proportion of forest land area by major forest-type groups (comprising at least 5 percent of total forest land area) for two time periods, see the [NRS-FIA Forest-type Group Dashboard](#) (USDA Forest Service 2026). All 24 Northern Research Station FIA states are selected by default.

Table 2.—Area of forest land by forest-type group for groups having at least 5 percent of total forest land and by forest type for types having at least 5 percent of the group, with respective 2010 area, Northern Great Plains States, 2020

Forest-type group	Forest type	Forest land area, 2020 (acres)	Percent of group, 2020	Percent of total, 2020	Forest land area, 2010 (acres)	Percent of group, 2010	Percent of total, 2010
Oak/hickory	Elm/ash/black locust	769,540	37.3	11.6	841,568	39.6	12.7
	Bur oak	413,182	20.0	6.2	436,845	20.6	6.6
	Mixed upland hardwoods	400,713	19.4	6.0	300,491	14.2	4.5
	White oak/red oak/hickory	262,217	12.7	4.0	322,774	15.2	4.9
	Post oak/blackjack oak	103,212	5.0	1.6	109,045	5.1	1.6
	Other	112,663	5.5	1.7	112,257	5.3	1.7
	Total	2,061,527	100.0	31.1	2,122,980	100.0	32.1
Elm/ash/ cottonwood	Sugarberry/hackberry/elm/green ash	881,665	62.6	13.3	852,396	57.9	12.9
	Cottonwood	348,050	24.7	5.3	366,457	24.9	5.5
	Other	177,919	12.6	2.7	254,266	17.3	3.8
	Total	1,407,634	100.0	21.2	1,473,119	100.0	22.3
Ponderosa pine	Ponderosa pine	1,207,166	100.0	18.2	1,369,987	100.0	20.7
	Total	1,207,166	100.0	18.2	1,369,987	100.0	20.7
Nonstocked	Nonstocked	416,498	100.0	6.3	307,870	100.0	4.7
	Total	416,498	100.0	6.3	307,870	100.0	4.7
Other eastern softwoods	Eastern redcedar	408,207	100.0	6.2	387,140	100.0	5.9
	Total	408,207	100.0	6.2	387,140	100.0	5.9
All other forest-type groups	All other forest types	1,125,069	100.0	17.0	952,518	100.0	14.4
	Total	1,125,069	100.0	17.0	952,518	100.0	14.4
Total forest land		6,626,101	100.0	100.0	6,613,614	100.0	100.0

What this means

Forest composition is generally slow to change. However, comparisons to estimates from 2010 show some shifting among the major forest-type groups. The oak/hickory, ponderosa pine, and elm/ash/cottonwood groups have lost a combined 290,000 acres of area since 2010 leading to a bit more diversity in the resource. Though many small groups, such as other hardwoods, gained area over the past 10 years, the biggest increase in area was in nonstocked forest land which was up 109,000 acres since 2010. Nonstocked lands made up 6.3 percent of forested area in 2020, up from 4.7 percent in 2010.

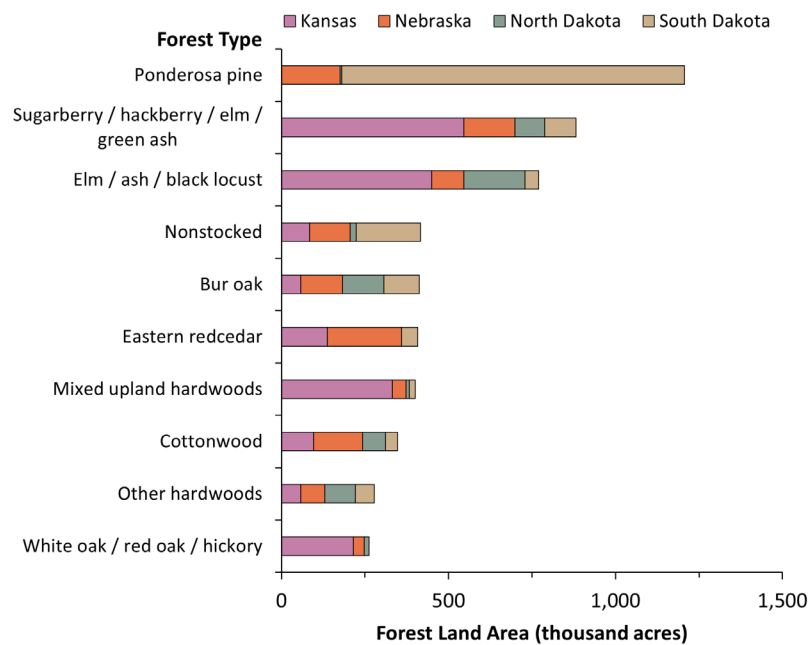


Figure 7.—Forest type area for forest types of at least 250,000 acres by State, Northern Great Plains, 2020.

Forest Structure

Background

The relationships between forest type, stand size, and stand age provide insight about overall forest composition and structure. Although stand size and stand age are closely related, examined separately, they can each provide valuable information about different aspects of a forest.

Three classes are used to describe the stand size of forested conditions. The seedling/sapling (small) stand-size class is assigned to stands where at least half of the total stocking present is in seedlings and saplings (trees less than 5.0 inches d.b.h./d.r.c.). The poletimber (medium) stand-size class describes stands where at least half of the stocking is of trees at least 5.0 inches d.b.h./d.r.c. but less than the diameter standards for a softwood or hardwood sawtimber tree. When the majority of stocking volume in a stand is made up of softwoods at least 9.0 inches d.b.h./d.r.c., hardwood species at least 11.0 inches d.b.h./d.r.c., or both the sawtimber (large) stand-size class is assigned. These simple classifications allow for easy comparisons of young, maturing, and mature forests. Stands reported as nonstocked are currently less than 10 percent stocked. Although a stand size classification is determined by field employees during data collection, the stand-size classes reported here use office calculated algorithms based on measured diameters and stocking.

An examination of stand age can provide an overview of forest dynamics related to succession, disturbances, and forest management. Consideration of other correlated variables, such as tree density, stand height, and associated species can provide insight on forest structure and habitat availability. Stand age is determined in the field by data collection staff by aging tree cores taken from trees which are not over-topped, and which best represent the trees within the predominant stand-size class.

What we found

The majority (52.7 percent) of forested stands in the Northern Great Plains region are classified in the sawtimber stand-size class with an overall average stand age of approximately 70 years. One quarter of that acreage is ponderosa pine sawtimber stands, averaging 91 years old (Schanning 2023). As a slow growing species, even sapling ponderosa pine stands average 60 years in age. In contrast, sawtimber stands of the next most prominent forest type, sugarberry/hackberry/elm/green ash, average only 60 years in age and sapling stands average 31 years.

Although it is the least forested State by far in the Northern Great Plains region, North Dakota stands apart from the others due to its relatively equal balance of large, medium, and small size class stands. Pole-sized stands are predominant, comprising 39 percent of forests across North Dakota. These primarily consist of two forest types, elm/ash/black locust and bur oak. North Dakota also has only 2.3 percent of its forested area currently nonstocked, which is the lowest of the four States.

To investigate the stand-size class structure and stand age for all forest types of the Northern Great Plains region during the 2020 survey, see the [Northern Great Plains, 2020 - Area of Forest Land by Forest Type and Stand Size dashboard](#) (Schanning 2023).

When considering the implications of stand size and stand age, it is important to understand that both are determined based on the size class that provides the greatest stocking value in the stand. For example, in a stand classified as sawtimber, the stand age represents the approximate age of all sawtimber-sized trees in the stand and does not include the age of smaller trees. Therefore, the classifications do not fully convey the diversity of individual tree sizes and ages within a stand. An assessment of the number of trees existing within each stand-size class can provide further information about the regeneration occurring within these stands. Across the Northern Great Plains, the nearly 3.5 million acres of forest land classified as sawtimber stands contain 612.7 million saplings and 289.3 million pole-sized trees. Saplings make up the majority of the tree count across all stand-size classes (Fig. 8).

What this means

The data describing the forest types of the Northern Great Plains by stand size and stand age can be used to inform management and decision making. Knowledge about the stand age of forest types across the States may provide guidance for long-term planning of resources. Wildlife researchers interested in the availability of specific habitat needs for animals of interest can assess the acreage available of individual forest types and better understand their associated characteristics through stand size and stand age. The availability of wood products can be more carefully assessed by investigating forest type by stand size. Although in some cases, the presence of old and larger stands may imply lower natural and anthropogenic disturbances, even heavily thinned forests may leave enough large, older trees by which to define the overall stand. Closer inspection of individual forest types, stand structure, and information about the trees recorded in those stands provides better information about the abundance and character of specific forest types.

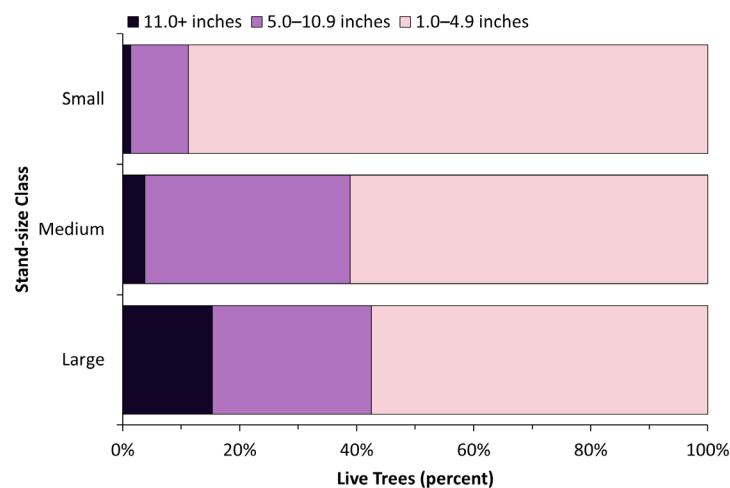


Figure 8.—Proportion of live trees by diameter class and stand-size class on forest land, Northern Great Plains States, 2020.

Forest Ownership

Background

To a large extent, the quantity and quality of available forest resources are determined by landowners, including timber supply, recreational opportunities, and wildlife habitat. By understanding the priorities of forest landowners, the forest conservation community can better assist these owners' efforts to conserve and manage the region's forests for future generations. The National Woodland Owner Survey (NWOS) studies private forest owners' attitudes, management objectives, and concerns with a focus on the families, individuals, and other unincorporated groups collectively referred to as "family forest ownerships". The NWOS results reported here are from studies completed in 2013 (Butler et al. 2016) and 2018 (Butler et al. 2020). In addition, preliminary results from the latest iteration of the NWOS, consisting of data collected from 2019 through 2021, are also included (USDA Forest Service 2023). Apart from the overall forest land distribution (Fig. 9), the results presented are for family forest ownerships with 10 or more acres of forest land.

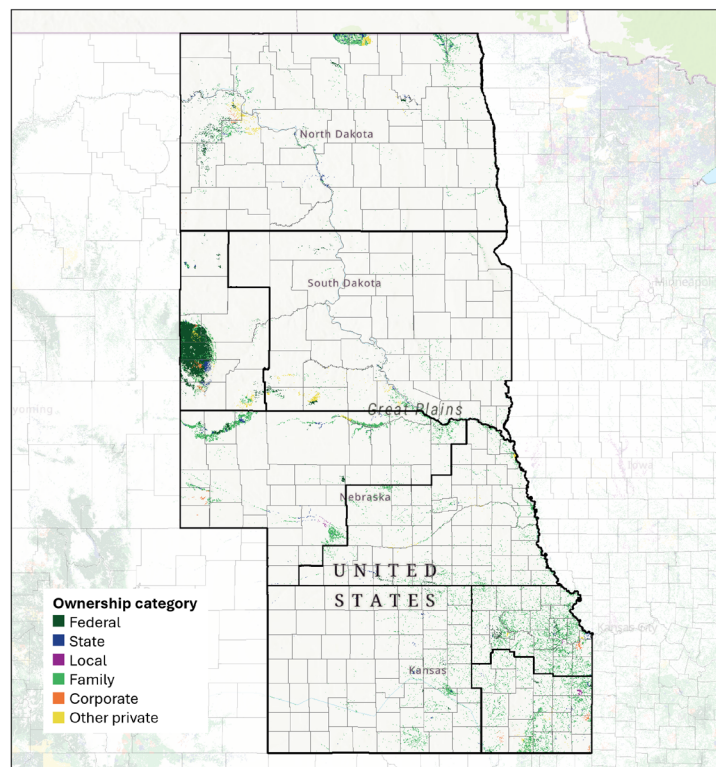


Figure 9.—Forest land by ownership category for the Northern Great Plains States, 2020. Esri, USGS | Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS | Forest Service Research Data Archive | US Forest Service Enterprise Map Services Program. Source: Sass et al. 2020.

What we found

Sixty-nine percent of the forest land across the Northern Great Plains is privately owned (Fig. 10). Most of these private acres, an estimated 4.0 million acres, are family forests. Corporate ownerships have an estimated 486,000 acres across the region and other private owners, including conservation organizations and unincorporated clubs and partnerships, own an additional, estimated 69,000 acres. Federal, State, and local governments are responsible for 26 percent of the region's forest land. Much of the 1.4 million acres of Federal forest land is in the Black Hills National Forest. County and other local governments manage an estimated 55,000 acres of forest land. The 245,000 acres of State-owned forest land are controlled by a combination of forestry, parks, and wildlife agencies. There are an additional 323,000 acres of forest land within Tribal boundaries across the region. The largest changes in area of forest land by ownership group between 2013 and 2020 have been a 191,000-acre decrease in family forest land and a 157,000-acre increase in corporate forest land.

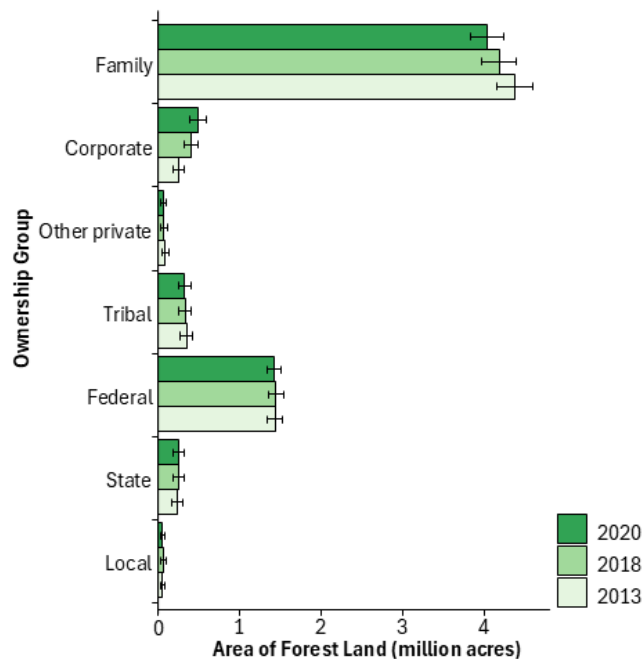


Figure 10.—Area of forest land by ownership group, Northern Great Plains States, 2013, 2018, and 2021. Error bars are 95 percent confidence intervals.

Forest ownership patterns vary across the Northern Great Plains States. Family forest ownerships dominate across three of the States: Kansas (83 percent), Nebraska (73 percent), and North Dakota (57 percent). While in South Dakota, Federal forest ownership dominates (55 percent).

Over half (61 percent) of the forest land across the Northern Great Plains is owned by family forest owners. As of 2021, there are an estimated 93,000 family forest ownerships with 10 or more acres of forest land across the region. An estimated 81 percent of these family forest ownerships own less than 50 acres of forest land, but 61 percent of the family forest land is in holdings of 50 or more acres (Fig. 11). The median size of family forest holdings in 2021 is 20 acres, the same as it was in 2018 and 2013.

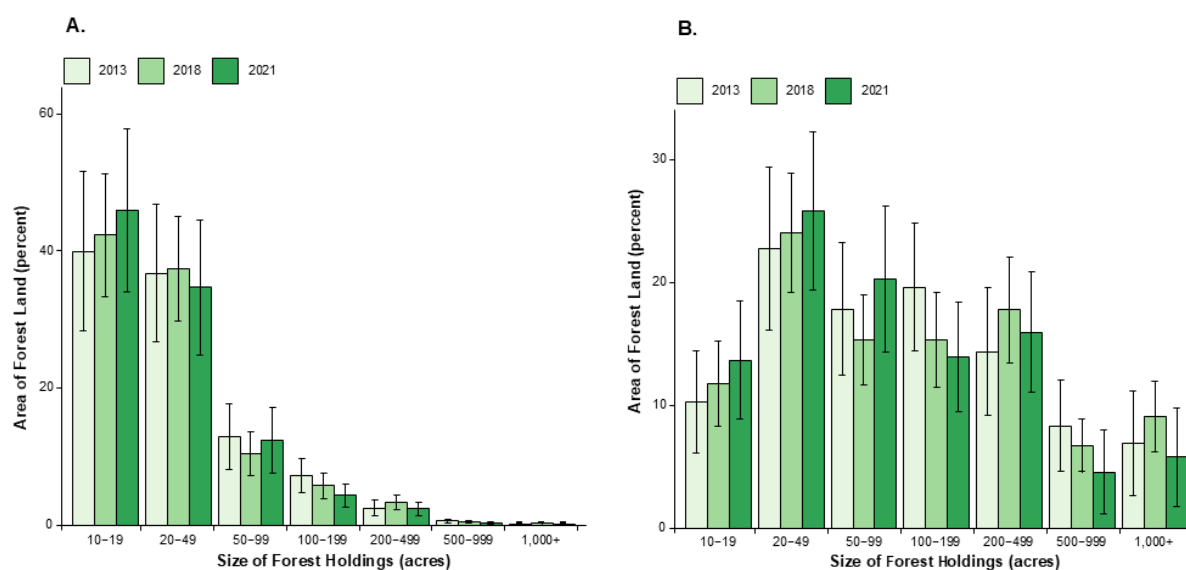


Figure 11.—Family forest (10+ acres) ownerships (A) and acreage (B) by size of forest holdings, Northern Great Plains States, 2013, 2018, and 2021. Error bars are 95 percent confidence intervals.

The primary reasons for owning family forests are related to amenity values, such as wildlife, aesthetics, and nature protection (Fig. 12). Objectives related to financial values, including timber production and land investment, are rated as important ownership reasons much less frequently. The overall order of reasons for owning did not change substantially between 2013 and 2021.

The most common activity on family forest land in the Northern Great Plains in the previous 5 years is personal recreation; 62 percent of the family forest ownerships that control 65 percent of the family forest land participated in activities such as hunting or walking on their land. Other relatively common activities are livestock grazing (27 percent of ownerships; 42 percent of acreage), mitigating invasive species (31 percent of ownerships; 40 percent of acreage), collecting nontimber forest products (42 percent of ownerships; 38 percent of acreage), and harvesting firewood (29 percent of ownerships; 37 percent of acreage). Commercial timber harvesting in the previous 5 years was done by 4 percent of the family forest ownerships who control 10 percent of the family forest land.

Regarding management practices and programs, 15 percent of the family forest ownerships, who control 17 percent of the family forest land, have received advice in the last 5 years and 6 percent of the family forest ownerships, who control 5 percent of the family forest land, have a written forest management plan. Participation in cost-share programs is reported by 8 percent of the family forest ownerships who control 11 percent of the family forest land. Less than 5 percent, in terms of both ownerships and acreage, have participated in a forest-related preferential property tax program, certification program, or have a conservation easement.

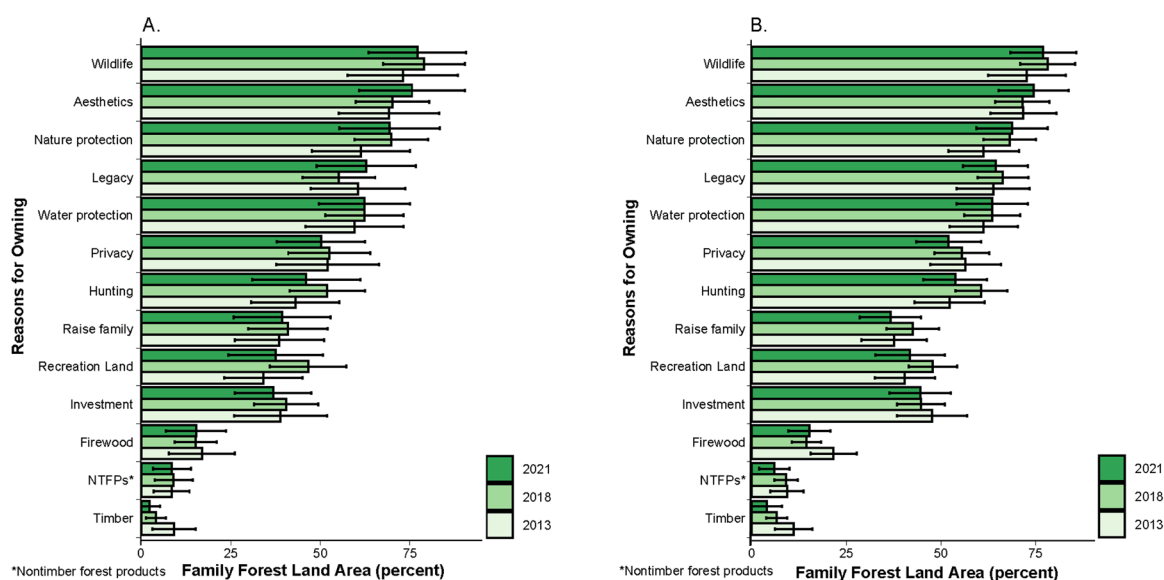


Figure 12.—Family forest (10+ acres) ownerships (A) and acreage (B) by reasons for owning, Northern Great Plains States, 2013, 2018, and 2021. Percentages include those who responded a specific reason was important or very important on a 5-point Likert scale. Error bars are 95 percent confidence intervals.

What this means

The fate of the forests lies primarily in the hands of those who own and control the land. It is therefore critical to understand forest owners and what policies and programs can help them conserve the forests for current and future generations. Looking particularly at family forest ownerships, the group that is the least understood and the fate whose land is arguably the most uncertain, they own their land primarily for amenity reasons, but many are actively doing things with their land. Seeing how low the percentages are for ownerships who have received forest management advice, have a written management plan, or have participated in other programs, there is a substantial opportunity to increase owner engagement and stewardship of their lands through programs that meet their needs and objectives. Other important trends to watch are the aging of the family forest owners and the steady increase in forest ownership transition from family to corporate ownership. Given that the average age of family forest owners across the region is 68 years (Fig. 13), many acres of land will be passing on to the next generation in the not-too-distant future.

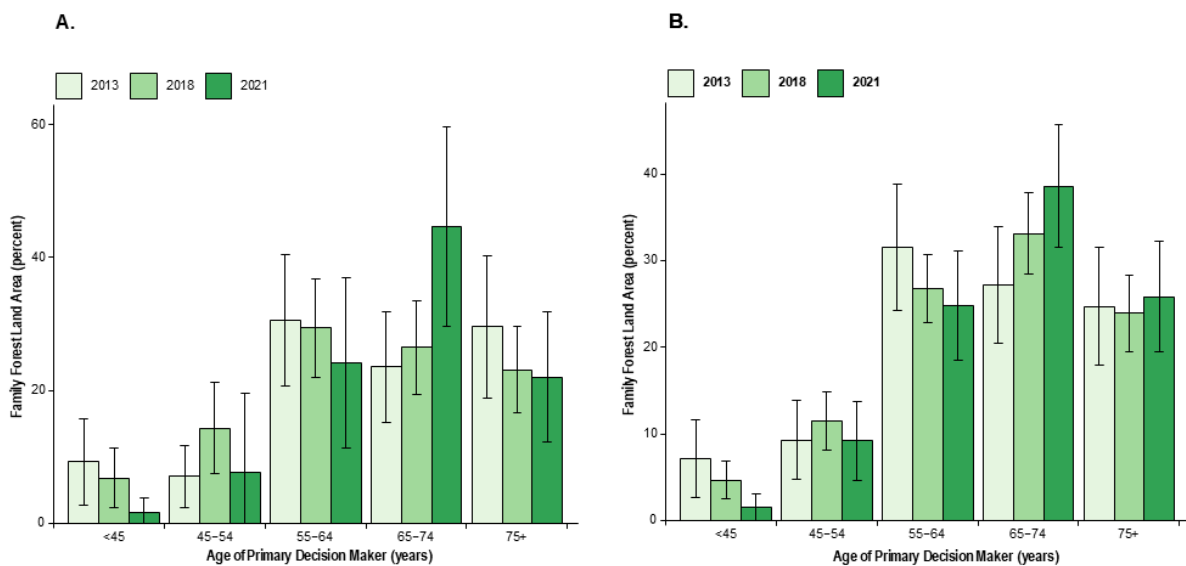


Figure 13.—Family forest (10+ acres) ownerships (A) and acreage (B) by age of primary decision maker, Northern Great Plains States, 2013, 2018, and 2021. Error bars are 95 percent confidence intervals.

Trees Outside Forests

Background

Areas of tree cover must be at least 1-acre in size and 120 feet wide to meet FIA's definition of forest land. Much of the tree cover in the Northern Great Plains, however, is configured in a way that does not meet these requirements (e.g., narrow linear strips).

Despite their small size, these groupings of trees are a critical resource and offer a wide range of benefits, such as preventing erosion, serving as riparian buffers, providing wildlife habitat, and protecting structures and livestock from harsh weather. Recently, natural resource agencies have recognized the lack of available information on this important resource, referred to as "trees outside forests" (TOF).

In response to forest health concerns, the spread of the emerald ash borer (*Agrilus planipennis*; EAB) in particular, State forestry agencies in the Northern Great Plains, with federal funding assistance from the USDA Forest Service, State & Private Forestry, began a project called the Northern Great Plains Tree and Forest Invasives Initiative (GPI; now referred to as GPI 1) (Lister et al. 2011, Meneguzzo et al. 2018b). Objectives of the GPI included a field-based inventory of the TOF resource, 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). Data were collected in 2008 and 2009 on urban and rural field plots with trees present but not classified as forest land; results of this specialized inventory can be found in Meneguzzo et al. (2018b). This was a one-time effort, and no updated data are available.

GPI 2 is a continuation of GPI 1 that focused on creating very high-resolution (1-meter) maps of tree cover and then identifying and quantifying the windbreak resource, one of the most important TOF categories in terms of ecosystem services provided. See the [National Agroforestry Center windbreak page](#) or the [Windbreaks of the Great Plains map journal](#) for more information about windbreaks.

What we found

The 1-meter tree cover maps identified more than 9.8 million acres of tree cover (Fig. 14). By way of comparison, the FIA estimate of forest land, which is a land-use category, is 6.8 million acres, not all of which have 100 percent tree cover. This is indicative of tree-covered areas exceeding those of FIA-defined forest land (Fig. 15). Results from the GPI 1 inventory indicate that the TOF resource consists of nearly 458 million trees with ash spp. being the most numerous (Fig. 16) and ranking second in gross volume. Most TOF (92 percent) occur on privately owned land and more than half of TOF acreage (56 percent) are associated with agriculture (Fig. 17).

To explore high-resolution tree cover and county percent tree cover in the Northern Great Plains region, see the [Trees Outside of Forests interactive map viewer](#) (USDA NAC and FS 2023).



Figure 14.—One-meter tree cover for the Northern Great Plains States. Derived from 2014 National Agriculture Imagery Program (NAIP) high-resolution imagery.

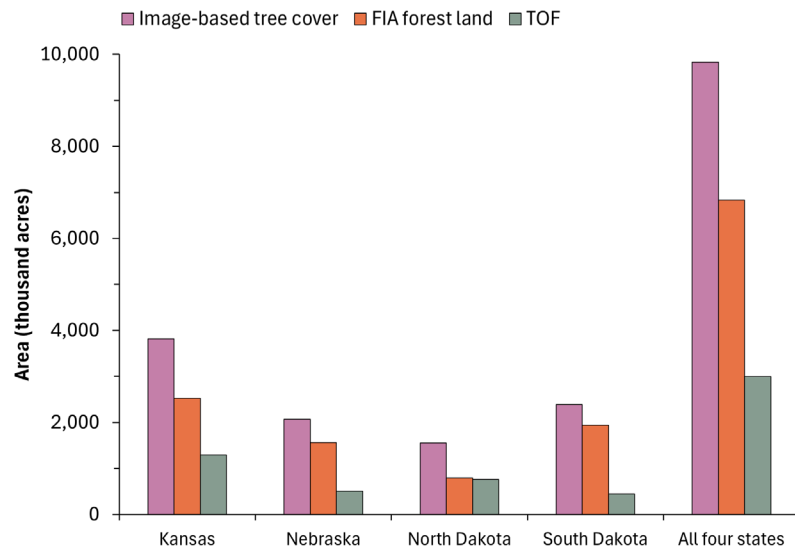


Figure 15.—Comparison of image-based estimates of tree cover, Forest Inventory and Analysis forest land, and potential area of trees outside forests by State, Northern Great Plains.

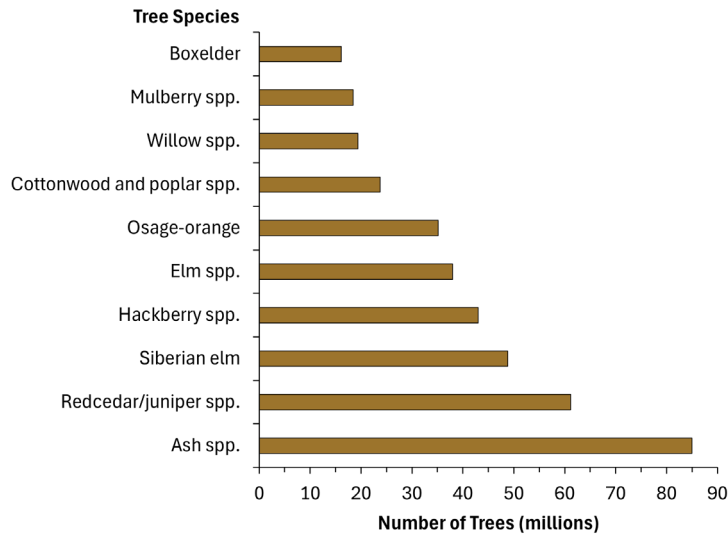


Figure 16.—The 10 most prevalent species of trees on land outside forests, Northern Great Plains States, derived from the Great Plains Initiative (GPI).

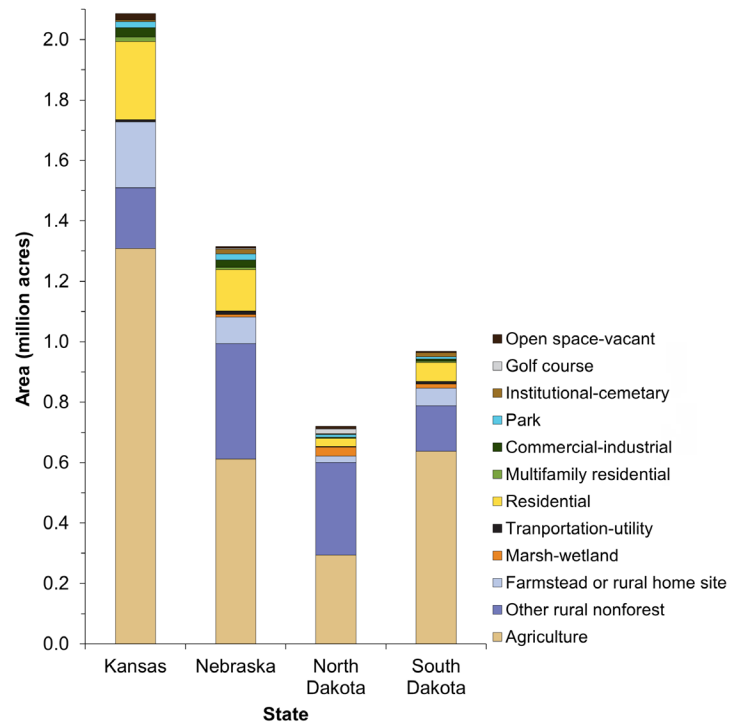


Figure 17.—Area of trees outside forests by land use, as classified by the Great Plains Tree and Invasives Initiative by Northern Great Plains State. Source: Lister et al. 2011.

Tree species composition varies between forested and TOF areas. For example, ponderosa pine is a key component of forest land areas but not nonforested areas with trees. Nonnative tree species, primarily Siberian elm and Russian olive are more prevalent in TOF areas. Osage-orange, eastern redcedar, and ash are the most prevalent species on private lands. Elm, ash, and ponderosa pine are the most common TOF species on publicly owned TOF lands.

Windbreaks, which are linear tree plantings that serve distinct purposes on the landscape, are a very important TOF feature. According to GPI 1, windbreaks occur on more than one-third (36 percent), of all TOF lands in the region, but windbreak occurrence and function varies by State (Figs. 18 and 19). For example, windbreaks are found on less than one-fourth (21 percent) of all TOF lands in Kansas but on more than half (62 percent) of TOF lands in North Dakota. The detailed TOF maps produced during GPI 2 provide more specific spatial information about windbreaks. For example, we now estimate there are more than 17,000 miles of windbreaks in Nebraska (Kellerman et al. 2019) and more than 30,000 miles of windbreaks in Kansas (Paull et al. 2019). Similar information for North Dakota (Johnson et al. 2022) and South Dakota (Haugan et al. 2022) is available.

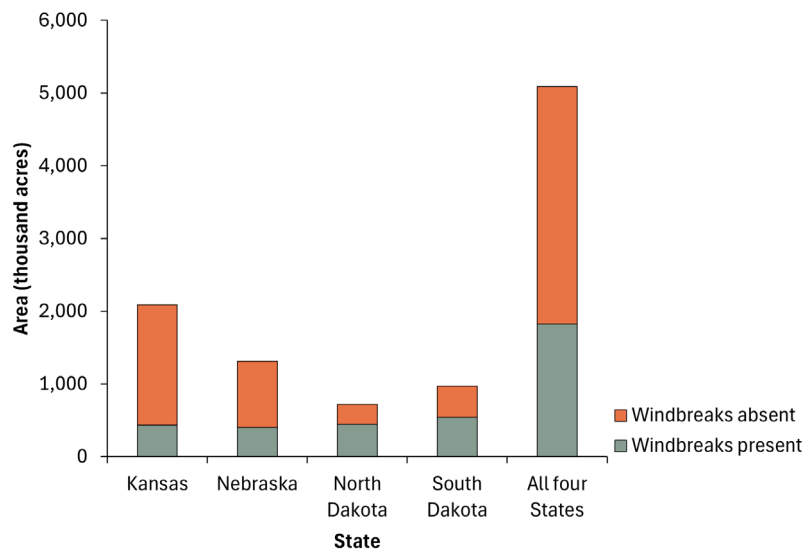


Figure 18.—Area of trees outside forests by windbreak presence or absence, by Northern Great Plains State, derived from the Great Plains Initiative (GPI).

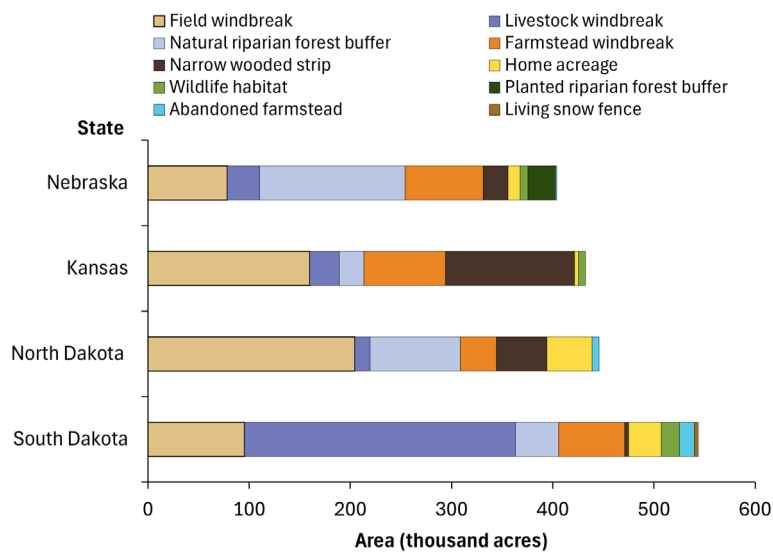


Figure 19.—Primary function of windbreaks by area, Northern Great Plains States, derived from the Great Plains Initiative (GPI).

What this means

The Northern Great Plains region contains a substantial area of lands with trees that do not meet FIA's definition of forest land but are nonetheless an important resource. It is essential that these areas continue to be monitored and protected because they are vital for protecting soil, wildlife, domestic animals, homes, roads, water sources, and recreational areas. The results obtained from the GPI provide useful information for careful management of the TOF resource and of the ecosystem services these trees provide. For example, the data can be used to promote wise windbreak stewardship, which may include monitoring for EAB infestation, removing dead or dying trees, and replacing them with nonsusceptible species. In addition, 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, such as wildlife habitat, windbreak functions, energy savings, and forest product development.

Differences in relative abundance of nonnative and potentially invasive plant species between forested and TOF areas are not surprising because fragmented areas often have higher proportions of nonnative or invasive species, the latter of which can include native species that exhibit invasive behavior. The higher prevalence of invasive tree species such as eastern redcedar, Siberian elm, and Russian olive in TOF areas compared to forest land supports this pattern. Although these species are useful for conservation trees, for example, when planted in windbreaks, they can tolerate conditions where other species struggle to grow and thereby can easily displace native vegetation.

TOF provide important ecological and economical services; two of the most important TOF functions according to Northern Great Plains researchers are windbreaks and riparian buffers. Windbreak location and function maps are important tools for identifying and prioritizing areas that would benefit from the establishment of new windbreaks, e.g., areas with highly erodible soils where windbreaks reduce windspeed and, thus, reduce soil erosion. Additional TOF function maps, such as those that identify riparian forest buffers may be available in the future for monitoring these critical resources.

Forest Health and Ecosystem Indicators



Dakota Prairie Grasslands, Little Missouri National Grassland, Northern Region, North Dakota. USDA Forest Service photo by Kim Grotte.

Regeneration Status

Background

Knowing that an understanding of the understory components of a forested stand is essential for successful future forest management, the Northern Research Station (NRS) FIA unit began an intensified regeneration protocol as part of the Phase 2 plus (P2+) suite of variables in 2012. The measurements in this protocol are made during the summer leaf-on window on 12.5 percent of all plots across the 24 states inventoried by NRS-FIA.

The regeneration indicator (RI) consists of established tree seedling counts categorized by length into six length classes (2.0 to 5.9 inches, 6.0 to 11.9 inches, 1.0 to 2.9 feet, 3.0 to 4.9 feet, 5.0 to 9.9 feet, and 10.0 feet and over). Large-seeded species, i.e., oaks, hickories, and walnuts, must be at least 6.0 inches in length or have a root collar diameter of at least 0.25 inches to be considered established. Additionally, seedlings of these species groups are classified as competitive when they reach a length of 3.0 feet or have a root collar diameter of at least 0.75 inches. Browse impact assessments classify herbivory impacts using evidence including light availability, food availability and preference, competition from understory vegetation, disturbance, and other factors. Five levels of impact (very low, low, moderate, high, and very high) describe forest conditions ranging from protection by a well maintained exclosure fence (very low) to all vegetation showing signs of heavy browsing and presence of an obvious browse line (very high) (USDA Forest Service 2024).

The results presented here are based on the 193 forested RI plots measured across the four States through 2020. They represent a baseline of the intensified regeneration metrics against which future results will be compared.

What we found

The impact of herbivory across the region was generally low, with 44 percent of forest land classified as being in the low impact category and 11 percent in either high or very high classes. To explore browse impacts, understory vegetation cover, and seedling abundance, see the [NRS-FIA Regeneration Dashboard](#) (Albright 2025). The 24 Northern Research Station FIA states are selected by default.

Regional variations in browse severity were evident. Across North and South Dakota, over three quarters of forest land fell in the low impact class while 65 percent of forest land in Nebraska and Kansas were affected by moderate browse impacts, though the incidence of high or very high were similar in the two regions. Higher browse impacts are generally associated with lower levels of advanced regeneration, i.e., fewer seedlings per acre.

Across the Northern Great Plains, there was an average of 4,184 seedlings per acre with nearly one-third of those being under 6.0 inches in length and an equal amount between 1.0 and 3.0 feet in length (Table 3). Again, the distribution of regeneration varies by geography. The Dakotas had 2,589 seedlings per acre and only 21 percent were under 6.0 inches. Nearly one-quarter of seedlings in the two States were over 3.0 feet in length. Seedling density was almost double in Nebraska and Kansas where there was an average of 5,227 seedlings per acre. However, 34 percent of these seedlings were under 6.0 inches and only 8 percent exceeded 3.0 feet in length. The effects of herbivory are evident in seedling counts as well. Samples in locations with high or very high deer impacts had only 1,406 seedlings per acre, 40 percent of which were under 6.0 inches in length. Where herbivory is low, 3,325 seedlings per acre were found with less than one-quarter in the shortest length class.

Table 3.—Seedlings per acre of forest land by length class and State, Northern Great Plains, 2020

State	2.0–5.9 inches	6.0–11.9 inches	1.0–2.9 feet	3.0–4.9 feet	5.0–9.9 feet	10.0+ feet	Total
Kansas	1,982	1,878	2,122	290	190	50	6,512
Nebraska	1,456	607	492	154	73	9	2,790
North Dakota	1,474	923	1,595	414	188	44	4,638
South Dakota	261	408	721	240	274	67	1,971
Region-wide average	1,303	1,079	1,308	258	191	46	4,184

Hackberry was the most abundant seedling across the combined States with a total of 1,055 seedlings per acre (Fig. 20). American elm had an average of 849 seedlings per acre though nearly half were under 6.0 inches in length. Chokecherry, green ash, and eastern redbud round out the five most abundant seedling species. Ponderosa pine and eastern redcedar were the only softwoods in the 10 most abundant seedling species and were nearly equal at 140 and 136 seedlings per acre, respectively.

Of course, species abundance varies across the States of the region. Kansas and Nebraska both have hackberry and American elm as the most common species though the distribution across length classes varies. A higher proportion of seedlings for these species (89 percent) were under 1.0 foot in length in Nebraska. Chokecherry was the most common species in the Dakotas. Ponderosa pine in South Dakota was nearly as abundant as chokecherry at 428 seedlings per acre and was notable for having over 60 percent of seedlings in length classes of at least 3.0 feet.

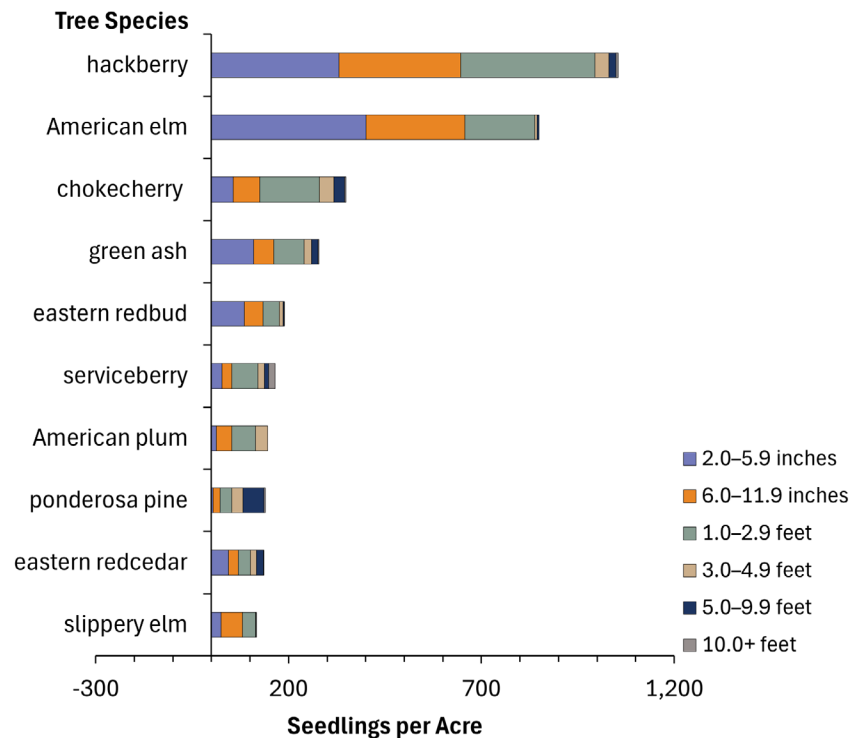


Figure 20.—Seedlings per acre of forest land by length class for the 10 most abundant seedling species, Northern Great Plains States, 2020.

What this means

The future of a healthy forest relies on the regeneration of trees to replace the portion of the resource lost to disturbances and mortality. Quantifying and analyzing such trends can provide the first signs of impending issues. Comparisons of regeneration and overstory can point to potential shifts in future forest composition. The baseline regeneration indicator data shows that browse impact is relatively low overall though the proportion of area showing moderate impacts indicates that herbivory does affect regeneration in the region. Initially, it appears that hackberry and American elm are overrepresented in the regeneration indicator data when compared to the overstory. However, a high proportion of the seedlings are less than 12.0 inches in length and relatively few American elm seedlings are over 3.0 feet. Thus, it is unlikely that these species will be gaining prominence in the forests of the region, but this baseline regeneration data provides the benchmark against which results will be compared in the future.

Forest Insect and Disease Activity

Insects and disease pathogens help shape the structure and composition of forest ecosystems. Monitoring their status provides a measure of forest health and is crucial in assessing the current state and changing trends in the forests of the Northern Great Plains. Mortality caused by insect and disease activity can be hard to differentiate from other causes and natural senescence. The ratio of mortality-to-gross growth volume has been used as a national indicator of mortality; ratios above 0.6 are considered high and may be indicative of an acute forest health issue, if forests are not senescing (Ambrose 2019). Further, a high mortality-to-gross growth ratio, in combination with high average annual mortality as a percentage of live volume suggests an increased likelihood of a serious threat to forest health.

Over the 2020 inventory cycle, Northern Great Plains forests have been impacted by a variety of insects and diseases, including emerald ash borer, Diplodia tip blight, pine wilt, mountain pine beetle (*Dendroctonus ponderosae*), and Dothistroma needle blight, along with abiotic stresses, such as weather and herbicide damage. For more information on current forest health concerns, see the State forest health websites for Kansas, Nebraska, North Dakota, and South Dakota.

Emerald ash borer

Background

Following the initial North American detection of emerald ash borer (*Agrilus planipennis*; EAB) near Detroit, Michigan in 2002, the wood-boring beetle was identified in Kansas in 2012, Nebraska in 2016, South Dakota in 2018, and remains undetected in North Dakota. All North American ash (*Fraxinus* spp.) are hosts of EAB; however, host preference appears to vary by species, with consistent observations of high mortality among green and black ash, and variable mortality of white ash (Herms and McCullough 2014, McCullough 2020). Although EAB shows some preference for stressed trees, all ash trees are susceptible regardless of vigor.

What we found

Ash trees represent 9 percent (191.3 million trees at least 1.0-inch d.b.h.) of total species abundance on forest land across the Northern Great Plains. Ash is most abundant in North Dakota, where it makes up 25 percent of the tree resource. Green ash is most abundant (94.1 percent), followed by white ash (5.6 percent), black ash (0.3 percent), and blue ash (less than 0.1 percent) (Fig. 21). Combined, ash species have a high mortality-to-gross growth ratio in Kansas and Nebraska, 0.66 and 0.63, respectively (Fig. 22).

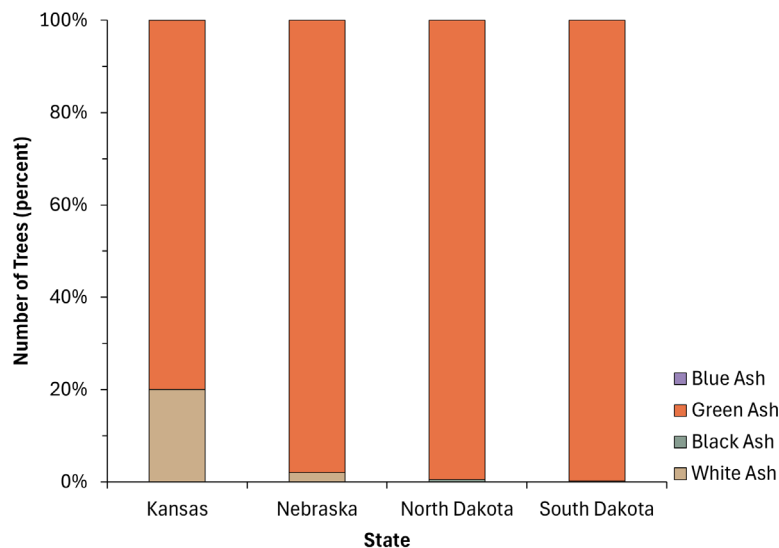


Figure 21.—Proportion of live trees on forest land by ash species and State, Northern Great Plains, 2020.

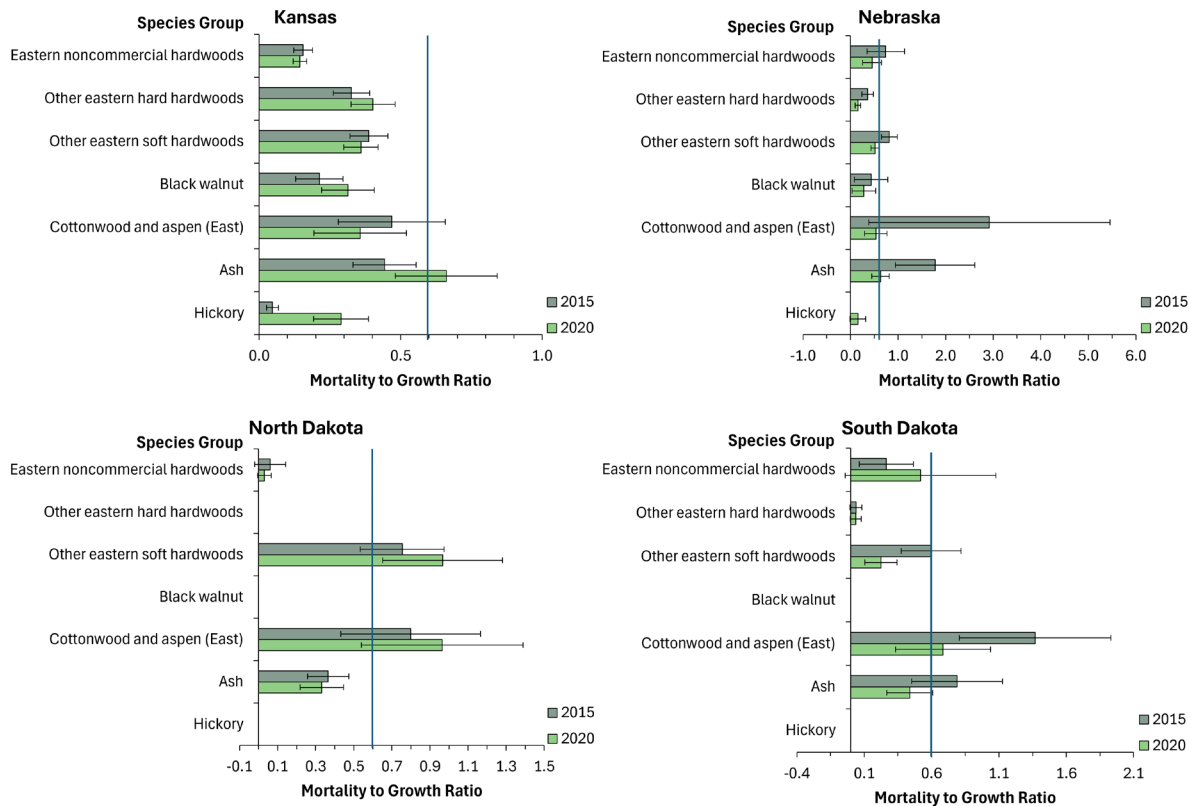


Figure 22.—Ratio of average annual mortality volume to gross growth volume for selected species groups on forest land by State, Northern Great Plains. Error bars represent a 68 percent confidence interval. The blue vertical line indicates the 0.6 threshold for acute health issue (Ambrose 2019).

What this means

Given that EAB has caused extensive ash mortality in the United States, it represents a significant threat to the rural and forested ash resource in the Northern Great Plains. Not surprisingly, the mortality-to-gross growth ratio is high (greater than 0.6) in Kansas and Nebraska, where EAB has been present the longest. This high mortality-to-gross growth ratio indicates that current statewide mortality of ash exceeds growth. Ash mortality is expected to increase as EAB persists and populations spread. While the loss of ash in forested settings will affect species composition and alter community dynamics, ash mortality in windbreaks and riparian areas will impact erosion control and water quality. Therefore, continued monitoring will help to identify the long-term impacts of EAB in the Northern Great Plains.

Invasive Plant Species

Background

Invasive plant species (IPS) are both native and nonnative species that spread aggressively and can outcompete surrounding vegetation, causing deleterious impacts. Within ecosystems they can alter nutrient availability, shade out or strangle desirable species, impact aesthetics, and cause negative economic impacts. Not only are these plants economically burdensome within forests, but they are also costly to manage in farmland and urban areas. Many of these species use efficient propagation methods such as rooting from small fragments and prolific seed production. Some IPS have beneficial uses such as for ecological site remediation, medicinal, and culinary use, however their negative impacts are worrisome, especially in the Northern Great Plains States where there is expansive agriculture. Species such as common barberry (*Berberis vulgaris*), is an alternate host for wheat stem rust, which can cause the loss of entire grain fields. Common buckthorn (*Rhamnus cathartica*) is another troublesome IPS that is problematic because it is the alternate host for the soybean aphid (*Aphis glycines*) (Kurtz 2013).

FIA assessed the presence and cover of 44 IPS (43 species and 1 undifferentiated genus: nonnative bush honeysuckle, or *Lonicera* spp.) as part of the P2+ protocols; this subset is made up of 193 forested plots that were monitored for IPS throughout the four States as part of the 2020 inventory. To maintain regional consistency, the species list (Appendix 2) represents native and nonnative species of regional concern and is not specific to the four States.

What we found

Of the 44 IPS monitored, 17 were found on forested P2+ plots in the Northern Great Plains States. Siberian elm is the most common (24 plots; 12.4 percent of plots) and is found in all four States with heaviest presence in the eastern half of the region (Fig. 23). It is found at over 10.0 percent presence in all States except South Dakota where it is found at 7.8 percent. After Siberian elm, the next most commonly observed species are bull thistle (*Cirsium vulgare*) and garlic mustard (*Alliaria petiolata*) (16 plots; 8.3 percent of plots). The presence of bull thistle has been observed in three of the four Northern Great Plains States, with the exception being North Dakota (Fig. 24). The occurrences appear to be concentrated in the Black Hills National Forest; however, it is important to note that forest land is concentrated in this area and thus a higher concentration of field plots that are monitored for IPS; nonforest plots are not measured for IPS so no IPS data are available for those plots. Garlic mustard has not been observed in the western part of the region or in South Dakota; the highest concentration was found in eastern Kansas.

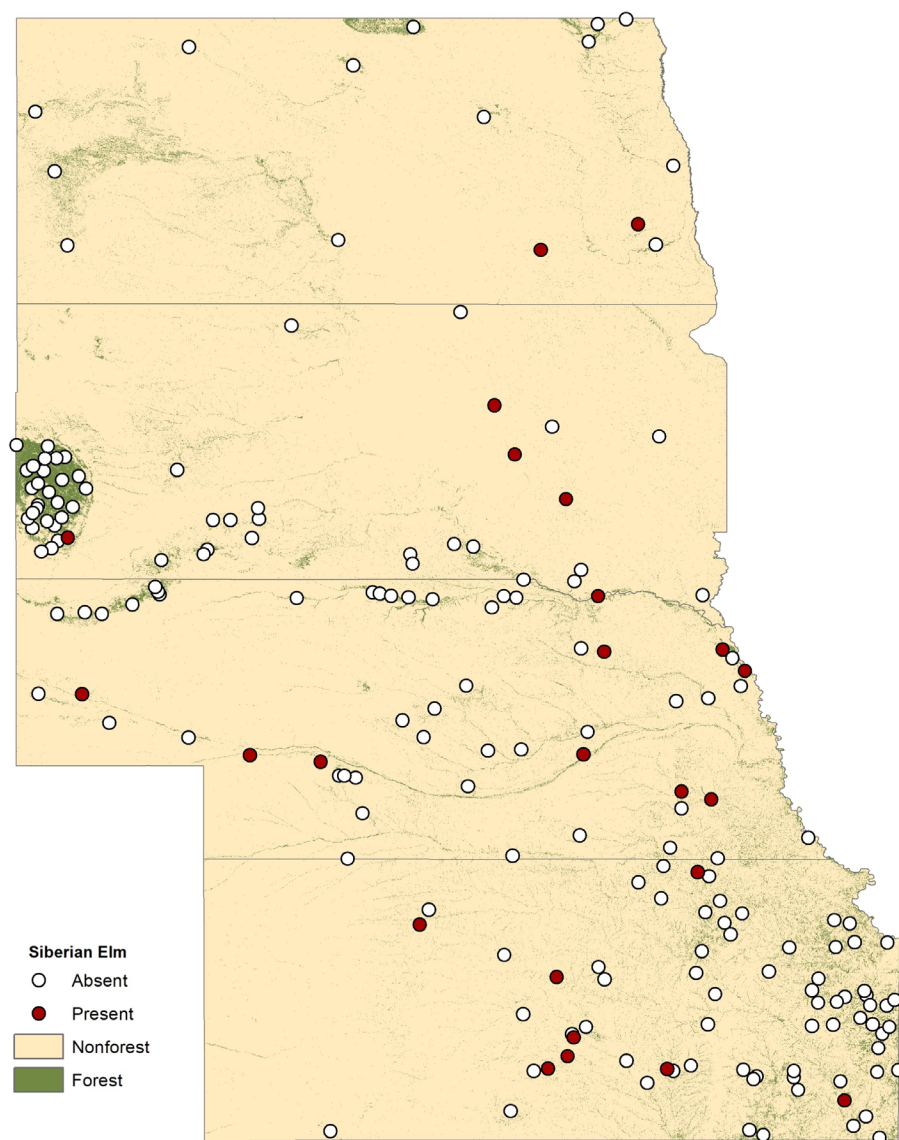


Figure 23.—Presence of Siberian elm on forested Forest Inventory and Analysis P2+ plots, Northern Great Plains States, 2020. Plot locations are approximate.

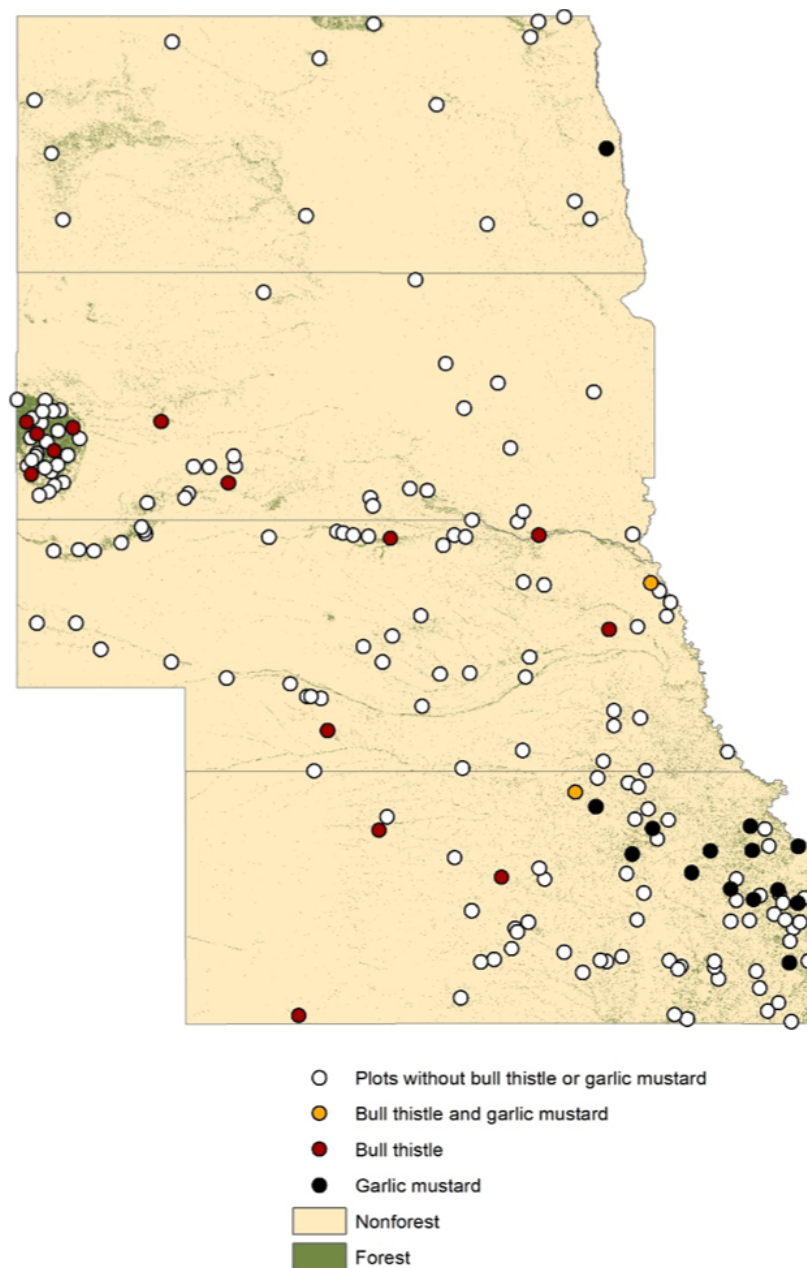


Figure 24.—Presence of bull thistle and garlic mustard on Forest Inventory and Analysis P2+ plots, Northern Great Plains States, 2020. Plot locations are approximate.

The number of IPS found varies by State. Nebraska has the highest number of different invasive plant species present on forested plots (13), followed by Kansas (10), North Dakota (8), and South Dakota (4) (Table 4). Additionally, the species most frequently observed varies with garlic mustard most common in Kansas (19.2 percent of plots), Siberian elm in Nebraska (18.5 percent), nonnative bush honeysuckle in North Dakota (53.3 percent), and Canada thistle in South Dakota (15.7 percent). As a percentage of forested plots that have IPS present (Table 5), South Dakota is highest at 62.7 percent, followed by Kansas at 52.1 percent, Nebraska at 51.9 percent, and North Dakota with 6.7 percent. Again, it is important to note the number of forested plots per State: Kansas (73), Nebraska (54), North Dakota (15), and South Dakota (51).

Table 4.—Invasive plant species recorded on Forest Inventory and Analysis P2+ plots by State, Northern Great Plains, 2020

State	Common name	Number of occurrences	Percentage of plots
Kansas	garlic mustard	14	19.2
	Amur honeysuckle	10	13.7
	Siberian elm	8	11.0
	bull thistle	4	5.5
	multiflora rose	4	5.5
	autumn olive	3	4.1
	Japanese honeysuckle	3	4.1
	dames rocket	1	1.4
	reed canarygrass	1	1.4
	Russian olive	1	1.4
Nebraska	Siberian elm	10	18.5
	reed canarygrass	9	16.7
	bull thistle	5	9.3
	Canada thistle	5	9.3
	dames rocket	3	5.6
	leafy spurge	3	5.6
	Russian olive	3	5.6

Continued on next page

Table 4.—(Continued)

State	Common name	Number of occurrences	Percentage of plots
Nebraska (cont.)	common buckthorn	2	3.7
	multiflora rose	2	3.7
	nonnative bush honeysuckle	2	3.7
	black locust	1	1.9
	garlic mustard	1	1.9
	saltcedar	1	1.9
North Dakota	nonnative bush honeysuckle	8	53.3
	reed canarygrass	5	33.3
	leafy spurge	3	20.0
	Canada thistle	2	13.3
	common buckthorn	2	13.3
	Siberian elm	2	13.3
	garlic mustard	1	6.7
	Tatarian honeysuckle	1	6.7
South Dakota	Canada thistle	8	15.7
	bull thistle	7	13.7
	Siberian elm	4	7.8
	common buckthorn	1	2.0

See Appendix 2 for the list of invasive plant species monitored that includes the common and scientific names.

Table 5.—Number of invasive plant species recorded on Forest Inventory and Analysis P2+ plots by State, Northern Great Plains, 2020

State	Number of invasive plant species	Number of plots	Percentage of plots
Kansas	0	38	52.1
	1	25	34.2
	2	6	8.2
	3	4	5.5
Nebraska	0	28	51.9
	1	14	25.9
	2	5	9.3
	3	5	9.3
	4	2	3.7
North Dakota	0	1	6.7
	1	5	33.3
	2	8	53.3
	3	1	6.7
South Dakota	0	32	62.7
	1	18	35.3
	2	1	2.0

Comparing the 2020 data to 2015, Kansas had one of the three species of the top three remain the same (garlic mustard). Nebraska had two of the top three species remain the same (Siberian elm and reed canary grass [*Phalaris arundinacea*]). North Dakota had all three remain unchanged and they also held the same rank. South Dakota is very similar with the same species in the top three but the first and second most common species changed with Canada thistle (*Cirsium arvense*) becoming more common than bull thistle in 2020. It is important to note that the species level nonnative bush honeysuckle observations are not combined with the genus level observations; this alters the abundance and ranking in the 2020 inventory versus the 2015 inventory when the species level observations were included with the genus level records.

What this means

Invasive plants have become an important management concern. Attentive monitoring of these species is useful to document changes in their abundance. IPS can reduce timber and agricultural yields and require substantial finances and labor to control. Disturbances by fragmentation, ungulates, and human activities can facilitate spread, however, some IPS are able to spread with little or no disturbance. It is important to see how the presence of these IPS composition changes over time. In comparison to 2015 data, more IPS were found and the percentage of plots the species were found on was generally higher in the Northern Great Plains States.

Forest Carbon

Background

Among terrestrial ecosystems, forests contain the largest reserves of sequestered carbon. The accumulation of carbon in forests helps to mitigate emissions of carbon dioxide to the atmosphere from sources such as wildfires or the burning of fossil fuels. Carbon accumulates in growing trees via the photosynthetically driven production of structural and energy-containing organic (carbon) compounds that primarily accumulate in trees as wood; approximately 50 percent of tree biomass is carbon (based on dry weight). Over time, this stored carbon also accumulates in standing dead trees, down woody materials, litter, and forest soils. The FIA program uses a combination of field measurements and models to estimate forest carbon stocks. Procedures for the estimation of carbon are detailed in U.S. EPA (2023). Forest carbon is often broken down into storage pools. The carbon storage pools and their relative components discussed here are defined as: live biomass (live trees at least 1.0 inch d.b.h./d.r.c. and live understory vegetation), dead wood (standing dead trees at least 1.0 inch d.b.h./d.r.c. and down dead wood), forest floor litter, and soil organic matter estimated to a depth of 1-meter (39 inches).

What we found

Total carbon stocks on forest land in the Northern Great Plains States are an estimated 519 million tons: 215 million tons in Kansas, 106 million tons in Nebraska, 66 million tons in North Dakota, and 132 million tons in South Dakota. Overall, this represents a slight decline in stocks from 2015. Carbon density in the Northern Great Plains is an estimated 78 tons per acre of forest land, which has remained stable since 2015. Soil organic carbon and live trees are the largest components of stored carbon; combined, these account for 92 percent of forest carbon stocks across the region and represent at least 89 percent of each individual State's total forest carbon stock (Fig. 25).

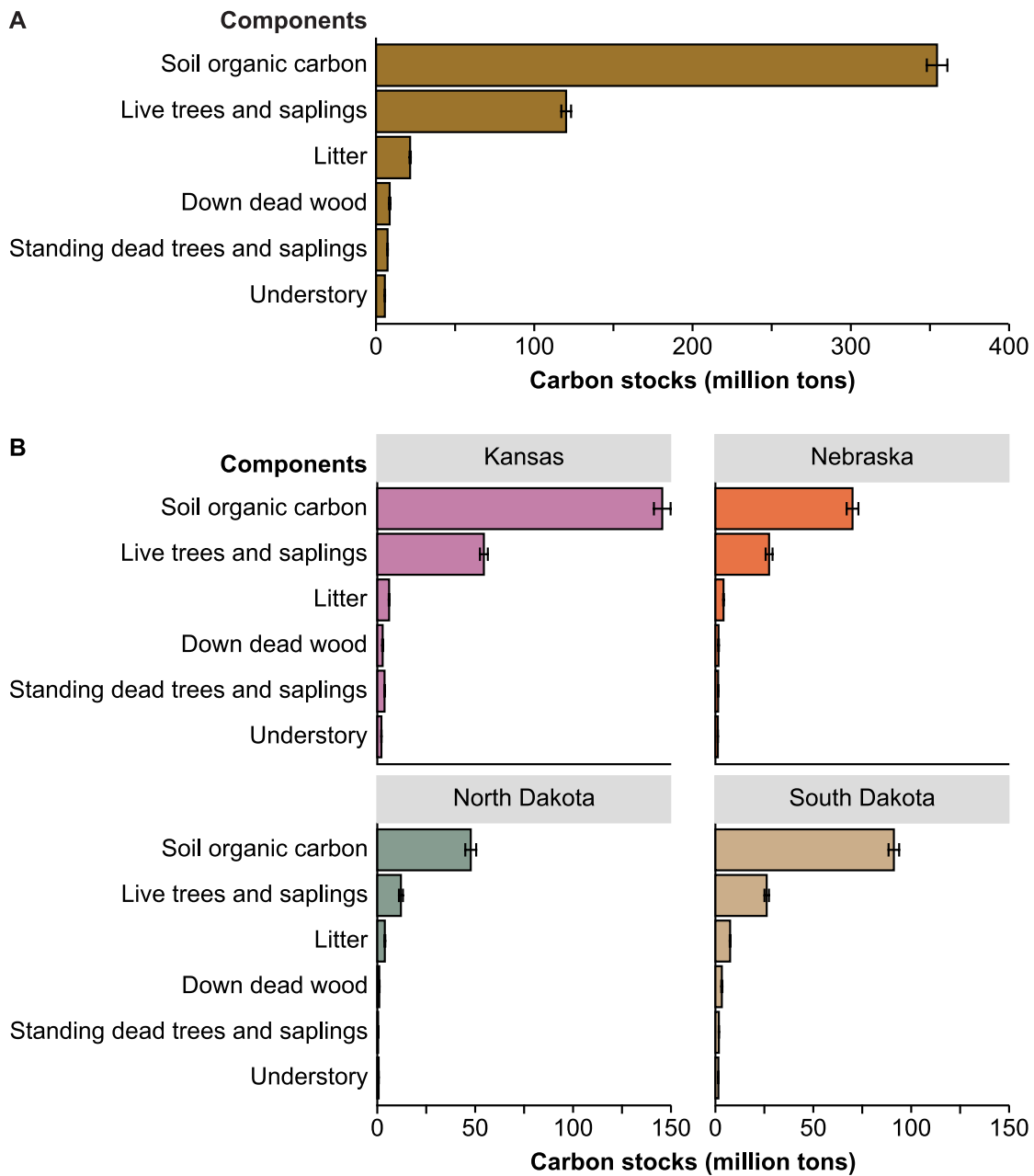


Figure 25.—Carbon stocks by component on forest land by region (A) and by State (B), Northern Great Plains, 2020. Error bars represent a 68 percent confidence interval around each estimate.

Regionally and by State, the majority of Northern Great Plains forest carbon stocks are in large diameter stands (58 percent of total forest carbon); This is true in each State (in Kansas 59 percent of forest carbon stocks are in large diameter stands, 66 percent in Nebraska, and 61 percent in South Dakota); except in North Dakota, where 37 percent of carbon stocks are in large diameter stands and 41 percent are in medium diameter stands. As stands mature and become dominated by larger diameter trees, total carbon density generally increases, driven in large part by net carbon accumulation in live biomass (Fig. 26).

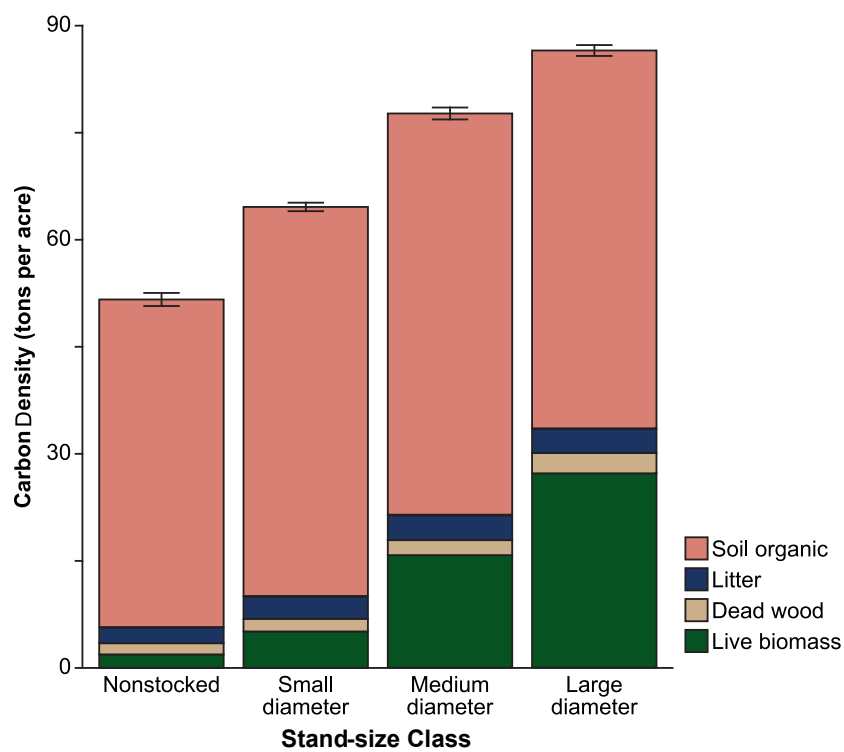


Figure 26.—Carbon density by stand-size class and carbon pool, Northern Great Plains States, 2020. Error bars represent a 68 percent confidence interval around the total density estimate (all pools).

Carbon density varies by forest-type groups with the live biomass pool being most affected by species composition (e.g., forest-type groups dominated by long-lived species can have a higher proportion of live biomass carbon). Among the forest-type groups that account for at least 1 percent of Northern Great Plains forest carbon, total density was highest in the elm/ash/cottonwood forest-type group (89 tons per acre) followed very closely by the oak/hickory group with 88 tons per acre (Fig. 27).

As the oak/hickory forest-type group is the most dominant by area, it therefore contributed most to total carbon stocks in the region (35 percent), followed by the elm/ash/cottonwood group with 24 percent of the total and the ponderosa pine group with 16 percent (Fig. 28).

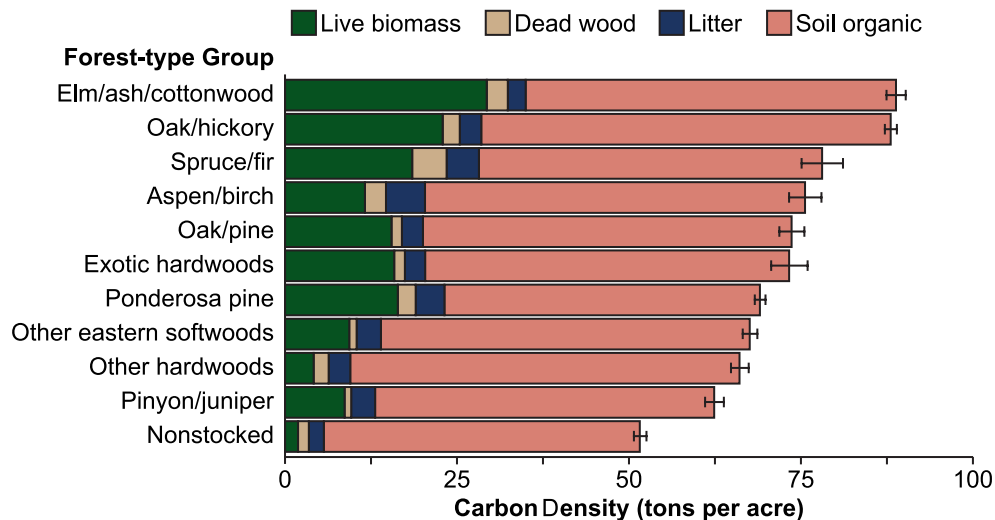


Figure 27.—Carbon density by forest-type group and carbon pool, Northern Great Plains States, 2020. Error bars represent a 68 percent confidence interval around the total carbon density estimate (all pools).

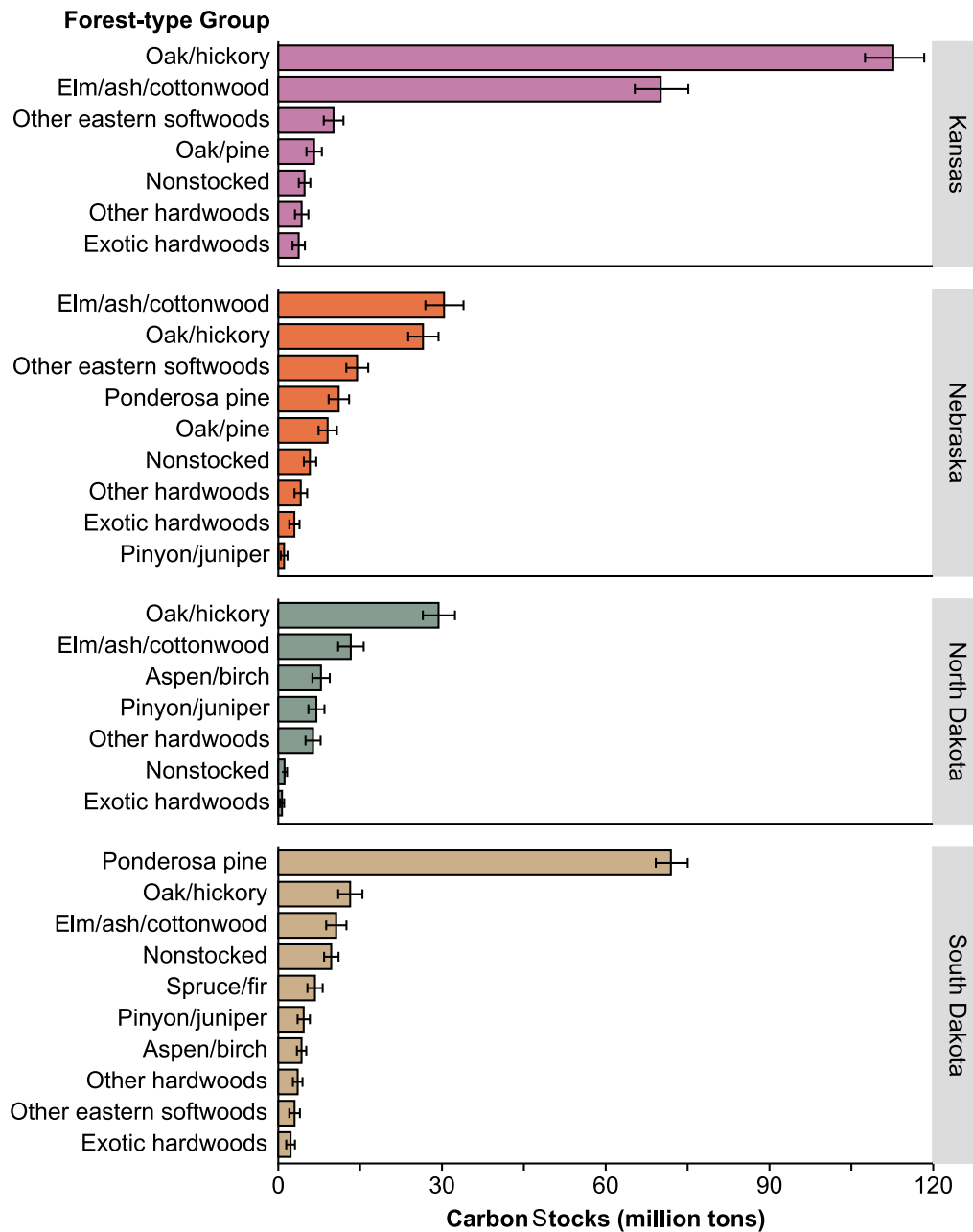


Figure 28.—Carbon stocks by forest-type group and State, Northern Great Plains, 2020. Forest-type groups included account for at least 1 percent of the State's total carbon stocks. Error bars represent a 68 percent confidence interval around each estimate.

What this means

The slight decline in forest carbon stocks throughout the Northern Great Plains region is most likely due to a decrease in forest area. Maturing stands accumulating carbon in the live biomass pool has contributed to the unchanged carbon density despite the loss of forest land area. Soil organic carbon stocks represent the largest pool in the Northern Great Plains and are important to long-term carbon storage. As live biomass also represents a substantial amount of the total carbon, there are opportunities to increase carbon stocks in the near term, as this pool is most affected by forest management. However, the greatest threat to the carbon stocks in Northern Great Plains forests is loss of forest land. As mitigating U.S. greenhouse gas emissions becomes increasingly important, an understanding of trends in carbon sequestration in the face of land-use change will be an essential tool for forest managers.

Average Annual Net Growth, Removals, and Mortality

Background

Forests are a renewable resource if they are managed to provide a constant supply of useful products without diminishing long-term productivity. The rate of growth is an indicator of the overall condition of a stand as well as forest health, successional stage, and tree vigor. Average annual net growth (gross growth minus mortality) is calculated by measuring trees (timber species at least 1.0-inch d.b.h. and woodland species at least 1.5-inch d.r.c.) at two points in time and determining the average annual change over the time period. Negative net growth occurs when mortality exceeds gross growth and is indicative of a serious forest health issue and results in a reduction of total inventory volume. Average annual net growth estimates reported here are based on the change in volume of growing stock on timberland between inventories. The terms average annual net growth and net growth are used interchangeably. A useful measure to assess growth is the ratio of annual net growth to current inventory volume.

Mortality is a natural part of stand development in healthy forest ecosystems. Many factors contribute to mortality, including competition, succession, insects, disease, fire, human activity, and severe weather events. Mortality is often initiated by one causal agent (inciting factor) that is followed by other contributing stress factors, making it difficult to identify the underlying cause. Although mortality is a natural event in a functional forest ecosystem, dramatic increases in mortality can be an indication of forest health problems. Average annual growing-stock mortality estimates represent the average cubic-foot volume of sound wood that dies each year between inventories.

What we found

Since 2010, average annual net growth of sound total-stem volume has decreased in the forests of the Northern Great Plains while average annual mortality and removals have increased slightly (Fig. 29). Net growth averaged 162.5 million cubic feet annually as of 2020, and the ratio of net growth to removals (1.5:1.0) decreased from 2010 (2.6:1.0) and 2015 (2.2:1.0). Annual net growth as a percentage of sound total-stem volume has been generally decreasing since 2010. By contrast, annual mortality averaged 212 million cubic feet as of 2020 and as a percentage of mortality has been generally increasing since 2010 (1.5:1.0 to 2.0:1.0). Softwoods comprise 42 percent of the annual mortality despite only making up 30 percent of sound total-stem volume. During the same period, annual removals of sound total-stem volume have remained relatively stable at about 100 million cubic feet annually. The balance of growth, removals, and mortality results in an average annual net change in sound total-stem volume of approximately 56 million cubic feet per year for 2020 (0.5 percent per year). This is a decrease from the net change rate of 1.4 percent annually from 2010.

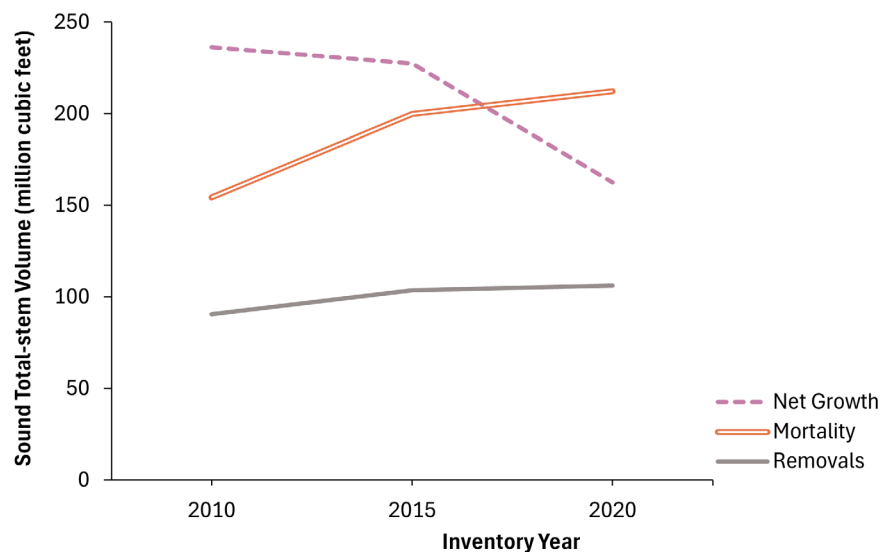


Figure 29.—Average annual net growth, mortality, and removals of sound total-stem bark and wood volume of trees by inventory year, Northern Great Plains States.

Variation between species was considerable. Species with notable annual net growth as of 2020 include eastern redcedar, red mulberry, and hackberry which are all above 3 percent of sound total-stem volume per year. By contrast, green ash annual net growth is below 1 percent (0.7 percent), and ponderosa pine had annual net growth rate at -1.2 percent (Fig. 30).

Many of the abundant species in the forests of the Northern Great Plains have relatively low mortality rates that are below the 2 percent annual average rate for all species combined. In contrast, ponderosa pine has a mortality rate that is nearly double the region-wide average (Fig. 31). A large proportion of the mortality can be explained by the impacts of insects (61 percent) and fire (26 percent) on ponderosa pine.

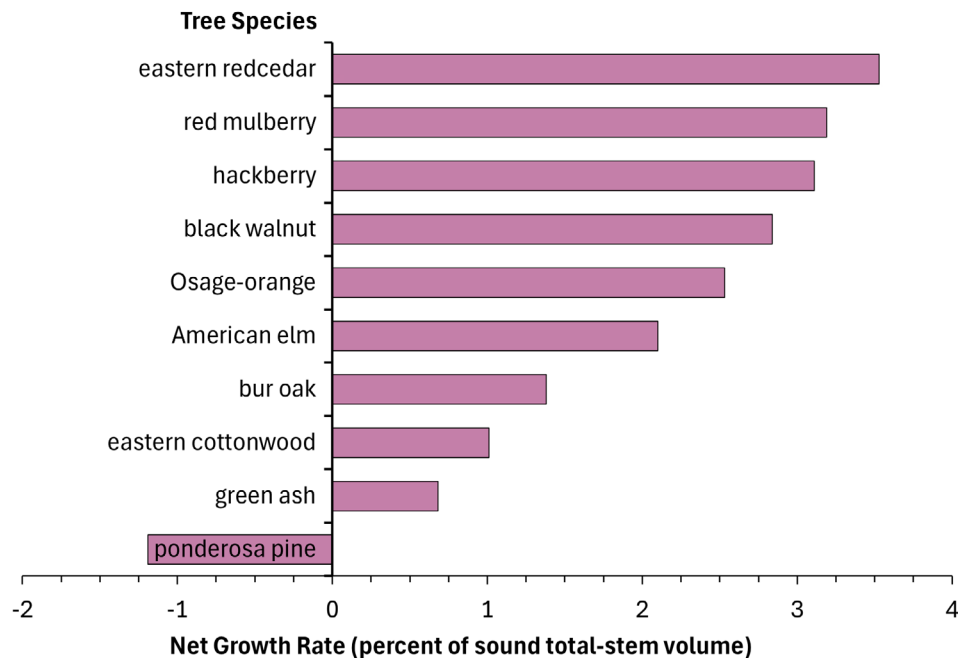


Figure 30.—Average annual net growth of sound total-stem bark and wood volume of trees as a percentage of sound total-stem bark and wood volume of trees for the 10 species with the highest volume, Northern Great Plains States, 2020.

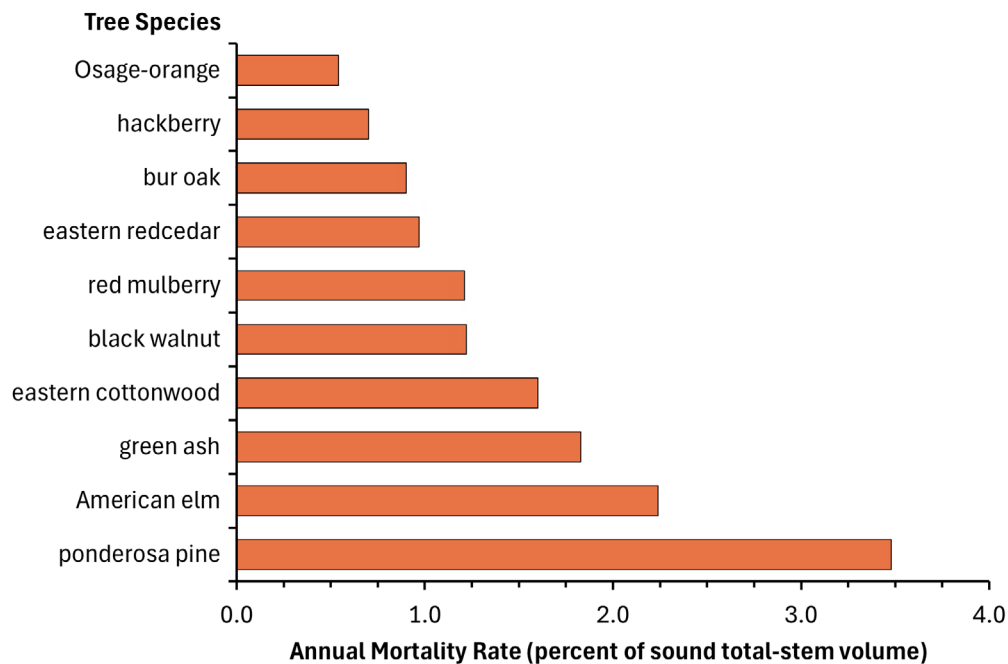


Figure 31.—Average annual mortality of sound total-stem bark and wood volume of trees as a percentage of sound total-stem bark and wood volume of trees for the 10 species with the highest volume, Northern Great Plains States, 2020.

What this means

The growth-to-removal ratio in the Northern Great Plains remains positive (1.5:1.0) although it has decreased substantially over the last decade. Most of the decreases in average annual net growth and net change are due to increases in mortality. Fortunately, all the removals volume is due to harvesting and not land-use change. Trees can be expected to regenerate if the land is not developed.

Forest Resource Attributes



Keeper of the Plains sculpture in downtown Wichita, Kansas. Licensed photo by Matthew Robey/Flickr. <https://flic.kr/p/o2BZqt>.

Volume

Background

The assessment of the volume of live trees provides information on trends in the resource, the potential uses of that wood, and its economic value. Current volumes and changes in volume over time can characterize forests and reveal important resource trends. FIA reports volume for trees at least 5.0 inches d.b.h./d.r.c. by several categories, including sound, net, growing stock, and sawtimber. Sound volume is the total volume less deductions for rotten and unsound wood. Net volume is sound volume minus additional deductions for roughness and form defects and is computed for the central stem from the 1-foot stump to a 4.0-inch top diameter outside bark (for woodland species, deductions are computed for the central stem from the point of diameter at root collar measurement to a 1.5-inch top diameter outside bark). Growing-stock volume excludes rough or rotten cull trees and non-commercial species. Volume estimates for sound, net, and growing stock are reported in cubic feet. Trees classified as rough cull either have two-thirds of their volume not meeting merchantable requirements with the majority of that volume being rough cull or are not a commercial species. Rotten cull trees have two-thirds of their volume as cull and the majority is unsound or rotten cull. While rough and rotten cull trees may not be available for timber utilization, they provide critical wildlife habitat and carbon storage. Estimates of sawtimber volume are reported in board feet (International ¼-inch), from a 1-foot stump for hardwoods, minimum 11.0 inches d.b.h./d.r.c. to a 9-inch top diameter, and from stump for softwoods, minimum 9.0 inches d.b.h./d.r.c. to a 7-inch top diameter.

What we found

Sound volume on forest land decreased 4 percent from 2015 to 2020 to 8.4 billion cubic feet, and 94 percent of that volume was on timberland. The remaining 6 percent of sound volume is located on land that is either excluded from timber management (reserved forest land) or land that does not meet minimum productivity standards (other forest land). The percentage of sound volume that is in hardwood species varies by State in the Northern Great Plains and ranges from 21 percent in South Dakota to 96 percent in Kansas (Fig. 32).

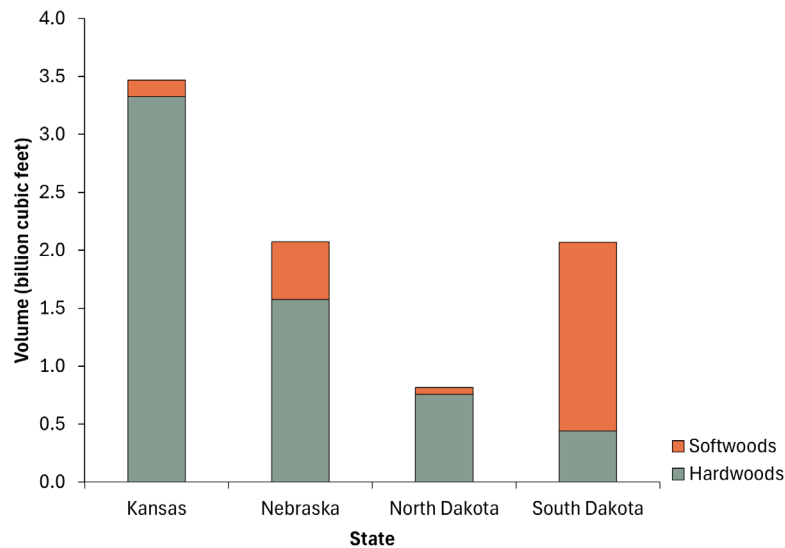


Figure 32.—Sound volume on forest land by State and major species group, Northern Great Plains, 2020.

Total net volume on timberland was 7.7 billion cubic feet, a 5 percent decrease since 2015. Kansas accounts for approximately 42 percent of the total volume with more than 3.2 billion cubic feet (Fig. 33). Most of the net volume loss was observed in Nebraska and South Dakota. While some of this decrease can be attributed to a decline in timberland area, per acre estimates of net volume also went down in South Dakota (Fig. 34).

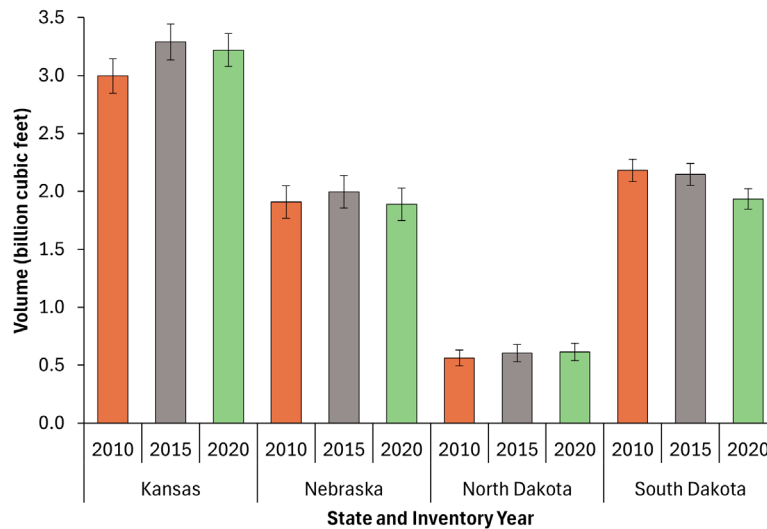


Figure 33.—Net volume of live trees on timberland by State and inventory year, Northern Great Plains. Error bars represent a 68 percent confidence interval.

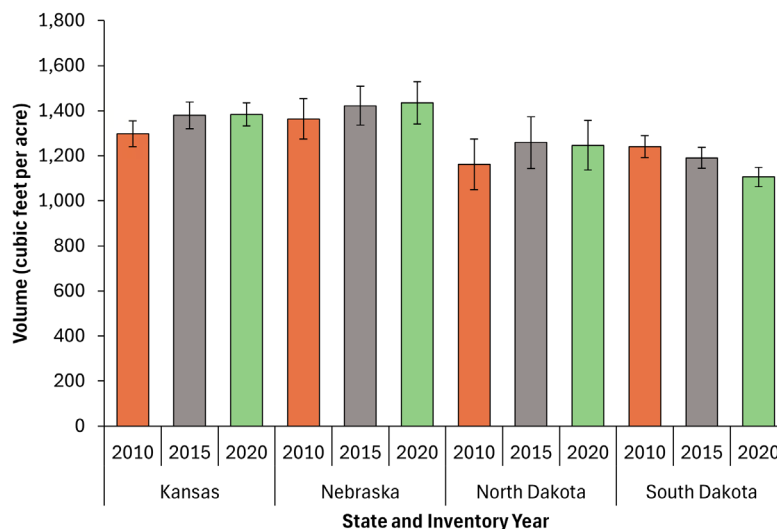


Figure 34.—Net volume per acre of live trees on timberland by State and inventory year, Northern Great Plains. Error bars represent a 68 percent confidence interval.

Growing-stock volume in the Northern Great Plains was 3.9 billion cubic feet, a 14 percent decrease from 2015. South Dakota has the most growing-stock volume with 1.6 billion cubic feet, followed by Kansas (1.1 billion cubic feet), Nebraska (863.2 million cubic feet), and North Dakota (613.2 million cubic feet). South Dakota also has the highest proportion of its net volume in growing-stock trees at 81 percent while Kansas has the lowest at 34 percent (Fig. 35). Rotten cull volume remains low in all States in the Northern Great Plains.

Among species with at least 1 percent of total net volume, the proportion of that volume that is in growing-stock trees varies widely. Boxelder, honeylocust, and red mulberry have nearly all of their net volume in rough cull trees (Fig. 36). The two softwoods on the list, ponderosa pine and white spruce, have nearly all of their net volume in growing-stock trees. Eastern cottonwood and northern red oak have the highest growing-stock proportions among hardwoods with 70 percent and 68 percent, respectively.

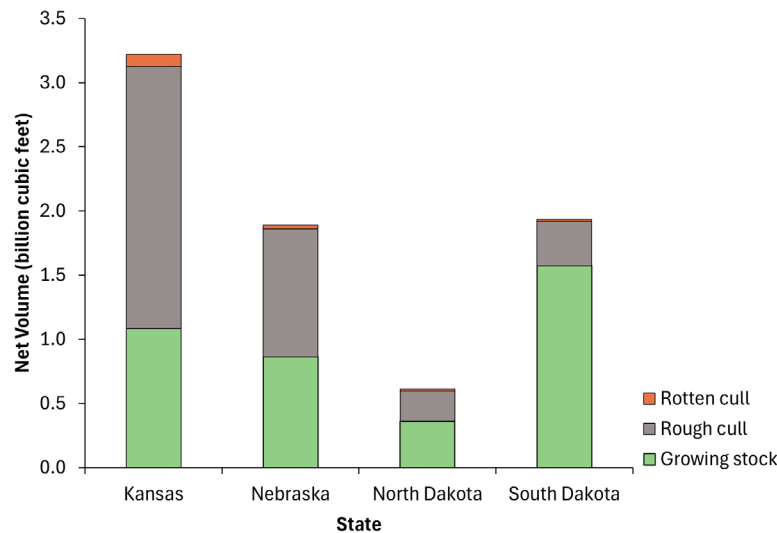


Figure 35.—Net volume on timberland by State and tree class, Northern Great Plains, 2020.

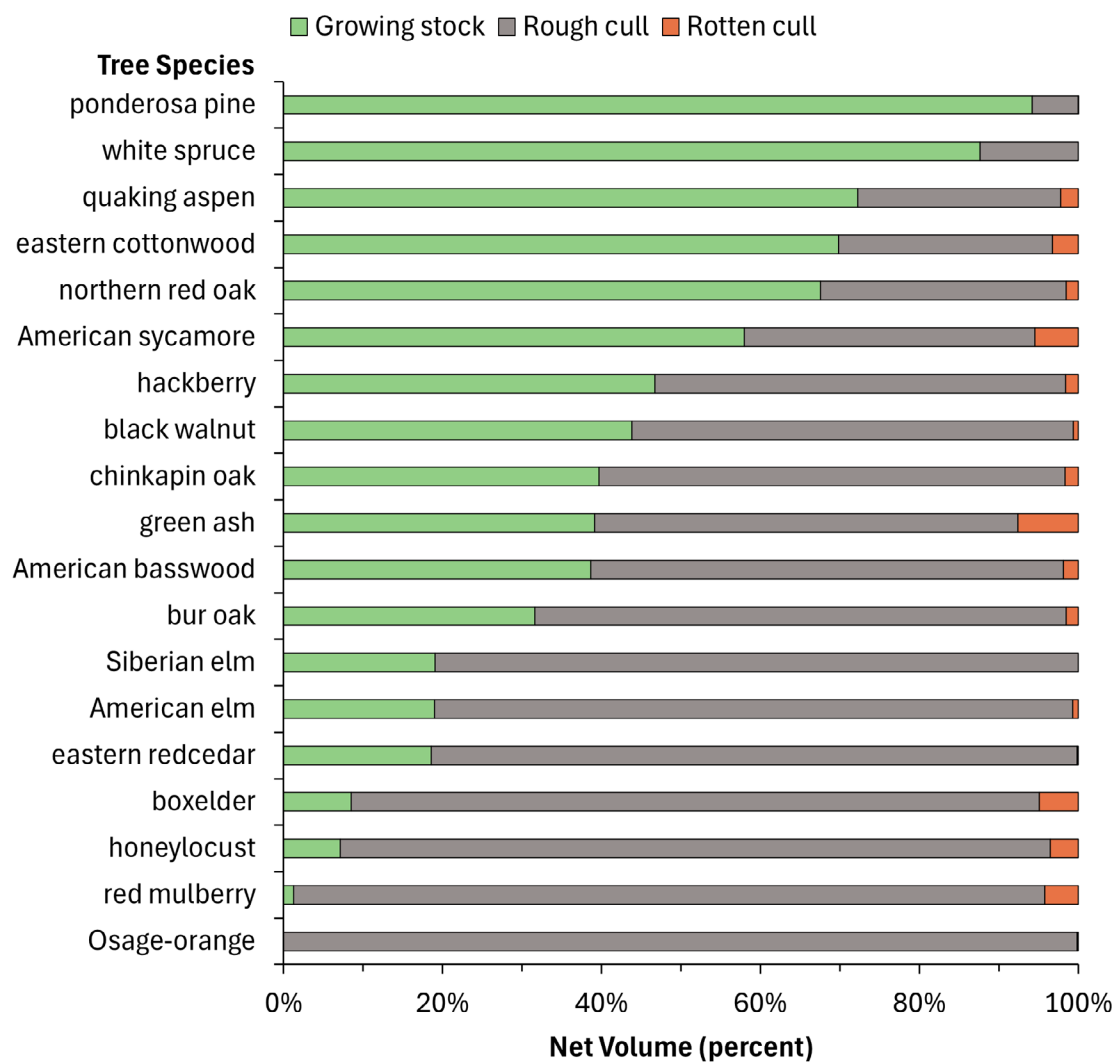


Figure 36.—Percentage of timberland net volume of species having at least 1 percent of total net volume by species and tree class, Northern Great Plains States, 2020.

Sawtimber volume was 15.3 billion board feet in the Northern Great Plains, a 13 percent decrease from 2015. Ponderosa pine and eastern cottonwood together account for more than 60 percent of the sawtimber volume in the Northern Great Plains (Fig. 37). The dominant pine species in the region saw an 11 percent loss in sawtimber volume from 2015 to 2020. Bur oak and northern red oak also experienced reductions in sawtimber volume over the same time period, 14 percent and 29 percent respectively. No species with at least 1 percent of total sawtimber volume in the Northern Great Plains had a volume increase since 2015.

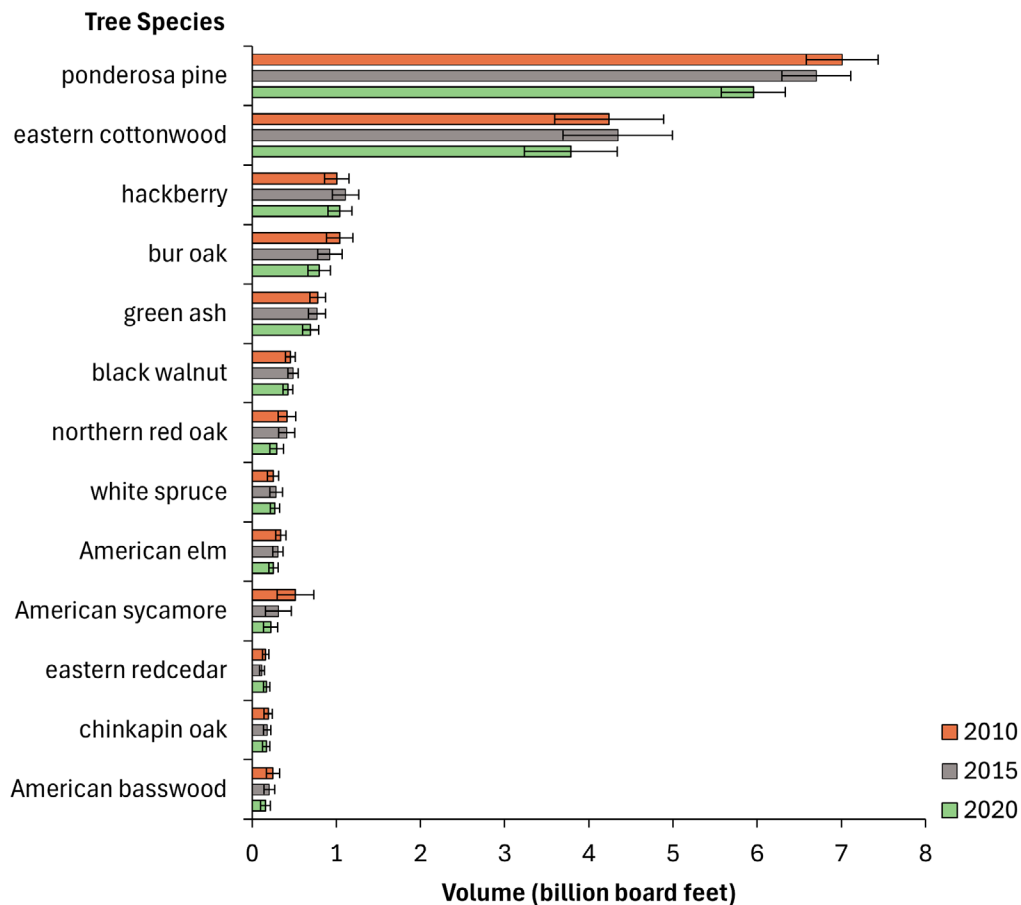


Figure 37.—Sawtimber volume on timberland of species having at least 1 percent of total sawtimber volume by species and inventory year, Northern Great Plains States. Error bars represent a 68 percent confidence interval.

Hardwood sawtimber volume decreased 15 percent from 2015 to 2020 to 8.9 billion board feet. The proportion of that volume occurring as high quality (grades 1 and 2) tree grades was unchanged at 29 percent although the proportion in grade 1 trees increased from 10 percent in 2015 to 16 percent in 2020 (Fig. 38). Grade 3 proportional volume also increased while the tie/timber grade decreased. The percentage of volume in “uppers” (trees containing a qualifying saw log outside the butt section) was unchanged.

Among trees with at least 1 percent of total hardwood sawtimber volume, American sycamore (49 percent), American basswood (42 percent), and eastern cottonwood (40 percent) have the highest proportion of their volume in high quality (grades 1 and 2) tree grades (Fig. 39). Silver maple and chinkapin oak both have no proportional volume in high quality tree grades.

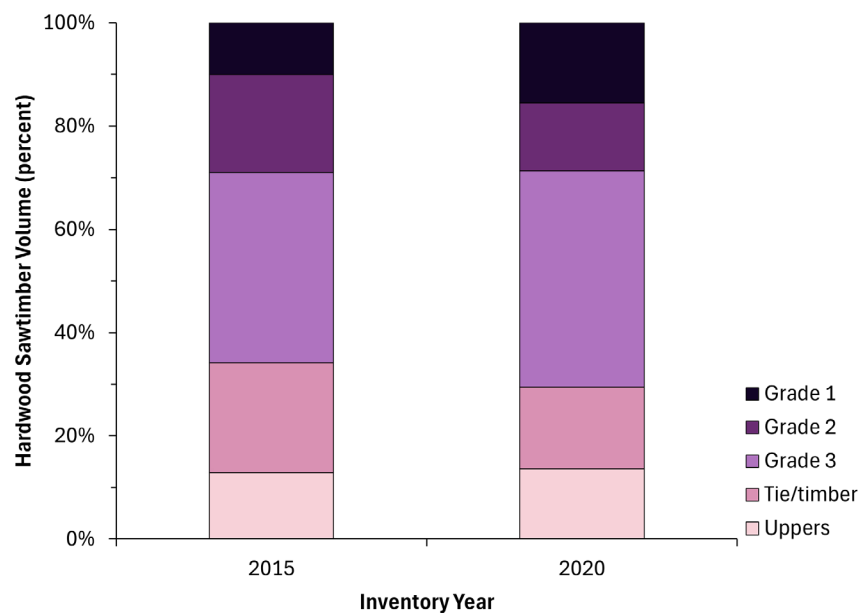


Figure 38.—Percentage of hardwood sawtimber volume on timberland, by tree grade and inventory year, Northern Great Plains States.

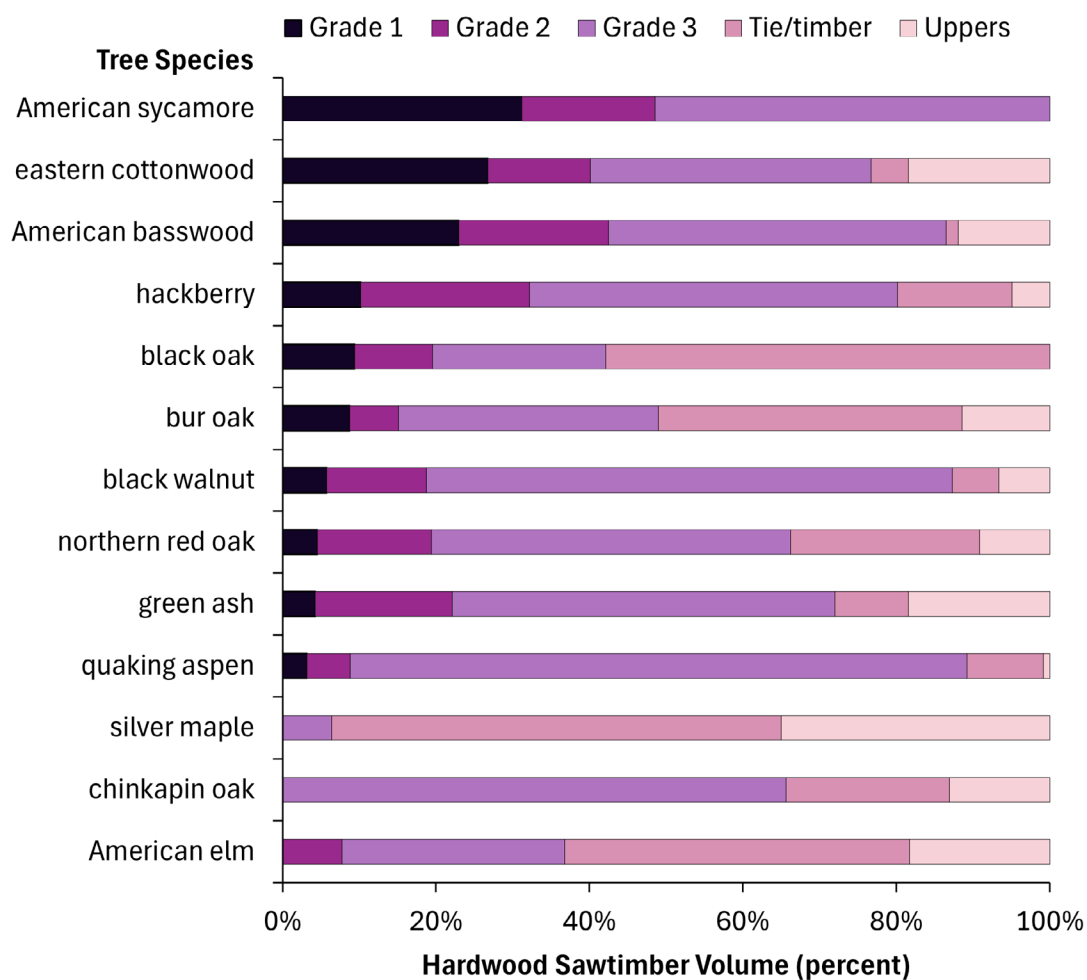


Figure 39.—Percentage of hardwood sawtimber volume on timberland by tree grade for species having at least 1 percent of total hardwood sawtimber volume, Northern Great Plains States, 2020.

What this means

Most of the metrics of volume presented here for the Northern Great Plains showed some decrease from 2015 to 2020. Some of this decrease can be attributed to a decrease in forest land and timberland area, in fact, all States in the Northern Great Plains except North Dakota experienced such a decrease over this time period. A look at per-acre estimates does show an increase in net volume for three States in the Northern Great Plains that are hardwood dominated: Kansas, Nebraska, and North Dakota. This may indicate resource maturity or that the remaining forest land has a larger proportion of high-volume forests. Those three States, however, have a high proportion of their net volume in rough cull trees, in part because of that hardwood dominance. Conversely, South Dakota has a relatively high proportion of net volume that is in growing-stock trees, due to the high proportion of softwood volume, namely ponderosa pine.

Ponderosa pine is the most voluminous species in the Northern Great Plains and high levels of mortality due, in part, to insects and fire have caused a decrease of more than 1 billion board feet in sawtimber volume since 2010. The decrease in volume for this key species comprises a large proportion of the total decreases reported for all growing-stock and sawtimber volumes for the region.

Urban Forests

Background

More than 80 percent of the United States population lives in urban areas and trees in these areas offer a wide range of benefits to urban residents including the improvement of air and water quality, aesthetic appeal and visual barriers, mitigation of rainfall runoff and flooding, and lower noise impacts.

Historically, the focus of the FIA inventory had been to collect information on trees that were part of a forest at least an acre in size with a natural or unmaintained understory. Because many urban trees do not fall into this category, they were not captured in the traditional FIA inventory. To address this data gap and improve urban forest monitoring, FIA established a national urban forest inventory program in 2014 and began monitoring in urban areas, focusing on the most populous cities. The [Urban FIA program](#) uses established FIA monitoring methods, database and reporting tools, and statistical techniques, along with [i-Tree software tools](#) that quantify ecosystem services. The goal of this effort is to assess the status of and trends in trees and forests in urban settings, including the services they provide, and to create a seamless reporting system that uses the existing FIA protocols to provide new and valuable information on urban trees that were previously unmeasured.

What we found

According to the 2020 U.S. Census, the Northern Great Plains region has 1.3 million acres of urban land, which covers 0.7 percent of the total land area comprising this four-State area (U.S. Census Bureau 2020). The proportion of urban area varies by State with Kansas having the largest percent urban area (1.7 percent), followed by Nebraska, South Dakota, and North Dakota (0.7 percent, 0.3 percent, and 0.3 percent, respectively). These percentages of urban land are below the national average of 3 percent, which reflects the fact that the States that comprise the Northern Great Plains region are among the 10 least populated States in the nation. Urban area is concentrated in and around the region's major cities including the most populous cities of Wichita, Kansas; Omaha and Lincoln, Nebraska; Fargo, North Dakota; and Sioux Falls, South Dakota, all of which experienced increases in population over the last two decades.

The Urban FIA program has begun to collect inventory data in urban areas across the four-State region and on an intensified sample of field plots in the five most populous cities, with the goal of characterizing the urban tree resource and its associated benefits and values. Data collection on these plots occurs over a 7-year cycle, so one-seventh of the plots are visited each year and remeasurement begins after the seventh year. Annualized urban inventory monitoring began in Fargo, Lincoln, and Wichita in 2017, in Sioux Falls in 2020, and in Omaha in 2022. At full implementation, tree and site field data will be monitored on approximately 200 sample plots in each of the cities and on approximately 200 plots within additional urban areas across the four-State region (Fig. 40).

The Urban FIA inventory in the Northern Great Plains is still being established, so it will be a few years before a complete cycle of data are published for each sampled city in the region. However, other research has been conducted by Forest Service scientists that uses remote sensing data to derive estimates of urban forest attributes. Nowak and Greenfield (2018a) conducted a study to quantify urban tree cover and cover change in the United States using aerial photointerpretation methods. According to their data, tree cover within urban areas of the Northern Great Plains Region remained unchanged between 2009 and 2014 at 27 percent.

Based on tree cover data and i-Tree models and assumptions using State-specific data, the dollar value of ecosystem services (carbon sequestration, air pollution removal, avoided energy use, and avoided emissions) associated with urban trees in the Northern Great Plains States was estimated to be roughly \$329 million per year (Nowak and Greenfield 2018b).

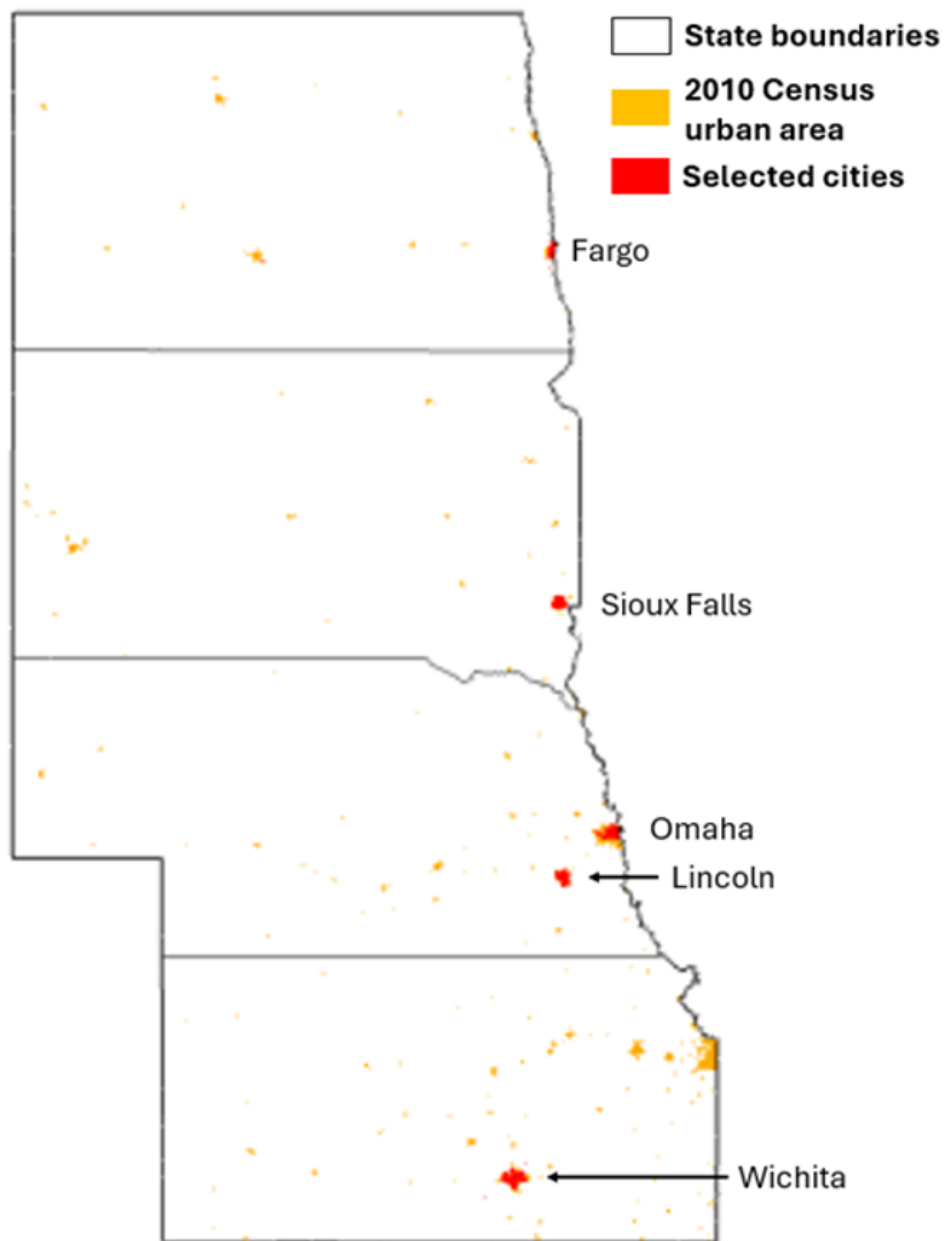


Figure 40.—Urban FIA monitoring is concentrated in Wichita, KS (1 plot per 500 acres), Omaha, NE (1 plot per 430 acres), Lincoln, NE (1 plot per 300 acres), Fargo, ND (1 plot per 160 acres), and Sioux Falls, SD (1 plot per 220 acres), with a lower intensity of sample plots (1 plot per 6,000 acres) distributed throughout the additional Census urban areas, Northern Great Plains States. Source: U.S. Census Bureau 2010.

What this means

Trees cover approximately 27 percent of the urban land in the Northern Great Plains region and represent a vital resource. Urban forests are important to the health and well-being of the people of this area and the ecosystem services these forests provide have both ecological and economic value. For these reasons, along with constant forest changes due to such forces as development, storms, aging and mortality, insects and diseases, tree planting and natural regeneration, it is especially important to monitor the urban forest resource and quantify changes in its structure, composition, and health. With implementation of the Urban FIA program in the Northern Great Plains region, data will soon be available to provide sample-based estimates of urban forest structure and associated ecosystem services, as well as provide a means to monitor resource changes through time.

Urban inventory data for cities with completed cycles are available on the urban data section of the [FIA DataMart](#) and posted for interactive data exploration on the [My City's Trees app](#). More information on the Urban FIA program, including field guides and a national implementation map, are available on the [Urban FIA website](#).

Timber Products Output

Background

The harvesting and processing of timber products produces a stream of income shared by timberland owners, managers, marketers, loggers, truckers, and processors. The wood products and paper manufacturing industries employed 10,500 people in Kansas, Nebraska, North Dakota, and South Dakota in 2019, with a total value of shipments of \$3.4 billion (U.S. Census Bureau 2020). To better manage the region's forests, it is important to know the species, amounts, and locations of timber being harvested.

What we found

Surveys of the primary wood-processing mills in the Northern Great Plains States are conducted annually to estimate the amount of wood volume that is processed into products, the species processed, and where the wood material came from—due to changes in the data collection method, current estimates should not be directly compared to older datasets. There were 118 active primary wood-processing mills in the Northern Great Plains States in 2019, which consisted of 104 sawmills that reported processing 26.6 million cubic feet; 6 post and pole mills that reported processing 1.9 million cubic feet; and 1 veneer mill, 1 particle board mill, 4 cabin log mills, 1 miscellaneous products mill, and 1 mill that exported logs out of the country, that combined, processed 2.5 million cubic feet. Ponderosa pine alone made up 88 percent of the processed wood, most of which was processed by South Dakota mills. Other important

species processed by the mills in the region were black walnut (3 percent), cottonwood (3 percent), spruce (2 percent), and cedar/juniper (2 percent). Eighty-five percent of the volume processed by Northern Great Plains States wood-processing mills came from these States. Most (79 percent) of the imported wood material into the region came from Wyoming and went to mills in South Dakota. Wood material from Iowa, Minnesota, Missouri, and Montana provided the remaining 21 percent of the imports.

A total of 27.8 million cubic feet of industrial roundwood was harvested from the Northern Great Plains States in 2019. Eighty-two percent of the total harvest came from South Dakota, followed by Nebraska (almost 10 percent), Kansas (8 percent), and North Dakota (less than 1 percent). Saw logs accounted for 87 percent of the total industrial roundwood harvested, followed by posts and poles at 7 percent of the total harvest (Fig. 41). Other products harvested include cabin logs, excelsior, veneer logs, composite panel products, and other miscellaneous products. Ponderosa pine (nearly all from South Dakota) was the most harvested species accounting for 84 percent of the total industrial roundwood harvest. Black walnut accounted for 4 percent of the total harvest; cottonwood accounted for another 3 percent; and cedar/juniper accounted for 2 percent (Fig. 42).

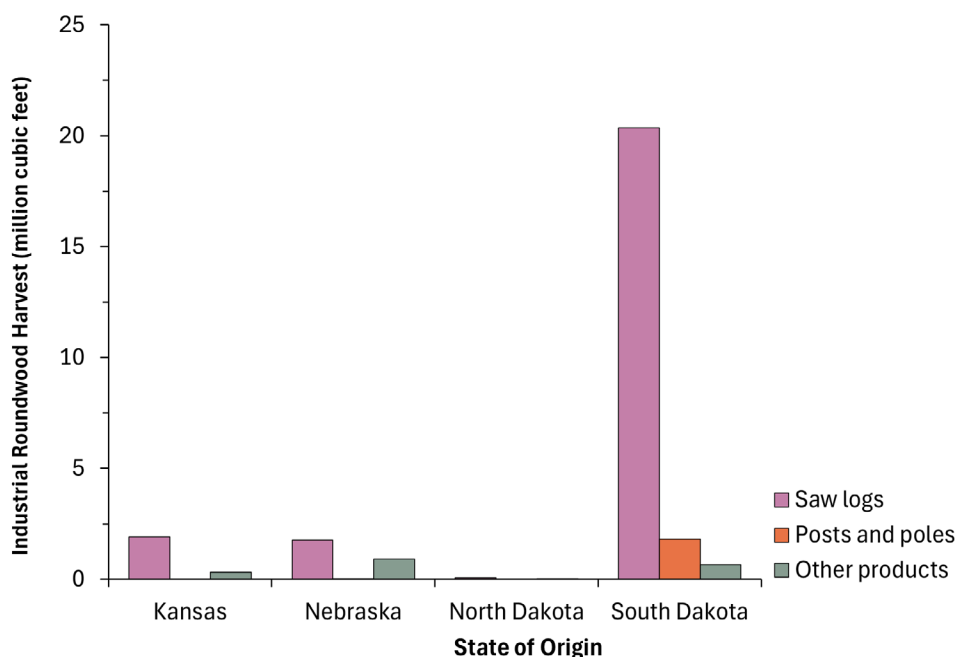


Figure 41.—Industrial roundwood harvest by State of origin and product, Northern Great Plains, 2019.

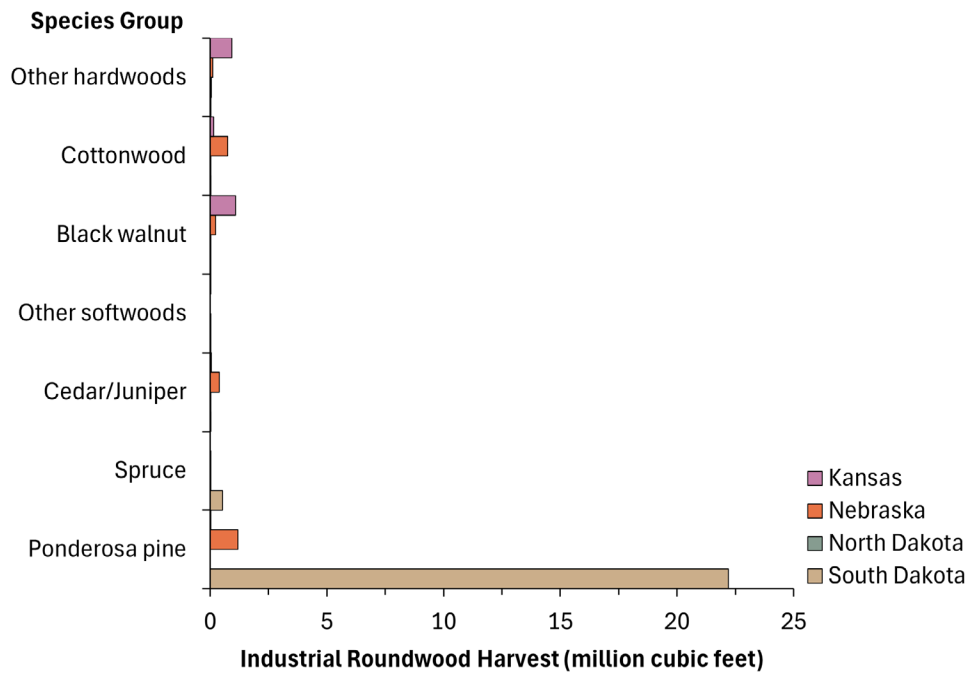


Figure 42.—Industrial roundwood harvest by species group and State, Northern Great Plains, 2019.

In the process of harvesting industrial roundwood in the Northern Great Plains States, an estimated 10.6 million cubic feet of harvest residue was left in the woods. Twenty percent of this volume was growing-stock material, considered useable for products by FIA standards. The remaining 80 percent is non-growing-stock material such as tops, limbs, and rotten sections that are not considered useable for products by FIA standards. South Dakota, which does have some harvest for pulpwood products, had only 17 percent of the harvest residues comprised of growing-stock material. In the other three Northern Great Plains States, which primarily harvested saw logs, more than a third of the harvest residues were comprised of growing-stock material (Fig. 43).

There were 400,000 green tons of mill residues produced at Northern Great Plains States' primary wood-using mills in 2019. South Dakota generated the largest amount of mill residues with 376,000 green tons, followed by Nebraska with 13,000 green tons, Kansas with 10,000 green tons, and North Dakota with 1,000 green tons. Fifty-six percent of the mill residues were sent to mills for use in making pulp or composite panels (Fig. 44). Other important uses for the mill residues were mulch (26 percent), industrial and residential fuelwood (13 percent), and other miscellaneous uses (3 percent). Only 1 percent of the mill residues went unutilized.

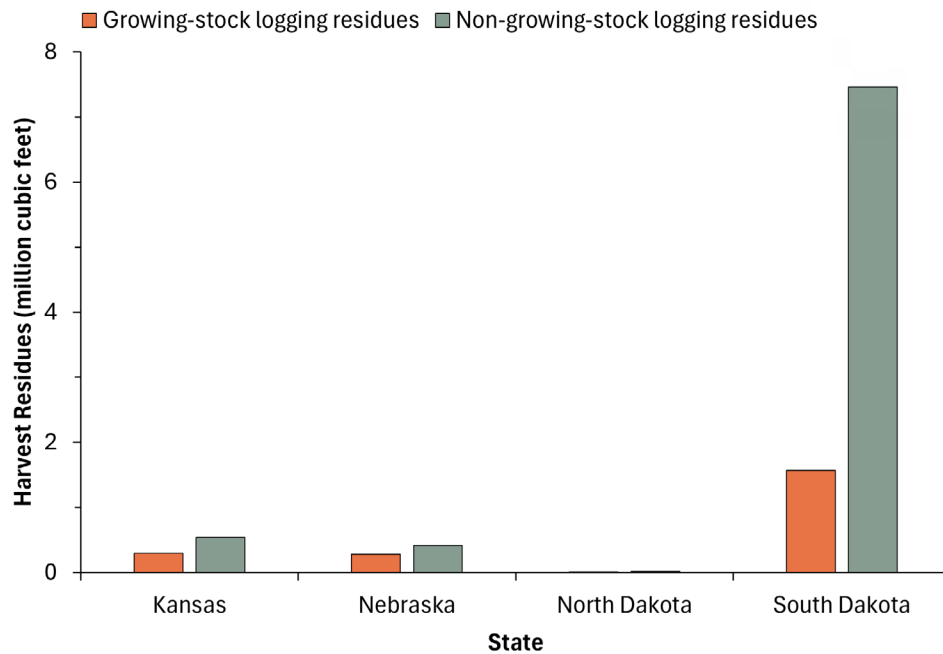


Figure 43.—Harvest residues generated by growing-stock and non-growing-stock sources and State, Northern Great Plains, 2019.

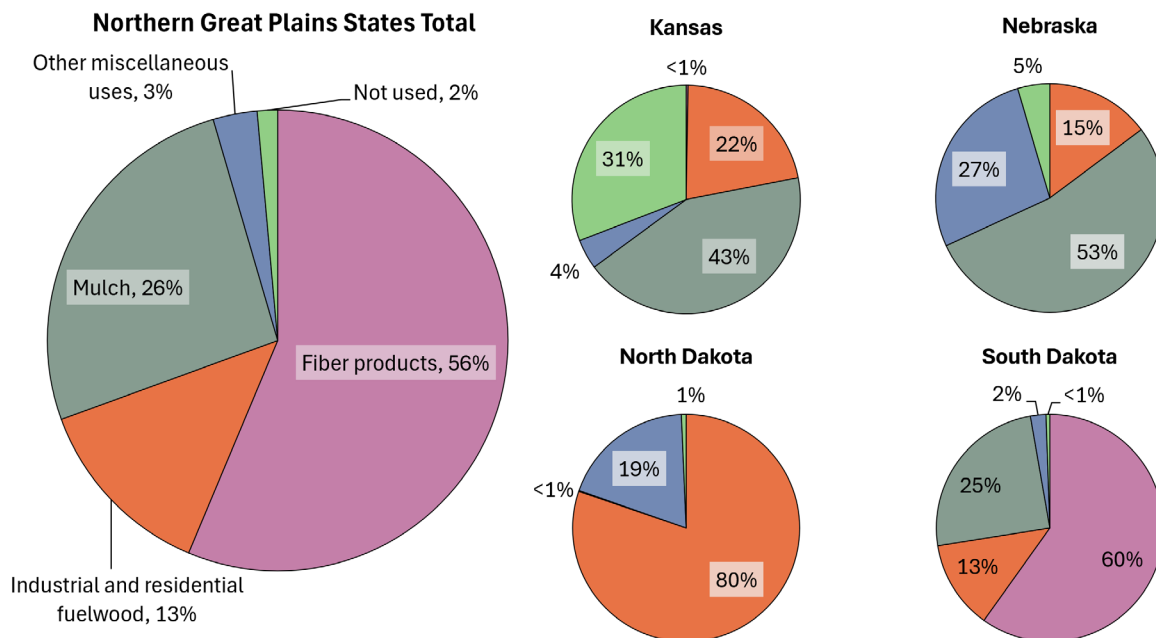


Figure 44.—Disposition of mill residues generated by primary wood-using mills by disposition and State, Northern Great Plains, 2019.

What this means

The Northern Great Plains States forest products industry is for the most part a regional or local economy. This is because, excluding the Black Hills region of South Dakota, forest land in the Northern Great Plains is scattered and cannot support a large forest products industry. There was an estimated 7.3 billion cubic feet of wood material in live trees at least 5.0 inches d.b.h./d.r.c. on forest land in the Northern Great Plains States in 2019. Average annual harvest removals of live trees at least 5.0 inches d.b.h./d.r.c. on forest land at 31.4 million cubic feet was less than 1 percent of the total volume. South Dakota, which has the most harvesting of the four States, averaged removals of just 1 percent of the total live tree volume between 2014 and 2019. Average annual net growth of live trees at least 5.0 inches d.b.h./d.r.c. on forest land is outpacing average annual harvest removals at a rate greater than 3.8 to 1. Only South Dakota, which has a high loss of volume due to mortality, has harvest removals greater than growth. This all points to the potential to increase the harvest of forest products in the Northern Great Plains. Many areas have the resources, but not the infrastructure, to process the material. Small local mills that process forest products for the local or regional economy would make the most sense for these scattered resources.

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Mouse-ear chickweed, Dakota Prairie Grasslands, Northern Region, South Dakota. USDA Forest Service photo by Jeremy Guinn.

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Appendixes



Wallflowers, Dakota Prairie Grasslands, Northern Region, North Dakota. USDA Forest Service photo by Jeremy Guinn.

Appendix 1.—List of tree species found on Forest Inventory and Analysis plots, Northern Great Plains States, 2020

Common name	Scientific name
ailanthus	<i>Ailanthus altissima</i>
American basswood	<i>Tilia americana</i>
American elm	<i>Ulmus americana</i>
American plum	<i>Prunus americana</i>
American sycamore	<i>Platanus occidentalis</i>
apple spp.	<i>Malus</i> spp.
Austrian pine	<i>Pinus nigra</i>
balsam poplar	<i>Populus balsamifera</i>
Bebb willow	<i>Salix bebbiana</i>
bitternut hickory	<i>Carya cordiformis</i>
black ash	<i>Fraxinus nigra</i>
black cherry	<i>Prunus serotina</i>
black hickory	<i>Carya texana</i>
black locust	<i>Robinia pseudoacacia</i>
black oak	<i>Quercus velutina</i>
black walnut	<i>Juglans nigra</i>
black willow	<i>Salix nigra</i>
blackjack oak	<i>Quercus marilandica</i>
blue ash	<i>Fraxinus quadrangulata</i>
boxelder	<i>Acer negundo</i>
bur oak	<i>Quercus macrocarpa</i>
cherry and plum spp.	<i>Prunus</i> spp.
chinkapin oak	<i>Quercus muehlenbergii</i>
chittamwood, gum bumelia	<i>Sideroxylon lanuginosum</i>
chokecherry	<i>Prunus virginiana</i>

Common name	Scientific name
common persimmon	<i>Diospyros virginiana</i>
downy hawthorn	<i>Crataegus mollis</i>
eastern cottonwood	<i>Populus deltoides</i>
eastern hophornbeam	<i>Ostrya virginiana</i>
eastern redbud	<i>Cercis canadensis</i>
eastern redcedar	<i>Juniperus virginiana</i>
eastern white pine	<i>Pinus strobus</i>
green ash	<i>Fraxinus pennsylvanica</i>
hackberry	<i>Celtis occidentalis</i>
hawthorn spp.	<i>Crataegus</i> spp.
honeylocust	<i>Gleditsia triacanthos</i>
jack pine	<i>Pinus banksiana</i>
Kentucky coffeetree	<i>Gymnocladus dioica</i>
mockernut hickory	<i>Carya alba</i>
northern catalpa	<i>Catalpa speciosa</i>
northern red oak	<i>Quercus rubra</i>
Norway spruce	<i>Picea abies</i>
Ohio buckeye	<i>Aesculus glabra</i>
osage-orange	<i>Maclura pomifera</i>
overcup oak	<i>Quercus lyrata</i>
paper birch	<i>Betula papyrifera</i>
pawpaw	<i>Asimina triloba</i>
peachleaf willow	<i>Salix amygdaloides</i>
pecan	<i>Carya illinoensis</i>
pin cherry	<i>Prunus pensylvanica</i>
pin oak	<i>Quercus palustris</i>

Continued on next page

Appendix 1.—(Continued)

Common name	Scientific name
ponderosa pine	<i>Pinus ponderosa</i>
post oak	<i>Quercus stellata</i>
prairie crab apple	<i>Malus ioensis</i>
quaking aspen	<i>Populus tremuloides</i>
red mulberry	<i>Morus rubra</i>
red pine	<i>Pinus resinosa</i>
Rocky Mountain juniper	<i>Juniperus scopulorum</i>
Russian-olive	<i>Elaeagnus angustifolia</i>
saltcedar	<i>Tamarix</i> spp.
Scotch pine	<i>Pinus sylvestris</i>
serviceberry spp.	<i>Amelanchier</i> spp.
shagbark hickory	<i>Carya ovata</i>
shellbark hickory	<i>Carya laciniosa</i>
shingle oak	<i>Quercus imbricaria</i>
Shumard oak	<i>Quercus shumardii</i>
Siberian elm	<i>Ulmus pumila</i>
silver maple	<i>Acer saccharinum</i>
slippery elm	<i>Ulmus rubra</i>
southern catalpa	<i>Catalpa bignonioides</i>
sugar maple	<i>Acer saccharum</i>
sugarberry	<i>Celtis laevigata</i>
Texas buckeye	<i>Aesculus glabra arguta</i>
western soapberry	<i>Sapindus saponaria drummondii</i>
white ash	<i>Fraxinus americana</i>

Common name	Scientific name
white mulberry	<i>Morus alba</i>
white oak	<i>Quercus alba</i>
white spruce	<i>Picea glauca</i>
white willow	<i>Salix alba</i>
willow spp.	<i>Salix</i> spp.

Appendix 2.—Invasive plant species monitored on Forest Inventory and Analysis plots, Northern Great Plains States, 2020

Common name	Scientific name
Amur honeysuckle	<i>Lonicera maackii</i>
autumn olive	<i>Elaeagnus umbellata</i>
black locust	<i>Robinia pseudoacacia</i>
Bohemian knotweed	<i>Polygonum x bohemicum</i>
bull thistle	<i>Cirsium vulgare</i>
Canada thistle	<i>Cirsium arvense</i>
Chinaberrytree	<i>Melia azedarach</i>
common barberry	<i>Berberis vulgaris</i>
common buckthorn	<i>Rhamnus cathartica</i>
common reed	<i>Phragmites australis</i>
creeping jenny	<i>Lysimachia nummularia</i>
dames rocket	<i>Hesperis matronalis</i>
English ivy	<i>Hedera helix</i>
European cranberrybush	<i>Viburnum opulus</i>
European privet	<i>Ligustrum vulgare</i>
European swallow-wort	<i>Cynanchum rossicum</i>
garlic mustard	<i>Alliaria petiolata</i>
giant knotweed	<i>Polygonum sachalinense</i>
glossy buckthorn	<i>Frangula alnus</i>
Japanese barberry	<i>Berberis thunbergii</i>
Japanese honeysuckle	<i>Lonicera japonica</i>
Japanese knotweed	<i>Polygonum cuspidatum</i>
Japanese meadowsweet	<i>Spiraea japonica</i>

Common name	Scientific name
Japanese stiltgrass	<i>Microstegium vimineum</i>
leafy spurge	<i>Euphorbia esula</i>
Louise’s swallow-wort	<i>Cynanchum louiseae</i>
multiflora rose	<i>Rosa multiflora</i>
Morrow’s honeysuckle	<i>Lonicera morrowii</i>
nonnative bush honeysuckle	<i>Lonicera</i> spp.
Norway maple	<i>Acer platanoides</i>
oriental bittersweet	<i>Celastrus orbiculatus</i>
princesstree	<i>Paulownia tomentosa</i>
punktree	<i>Melaleuca quinquenervia</i>
purple loosestrife	<i>Lythrum salicaria</i>
reed canarygrass	<i>Phalaris arundinacea</i>
Russian olive	<i>Elaeagnus angustifolia</i>
saltcedar	<i>Tamarix ramosissima</i>
showy fly honeysuckle	<i>Lonicera x bella</i>
Siberian elm	<i>Ulmus pumila</i>
silktree	<i>Albizia julibrissin</i>
spotted knapweed	<i>Centaurea stoebe</i> ssp. <i>micranthos</i>
tallow tree	<i>Triadica sebifera</i>
tatarian honeysuckle	<i>Lonicera tatarica</i>
tree of heaven	<i>Ailanthus altissima</i>

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