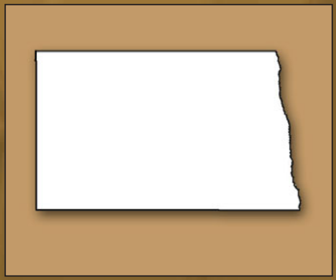
North Dakota's Forests

2005



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Cover: Little Missouri River corridor. Photo used with permission from the North Dakota Forest Service.

North Dakota's Forests
2005

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Foreword

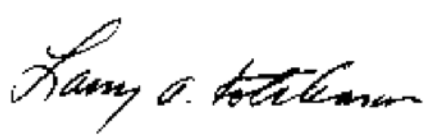
We welcome you to read the latest results of our statewide forest inventory, North Dakota's Forests 2005. The inventory and report are the product of a cooperative effort between the North Dakota Forest Service and the Forest Inventory and Analysis program of the U.S. Forest Service.

North Dakota's 724,000 acres of forests provide wildlife habitat, recreational opportunities, and wood products; stabilize river banks; filter water runoff from adjacent agricultural lands; serve as seed sources for conservation tree production; and contribute to the botanical diversity of the State.

Private landowners hold 70 percent of the State's forest land, and State or Federal agencies own the remaining 30 percent. Both ownership groups play an important role in the State's natural resource heritage.

North Dakota's forests are robust, but threats to these important resources exist. Invasive species, conversion of forests to other land uses, overmaturity of existing stands, and suppression of natural disturbances essential in regenerating forests are issues that will require attention.

Society demands a wide array of goods and services from our forests. North Dakota's Forests 2005 provides a common set of statistically accurate estimates that can be used to make sound forest management decisions. We invite you to read this report of North Dakota's Forests 2005 and participate in the discussions about the future of forests and forestry in our State.



Larry A. Kotchman
North Dakota State Forester

Contents

Highlights

On the Plus Side

- North Dakota forest lands represent 1.6 percent of the State's total land area, at 724,000 acres.
- There is an average of 478 trees per acre on forest land in the State.
- There is an average of 22.3 tons per acre of dry all live-tree biomass on timberland in the State.
- Cubic-foot volume in all live trees on forest land was estimated at 719 million cubic feet in 2005. Over 77 percent of the cubic-foot volume in the State is on private forest land.
- The volume of sawtimber on timberland equaled just over 1.1 billion board feet in 2005, with close to half of the volume coming from cottonwood.
- Fuel loadings of down woody materials are less in North Dakota compared to areas of high fire hazard in Western States.
- No ozone damage was observed on indicator plants in North Dakota during the inventory period.

Areas of Concern

- North Dakota's aging cottonwood forests lack cottonwood regeneration with the 2005 inventory estimating no cottonwood forest in the 0- to 20-year stand age category.
- Only 21 percent of all timberland acres in North Dakota are categorized as small diameter stands (1- to 5-inch diameter).
- The majority of sawtimber (71 percent) is in lower valued tree grades 3, 4, and 5.
- Aspen forests in North Dakota are in a general state of poor health. Lack of fire disturbance and/or harvesting has resulted in older stands with minimal natural regeneration.

- Eastern bottomland forests have been severely impacted by Dutch elm disease. This disease has eliminated many of the American elms that once made up a large portion of this forest type and has shifted the species composition toward green ash and boxelder.

Issues to Watch

- With over 78 million ash trees growing on forest lands throughout the State, the emerald ash borer could have a dramatic impact on the North Dakota forest landscape.
- The decline of cottonwood forests along the Missouri River is largely attributed to the absence of regeneration and the gradual senescence of mature overstory trees. Encroachment of nonnative species such as Russian-olive, buckthorn, and brome grass create additional management problems.
- In ponderosa pine forests, years of past fire suppression coupled with high stand density have created conditions that may intensify fire behavior.
- With the increased interest in biobased fuels, marginal farm land that was once in set-aside conservation programs is being put back into crop production, which might reduce total forest land area in North Dakota in the future.

Background

Ponderosa pine forest. Photo by Cassandra Olson, U.S. Forest Service.

A Brief Primer on Forest Inventory

What is a tree?

Trees are perennial woody plants that have central stems and distinct crowns. In general, FIA defines a tree as any perennial woody plant species that can attain a height of 15 feet at maturity.

What is a forest?

FIA defines forest land as land that is at least 10 percent stocked by trees of any size or formerly having had such tree cover and not currently developed for nonforest use. The area with trees must be at least 1 acre in size, and wooded strips, such as those along roads, streams, and agricultural fields, must be at least 120 feet wide and 363 feet long to qualify as forest land.

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

From an FIA perspective, there are three types of forest land: timberland, reserved forest land, and other forest land. In North Dakota, almost 74 percent of the forested acreage is timberland, 3 percent is reserved forest land, and 23 percent is other forest land.

- Reserved forest land is withdrawn from timber utilization through legislation or administrative regulation.
- Other forest land is land not capable of producing 20 cubic feet/acre/year at its peak; this is often due to poor soil conditions.
- Timberland is forest land that is not reserved and meets the minimum productivity requirements that other forest land does not.

In prior inventories, FIA measured trees only on timberland plots and was unable to report volume on all forest land. The implementation of the new annual inventory system allows volume to be reported on all forest land, not just on timberland. As these annual plots are remeasured in the years ahead, FIA will also be able to report growth, removals, and mortality on all forest land. In this report, trend reporting is limited to timberland except for the area of forest land where individual tree measurements are not required.

How do we estimate a tree's volume?

Volume can be precisely determined by immersing a tree in a pool of water and measuring the amount of water displaced. The method used by the Northern Research Station to estimate volume is less precise but more logistically feasible. In this method, several hundred cut trees were measured taking detailed diameter measurements along their lengths to accurately determine their volumes (Hahn 1984). Regression lines were then fit to this data by species group. Using these regression equations, FIA can produce individual tree volume estimates based on species, diameter, and site index.

The same method was used to determine sawtimber volumes. FIA reports sawtimber volumes in International 1/4-inch Rule board-foot scale. Factors for converting to Scribner board-foot scale are also available (Smith 1991).

How much does a tree weigh?

Building on previous works, the Forest Products Laboratory of the U.S. Forest Service developed specific gravity estimates for a number of tree species (USDA FS 1999). These specific gravities were then applied to tree volume estimates to estimate merchantable tree biomass (the weight of the bole). Determining live-tree biomass is more complicated because the stump (Raile 1982), the limbs, and the bark (Hahn 1984) must be added in as well. FIA does not currently report the biomass in roots and foliage.

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

How do we compare data from different inventories?

Data from new inventories are often compared with data from earlier inventories to determine trends in forest resources. However, for comparisons to be valid, procedures used in the two inventories must be similar. As a result of FIA's ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have occurred since the last North Dakota inventory in 1994. Although these changes will have little effect on statewide estimates of timberland, timber volume, and tree biomass, they may have significant effects on plot classification variables such as forest type and stand-size class. Some of these changes make it inappropriate to directly compare 2005 data tables with those published for 1994.

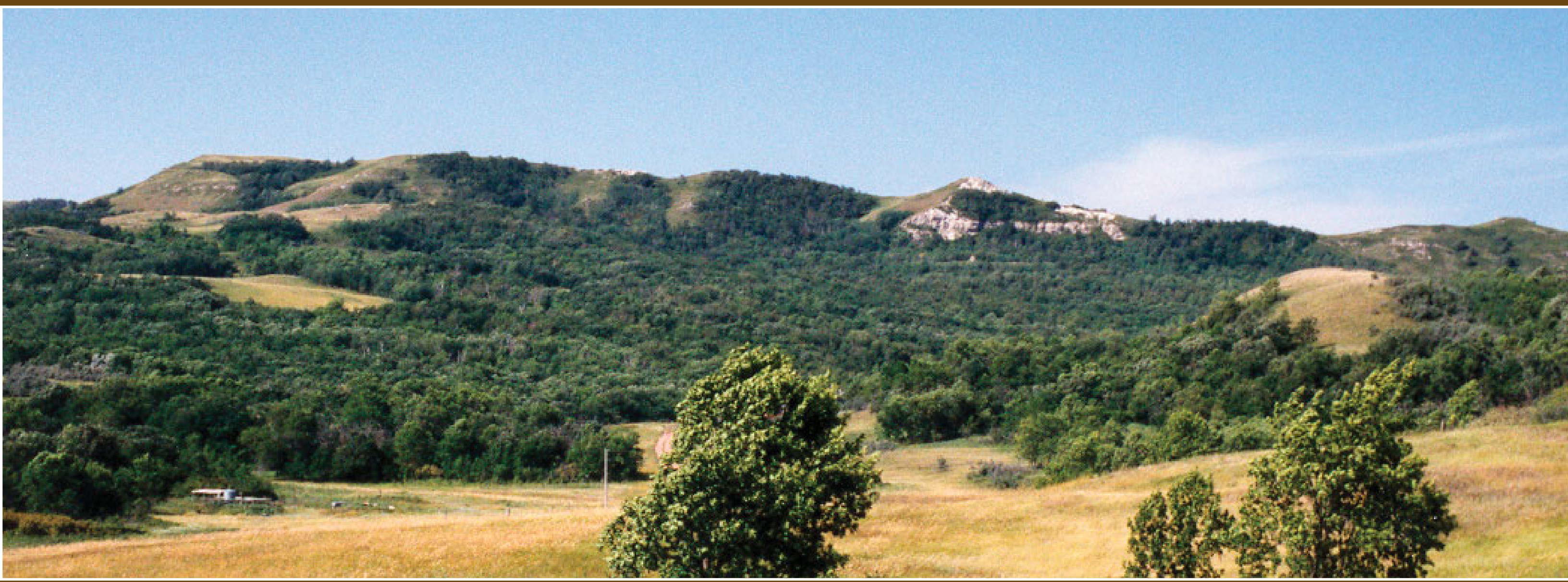
The biggest change between inventories was the change in plot design. For consistency's sake, a new national plot design was implemented by all five regional FIA units in 1999.

The old North Central plot design used in the 1994 North Dakota inventory consisted of variable-radius subplots. The new national plot design used in the 2005 inventory used fixed-radius subplots. Both designs have their strong points, but they often produce different classifications for individual plot characteristics.

A word of caution on suitability and availability

FIA does not attempt to identify which lands are suitable or available for timber harvesting— especially since suitability and availability are subject to changing laws and ownership objectives. Just because land is classified 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 harvest because laws and regulations, voluntary guidelines, physical constraints, economics, proximity to people, and ownership objectives may prevent timberland from being available for timber production.

The Features, Health, and Products of North Dakota's Forests



Killdeer Mountains. Photo used with permission from the North Dakota Forest Service.

Forest Features

Ponderosa pine on Logging Camp Ranch. Photo by Cassandra Olson, U.S. Forest Service.

North Dakota's Forest Land Base

Background

North Dakota is characterized primarily as a prairie state due to the topography, soils, and climate that promotes perennial grasses and forbs. Forests are found scattered across the State in woodlots, along streams and river bottoms, within wooded draws of the western region, and in the hills of the north-central and northeastern regions.

What we found

The area of forest land in North Dakota was estimated at 724,000 acres in 2005 (Fig. 1). Timberland, a subset of forest land, increased between inventories by an estimated 92,000 acres (441,000 acres in 1994 to 533,000 acres in 2005) (Fig. 2).

What this means

Although area of forest land is small compared to the entire land area of the State (roughly 1.6 percent), it is an important resource for multiple uses including recreation, wildlife, water, and forest products. As we move forward with the annual inventory, we should gain valuable trend data that will help in crafting management decisions in the future.

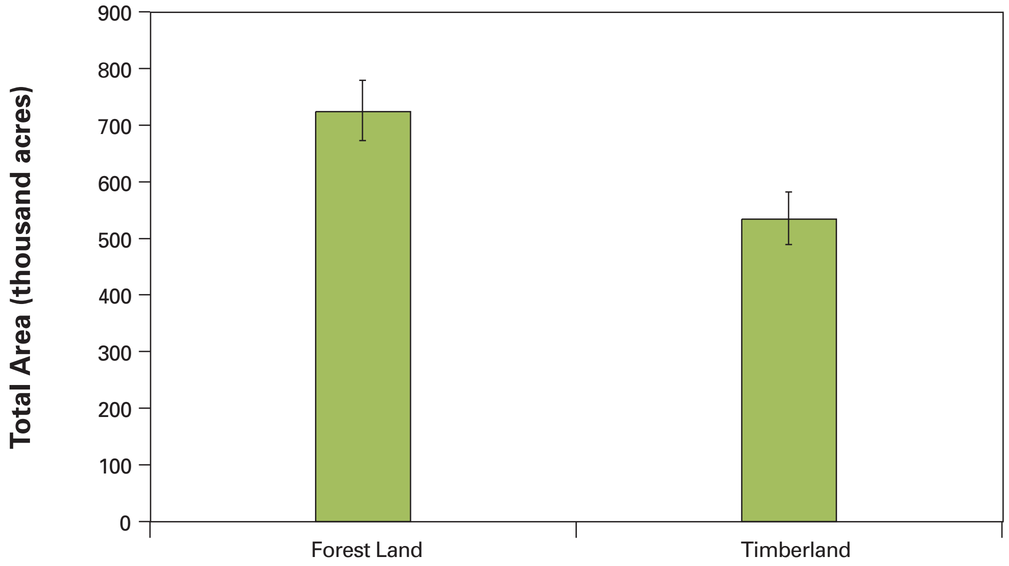


Figure 1.—Total forest land and timberland area and associated standard error in North Dakota, 2005.

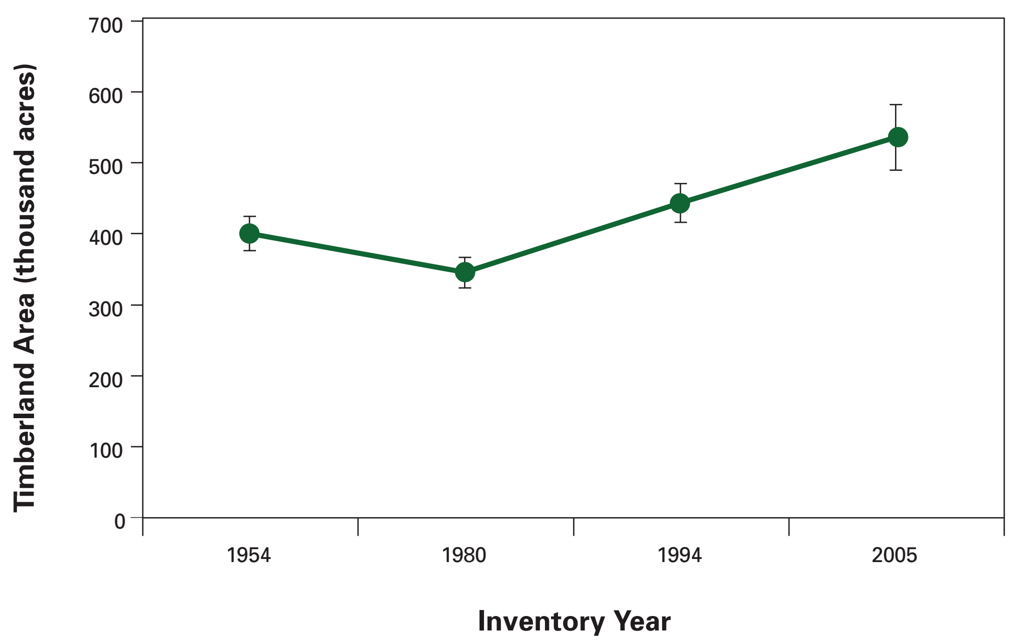


Figure 2.—Total timberland area and associated standard error in North Dakota, 1954 to 2005.

North Dakota's Forests—Where are They?

Background

The natural forests of North Dakota occur in the water rich areas along streambanks, lakeshores, and in the draws, gulches, and ravines of the hills. The frequency and intensity of drought is the primary factor that restricts forest growth within the State. North Dakota is one of the few states where both eastern and western forest types occur (Warner and Chase 1956).

What we found

North Dakota's forests can be separated into four geographical watershed units: Devils Lake/James River, Missouri River, Red River, and Souris River (Fig. 3). An estimated 275,000 acres (38 percent) of forest land are found in the Missouri River watershed (Fig. 4). The Red River watershed and the Souris River watershed have an estimated 208,000 (29 percent) and 196,000 (27 percent) acres of forest land, respectively. The Devils Lake/James River watershed has only 44,000 acres (6 percent) of the State's forest land area.

What this means

Generally, forests are more abundant in the eastern half of North Dakota and less abundant to the west as the soil and climate become less favorable for the growth and survival of eastern forest tree species. Forests are primarily found along the streams and river bottoms where they are better protected from the drying effects of winds and soil moisture is greater. The Turtle Mountains, Pembina Hills, and the area around Devils Lake hold some of the largest tracts of forest land in the State. The Missouri, Red, and Sheyenne Rivers and their tributaries contain much of the riparian forest lands in the State. Forest land area is scattered in the Little Missouri watershed and Killdeer Mountains of the western region. Forests are found in the draws and ravines, in canyons, and on lower north-facing slopes across the west.

Figure 3.—Forest area by major watershed units, North Dakota, 2005.

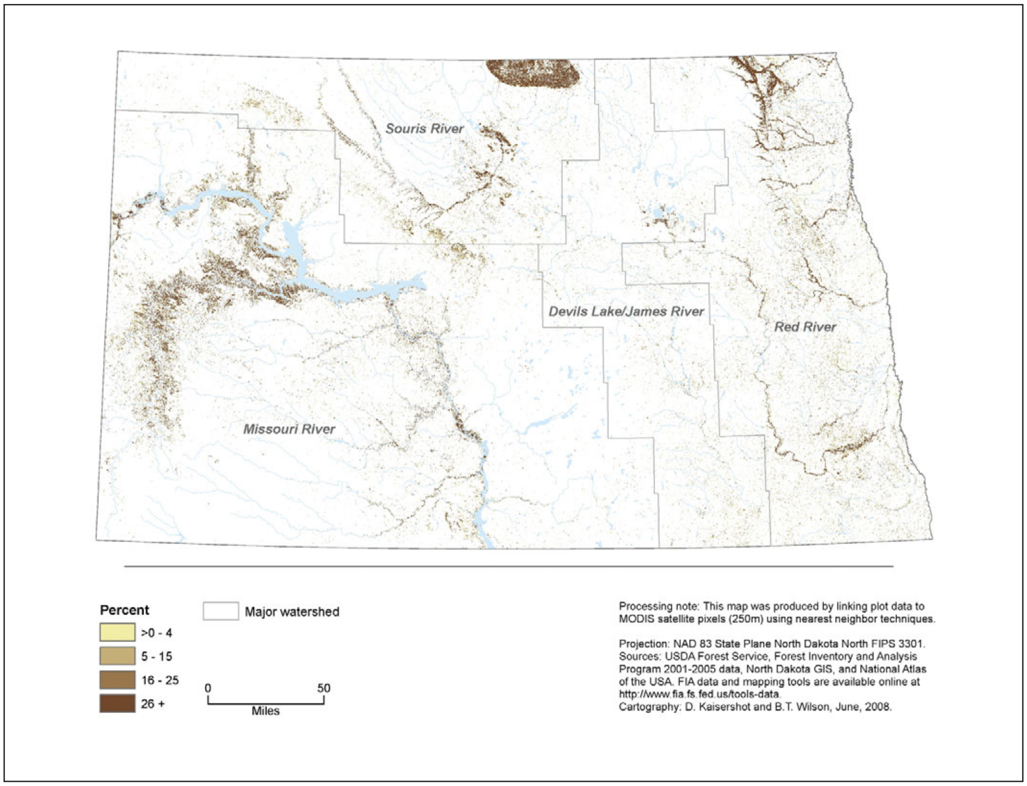
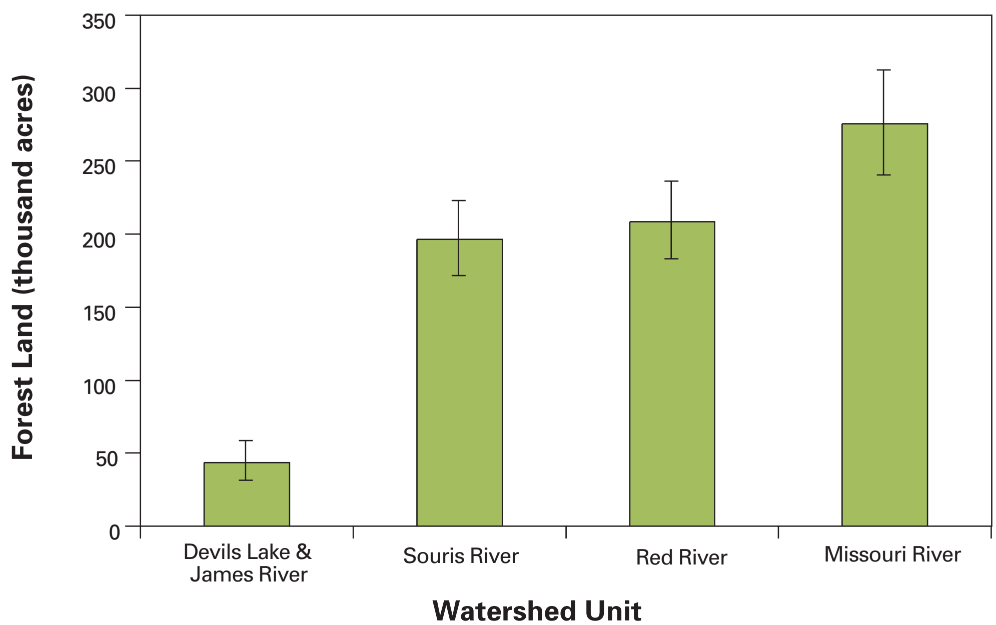


Figure 4.—Total forest land by major watershed unit and associated standard error in North Dakota, 2005.



Forest Tree Diversity

Background

The species composition of a forest stand can indicate the type of wildlife habitat, potential for forest products, and future silvicultural activities.

What we found

North Dakota's forest lands contain just over 346 million trees (Fig. 5), an average of 478 trees per acre. Deciduous trees occupy 94 percent of North Dakota's forest area. Elm/ash forests are the most abundant (Fig. 6) and are composed of green ash, American elm, bur oak, and cottonwood. The elm/ash forest type is important in terms of acreage and volume. It covers nearly 28 percent (202,000 acres) of the State's total forest land area and accounts for more then 22 percent of all live-tree volume in the State (Fig. 7). Although aspen trees are found throughout North Dakota, the largest concentration of the aspen forest type is found in the Turtle Mountains and Pembina Hills regions, occupying 116,000 acres (16 percent) of the State's forest land area. The bur oak forest type occurs on 77,000 acres of forest land and is found primarily in and around the Turtle Mountains, Pembina Hills, and Devils Lake region.

The cottonwood forest type covers just 8 percent of North Dakota's forest area, but represents more than 30 percent of the State's total forest volume. Cottonwood is commonly found growing in pure stands but also grows in other forest types such as elm/ash. Conifer-dominated stands cover roughly 5.8 percent of the forest area in North Dakota and are composed primarily of ponderosa pine and Rocky Mountain juniper. The Rocky Mountain juniper forest type covers more than 5 percent of North Dakota's forest area and occurs in the western part of the State known as the Badlands. This species grows best in moist draws and ravines and on northern and western slopes.

What this means

Although the State's forest lands hold some potential for wood products, many of the forested acres are more valuable for protecting watersheds and providing wildlife habitat and recreational opportunities.

Figure 5.—Top 10 species groups in terms of number of live trees occurring on North Dakota's forest land, 2005.

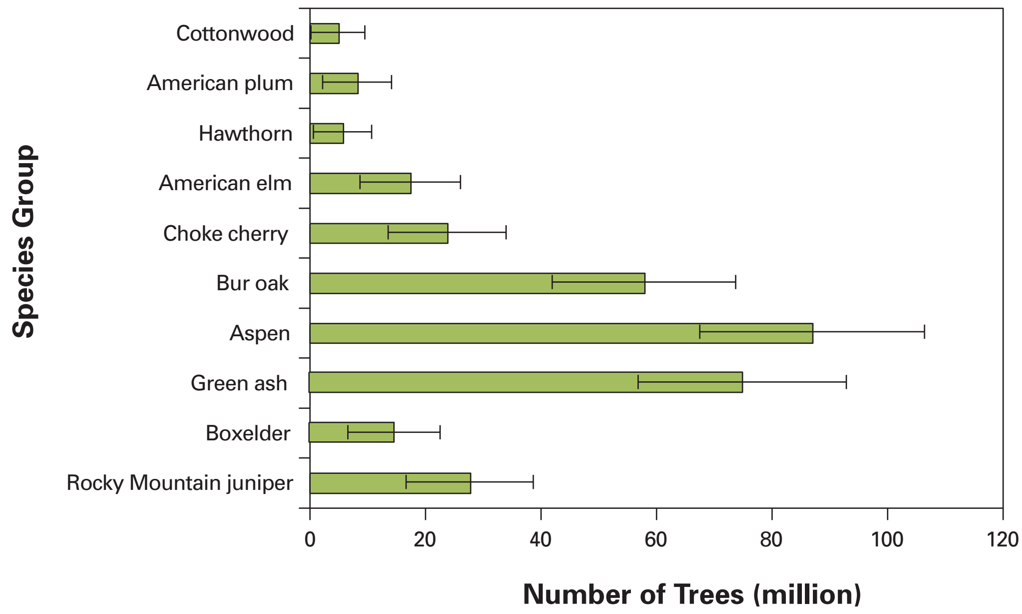


Figure 6.—Area of forest land in North Dakota by forest-type group/local group, 2005.

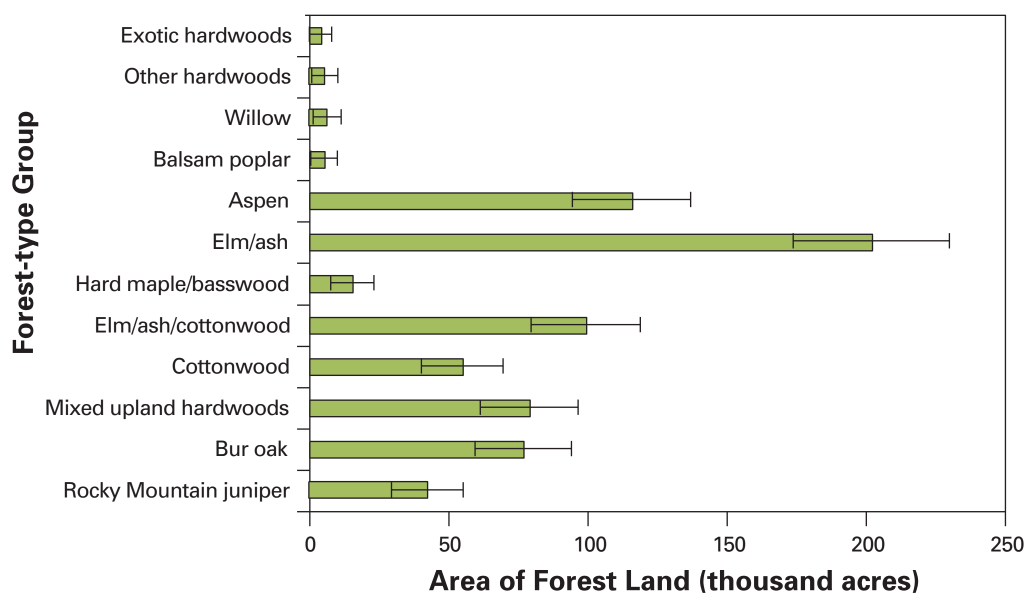
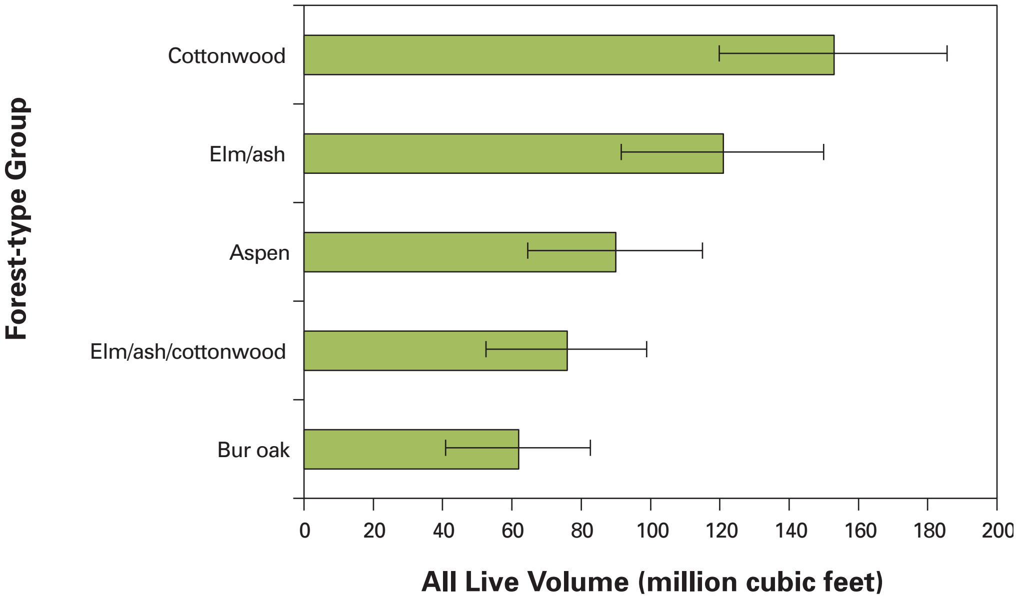


Figure 7.—All live volume on selected forest-type group/local groups in North Dakota, 2005.



The Size of It All—North Dakota's Woods

Background

Forests are composed of many tree species representing various sizes. Forest stands are analyzed by size classes as a means to delineate the structure of a forest. Stand-size class is a measure of the average diameter of the dominant trees in a stand. There are three stand-size classes: sawtimber—large trees, softwoods at least 9 inches in diameter at breast height (d.b.h.) and hardwoods at least 11 inches d.b.h.; poletimber—medium trees 5 inches d.b.h. to sawtimber size; and sapling/seedling—small trees 1 to 5 inches d.b.h. Tracking change in the distribution of stand-size class provides information about forest sustainability and succession, and potential for wood products, wildlife habitat, and recreation opportunities.

What we found

Figures 8a and 8b show the distribution of forest land and timberland by stand-size class in the State. Since the first inventory in 1954, the area of sawtimber in North Dakota has steadily increased and now covers more than 198,000 acres of timberland (Fig. 9), and the acreage of poletimber-size stands also increased over the same period of time. Currently, poletimber-size stands represent more than 214,000 acres. The area of sapling-seedling size stands has decreased since 1954 and now represents 110,000 acres. Two percent of the timberland area is considered nonstocked. Forest types with a majority of area in the sawtimber-size class include the cottonwood and bur oak types (Fig. 10).

What this means

The steady increase in sawtimber-size stands indicates maturing forests. The decline in sapling-seedling-size stands over this time period is an area of concern. This decline is due in part to the lack of either natural or human-induced disturbance in many of these forest stands.

Figure 8a.—Area of forest land by stand-size class, North Dakota, 2005.

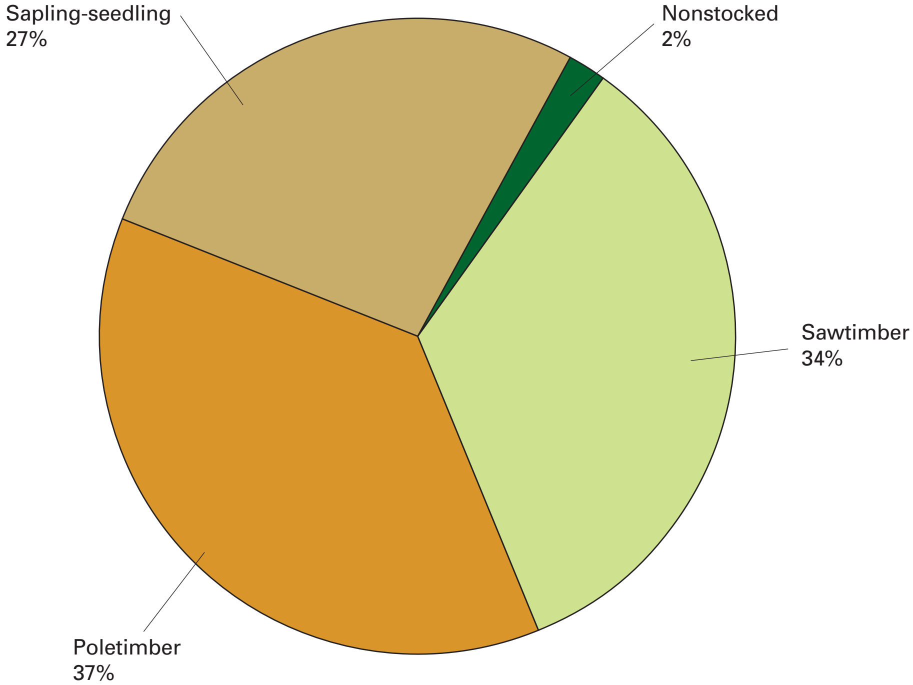


Figure 8b.—Area of timberland by stand-size class, North Dakota, 2005.

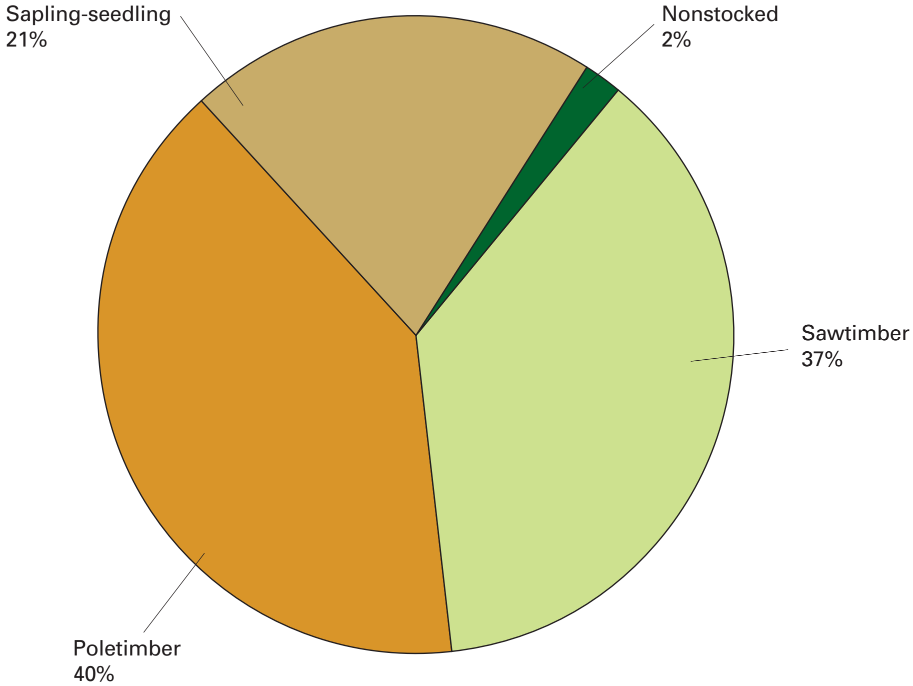


Figure 9.—Area of timberland by stand-size class, North Dakota, 1954-2005.

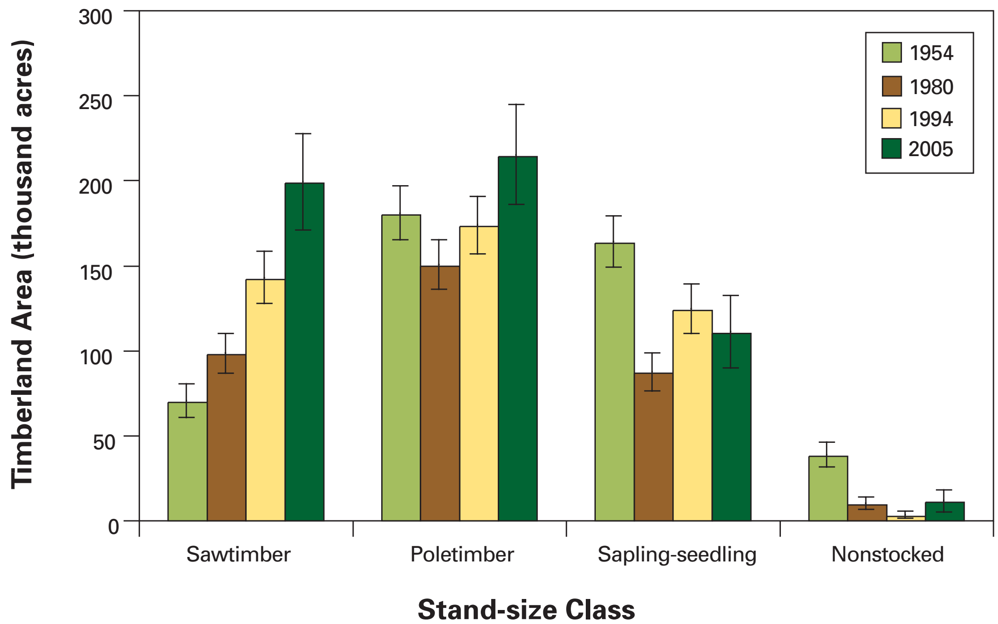
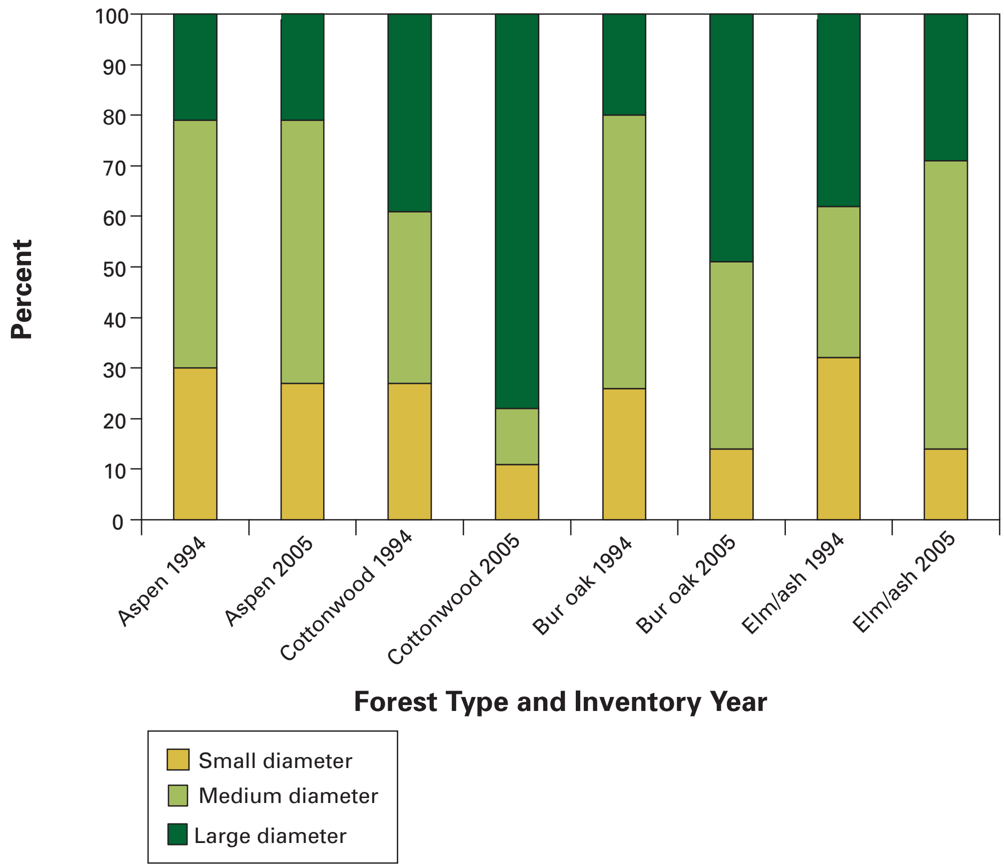


Figure 10.—Percentage of select forest types on timberland by stand-size class, North Dakota, 2005.



How Old?—Forest Stand Age in North Dakota

Background

North Dakota's forest stands are represented by numerous age classes. Age is estimated based on core samples from dominant or codominant trees from the overstory of a stand. Estimating age is an important tool that provides information about the successional development of a State's forest lands. For example, a mixed age class distribution in aspen forest types provides ruffed grouse with nesting cover, feeding areas, and drumming sites along with places to roost.

What we found

North Dakota's forests can be categorized into six broad age classes: 0 to 20 years old, 21 to 40 years, 41 to 60 years, 61 to 80 years, 81 to 100 years, and 100+ years (Fig. 11). Stand age varies by forest types. In 2005, stands dominated by Rocky Mountain juniper, bur oak, and cottonwood contained a greater proportion of area in the oldest age class (Fig. 12) whereas stands dominated by aspen generally are younger.

What this means

More than three-quarters of the forest stands in North Dakota are 40 years or older. Lack of regeneration is an issue of concern for many forest types within the State. This is due in part to the lack of disturbances that are required to create suitable seedbeds and/or promote root suckering.

Figure 11.—Distribution of forest land by stand age class, North Dakota, 2005.

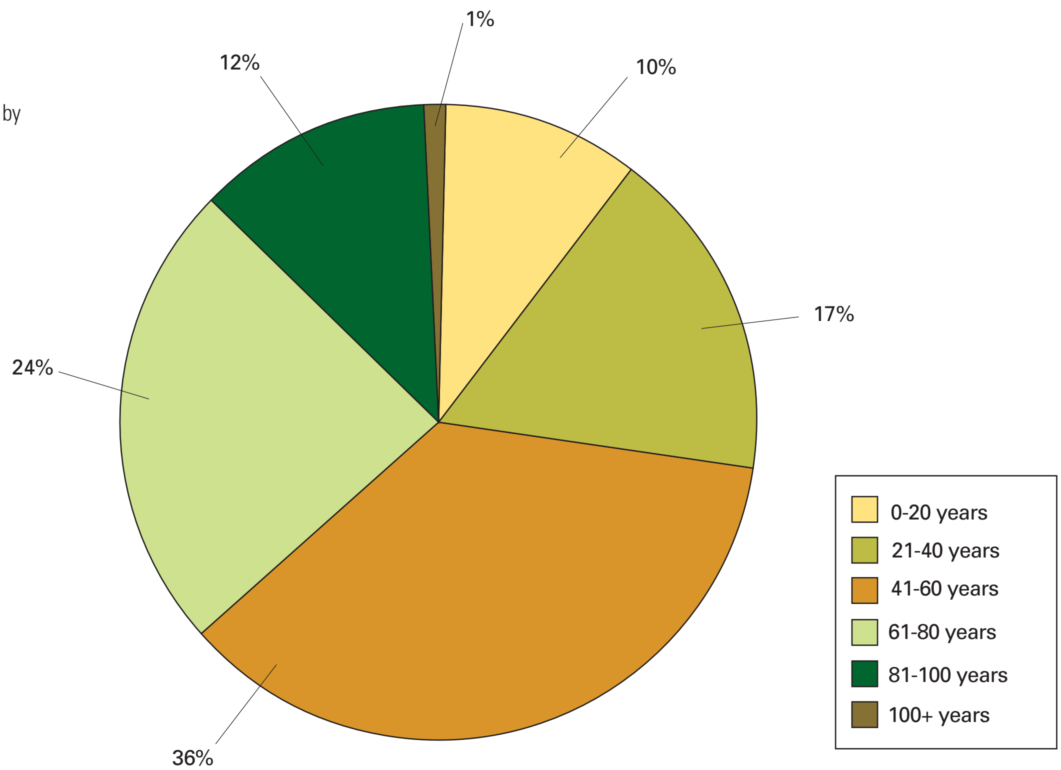
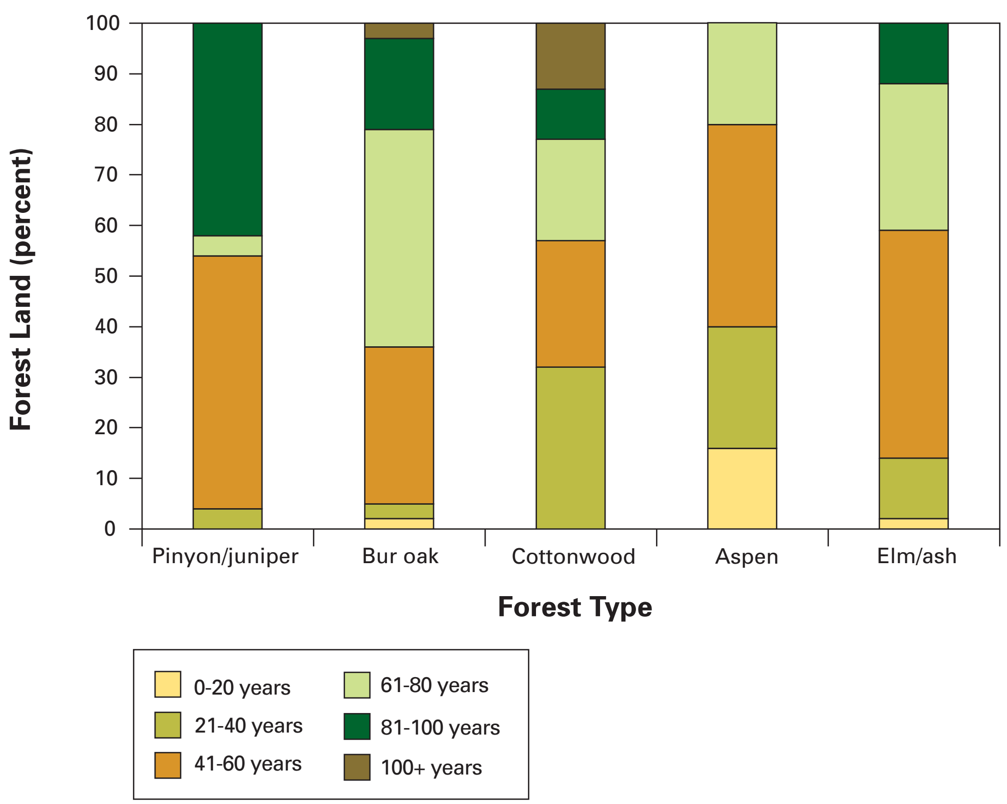


Figure 12.—Distribution of proportion of area for selected forest types by stand age class, North Dakota, 2005.



How Dense are the Woods?

Background

The extent to which trees occupy forests, woodlots, and riparian areas can indicate the stage of stand development. Stand density can indicate the need for harvesting trees or other activities that promote forest growth.

What we found

We used three features of stands to derive measures of density: number of growing-stock trees per acre of timberland, growing-stock volume per acre of timberland, and percentage of timberland by stocking class. The average number of growing-stock trees per acre of timberland increased slightly between 1980 and 1994 and decreased between 1994 and 2005 (Fig. 13). Although volume of growing-stock trees on timberland increased between 1994 and 2005 (11 percent), the average volume of growing stock per acre of timberland decreased between inventories due to the increase in nonstocked timberland. (Fig. 14, 15a). Stocking, a relative measure of tree density, is used to describe how fully trees occupy stands. A stand is considered fully stocked when trees occupy the amount of space in a stand that creates conditions for the best growth and form. Almost half of the timberland is in the moderately stocked (30 percent of all timberland) or fully stocked (15 percent of all timberland) categories (Fig. 15b). About one-third of North Dakota's timberland area is poorly stocked. Such stands contain insufficient numbers of growing-stock trees per acre. Nonstocked timberland represents 18 percent of the State's total and has less then 10 percent stocking of live trees.

What this means

These varying stand density estimates indicate the varying stages of stand development and ranges of ecological niches and processes across North Dakota. For example, on more favorable growing sites certain trees gain early dominance, thus reducing the number of competing trees. The remaining trees grow more vigorously than those on poor sites and add more volume over the same period of growth. In contrast, many forest and woodlots are nonstocked or poorly stocked across the State. Factors that affect stand development on these sites include (1) marginal agricultural lands reverting to forests—stocking densities usually are low on these sites, (2) stocking reduced by livestock grazing, (3) extreme environmental conditions—low rainfall amounts.

Figure 13.—Average number of growing-stock trees per acre of timberland, North Dakota, 1980-2005.

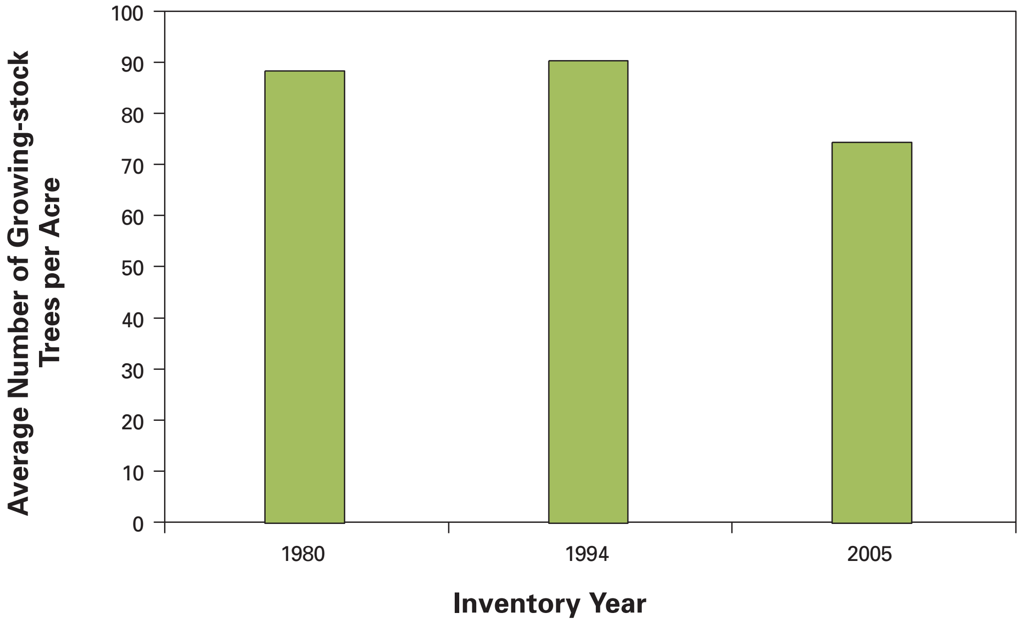


Figure 14.—Average volume of growing stock per acre of timberland, North Dakota, 1954-2005.

Figure 15a.—Area of timberland by percent stocking class, North Dakota, 1994 and 2005.

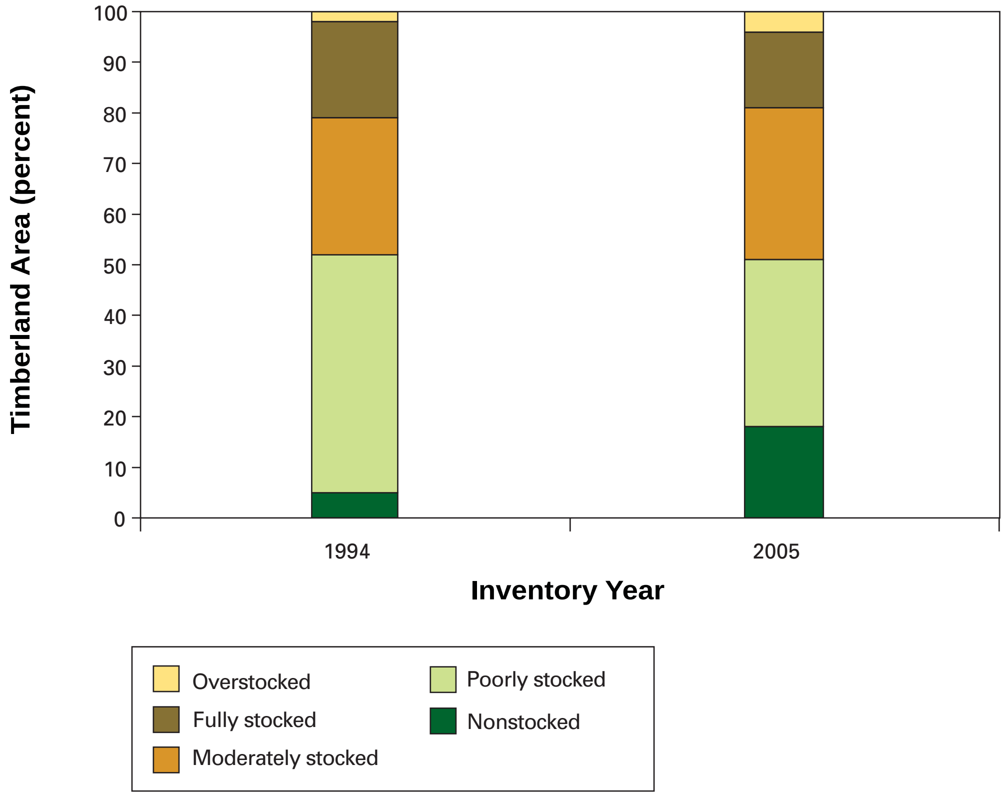
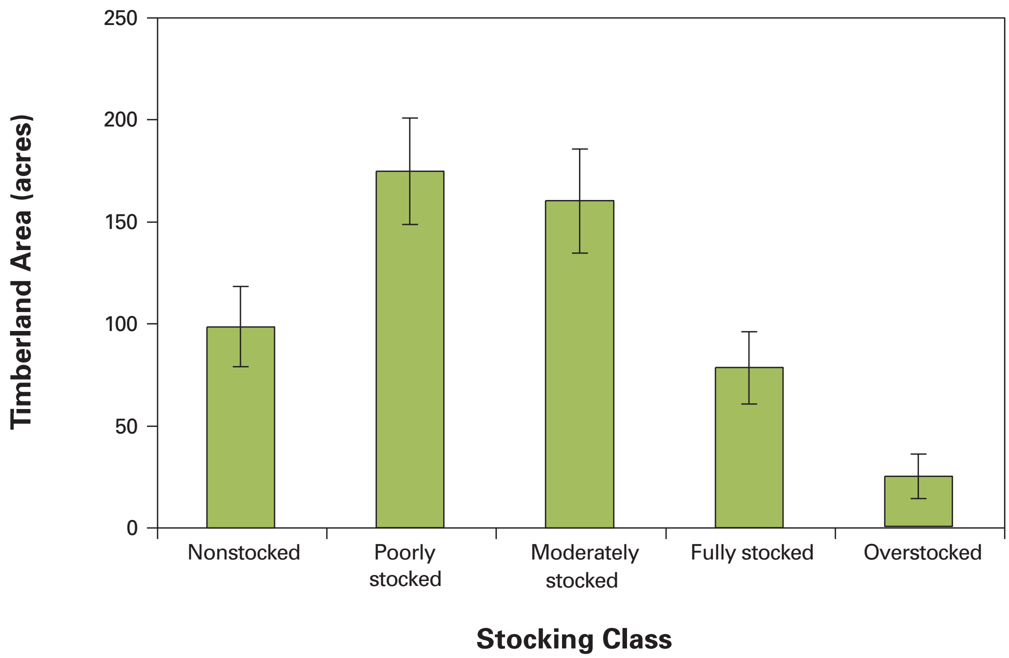


Figure 15b.—Area of timberland by stocking class and associated standard error, North Dakota, 2005.



Biomass: North Dakota's Forest Weighing In

Background

In this report, tree biomass is defined as the total dry weight of all live aboveground components of a forest tree including boles, stumps, tops, and limbs. In commercial timber harvesting, the bole usually is the primary product because it contains wood used as lumber, pulp, post, and other wood products. Estimates of biomass are becoming increasingly important for analyses of carbon sequestration, fiber availability for fuel, and fuel loading/wildfire risk assessments. As new biofuel industries emerge across the country, residual biomass from forest thinning and harvest operations takes on added environmental and economical importance.

What we found

Live aboveground tree biomass is estimated at 19.8 million dry tons, an average of about 27 dry tons/acre of forest area (Fig. 16). Total aboveground tree biomass on timberland increased by 2.3 million dry tons between 1994 and 2005. The bole (main stem) of trees accounts for nearly 7 of every 10 dry tons of aboveground tree biomass in the State (Fig. 17). Stumps, tops, and limbs account for 25 percent of aboveground biomass and small trees (1-5 inches d.b.h.) account for the remaining 10 percent. More than 77 percent of the state total for aboveground biomass (trees) is found on privately owned forest lands (Fig. 18). Only county and local government forest lands have a higher per acre tonnage of biomass than private forests (Fig. 19).

What this means

North Dakota is steadily accruing tree biomass as the forests continue to grow and mature. Although the live-tree biomass of the forests holds substantial amounts of carbon, other forest pools such as soils, dead trees, roots, and non-tree vegetation also contribute to the total carbon pool of the forest ecosystem.

Figure 16.—Area of aboveground biomass by dry tons per acre, North Dakota, 2005.

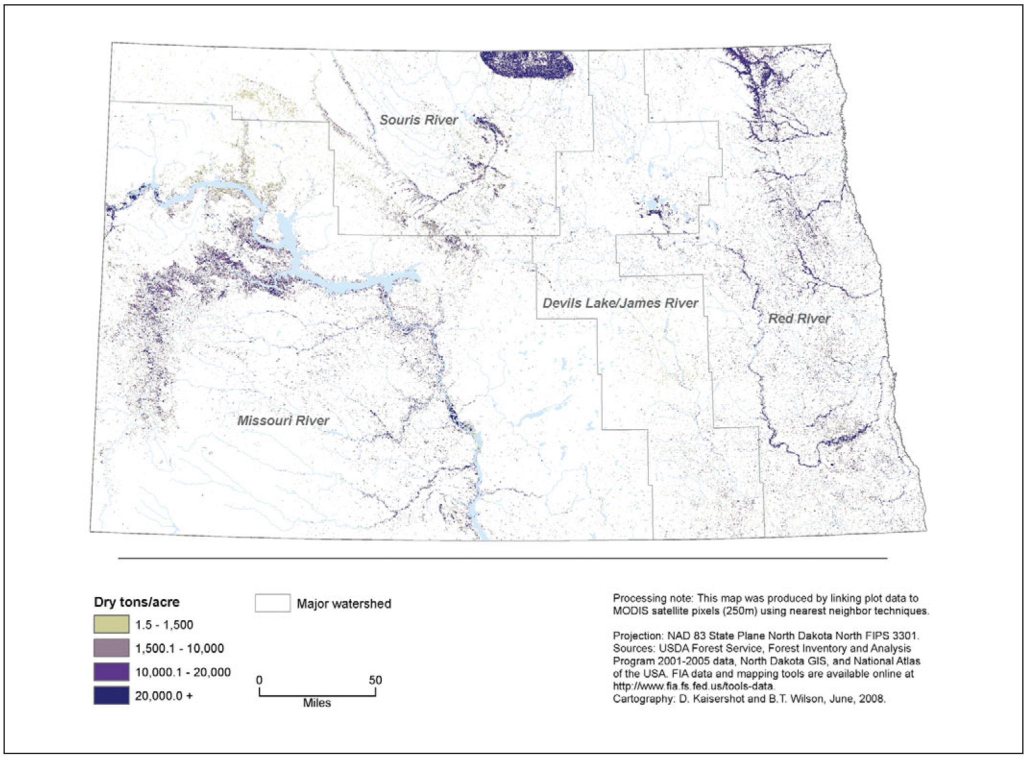


Figure 17.—Components of live-tree biomass, North Dakota, 2005.

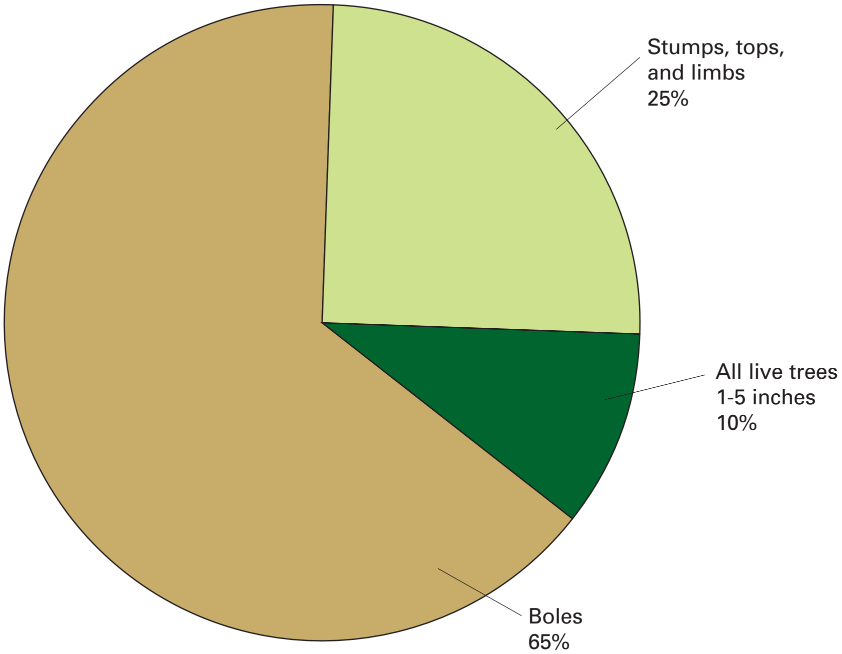


Figure 18.—Ownership of forest biomass (dry tons) for growing-stock and non-growing-stock trees on forest land, North Dakota, 2005.

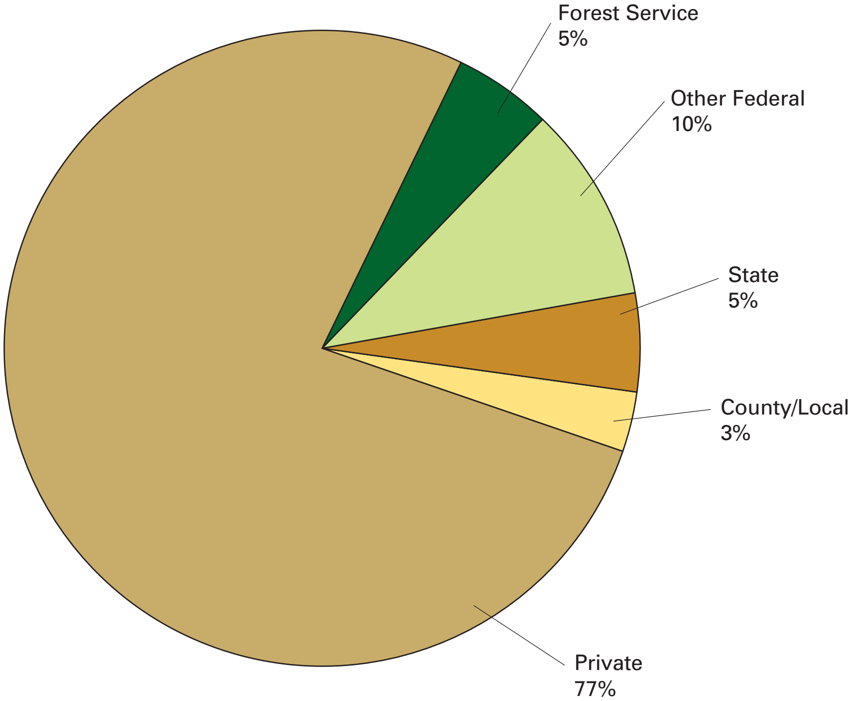
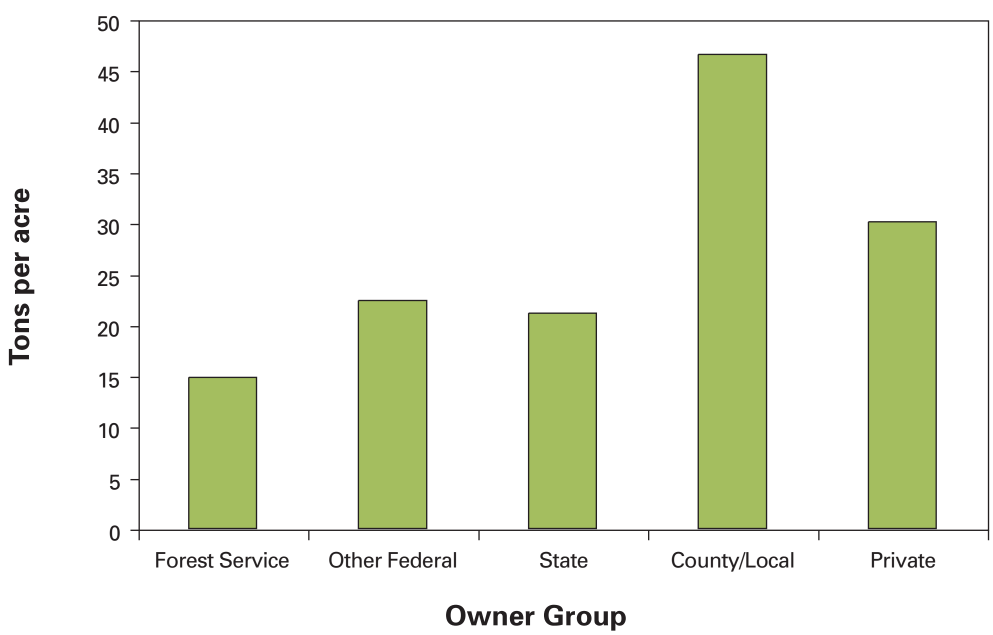


Figure 19.—Per acre aboveground dry weight of all live-tree biomass on forest land by owner group, North Dakota, 2005.



Cottonwood—A Special Situation

Background

Cottonwood trees hold a special place in the history of North Dakota. The giant cottonwood trees along the Missouri River near Washburn in Smith Grove are living witnesses to the Lewis and Clark Corps of Discovery Expedition that explored the Louisiana Purchase some 200 years ago (North Dakota Forest Service 2003). In 1873, Congress passed the Timber Culture Act, which offered 160 acres to any settler willing to plant 10 acres of trees (North Dakota Forest Service 1991). Many of the tree plantings included cottonwoods that are still around today. Cottonwood has always been one of the primary tree species harvested in the State. The potential loss of area in the cottonwood forest type is a major concern for North Dakota.

What we found

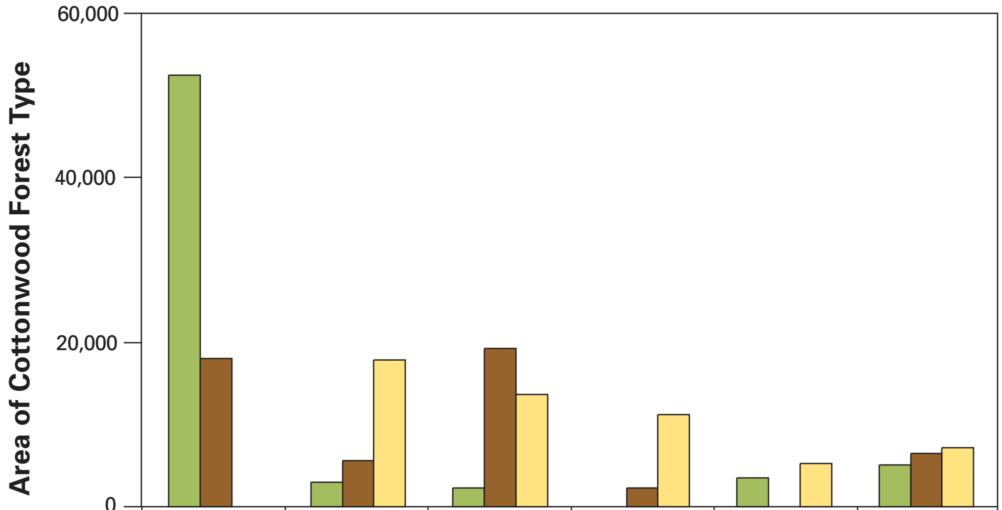
To gauge the future status of cottonwood in North Dakota, we looked at the area of cottonwood forest type by stand age over time. In 1980, there were an estimated 66,000 acres in the cottonwood forest type; by 2005 that had dropped to 55,000 acres, a decrease of around 20 percent (Fig. 20). Over this 25-year period, the cottonwood forest type in the stand age category of 0 to 20 years dropped to zero acres.

We also assessed the number of cottonwood trees by diameter between the 1994 and 2005 survey. Across all forest types in North Dakota, we estimate that the number of cottonwood saplings in the 1.0- to 2.9-inch diameter range is zero and there are only 445,000 saplings in the 3.0- to 4.9-inch diameter range. These estimates illustrate the lack of cottonwood regeneration within the State (Fig. 21).

What this means

The lack of young stands of cottonwood across North Dakota, along with the low rate of regeneration as expressed by the number of saplings across all forest types, illustrates the shifts in natural disturbance regimes required to perpetuate cottonwood forests. Cottonwood seeds require a moist bare mineral soil seedbed in which to germinate. Frequent flooding along streambanks helps prepare suitable seedbeds. Flood control structures on many of the major rivers across the State have resulted in the loss of suitable sites for cottonwood regeneration. If these trends persist across North Dakota, the area and the number of cottonwood trees growing in the State will continue to decrease.

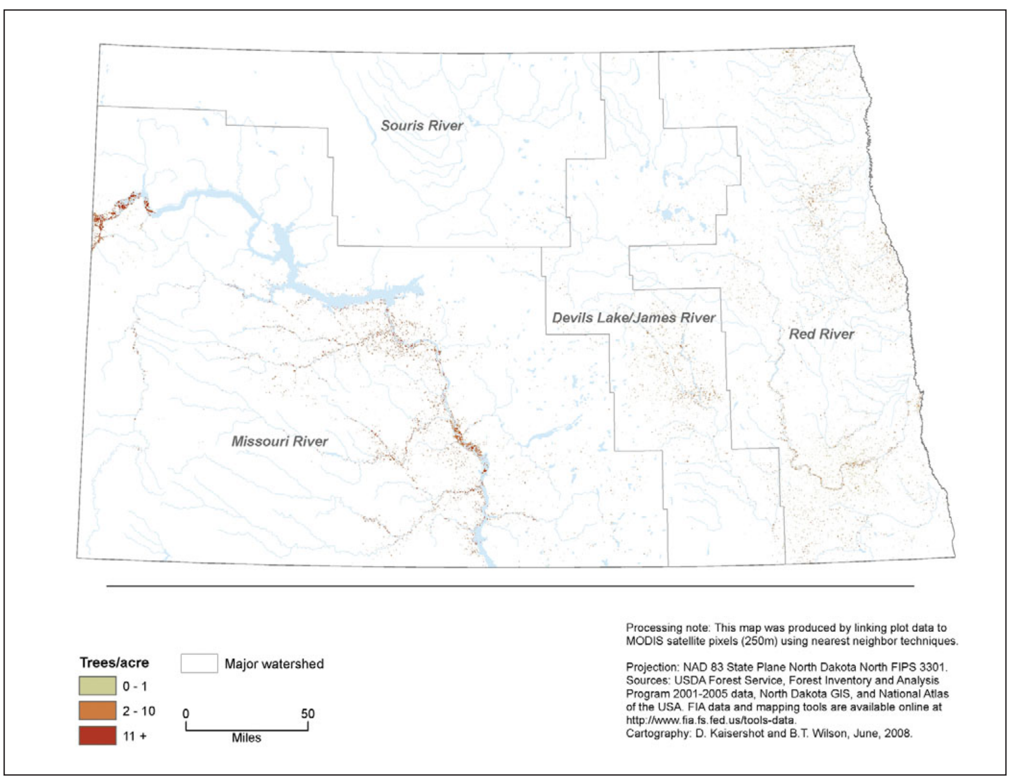
Figure 20.—Area of cottonwood forest type by stand age and inventory year, North Dakota, 1980-2005.



	0-20 years	21-40 years	41-60 years	61-80 years	81-100 years	100+ years
1980	52,547	2,962	2,286	0	3,426	5,153
1995	18,022	5,600	19,178	2,293	80	6,545
2005	0	17,852	13,609	11,249	5,236	7,129

Stand Age

Figure 21.—Cottonwood trees per acre, North Dakota, 2005.



The Aspen Resource

Background

With the exclusion of fire, much of the aspen in North Dakota has become overmature and is declining in health and vigor (North Dakota Forest Service 2004a). Second only to the elm/ash forest type in area with 116,000 acres of forest land, the aspen forest type is an important resource for wildlife, recreation, esthetics, and forest industry.

What we found

In 1980, there were an estimated 154,000 acres in the aspen forest type. By 2005, the area of aspen had dropped to 116,000 acres, a decrease of around 25 percent (Fig. 22). Over this 25-year period, the aspen forest type in the stand age category of 0 to 20 years decreased by more than 35,000 acres, while 60 percent of aspen stands in the State in 2005 were 40 years or older.

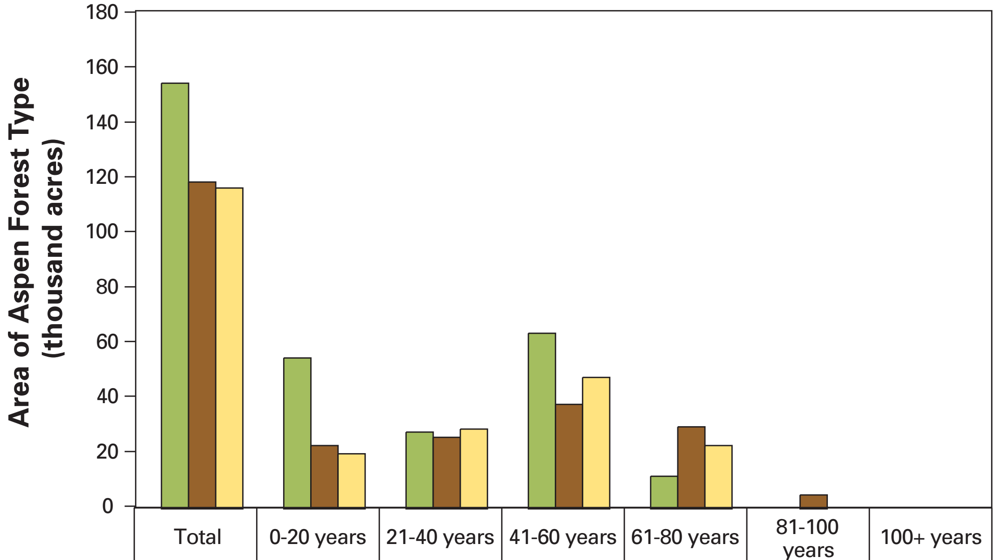
All live volume of aspen across all forest types in North Dakota in 2005 was estimated at just over 100 million cubic feet (Fig. 23), an increase of just over 5.9 million cubic feet or 6 percent between inventories. Taking a look at volume per acre just on aspen stands between inventories, we note a decrease in aspen volume. In 1995, aspen volume per acre was estimated at 761 cubic feet per acre. By 2005, aspen volume per acre had dropped to 632 cubic feet per acre.

What this means

The aspen forest type in North Dakota is in decline. Stands of aspen are at or near maturity for this pioneer species. Without disturbances (e.g., fire or harvesting) the aging stands of aspen will continue to deteriorate, succumbing to weather, insects, and disease.

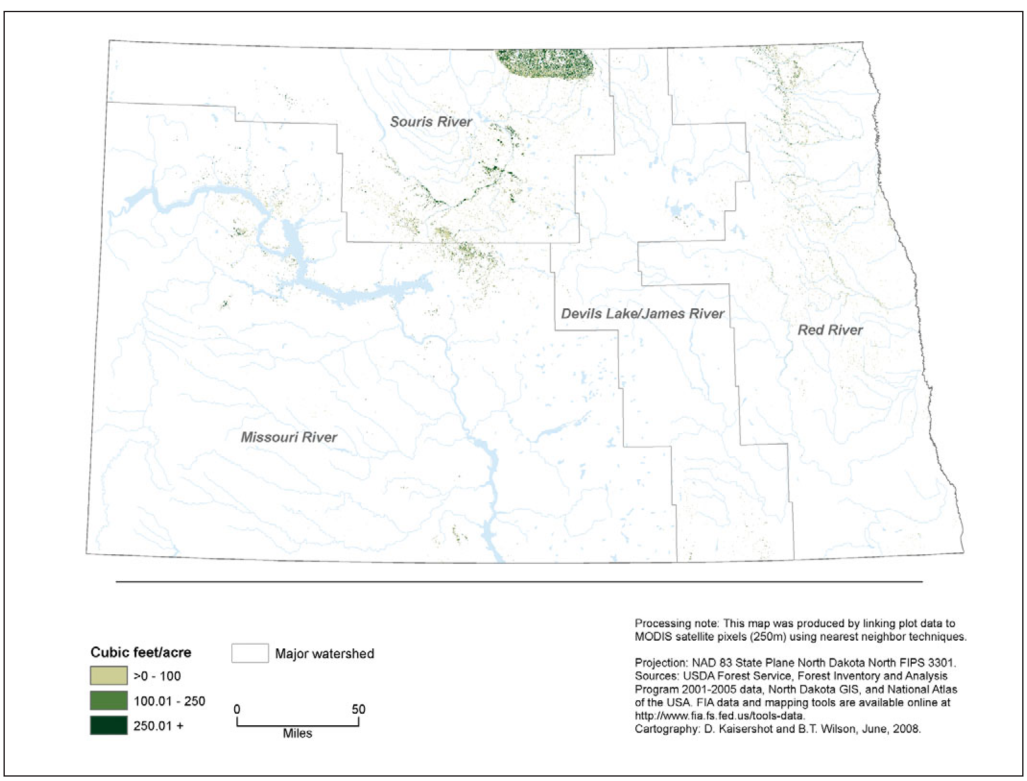
Aspen trees. Photo by U.S. Forest Service, Northern Research Station.

Figure 22.—Area of aspen forest type by stand age and inventory year, North Dakota, 1980-2005.



	Total	0-20 years	21-40 years	41-60 years	61-80 years	81-100 years	100+ years
1980	154	54	27	63	11	0	0
1995	118	22	25	37	29	4	0
2005	116	19	28	47	22	0	0

Figure 23.—Aspen live volume per acre, North Dakota, 2005.



Whose Woods Are These? Family Forest Owners

Background

FIA conducts the National Woodland Owner Survey (NWOS) to increase our understanding of who owns the forest, why they own it, and what their management objectives are. Data presented here are based on survey responses from 28 randomly selected families and individuals who own forest land in North Dakota. Although this sample size is relatively small, the trends for North Dakota are consistent with the trends for the region as a whole, albeit with large sampling errors. The general trends appear to be accurate. For additional information on the NWOS, visit: www.fs.fed.us/woodlandowners.

What we found

The majority of the forest land in North Dakota, 424,000 acres or 58 percent, is owned by families and individuals (Fig. 24). An additional 86,000 acres are owned by other private groups (e.g., corporations, tribes, etc.). Collectively, private owners possess 70 percent of the State's forests. An estimated 30,000 families and individuals collectively own 424,000 acres of forest land in North Dakota. They are the dominant forest ownership group in the State. Although 76 percent of family forest owners have fewer than 10 acres of forest land, 86 percent of family forest land is owned by people with landholdings of 10 acres or more (Table 1). Although most family forest owners in North Dakota plan to do little or nothing with their forest land in the next 5 years, approximately 1 in every 3 acres is held by owners who plan to either transfer their land to heirs or otherwise sell it within the next 5 years (Table 2). Land transfer is related, in part, to the age of the owners. Twenty-one percent of the family forest land is owned by people 75 years or older, and an additional 38 percent of the family forest land is owned by people between 65 and 75 years old (Table 3). This large-scale intergenerational shift will change the characteristics of the family forest owners; influence how owners view, interact, and relate to their land; and, as a result, alter future forest characteristics.

What this means

North Dakota's family forest landowners are stewards of an important resource that provides both personal and societal benefits. As stewards, landowners maintain their woodlots and forests to protect and enhance their personal interests while providing environmental and other benefits to the public.

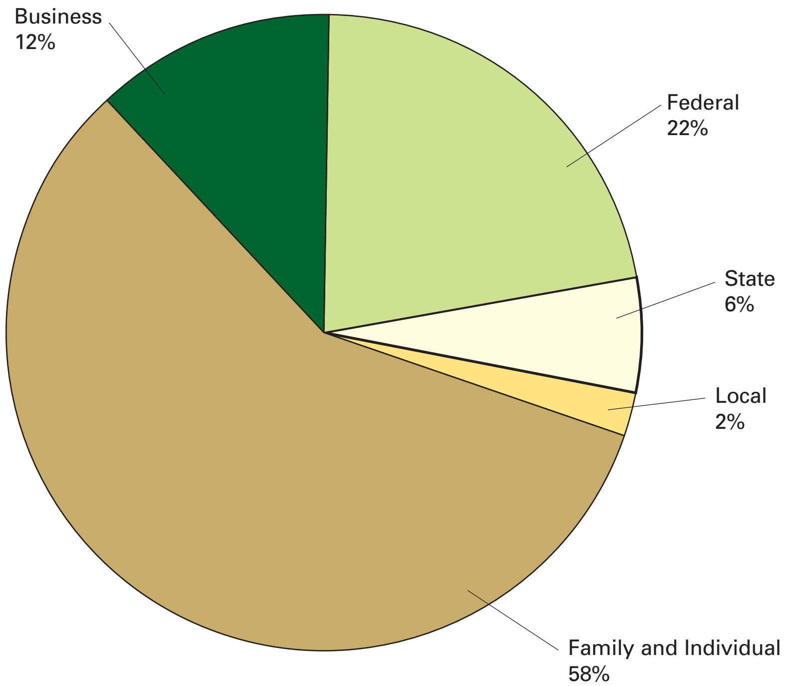


Figure 24.—Forest ownership in North Dakota, 2005.

Table 1.—Area and number of family owned forests in North Dakota by size of forest holdings, 2005

Size of forest landholdings (acres)	Area		Ownerships	
	Acres	**Sampling error**	**Number**	**Sampling error**
	Thousands	*%*	*Thousands*	*%*
1-9	61	82	22	69
10-49	106	51	5	39
50-99	45	106	1	58
100-499	151	37	1	30
500+	61	107	<1	100
Total	**424**	**10**	**30**	**52**

Table 2.—Area and number of family owned forests in North Dakota by landowners' 5-year plans for their forest land, 2005.

Future plans[a]	Area		Ownerships	
	Acres	Sampling error	Number	Sampling error
	Thousands	*%*	*Thousands*	*%*
No activity	91	58	1	46
Minimal activity	136	41	6	57
Harvest firewood	151	37	9	45
Harvest saw logs or pulpwood	15	287	<1	100
Collect NTFPs[b]	42	118	1	38
Transfer all or part of land to heirs	151	37	4	59
Buy more forest land	15	287	<1	100
Land use conversion (forest to other)	45	106	<1	67
No current plans	30	151	<1	80

[a] Categories are not exclusive.

[b] NTFPs = non-timber forest products.

Table 3.—Area and number of family owned forests in North Dakota by age of owner, 2005.

Age (years)	Area		Ownerships	
	Acres	Sampling error	Number	Sampling error
	Thousands	*%*	*Thousands*	*%*
<45	21	217	4	51
45-54	85	66	10	33
55-64	64	84	<1	28
65-74	148	42	13	34
75+	85	66	1	28
No Answer	21	217	1	51

Whose Woods Are These? Public Forests

Background

Public forests are an important part of North Dakota's natural resource heritage. Forests provide access to outdoor education and recreational opportunities, provide wildlife habitat, and play an important role in protecting watersheds.

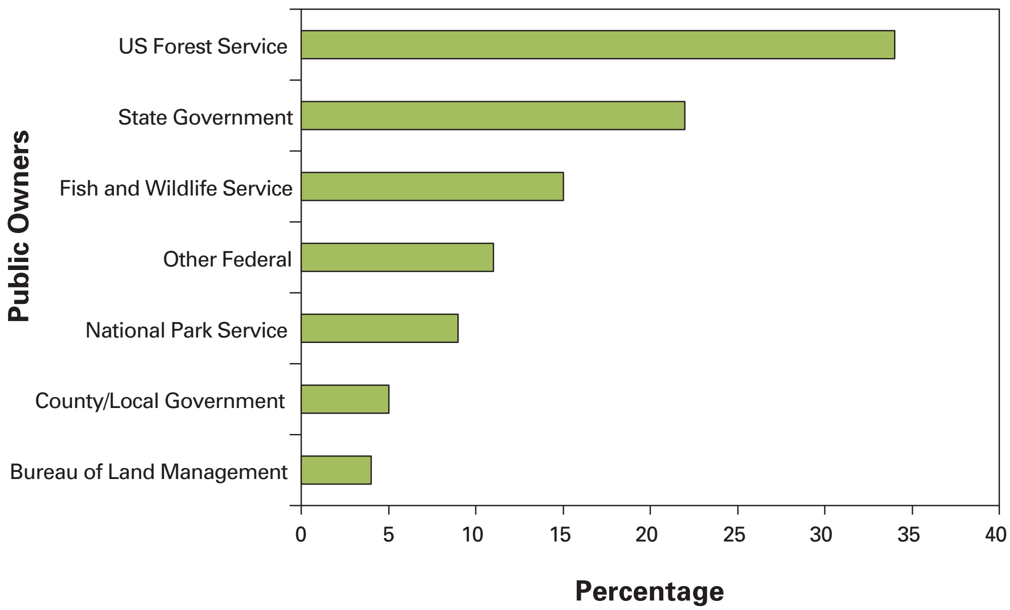
What we found

Roughly 30 percent (214,400 acres) of forest lands in North Dakota are publicly owned (Fig. 25). The Federal government, primarily the U.S. Forest Service, is responsible for managing 72,000 acres or 34 percent while the State of North Dakota manages just over 46,000 acres or 22 percent of the forest land. More than 39 percent of the public lands are managed by other Federal agencies, which include the Fish and Wildlife Service, National Park Service, and Bureau of Land Management.

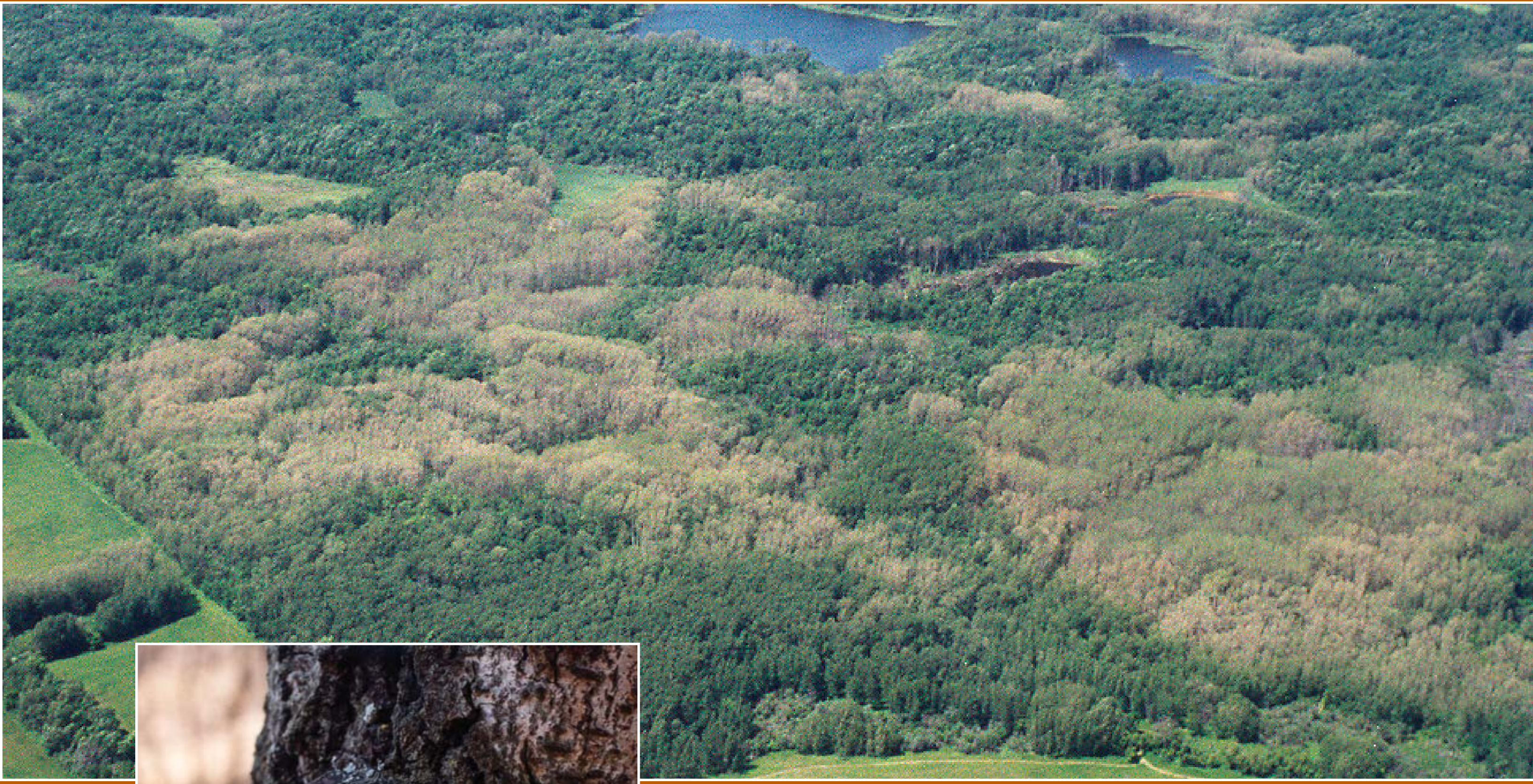
What this means

Much of the land available for public outdoor recreation such as hunting, fishing, hiking, camping, or bird watching is managed by State and Federal agencies. For example, the North Country Trail, which runs from New York to North Dakota, travels through both state forest and U.S. Forest Service lands in southeast North Dakota. The North Dakota Parks and Recreation Department administers 19 state parks and recreation areas across the State. The North Dakota Forest Service manages lands for multiple benefits including recreation and forest products. Federal agencies like the U.S. Forest Service, National Park Service, and Fish and Wildlife Service manage areas available for recreation, many of which are forested.

Figure 25.—Distribution of public ownership by percent, North Dakota, 2005.



Forest Health



Aerial view of forest tent caterpillar defoliation in the Turtle Mountains. Photo used with permission from the North Dakota Forest Service.

Aspen conk produced by the fungus *Phellinus tremulae*. Photo used with permission from the North Dakota Forest Service.

Crowns

Background

The overall condition of the tree crowns indicates the health of a forest stand. For example, a forest suffering repeated insect infestation will have low crown ratios, high transparency, low density, and signs of dieback. Because tree crowns form part of the basic structural architecture of a forest ecosystem, they also influence the composition, process, and vigor of understory flora and fauna (Schomaker et al. 2007).

What we found

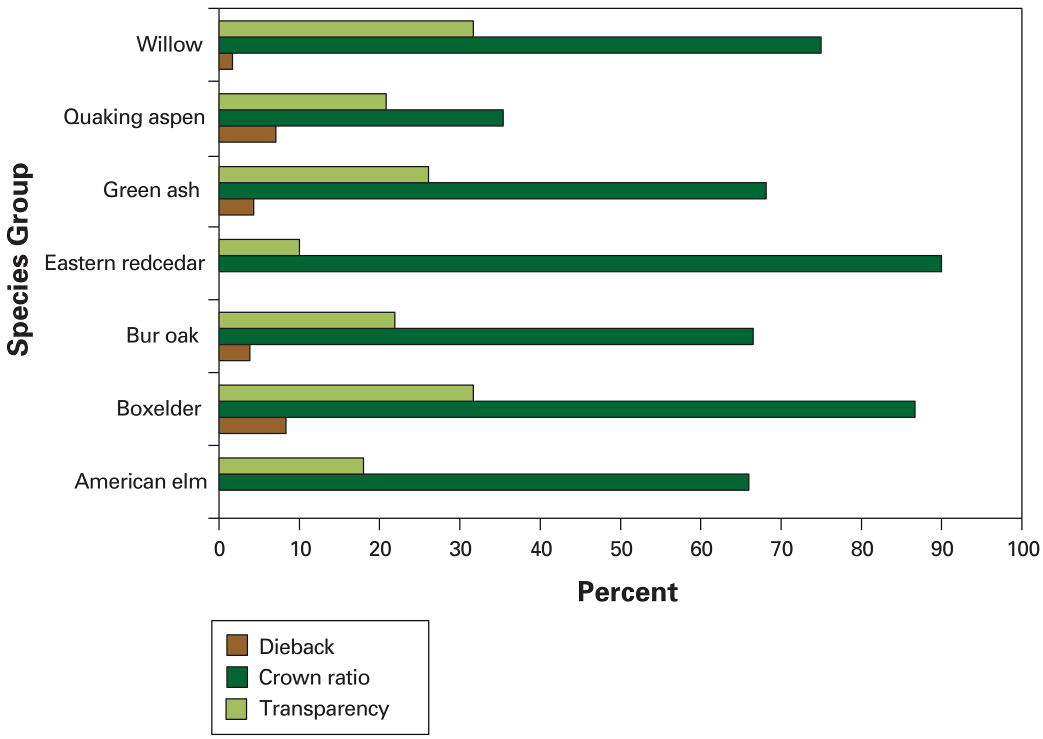
Crown indicator variables are collected only on a subset of forest land plots. The following data are from seven Phase 3 plots or 150 trees. Dieback is measured as the percentage of branch tips in the crown that are dead. The categories for the dieback indicator are none (0-5 percent), light (6-20 percent), moderate (21-50 percent), and severe (51-100 percent) (Fig. 26). Most trees were found to be in the none or light categories. Boxelder (8.3 percent) and aspen (7.1 percent) had the highest dieback ratios.

The crown ratio of a tree is defined as the portion of the tree height supporting live foliage. Eastern redcedar has the highest mean crown ratio at 90 percent; quaking aspen has the lowest mean ratio at just over 35 percent. Crown transparency is a measure of the proportion of the crown through which the sky is visible. The willow and boxelder species groups have the highest average crown transparency, approaching 32 percent; the eastern redcedar has an average crown transparency of only 10 percent.

What this means

Means of the crown indicators by species group appear to indicate healthy crown conditions in North Dakota. Crown ratio and crown transparency appear to be inversely related: the higher the crown ratio the lower the transparency. Crown ratios are generally higher for trees on the edge of the forest. With the baseline data collected, we will continue to monitor crown health and will be able to detect trends as they develop.

Figure 26.—Percentage of dieback, mean crown transparency, and mean uncompacted crown ratio for selected species groups, North Dakota, 2005.



North Dakota Soils

Background

Soils are vital to a tree's survival. In addition to physically supporting the roots, and therefore the rest of the tree, soils also provide essential water and nutrients to the tree (North Dakota Forest Service 2004b). Inventory and assessment of the forest soil resource provides critical baseline information on forest health and productivity.

What we found

Field data are available from 2001 to 2004. There are relatively few soil inventory plots in North Dakota, but it is possible to make some very broad generalizations using data from other Plains States (South Dakota, Nebraska, and Kansas).

Forest floor accumulations under North Dakota's forests are at or above the median forest floor thickness observed in the region (Fig. 27).

Soil carbon content in the forest floor and mineral soil was calculated from laboratory measurements. The forest floor under North Dakota's forests stores as much or more carbon than that in most samples from neighboring states, both within and across forest-type groups (Fig. 28). The same is true in the 0- to 10-cm layer of mineral soil (Fig. 29). In the 10- to 20-cm layer, carbon storage is more consistent across the region.

The Soil Quality Index (SQI) is a new measure designed to combine the distinct physical and chemical properties of the soil into a single, integrative assessment (Amacher et al. 2007). SQI values in North Dakota are generally higher than those observed in neighboring states (Fig. 30). The high quality of the sampled soils results from several factors: moderate soil pH, abundant calcium and magnesium, and low levels of aluminum.

What this means

Soil carbon is significant for several reasons. First, carbon is the primary component of soil organic matter, which has a number of important functions. These include increasing water holding capacity, retaining some nutrients by cation exchange (e.g., Ca2+, Mg2+, K+), releasing other nutrients as it decays (e.g., nitrogen, phosphorus, and sulfur), and capturing potential toxic agents (e.g., mercury) (McBride 1994). Nationally and internationally, carbon is also inventoried to track the sequestration of certain greenhouse gases.

Calcium and magnesium are essential elements for plant growth. Calcium is required for cell wall formation, and magnesium is essential to photosynthesis as the central atom of the chlorophyll molecule (Marschner 1986). High levels of aluminum reduce root growth (Marschner 1986).

The soil indicator is in its infancy, but the existing data suggest that the forest soils of North Dakota are of high quality and storing above average amounts of carbon. This may indicate an opportunity for the State's limited forests to play an important role in future sequestration programs.

Figure 27.—Observations of forest floor thickness, North Dakota and other Plains States, 2001-2004.

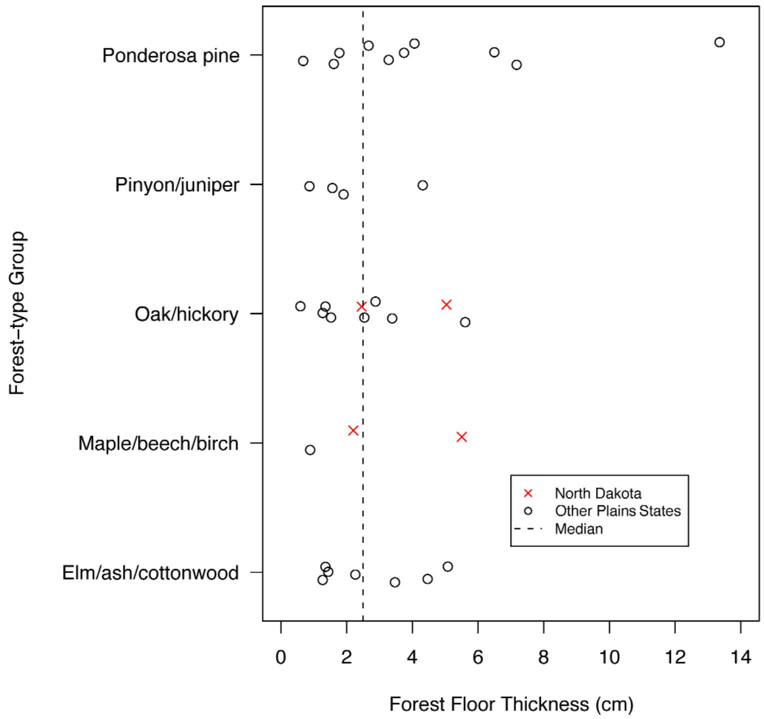


Figure 28.—Observations of forest floor soil carbon content, North Dakota and other Plains States, 2001-2004.

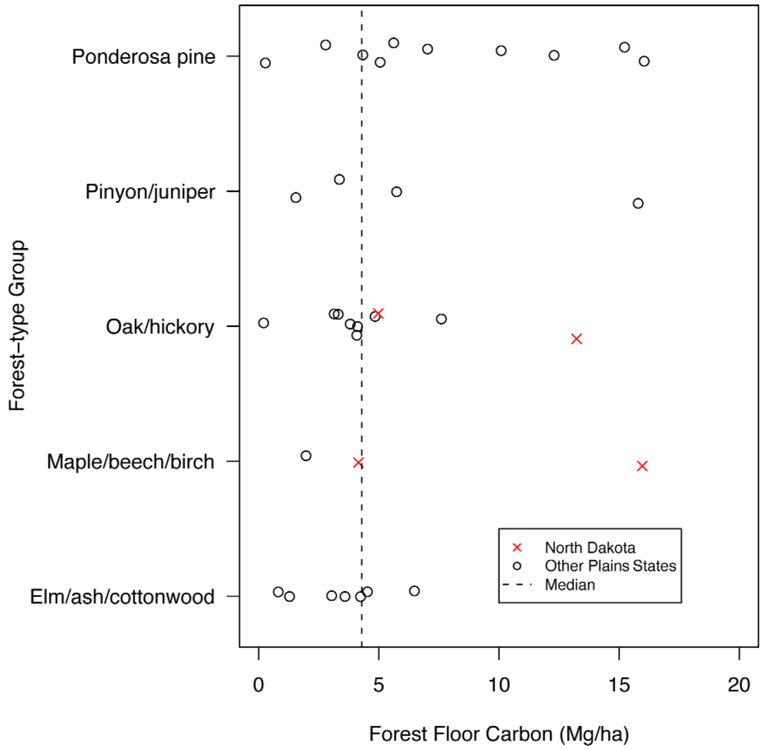
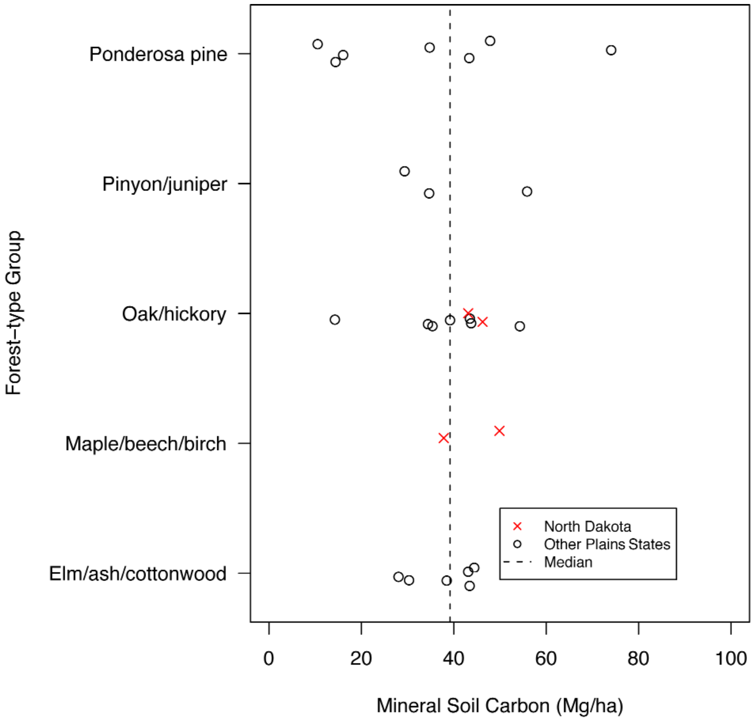


Figure 29.—Observations of mineral soil carbon content, 0-10 cm, North Dakota and other Plains States, 2001-2004.



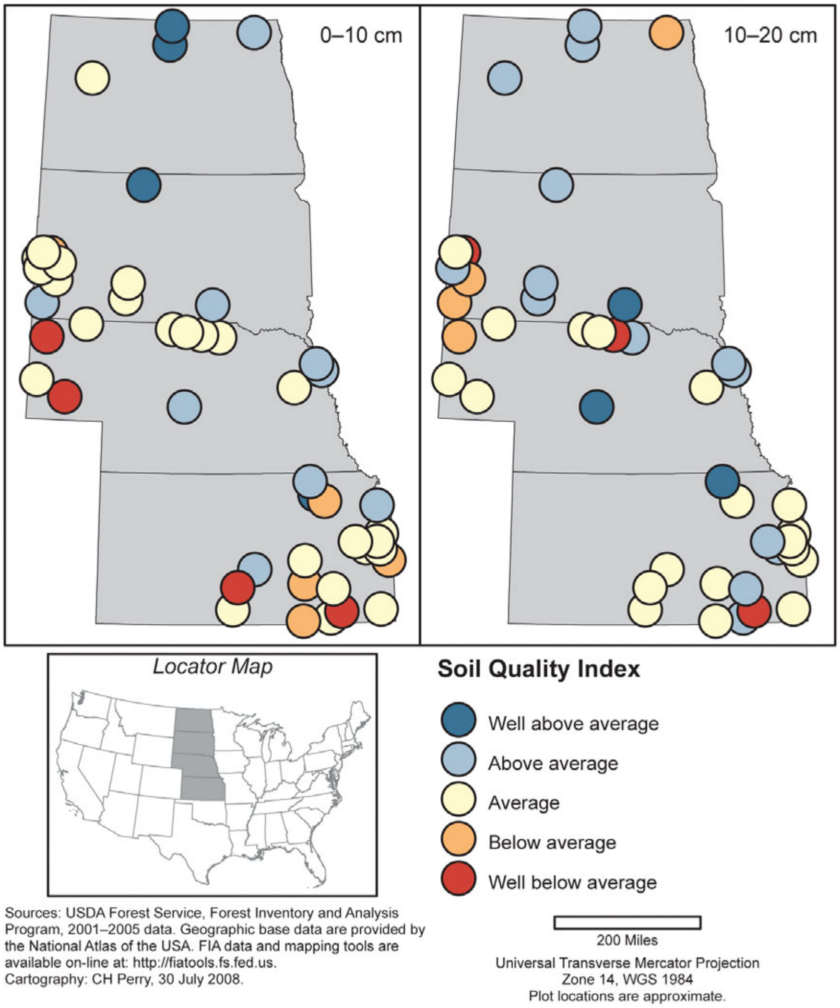


Figure 30.—The Soil Quality Index (Amacher et al. 2007) highlights differences in the overall chemical and physical condition of the soil.

Down Woody Materials

Background

Down woody materials, in the form of fallen trees and branches, fill a critical ecological niche in North Dakota's forests. Down woody materials provide valuable wildlife habitat in the form of coarse woody debris, increase the diversity of forest structure, and are an important determinant of forest fire behavior.

What we found

Overall, the fuel loadings of down woody materials (time-lag fuel classes) are relatively low for most classes in North Dakota (Fig. 31) (for time-lag definitions see Woodall and Monleon 2008). For comparison, the combined loadings of 1-hr, 10-hr, and 100-hr fuels in blowdown areas of the Boundary Waters Canoe Area Wilderness in Minnesota exceeded 16 tons/ac (Woodall and Nagel 2007), while North Dakota's combined loadings were below 3 tons/ac. One exception is the 1,000+-hr fuels that averaged over 8 tons per forest land acre. However, it should be noted that this 1,000+-hr fuel estimate has a standard error of 3 tons/acre, which indicates that it may not be statistically different from that of neighboring states. The size class distribution of coarse woody debris appears to be heavily skewed (84 percent) toward pieces less than 8 inches in diameter at the point of intersection with plot sampling transects (Fig. 32a). In the decay class distribution of coarse woody debris, there appears to be a fairly uniform distribution of stages of coarse woody decay across the State, except for decay class 3 logs (48 percent) (Fig. 32b). Decay class 3 coarse woody pieces are typified by moderately decayed logs that are still structurally sound but missing most of their bark with extensive sapwood decay. There is no strong trend in coarse woody debris volumes/acre among classes of live-tree density (basal area/acre) (Fig. 33).

What this means

The down woody fuel loadings in North Dakota's forests are not significantly different from those found in neighboring states. Therefore, only in times of extreme drought would these low amounts of fuels pose a hazard across the State. Of all down woody components, 1,000+-hr fuels made up the largest amounts possibly due to windthrow events along the numerous forest fringes in this Plains State. However, coarse woody debris volumes are still relatively low and were represented by small, moderately decayed pieces. Overall, because fuel loadings are not exceedingly high across North Dakota, possible fire dangers are outweighed by the benefits of down woody material for wildlife habitat and carbon pools.

Figure 31.—Means and associated standard errors of fuel loadings (tons/acre, time-lag fuel classes) on forest land in North Dakota and neighboring states, 2001-2005.

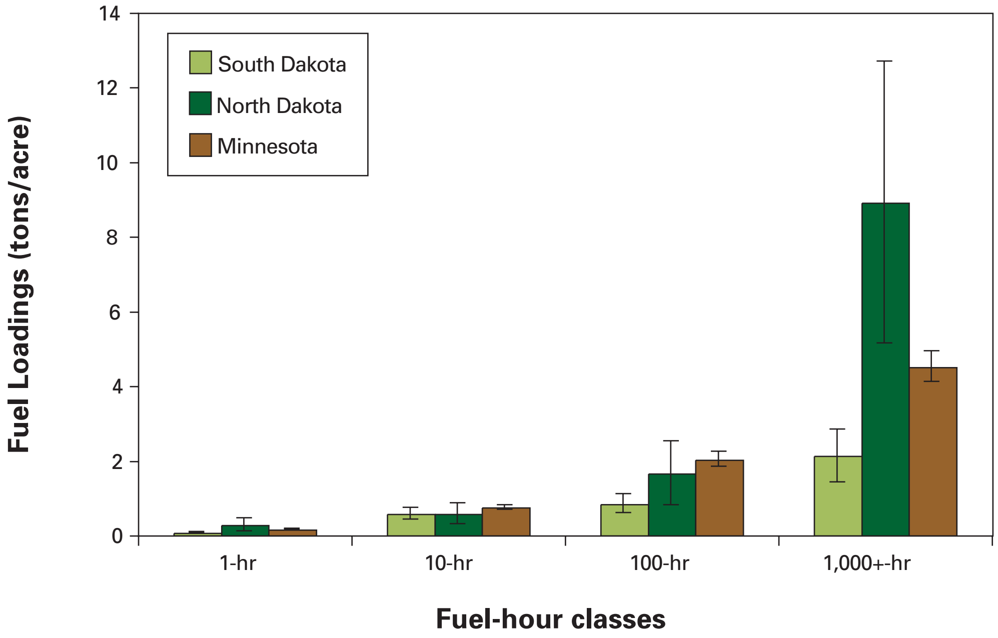
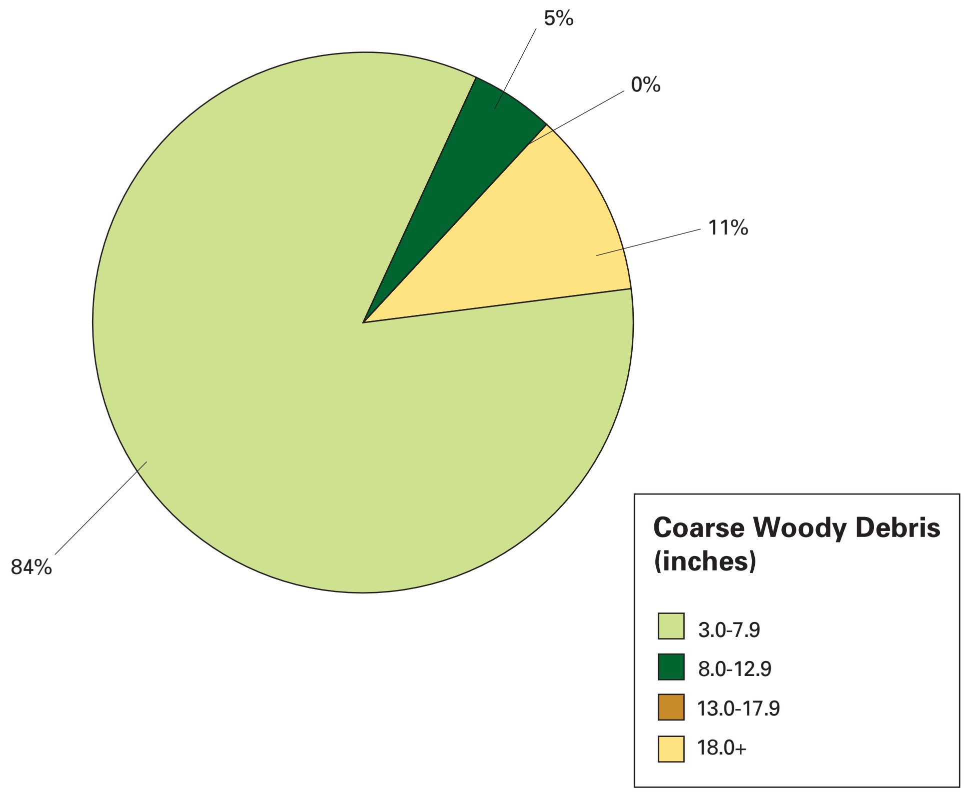


Figure 32 a and b.— Mean proportions of coarse woody debris total pieces per acre by transect diameter (inches) and decay classes on forest land in North Dakota, 2001-2005.



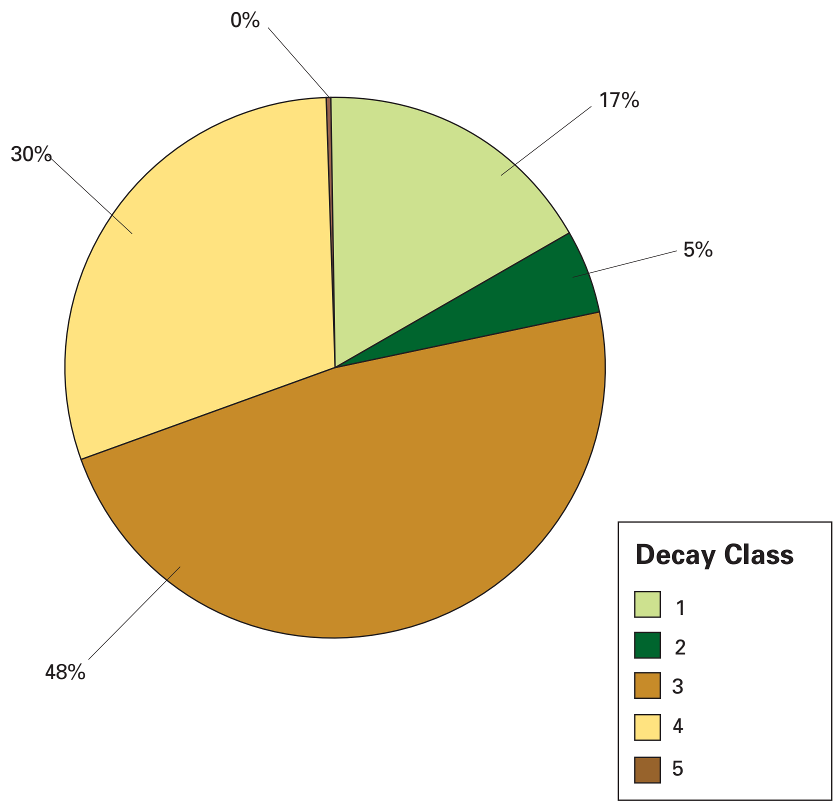
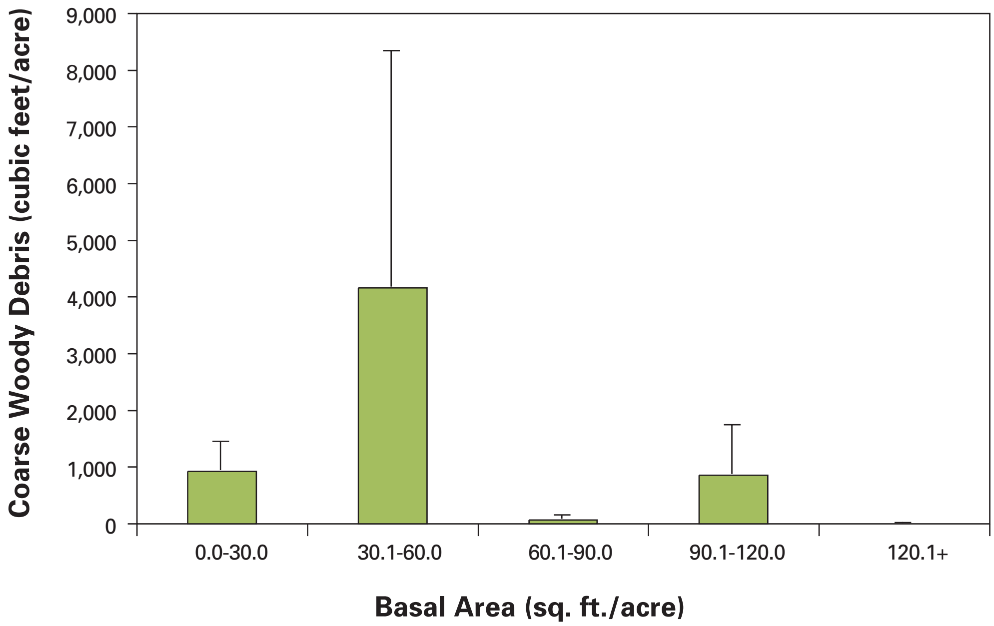


Figure 33.—Means and associated standard errors of coarse woody debris volumes (cubic feet/acre) on forest land in North Dakota, 2001-2005.



Ozone

Background

Bioindicator leaf injury surveys were initiated in North Dakota in 2002. North Dakota has eight permanent biosites scattered across the State; no foliar injury symptoms have been observed so far.

What we found

Ground-level ozone exposure in North Dakota has not been detected by our inventory measurements:

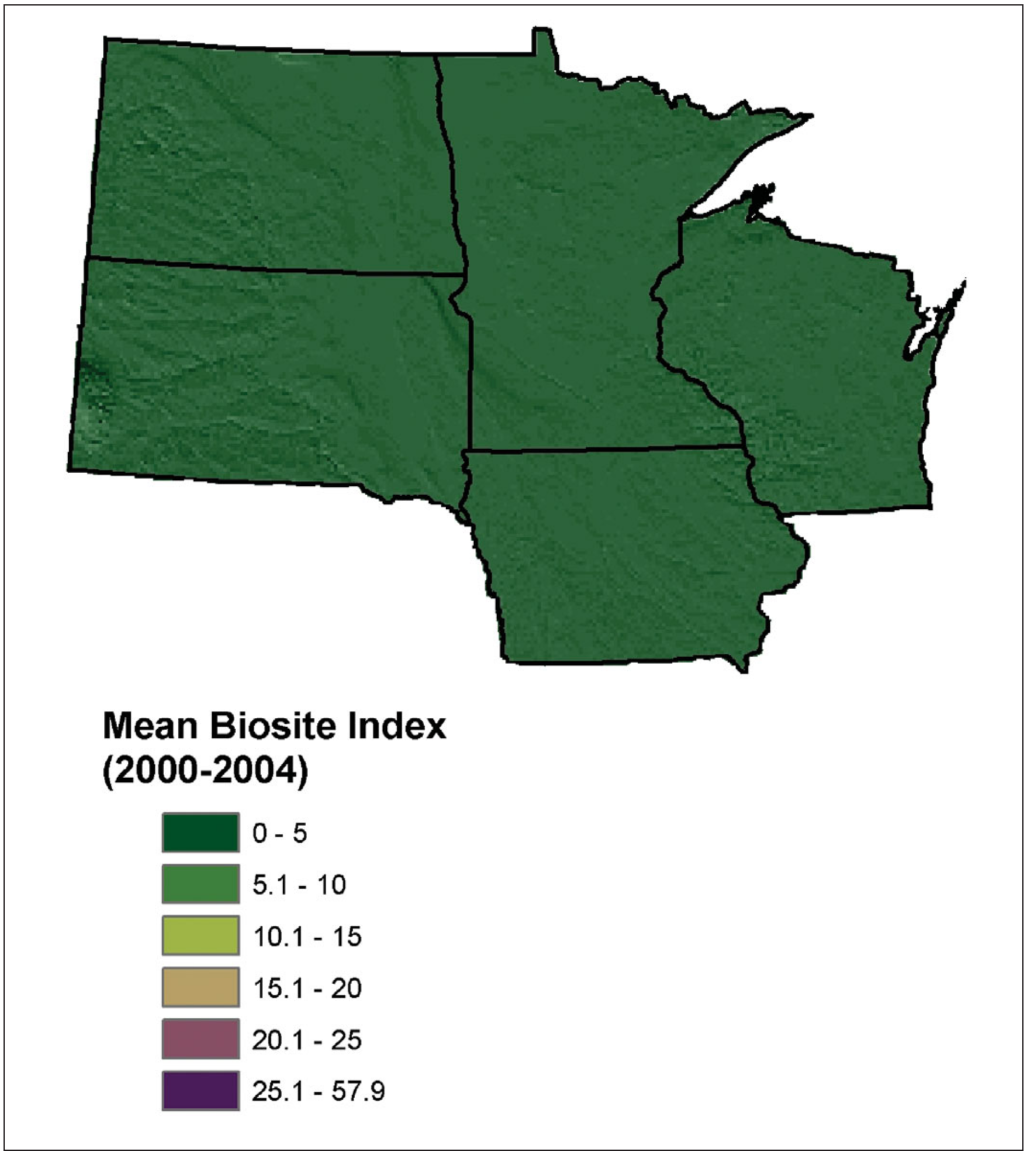
Parameter	2002	2003	2004	2005
Number of biosites	8	8	8	8
Biosites with injury (%)	0	0	0	0
Number of plants evaluated	866	695	752	775
Number of plants with injury	0	0	0	0
Mean biosite index	0	0	0	0

North Dakota's ozone levels are some of the lowest in the country (Fig. 34). Plant species used in the ongoing study to detect ozone damage include skunkbush, mountain snowberry, common milkweed, and western wormwood. Tree species studied include green ash, quaking aspen, and ponderosa pine.

What this means

North Dakota's forests appear to be at low risk of suffering ozone damage to ozone-sensitive species. Still, baseline data are needed to develop trends for potential ozone damage in the future.

Figure 34.—Mean biosite index map for North Dakota, 2000-2004.



Invasive Plant Species

Background

Invasive plants spread into intact ecosystems and cause economic or environmental harm by developing self-sustaining populations and becoming dominant or disruptive to those systems (Clyde 2002). Nonnative invasive plant species can compete with and replace native forest plants, reduce wildlife forage and habitat, and increase forest management costs through their impact on tree regeneration and growth.

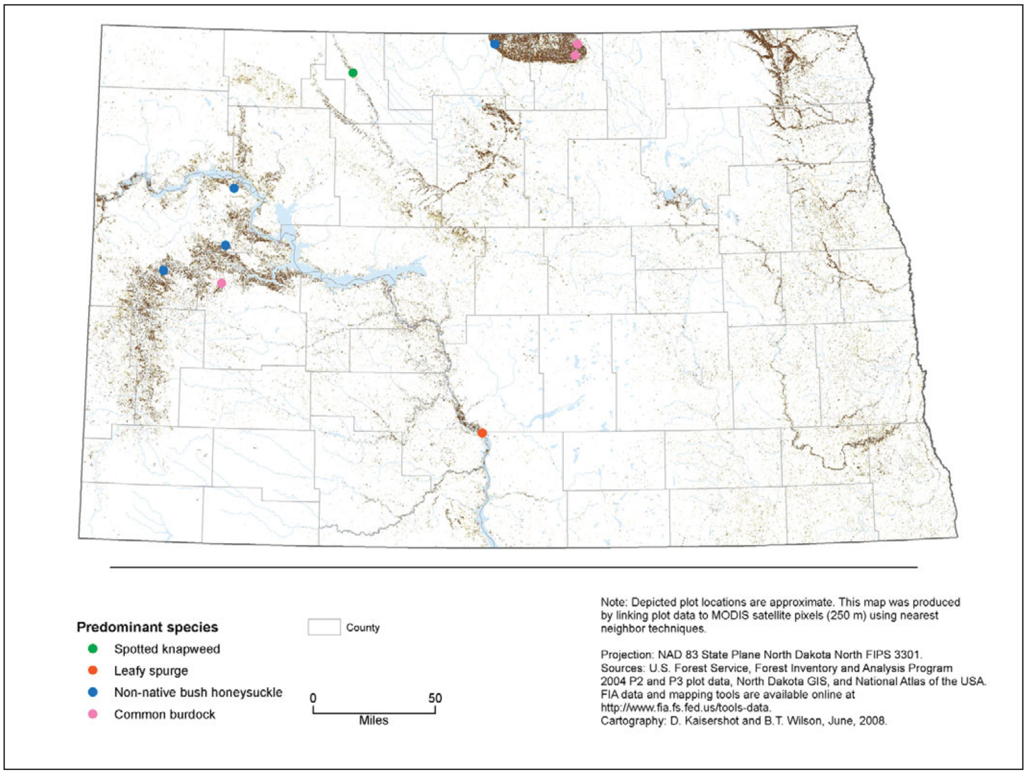
What we found

Between the 2001 and 2003 field seasons, we collected data on native and nonnative forest plant species from our seven ground vegetation plots, a subset of our forest inventory plots. In 2005, we began collecting data on a select list of nonnative invasive plants on all forest inventory plots across the State (Fig. 35). The two most prevalent nonnative species were nonnative bush honeysuckle and common burdock, both species found on 19 percent of sampled plots. Leafy spurge was the third most common nonnative species found. Other nonnative species found include common buckthorn, spotted knapweed, Canada thistle, and bull thistle.

What this means

Nonnative plant species are an emerging forest health concern in North Dakota because they compete with native plant species for resources and threaten ecological diversity by altering natural plant communities. Nonnative plants can also cause economic problems by lowering land values for agriculture, forestry, and recreation.

Figure 35.—Nonnative invasive plants on forest lands, North Dakota, 2005.



Emerald Ash Borer

Background

Since its discovery in North America in 2002, the emerald ash borer (EAB) has caused extensive decline and mortality of ash trees in the central portion of the U.S. and in south-central Canada (Poland and McCullough 2006). EAB is an exotic wood-boring beetle that is a pest of all major species of ash, including green, white, black, and blue ash, and all ash cultivars. Both healthy and stressed ash trees, ranging in size from 1 to 59 inches in diameter, are susceptible (Cappaert et al. 2005). Trees infested with EAB generally die within 1 to 3 years (Poland and McCullough 2006).

What we found

North Dakota's forest land contains an estimated 78.1 million ash trees greater than 1 inch in diameter. Almost all of the State's ash trees (96 percent) are green ash, with only a minor component of black ash (4 percent). Overall, green ash represents 22 percent of all of the live-tree species on forest land. Green ash is the second most abundant tree species in North Dakota by number of trees and is ranked third by estimate of total volume. The total volume of ash, both green and black, is 132.2 million cubic feet, or 18 percent of the total volume on forest land. Ash is found throughout the State, with high densities in the Turtle Mountain region and in west-central North Dakota, area including the Theodore Roosevelt National Park and Wilderness, the Fort Berthold Indian Reservation, and the Little Missouri National Grassland (Fig. 36). Ash is present on 507,700 acres, or 70 percent of North Dakota's forest land (Fig. 37). Although it generally makes up less than 25 percent of total live-tree basal area (BA), in many areas ash represents more than 50 percent of total stand basal area.

What this means

Ash is a major component of North Dakota's woodland forests. It is also found in shelterbelts and riparian areas and it is widely planted in North Dakota communities. Human transportation of infested ash materials increases the risk of EAB introduction to the State and therefore the potential impacts to statewide forest resources and forest industries. Because ash is so abundant throughout the State, EAB would have a significant impact on the structure and composition of North Dakota's woodland, riparian, and community forests.

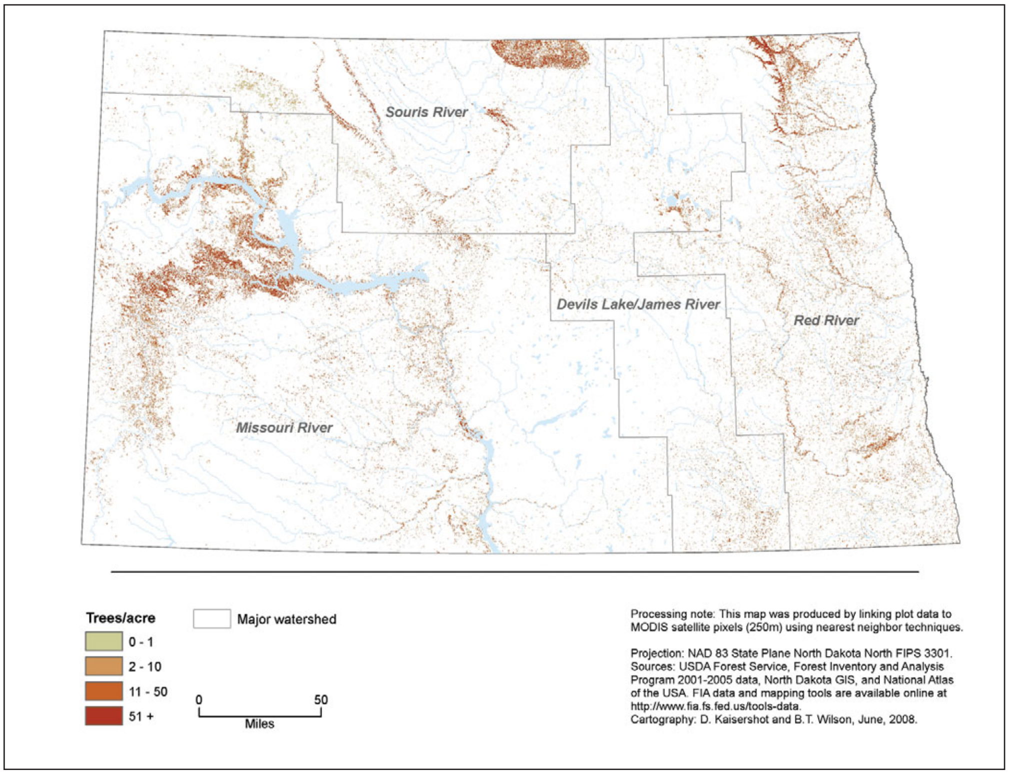


Figure 36.—Density of all live ash trees on forest land in North Dakota, 2001-2005.

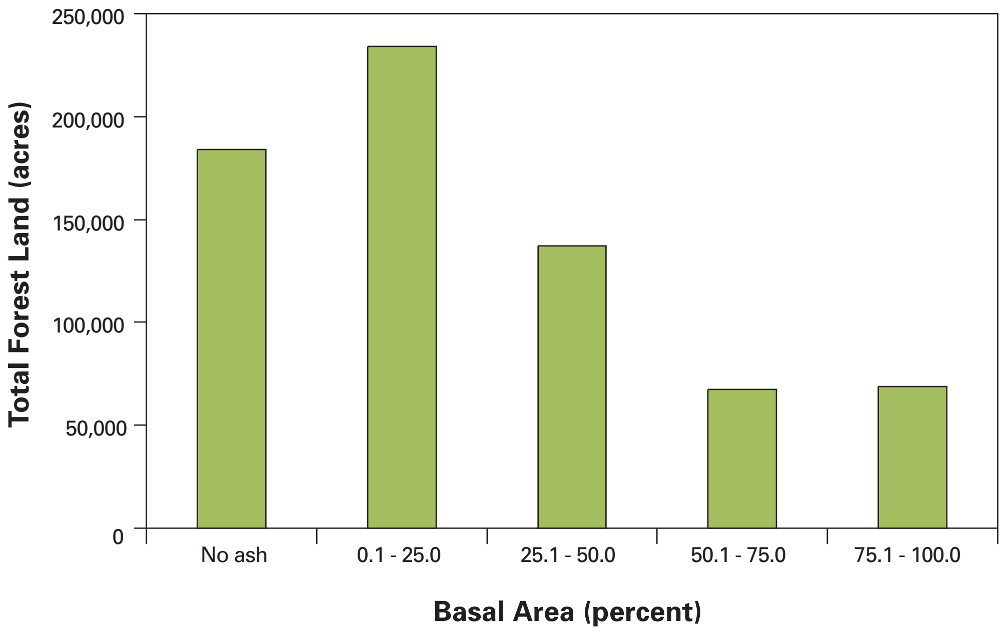


Figure 37.—Presence of ash on forest land, expressed as a percentage of stand basal area (ash BA per acre/total live BA per acre), North Dakota, 2001-2005.

Wildlife Habitat—Snags

Background

Dead and dying standing trees are important to numerous wildlife species. More than 85 species of North American birds are cavity nesters, and several dozen mammals also use holes in trees for burrows and rearing of young. Nearly 40 percent of birds found in midwestern forested areas are cavity nesters. In some areas of the northern plains, such as North Dakota, it may be even more (North Dakota Outdoors 1994).

What we found

The abundance of standing dead or snag trees varies across the different forest types of North Dakota (Fig. 38). For example, the average number of snags per acre in the aspen forest type is higher (29.5) than what we find in the bur oak forest type (12.3). Many factors contribute to the number of snags per stand including stand age, stocking levels, and disturbances like insects, diseases, and weather. On average, there are an estimated 19.0 snags per acre on forest land in the State. Snags per acre differ by ownership as well across the State (Fig. 39). Factors mentioned above along with different forest management strategies will affect the number of snags per acre.

What this means

North Dakota's inventory data indicate a rich abundance of snags across all forest types that provide important habitat for birds and mammals. In addition to providing nesting habitat for cavity nesting birds, dead trees are used by great blue herons, cormorants, hawks, and eagles as secure above-the-ground nest sites. Bats readily use the spaces under loose bark of dead trees as places to raise young and gain protection from the elements. Chipmunks, squirrels, raccoons, and weasels all will use holes in trees for raising young, hibernating, or getting protection from the weather (North Dakota Outdoors 1994).

Figure 38.—Standing dead trees by select forest types, North Dakota, 2005.

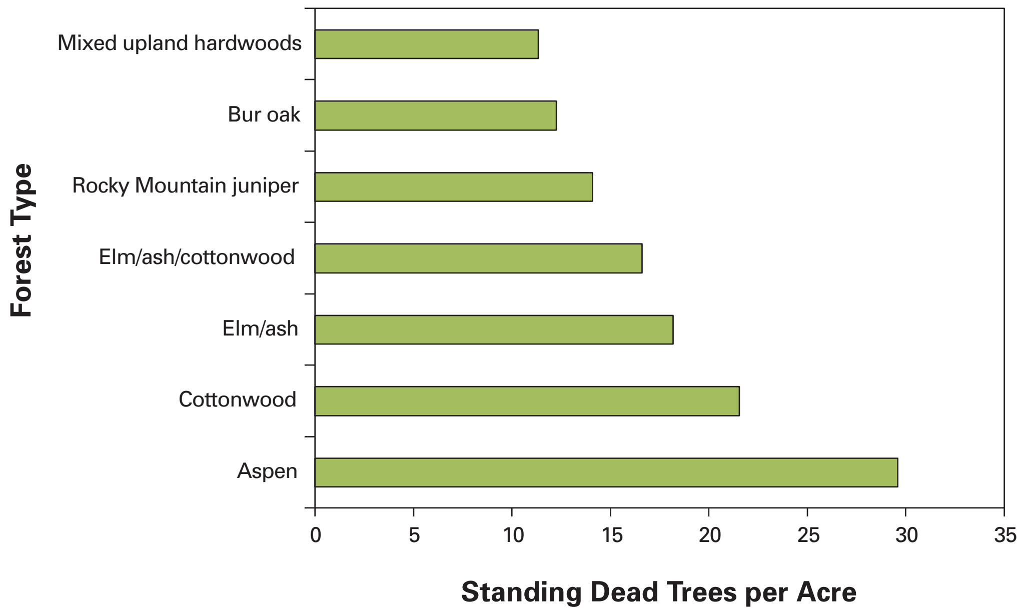
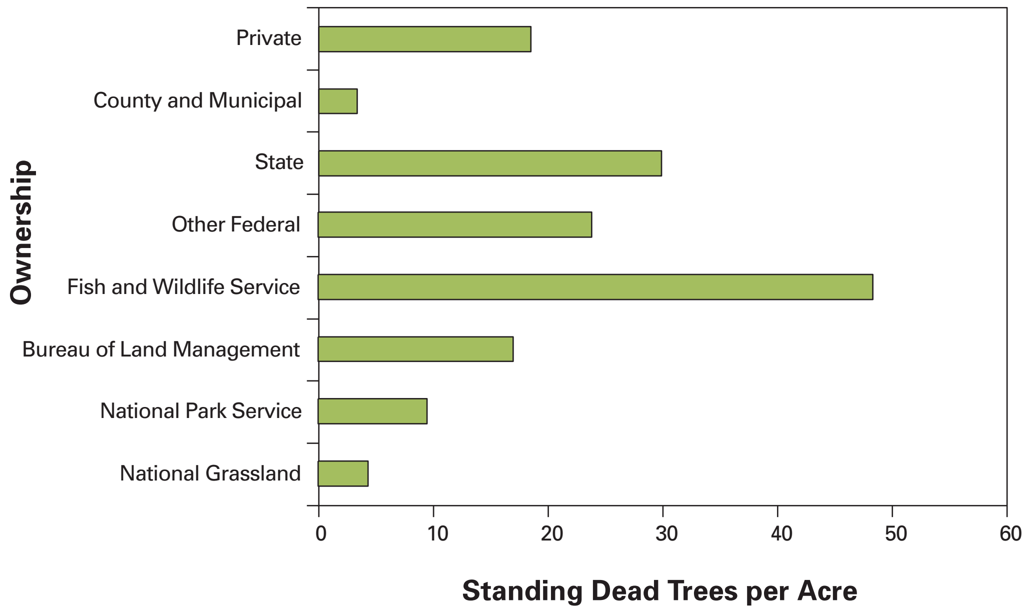


Figure 39.—Standing dead trees by ownership, North Dakota, 2005.



Forest Health Summary

The following summaries provide information on the general conditions of North Dakota's native forests. These narratives depict the factors that have led to the current condition of these resources; they do not necessarily describe specific causal agents of tree/forest decline. The information presented in this section was compiled from various sources and methods including site visits, forest surveys, and personal communication with natural resource professionals.

Riparian Forests

The elm/ash/cottonwood forest type is one of the most abundant of all native forest land and is found along rivers throughout North Dakota. These forests have changed significantly over the past decades due to damage caused by Dutch elm disease, overgrazing, altered water flows, and conversion to nonforest.

Since Dutch elm disease was first detected in 1969, the disease has spread throughout North Dakota. The American elm once was a major component of the State's riparian forests and occupied a wide range of sites. However, Dutch elm disease spread aggressively and decimated the elm population that once made up a large portion of the riparian forests along the Red, James, Sheyenne, and Pembina Rivers. In addition, the disease continues to kill elms that grow in the wooded draws of western North Dakota. Although the American elm has not been eliminated entirely from these forests, the species primarily persists as a small understory tree, occupies a small proportion of the total stand basal area, and often dies before reaching maturity. The loss of American elm dominance in these systems has shifted the species composition toward green ash, boxelder, and other species.

In addition to the impacts of Dutch elm disease, many riparian forests have been converted to nonforest through agricultural and residential development particularly along the Red River of eastern North Dakota. Other damaging factors include overgrazing and water flow changes that can gradually reduce the vigor of existing trees and destroy understory woody vegetation. Such forest changes and conversions adjacent to watercourses have important implications for water quality, flood control, wildlife habitat, and recreation opportunities.

The cottonwood forests that occur within the Missouri flood plain from Garrison Dam to Lake Oahe are in a poor condition that has resulted from progressive mortality of mature trees and the absence of natural regeneration to replace those that have died. Before flood mitigation, the Missouri flood plain was periodicly inundated as high spring water flows deposited sand in low-lying areas. These moist sandbars serve as seedbeds for cottonwood and are critical for natural regeneration of the species (Burns and Honkala 1990). This historical disturbance regime of periodic flooding drove the succession, distribution, and age class structure of cottonwood forests along the flood plain (Ball 1997).

In the absence of flooding and subsequent sandbar formation, there is limited cottonwood regeneration to replace the overmature trees that have succumbed to old age and senescence. As a result, the flood plain that once persisted as a fluctuating mosaic of backwater wetlands, sandbars, and cottonwood forests now exists as a xeric, fire-prone flood plain bisected by a channelized river. The cottonwood component of the Missouri flood plain may eventually die out and give way to other tree species (both native and nonnative) with the exception of a few isolated sites adjacent to the ever-deepening river channel.

Aspen Forests

Aspen/birch forests are abundant in the Turtle Mountains region and represent the State's largest concentration of forest land. Quaking aspen is the dominant species in these stands, but paper birch, bur oak, and green ash can also be common on these sites.

A significant portion of this aspen resource can be characterized by low productivity, stem decay, and large stem mortality that is associated with stand overmaturity. In the absence of stand-replacing disturbances to encourage vigorous aspen regeneration, aspen stands age and deteriorate over time as the result of numerous inciting, predisposing, and contributing factors. These may include frost injury, drought, hail damage, windstorms, and several forest pests.

Forest pests such as defoliating insects, wood rotting fungi, and canker diseases also contribute to the deterioration of these aspen stands. The Turtle Mountains are prone to periodic defoliation episodes caused by the forest tent caterpillar. Defoliation reduces growth, predisposes trees to other damaging agents, and exacerbates the senescence of aging aspen stands. Internal decay of live aspen trees is common within mature aspen stands, particularly those older than 60 years. Stem decay caused by the fungus *Phellinus tremulae* reduces the amount of usable wood within a stand in addition to increasing the probability of stem breakage. The wood volume loss due to this stem decay has been increasing as the aspen resource continues to age in the Turtle Mountains. Similarly, mortality of large diameter trees due to Hypoxylon canker contributes to the deterioration of older stands.

The damage caused by these pests should not be perceived as unnatural but rather as a reflection of a disturbance regime shift. Without disturbance (whether by fire, harvesting, bulldozing, or other means) to encourage vigorous aspen regeneration, pests and environmental factors deteriorate the aging aspen and give way to other species. Throughout its western and eastern range, aspen is a pioneer species that is often succeeded (replaced) by shade-tolerant conifer species in the absence of disturbance. However, many aspen forests of the northern prairie regions of North America convert to shrubland where shade-tolerant conifers do not naturally occur (Harniss 1981, Perala 1990). This successional scenario is apparent within some areas of the Turtle Mountains where beaked hazel dominates the understory of deteriorating aspen stands and prevents the establishment of other tree species.

In addition to the senescence of the aspen resource, many areas within the Turtle Mountains have been converted to pastureland. This conversion may be driven in part by reduced productivity and vigor of the stands coupled with a lack of harvesting opportunities for private landowners. As a result, some private landowners are inclined to clear low-production forests and use the land for agricultural purposes that generate marginal economic benefits.

Fortunately, forest land owners have had a renewed interest in harvesting aspen in recent years. Although clearcutting may look unappealing at first, the vigorous regeneration of aspen that soon follows is important for the long-term perpetuation of this unique forested resource. The young aspen stands that regenerate following harvest are beneficial to many wildlife species.

Ponderosa Pine Forests

Several animals, insect pests, and pathogens are found in the native ponderosa pine stands of southwestern North Dakota. Of these, animal damage caused by deer and porcupines is most apparent. Additionally, shoot death and branch dieback caused by western gall rust, Diplodia shoot blight and canker, and pine pitch nodule maker are commonly encountered. Such pests may lead to tree mortality if conditions favor repeated infections/infestations over several years. Many pines weakened by these pests and other factors die following colonization by pine engraver beetles or turpentine beetles. Despite the presence of pests, these isolated pine stands are quite resilient and the level of tree mortality has remained low.

Perhaps the greatest concern in these areas has been wildfire. Years of past fire suppression coupled with high stand density create conditions that may intensify fire behavior. These wildfire concerns were realized when a large prairie fire spread into portions of the native ponderosa pine stands of Slope County, ND, in September 2004. The fire (known as the Deep Creek Fire) burned through approximately 800 acres of privately owned forest. Mortality may reach 100 percent in stands that experienced high fire intensity with severe needle scorching and stem charring, but estimations of tree mortality are uncertain in areas that had less intense fires. The dense stocking and general low vigor of these stands suggest that tree mortality could be significant within the following years. Survey plots were created on these sites to assess delayed tree mortality during the following years.

Forest Products

Wood chips. Photo by U.S. Forest Service.

Growing-Stock Volume

Background

Growing-stock volume is a measure of the amount of wood available for use in the manufacturing of products such as lumber and paper. The definition of growing-stock volume is the net volume of a growing-stock tree, 5.0 inches or greater d.b.h., from 1 foot above the ground to a minimum 4.0-inch top. In other words, growing-stock volume is wood volume in standing trees that are healthy, sound, reasonably straight, and have a diameter of at least 5 inches. Estimating volume is important when determining the potential availability of wood for harvest (economic planning) and is an important measure when evaluating forest sustainability (forest management planning).

What we found

Growing-stock volume has increased steadily in North Dakota since 1980 and currently is estimated at 366 million cubic feet (Fig. 40). Five species account for 95 percent of all growing-stock volume in North Dakota: cottonwood, green ash, bur oak, quaking aspen, and American elm (Fig. 41). Between 1994 and 2005, four of the top five species (all but quaking aspen) increased in volume. Growing-stock volume currently averages 687 cubic feet per acre, down by about 9 percent from the 1994 survey (Fig. 42). The decrease is due in large part to the increase in nonstocked timberland across the State (Fig. 43). Much of the increase in growing-stock volume can be attributed to the growth of larger trees (Fig. 44).

What this means

Even though the growth of larger trees is the main reason for the increase in growing-stock volume since 1980, riparian forest restoration and the gain of forested acres in North Dakota have also contributed to this increase.

Figure 40.—Total volume of growing stock on North Dakota's timberland, 1954-2005.

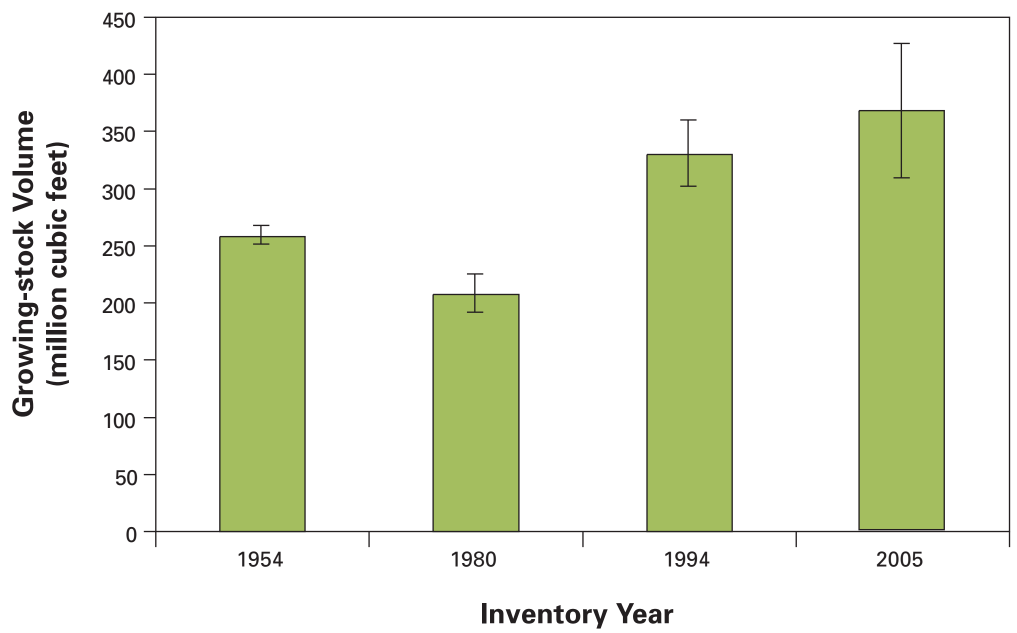


Figure 41.—Net volume of growing stock by select species group, 1994-2005.

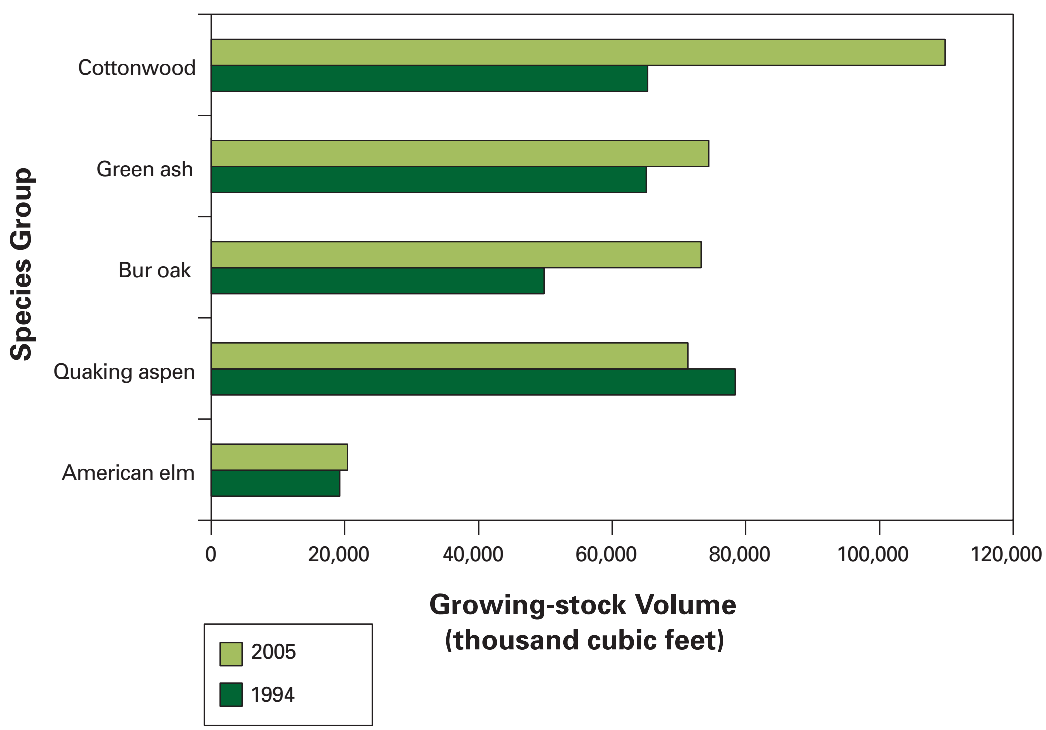


Figure 42.—Average growing-stock volumes per acre of timberland in North Dakota, 1954-2005.

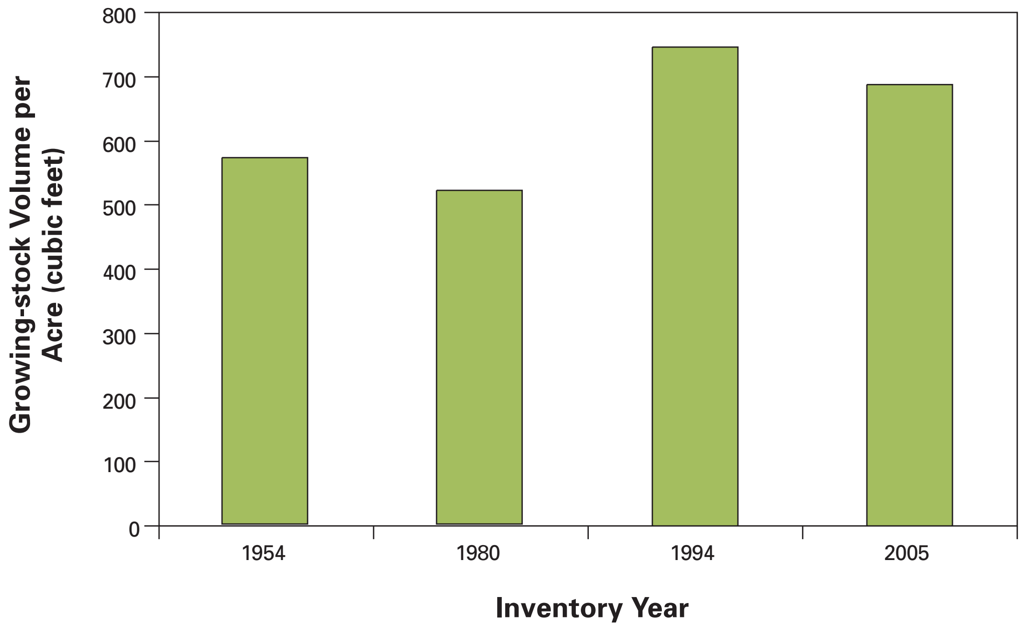


Figure 43.—Acres of nonstocked timberland, North Dakota, 1994 and 2005.

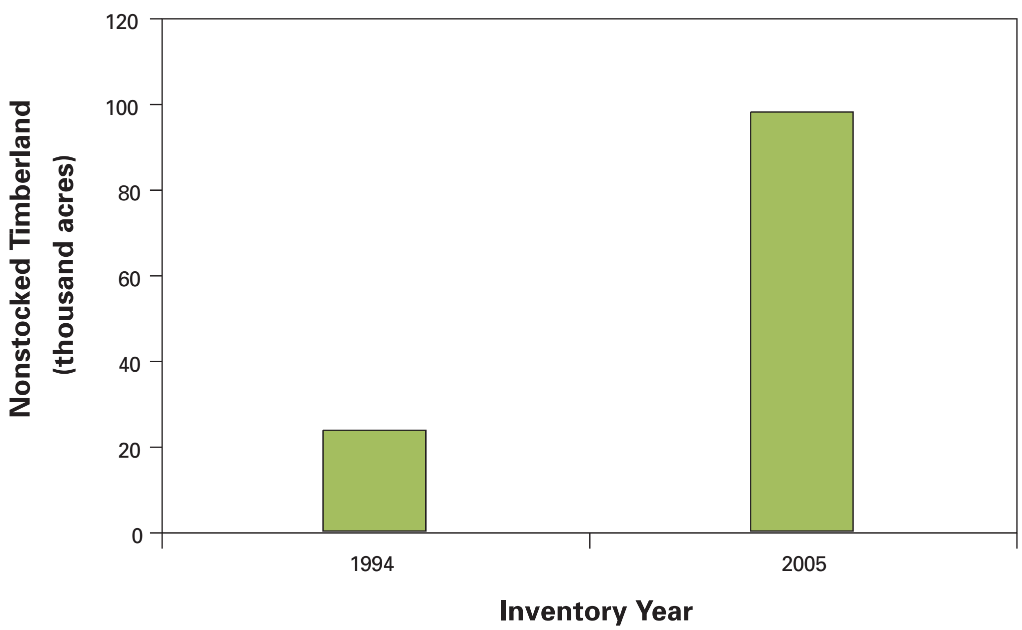
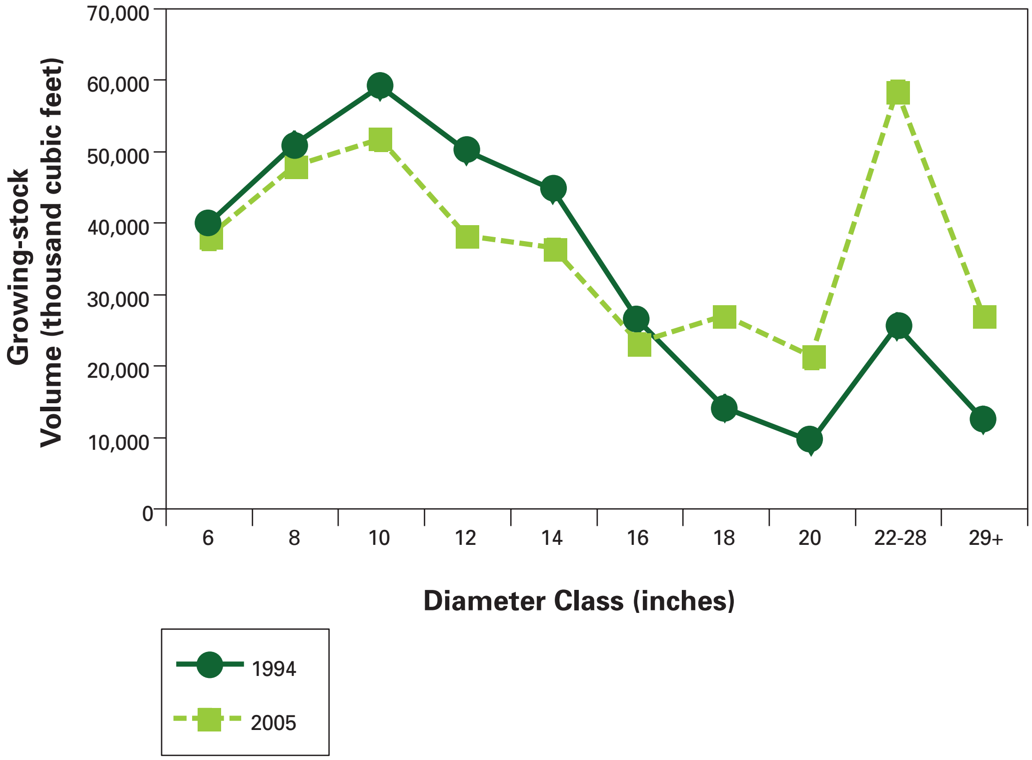


Figure 44.—Distribution of growing-stock volume by diameter class in North Dakota, 1994-2005.



Sawtimber Volume

Background

Sawtimber is the wood in the saw log portion of a tree (main trunk between the stump and the merchantable top, measured in board feet). Sawtimber volume is a measurement used to determine the monetary value of wood volume in a tree or the amount of usable product that might be manufactured from a given tree(s).

What we found

Sawtimber volume between 1954 and 1980 remained relatively unchanged. Between 1980 and 2005, sawtimber volume steadily increased to more than 1.1 billion board feet (Fig. 45). Average sawtimber volume per acre in 2005 was 2,102 board feet, an increase of 233 board feet since 1994. Virtually all sawtimber volume is in hardwoods (Fig. 46), with cottonwood, bur oak, and green ash accounting for more than 81 percent of all sawtimber volume in the State.

What this means

Sawtimber volume continues to increase, with cottonwood volume doubling between 1980 and 2005. Sawtimber volume on timberland should be able to supply the forest product industry in the State for years to come.

Figure 45.—Total sawtimber volume on North Dakota's timberland, 1954-2005.

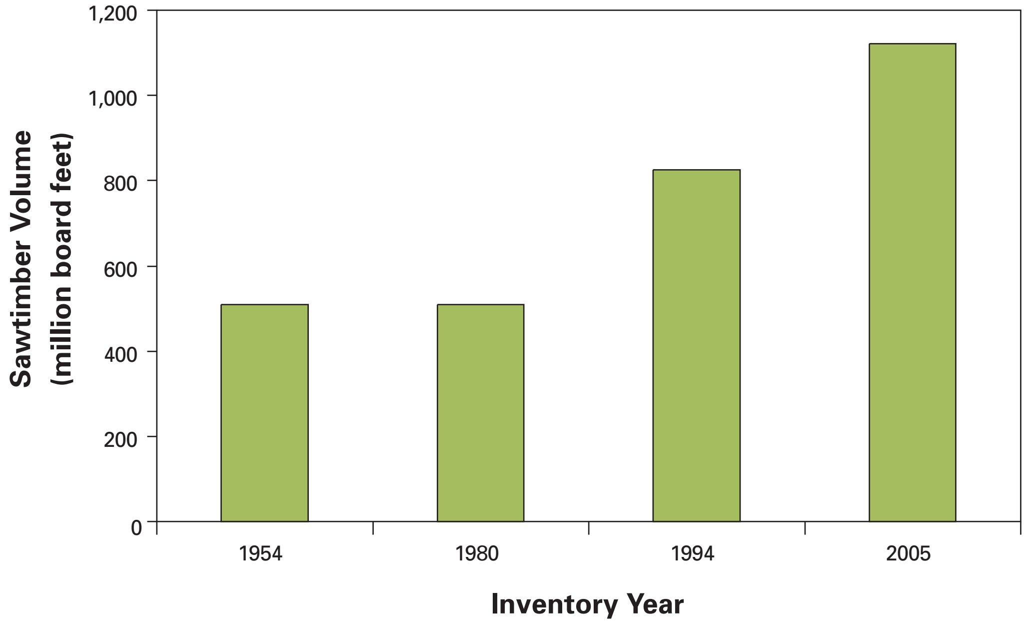
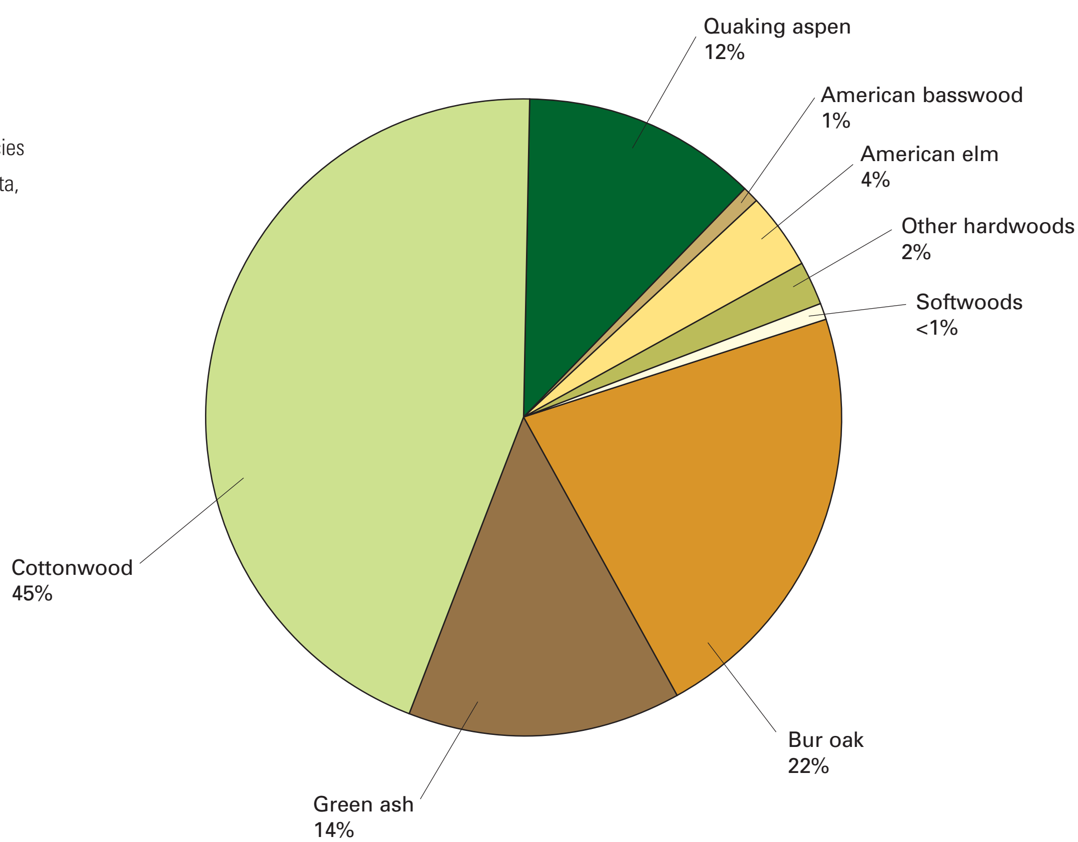


Figure 46.—Percentage of total sawtimber volume by species/species group on timberland in North Dakota, 2005.



Timber Product Output

Background

North Dakota's wood products manufacturing industries employ more than 2,000 workers with an output of approximately $355 million (U.S. Census Bureau 2005). Most of the wood product manufacturers in the State are secondary manufacturers, such as cabinet and mill works. Much of their wood material originates from out-of-state sources. Sawmills are the primary wood-using industry in North Dakota and utilize local timber. To properly manage and sustain North Dakota's forests, it is essential to have information about the location and species of timber that will supply these mills.

What we found

A mill survey was conducted of all known primary wood-using mills in North Dakota in 2003. The study included the size of the industry, the amount of roundwood harvested, and its uses. Questions about the generation and distribution of wood residues were also asked. The top three hardwood species harvested in the State were cottonwood, aspen, and bur oak; the top softwood species harvested was spruce (Fig. 47).

By product, saw logs accounted for 60 percent of all the roundwood produced, with pulpwood making up the remaining 40 percent. Wood material harvested for industrial roundwood on North Dakota's forests was more than 400,000 cubic feet in 2003: 73 percent used for products, 17 percent was logging slash, and 10 percent was logging residues.

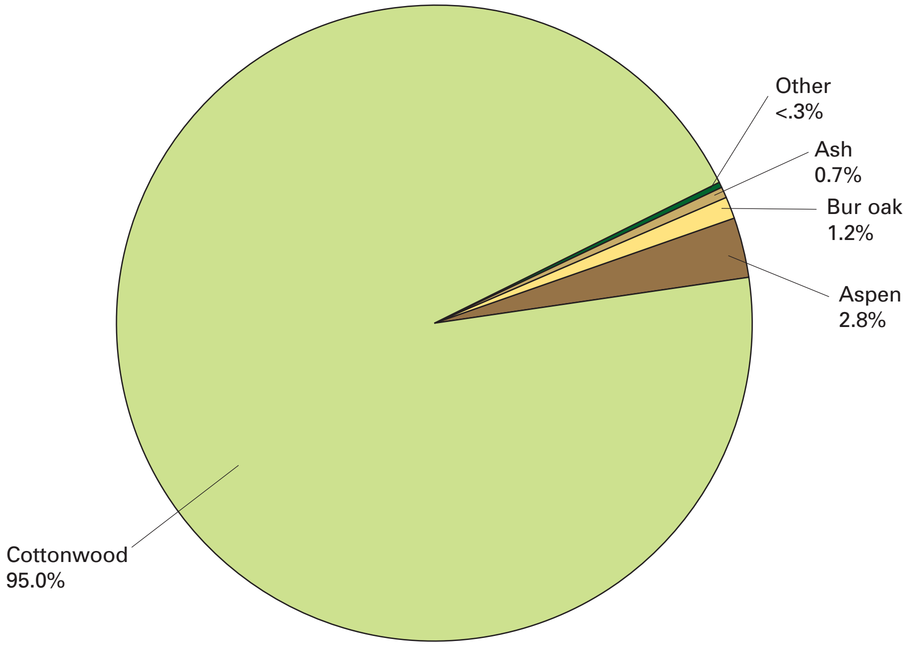
In 2003, 73 percent of the State's saw log production was exported to mills in Minnesota. The remaining 27 percent went to mills in North Dakota. Totals from saw log mill receipts from the 2003 survey illustrate that 100 percent of the wood coming into the mills is grown in North Dakota.

What this means

A comparison of the 1998 and 2003 timber products inventories shows a decrease in industrial roundwood production of 29 percent, which may be due in part to the closing of one mill in the State. Even though the total active mills in North Dakota dropped slightly, production capacity was changed considerably with the loss of this one mill.

Cottonwood is still the most commonly harvested species in the State, partly because the elm/ash/cottonwood forest-type group covers an estimated 165,000 acres of forest land and cottonwoods are some of the State's largest trees. In addition, there is also strong interest from Minnesota's timber industry.

Figure 47.—Saw log production by select species/species group, North Dakota, 2003.



Data Sources and Techniques

Field crew member on plot in western North Dakota. Photo by Cassandra Olson, U.S. Forest Service.

Forest Inventory

Haugen (2003) described the annualized inventory methods for North Dakota. Since the 1994 inventory, several changes in FIA methods have improved the quality of the inventory and have met increasing demands for timely forest-resource information. The most significant change between inventories has been the shift from periodic to annual inventories. Historically, FIA inventoried each state on a cycle that averaged about 12 years. However, the need for timely and consistent data across large geographical regions along with national legislative mandates resulted in FIA implementing an annual inventory. This system was initiated in North Dakota in 2001.

With the NRS-FIA annual inventory system, approximately one-fifth of all field plots are measured in any single year. After 5 years, the entire inventory is completed. After this initial 5-year period, NRS-FIA will report and analyze results using a moving 5-year average. For example, NRS-FIA will be able to generate inventory results for 2001 through 2005 or for 2002 through 2006.

Other significant changes between inventories include implementing new remote-sensing technology as well as a new field-plot configuration and sample design, and gathering additional remotely sensed and field data. The use of new remote-sensing technology allows NRS-FIA to use classifications of Multi-Resolution Land Characterization data and other remote-sensing products to stratify the total area of North Dakota and to improve estimates. New algorithms were used in 2001-2005 to assign forest type and stand-size class to each condition observed on a plot. These algorithms are being used nationwide by FIA to provide consistency from state to state and will be used to reassign the forest type and stand-size class of every plot in the 1994 inventory when it is updated. As a result, changes in forest type and stand-size class will reflect actual changes in the forest and not changes due to differences between algorithms. The list of recognized forest types, groupings of these forest types for reporting purposes, models used to assign stocking values to individual trees, definition of nonstocked (stands with a stocking value of less than 10 percent for all live trees), and names given to the forest types changed with the new algorithms. As a result, comparisons between the published 2001-2005 results and those published for the 1994 inventory may be invalid. Contact NRS-FIA for additional information on the algorithms used in both inventories.

Sampling Phases

The 2005 North Dakota inventory was conducted in three phases. In the first phase, satellite imagery was used to stratify the State and aerial photography was used to select plots for measurement. The second phase entailed measuring the traditional suite of mensurational variables; the third phase focused on a suite of variables related to forest health.

Land that could not be sampled included private tracts where field personnel were unable to obtain permission to measure a Phase 2 plot and plots that were inaccessible because of a hazard or danger to field personnel. The methods used in preparing this report were adjusted to account for such sites.

Phase 1

For the North Dakota inventory, FIA used a classification of satellite imagery for stratification. The imagery was used to form two initial strata: forest and nonforest. Pixels within 60 m (2-pixel widths) of a forest/nonforest boundary formed two additional strata: forest edge and nonforest edge. Forest pixels within 60 m of the boundary on the forest side were classified as forest edge and pixels within 60 m of the boundary on the nonforest side were classified as nonforest edge. All strata were divided into public or private ownership based on information available in the Protected Lands Database (DellaSala et al. 2001). The estimated population total for a variable is the sum across all strata of the product of each stratum's area (from the pixel count) and the variable's mean per unit area (from plot measurements) for the stratum.

Phase 2

Phase 2 of the inventory consisted of the measurement of the annual sample of field plots in North Dakota. Current FIA precision standards for annual inventories require a sampling intensity of one plot for approximately every 6,000 acres. FIA has divided the entire area of the United States into nonoverlapping hexagons, each of which contains 5,937 acres (McRoberts 1999). An array of field plots was established by establishing a plot in each hexagon. This array of plots is designated the Federal base sample and is considered an equal probability sample; its measurement in North Dakota is funded by the Federal government.

Fieldwork for this inventory was expedited through the cooperation and assistance of the North Dakota Forest Service.

The total Federal base sample was systematically divided into five interpenetrating, non-overlapping subsamples or panels. Each year the plots in a single panel are measured, and panels are selected on a 5-year, rotating basis (McRoberts 1999). For estimation purposes, the measurement of each panel of plots may be considered an independent random sample of all land in the State. Field crews measure vegetation on plots currently classified as forest by trained photointerpreters using aerial photos or digital orthoquads.

Phase 3

NRS-FIA has two categories of field measurements: Phase 2 and Phase 3 field plots. Both types are distributed systematically geographically and temporally. Phase 3 plots are measured with the full array of vegetative and health variables as well as the full suite of measures associated with Phase 2 plots. Phase 3 plots must be measured between June 1 and August 30 to accommodate measurement of nonwoody understory vegetation, ground cover, soils, and other variables. The complete 5-year annual inventory of North Dakota includes seven forested Phase 3 plots. On the remaining plots, only variables that can be measured throughout the entire year are collected. In North Dakota, the complete 5-year annual inventory includes 164 forested Phase 2 plots.

The national FIA four-subplot cluster configuration (Fig. 48) was first used for data collection in North Dakota in 2001 and will be used in subsequent years. The national plot configuration requires mapping all forest conditions on each plot. Due to the small sample size each year, precision associated with estimates of components of change such as mortality will be relatively low. Consequently, we report estimates of components of change only after multiple annual panels have been measured. With completion of the annual inventory in 2010, the full range of change estimates will be available.

The overall plot layout for the new configuration consists of four subplots. The centers of subplots 2, 3, and 4 are located 120 feet from the center of subplot 1. The azimuths to subplots 2, 3, and 4 are 0, 120, and 240 degrees, respectively. The center of the new plot is located at the same point as the center of the previous plot if a previous plot existed at the location. Trees that are 5 inches and larger in d.b.h. are measured on a 24-foot-radius (1/24-acre) circular subplot. All trees less than 5 inches d.b.h. are measured on a 6.8-foot-radius (1/300- acre) circular microplot located 12 feet due east of the center of each of the four subplots. Forest conditions on each subplot are recorded. Factors that differentiate forest conditions are changes in forest type, stand-size class, land use, regeneration status, reserved status, ownership, and density. Each condition that occurs on one of the subplots is identified, described, and mapped so long as the area of the condition is at least 1 acre. Field-plot measurements are combined with Phase 1 estimates in the compilation process and table production. The number of tables presented here is limited, but others can be generated at http://fiatools.fs.fed.us.

For additional information, contact: Program Manager, Northern Research Station, Forest Inventory and Analysis, 1992 Folwell Avenue, St Paul, MN 55108 or State Forester, North Dakota Forest Service, Molberg Center, 307 1st Street East, Bottineau, ND 58318-1100.

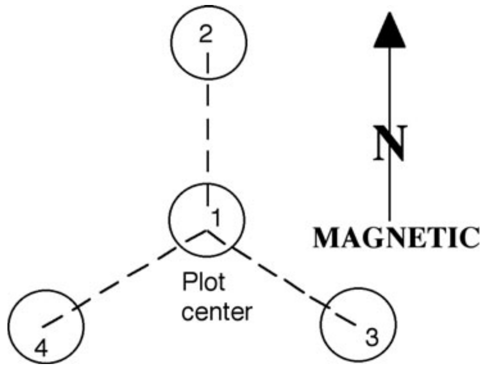


Figure 48.—Current NRS-FIA field-plot design.

Timber Products Output Survey

The timber products inventory study was a cooperative effort between the North Dakota Forest Service (NDFS) and the Northern Research Station (NRS) (Haugen and Harsel 2005). The NDFS canvassed all primary wood-using mills within the State using mail questionnaires supplied by the NRS and designed to determine the size and composition of North Dakota's primary wood-using industry, its use of roundwood, and its generation and disposition of wood residues. The NDFS then contacted nonresponding mills through additional mailings, telephone calls, and personal contacts until a nearly 100 percent response was achieved. Completed questionnaires were forwarded to NRS for compilation and analysis.

As part of data processing and analysis, all industrial roundwood volumes reported on the questionnaires were converted to standard units of measure using regional conversion factors. Timber removals by source of material and harvest residues generated during logging were estimated from standard product volumes using factors developed from previous NRS logging utilization studies. Data on North Dakota's industrial roundwood receipts were added to a regional timber removals database and supplemented with data on out-of state uses of State roundwood to provide a complete assessment of North Dakota's timber product output.

National Woodland Owner Survey

The National Woodland Owner Survey is conducted annually by the USDA Forest Service to increase our understanding of private woodland owners – the critical link between society and forests. Each year, questionnaires are mailed to individuals and private groups who own the woodlands where NRS-FIA has established inventory plots (Butler et al. 2005). Twenty percent of these ownerships (about 50,000 nationwide) are contacted each year with more detailed questionnaires mailed in years that end in 2 or 7 to coincide with national census, inventory, and assessment programs. The target accuracies of the data are plus or minus 10 percent at the state level.

Ozone Bioindicator Species

Several bioindicator species have been tested in both laboratory and field settings over several decades and have proven to be reliable indicators of ground-level ozone stress. These include white ash, black and pin cherry, dogbane, milkweed, big leaf aster, and blackberry. In North Dakota, the annual ozone biomonitoring by FIA began in 2002. Foliar injury can be related to seasonal exposures as well as peak concentrations. Seasonal exposures measure ozone stress by summing hourly concentrations above a threshold concentration over several months.

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The first completed annual inventory of North Dakota's forests reports estimates of more than 724,000 acres of forest land. Information about forest attributes and forest health is presented along with information on agents of change including changing land use patterns and the introduction of nonnative plants, insects, and disease.

KEY WORDS: inventory, forest statistics, forest health

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