NORTH CENTRAL FOREST EXPERIMENT STATION
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North Dakota's Forest Resources, 1994

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This report includes the most commonly used U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis (FIA) statistics. Additional forest resource data can be obtained through FIA staff, an FIA CD-ROM, or through a table generator on the North Central Research Station's Internet page. Persons requesting additional information that requires FIA staff time are expected to pay the retrieval costs. Requests for information may be directed to:

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FOREWORD

Forest Inventory and Analysis (FIA) is a continuing endeavor as mandated by the Renewable Resources Research Act of 1978. The objective of FIA is to periodically inventory the Nation's forest resources. Up-to-date resource information is essential to frame forest policies and programs. U.S. Department of Agriculture, Forest Service regional Research Stations are responsible for conducting these inventories and publishing summary reports for individual States. The North Central Research Station is responsible for inventory and analysis in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.

Fieldwork for the third North Dakota forest inventory was begun in September 1994 and completed in November 1994. Results of the inventory are based on a sample of 266 forested plots and the modeling of 48 undisturbed-forested plots from the previous inventory. The reported statistics are estimates. The user of these data is cautioned to consult the table of sampling errors and the inventory methods section of the Appendix. Fieldwork for this inventory was expedited through the cooperation and assistance of the North Dakota Forest Service. In addition, that agency surveyed primary wood-using plants in the State to determine current timber removals.

The third inventory of North Dakota was directed by Neal Kingsley, FIA Program Manager, North Central Research Station, St. Paul, Minnesota. Robert Harsel, North Dakota Forest Service, coordinated the State's participation.

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NOTE: Comparison of data from new forest inventories with data from earlier inventories indicates trends in forest resources. However, comparisons are valid only if the procedures used in the two inventories are similar. Because of our ongoing efforts to improve the efficiency and reliability of our inventories, several changes in procedures and definitions have been made since 1980. Some of these changes make it inappropriate to directly compare the 1994 data with those published for 1980. Therefore, data from the 1980 inventory were reprocessed using 1994 procedures and definitions. Please refer to the Appendix section entitled "Comparing the Third Inventory of North Dakota with the Second Inventory" for more detail.

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HIGHLIGHTS

- In 1994, North Dakota had 673 thousand acres of forest land, an increase of 18 percent from the 572 thousand acres in 1980. Of this total forest land area, 442 thousand acres were classified as timberland.
- Regional comparisons show that in 1994, the Missouri River County Group had the greatest amount of forest land with 319 thousand acres, of which 116 thousand acres were classified as timberland.
- Besides the forest land area, North Dakota has an additional 1.5 million acres of land with trees. This includes wooded strips, farm and field windbreaks, wooded pastures, abandoned cropland, and urban forest land.
- Non-industrial private landowners hold 77 percent, or 341 thousand acres of the State's timberland.
- Elm-ash is the most extensive forest type found in the State, accounting for more than 38 percent, or 166 thousand acres of timberland.
- Even with the prevalence of adverse growing conditions in North Dakota, more than a quarter of the State's timberland is capable of growing more than 50 cubic feet per acre per year.
- Growing-stock volume in North Dakota increased from 243.7 million cubic feet in 1980 to 329.7 million cubic feet in 1994—a gain of 35 percent.
- Sawtimber volume in 1994 stood at 825.2 million board feet, up 56 percent, from 530.2 million in 1980. This reflects the continuing maturation of the State's forests.
- In 1980, elm sawtimber volume was estimated at 136.3 million board feet. By 1993, elm sawtimber volume had declined by more than half, dropping to 66.5 million board feet. The loss of this volume can be attributed mostly to Dutch elm disease.
- In 1980, current annual net growth of growing stock was 18.2 cubic feet per acre per year; in 1993, current annual net growth of growing stock was 17.5 cubic feet per acre per year. However, between 1980 and 1993, annual net growth averaged 16.5 cubic feet per acre per year. The fact that average annual net growth is lower than current net growth for both the previous and most recent inventory may reflect the effects of the drought of the mid- to late-1980's.
- On a per acre basis, growing-stock mortality averaged 11.5 cubic feet per acre per year from 1980 to 1993. Thus, nearly 41 percent of the annual gross growth of growing stock was lost to mortality.
- Average annual removals of growing stock between 1980 and 1993 were 3.9 cubic feet per acre per year.

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- In 1992, North Dakota's 44 lumber and wood product establishments employed about 1,000 people, paid around $19.6 million in wages and salaries, and shipped products valued at almost $73 million. In 1977, there were 27 establishments employing about 400 people. Although the State's lumber and wood products industry is relatively small, it is growing.

- North Dakota has 55,000 miles of windbreak plantings that provide protection from wind and snow.

- North Dakota's forests provide food, cover, and protection for a vast array of wildlife species from elk to ruffed grouse. In addition, they protect water quality and control streambank erosion and sedimentation.

- North Dakota's 19 State parks and recreation areas average more than 1 million visitors each year. An additional 11,000 people use North Dakota's five State forests each year for hiking, hunting, skiing, and other outdoor activities.

INTRODUCTION

When one thinks of North Dakota, one should think not only of prairies and agriculture, but also of trees. Although forests cover only 1.5 percent of the State's land area, they are an extremely important component of the landscape. In North Dakota, forests, wooded strips, shelterbelts, and windbreaks play a crucial role in protecting riparian areas, farmsteads, crops, livestock, and wildlife.

HISTORICAL BACKGROUND

The first settlers in North Dakota found about 700 thousand acres of forest land (Jakes and Smith 1982). Most of this was found primarily in the Turtle Mountains, Killdeer Mountains, Pembina Hills, the Devil's Lake area, and along major rivers and their tributaries.

Generally, North Dakota provides a hostile environment for trees due to low annual precipitation and periodic drought. Precipitation is limited throughout the State, ranging from 22 inches per year in the Red River Valley of eastern North Dakota to only 14 inches on the Montana border (Warner and Chase 1956).

Pioneers recognized the importance of forests and trees. In 1873, Congress passed the Timber Culture Act, which offered 160 acres to any settler willing to plant 10 acres of trees (Warner and Chase 1956, North Dakota Forest Service 1991). As a result, nearly 8,000 people gained ownership to 1.2 million acres of land in the area of Dakota Territory, which is now North Dakota (North Dakota Forest Service 1991). In 1891, the State forestry office was established, and in 1897, a forestry school was established at Bottineau.

In 1908, at the urging of Forest Service Chief Gifford Pinchot, President Taft signed a proclamation creating the North Dakota National Forest. Establishment plans called for managing the region's native stands of ponderosa pine and implementing an extensive tree planting program within the forest boundary. Unfortunately, high administrative costs and poor seedling survival led to the abolishment of the forest in 1917 (North Dakota Forest Service 1991).

In 1912, the U.S. Department of Agriculture established the Northern Great Plains Field Station at Mandan. It was here in 1914 that the first systematic research in shelterbelt growth and survival was begun in an effort to discover and correct the causes contributing to the large number of failures in planted stands (Warner and Chase 1956). In 1931, the USDA Forest Service's Lake States Forest Experiment Station, in cooperation with the North Dakota School of Forestry, undertook a project to determine from experimental plantings if a national forest could be established on the sand plains near Denbigh. In 1935, the Lake States Station, in a report to the National Forest Reservation Commission, recommended the acquisition of 260,000 acres in McHenry County so a national forest could be established. The Reservation Commission approved the purchase, and the Eastern Region of the USDA Forest Service (Region 9) was given the go-ahead to start a tree nursery near Towner. Although funding was approved for the nursery, Congress failed to appropriate funds for purchasing the land during the intervening years and the plan to establish the national forest was eventually dropped.

The Dust Bowl of the 1930's had both a devastating and a positive effect on forestry in North Dakota. While the extreme drought laid thousands of acres barren, it also spurred tree planting. Since the Dust Bowl, North Dakota landowners have established more than 55,000 miles of field windbreaks and 286,000 acres of protection plantings (North Dakota Forest Service 1991). Today, the State is in the midst of its Centennial Tree Program, with a goal to plant 100 million trees between the years 1990 and 2000.

NORTH DAKOTA FORESTS INVENTORIED FOR THE THIRD TIME

The USDA Forest Service's Lake States Forest Experiment Station inventoried North Dakota's forest resources for the first time in 1954. The Station, now the North Central Research Station, inventoried the forest resource again in 1980. The Station's Forest Inventory and Analysis Unit, in cooperation with the North Dakota Forest Service, also conducted the third inventory, which was completed in 1994.

The 1994 forest inventory consisted of classifying nearly 240 thousand points on aerial photographs of the State, measuring 266 forested plots on the ground and computer modeling an additional 48 forested plots that were found to have been undisturbed since the previous inventory. Because forest land accounts for only 1.5 percent of the total land area in North Dakota, it was necessary to group individual counties for statistical reasons (fig. 1). These county groups are based on the major watersheds in North Dakota. When using this report, refer to the Appendix especially the section on sampling errors.

THE EXTENT OF NORTH DAKOTA'S FORESTS

In 1994, forest land in North Dakota totaled more than 673 thousand acres—an increase of 18 percent from the 1980 total of 572 thousand acres and only 4 percent less than the 700 thousand acres believed to have been in the State when the first European settlers arrived. Much of the increase can be attributed to the reclassification of wooded strips (a

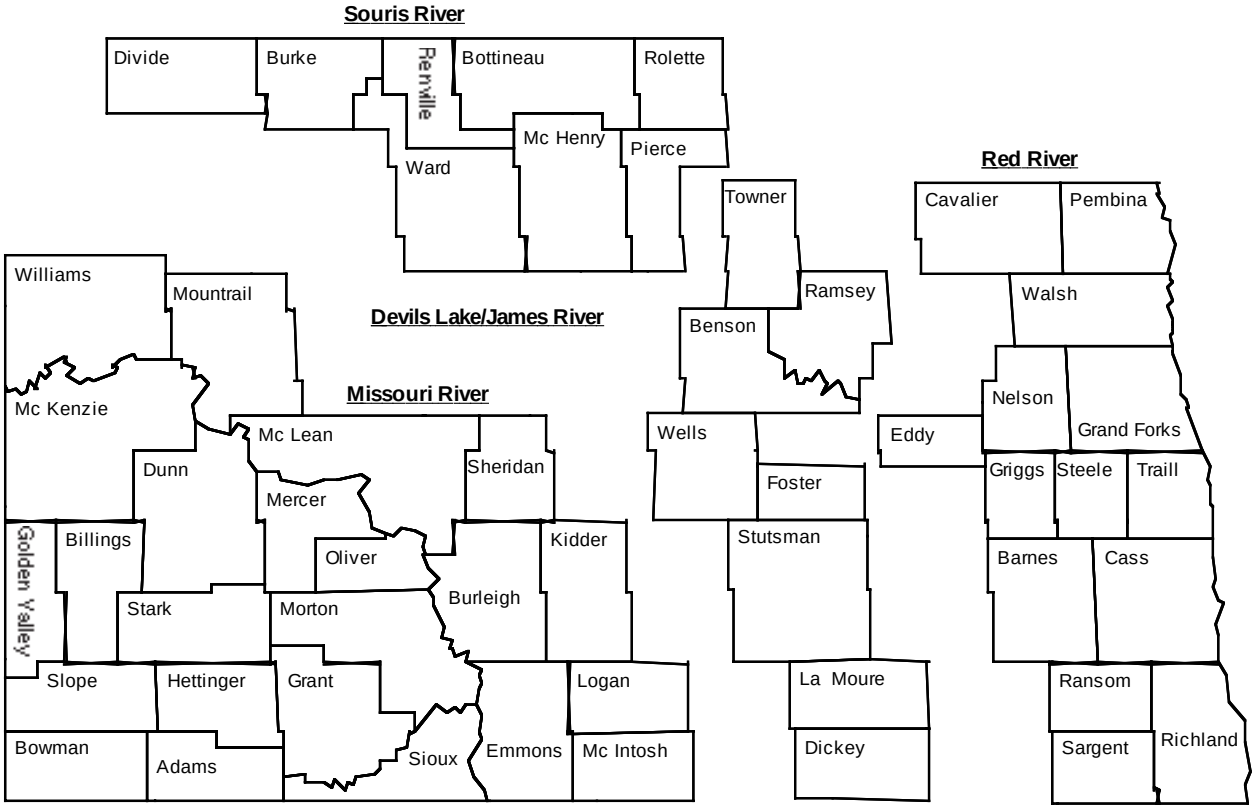

Figure 1.—*County group map of North Dakota, 1994.*

ground land use) in the 1980 survey to timberland in the 1994 survey (table A). In 1994, timberland accounted for 442 thousand acres, or 66 percent of the total forest land in the State. Timberland is classified as land that is producing, or is capable of producing, more than 20 cubic feet per acre per year of industrial wood crops and is available for harvesting. Note that timberland is broken down into forest types. In North Dakota, local forest types reflect the species present and are subgroups of the nationwide forest type groups. For example, the elm-ash local type is a subgroup of the elm-ash-locust forest type group. Local types are used throughout this report. In addition to timberland, 232 thousand acres were classified as other forest land in 1994. Other forest land is forest land not sufficiently productive to be classified as timberland.

In addition to forest land in 1994, 1.5 million acres in North Dakota were classified as nonforest land with trees—a 76-percent increase over the 872 thousand acres reported in 1980. Improved pasture with trees accounted for 955 thousand acres, or 62 percent of the total area of nonforest land with trees in 1994. Area in windbreaks accounted for 263 thousand acres, or 17 percent of the total area, and wooded strips accounted for another 106 thousand acres, or 7 percent of the 1994 total area of nonforest land with trees. Wooded pastures had the largest gain in area, percentage-wise, estimated at more than 1,000 percent (1980 area of wooded pastures was estimated at 9 thousand acres and 1994 area was estimated at 98 thousand acres). Traditionally, nonforest land with trees offers few opportunities for commercial forestry use. Nonetheless, this land does offer many benefits, which include shade for livestock, soil erosion control, rural building and land protection, and shelter and food for wildlife.

FOREST RIPARIAN AREAS

Almost one-fifth (80 thousand acres) of the timberland in North Dakota is within 200 feet of a stream or lake, and over one-tenth (47 thousand acres) is within 100 feet of a stream or lake (fig. 2). While most of this acreage is in the elm-ash type (45 thousand acres), the elm-ash-cottonwood type is more closely associated with riparian areas. Of the 16 thousand acres of elm-ash-cottonwood, 86 percent is within

Figure 2.—*Riparian area along the Sheyenne River, North Dakota. (Photo courtesy of the North Dakota Forest Service)*

200 feet of a stream or lake. Although these two forest types dominate riparian timberland in North Dakota, the aspen-birch, bur oak, basswood, and cottonwood forest types are also represented.

Nearly one-fourth or 38 thousand acres of timberland in the Red River County Group is within 200 feet of water. Seventeen percent of the timberland in the Missouri River County Group, 16 percent of the Souris River County Group, and 6 percent of the Devils Lake/James River County Group is within 200 feet of water.

The importance of wooded riparian areas in stabilizing streambanks and stream flow, and in preventing sedimentation and flooding cannot be overstated. Due to deep-rooted tree species, forest riparian areas help hold the soil and prevent the undercutting of streambanks and lakeshores. However, in more subtle ways, wooded riparian areas function as filters that improve water quality and stabilize stream flow. In a study of hardwood stands in the Central States, Gaiser (1952) found more than 4,000 root channels per acre. These channels, as well as those made by burrowing organisms, greatly increase the rate at which water enters and percolates through the soil. The rate of infiltration and percolation of most soils increases with increasing density of forest cover. Consequently, a larger percentage of precipitation enters the soil and recharges the groundwater supply. This increased infiltration and percolation helps prevent excessive runoff, thus stabilizing stream flow and helping to avoid excessive peak flows. In soils that

Table A.-Land use classification changes in North Dakota, 1980-1994.

		1994 Land Classification 1														
		Timberland - Local forest type														
Land classification	1980 land area 2	Ponderosa pine	Rocky Mountain juniper	Bur oak	Cottonwood	Elm-ash-cottonwood	Willow	Basswood	Aspen-birch	Elm-ash	Non-stocked	Other forest land	Wooded strips	Nonforest with trees	Nonforest without trees	Noncensus water
Forest land	ousand acres)															
Timberland																
Ponderosa pine	2.1	1.7	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--
Rocky Mountain juniper	4.9	--	4.3	--	--	--	--	--	--	--	--	--	--	0.6	--	--
Bur oak	52.2	--	--	38.1	5.5	--	--	3.4	--	--	--	1.6	--	2.5	1.1	--
Cottonwood	17.0	--	--	--	15.9	--	--	--	--	1.0	--	--	--	0.1	--	--
Elm-ash-cottonwood	42.6	--	--	--	--	12.6	--	--	--	17.1	--	--	6.3	6.6	--	--
Basswood	6.8	--	--	--	--	--	--	3.7	--	--	--	--	--	3.1	--	--
Aspen-birch	139.9	--	--	--	--	--	--	--	106.1	18.6	--	--	--	2.0	13.2	--
Elm-ash	101.6	--	--	15.3	--	1.6	--	--	--	54.2	--	2.3	9.7	6.7	11.8	--
Other forest land	137.6	--	--	11.6	--	--	--	--	--	12.2	--	81.2	3.0	16.6	13.0	--
Reserved forest land	67.2	--	--	--	15.9	--	--	--	5.4	16.6	--	12.9	11.6	4.8	--	--
Wooded strips	168.2	--	--	--	11.3	1.3	3.6	--	--	31.4	--	33.7	51.0	15.4	20.5	--
Other nonforest with trees	704.1	--	--	3.6	3.1	--	--	2.3	5.2	10.4	2.2	77.6	18.3	561.7	19.7	--
Nonforest without trees	43,127.2	--	--	0.6	--	--	--	--	1.1	4.2	--	22.4	6.1	808.5	41,648.6	139.9
Noncensus water	80.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	80.8
Total	44,652.2	1.7	4.3	69.2	51.7	15.5	3.6	9.4	117.8	165.7	2.6	231.7	106.0	1,428.6	41,727.9	220.7

1 Read across rows to determine dispersion of 1980 classes to 1994 classes. Read down columns to determine origin of 1980 classes.

2 Total land area adjusted to conform to 1980 census figures. Census water was not incorporated into table.

To use Table A - for example, to find out what happened to the 52.2 thousand acres of bur oak present in 1980 - simply read across the bur oak row and find that about 38 thousand acres stayed as bur oak, 5.5 thousand acres were reclassified as cottonwood, and so on.

To determine the source of the 69.2 thousand acres of bur oak present in 1994, read down the bur oak column. Of these acres, about 38 thousand acres were classified as bur oak in both inventories, 15 thousand acres were reclassified from elm-ash to bur oak, and so on.

are unprotected by forest cover, fine soil particles often clog and seal soil pores. This decreases infiltration and percolation, and in turn increases runoff. Soil particles may be carried into the stream where they eventually can cause sedimentation as they settle out. In addition to the environmental costs, increased sedimentation may necessitate the dredging of navigable waters or the channeling of streams.

Sedimentation of streams and water bodies has been labeled as the major cause of nonpoint water pollution in the United States (Welsch 1991). Fortunately, the risk of nonpoint pollution from forested riparian areas is low. However, livestock grazing and logging can cause serious problems if not properly done. When cattle are permitted to graze in riparian areas, they can destroy the protective litter layer of organic matter and compact soils, which can increase runoff and impede infiltration and percolation. Similarly, if logging is not done with a concern for the hydrological function of the area, soils can suffer nutrient loss, compaction, and erosion (Grigal and Bates 1992). Within the forestry community, there is an effort to reduce the detrimental effects of logging by the use of Best Management Practices (BMP's). BMP's prescribe ways to build roads, harvest timber, and conduct other forest operations in ways that will keep streams and lakes clean (North Dakota Forest Service 1998).

Forested riparian areas have other benefits besides preventing siltation and sedimentation. By trees shading streams, the water temperature is lowered, which improves fish habitat. As water temperature increases, the amount of available oxygen in water decreases. Forested riparian areas also provide organic materials needed by insects and other organisms, which in turn become food for fish. Coarse woody debris that falls into streams provides structure and cover for fish. These wooded water borders also provide important habitat and cover for terrestrial animals. Some species, like beavers and salamanders, use these areas as primary habitat; others, such as whitetail deer and pheasants, use them primarily for cover. To humans, these areas add aesthetically pleasing diversity to the landscape.

WINDBREAKS AND WOODED STRIPS

In 1994, North Dakota had 263 thousand acres of windbreaks and 106 thousand acres of wooded strips. Windbreaks are strips of trees less than 120 feet wide designed to protect farmstead or livestock buildings from excessive wind (fig. 3). These usually consist of several rows of trees and shrubs with the tallest tree species in the middle rows descending to shorter tree species to shrubs in the outer rows. Wooded strips are an acre or more of continuous forest land less than 120 feet in width. These usually occur in gullies, along riparian areas, fence rows, or areas not readily suited to agriculture. In some cases, they may be strips of trees that have been left during land clearing for the purpose of controlling the effects of high winds.

Figure 3.—*Farmstead windbreak system, North Dakota. (Photo courtesy of North Dakota State University Extension Service)*

The total area of windbreaks and wooded strips in North Dakota increased slightly between inventories, from 360 thousand acres in 1980 to 369 thousand acres in 1994. The area of windbreaks rose from 192 thousand acres in 1980 to 263 thousand acres in 1994. However, the area of wooded strips declined from 168 thousand acres in 1980 to 106 thousand in 1994.

Windbreaks, whether planted or natural, can significantly affect microclimatic conditions for a distance of at least 10 times the height of the windbreak (Wardle and Schmidt 1984). The positive environmental impacts of wind protec-

tion include reduced soil moisture evaporation, lowered vegetation transpiration, snow control, and decreased soil movement. Windbreaks have been shown to significantly reduce the amount of feed needed by livestock during the winter, shelter farm buildings from severe winter winds, and provide cooling shade in the summer.

Historically, the major forestry effort in North Dakota has centered on the planting of trees to protect homes, livestock, soil, roads, pastures, crops, and wildlife. Following the Dust Bowl of the 1930's, an ambitious program of planting was undertaken by the Prairie States Forestry Project. Between 1935 and 1942, nearly 35 thousand acres of protection plantings were established in North Dakota. These plantings extended 2,645 miles on 3,954 farms. By 1954 the USDA Soil Conservation Service estimated that it had helped establish an additional 54,000 acres of protection plantings in North Dakota. Together these plantings earned North Dakota the distinction of having more protection plantings than any other State. Currently, approximately 4,600 acres are planted in North Dakota each year.

OWNERSHIP

More than three-fourths of the timberland in North Dakota is privately owned (fig. 4). These owners include farmers, ranchers, business people, retirees, and persons from nearly every walk of life. Of the 341 thousand acres of timberland owned by private individuals, 43 percent are within the Red River County Group. Pembina and Cavalier Counties contain the largest area of privately owned timberland in the State, with 27 thousand acres and 25 thousand acres, respectively.

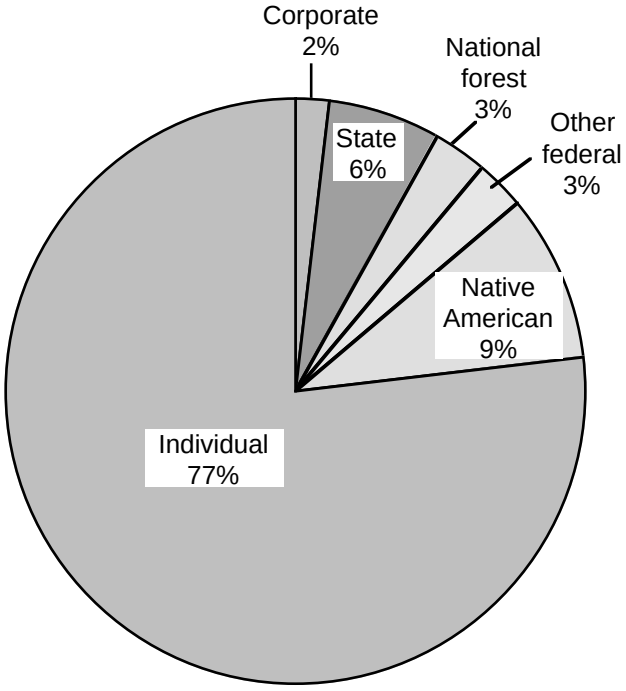

Figure 4.—*Area of timberland by ownership class, North Dakota, 1994.*

Owners with 50 acres or less hold more than 72 percent of the privately owned timberland. About 12 percent of the ownership holdings are between 51 and 100 acres, while another 15 percent of the timberland holdings are between 101 and 500 acres. Less than 1 percent of the privately owned timberland is in holdings of more than 500 acres. These areas represent the total area of timberland owned by each owner, and may include one or more non-contiguous tracts of timberland. The area of privately owned timberland by size of holding is shown in table B.

Table B.—*Area of privately owned timberland by size of holding, North Dakota, 1994*

Size of holdings	Timberland area held by private owners
(Acres)	(Thousand acres)
1-4	45.4
5-10	42.0
11-20	64.5
21-50	94.5
51-100	40.6
101-500	52.5
501 +	1.9
Total	341.4

Native Americans are the second largest group of timberland owners within the State, with 39 thousand acres. More than two-thirds of the timberland owned by Native Americans is found in the Souris River County Group. The Turtle Mountain Indian Reservation is located in Rolette County, which contains the largest area of timberland in the State, and is part of the Souris River County Group.

The State of North Dakota owns 26 thousand acres of timberland, an increase of 21 percent between inventories. Roughly half of the State's timberland is found in the five State forests. The largest of these holdings, the Turtle Mountain State Recreational Forest (fig. 5), is located in Bottineau County, which is part of the Souris River County Group.

Figure 5.—*Strawberry Lake, Turtle Mountain State Forest, North Dakota. (Photo courtesy of the North Dakota Forest Service)*

The Dakota Prairie Grasslands accounts for 14 thousand acres of timberland in the State. This land is scattered in small holdings in the Missouri River County Group. Other federal lands (Bureau of Land Management and U.S. Army Corps of Engineers) total 14 thousand acres of timberland, scattered throughout the State. Private corporations hold almost 7 thousand acres of timberland, much of which is scattered throughout the Red River and Missouri River County Groups.

FOREST TYPES

In North Dakota, hardwoods dominate the forest landscapes—98 percent of all forest types are hardwoods. Exceptions include the Rocky Mountain juniper and ponderosa pine forest types scattered in the western part of the State (fig. 6).

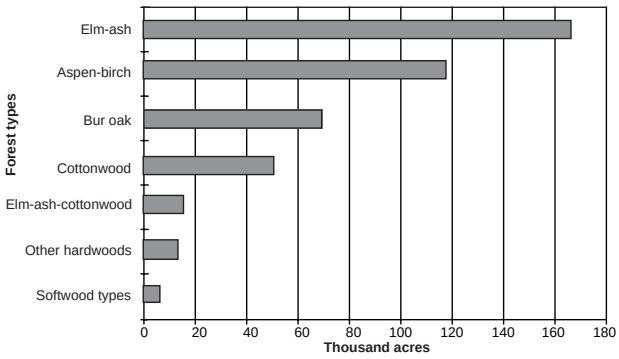

Figure 6.—*Area of timberland by forest type, North Dakota, 1994.*

Elm-ash

In 1994, the elm-ash forest type occupied 166 thousand acres, or 38 percent of the State's total timberland area. This forest type had the greatest increase in area of all the forest types in the State—a 63-percent increase. One reason for this increase is that many wooded strips now meet the definition of forest land. In North Dakota, American elm and green ash dominate this forest type. On a regional basis, elm-ash, an upland type, accounts for more then 60 thousand acres of timberland, in both the Missouri River and Red River County Groups.

Elm-ash-cottonwood

The elm-ash-cottonwood forest type, a lowland forest type, decreased by 64 percent between inventories, from 43 thousand acres in 1980 to 16 thousand acres in 1994. Cottonwood, elm, and green ash are the major components of this forest type. Much of the decline in the elm-ash-cottonwood forest type is the result of reclassification to the elm-ash forest type because of low regeneration of cottonwood. As the cottonwood component of the stand decreased, stands were reclassed into the elm-ash forest type.

Aspen-birch

The aspen-birch forest type is one of four forest types to show a decrease in area between inventories. This forest type decreased in area, from 140 thousand acres in 1980 to 118 thousand acres in 1994. Even with this decrease, the aspen-birch forest type still represents 27 percent of the total timberland

area in the State. Most of the aspen-birch type (84 percent) is found in the Souris River County Group, which contains the Turtle Mountains area of northern North Dakota.

Cottonwood

In 1994, the cottonwood forest type in North Dakota was estimated at 52 thousand acres, an increase of 35 thousand acres between inventories. Much of the gain in area can be attributed to shifts between forest type groups, other land classifications, and the continued refinement and improvements of inventory techniques rather than the establishment of young stands.

Loss of area in the cottonwood forest type is a concern not only for North Dakota, but also for the Plains States as a whole. In Kansas, area of cottonwood decreased from 107 thousand acres in 1936 to 66 thousand acres in 1994 (Leatherberry *et al.* 1998). In Nebraska, a loss of suitable sites for cottonwood regeneration was due partly to the construction of several flood control dams on major rivers and streams across the State (Schmidt and Wardle 1998). Cottonwood seeds require a nearly bare mineral soil seedbed to germinate. Frequent flooding along the streambanks helps prepare a suitable seedbed for germination. Because of reduced periodic flooding, less bare mineral soil is available for cottonwood seeds to germinate in.

In 1980, 29 percent of the cottonwood forest type was in the sapling/seedling stand-size class, compared to 27 percent in 1994. The number of cottonwood growing-stock trees less than 5 inches in diameter was estimated at 2.5 million trees in 1980 and 1.8 million trees in 1994, a decrease of 29 percent. If these trends persist in the cottonwood forest type, area as well as the number of cottonwood trees growing in the State will decrease.

Bur oak

Bur oak is the only native oak species found in North Dakota. In 1994, the area of bur oak forest type equaled 69 thousand acres, an increase of 33 percent between inventories. Although the bur oak forest type is found throughout the State, 58 percent of the forest type is in the Red River County Group.

Basswood

In 1994, the basswood forest type occupied more than 9 thousand acres of timberland in the Red River County Group. Although the area represents only 2 percent of the total timberland area of the State, there was a 38 percent increase within the forest type between inventories.

Softwood Forest Types

Although softwood forest types account for only 6 thousand acres in North Dakota, their many benefits include shelter for wildlife, wood products, and human enjoyment. The ponderosa pine forest type accounts for 1.7 thousand acres, and the Rocky Mountain juniper forest type accounts for 4.3 thousand acres (fig. 7). Both of these forest types occur in the western half of the State, within the Missouri River County Group.

Figure 7.—*Natural ponderosa pine regeneration, Logging Camp Ranch, North Dakota. (Photo courtesy of the North Dakota Forest Service)*

NONSTOCKED TIMBERLAND

In 1994, an estimated 2.6 thousand acres of nonstocked timberland was inventoried in the State. Nonstocked timberland is land that is identified as forest land but that does not meet the stocking requirements to be classified as a forest type. This occurs when the land does not have enough trees present when inventoried. All of the nonstocked timberland in North Dakota is in the Devils Lake/James River County Group.

STAND-SIZE CLASSES

The area of timberland in all stand-size classes increased between inventories. The area of sawtimber-size stands in North Dakota was estimated at 142 thousand acres in 1994 (fig. 8), an increase of 28 thousand acres from the 1980 inventory. As a percentage of timberland area, sawtimber-size stands did not change significantly between inventories. The area of timberland covered by poletimber-size stands totaled 173 thousand acres in 1994, an increase of almost 6 thousand acres since 1980. Poletimber-size stands, as a percent of total timberland area, declined from 46 percent in 1980 to 39 percent in 1994. In 1994, sapling-seedling-size stands accounted for 124 thousand acres, or 28 percent of all stands. This is an increase from the 1980 inventory when sapling-seedling-size stands accounted for 86 thousand acres, or 23 percent of the total timberland area.

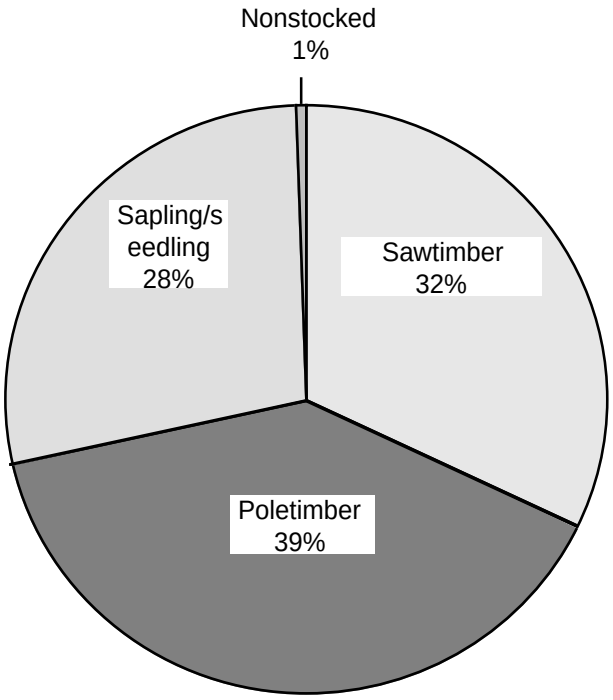

Figure 8.—*Area of timberland by stand-size class, North Dakota 1994.*

Aspen-birch

Within the aspen-birch forest type, sawtimber-size stands increased in area, while poletimber-size and seedling-sapling-size stands decreased. In 1980, only 7 percent of the forest type was in sawtimber-size stands; however, in 1994, 21 percent of the forest type was classified as sawtimber-size. The area of poletimber-size stands decreased, falling from 87 thousand acres (62 percent of the forest type) in 1980 to 57 thousand acres (49 percent of all aspen-birch stands) in 1994. Much of the decrease in poletimber-size stands is related to the natural maturing process of the forest. The area in seedling-sapling size stands decreased by 17 percent between inventories. Seedling-sapling stands accounted for 30 percent of the aspen-birch stand area in both the 1980 and 1994 inventories. Much of the decrease in the area of aspen-birch is most likely due to natural mortality. Both aspen and birch are relatively short lived species that tend to decline at about age 60 and give way to later successional types. In fact, aspen and birch together account for 46 percent of the growing-stock mortality in 1993. The leading cause of mortality in aspen is hypoxylon canker. In birch, the leading cause is bole borers. Both of these causes of mortality are typical of decadent stands.

Elm-ash

Sawtimber-size stands accounted for 50 percent of the elm-ash forest type area in 1980. By 1994, only 37 percent of the area was sawtimber-size, although the acreage of sawtimber-size stands increased by 11 thousand acres. The area of poletimber-size stands in 1994 was estimated at 50 thousand acres, an increase of 24 thousand acres. Sapling-seedling-size stands had the greatest increase in area of all size classes, rising from 25 thousand acres in 1980 to 54 thousand acres in 1994. The increase in the elm-ash type is the result of several causes. In the previous inventory, several field plots were classified as unproductive oak stands. Upon revisiting these plots, it was found that much of the oak was being replaced by young ash. Also, elm-ash-cottonwood and aspen-birch stands have been reclassed to elm-ash as aspen and birch decline and die, and cottonwood fails to regenerate.

Elm-ash-cottonwood

The elm-ash-cottonwood forest type, which is essentially a riparian variant of the elm-ash type, decreased in area from 43 thousand acres in 1980 to 16 thousand acres in 1994. Of all the forest types to post decreases between inventories, this forest type had the largest decrease both percentage-wise (64 percent) and area-wise (27 thousand acres). Sawtimber-size stands decreased in area from an estimated 28 thousand acres in 1980 to 13 thousand acres in 1994. Poletimber-size stands decreased by 89 percent, from 9 thousand acres in 1980 to 1 thousand acres in 1994, because of the severity of the 1980's drought. Between inventories, seedling-sapling-size stands also decreased in area by 70 percent. In addition to the drought, Dutch elm disease contributed to the decline in this forest type.

PRODUCTIVITY OF TIMBERLAND

In North Dakota, potential productivity class is used to evaluate timberland site quality as related to potential timber production. Potential productivity is expressed in cubic feet of net growth per acre per year on a given site. In North Dakota, timberland productivity is lower than in other States. Only 4 percent of timberland in North Dakota has the potential to produce more than 85 cubic feet per acre per year of growth. More than half of this more productive timberland is found within the Red River County Group. Another 22 percent of the timberland in the State has the potential to produce between 50 and 84 cubic feet per acre per year of growth. Most timberland found in the State (325 thousand acres) has the potential to produce less than 50 cubic feet of growth per acre per year.

STOCKING HOLDS THE KEY TO IMPROVING PRODUCTIVITY

Stocking is an estimate of occupancy of a given site, usually measured by basal area or number of trees. In North Dakota, 53 percent of the timberland area is either nonstocked or poorly stocked, while 27 percent of the timberland area is moderately stocked. In the Red River County Group alone, more than 50 percent of the timberland area is poorly stocked. If stocking is increased, even to moderate levels, growth will increase and the potential of timberland to grow and hold wood fiber will be realized.

STAND-AGE CLASS

The 41- to 60-year age class contained the largest timberland area in 1994, with an estimated 120 thousand acres (fig. 9). Other age classes with relatively large areas of timberland included the 61 to 80 age class with 114 thousand acres, and the 21 to 40 age class with 83 thousand acres.

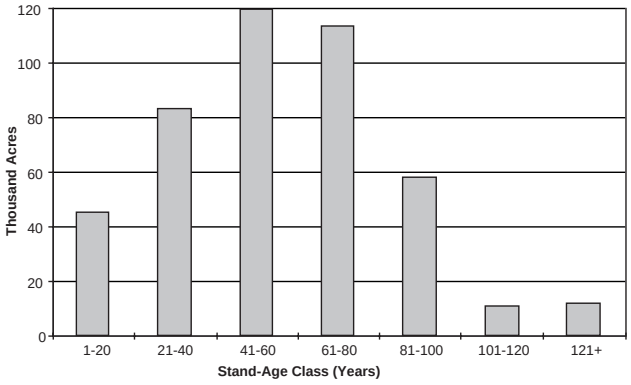

Figure 9.—*Timberland area by stand-age class, North Dakota, 1994.*

North Dakota timberlands have an exemplary distribution of stand ages: 29 percent of stands are less than 40 years of age; 53 percent are between 40 and 80 years of age; and 18 percent are more than 80 years of age. This age class distribution, comparable to that in Nebraska, exhibits the potential for effective management because younger trees respond best to timber stand improvement efforts such as thinning and pruning (Schmidt and Wardle 1998).

North Dakota has an estimated 12 thousand acres of timberland older than 120 years. This age class is generally accepted as the threshold for "old forest" (Schmidt and Wardle 1998) and offers some interesting forest management opportunities for the future, such as classification of climax vegetation establishment of ecological study areas.

NUMBER OF TREES

In 1994, an estimated 189 million live trees 1-inch or greater in d.b.h. were growing on North

Dakota's 442 thousand acres of timberland, an average of 428 trees per acre. Aspen and green ash were the dominant species in 1994, each accounting for 25 percent of all live trees growing in the State.

Of the total number of live trees, growing-stock trees (a live tree of commercial species that meets specified standards of size, quality, and merchantability) account for 142 million trees, or 75 percent of all live trees in the State. Noncommercial tree species, which include eastern hophornbeam (ironwood), wild plum, and peachleaf willow, account for 18 million trees, or 10 percent of all live trees.

TIMBERLAND VOLUME IN NORTH DAKOTA

Growing Stock

Between inventories, the volume of growing stock in North Dakota increased by 35 percent—from 244 million cubic feet to 330 million. All of the major species in the State, except elm, showed significant gains in volume. Quaking aspen, the most abundant species in North Dakota, increased by 24 percent between inventories to 78 million cubic feet (fig. 10).

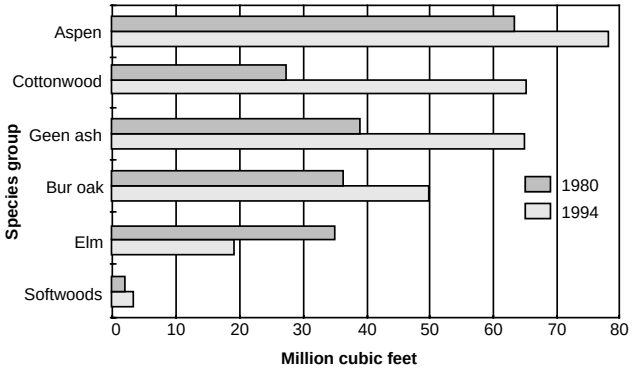

Figure 10.—*Growing-stock volume by species group and year of inventory, North Dakota, 1994.*

In North Dakota, more than 78 percent of all growing-stock volume is contained in four species: quaking aspen, cottonwood, green ash, and bur oak. Softwood species make up only 1 percent of the growing-stock volume in the State. In the 14 years between inventories, growing-stock volume averaged an increase of more than 6.1 million cubic feet per year. Most species in the State showed some sort of gain in growing-stock volume, except for elm, paper birch, and basswood.

Volume Per Acre Increases

In 1980, growing-stock volume per acre averaged 664 cubic feet on timberland. By 1994, it had increased to 747 cubic feet (an increase of 12 percent). The basswood forest type had the highest average for growing-stock volume per acre in the State in 1994 with 1,287 cubic feet per acre. Other above-average forest types were ponderosa pine (1,146 cubic feet per acre), cottonwood (1,116 cubic feet per acre), and aspen-birch (931 cubic feet per acre). The Rocky Mountain juniper forest type had the lowest per acre volume with 198 cubic feet per acre.

Sawtimber

The volume of sawtimber in North Dakota increased by nearly 56 percent between 1980 and 1994. In 1980, sawtimber volume was estimated at 530 million board feet; by 1994, it had increased to 825 million board feet. Almost every species, except elm and paper birch, showed significant gains in sawtimber volume. In 1980, elm accounted for 136 million board feet; by 1994, it had decreased to 67 million, a drop of 51 percent. The volume of cottonwood sawtimber increased by 124 percent between inventories and now accounts for 29 percent of the State's sawtimber volume, with 236 million board feet.

Timber Quality

Field crews assigned butt log grades to softwood sawtimber trees and tree grades to hardwood sawtimber trees. The most critical element in determining grade is the d.b.h. of the tree. Because none of the softwoods sampled exceeded 13 inches d.b.h., all of the softwood sawtimber in North Dakota received a log grade of 3. Sixty percent of the hardwood sawtimber in the State is in grade 3 or poorer trees. Again, diameter is the critical element in determining tree grade. Quaking aspen and paper birch have more than three-fourths of their volume in sawtimber trees less than 15 inches d.b.h. and have more than 80 percent of their volume in grade 3 or poorer trees. Cottonwood, with only 26 percent of its volume

in sawtimber trees less than 15 inches d.b.h., has 65 percent of its volume in grade 1 and 2 trees.

Volume in Non-Growing-Stock Trees

In addition to the 330 million cubic feet of growing stock volume in North Dakota, there is an additional 182 million cubic feet of usable volume in non-growing-stock trees (table C). Non-growing-stock volume comes from trees that are dead or dying, have rot, have a form defect, or are too short to meet commercial lumber standards. Volume from these trees is called non-growing-stock volume but is often used for products such as fuelwood, pulpwood, pallets, and fence posts. Non-growing-stock trees also provide important benefits such as wildlife habitat and visual diversity.

Table C.—*Non-growing-stock volume in North Dakota, 1994*

Non-growing-stock type	Volume
	(Thousand cubic feet)
Short-log trees	25,800
Rough trees	91,400
Rotten trees	29,600
Salvable dead trees	35,600
Total	182,400

BIOMASS

Biomass is a measure of the weight of aboveground living vegetation. Although growing stock and potential productivity provide valuable information to those interested in timber production, biomass is a more inclusive measure of total site productivity. For example, ecologists estimate annual production, accumulation, and distribution of biomass to describe and compare terrestrial ecosystems. Forest Inventory and Analysis estimates of biomass do not include foliage or root systems. In this report, we report only the aboveground woody biomass of trees.

The total aboveground woody biomass of all live trees greater than 1 inch d.b.h. on timberland in North Dakota was 26 million green tons, an average of 58 tons per acre. This compares to 60 tons in Minnesota and 40 tons in South Dakota. The most productive type in North Dakota is the basswood forest type with 75 tons per acre, and the least productive is the Rocky Mountain juniper forest type with only 18 tons per acre.

Seven percent of all live tree biomass is in trees from 1 to 5 inches d.b.h. as of 1994. Of the 93 percent of biomass in live trees greater than 5 inches d.b.h., 67 percent (17 million tons) is found in the bole. Tops and limbs make up another 20 percent and stumps contain 6 percent. Fifty-seven percent of all live tree biomass is in growing-stock trees, and 36 percent is in non-growing-stock trees.

GROWTH

Growth is important when looking at the forest resource because it is an indication of the change in the volume of wood and a sign of the health, vigor, and stage of development of stands. Growth is expressed as average annual net growth and current annual net growth for both growing stock and sawtimber (net growth is gross growth minus mortality). Current annual net growth is the net growth for a given year and is useful in comparing growth during two distinct years. Average annual net growth is the average net growth over a given number of years. Average annual net growth will even out the fluctuations that may occur from year to year due to weather changes or catastrophes. For the 1994 inventory of North Dakota's forest resources, average annual net growth is based on the average growth rate between 1980 and 1993, and current annual net growth is for 1993. Unless otherwise noted, all references to growth will be for timberland.

Growing-Stock Growth

An average of 6.7 million cubic feet of net growth of growing stock was added to timberland per year between 1980 and 1993. The average annual growth rate in North Dakota is about 2 percent of the State's growing-stock inventory. Growing-stock current annual net growth in 1980 was 6.7 million cubic feet, or an average of 18.2 cubic feet per acre of timberland. In 1993, the current annual net growth was 7.7 million cubic feet, or an average of 17.5 cubic feet per acre of timberland. There was a 16-percent increase of current

annual net growth statewide between 1980 and 1993, but on a per acre basis, there was a decline of almost 4 percent. Average annual net growth was 16.5 cubic feet per acre (with a consistent increase in the area of timberland throughout the period between surveys). This was lower than both 1980 and 1993 current annual net growth because the area of sapling-seedling-size stands and nonstocked stands represented a larger portion of stands in 1993 than in 1980. Elm mortality (as a result of Dutch elm disease), a negative growth rate for paper birch (reflecting the many mature and overmature stands that have begun to decline), and the drought of the mid- to late-1980's were partly responsible for this lower increase in growing-stock growth on a per acre basis.

The aspen-birch forest type accounted for 42 percent of the average net growth between 1980 and 1993. Even though the area of aspen-birch forest type decreased by 16 percent, the area of aspen-birch sawtimber-size stands more than doubled, rising from 10 thousand acres in 1980 to 25 thousand acres in 1994. Green ash, which accounted for 31 percent of the total average annual net growth, contributed to the elm-ash forest type, making up another 22 percent of the average net growth.

Rocky Mountain juniper had the highest rate of growth with 6 percent per year. However, it accounted for less than 0.5 percent of the State's growing-stock volume because the area of Rocky Mountain juniper forest type that was poletimber size increased by 72 percent, from 2.5 thousand acres in 1980 to 4.3 thousand acres in 1994. Among the major species in North Dakota, green ash had the highest rate of growing-stock growth with 3 percent of the species inventory. Elm and paper birch each had negative growth rates of -2 percent and -1 percent per year, respectively.

On a regional basis, the Souris River County Group accounted for 42 percent of the State's average annual net growth. This County Group contains 84 percent of the aspen-birch forest type, which had the largest percentage increase in average annual net growth. The Red River and the Missouri River County Groups accounted for 28 percent and 24 percent, respectively. The Devils Lake/James River County Group made up only 6 percent of average annual net growth. This county group contains only 7 percent of North Dakota's timberland, of which 53 percent is in sapling-seedling-size stands.

Sawtimber Growth

Both the average annual net growth between 1980 and 1993 and current annual net growth for 1980 of sawtimber were 25 million board feet, an average of 3 percent of the State's total sawtimber volume. For 1993, the current annual net growth of sawtimber was 26 million board feet. The negative average annual net growth of both elm and paper birch, and the drought of the mid- to late-1980's, contributed to the lack of greater current annual net growth of sawtimber.

The aspen-birch forest type accounted for 35 percent of the average annual net growth of sawtimber in North Dakota between 1980 and 1993. The large increase in the area of sawtimber-size aspen-birch stands is the primary reason. The other major contributors to average annual net growth of sawtimber were the elm-ash and the cottonwood forest types, each with 24 percent.

Balsam poplar had the highest rate of sawtimber average annual net growth between 1980 and 1993 with a growth rate of 5 percent. This species makes up 6 percent of the sawtimber volume in the State and accounts for 10 percent of the average annual net growth each year. Green ash has the second highest rate of sawtimber net growth with an average annual growth of almost 5 percent. Because elm and paper birch mortality exceeds gross growth, each has a negative net growth of sawtimber, -4 percent and -1 percent, respectively.

The Red River County Group accounted for 44 percent of the average annual net growth of sawtimber between 1980 and 1993. This county group contains 54 percent of the State's sawtimber-size stands.

Potential Growth

North Dakota has the potential of growing more wood volume if stocking levels are improved. Poorly stocked and nonstocked stands represent 53 percent of all the area of timberland in the State. To get an idea of how much

additional volume of wood timberlands in North Dakota might produce, we estimated the potential average annual net growth on timberland. This is based on the potential growth of fully stocked natural stands at culmination of mean annual increment in each potential productivity class. We multiplied the area in each productivity class by the midpoint of the range of growth in that class. Spurr and Vaux (1976) discounted an estimate of potential growth by 10 percent to adjust for the differences between actual stand conditions and the fully stocked natural conditions implicit in use of potential productivity data. Thus, we discounted the potential productivity data by 10 percent to more accurately reflect current stand conditions in North Dakota in 1994. Potential net annual growth for North Dakota is estimated to be 17.7 million cubic feet per year (table D).

North Dakota has the potential to increase its net growth of growing stock by 166 percent based on an average annual net growth of 6.7 million cubic feet and a potential annual net growth of 17.7 million cubic feet. One of the advantages of increasing net growth is that no additional acres of timberland are needed to increase the volume of wood. This is important because land will not need to be taken from other uses such as agricultural production and urban growth to increase wood production. The most efficient method of increasing wood production is through more intensive management of existing timberland.

MORTALITY

The death of trees is an important part of forest ecology. Dead trees provide shelter, nesting and roosting sites, and food for many organisms. Fungi and insects that help break down the woody material are important sources of food for other animals. Decomposition of woody material releases nutrients and improves the composition of the soil, which is beneficial to the remaining forest community.

Mortality in Growing Stock

Average annual mortality for growing stock in North Dakota was 4.6 million cubic feet between 1980 and 1993. Statewide, average annual mortality as a percent of total volume was 1 percent of growing stock. Mortality of growing stock in 1980 averaged 11 cubic feet per acre compared to 10 cubic feet per acre of timberland in 1993.

Unknown causes accounted for most of the growing-stock mortality in the State between 1980 and 1993. Dutch elm disease was the leading known cause of death, accounting for 13 percent of the total growing-stock mortality for the State. Hypoxylon canker, primarily a problem of aspen, was the second highest known cause of death, but accounted for only 2 percent of the total known causes of growing-stock mortality.

Quaking aspen made up 33 percent of the growing-stock average annual mortality in North Dakota, followed by elm, with 28 percent of the mortality. With 54 percent of the aspen-birch forest type more than 50 years of age, much of the aspen in the State is mature or overmature. Cankers and stem decay, like hypoxylon canker, accounted for 11 percent of all aspen average annual mortality. Dutch elm disease accounted for 49 percent of the average annual mortality of elm, with decline/dieback and foliage diseases combined adding another 11 percent.

Table D.—*Estimation of potential net annual growth on timberland, North Dakota, 1994*

Potential productivity class	Timberland area	Potential net growth per acre	Unadjusted total potential growth	Adjusted total potential growth (discounted 10%)
(Cubic ft/ac/yr)	(Thousand acres)	(Cubic ft/ac/yr)	- - - - -(Thousand cubic ft/yr) - - - - -	
85+	18.8	102.0	1,917.6	1,725.8
50-84	97.9	67.0	6,559.3	5,903.4
20-49	324.8	34.5	11,205.6	10,085.0
	441.5		19,682.5	17,714.2

Mortality in Sawtimber

Sawtimber average annual mortality was 10 million board feet for the period between inventories. Current annual mortality was 10 million board feet in 1980 and 12 million board feet in 1993. Annual mortality was 2 percent of the sawtimber volume in 1980 and only 1 percent in 1993. In 1980, 26 board feet per acre on timberland was lost due to mortality. In 1993, that number increased to 27 board feet per acre on timberland. This rise in mortality between inventories was partly due to mortality keeping pace with the increase in inventory of timber as trees added volume and advanced in age.

REMOVALS

Timber removals are made up of three components: roundwood products, logging residues, and other removals. The roundwood products portion includes saw logs, veneer logs, pulpwood, and other products harvested. Logging residues include growing-stock volume that is not used when the tree is harvested and growing-stock volume of any unused trees that were killed due to harvesting. Other removals include the volume of growing stock removed from the inventory that is not related to the harvest of products. Examples of other removals include land clearing for residential or agricultural uses and the reclassification of timberland to a non-timberland ground land use such as reserved forest land or inclusion in urban areas. The breakdown of current annual removals of growing stock for 1993 was 39 percent due to product removals, 6 percent logging residue, and 55 percent other removals.

Growing-Stock Removals

Average annual growing-stock removals for North Dakota between 1980 and 1993 was 1.57 million cubic feet, only 0.5 percent of the State's growing-stock volume. The current annual removals for 1980 and 1993 were 1.50 million cubic feet and 1.56 million cubic feet, respectively. Since the average annual growing-stock removals is higher than the current removals for both the start and the end of the period, removals of growing stock were higher at some time between 1980 and 1993.

The basswood forest type, which accounts for only 2 percent of North Dakota's timberland area, had the highest amount of growing-stock removals with 26 percent of the total average annual removals (fig. 11), or 403 thousand cubic feet of growing stock removed each year. Sawtimber-size stands comprise 85 percent of the basswood forest type. Regionally, the Red River County Group contains all of the basswood forest type in the State, and in 1993 accounted for 99 percent of the saw-log production for the State. This suggests that the majority of the basswood forest type removals were for the production of wood products and not land clearing or because of forest land reclassification.

Figure 11.—*Cottonwood fuelwood along the Missouri River near Bismarck, North Dakota. (Photo courtesy of the North Dakota Forest Service)*

The elm forest types (elm-ash-cottonwood and elm-ash) accounted for 42 percent of the total average annual removals. While the aspen-birch forest type accounted for 13 percent, cottonwood forest type 11 percent, and the bur oak forest type 8 percent of the States total average annual removals.

As for species groups, elm, ash, and cottonwood (the major components of both elm-ash-cottonwood and elm-ash forest types) accounted for 59 percent of the growing-stock average removals between 1980 and 1993. Elm, with 29 percent of the total average annual removals, and bur oak, with 21 percent, accounted for just over half of the average annual removals in the State.

Regional Growing-Stock Removals

The Red River County Group, which contains 37 percent of the timberland in North Dakota, had 62 percent of the State's average annual removals of growing stock. Eight of the 12 primary wood-using mills in the State are located in this region. All the removals for composite panel products came from this region as well. The Souris River County Group accounted for another 24 percent of the average removals of growing stock between 1980 and 1993, and the Missouri River County Group had the remaining 14 percent of average annual removals of growing stock.

Sawtimber Removals

Annual removals from sawtimber on timberland in North Dakota averaged 4.3 million board feet between 1980 and 1993. The annual removals of sawtimber was 2.9 million board feet in 1980 and 5.1 million board feet in 1993, an increase of 72 percent. Much of this increase is due to the increase in saw-log production for roundwood products. The increase of current annual removals of growing stock for 1980 and 1993 was much lower than the increase of current annual removals of sawtimber, 4 percent versus 72 percent. This suggests that a large portion of the removals in 1980 was from trees less than sawtimber size and 1993 removals contained a higher percentage of sawtimber-size trees.

Average removals of sawtimber from the elm-ash-cottonwood forest type accounted for 36 percent of the total removals between 1980 and 1993. The elm-ash forest type contributed 24 percent of the average annual removals of sawtimber. This high volume of removals of sawtimber from these two forest types may be due to the harvesting of the elm in anticipation of mortality as a result of Dutch elm disease. Elm accounted for nearly 50 percent of the average annual removals of sawtimber between 1980 and 1993 (fig. 12).

The basswood forest type had the second highest volume of average annual sawtimber removals between 1980 and 1993, accounting for 31 percent of the total removals from sawtimber. Since this forest type is of mostly sawtimber size (85 percent of the area is in sawtimber-size stands) and it had the largest volume of average annual removals of growing stock, much of the growing-stock removals would also show up in the sawtimber removals. The remaining average annual removals of sawtimber in North Dakota came from the bur oak and cottonwood forest types.

Figure 12.—*Elm harvest along the Red River, North Dakota. (Photo courtesy of the North Dakota Forest Service)*

RELATION BETWEEN GROWTH, MORTALITY, AND REMOVALS

Annual gross growth (average annual net growth plus average annual mortality) on timberland in North Dakota between 1980 and 1993 averaged 11.3 million cubic feet for growing stock and 34.8 million board feet for sawtimber (fig. 13). Mortality subtracted 4.6 million cubic feet from growing-stock growth and 10.0 million board feet from sawtimber growth each year. The removal of trees took away an average of 1.6 million cubic feet of growing stock and 4.3 million board feet of sawtimber each year. The net increase in volume (gross growth minus mortality and removals) in North Dakota averaged 5.1 million cubic feet of growing stock and 20.6 million board feet of sawtimber each year between 1980 and 1993. On an average per acre basis, this is a net increase in volume of 12 cubic feet per acre per year for growing stock and 47 board feet per acre per year for sawtimber on timberland in the State.

On timberland in North Dakota wood fiber is growing at a rate of 15 cubic feet of net growth per acre per year. This is comparable to the most recent South Dakota and Nebraska figures of 14 and 16 cubic feet of net growth per acre per year. However, it is not as high as Minnesota's average net growth rate of 25 cubic feet per acre per year.

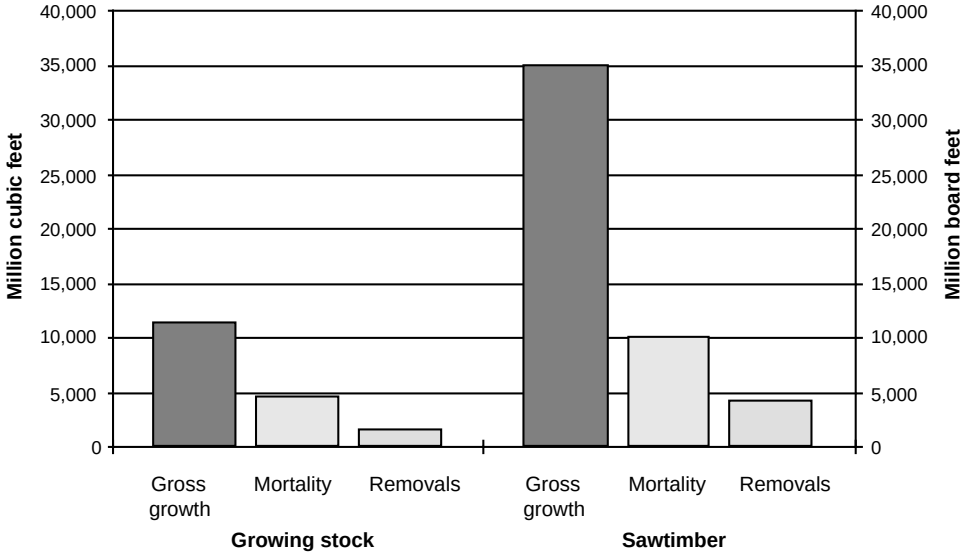

Figure 13.—*Average annual gross growth, mortality, and removals of growing stock and sawtimber on timberland, North Dakota, 1980-1993.*

Much of the timberland in North Dakota is approaching maturity or overmaturity. Sawtimber stands make up 32 percent of the timberland area in the State, but 60 percent of the timberland is more than 50 years old. As forest stands become overmature, they become more susceptible to rot and decay. This can lead to a decline in growth, and eventually death. Removal by harvesting for timber products can capture this growth before the stand's growth begins to decline. The creation of wildlife openings by cutting in over-mature stands can release the understory vegetation and creates a diversity of stand-age classes within timberland area.

FOREST PRODUCTS

According to the 1992 Census of Manufactures, there were 44 establishments in the lumber and wood products industry (SIC Code 24) in North Dakota that year. The lumber and wood products industry employed approximately 1,000 people, paid $19.6 million in wages and salaries, and shipped products valued at $72.9 million (fig. 14). Of these, most establishments (29) were in the millwork, plywood, and dimension lumber segment of the industry. Seventeen of these produced wood kitchen cabinets. By comparison, the 1977 Census of Manufactures found 27 wood-using plants in North Dakota. At that time, these plants employed 400 people and produced $18.9 million worth of products.

The most recent inventory of the primary wood-using industry in North Dakota (May and Harsel 1995) was based on 1993 production. Primary wood-using industries receive roundwood, or chips from roundwood for processing. They do not produce a finished product. In North Dakota, these mills produce lumber, pallet lumber, and cabin logs. Secondary wood-using industries make such products as millwork, trusses, cabinets, and furniture. These industries use raw materials that come primarily from outside the State.

In 1993, there were 12 primary wood using industries in North Dakota, 11 sawmills and 1 cabin log mill—4 more mills than in 1977.

Figure 14.—*Portable sawmill cutting ponderosa pine logs, Logging Camp Ranch, North Dakota. (Photo courtesy of the North Dakota Forest Service)*

Eight of the mills were located in the Red River County Group. Most of the mills in 1993 were small sawmills that processed less than 50 thousand board feet of saw logs per year.

Cottonwood accounted for 90 percent of all saw logs produced in 1993. The remaining 10 percent of the saw logs produced, in order of decreasing volume harvested, were basswood, bur oak, green ash, elm, quaking aspen, and ponderosa pine. Ponderosa pine was the only species harvested for cabin log production.

Fuelwood, according to the 1994 North Dakota residential fuelwood survey (May 1996), is the largest consumer of wood fiber in the State. A total of 2.4 million cubic feet of timber was removed for residential fuelwood production in 1994. Fuelwood accounted for 78 percent of the total volume of wood fiber used for products in the State (fig. 15). Nearly all of the fuelwood cut came from non-growing-stock removals on timberland and non-timberland sources. Elm trees killed by Dutch elm disease were the major source of fuelwood for the State. Cutting of dead elm trees on timberland alone supplied 10 percent of the total residential fuelwood production, while the harvest of growing-stock trees on timberland supplied less than 1 percent of the total.

In the process of harvesting roundwood products from North Dakota's forests in 1993, 701 thousand cubic feet of growing stock was removed. Of this volume, 605 thousand cubic feet or 86 percent was used for products. The remaining 96 thousand cubic feet was left as logging residue. An additional 862 thousand cubic feet of growing stock was removed as a result of land clearing or land-use change. This material was not used for wood products.

TIMBER SUPPLY PROJECTION

The results of this third inventory of North Dakota show that average annual net growth of growing stock rose from 6.7 million cubic feet in 1980 to 7.7 million in 1994. During this same period, timber removals from growing stock rose slightly from 1.5 million cubic feet in 1980 to 1.6 million cubic feet in 1993. As a result, the volume of growing stock rose from 243.7 million cubic feet in 1980 to 329.7 million in 1994. At the same time, the area of timberland in the State rose from 367.1 thousand acres in 1980 to 441.5 thousand in 1994.

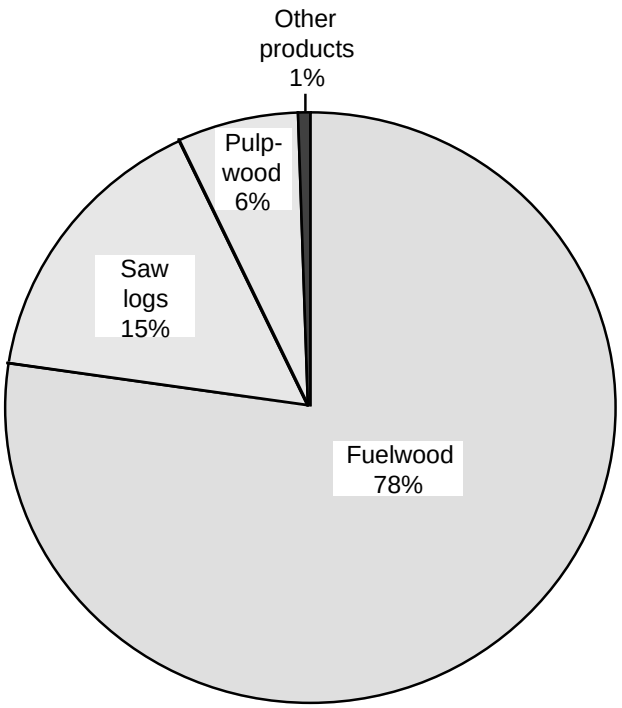

Figure 15.—*Timber product output, North Dakota, 1993.*

With these past trends as prologue, we now confront the question of what we might expect in the coming 30 years. As figure 16 shows, the inventory of growing stock actually declined slightly from 1954 to 1980 and then rebounded. We expect this rebound to continue but at a slightly decreasing rate. Timber removals are expected to nearly double over the projection period (fig. 17). Current removals are well below annual net growth at a ratio of 5 to 1. Thus, the resource could easily sustain an increase in removals. It seems likely that an increase could occur as the pressure on the resource in Minnesota increases. However, even with a doubling of removals, North Dakota would still end the projection period with a healthy 2.2 to 1 growth to removals ratio.

Annual net growth during the projection period is expected to decline slightly from 7.7 million cubic feet in 1994 to 6.5 million cubic feet in 2024. The reason for the slight decrease in growth over the projected 30-year cycle is due to increased mortality in overmature stands, and the projected increase, over the same period for removals. Volume per acre is expected to rise from 747 cubic feet to 1,073 cubic feet in 2024. We

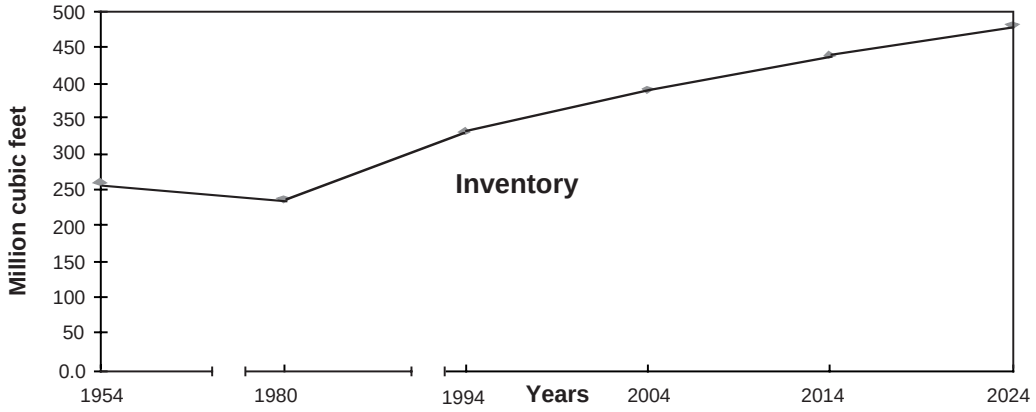

Figure 16.—*Projected inventory, North Dakota, 1954-2024.*

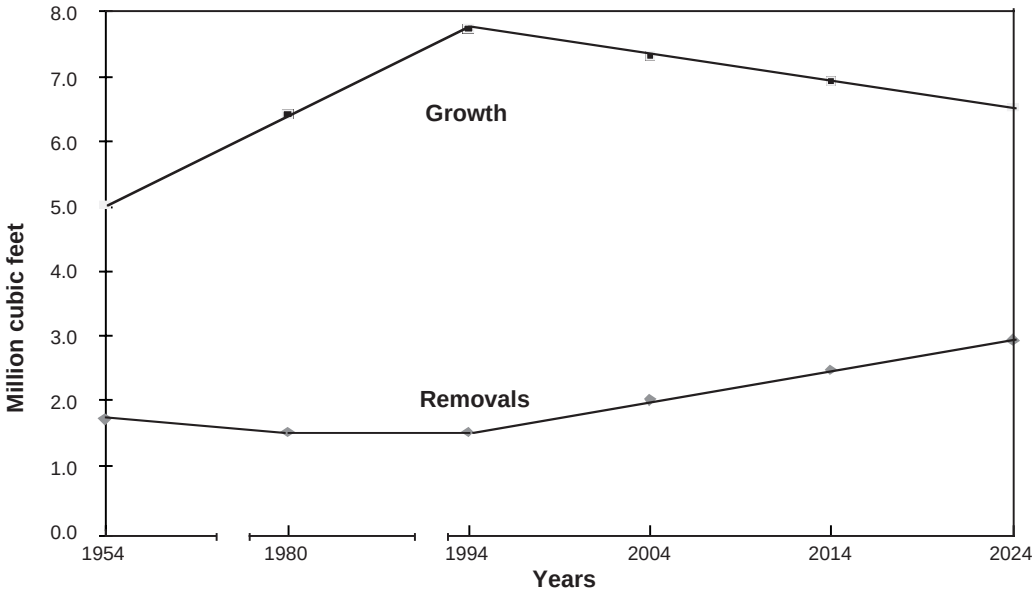

Figure 17.—*Projected growth and removals, North Dakota, 1954-2024.*

expect an increase in volume, due in part, to many poorly stocked stands reaching moderate levels of stocking within the 30-year projection cycle. This projection represents what we expect is the likely future development of the State's forest resource. Changing economic or social conditions could significantly alter the projection. However, in the first decade we feel that any changes will have little impact. Beyond the first decade, it becomes less likely that all the assumptions upon which the projection is based will be realized. This projection also does not depict desirable silvicultural or management objectives. Rather, it represents what is likely to occur given the assumptions and the biology of the resource.

NON-TIMBER BENEFITS FROM NORTH DAKOTA'S FORESTS

Although the forest resource base of North Dakota is small, forests provide many important non-timber benefits to the people of the

State. They provide esthetic diversity, wildlife habitat, clean water, recreation, erosion control, and many non-timber forest products. The fact that people who live in North Dakota appreciate trees is demonstrated by the Centennial Trees Project, which has the goal of planting 100 million trees during the 1990's. Most North Dakota landowners realize the value of trees for timber products, but generally place a higher value on trees for their non-timber benefits.

Erosion and Snow Control

Probably the greatest value that trees have in North Dakota is the wind and snow protection they provide to humans, wildlife, crops, and livestock. Intentionally planted strips of trees, windbreaks, protect thousands of acres of farmland. Windbreaks reduce soil erosion by slowing down the wind as it passes over a field. This benefit of windbreaks can extend leeward for a distance of at least 10 times the height of the trees (Wardle and Schmidt 1984).

Windbreaks also reduce wind velocity in the wind shadow area, which in turn, controls wind erosion, deposits snow uniformly, increases crop quality and production, and improves water use efficiency (U.S. Department of Agriculture, Natural Resources Conservation Service 1996). The snowy winters of the 1990's demonstrated that well-placed trees can significantly reduce blowing snow on highways and around farmsteads. Windbreaks by homes and farmsteads can reduce energy loss, trap snow away from buildings, and improve human habitat. Windbreaks can control energy loss and feed intake by livestock, and reduce snow drifting in the livestock concentration area (U.S. Department of Agriculture, Natural Resources Conservation Service 1996).

Wildlife Habitat

Both native and introduced tree species provide valuable food and cover for many wildlife species in North Dakota. Native species such as bur oak provide mast (acorns) for turkey, squirrels, and deer. Exotic species like Colorado spruce provide excellent nesting cover for birds. Native species such as chokecherry, juneberry, and buffaloberry provide food for both humans and wildlife. Ruffed grouse, moose, elk, and deer make extensive use of the aspen resource in the northern part of the State, particularly in those areas that are managed to provide three age classes. Ruffed grouse in particular benefit from a mix of aspen stands of various ages, where both juvenile and adult birds can find food and shelter.

Cavity nesting species such as woodpeckers, owls, and wood ducks depend on mature forests for nesting sites. Brown thrashers require open younger forests. Even species that typically inhabit non-forest environments depend somewhat on forests. Bluebirds prefer cavities in trees in open forest areas, while sharptail grouse use forests as a haven from enemies or the elements (Trippensee 1948).

The North Dakota Game and Fish Department provides technical and financial assistance to landowners to improve wildlife habitat. They also manage about 150,000 acres of wildlife management areas around the State. More than 25,000 acres of these areas are wooded (North Dakota Outdoors 1997). The Game and Fish Department has also teamed up with the North Dakota Forest Service to manage aspen on State lands and to assist landowners in managing aspen stands for both wildlife and timber.

Esthetics and Recreation

Trees add beauty, diversity, and value to both urban and rural landscapes. Native species like aspen and introduced species like Amur maple and Siberian larch provide spectacular fall beauty. Evergreens provide much needed color to the harsh winter landscape. People value having trees in their environment. One study showed that trees near homes and buildings contributed nearly 20 percent to the total value of the property (National Arbor Day Foundation 1991).

Hunting is a popular activity in North Dakota. Records attest to both the abundance of forest game species and the success of North Dakota hunters. In 1994, 80,737 hunters harvested 61,029 deer, a success rate of more than 75 percent. In the same year, 3,770 hunters harvested 2,193 turkeys, and 1,154 hunters harvested 2,260 ruffed grouse (North Dakota Outdoors 1997).

Much of the land available for public outdoor recreation, be it hunting, fishing, hiking,

camping, bird watching, boating, cross country skiing, or snowmobiling, is owned and managed by State or Federal agencies. One agency that deals with non-hunting recreational activities is the North Dakota Parks and Recreation Department. This agency administers 19 State parks and recreation areas that average more than one million visitors each year (State of North Dakota 1997). Many of these parks are situated in diverse forested areas—Fort Ransom State Park (Sheyenne River valley forest), Lake Metigoshe State Park (Turtle Mountain forests), Fort Lincoln State Park (Missouri River bottomland forest), and the Turtle River State Park (bottomland forests) to name just a few.

The North Dakota Forest Service manages its lands for multiple benefits that include recreation and esthetics. This agency manages 13,278 acres in five State forests that contain five campground/recreation areas and 50 miles of wooded trails. Approximately 11,000 people use the State forests each year for hiking, hunting, camping, skiing, snowmobiling, and other outdoor activities (North Dakota Forest Service 1994).

Several Federal agencies manage areas available for recreation, many of which are forested or enhanced by trees. These agencies include the Forest Service, the National Park Service, the Fish and Wildlife Service, and the Corps of Engineers.

Water Quality

An important function of forests in North Dakota is the maintenance of water quality and the prevention of erosion. An estimated 60 percent of North Dakota's total river and stream system is either threatened or impaired by pollution (North Dakota Department of Health 1996). Activities such as overgrazing, land clearing, and improper timber harvesting all can impact riparian forests and result in erosion and decreased water quality. Statewide, grazing impacts 2,800 miles of rivers and riparian vegetation has been cleared from another 300 miles (North Dakota Department of Health 1996). Efforts to control this nonpoint source pollution are primarily conducted through the North Dakota Nonpoint Source Pollution Management Program. This program's task force provides input and recommendations on local projects funded by Environmental Protection Agency grants. Several watershed projects have recently been initiated to restore riparian areas. One of these, the Red River Basin Riparian Project, began in 1994 and is sponsored by the Red River Resource Conservation and Development District.

The maintenance of forested riparian areas along rivers, streams, and lakes can reduce siltation and sedimentation by holding soil in place and reducing bank sloughing. Trees in riparian areas also act as buffers and filterstrips by removing contaminants before they wash into rivers, streams, and lakes. In addition to improving water quality, trees along streams lower the water temperature, and provide both food and cover for fish. Fishing is an important pastime in North Dakota. In 1996, more than 125,000 fishing licenses were sold in the State (North Dakota Outdoors 1997).

Special Products

North Dakota produces an array of forest products that are not related to timber harvesting for wood fiber. Basswood is a popular species with wood carvers. The thick bark of cottonwood is used to make etchings. Chainsaw carvings are also popular. Jellies, jams, and syrup are made from the fruit of native trees like chokecherry and wild plum. Juneberries are often sold as fruit. In addition, many novelty items are made from wood. Ash is used to make canoe paddles and dog sleds. Birch bark is used for baskets and willow is used for canes.

THE PAST, PRESENT, AND FUTURE OF NORTH DAKOTA FORESTS

The Past

In 1937, James H. Anthony, Acting State Forester, released a report on the conditions of forests in North Dakota. In that report he talked about shelterbelts and woodland plantings and the important tie to agricultural lands. He also talked about the importance of managing forest lands for the greatest benefits for the people of North Dakota. In addition, he discussed the importance on the collection and publication of both technical and non-technical information related to the forest conditions of the State.

The Present

What was important to James H. Anthony in the 1930's still holds true in the 1990's. Tree planting, whether a single tree planted in an urban setting or many trees planted in a windbreak, is an important component of North Dakota's forest programs. With 19 State parks and 5 State forests, multiple-use of North Dakota's forest lands is a reality. The fact that for a third time this half century the State forest lands have been inventoried shows the importance of forest lands (even though only 1.5 percent of all land in the State is forested).

The Future

No one can say for certain what the future of forestry holds for North Dakota. Planting trees and managing forest lands under multiple uses are sure to be practiced into the new millennium. Other opportunities need to be explored. More than half of the timberlands in the State are poorly stocked. If stocking is improved, chances are that productivity on timberland can be increased. With an estimated 12 thousand acres of timberland older than 120 years, important and interesting management decisions lay ahead.

One of the most important factors that weave throughout all management decisions is the private landowner. Private landowners hold more than 341 thousand acres of the State's timberland, and their continued involvement and support of forest programs is crucial. The future of forestry looks bright for the State of North Dakota.

APPENDIX

RELIABILITY OF THE SURVEY

Forest Inventory and Analysis information is based on a sampling procedure designed to provide reliable statistics at the State level. Consequently, the reported figures are estimates only. A measure of reliability of these figures is given by sampling errors (table E). These sampling errors mean that the chances are two out of three that if a 100-percent inventory had been made, using the same methods, the results would have been within the limits indicated.

For example, the estimated growing-stock volume in North Dakota in 1994, 329.7 million cubic feet, has a sampling error of ± 8.8 percent (± 29.0 million cubic feet). The growing-stock volume from a 100-percent inventory would be expected to fall between 300.7 million cubic feet and 358.7 million cubic feet (329.7 ± 29.0), there being a one in three chance that this is not the case.

Table E.—*Sampling errors for the 1994 inventory of North Dakota's forests*

Item	State totals	Sampling error
Growing stock	(Million cubic feet)	(Percent)
Volume (1994)	329.7	8.8
Average annual growth (1980-1993)	6.7	12.8
Average annual removals (1980-1993)	1.6	35.5
Sawtimber	(Million board feet)	
Volume (1994)	825.2	10.5
Average annual growth (1980-1993)	24.9	15.0
Average annual removals (1980-1993)	4.3	31.2
	(Thousand acres)	
Timberland area (1994)	441.5	6.2

As survey data are broken down into sections smaller than State totals, the sampling error increases. For example, the sampling error for timberland area in a particular county or county grouping is higher than that for total timberland area in the State. To estimate sampling error for data smaller than State totals, use the formula on the next page:

$$E = \frac{(SE)\sqrt{\text{(State total volume or area)}}}{\sqrt{\text{(Volume or area smaller than State total)}}}$$

Where:

E = Sampling error in percent.

SE = State total error for volume or area.

For example, to compute the error on the area of timberland in the elm-ash type for the State, proceed as follows:

1. Total statewide area of elm-ash type = 165.7 thousand acres.
2. Total statewide area of all timberland = 441.5 thousand acres.
3. The State total error for timberland area = 6.2 percent.
4. Using the above formula:

$$E = \frac{(0.062)\sqrt{441.5}}{\sqrt{165.7}}$$

E = 10.1 percent sampling error for the elm-ash forest type in North Dakota. Sampling errors for area, volume, growth, and removals, for both growing stock and sawtimber, by county group, are shown in table 56.

COMPARING THE THIRD INVENTORY OF NORTH DAKOTA WITH THE SECOND INVENTORY

A volume estimation procedure developed for Minnesota's prairie region was used to compute the 1994 volumes and to recompute the 1980 volume. Although the adjusted volumes will differ by species, the recomputed 1980 growing-stock and sawtimber volumes will generally be greater than those shown in the 1980 report.

Past surveys used only growing-stock trees to determine stand-size class. Current survey procedures require that stand-size class be determined on the basis of all live trees. Therefore, direct comparisons of current inventory data to old inventory data by stand-size class may be misleading.

SURVEY PROCEDURES

The survey procedures used in this inventory are described in detail in Hansen (1999). A summary of these procedures is presented here. It consists of three parts:

1. A description of the statistical design used in the inventory that deals with the methods used for stratification, aerial photo, and ground plot selection and estimation.

2. A description of the ground plot measurements that focuses on the plot design and changes in the design between the 1980 and 1994 inventories.

3. A description of the methods used to compute items presented in this report (area, number of trees, volume, growth, mortality, removals, and biomass) from field plot measurements.

STATISTICAL DESIGN

The basic design for this inventory consists of two independent samples that were combined to provide an overall estimate of the forest resources of North Dakota. The first sample is based on the remeasurement of the 1980 NCFIA inventory, and the second sample is based on the Natural Resources Inventory (NRCS-NRI) of the USDA Natural Resources Conservation Service. These samples produced two independent estimates of the total forest resource in North Dakota and were combined, using statistically appropriate methods, to provide the best overall estimates possible.

SAMPLE BASED ON THE REMEASUREMENT OF THE 1980 NCFIA INVENTORY

The first sample was based on the remeasurement of aerial photo and ground plots taken during the 1980 NCFIA inventory of North Dakota. This inventory used double (two phase) sampling for stratification as presented in various texts on sampling such as Cochran (1977) and Loetsch and Haller (1964). Aerial photo plots were observed in the first phase, and ground measurement or field plots were measured in the second phase.

1980 NCFIA Inventory Aerial Photo Plots (Phase 1)

The first phase of the 1980 inventory was a systematic sample of aerial photo plots distributed over the entire State. Sampling was completed using a grid at the intensity of 121 photo plots per township (6 miles by 6 miles). This provided a phase 1 sampling rate of one photo plot per 190.4 acres. Each photo sample plot was classified as forest, nonforest, questionable (samples where the photo interpreter was unable to make a definite call between forest and nonforest), and unproductive. The distribution of photo plots by aerial photo classification in the 1980 NCFIA forest inventory was:

Forest	2,848
Questionable	247
Unproductive	401
Nonforest	223,397
Total	226,893

1980 NCFIA Inventory Ground Plots (Phase 2)

A systematic sample of the aerial photo plots was selected as ground plots in phase 2 of the 1980 inventory. A total of 17,452 ground plots were selected from the 226,893 photo plots. These ground plot locations were carefully examined stereoscopically, pinpricked on the aerial photo, and assigned a ground plot identification number. Ground plots that definitely were not forest land (those classified as nonforest without trees, noncensus water, or census water) were given a nonforest ground land-use classification (more detailed than the photo classification done on all photo plots) by the photo interpreter and not sent to the field for measurement. These plots are referred to as office ground plots. Ground plot locations that could possibly be forest land (those classified as forest, questionable, unproductive or nonforest with trees) were sent to the field for ground classification. The average ground plot sampling intensity was one ground plot per 2,541 acres. The distribution of ground plots by aerial photo classification in the 1980 NCFIA inventory was:

Forest	219
Questionable	19
Unproductive	31
Nonforest	17,183
Total	17,452

Estimates of the forest resources presented in 1980 inventory reports are based on double sampling for stratification based on these strata.

Remeasurement of the 1980 NCFIA Inventory

The aerial photo classification completed in the 1980 inventory was used for stratification in the first sample of the 1994 North Dakota forest resources inventory. These 226,893 photo plots were used as the phase one sample to estimate the area in each of the seven strata. The second phase used plots that were visited by field crews to sample and observe ground conditions (land use, volume, growth, mortality, removals, etc.) within the seven strata.

The 1980 ground plots measured in the field form the second phase of this sample. In the forest, nonforest with trees, questionable, and unproductive strata, remeasurement observations of every systematic ground plot location established during the 1980 inventory were used to estimate average ground conditions within each stratum in 1994. In the nonforest without trees, census water, and noncensus water strata, a cluster sampling scheme (using townships as clusters) was used to make repeated ground observations of the photo plots established in the 1980 inventory.

This sampling scheme was selected to improve our ability to estimate the area of forest, with particular emphasis on estimating the actual area of land change to and from forest. Because all stratification was based on the same photo classification used in the previous inventory, estimates of change in forest area cannot be biased by differences in the quality of the aerial photography, the equipment and techniques used, and the individual photo interpreters and their skills. This design maintained the same level of intensity as the previous inventory in the strata where we found most of the forest land in the 1980 inventory (the forest and questionable strata), and in those strata where we anticipated most of the additional forest land would come from (the nonforest with trees and unproductive strata). The photo plots classified as nonforest without trees, census water, and noncensus water in the 1980 inventory were, by far, the largest portion of the 1980 photo sample. In addition, on a plot by plot basis, these strata

were anticipated to have a low probability of currently being forest. Cluster sampling provided an efficient sample of this large area with a low probability of change, by examining many locations at two points in time.

In the forest, questionable, unproductive, and nonforest with trees strata where double sampling was used, the ground plot sampling intensity was one plot per 2,876 acres. In the nonforest without trees, noncensus water, and census water strata where cluster sampling was used, a sample of 78 townships from the total of 2,147 townships in the region were sampled. The ground plot intensity in this region for the nonforest without tree stratum was 9,619 acres per plot.

Every ground plot in the 1994 inventory was classified for disturbance and other changes that may have taken place between 1980 and 1994. Disturbed plots are those plots that showed evidence of harvesting, insect or disease damage, land-use change, or other significant changes since the last inventory. A subset of the undisturbed forest ground plots was not remeasured. Instead, these plots were updated using the Stand and Tree Evaluation Modeling System (STEMS) (Belcher *et al.* 1982). The undisturbed forest plots that were remeasured were used to adjust the STEMS model for discrepancies between updated and actual remeasurements using methods presented in Hansen (1990) that have been used in previous NCFIA inventories in Michigan, Minnesota, Iowa, Missouri, and Wisconsin. The undisturbed forest plots that were not remeasured are referred to as pseudo-remeasurement plots because they contain all the data normally collected on a remeasurement plot (new plot and tree level data) but without the expense of a field visit. This methodology has been very efficient in other States inventoried by NCFIA. Not remeasuring these undisturbed forest plots made available the resources needed to establish additional ground plots for the second inventory based on the NRCS-NRI.

SAMPLE BASED ON THE NRCS-NRI

Just before this inventory, the Natural Resources Conservation Service (NRCS) conducted its National Resources Inventory (NRI) in the Plains States (USDA, Soil Conservation Service 1991) using a two-stage sampling design. This sample design consisted of 160-acre and 640-acre primary sampling units (PSU) with three 2-acre secondary sampling units (SSU) located within the PSU's. The NRCS-NRI inventory sampled all lands except those owned by the Federal government. Estimates of the 1994 forest resources on Federal lands (primarily Forest Service, Corps of Engineers, and Bureau of Indian Affairs lands) come entirely from the NCFIA inventory described in the previous section. The data collected in the NRI formed the basis for stratification of the second independent inventory.

This second portion of the overall inventory of North Dakota's forest resources used the NRCS-NRI area estimates and point data as its basis for stratification and ground plot location in a double sampling scheme similar to the first portion of the inventory (the NCFIA remeasurement of the 1980 field ground plots). The number of 2-acre SSU plots sampled by NRCS in the North Dakota NRI was:

Forest (20 percent tree cover or greater)	2,721
Nonforest (less than 20 percent tree cover)	234,858
Total	237,579

NCFIA photo classified and installed standard NCFIA field ground plots on a subset of the NRI - SSU plot locations. The selection criteria used selected a random sample of 5 percent of all PSU's and established plots at all three SSU points within this 5-percent sample. In addition any SSU having 20 percent or greater tree cover was also included in the NCFIA sample. This subsampling of the NRI (5 percent of the less than 20 percent tree cover and 100 percent of the 20 percent or more tree cover) formed the basis of the estimation of means within strata. The average sampling intensity was one ground plot per 6,071 acres in the forest stratum and one ground plot per 61,647 acres in the nonforest stratum.

COMBINED ESTIMATE BASED ON THE TWO INDEPENDENT INVENTORIES

These two inventories produced two independent estimates of the forest resources in North Dakota. Final estimates presented in this report are based on weighted averages from these two independent estimates. Weighting

was proportional to the number of ground plots on forest land for the estimates of most items including area, number of trees, volume, growth, mortality, and biomass. Weighting based on the number of remeasurement plots on forest land was used for estimates of items that can only be obtained from remeasurement plots, including removals and area change over time.

Field Measurements: 1980 Inventory Plot Design

On plots classified as timberland, wooded pasture, or windbreak (at least 120 feet wide), a ground plot was established, remeasured, or the growth and mortality of its trees were predicted using the STEMS models. Old plots selected for remeasurement that could not be relocated were replaced with new plots at the approximate locations of the old plots. Each ground plot consisted of a cluster of 10 subplots collectively covering approximately 1 acre. Trees 5.0 inches or greater in d.b.h. were sampled using 37.5 basal area factor (BAF) variable-radius plots, and trees less than 5.0 inches d.b.h. were sampled on 6.8-foot radius (1/300th acre) microplots established at the centers of subplots 1, 2, and 3. Under the estimation procedures used for this inventory, an entire plot was represented by a single condition class where condition was determined by forest type, stand-size class, land use, stand origin, and density. Thus, the arrangement of the 10 subplots within the plot was adjusted if any subplots were located in condition classes different from that of subplot 1. In particular, if a subplot was located outside the condition class for the plot, it was re-established or rotated into the condition class used for the entire plot. For example, if subplots 1 through 9 were located in forest land, and subplot 10 was located in a pasture, then subplot 10 was rotated back into the forest land condition class.

Field Measurements: 1994 Inventory Plot Design

Field ground plots were established, remeasured, or the growth and mortality of their trees were predicted using the STEMS models for all forest lands (including reserved forest land, unproductive forest land, and timberland), wooded pasture, or windbreaks (at least 120 feet wide). Establishing ground plots on all forest lands represented a major change between the 1980 and 1994 inventories.

In 1994, the overall plot layout consisted of 10 subplots arranged in a cluster with 70 feet between subplots. The basic locations of plots and subplots were the same as in the 1980 plot layout. All trees less than 5 inches in d.b.h. were measured on 6.8-foot radius (1/300th acre) microplots established at the centers of all 10 subplots. (In 1980, these microplots were measured only on subplots 1, 2, and 3). This radius was the maximum distance at which a 5.0-inch-d.b.h. tree would be selected using a basal area factor (BAF) of 37.5. Trees with diameters between 5.0 and 17.0 inches were selected for measurement at each of the 10 subplots with a BAF of 37.5. All trees greater than 17.0 inches d.b.h. located within a 24-foot radius macroplot centered at each of the 10 subplots were selected for measurement.

In 1994, subplots of the same plot were not rotated, even if they were located in multiple condition classes or straddled condition classes. As in 1980, factors determining condition class were forest type, stand-size class, land use, stand origin, and density. Plots with multiple condition classes were mapped in the field to record how the boundaries between classes split the plot. This procedure identified the area of the plot located in each class and assigned each tree to a specific class. When multiple condition classes occurred on a plot, all information normally collected for the plot as a whole, such as forest type, site index, stand age, and stand-size class, was collected for each condition class.

On remeasured plots, the rotated subplots and all trees measured from the 1980 plot design were also remeasured in 1994 to obtain change data such as growth and mortality. On new plots, subplots were not rotated.

New Inventory Plots

New ground plots were selected from the plots identified in NCFIA's evaluation of the NRCS-NRI inventory. These new ground plots were established, and measures of current classification, such as land use, forest type, ownership, and size and condition of all trees on the plot, were recorded. These locations were monumented for future remeasurement.

Old Inventory Plots

Old inventory plots are those plots established, monumented, and measured as part of the 1980 field inventory. The procedures for these old plots were different from those for new plots. Old plots were classified as "disturbed" on the basis of aerial photo analyses if either: (1) a reduction in vegetation on the plot occurred between inventories that resulted in a detectable change in the structure or function of the plant community; or (2) conditions on the plot were such that the STEMS models were unable to accurately predict growth or mortality. Plots not predicted to be disturbed were classified as "undisturbed." All disturbed plots and a one-third sample of the undisturbed plots were remeasured in the field to obtain estimates of current conditions and changes since the last inventory. All remaining live trees measured on these plots in 1980 were remeasured, and all new trees were identified and measured.

About two-thirds of the sample plots that were in timberland at the time of the 1980 inventory and predicted to be undisturbed until the 1994 inventory were not remeasured. Growth and mortality for these plots were predicted using the STEMS models as a means of obtaining growth and current volume. A comparison of the predicted growth and mortality for these undisturbed plots and observations for growth and mortality for the one-third sample of remeasured undisturbed plots was used to adjust the model predictions to accommodate local conditions. The adjustment procedure is a modified version of the method described by Smith (1983).

The undisturbed timberland plots whose growth and mortality were predicted were treated in the estimation process as measured ground plots, even though they were not visited by field crews. The plot records for these plots were sent to the field for verification of current ownership information. All old plots classified as disturbed were selected for remeasurement to assess and verify changes since the last inventory. Table F summarizes the distribution of all ground plots for the 1994 North Dakota inventory by type and plot.

COMPUTATION OF ESTIMATES: AREA

All area estimates were made using two-phase estimation methods. In this type of estimation, a preliminary estimate of area by land use is obtained from stratification (phase 1) and corrected by plot measurements (phase 2). A complete description of these methods is presented by Loetsch and Haller (1964).

COMPUTATION OF ESTIMATES: VOLUME

Estimates of volume per acre were made from the measurements and predictions for trees on each of the 10 subplots per plot. For each condition class on a plot, the volume per acre estimate was multiplied by the area estimate represented by the condition, and these products were summed over all plots to obtain estimates of total volume for the condition class. Net cubic and board foot volumes are based on tree measurements (d.b.h., tree class, and site index) and volume equations presented by Hahn and Hansen (1984).

Table F.—*Distribution of ground plots by ground land-use class and type of plot, 1994 inventory of North Dakota's forest resources*

Sample base [1]	1980 NCFIA remeasurement		NRCS-NRI	Total
	Remeasured	Updated	New	plots
Timberland	125	48	85	258
Other forest land	44	0	12	56
Nonforest with trees	333	13	80	426
Nonforest without trees	8,994	10	734	9,738
Water	121	0	10	131
Total	9,617	71	921	10,609

[1]*Plots that straddle more than one land use are included in this table in the first land-use class that occurs on this list. For example, a plot that straddled other forest land and water would be included in this table as other forest land.*

COMPUTATION OF ESTIMATES: GROWTH AND MORTALITY

On remeasured plots, estimates of growth and mortality per acre were derived from remeasurements and observations of trees that died between inventories. These estimates were based on the remeasurement of the 1980 inventory plots using the 1980 plot design. Growth, reported as average annual net growth between the 1980 and 1994 inventories, was computed from data for both plots that had been remeasured and plots whose growth and mortality had been predicted using methods presented by Van Deusen *et al.* (1986). Average annual mortality was also calculated for the remeasurement period.

On new plots, estimates of growth and mortality were obtained by using the STEMS models to predict growth and mortality for 1 year. Current diameter and living tree estimates for old undisturbed plots were predicted using growth and mortality predictions and were derived in the same manner as for remeasured plots. Predictions of growth and mortality using the STEMS models were adjusted for the State to accommodate local conditions using data from the undisturbed remeasured plots. As with volume, total growth and mortality estimates were obtained by multiplying the plot-level per acre estimates by area expansion factors and then summing over plots. Current annual net growth for 1993 was computed using adjusted, 1-year STEMS predictions of growth for all inventory plots.

COMPUTATION OF ESTIMATES: AVERAGE ANNUAL REMOVALS

Average annual growing-stock and sawtimber removals (1980-1993) were estimated only from the remeasured plots. These estimates were based on the remeasurement of the 1980 inventory plots using the 1980 plot design. Measurements for new plots and predictions from the STEMS models were not used to estimate removals. These estimates were obtained from trees measured in the last inventory and either cut or otherwise removed from the timberland base. Because remeasurement plots constitute about one-half the total ground plots, and not all remeasured plots had cutting, average annual removals estimates have greater sampling errors than volume and growth estimates.

TREE AND LOG GRADES

The Forest Service reports all board foot volume in International 1/4-inch rule. In North Dakota, the Scribner log rule is commonly used. Scribner log rule conversion factors were derived from full tree measurements and an equation developed by Wiant and Castenaeda (1977). The factors (multipliers) used to convert board foot International volumes to the Scribner rule are shown in the following tabulation:

D.b.h. (inches)	Scribner rule conversion factor	
	Softwoods	Hardwoods
9.0-10.9	0.7830	—
11.0-12.9	0.8287	0.8317
13.0-14.9	0.8577	0.8611
15.0-16.9	0.8784	0.8827
17.0-18.9	0.8945	0.8999
19.0-20.9	0.9079	0.9132
21.0-22.9	0.9168	0.9239
23.0-24.9	0.9240	0.9325
25.0-26.9	0.9299	0.9396
27.0-28.9	0.9321	0.9454
29.0+	0.9357	0.9544

Log grades and tree grades were based on the classification of external characteristics as indicators of quality. Log grades or tree grades were taken on approximately one-third of the sample plots in North Dakota. All sawtimber softwood sample trees were graded for quality and assigned a butt log grade. All sawtimber hardwood sample trees were graded for quality and assigned a tree grade. The volume yield by log grade or tree grade for this sample was used to distribute the volume of the ungraded sample trees by species group.

Hardwood sawtimber trees were graded according to "Hardwood tree grades for factory lumber" (Hanks 1976). The best 12-foot section of the lowest 16-foot hardwood log was used for grading. Hardwood sawtimber trees that did not meet minimum tree grade specifications for grades 1 through 3 were assigned grade 4 according to Forest Service standard specifications for hardwood construction logs described in "A guide to hardwood log grading" (Rast *et al.* 1973).

Ponderosa pine and other softwood sawtimber trees were graded according to Forest Service specifications. For all softwoods, the first merchantable 16-foot log or shorter lengths down to 12 feet were used for grading.

Hardwood Tree Grade for Factory Lumber [a]

Grade factor	Tree grade 1	Tree grade 2	Tree grade 3
Length of grading zone (feet)	Butt 16	Butt 16	Butt 16
Length of grading section [b] (feet)	Best 12	Best 12	Best 12
D.b.h., minimum (inches)	16 [c]	13	11
D.i.b., minimum at top of grading section (inches)	13 [c] 16 20	11 [d] 12	8
Clear cuttings (on the 3 best faces) [e]			
Length, minimum (feet)	7 5 3	3 3	2
Number on face (maximum)	2	2 3	Unlimited
Yield in face length (minimum)	5/6	4/6	3/6
Cull deduction (including crook and sweep, but excluding shake) maximum within grading section (percent)	9	f	50

[a] Hanks (1976)

[b] Whenever a 14- or 16-foot section of the butt 16-foot log is better than the best 12-foot section, the grade of the longer section will become the grade of the tree. This longer section, when used, is the basis for determining the grading factors such as diameter and cull deduction.

[c] In basswood and ash, d.i.b. at top of grading section must be 12 inches and d.b.h. must be 15 inches.

[d] Grade 2 trees can be 10 inches d.i.b. at top of grading section if they otherwise meet surface requirements for small grade 1's.

[e] A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth of the surface of the grading section as divided lengthwise.

[f] Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2 trees, if size and surface of grading section qualify as grade 1. If rot shortens the required clear cuttings to the extent of dropping the butt log to grade 2, do not drop the tree's grade to 3 unless the cull deduction for rot is greater than 40 percent.

Forest Service Standard Specifications for Hardwood Construction Logs

(tie and timber logs) [a, b]

Position in tree	Butts and uppers
Minimum diameter, small end	8 inches
Minimum length without trim	8 feet
Clear cuttings	No requirements
Sweep allowance	One-fourth of the diameter at the small end for each 8 feet of length.
Sound surface defects:	
Single knots	Any number, if no one knot has an average diameter above the callus in excess of one-third of the log diameter at point of occurrence.
Whorled knots	Any number, if the sum of knot diameters above the callus does not exceed one-third of the log diameter at point of occurrence.
Holes	Any number, provided none has a diameter over one-third of the log diameter at point of occurrence and none extends more than 3 inches into included timber [c].
Unsound surface defects:	Same requirements as for sound defects if they extend into included timber.
No limit if they do not.	

[a] Rast et al. (1973).

[b] These specifications are minimum for the class. If, from a group of logs, factory logs are selected first, thus leaving only nonfactory logs from which to select construction logs, then the quality range of the construction logs so selected is limited, and the class may be considered a grade. If selection for construction logs is given first priority, it may be necessary to subdivide the class into grades.

[c] Included timber is always square, and dimension is judged from small end.

Log Grades for Ponderosa Pine and Other Softwoods

Grade 1

1. Trees must be 16 inches in diameter or larger, grading section 12 feet in length or longer, and with deduction for defect not over 30 percent of gross scale.

2. Trees must be at least 75 percent clear on each of three faces.

3. All knots outside clear cutting must be sound and not more than 2-1/2 inches in size.

Grade 2

1. Trees must be 12 inches in diameter or larger, grading section 12 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross scale deducted for defect.

2. Trees must be at least 50 percent clear on each of three faces or 75 percent clear on two faces.

Grade 3

1. Trees must be 6 inches in diameter or larger, grading section 12 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross contents of the log.

Note: Diameters are diameter inside bark (d.i.b.) at small end of grading section. Percent clear refers to percent clear in one continuous section.

METRIC EQUIVALENTS

1 acre = 4,046.86 square meters or 0.405 hectare.
1,000 acres = 405 hectares.
1 cubic foot = 0.0283 cubic meter.
1 foot = 30.48 centimeters or 0.3048 meter.
1 inch = 25.4 millimeters, 2.54 centimeters, or 0.0254 meter.
1 pound = 0.454 kilograms.
1 ton = 0.907 metric tons.

TREE SPECIES GROUPS IN NORTH DAKOTA

(Little 1981)

Note: Many additional tree species have been planted around homesteads and farm headquarters in rural North Dakota, in urban settings, and in tree plantings. However, only those species encountered during the third inventory of the forest resources of North Dakota are listed here. For a complete list of all of the tree species in North Dakota, please contact the North Dakota Forest Service or your local Extension Service office.

Hardwoods

Silver maple[1] ..... *Acer saccharinum*
Paper birch[1] ..... *Betula papyrifera*
River birch[1] ..... *B. nigra*
Hackberry[1] ..... *Celtis occidentalis*
Ashes
  Black ash[1] ..... *Fraxinus nigra*
  Green ash[2] ..... *F. pennsylvanica*
Cottonwoods[1]
  Eastern cottonwood ..... *Populus deltoides*
  Plains cottonwood ..... *P. sargentii*
Balsam poplar[1] ..... *P. balsamifera*
Quaking aspen[1] ..... *P. tremuloides*
Black cherry[1] ..... *Prunus serotina*
Select white oaks[2]
  Bur oak ..... *Quercus macrocarpa*
Black willow[1] ..... *Salix nigra*
American basswood[1] ..... *Tilia americana*
Elms
  American elm[1] ..... *Ulmus americana*
  Siberian elm[1] ..... *U. pumila*
  Slippery elm[1] ..... *U. rubra*
Other hardwoods
  Boxelder[1] ..... *Acer negundo*
  White poplar[1] ..... *Populus alba*

Softwoods[1]

Rocky Mountain juniper ..... *Juniperus scopulorum*
Eastern redcedar ..... *J. virginiana*
Ponderosa pine ..... *Pinus ponderosa*
White spruce ..... *Picea glauca*
Other softwoods
  Blue spruce ..... *P. pungens*

Noncommercial species

Eastern hophornbeam ..... *Ostrya virginiana*
Hawthorn ..... *Crataegus* spp.
Wild plum ..... *Prunus* spp.
Chokecherry ..... *P. virginiana*
Pin cherry ..... *P. pennslyvanica*
Canada plum ..... *P. nigra*
Diamond willow ..... *Salix bebbianna*
White willow ..... *S. alba*
Peachleaf willow ..... *S. amygdaloides*

[1] *This species or species group is considered a softwood or a soft hardwood, with an average specific gravity of less than 0.50.*
[2] *This species or species group is considered a hard hardwood, with an average specific gravity greater than or equal to 0.50.*

DEFINITION OF TERMS

Average annual mortality of growing stock.—The average cubic foot volume of sound wood in growing-stock trees that died in 1 year. Average annual mortality is the average for the years between inventories (1980 through 1993 in this report).

Average annual mortality of sawtimber.—The average board foot volume of sound wood in sawtimber trees that died in 1 year. Average annual mortality is the average for the years between inventories (1980 through 1993 in this report).

Average annual net growth of growing stock.—The annual change in cubic foot volume of sound wood in live sawtimber and poletimber trees, and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes. Average annual net growing stock is the average for the years between inventories (1980 through 1993 in this report).

Average annual net growth of sawtimber.—The annual change in the board foot volume of live sawtimber trees, and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes. Average annual net growth of sawtimber is the average for the years between inventories (1980 through 1993 in this report).

Average annual removals from growing stock.—The average net growing-stock volume in growing-stock trees removed

annually for roundwood forest products, in addition to the volume of logging residues and the volume of other removals. Average annual removals of growing stock are the average for the years between inventories (1980 through 1993 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Average annual removals from sawtimber.—The average net board foot sawtimber volume of live sawtimber trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Average annual removals of sawtimber are the average for the years between inventories (1980 through 1993 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Basal area.—Tree area in square feet of the cross section at breast height (4.5 feet) of a single tree. When the basal areas of all trees in a stand are summed, the result is usually expressed as square feet of basal area per acre.

Biomass.—The aboveground volume of all live trees (including bark but excluding foliage) reported in green tons (i.e., green weight). Biomass has four components:

Bole.—Biomass of a tree from 1 foot above the ground to a 4-inch top outside bark.

Tops and limbs.—Total biomass of a tree from a 1-foot stump minus the bole.

1- to 5-inch trees.—Total aboveground biomass of a tree from 1 to 5 inches in diameter at breast height.

Stump.— Biomass of a tree 5 inches d.b.h. and larger from the ground to a height of 1 foot.

Bolts.—Roundwood logs of less than 8 feet in length that are converted into shingles, cooperage stock, dimension stock, blocks, blanks, excelsior, etc. No minimum diameter limits. Does not include logs used for the manufacture of pulp or veneer.

Commercial species.—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality.)

Cord.—One standard cord is 128 cubic feet of stacked wood, including bark and air space. Cubic feet can be converted to solid wood standard cords by dividing by 79.

Corporate.—Lands owned by a private corporation not in the business of operating primary wood-using plants.

County and municipal land.—Land owned by counties and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Cropland.—Land under cultivation within the last 24 months; including cropland harvested, crop failures, cultivated summer fallow, idle cropland used only for pasture, orchards, active Christmas tree plantations indicated by annual shearing, nurseries, and land in soil improvement crops, but excluding land cultivated in developing improved pasture.

Cull.—Portions of a tree that are unusable for industrial wood products because of rot, missing or dead material, form, or other defect.

Current annual net growth of growing stock.—The annual change in volume of sound wood in live sawtimber and poletimber trees, and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes, reported for a single year (1993 in this report). Current growth is based on an estimate of the current annual increment of each growing-stock tree in the inventory.

Current annual net growth of sawtimber.—The annual change in the volume of live sawtimber trees, and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes, reported for a single year (1993 in this report). Current growth is based on an estimate of the current annual increment of each growing-stock tree in the inventory.

Current annual removals from growing stock.—The current net growing-stock volume in growing-stock trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Current

annual removals of growing stock are reported for a single year (1993 in this report); they are based on a survey of primary wood processing mills to determine removals for products and on information from remeasurement plots (see Survey Procedures in Appendix) to determine removals due to land-use change.

Current annual removals from sawtimber.—The current net board foot sawtimber volume of live sawtimber trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Current annual removals of sawtimber are reported for a single year (1993 in this report); they are based on a survey of primary wood processing mills to determine removals for products and on information from remeasurement plots (see Survey Procedures in Appendix) to determine removals due to land-use change.

Diameter class.—A classification of trees based on diameter outside bark, measured at breast height 4.5 feet above the ground. (Note d.b.h. is the common abbreviation for diameter at breast height.) Two-inch diameter classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

Diameter at breast height (d.b.h.).—The outside bark diameter at 4.5 feet (1.37 m) above the forest floor on the uphill side of the tree. For determining breast height, the forest floor includes the duff layer that may be present, but does not include unincorporated woody debris that may rise above the ground line.

Forest industry land.—Land owned by companies or individuals operating primary wood-using plants.

Forest land.—Land at least 10 percent stocked (Note: historically, 16.7 percent was used based on full stocking equaling 167 percent. Consequentially, this equaled to a standard of 10 percent based on a 100 percent scale which is now used) by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparing specified standards with basal area and/or number of trees, age or size, and spacing.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas shall be classed as forest if less than 120 feet wide. (See Tree, Land, Timberland, Reserved forest land, Other forest land, Stocking, and Water.)

Forest type.—A classification of forest land based on the species forming a plurality of live tree stocking. The associated species for each forest type are based on net volume of growing stock and all live biomass by species group and forest type from the 1994 inventory of North Dakota forests. Major forest types in North Dakota are:

Ponderosa pine.—Forests in which ponderosa pine makes up a majority of the forest stocking in North Dakota.

Rocky Mountain juniper.—Forests in which Rocky Mountain juniper makes up a majority of forest stocking. A common associate of the Rocky mountain juniper forest type in North Dakota is the green ash.

Bur oak.—Forests in which bur oak makes up a majority of forest stocking. Species commonly associated with the bur oak forest type in North Dakota include basswood and green ash.

Cottonwood.—Forests in which cottonwood makes up a majority of the forest stocking in North Dakota. A common associate of the cottonwood forest type in North Dakota is green ash.

Elm-ash-cottonwood.—Lowland forests in which cottonwood, green ash, and elm make up a plurality of the forest stocking. A common associate of the elm-ash-cottonwood forest type in North Dakota is bur oak.

Basswood.—Forests in which hardwoods make up a plurality of the forest stocking. Species commonly associated with the basswood forest type in North Dakota include bur oak and green ash.

Aspen-birch.—Forests in which quaking aspen, paper birch and river birch, singly or in combination, make up a plurality of forest stocking. Species commonly associated with the aspen-birch forest type in North Dakota include balsam poplar, bur oak, and green ash.

Elm-ash.—Upland forests in which elm and green ash make up a plurality of the forest stocking. Species commonly associated with the elm-ash forest type in North Dakota include cottonwood and bur oak.

Growing-stock tree.—A live tree of commercial species that meets specified standards of size, quality, and merchantability. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.—Net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a minimum 4.0-inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs.

Hard hardwoods.—Hardwood species with an average specific gravity greater than 0.50 such as oaks, hard maple, hickories, and ash.

Hardwoods.—Dicotyledonous trees, usually broad-leaved and deciduous. (See Soft hardwoods and Hard hardwoods.)

Improved pasture.—Land currently improved for grazing by cultivating, seeding, irrigating, or clearing trees or brush and less than 10 percent stocked with trees.

Indian land.—Land held in trust by the United States for tribes or individual Indians.

Industrial wood.—All roundwood products except residential fuelwood.

Land.—*(a) Bureau of the Census*.—Dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains, streams, sloughs, estuaries, and canals less than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

(b) Forest Inventory and Analysis.—The same as the Bureau of the Census, except minimum width of streams, etc., is 120 feet and minimum size of lakes, etc., is 1 acre.

Live trees.—Growing-stock, rough, and rotten trees 1.0 inch d.b.h. and larger.

Log grade.—A log classification based on external characteristics as indicators of quality or value. Log grade was assigned to a sample of softwood sawtimber trees throughout the State during the 1994 inventory. Also see Tree grade. (See Appendix for specific grading factors used.)

Logging residue.—The unused portions of the merchantable central stem of growing-stock trees cut or killed by logging.

Marsh.—Nonforest land that characteristically supports low, generally herbaceous or shrubby vegetation, and that is intermittently covered with water.

Merchantable.—Refers to a pulpwood or saw-log section that meets pulpwood or saw-log specifications, respectively.

Miscellaneous Federal land.—Federal land other than national forest and land administered by the Bureau of Land Management, Corps of Engineers, or Bureau of Indian Affairs.

National Forest land.—Federal land that has been legally designated as national forest or purchase units, and other land administered by the USDA Forest Service. The administrative unit in North Dakota is named "Dakota Prairie Grasslands."

Net volume.—Gross volume less deductions for rot, sweep, or other defect affecting use for timber products.

Noncommercial species.—Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, active Christmas tree plantations as indicated by annual shearing, orchards, nurseries, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land.) If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area to qualify as nonforest land.

Nonforest land without trees.—Nonforest land with no live trees present.

Nonforest land with trees.—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Nonstocked land.—Timberland less than 10 percent stocked with all live trees.

Other forest land.—Forest land not capable of producing 20 cubic feet per acre per year of industrial wood crops under natural conditions and not associated with urban or rural development. Many of these sites contain tree species that are not currently used for industrial wood production or trees of poor form, small size, or inferior quality that are unfit for most industrial products. Unproductivity may be the result of adverse site conditions such as sterile soil, dry climate, poor drainage, high elevation, and rockiness. This land is not withdrawn from timber use.

Other removals.—Growing-stock trees removed but not used for products, or trees left standing but "removed" from the timberland classification by land-use change. Examples are removals from cultural operations such as timber stand improvement work and land clearing, and the standing volume on land classified originally as timberland but later designated as reserved from timber harvesting (such as a newly established State park).

Pasture.—Land presently used for grazing or under cultivation to develop grazing.

Plant byproducts.—Plant residues used for products such as mulch, pulp chips, and fuelwood.

Plantation.—An artificially reforested area sufficiently productive to qualify as timberland. The planted species is not necessarily predominant. Christmas tree plantations, which are considered cropland, are not included.

Plant residues.—Wood and bark materials generated at manufacturing plants during production of other products.

Poletimber stand.—(See Stand-size class.)

Poletimber tree.—A live tree of commercial species at least 5.0 inches d.b.h., but smaller than sawtimber size.

Potential productivity class.—A classification of forest land in terms of inherent capacity to grow crops of industrial wood. The class identifies the potential growth in merchantable cubic feet/acre/year at culmination of mean annual increment of fully stocked natural stands.

Private individual land.—Privately owned land not owned by forest industry. This class includes the formerly used Farmer and Miscellaneous private classes.

Reserved forest land.—Forest land withdrawn from timber use through statute, administrative regulation, or designation. Note: historically, Christmas tree plantations were classified as reserved forest land, but now they are classified as cropland.

Rotten tree.—Live trees of commercial species that do not contain at least one 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of rot; that is, when more than 50 percent of the cull volume in a tree is rotten.

Rough tree.—(a) Live trees of commercial species that do not contain at least one merchantable 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of roughness or poor form, and (b) all live trees of noncommercial species.

Roundwood products.—Logs, bolts, or other round sections (including chips from roundwood) cut from trees for industrial or consumer uses. (Note: Includes saw logs, veneer logs, and bolts; cooperage logs and bolts; pulpwood; fuelwood; pilings; poles; posts; hewn ties; mine timbers; and various other round, split, or hewn products.)

Salvable dead tree.—A standing or down dead tree considered merchantable by regional standards.

Sapling.—A live tree 1.0 to 5.0 inches d.b.h.

Sapling-seedling stand.—(See Stand-size class.)

Saw log.—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight, and with a minimum diameter outside bark (d.o.b.) for softwoods of 7.0 inches (9.0 inches for hardwoods) or other combinations of size and defect specified by regional standards.

Saw-log portion.—That part of the bole of sawtimber trees between the stump and the saw-log top.

Saw-log top.—The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw-log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber stand.—(See Stand-size class.)

Sawtimber tree.—A live tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d.b.h. Hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume.—Net volume of the saw-log portion of live sawtimber in board feet, International 1/4-inch rule (unless specified otherwise), from stump to a minimum 7.0 inches top d.o.b. for softwoods and a minimum 9.0 inches top d.o.b. for hardwoods.

Seedling.—A live tree less than 1.0 inch d.b.h. that is expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Short-log (rough tree).—A sawtimber-size tree of commercial species that contains at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

Shrub.—A woody, perennial plant differing from a perennial herb in its persistent and woody stem(s) and less definitely from a tree in its lower stature and/or the general absence of a well-defined main stem. For this report, shrubs were separated somewhat arbitrarily into tall and low shrubs as follows:

Tall shrubs.—Normally taller than 1.6 to 3.2 feet.

Low shrubs.—Normally shorter than 1.6 to 3.2 feet. (Woody perennial vines, such as grape, were included with low shrubs.)

Shrub and tree seedling biomass.—The total aboveground weight of trees less than 1.0 inch in diameter and all shrubs.

Site index.—An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Soft hardwoods.—Hardwood species with an average specific gravity less than 0.50, such as cottonwood, red maple, basswood, and willow.

Softwoods.—Coniferous trees, usually evergreen, having needles or scale-like leaves.

Stand.—A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-age class.—A classification based on age of the main stand. Main stand refers to trees of the dominant forest type and stand-size class.

Stand-size class.—A classification of stocked (see Stocking) forest land based on the size class of live trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

Sawtimber stands.—Stands with half or more of live tree stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Poletimber stands.—Stands with half or more of live tree stocking in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

Sapling-seedling stands.—Stands with more than half of the live tree stocking in saplings and/or seedlings.

State land.—Land owned by the State of North Dakota or leased to it for 50 years or more.

Stocking.—The degree of occupancy of land by all live trees, measured by basal area and/or the number of trees in a stand by size or age and spacing, compared to the basal area and/or number of trees required to fully use the growth potential of the land; that is, the stocking standard. A stocking

percent of 100 indicates full use of the site and is equivalent to 80 square feet of basal area per acre in trees 5.0 inches d.b.h. and larger. In a stand of trees less than 5 inches d.b.h., a stocking percent of 100 would indicate that the present number of trees is sufficient to produce 80 square feet of basal area per acre when the trees reach 5 inches d.b.h.

Stands are grouped into the following stocking classes:

Overstocked stands.—Stands in which stocking of live trees is 100 percent or more.

Fully stocked stands.—Stands in which stocking of live trees is from 60 to 100 percent.

Medium stocked stands.—Stands in which stocking of live trees is from 35 to 60 percent.

Poorly stocked stands.—Stands in which stocking of live trees is from 10 to 35 percent.

Nonstocked areas.—Timberland on which stocking of live trees is less than 10 percent.

Timber products output.—All timber products cut from roundwood and byproducts of wood manufacturing plants. Roundwood products include logs, bolts, or other round sections cut from growing-stock trees, cull trees, salvable dead trees, trees on nonforest land, noncommercial species, sapling-size trees, and limbwood. Byproducts from primary manufacturing plants include slabs, edging, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and screenings of pulpmills that are used as pulpwood chips or other products.

Timberland.—Forest land that is producing, or is capable of producing, more than 20 cubic feet per acre per year of industrial wood crops under natural conditions, that is not withdrawn from timber use, and that is not associated with urban or rural development. Currently inaccessible and inoperable areas are included. (Timberland was formerly called commercial forest land.)

Tree.—A woody plant usually having one or more erect perennial stems, a stem diameter at breast height of at least 3 inches, a more or less definitely formed crown of foliage, and a height of at least 13 feet at maturity.

Tree biomass.—The total aboveground weight (including the bark but excluding the foliage) of all trees from 1 to 5 inches in d.b.h., and the total aboveground weight (including the bark but excluding the foliage) from a 1-foot stump for trees more than 5 inches in diameter.

Tree grade.—A classification of the lower 16 feet of the bole of standing trees based on external characteristics as indicators of the quality and quantity of lumber that could be produced from the tree. Tree grade was assigned to a sample of hardwood sawtimber trees during the 1994 inventory. Also see Log grade. (See Appendix for specific grading factors used.)

Tree size class.—A classification of trees based on diameter at breast height, including sawtimber trees, poletimber trees, saplings, and seedlings.

Upper stem portion.—That part of the bole of sawtimber trees above the saw-log top to a minimum top diameter of 4.0 inches d.o.b. or to the point where the central stem breaks into limbs.

Urban and other areas.—Areas within the legal boundaries of cities and towns; suburban areas developed for residential, industrial, or recreational purposes; school yards; cemeteries; roads; railroads; airports; beaches; powerlines and other rights-of-way; or other nonforest land not included in any other specified land-use class.

Urban forest land.—Land that would otherwise meet the criteria for timberland, but that is in an urban-suburban area surrounded by commercial, industrial, or residential development and not likely to be managed for the production of industrial wood products on a continuing basis. Wood removed would be for land clearing, fuelwood, or esthetic purposes. Such forest land may be associated with industrial, commercial, residential subdivision, industrial parks, golf course perimeters, airport buffer strips, and public urban parks that qualify as forest land.

Water.—*(a) Bureau of the Census*.—Permanent inland water surfaces, such as lakes, reservoirs, and ponds at least 40 acres in area;

and streams, sloughs, estuaries, and canals at least one-eighth of a statute mile wide.

(b) Noncensus.—Permanent inland water surfaces, such as lakes, reservoirs, and ponds from 1 to 39.9 acres in area; and streams, sloughs, estuaries, and canals from 120 feet to one-eighth of a statute mile wide.

Wooded pasture.—Improved pasture with more than 10 percent stocking in live trees, but less than 25 percent stocking in growing-stock trees. Area is currently improved for grazing or there is other evidence of grazing.

Wooded strip.—An acre or more of natural continuous forest land that would otherwise meet survey standards for timberland except that it is less than 120 feet wide.

LITERATURE CITED

Belcher, D.W.; Holdaway, M.R.; Brand, G.J. 1982. **A description of STEMS the stand and tree evaluation and modeling system.** Gen. Tech. Rep. NC-79. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 18 p.

Cochran, W.G. 1977. **Sampling techniques**. New York, NY: John Wiley and Sons, Inc. 413 p.

Gaiser, R.N. 1952. **Root channels and roots in forest soil**. Soil Science Proceedings. 16: 62-65.

Grigal, D.F.; Bates, P.C. 1992. **Forest soils: a technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota.** Raleigh, NC: Jaakko Poyry Consulting, Inc. Prepared for: Minnesota Environmental Quality Board.

Hahn, J.T.; Hansen, M.H. 1984. **Cubic and board foot volume models for the Central States**. Northern Journal of Applied Forestry. 8(2): 47-57.

Hanks, L.F. 1976. **Hardwood tree grades for factory lumber**. Res. Pap. NE-333. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 81 p.

Hansen, M.H. 1990. **A comprehensive sampling system for forest inventory based on an individual tree growth model**. St. Paul, MN: University of Minnesota, College of Natural Resources. 256 p. Ph.D. dissertation.

Hansen, M.H. 1999. **Design and methodology of the 90's forest resources inventory of the Northern Plains States (Kansas, Nebraska, South Dakota, and North Dakota)**. Res. Pap. NC-xx. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. (In prep.)

Jakes P.J.; Smith, W.B. 1982. **A second look at North Dakota's timberland, 1980**. Resour. Bull. NC-58. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 86 p.

Leatherberry, E.C.; Schmidt, T.L.; Strickler, J.K.; Aslin, R.G. 1999. **An analysis of the forest resources of Kansas, 1994.** Res. Pap. NC-334. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 114 p.

Little, E.L. 1981. **Check list of native and naturalized trees of the United States**. Agric. Handb. 541. Washington, DC: U.S. Department of Agriculture, Forest Service. 385 p.

Loetsch, F.; Haller, K.E. 1964. **Forest inventory, volume 1, statistics of forest inventory and information from aerial photographs**. BLV Verlagsgesellschaft Munch Basle, Vienna. 436 p.

May, D.M. 1996. **Residential fuelwood consumption and production in North Dakota, 1994**. Resour. Bull. NC-167. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 24 p.

May, D.M.; Harsel, R. 1995. **North Dakota timber industry—an assessment of timber product output and use, 1993**. Resour. Bull. NC-161. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 14 p.

National Arbor Day Foundation. 1991. **Conservation trees for your farm, family and future**. Nebraska City, NE: The National Arbor Day Foundation. 31 p.

North Dakota Department of Health. 1996. **North Dakota's water...keeping it clean**. Bismarck, ND: North Dakota Department of Health. 16 p.

North Dakota Forest Service. 1998. **Riparian forests: should you care?** Bottineau, ND: North Dakota Forest Service. The Prairie Forester. 12(2): 1.

North Dakota Forest Service. 1994. **North Dakota State Forest Service program brochure**. Bottineau, ND: North Dakota Forest Service.

North Dakota Forest Service. 1991. **Forest resource plan**. Bottineau, ND: North Dakota Forest Service. 47 p.

North Dakota Outdoors. 1997. **Annual report of the North Dakota Game and Fish Department**. Bismarck, ND: State Game and Fish Department. January 1997: 25 p.

Rast, E.D.; Sonderman, D.L.; Gammon, G.L. 1973. **A guide to hardwood log grading**. Gen. Tech. Rep. NE-1. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 31 p.

Schmidt, T.L.; Wardle, T.D. 1998. **The forest resources of Nebraska**. Res. Pap. NC-332. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 114 p.

Smith, W.B. 1983. **Adjusting the STEMS regional growth models to improve local predictions**. Res. Note NC-297. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.

Spurr, S.H.; Vaux, H.J. 1976. **Timber: biological and economic potential**. Science. 191(4228): 751-756.

State of North Dakota. 1997. **North Dakota adventure guide.** Bismarck, ND: North Dakota Parks and Recreation Department; North Dakota Tourism Department. 28 p.

Trippensee, R.E. 1948. **Wildlife management**. Vol. 1, 1st ed. American Forestry Series. New York, NY: McGraw-Hill. 447 p.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1996. **Agroforestry for farms and ranches**. Agrofor. Tech. No. 1. U.S. Department of Agriculture, Natural Resources Conservation Service web site http://www.nhq.nrcs.usda.gov/BCS/forest/note1.html#field

U.S. Department of Agriculture, Soil Conservation Service. 1991. **Instructions for collecting 1992 national resources inventory sample data**. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service. 69 p.

U.S. Department of Commerce. 1981. **1977 Census of manufactures**. Part 2. General Summary, Nebraska-Wyoming. Vol. 3-Geographic area statistics. Washington, DC: U.S. Department of Commmerce, Bureau of the Census: 35-8.

U.S. Department of Commerce. 1995. **1992 Census of manufactures**. Geographic area series-North Dakota. MC92-A35. Washington, DC: U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census: ND-8.

Van Deusen, P.C.; Dell, T.R.; Thomas, C.E. 1986. **Volume growth estimation from permanent horizontal points**. Forest Science. 32: 415-422.

Wardle, T.D.; Schmidt, T.L. 1984. **The benefits of the woodland resources of Nebraska**. Lincoln, NE: University of Nebraska-Lincoln, Nebraska Forest Service, Sept. 1984. 60 p.

Warner, J.R.; Chase, C.D. 1956. **The timber resource of North Dakota.** Sta. Pap. No. 36. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Lake States Forest Experiment Station. 39 p.

Welsch, D.J. 1991. **Riparian forest buffers.** NA-PR-07-91. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry. 23 p.

Wiant, H.V., Jr.; Castenaeda, F. 1977. **Mesavage and Girard's volume tables formulated**. BLM4. Denver, CO: U.S. Department of the Interior, Bureau of Land Management, Denver Service Center: 1-4.

TABLE TITLES

Table 1. -- Area of land by county/county group and major land-use class, North Dakota, 1994

(In thousand acres)

County/county group	Total 1 land area	Forest land			Other 2 land
		Total forest	Timberland	Other forest land	
Red River 3					
Pembina Co.	627.9	32.3	31.1	1.2	595.6
Cavalier Co.	1,139.5	42.8	31.3	11.5	1,096.7
All other counties	11,188.6	107.3	100.4	6.9	11,081.3
Total	12,956.0	182.4	162.8	19.6	12,773.6
Devils Lake & James River 4	6,112.3	33.8	30.4	3.4	6,078.5
Total	6,112.3	33.8	30.4	3.4	6,078.5
Souris River 5					
Rolette Co.	661.8	71.6	71.6	--	590.2
All other counties	4,546.8	66.9	61.1	5.8	4,479.9
Total	5,208.6	138.5	132.7	5.8	5,070.1
Missouri River 6	19,879.5	318.5	115.6	202.9	19,561.0
Total	19,879.5	318.5	115.6	202.9	19,561.0
State total	44,156.4	673.2	441.5	231.7	43,483.2

1 From U. S. Bureau of the Census, 1990.

2 Includes 220.7 thousand acres of water according to FIA standards of area classification, but defined by the Bureau of the Census as land.

3 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

4 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

5 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

6 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 2. -- Area of timberland by county group and ownership class, North Dakota, 1994

(In thousand acres)

County group	All owners	Ownership class					
		National forest	Other federal	State	Indian	Individual	Corporate
Red River 1	162.8	--	0.4	9.7	2.3	147.1	3.3
Devils Lake & James River 2	30.4	--	--	--	7.3	23.1	--
Souris River 3	132.7	--	7.1	16.5	26.9	82.2	--
Missouri River 4	115.6	14.2	6.9	--	2.3	89.0	3.2
State total	441.5	14.2	14.4	26.2	38.8	341.4	6.5

1 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

2 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

3 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

4 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 3. -- Area of timberland by county group and forest type group/local type, North Dakota, 1994

(In thousand acres)

	Forest type group/local type											
		Ponderosa pine	Rocky Mountain juniper	Oak-hickory	Elm-ash-cottonwood				Maple-beech-birch	Aspen-birch	Elm-ash-locust	Non-stocked
County group	All types	Ponderosa pine	Rocky Mountain juniper	Bur oak	Total	Cottonwood	Elm-ash-cottonwood	Willow	Basswood	Aspen-birch	Elm-ash	Non-stocked
Red River 1	162.8	--	--	39.9	31.9	13.6	14.7	3.6	9.4	14.3	67.3	--
Devils Lake & James River 2	30.4	--	--	12.4	0.5	0.5	--	--	--	0.9	14.0	2.6
Souris River 3	132.7	--	--	8.9	0.2	--	0.2	--	--	99.5	24.1	--
Missouri River 4	115.6	1.7	4.3	8.0	38.2	37.6	0.6	--	--	3.1	60.3	--
State total	441.5	1.7	4.3	69.2	70.8	51.7	15.5	3.6	9.4	117.8	165.7	2.6

1 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.
2 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.
3 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.
4 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 4. -- Area of timberland by county group and stand-size class, North Dakota, 1994

(In thousand acres)

County group	All stands	Stand-size class			
		Sawtimber	Poletimber	Sapling-Seedling	Non-stocked
Red River 1	162.8	76.8	60.3	25.7	--
Devils Lake & James River 2	30.4	4.6	7.2	16.0	2.6
Souris River 3	132.7	40.2	57.8	34.7	--
Missouri River 4	115.6	20.6	47.6	47.4	--
State total	441.5	142.2	172.9	123.8	2.6

1 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

2 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

3 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

4 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 5. -- Area of timberland by county group and potential productivity class, North Dakota, 1994

(In thousand acres)

County group	All classes	Potential productivity class		
		85+	50-84	20-49
Red River 1	162.8	10.3	29.2	123.3
Devils Lake & James River 2	30.4	1.5	1.4	27.5
Souris River 3	132.7	4.0	57.6	71.1
Missouri River 4	115.6	3.0	9.7	102.9
State total	441.5	18.8	97.9	324.8

1 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

2 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

3 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette,. and Ward Counties.

4 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 6. -- Area of timberland by county group and stocking class of growing-stock trees 1, North Dakota, 1994

(In thousand acres)

County group	All classes	Stocking class of growing-stock trees				
		Non-stocked 2	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Red River 3	162.8	11.0	82.8	34.8	29.9	4.3
Devils Lake & James River 4	30.4	4.3	22.1	2.6	1.4	--
Souris River 5	132.7	1.5	36.6	47.4	45.4	1.8
Missouri River 6	115.6	6.7	67.0	35.0	4.0	2.9
State total	441.5	23.5	208.5	119.8	80.7	9.0

1 This table is based on the stocking percent of growing-stock trees, rather than that of "live" trees. For this table, to use the definition of stocking found in the Appendix, replace the term "live trees" with "growing-stock trees."

2 Area of nonstocked in this table and in Table 8 differs from that in other tables in this report because this table includes land stocked only with growing-stock trees, rather than with "live" trees.

3 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

4 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

5 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

6 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 7. -- Area of timberland by forest type group/local type and ownership class, North Dakota,1994

(In thousand acres)

Forest type group/ local type	All ownerships	Ownership class							
		Public				Private			
		Total public	National forest	Other federal	State	Total private	Indian	Individual	Corporate
Ponderosa pine									
Ponderosa pine	1.7	--	--	--	--	1.7	--	1.7	--
Total	1.7	--	--	--	--	1.7	--	1.7	--
Rocky Mountain juniper									
Rocky Mountain juniper	4.3	2.4	2.4	--	--	1.9	--	1.9	--
Total	4.3	2.4	2.4	--	--	1.9	--	1.9	--
Oak-hickory									
Bur oak	69.2	6.0	--	--	6.0	63.2	12.8	48.9	1.5
Total	69.2	6.0	--	--	6.0	63.2	12.8	48.9	1.5
Elm-ash-cottonwood									
Cottonwood	51.7	4.0	--	4.0	--	47.7	--	47.7	--
Elm-ash-cottonwood	15.5	--	--	--	--	15.5	--	15.5	--
Willow	3.6	--	--	--	--	3.6	--	3.6	--
Total	70.8	4.0	--	4.0	--	66.8	--	66.8	--
Maple-beech-birch									
Basswood	9.4	1.2	--	--	1.2	8.2	--	8.2	--
Total	9.4	1.2	--	--	1.2	8.2	--	8.2	--
Aspen-birch									
Aspen-birch	117.8	21.7	--	7.1	14.6	96.1	22.4	72.3	1.4
Total	117.8	21.7	--	7.1	14.6	96.1	22.4	72.3	1.4
Elm-ash-locust									
Elm-ash	165.7	19.5	11.8	3.3	4.4	146.2	3.6	139.0	3.6
Total	165.7	19.5	11.8	3.3	4.4	146.2	3.6	139.0	3.6
Nonstocked	2.6	--	--	--	--	2.6	--	2.6	--
All types	441.5	109.6	14.2	14.4	26.2	386.7	38.8	341.4	6.5

Table 8. -- Area of timberland by ownership class and stocking class of growing-stock trees 1, North Dakota, 1994

(In thousand acres)

Ownership class	All classes	Stocking class of growing-stock trees				
		Non-stocked 2	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Public						
National forest	14.2	--	8.9	5.3	--	--
Other federal	14.4	--	6.3	2.9	2.3	2.9
State	26.2	--	14.0	1.9	10.3	--
Total	54.8	--	29.2	10.1	12.6	2.9
Private						
Indian	38.8	2.5	12.9	11.8	11.6	--
Individual	341.4	21.0	162.8	97.8	53.7	6.1
Corporate	6.5	--	3.6	0.1	2.8	--
Total	386.7	23.5	179.3	109.7	68.1	6.1
All ownerships	441.5	23.5	208.5	119.8	80.7	9.0

1 This table is based on the stocking percent of growing-stock trees, rather than that of "live" trees. For this table, to use the definition of stocking found in the Appendix, replace the term "live trees" with "growing-stock trees."

2 Area of nonstocked in this table and in Table 6 differs from that in other tables in this report because this table includes land stocked only with growing-stock trees, rather than with "live" trees.

Table 9. -- Area of timberland by forest type group/local type and stand-size class, North Dakota, 1994

(In thousand acres)

Forest type group/ local type	All stands	Stand-size class			
		Sawtimber	Poletimber	Sapling-Seedling	Non-stocked
Ponderosa pine					
Ponderosa pine	1.7	--	1.7	--	--
Total	1.7	--	1.7	--	--
Rocky Mountain juniper					
Rocky Mountain juniper	4.3	--	4.3	--	--
Total	4.3	--	4.3	--	--
Oak-hickory					
Bur oak	69.2	13.8	37.5	17.9	--
Total	69.2	13.8	37.5	17.9	--
Elm-ash-cottonwood					
Cottonwood	51.7	20.3	17.6	13.8	--
Elm-ash-cottonwood	15.5	12.8	1.0	1.7	--
Willow	3.6	--	3.6	--	--
Total	70.8	33.1	22.2	15.5	--
Maple-beech-birch					
Basswood	9.4	8.0	--	1.4	--
Total	9.4	8.0	--	1.4	--
Aspen-birch					
Aspen-birch	117.8	25.2	57.4	35.2	--
Total	117.8	25.2	57.4	35.2	--
Elm-ash-locust					
Elm-ash	165.7	62.1	49.8	53.8	--
Total	165.7	62.1	49.8	53.8	--
Nonstocked	2.6	--	--	--	2.6
All types	441.5	142.2	172.9	123.8	2.6

Table 10. -- Number of all live trees on timberland by species group and diameter class, North Dakota, 1994

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height)											
		1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
Ponderosa pine	923	408	102	213	124	61	15	--	--	--	--	--	--
Other softwoods	2,045	456	666	557	261	94	11	--	--	--	--	--	--
Total softwoods	2,968	864	768	770	385	155	26	--	--	--	--	--	--
Hardwoods													
Bur oak	25,406	9,385	4,791	5,050	2,379	1,721	1,128	503	257	63	69	60	--
Basswood	1,983	1,098	51	156	46	109	201	103	107	57	36	16	3
Elm	11,634	4,080	4,030	1,413	836	353	349	212	135	101	43	71	11
Green ash	46,894	22,948	8,434	7,442	3,298	2,205	1,407	528	327	154	68	79	4
Cottonwood	6,513	682	1,073	1,373	1,214	651	447	491	159	91	60	194	78
Hackberry	175	78	39	--	14	26	7	4	--	3	4	--	--
Balsam poplar	4,518	1,131	1,230	644	376	541	284	251	53	2	6	--	--
Quaking aspen	48,168	26,369	8,282	4,591	3,918	2,339	1,743	689	177	43	13	4	--
Paper birch	1,816	972	200	146	294	118	66	11	9	--	--	--	--
Other hardwoods	20,678	10,625	3,230	3,161	1,265	1,056	513	365	200	106	80	77	--
Total hardwoods	167,785	77,368	31,360	23,976	13,640	9,119	6,145	3,157	1,424	620	379	501	96
Noncommercial species	18,368	16,245	567	429	529	208	233	93	5	47	4	8	--
All species	189,121	94,477	32,695	25,175	14,554	9,482	6,404	3,250	1,429	667	383	509	96

Table 11. -- Number of all growing-stock trees on timberland by species group and diameter class, North Dakota, 1994

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height)											
		1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
Ponderosa pine	855	408	51	213	107	61	15	--	--	--	--	--	--
Other softwoods	1,648	456	666	431	71	24	--	--	--	--	--	--	--
Total softwoods	2,503	864	717	644	178	85	15	--	--	--	--	--	--
Hardwoods													
Bur oak	18,807	8,469	3,416	3,149	1,395	1,170	622	278	175	41	50	42	--
Basswood	1,776	1,098	51	123	14	88	147	97	92	38	20	5	3
Elm	9,033	3,966	3,201	823	389	169	160	116	89	42	27	41	10
Green ash	39,040	22,756	6,637	5,316	1,801	1,254	602	313	180	79	41	61	--
Cottonwood	6,180	682	1,073	1,342	1,165	610	349	450	159	87	31	177	55
Hackberry	164	78	39	--	14	26	--	4	--	3	--	--	--
Balsam poplar	4,344	1,131	1,230	624	339	470	277	225	42	--	6	--	--
Quaking aspen	44,326	26,042	7,658	4,129	3,221	1,848	929	394	82	23	--	--	--
Paper birch	1,702	972	200	94	277	92	47	11	9	--	--	--	--
Other hardwoods	14,584	10,174	2,145	1,231	466	325	94	92	30	15	3	9	--
Total hardwoods	139,956	75,368	25,650	16,831	9,081	6,052	3,227	1,980	858	328	178	335	68
All species	142,459	76,232	26,367	17,475	9,259	6,137	3,242	1,980	858	328	178	335	68

Table 12. -- Net volume of growing stock on timberland by species group and diameter class, North Dakota, 1994

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height)									
		5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
Ponderosa pine	1,948	490	621	578	259	--	--	--	--	--	--
Other softwoods	1,396	867	331	198	--	--	--	--	--	--	--
Total softwoods	3,344	1,357	952	776	259	--	--	--	--	--	--
Hardwoods											
Bur oak	49,786	6,628	6,959	10,280	8,460	5,577	5,078	1,484	2,355	2,965	--
Basswood	12,210	305	91	929	2,345	2,203	2,836	1,659	995	487	360
Elm	19,248	1,576	1,598	1,548	2,385	2,446	2,368	1,613	1,425	2,925	1,364
Green ash	65,094	11,830	9,607	12,026	9,170	7,076	5,585	3,374	2,186	4,240	--
Cottonwood	65,255	2,622	5,828	5,690	5,337	10,327	5,102	4,039	1,702	14,112	10,496
Hackberry	530	--	77	259	--	86	--	108	--	--	--
Balsam poplar	19,040	1,343	1,984	4,481	4,306	5,287	1,308	--	331	--	--
Quaking aspen	78,371	11,238	19,432	18,964	15,530	9,501	2,748	958	--	--	--
Paper birch	4,527	287	1,827	1,067	804	280	262	--	--	--	--
Other hardwoods 1	12,309	2,409	2,357	2,794	1,168	1,579	736	542	158	566	--
Total hardwoods	326,370	38,238	49,760	58,038	49,505	44,362	26,023	13,777	9,152	25,295	12,220
All species	329,714	39,595	50,712	58,814	49,764	44,362	26,023	13,777	9,152	25,295	12,220

1 All other hardwood growing-stock volume is boxelder.

Table 13. -- Net volume of growing stock in the saw-log portion of sawtimber trees on timberland by species group and diameter class, North Dakota, 1994

(In thousand cubic feet)

		Diameter class (inches at breast height)							
Species group	All classes	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Ponderosa pine	750	509	241	--	--	--	--	--	--
Other softwoods	164	164	--	--	--	--	--	--	--
Total softwoods	914	673	241	--	--	--	--	--	--
Hardwoods									
Bur oak	18,391	--	5,382	3,975	3,790	1,128	1,812	495	1,809
Basswood	8,165	--	1,593	1,638	2,177	1,292	786	--	679
Elm	10,425	--	1,480	1,694	1,706	1,197	1,071	1,005	2,272
Green ash	23,306	--	6,168	5,239	4,249	2,610	1,704	1,834	1,502
Cottonwood	36,692	--	3,062	6,775	3,576	2,924	1,256	2,746	16,353
Hackberry	143	--	--	62	--	81	--	--	--
Balsam poplar	8,031	--	2,886	3,897	994	--	254	--	--
Quaking aspen	20,563	--	10,626	7,063	2,125	749	--	--	--
Paper birch	922	--	530	199	193	--	--	--	--
Other hardwoods 1	3,498	--	770	1,167	563	425	125	280	168
Total hardwoods	130,136	--	32,497	31,709	19,373	10,406	7,008	6,360	22,783
All species	131,050	673	32,738	31,709	19,373	10,406	7,008	6,360	22,783

1 All other hardwood volume is boxelder.

Table 14. -- Net volume of sawtimber on timberland by species group and diameter class, North Dakota, 1994

(In thousand board feet) 1

Species group	All classes	Diameter class (inches at breast height) 9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Ponderosa pine	4,289	2,943	1,346	--	--	--	--	--	--
Other softwoods	989	989	--	--	--	--	--	--	--
Total softwoods	5,278	3,932	1,346	--	--	--	--	--	--
Hardwoods									
Bur oak	115,401	--	34,416	24,359	23,265	6,998	11,432	14,931	--
Basswood	51,172	--	10,095	10,088	13,445	8,082	4,965	2,545	1,952
Elm	66,502	--	9,570	10,543	10,601	7,494	6,809	14,393	7,092
Green ash	144,804	--	38,465	31,816	25,972	16,227	10,766	21,558	--
Cottonwood	235,871	--	19,536	41,365	21,879	18,211	7,918	70,240	56,722
Hackberry	894	--	--	387	--	507	--	--	--
Balsam poplar	49,940	--	18,254	23,930	6,142	--	1,614	--	--
Quaking aspen	127,710	--	66,565	43,326	13,138	4,681	--	--	--
Paper birch	5,793	--	3,364	1,228	1,201	--	--	--	--
Other hardwoods 2	21,822	--	4,928	7,153	3,448	2,626	791	2,876	--
Total hardwoods	819,909	--	205,193	194,195	119,091	64,826	44,295	126,543	65,766
All species	825,187	3,932	206,539	194,195	119,091	64,826	44,295	126,543	65,766

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 15. -- Net volume of sawtimber on timberland by species group and grade, North Dakota, 1994

(In thousand board feet) 1

Species group	Total	Log grade 1	2	3	4
Softwoods					
Ponderosa pine	4,289	--	--	4,289	--
Other softwoods	989	--	--	989	--
Total softwoods	5,278	--	--	5,278	--

Species group	Total	Tree grade 1	2	3	Tie & timber
Hardwoods					
Bur oak	115,401	6,295	11,035	42,507	55,564
Basswood	51,172	12,486	22,999	15,687	--
Elm	66,502	10,142	7,009	30,130	19,221
Green ash	144,804	22,323	36,127	62,484	23,870
Cottonwood	235,871	92,381	60,632	38,449	44,409
Hackberry	894	507	--	387	--
Balsam poplar	49,940	--	19,273	14,619	16,048
Quaking aspen	127,710	--	22,736	83,262	21,712
Paper birch	5,793	--	--	5,793	--
Other hardwoods 2	21,822	--	4,707	8,838	8,277
Total hardwoods	819,909	144,134	184,518	302,156	189,101
All species	825,187	144,134	184,518	307,434	189,101

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 16. -- Net volume of growing stock and sawtimber on timberland by county group and major species group, North Dakota, 1994

County group	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					*(In thousand board feet) 1*				
Red River 2	140,286	--	96	75,668	64,522	420,205	--	--	238,345	181,860
Devils Lake & James River 3	12,028	--	--	3,103	8,925	19,042	--	--	7,683	11,359
Souris River 4	120,222	--	--	91,512	28,710	230,771	--	--	180,811	49,960
Missouri River 5	57,178	1,948	1,300	41,207	12,723	155,169	4,289	989	132,865	17,026
State total	329,714	1,948	1,396	211,490	114,880	825,187	4,289	989	559,704	260,205

1 International 1/4-inch rule.

2 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

3 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

4 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

5 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 17. -- Net volume of all live trees and salvable dead trees on timberland by class of timber and major species group, North Dakota, 1994

(In thousand cubic feet)

Class of timber	All species	Major species group: Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Live trees					
Growing-stock trees					
Sawtimber					
Saw-log portion	131,050	750	164	88,439	41,697
Upper-stem portion	50,319	87	34	34,345	15,853
Total	181,369	837	198	122,784	57,550
Poletimber	148,345	1,111	1,198	88,706	57,330
All growing-stock trees	329,714	1,948	1,396	211,490	114,880
Cull trees					
Short-log trees	25,800	--	111	12,925	12,764
Rough trees 1					
Sawtimber size	42,321	--	492	26,408	15,421
Poletimber size	49,115	95	846	23,314	24,860
Total	91,436	95	1,338	49,722	40,281
Rotten trees 1					
Sawtimber size	22,289	--	--	17,403	4,886
Poletimber size	7,261	--	--	4,612	2,649
Total	29,550	--	--	22,015	7,535
All cull trees	146,786	95	1,449	84,662	60,580
All live trees	476,500	2,043	2,845	296,152	175,460
Salvable dead trees					
Sawtimber size	20,480	--	--	19,268	1,212
Poletimber size	15,118	--	--	11,930	3,188
All salvable dead trees	35,598	--	--	31,198	4,400
All classes	512,098	2,043	2,845	327,350	179,860

1 Includes noncommercial species.

Table 18. -- Net volume of all live trees and growing-stock trees on timberland by ownership class and major species group, North Dakota, 1994

(In thousand cubic feet)

	All live trees					Growing-stock trees				
		Major species group					Major species group			
Ownership class	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other Softwoods	Soft hardwoods	Hard hardwoods
National forest	4,609	--	1,714	926	1,969	2,041	--	1,033	435	573
Other federal	13,172	--	--	13,172	--	10,949	--	--	10,949	--
State	27,887	--	--	19,105	8,782	20,797	--	--	15,141	5,656
Indian	31,473	--	--	22,104	9,369	21,011	--	--	16,237	4,774
Individual	394,014	2,043	1,131	238,361	152,479	273,005	1,948	363	168,201	102,493
Corporate	5,345	--	--	2,484	2,861	1,911	--	--	527	1,384
All ownerships	476,500	2,043	2,845	296,152	175,460	329,714	1,948	1,396	211,490	114,880

Table 19. -- Net volume of growing stock on timberland by forest type group/local type and major species group, North Dakota, 1994

(In thousand cubic feet)

Forest type group/ local type	All species	Major species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Ponderosa pine					
Ponderosa pine	1,948	1,948	--	--	--
Total	1,948	1,948	--	--	--
Rocky Mountain juniper					
Rocky Mountain juniper	852	--	759	--	93
Total	852	--	759	--	93
Oak-hickory					
Bur oak	49,198	--	--	6,084	43,114
Total	49,198	--	--	6,084	43,114
Elm-ash-cottonwood					
Cottonwood	57,712	--	91	54,800	2,821
Elm-ash-cottonwood	10,610	--	--	7,266	3,344
Willow	--	--	--	--	--
Total	68,322	--	91	62,066	6,165
Maple-beech-birch					
Basswood	12,093	--	--	8,175	3,918
Total	12,093	--	--	8,175	3,918
Aspen-birch					
Aspen-birch	109,680	--	--	97,097	12,583
Total	109,680	--	--	97,097	12,583
Elm-ash-locust					
Elm-ash	87,621	--	546	38,068	49,007
Total	87,621	--	546	38,068	49,007
All forest types	329,714	1,948	1,396	211,490	114,880

Table 20. -- Average annual net growth of growing stock and sawtimber on timberland by county group and major species group, North Dakota, 1980-1993

County group	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					*(In thousand board feet) 1*				
Red River 2	1,829	--	3	450	1,376	10,889	--	--	4,213	6,676
Devils Lake & James River 3	404	--	--	57	347	89	--	--	-131	220
Souris River 4	2,820	--	--	1,861	959	9,210	--	--	6,499	2,711
Missouri River 5	1,610	23	81	1,104	402	4,662	88	27	3,533	1,014
State total	6,663	23	84	3,472	3,084	24,850	88	27	14,114	10,621

1 International 1/4-inch rule.

2 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

3 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

4 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

5 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 21. -- Average annual removals of growing stock and sawtimber on timberland by county group and major species group, North Dakota, 1980-1993

County group	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					*(In thousand board feet) 1*				
Red River 2	977	--	--	660	317	3533	--	--	2945	588
Devils Lake & James River 3	--	--	--	--	--	--	--	--	--	--
Souris River 4	378	--	--	246	132	484	--	--	340	144
Missouri River 5	218	--	--	173	45	245	--	--	194	51
State total	1,573	--	--	1,079	494	4,262	--	--	3,479	783

1 International 1/4-inch rule.

2 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

3 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

4 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

5 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 22. -- Average annual net growth and average annual removals of growing stock and sawtimber on timberland by species group, North Dakota, 1980-1993

Species group	Growing stock		Sawtimber	
	Average annual net growth	Average annual removals	Average annual net growth	Average annual removals
	(In thousand cubic feet)		*(In thousand board feet) 1*	
Softwoods				
Ponderosa pine	23	--	88	--
Other softwoods	84	--	27	--
Total softwoods	107	--	115	--
Hardwoods				
Bur oak	1,021	332	3,805	525
Basswood	133	76	1,058	378
Elm	-436	458	-2,491	2,117
Green ash	2,063	162	6,816	258
Cottonwood	1,163	312	6,660	876
Hackberry	18	--	6	--
Balsam poplar	453	30	2,454	--
Quaking aspen	1,844	127	5,551	--
Paper birch	-48	7	-36	--
Other hardwoods 2	345	69	912	108
Total hardwoods	6,556	1,573	24,735	4,262
All species	6,663	1,573	24,850	4,262

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 23. -- Average annual mortality of growing stock and sawtimber on timberland by species group, North Dakota, 1980-1993

Species group	Growing stock average annual mortality	Sawtimber average annual mortality
	(In thousand cubic feet)	*(In thousand board feet) 1*
Bur oak	239	281
Basswood	79	310
Elm	1,276	4,325
Green ash	264	397
Cottonwood	506	1,413
Hackberry	--	1
Balsam poplar	372	377
Quaking aspen	1,529	2,201
Paper birch	186	327
Other hardwoods 2	188	366
All species	4,639	9,998

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 24. -- Average annual net growth and average annual removals of growing stock and sawtimber on timberland by ownership class and major species group, North Dakota, 1980-1993

Ownership class	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	Average annual net growth of growing stock				
		Major species group			
	(In thousand cubic feet)				
National forest	173	--	66	-19	126
Other federal	235	--	--	235	--
State	159	--	--	6	153
Indian	684	--	--	548	136
Individual	5,310	23	18	2,659	2,610
Corporate	102	--	--	43	59
All ownerships	6,663	23	84	3,472	3,084
	Average annual removals of growing stock				
		Major species group			
	(In thousand cubic feet)				
National forest	26	--	--	--	26
Other federal	--	--	--	--	--
State	92	--	--	13	79
Indian	54	--	--	37	17
Individual	1,401	--	--	1,029	372
Corporate	--	--	--	--	--
All ownerships	1,573	--	--	1,079	494
	Average annual net growth of sawtimber				
		Major species group			
	(In thousand board feet)1				
National forest	41	--	27	14	--
Other federal	801	--	--	801	--
State	1,072	--	--	851	221
Indian	850	--	--	649	201
Individual	22,078	88	--	11,791	10,199
Corporate	8	--	--	8	--
All ownerships	24,850	88	27	14,114	10,621
	Average annual removals of sawtimber				
		Major species group			
	(In thousand board feet)1				
National forest	--	--	--	--	--
Other federal	--	--	--	--	--
State	202	--	--	32	170
Indian	--	--	--	--	--
Individual	4,060	--	--	3,447	613
Corporate	--	--	--	--	--
All ownerships	4,262	--	--	3,479	783

1 International 1/4-inch rule.

Table 25. -- Average annual net growth and average annual removals of growing stock and sawtimber on timberland by forest type group/local type and major species group, North Dakota, 1980-1993

Forest type group/ local type	Average annual net growth of growing stock					Average annual removals of growing stock				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					*(In thousand cubic feet)*				
Ponderosa pine										
Ponderosa pine	23	23	--	--	--	--	--	--	--	--
Total	23	23	--	--	--	--	--	--	--	--
Rocky Mountain juniper										
Rocky Mountain juniper	61	--	54	--	7	--	--	--	--	--
Total	61	--	54	--	7	--	--	--	--	--
Oak-hickory										
Bur oak	999	--	--	-66	1,065	125	--	--	20	105
Total	999	--	--	-66	1,065	125	--	--	20	105
Elm-ash-cottonwood										
Cottonwood	1,141	--	3	1,057	81	173	--	--	173	--
Elm-ash-cottonwood	38	--	--	1	37	348	--	--	283	65
Total	1,179	--	3	1,058	118	521	--	--	456	65
Maple-beech-birch										
Basswood	111	--	--	8	103	403	--	--	205	198
Total	111	--	--	8	103	403	--	--	205	198
Aspen-birch										
Aspen-birch	2,817	--	--	2,336	481	204	--	--	157	47
Total	2,817	--	--	2,336	481	204	--	--	157	47
Elm-ash-locust										
Elm-ash	1,473	--	27	136	1,310	320	--	--	241	79
Total	1,473	--	27	136	1,310	320	--	--	241	79
All forest types	6,663	23	84	3,472	3,084	1,573	--	--	1,079	494

Forest type group/ local type	Average annual net growth of sawtimber					Average annual removals of sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand board feet) 1					*(In thousand board feet) 1*				
Ponderosa pine										
Ponderosa pine	88	88	--	--	--	--	--	--	--	--
Total	88	88	--	--	--	--	--	--	--	--
Oak-hickory										
Bur oak	2,883	--	--	97	2,786	202	--	--	32	170
Total	2,883	--	--	97	2,786	202	--	--	32	170
Elm-ash-cottonwood										
Cottonwood	5,922	--	--	5,767	155	194	--	--	194	--
Elm-ash-cottonwood	323	--	--	188	135	1,525	--	--	1,330	195
Total	6,245	--	--	5,955	290	1,719	--	--	1,524	195
Maple-beech-birch										
Basswood	950	--	--	210	740	1,325	--	--	970	355
Total	950	--	--	210	740	1,325	--	--	970	355
Aspen-birch										
Aspen-birch	8,600	--	--	7,872	728	--	--	--	--	--
Total	8,600	--	--	7,872	728	--	--	--	--	--
Elm-ash-locust										
Elm-ash	6,084	--	27	-20	6,077	1,016	--	--	953	63
Total	6,084	--	27	-20	6,077	1,016	--	--	953	63
All forest types	24,850	88	27	14,114	10,621	4,262	--	--	3,479	783

1 International 1/4-inch rule.

Table 26. -- All live aboveground tree biomass on timberland by ownership class, major species group, and tree biomass component, North Dakota, 1994

(In green tons)

Ownership class and major species group	All components	Tree biomass component						
		All 1-5 inch trees	Growing-stock trees			Non-growing-stock trees		
			Stumps	Boles	Tops and limbs	Stumps	Boles	Tops and limbs
National forest								
Other softwoods	81,434	11,497	3,626	26,490	9,088	2,537	21,608	6,588
Soft hardwoods	55,823	5,200	1,890	14,576	4,956	2,553	19,736	6,912
Hard hardwoods	139,259	21,182	2,140	17,844	6,743	6,885	61,554	22,911
Total	276,516	37,879	7,656	58,910	20,787	11,975	102,898	36,411
Other federal								
Soft hardwoods	644,544	16,008	24,771	344,056	85,778	8,680	133,510	31,741
Hard hardwoods	6,144	6,144	--	--	--	--	--	--
Total	650,688	22,152	24,771	344,056	85,778	8,680	133,510	31,741
State								
Soft hardwoods	1,064,551	106,765	30,399	466,482	130,648	15,886	254,872	59,499
Hard hardwoods	492,650	26,015	20,429	190,649	67,956	15,201	126,001	46,399
Total	1,557,201	132,780	50,828	657,131	198,604	31,087	380,873	105,898
Indian								
Soft hardwoods	1,184,331	125,441	37,358	510,571	147,830	19,342	272,264	71,525
Hard hardwoods	604,996	97,054	18,757	168,187	59,546	18,851	182,363	60,238
Total	1,789,327	222,495	56,115	678,758	207,376	38,193	454,627	131,763
Individual								
Pine	68,761	4,800	4,063	50,268	6,354	214	2,726	336
Other softwoods	52,158	3,830	1,154	9,210	3,188	2,854	24,367	7,555
Soft hardwoods	12,317,916	807,473	431,464	5,228,232	1,476,104	270,713	3,211,443	892,487
Hard hardwoods	8,522,918	594,561	314,307	3,413,336	1,111,050	197,719	2,191,371	700,574
Total	20,961,753	1,410,664	750,988	8,701,046	2,596,696	471,500	5,429,907	1,600,952
Corporate								
Soft hardwoods	120,798	6,751	1,659	16,101	5,180	5,880	66,617	18,610
Hard hardwoods	154,785	9,431	4,790	43,810	16,334	5,811	54,590	20,019
Total	275,583	16,182	6,449	59,911	21,514	11,691	121,207	38,629
All ownerships								
Pine	68,761	4,800	4,063	50,268	6,354	214	2,726	336
Other softwoods	133,592	15,327	4,780	35,700	12,276	5,391	45,975	14,143
Soft hardwoods	15,387,963	1,067,638	527,541	6,580,018	1,850,496	323,054	3,958,442	1,080,774
Hard hardwoods	9,920,752	754,387	360,423	3,833,826	1,261,629	244,467	2,615,879	850,141
Total	25,511,068	1,842,152	896,807	10,499,812	3,130,755	573,126	6,623,022	1,945,394

Table 27. -- Area of land by land class and local forest type, North Dakota, 1980 and 1994

(In thousand acres)

Land class and local forest type	1980	1994
Forest land		
Timberland		
Ponderosa pine	2.1	1.7
Rocky Mountain juniper	4.9	4.3
Bur oak	52.2	69.2
Cottonwood	17.0	51.7
Willow	--	3.6
Elm-ash-cottonwood	42.6	15.5
Basswood	6.8	9.4
Aspen-birch	139.9	117.8
Elm-ash	101.6	165.7
Nonstocked	--	2.6
Total	367.1	441.5
Reserved forest land	67.2	--
Other forest land	137.6	231.7
All forest land	571.9	673.2
Nonforest land		
Nonforest with trees		
Cropland with trees	45.0	29.8
Improved pasture with trees	434.8	954.8
Wooded strips	168.2	106.0
Idle farmland with trees	10.0	3.6
Marsh with trees	14.1	10.8
Urban and other with trees	--	69.1
Windbreaks	191.6	263.0
Wooded pasture	8.6	97.5
Total	872.3	1,534.6
Nonforest without trees		
Cropland	30,806.8	28,277.3
Improved pasture	10,212.9	12,012.9
Idle farmland	15.0	782.8
Marsh	977.5	253.4
Other farm-farmstead	217.5	219.7
Urban and other	897.5	181.8
Noncensus water	80.8	220.7
Total	43,208.0	41,948.6
All nonforest land	44,080.3	43,483.2
Total land	44,652.2	44,156.4

Table 28. -- Area of timberland by county group,
North Dakota, 1980 and 1994

(In thousand acres)

County group	1980	1994
Red River 1	141.1	162.8
Devils Lake & James River 2	17.7	30.4
Souris River 3	139.3	132.7
Missouri River 4	69.0	115.6
State total	367.1	441.5

1 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

2 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

3 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

4 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

Table 29. -- Area of timberland by stand-size class, North Dakota, 1980 and 1994

(In thousand acres)

Stand-size class	1980	1994
State total		
Sawtimber	114.2	142.2
Poletimber	167.2	172.9
Sapling & seedling	85.7	123.8
Nonstocked	--	2.6
Total	367.1	441.5

Table 30. -- Area of timberland by local forest type, stand-size class, and ownership class, North Dakota, 1994

(In thousand acres)

Local forest type and stand-size class	All ownerships	Ownership class						
		National forest	Other federal	State	County and municipal	Indian	Individual	Corporate
Ponderosa pine								
Sawtimber	--	--	--	--	--	--	--	--
Poletimber	1.7	--	--	--	--	--	1.7	--
Sapling & seedling	--	--	--	--	--	--	--	--
Total	1.7	--	--	--	--	--	1.7	--
Rocky Mountain juniper								
Sawtimber	--	--	--	--	--	--	--	--
Poletimber	4.3	2.4	--	--	--	--	1.9	--
Sapling & seedling	--	--	--	--	--	--	--	--
Total	4.3	2.4	--	--	--	--	1.9	--
Bur oak								
Sawtimber	13.8	--	--	--	--	4.0	9.8	--
Poletimber	37.5	--	--	4.8	--	4.6	28	0.1
Sapling & seedling	17.9	--	--	1.2	--	4.2	11.1	1.4
All stands	69.2	--	--	6.0	--	12.8	48.9	1.5
Cottonwood								
Sawtimber	20.3	--	3.4	--	--	--	16.9	--
Poletimber	17.6	--	--	--	--	--	17.6	--
Sapling & seedling	13.8	--	0.6	--	--	--	13.2	--
Total	51.7	--	4.0	--	--	--	47.7	--
Elm-ash-cottonwood								
Sawtimber	12.8	--	--	--	--	--	12.8	--
Poletimber	1.0	--	--	--	--	--	1.0	--
Sapling & seedling	1.7	--	--	--	--	--	1.7	--
Total	15.5	--	--	--	--	--	15.5	--
Willow								
Sawtimber	--	--	--	--	--	--	--	--
Poletimber	3.6	--	--	--	--	--	3.6	--
Sapling & seedling	--	--	--	--	--	--	--	--
Total	3.6	--	--	--	--	--	3.6	--
Basswood								
Sawtimber	8.0	--	--	1.2	--	--	6.8	--
Poletimber	--	--	--	--	--	--	--	--
Sapling & seedling	1.4	--	--	--	--	--	1.4	--
Total	9.4	--	--	1.2	--	--	8.2	--
Aspen-birch								
Sawtimber	25.2	--	2.5	4.8	--	1.7	16.2	--
Poletimber	57.4	--	2.3	5.9	--	13.4	35.8	--
Sapling & seedling	35.2	--	2.3	3.9	--	7.3	20.3	1.4
Total	117.8	--	7.1	14.6	--	22.4	72.3	1.4
Elm-ash								
Sawtimber	62.1	--	--	1.2	--	1.5	59.4	--
Poletimber	49.8	1.2	0.4	1.9	--	--	42.7	3.6
Sapling & seedling	53.8	10.6	2.9	1.3	--	2.1	36.9	--
Total	165.7	11.8	3.3	4.4	--	3.6	139.0	3.6
Nonstocked	2.6	--	--	--	--	--	2.6	--
All forest types								
Sawtimber	142.2	--	5.9	7.2	--	7.2	121.9	--
Poletimber	172.9	3.6	2.7	12.6	--	18.0	132.3	3.7
Sapling & seedling	123.8	10.6	5.8	6.4	--	13.6	84.6	2.8
Nonstocked	2.6	--	--	--	--	--	2.6	--
Total	441.5	14.2	14.4	26.2	--	38.8	341.4	6.5

Table 31. -- Area of timberland by local forest type, stand-size class, and potential productivity class, North Dakota, 1994

(In thousand acres)

Local forest type and stand-size class	Potential productivity class (All feet of growth per acre per year)			
	classes	85+	50-84	20-49
Ponderosa pine				
Sawtimber	--	--	--	--
Poletimber	1.7	--	--	1.7
Sapling & seedling	--	--	--	--
Total	1.7	--	--	1.7
Rocky Mountain juniper				
Sawtimber	--	--	--	--
Poletimber	4.3	--	--	4.3
Sapling & seedling	--	--	--	--
Total	4.3	--	--	4.3
Bur oak				
Sawtimber	13.8	2.2	2.7	8.9
Poletimber	37.5	--	3.9	33.6
Sapling & seedling	17.9	--	0.7	17.2
Total	69.2	2.2	7.3	59.7
Cottonwood				
Sawtimber	20.3	6.9	3.9	9.5
Poletimber	17.6	1.4	6.3	9.9
Sapling & seedling	13.8	0.6	--	13.2
Total	51.7	8.9	10.2	32.6
Elm-ash-cottonwood				
Sawtimber	12.8	1.2	1.7	9.9
Poletimber	1.0	1.0	--	--
Sapling & seedling	1.7	--	--	1.7
Total	15.5	2.2	1.7	11.6
Willow				
Sawtimber	--	--	--	--
Poletimber	3.6	--	--	3.6
Sapling & seedling	--	--	--	--
Total	3.6	--	--	3.6
Basswood				
Sawtimber	8.0	--	--	8.0
Poletimber	--	--	--	--
Sapling & seedling	1.4	--	--	1.4
Total	9.4	--	--	9.4
Aspen-birch				
Sawtimber	25.2	2.0	14.9	8.3
Poletimber	57.4	2.0	28.0	27.4
Sapling & seedling	35.2	--	16.5	18.7
Total	117.8	4.0	59.4	54.4
Elm-ash				
Sawtimber	62.1	1.5	14.4	46.2
Poletimber	49.8	--	0.6	49.2
Sapling & seedling	53.8	--	4.3	49.5
Total	165.7	1.5	19.3	144.9
Nonstocked	2.6	--	--	2.6
All forest types				
Sawtimber	142.2	13.8	37.6	90.8
Poletimber	172.9	4.4	38.8	129.7
Sapling & seedling	123.8	0.6	21.5	101.7
Nonstocked	2.6	--	--	2.6
Total	441.5	18.8	97.9	324.8

Table 32. -- Area of timberland by local forest type, stand-size class and basal-area class, North Dakota, 1994

(In thousand acres)

Local forest type and stand-size class	All classes	Basal-area class (square feet per acre) 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-150	151-180	181+
Ponderosa pine															
Sawtimber	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Poletimber	1.7	--	--	--	--	--	--	--	--	1.7	--	--	--	--	--
Sapling & seedling	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	1.7	--	--	--	--	--	--	--	--	1.7	--	--	--	--	--
Rocky Mountain juniper															
Sawtimber	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Poletimber	4.3	--	--	--	--	4.3	--	--	--	--	--	--	--	--	--
Sapling & seedling	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	4.3	--	--	--	--	4.3	--	--	--	--	--	--	--	--	--
Bur oak															
Sawtimber	13.8	--	0.2	--	2.2	--	1.7	2.3	2.1	--	1.4	1.3	2.6	--	--
Poletimber	37.5	0.2	1.8	0.4	1.3	1.7	8.5	4.3	1.4	1.2	--	6.8	9.9	--	--
Sapling & seedling	17.9	5.6	0.8	3	1.1	1.2	1.4	--	1.0	--	--	--	3.8	--	--
Total	69.2	5.8	2.8	3.4	4.6	2.9	11.6	6.6	4.5	1.2	1.4	8.1	16.3	--	--
Cottonwood															
Sawtimber	20.3	0.6	--	--	--	--	1.0	5.0	3.0	--	--	1.8	4.2	--	4.7
Poletimber	17.6	--	3.8	1.9	--	2.3	--	--	1.9	--	--	5.0	1.3	1.4	--
Sapling & seedling	13.8	11.1	2.7	--	--	--	--	--	--	--	--	--	--	--	--
Total	51.7	11.7	6.5	1.9	--	2.3	1.0	5.0	4.9	--	--	6.8	5.5	1.4	4.7
Elm-ash-cottonwood															
Sawtimber	12.8	--	0.2	--	1.3	1.3	3.4	--	0.6	3.0	1.8	--	--	--	1.2
Poletimber	1.0	--	--	--	--	--	--	--	1.0	--	--	--	--	--	--
Sapling & seedling	1.7	--	--	1.7	--	--	--	--	--	--	--	--	--	--	--
Total	15.5	--	0.2	1.7	1.3	1.3	3.4	--	1.6	3.0	1.8	--	--	--	1.2
Willow															
Sawtimber	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Poletimber	3.6	--	--	--	--	3.6	--	--	--	--	--	--	--	--	--
Sapling & seedling	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	3.6	--	--	--	--	3.6	--	--	--	--	--	--	--	--	--

(Table 32 continued on next page)

(Table 32 continued)

Local forest type and stand-size class	All classes	Basal-area class (square feet per acre) 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-120	121-150	151-180	181+
Basswood															
Sawtimber	8.0	--	--	--	--	--	--	--	1.2	2.7	1.6	--	2.5	--	--
Poletimber	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sapling & seedling	1.4	--	--	1.4	--	--	--	--	--	--	--	--	--	--	--
Total	9.4	--	--	1.4	--	--	--	--	1.2	2.7	1.6	--	2.5	--	--
Aspen-birch															
Sawtimber	25.2	--	--	--	--	1.9	1.0	3.5	2.0	6.5	1.9	6.4	2.0	--	--
Poletimber	57.4	0.1	0.5	1.4	--	3.1	0.7	9.6	3.2	5.6	1.7	21.7	9.8	--	--
Sapling & seedling	35.2	4.8	1.4	3.5	3.5	9.3	5.4	1.5	1.9	--	2.0	1.9	--	--	--
Total	117.8	4.9	1.9	4.9	3.5	14.3	7.1	14.6	7.1	12.1	5.6	30.0	11.8	--	--
Elm-ash															
Sawtimber	62.1	0.3	0.6	2.6	1.9	4.9	6.5	3.9	8.5	14.0	5.5	6.0	4.4	2.2	0.8
Poletimber	49.8	0.5	--	2.2	4.2	5.3	1.3	--	10.9	11.0	5.3	4.0	5.1	--	--
Sapling & seedling	53.8	4.1	4.4	3.4	20.7	8.3	9.6	3.3	--	--	--	--	--	--	--
Total	165.7	4.9	5.0	8.2	26.8	18.5	17.4	7.2	19.4	25.0	10.8	10.0	9.5	2.2	0.8
Nonstocked	2.6	2.6	--	--	--	--	--	--	--	--	--	--	--	--	--
All forest types															
Sawtimber	142.2	0.9	1.0	2.6	5.4	8.1	13.6	14.7	17.4	26.2	12.2	15.5	15.7	2.2	6.7
Poletimber	172.9	0.8	6.1	5.9	5.5	20.3	10.5	13.9	18.4	19.5	7.0	37.5	26.1	1.4	--
Sapling & seedling	123.8	25.6	9.3	13.0	25.3	18.8	16.4	4.8	2.9	--	2.0	1.9	3.8	--	--
Nonstocked	2.6	2.6	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	441.5	29.9	16.4	21.5	36.2	47.2	40.5	33.4	38.7	45.7	21.2	54.9	45.6	3.6	6.7

Table 33. -- Net volume of growing stock on timberland by species group, North Dakota, 1980 and 1994

(In thousand cubic feet)

Species group	1980	1994
Softwoods		
Ponderosa pine	1,932	1,948
Other softwoods	87	1,396
Total softwoods	2,019	3,344
Hardwoods		
Bur oak	36,378	49,786
Basswood	12,786	12,210
Elm	35,200	19,248
Green ash	39,058	65,094
Cottonwood	27,483	65,255
Hackberry	221	530
Balsam poplar	14,044	19,040
Quaking aspen	63,357	78,371
Paper birch	7,018	4,527
Other hardwoods 1	6,167	12,309
Total hardwoods	241,712	326,370
All species	243,731	329,714

1 All other hardwood volume is boxelder.

Table 34. -- Net volume of sawtimber on timberland by species group, North Dakota, 1980 and 1994

d board feet) 1

Species group	1980	1994
Softwoods		
Ponderosa pine	3,646	4,289
Other softwoods	--	989
Total softwoods	3,646	5,278
Hardwoods		
Bur oak	60,571	115,401
Basswood	50,833	51,172
Elm	136,320	66,502
Green ash	90,374	144,804
Cottonwood	105,474	235,871
Hackberry	565	894
Balsam poplar	15,022	49,940
Quaking aspen	46,990	127,710
Paper birch	8,521	5,793
Other hardwoods 2	11,874	21,822
Total hardwoods	526,544	819,909
All species	530,190	825,187

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 35. -- Net volume of all live trees greater than 5 inches in diameter at breast height on timberland by species group and diameter class, North Dakota, 1994

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height) 5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
Ponderosa pine	2,043	490	716	578	259	--	--	--	--	--	--
Other softwoods	2,845	1,084	960	680	121	--	--	--	--	--	--
Total softwoods	4,888	1,574	1,676	1,258	380	--	--	--	--	--	--
Hardwoods											
Bur oak	76,876	10,173	11,090	14,732	14,883	9,435	7,071	2,163	3,218	4,111	--
Basswood	15,263	363	251	1,119	3,124	2,251	3,128	1,946	1,743	978	360
Elm	34,019	2,933	3,707	3,073	4,866	4,097	3,486	3,535	2,121	4,794	1,407
Green ash	98,476	15,273	15,148	18,315	17,835	10,205	8,218	5,205	2,916	4,892	469
Cottonwood	73,423	2,710	6,067	5,816	6,500	10,854	5,102	4,195	2,918	15,191	14,070
Hackberry	852	--	77	259	97	86	--	108	225	--	--
Balsam poplar	20,196	1,369	2,184	4,839	4,353	5,602	1,489	29	331	--	--
Quaking aspen	95,249	12,089	21,752	21,180	21,960	12,316	4,162	1,283	306	201	--
Paper birch	5,222	466	1,936	1,218	1,060	280	262	--	--	--	--
Other hardwoods	40,995	5,693	5,521	7,665	5,098	5,231	3,789	2,508	2,449	3,041	--
Total hardwoods	460,571	51,069	67,733	78,216	79,776	60,357	36,707	20,972	16,227	33,208	16,306
Noncommercial secies	11,041	659	2,234	1,560	2,615	1,399	123	1,533	169	749	--
All species	476,500	53,302	71,643	81,034	82,771	61,756	36,830	22,505	16,396	33,957	16,306

Table 36. -- Net volume of tree species on timberland by individual species and major tree class, North Dakota, 1994

Species	Major tree class: All live trees: Total all live	Growing stock	Short-log	Rough	Rotten	Saw-log size trees: Total saw-log size trees	Sawtimber	Short-log
	(In thousand cubic feet)					*(In thousand board feet) 1*		
Softwoods								
Ponderosa pine	2,043	1,948	--	95	--	4,289	4,289	--
Eastern redcedar	96	96	--	--	--	--	--	--
Rocky Mountain juniper	2,749	1,300	111	1,338	--	1,483	989	494
Total softwoods	4,888	3,344	111	1,433	--	5,772	5,278	494
Hardwoods								
Bur oak	76,876	49,786	6,078	20,687	325	129,022	115,401	13,621
American basswood	15,263	12,210	1,291	1,000	762	53,870	51,172	2,698
American elm	32,361	17,703	4,237	9,870	551	74,067	63,365	10,702
Siberian elm	1,658	1,545	113	--	--	3,386	3,137	249
Green ash	98,476	65,094	6,686	19,486	7,210	158,555	144,804	13,751
Eastern cottonwood	73,423	65,255	2,299	2,201	3,668	243,367	235,871	7,496
Hackberry	852	530	225	97	--	1,501	894	607
Balsam poplar	20,196	19,040	231	397	528	50,501	49,940	561
Quaking aspen	95,249	78,371	1,603	3,382	11,893	130,836	127,710	3,126
Paper birch	5,222	4,527	132	494	69	6,097	5,793	304
River birch	108	--	--	108	--	--	--	--
Boxelder	40,811	12,309	2,794	21,474	4,234	30,354	21,822	8,532
Poplars introduced	76	--	--	76	--	--	--	--
Total hardwoods	460,571	326,370	25,689	79,272	29,240	881,556	819,909	61,647
Noncommercial spp.	11,041	--	--	10,731	310	--	--	--
All species	476,500	329,714	25,800	91,436	29,550	887,328	825,187	62,141

1 International 1/4-inch rule.

Table 37. -- Net volume of noncommercial tree species on timberland by individual species, North Dakota, 1994

(In thousand cubic feet)

Noncommercial tree species	Non-growing-stock volume
Eastern hophornbeam	142
Wild plum	26
Peachleaf willow	10,873
All noncommercial species	11,041

Table 38. -- Net volume of growing stock on timberland by species group and local forest type, North Dakota, 1994

(In thousand cubic feet)

Species group	All types	Local forest type							
		Ponderosa pine	Rocky Mountain juniper	Bur oak	Cottonwood	Elm-ash-cottonwood	Basswood	Aspen-birch	Elm-ash
Softwoods									
Ponderosa pine	1,948	1,948	--	--	--	--	--	--	--
Other softwoods	1,396	--	759	--	91	--	--	--	546
Total softwoods	3,344	1,948	759	--	91	--	--	--	546
Hardwoods									
Bur oak	49,786	--	--	33,204	--	1,207	2,652	6,664	6,059
Basswood	12,210	--	--	2,790	--	556	7,374	--	1,490
Elm	19,248	--	--	471	64	3,274	406	1,146	13,887
Green ash	65,094	--	93	9,910	2,821	2,137	1,266	5,919	42,948
Cottonwood	65,255	--	--	--	52,795	2,454	--	--	10,006
Hackberry	530	--	--	--	--	--	86	--	444
Balsam poplar	19,040	--	--	462	--	--	--	17,182	1,396
Quaking aspen	78,371	--	--	1,837	--	--	--	74,766	1,768
Paper birch	4,527	--	--	524	--	--	--	4,003	--
Other hardwoods 1	12,309	--	--	--	1,941	982	309	--	9,077
Total hardwoods	326,370	--	93	49,198	57,621	10,610	12,093	109,680	87,075
All species	329,714	1,948	852	49,198	57,712	10,610	12,093	109,680	87,621

1 All other hardwood volume is boxelder.

Table 39. -- Net volume of sawtimber on timberland by species group and local forest type, North Dakota, 1994

(In thousand board feet) 1

Species group	All types	Local forest type: Ponderosa pine	Bur oak	Cottonwood	Elm-ash-cottonwood	Basswood	Aspen-birch	Elm-ash
Softwoods								
Ponderosa pine	4,289	4,289	--	--	--	--	--	--
Other softwoods	989	--	--	--	--	--	--	989
Total softwoods	5,278	4,289	--	--	--	--	--	989
Hardwoods								
Bur oak	115,401	--	66,512	--	5,934	11,890	7,346	23,719
Basswood	51,172	--	10,876	--	1,531	31,652	--	7,113
Elm	66,502	--	1362	--	15,504	1,368	4,047	44,221
Green ash	144,804	--	10,799	3,929	7,557	6,020	4,491	112,008
Cottonwood	235,871	--	--	173,355	12,436	--	--	50,080
Hackberry	894	--	--	--	--	387	--	507
Balsam poplar	49,940	--	1,194	--	--	--	43,526	5,220
Quaking aspen	127,710	--	1784	--	--	--	123,901	2,025
Paper birch	5,793	--	--	--	--	--	5,793	--
Other hardwoods 2	21,822	--	--	534	1,026	660	--	19,602
Total hardwoods	819,909	--	92,527	177,818	43,988	51,977	189,104	264,495
All species	825,187	4,289	92,527	177,818	43,988	51,977	189,104	265,484

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 40. -- Net volume of short-log trees (cull volume) in thousand cubic feet on timberland by species group and diameter class, North Dakota, 1994

Species group	All classes	Diameter class (inches at breast height)							
		9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Other softwoods	111	111	--	--	--	--	--	--	--
Total softwoods	111	111	--	--	--	--	--	--	--
Hardwoods									
Bur oak	6,078	--	3,266	1,480	582	247	290	213	--
Basswood	1,291	--	416	--	202	--	673	--	--
Elm	4,350	--	1,251	520	474	671	514	920	--
Green ash	6,686	--	3,496	987	813	763	158	--	469
Cottonwood	2,299	--	450	419	--	156	--	1,027	247
Hackberry	225	--	--	--	--	--	225	--	--
Balsam poplar	231	--	--	172	59	--	--	--	--
Quaking aspen	1,603	--	1,322	117	164	--	--	--	--
Paper birch	132	--	132	--	--	--	--	--	--
Other hardwoods 1	2,794	--	510	426	477	256	441	684	--
Total hardwoods	25,689	--	10,843	4,121	2,771	2,093	2,301	2,844	716
All species	25,800	111	10,843	4,121	2,771	2,093	2,301	2,844	716

1 All other hardwood volume is boxelder.

Table 41. -- Net volume of short-log trees (cull volume) in thousand board feet 1 on timberland by species group and diameter class, North Dakota, 1994

Species group	All classes	Diameter class (inches at breast height) 9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Other softwoods	494	494	--	--	--	--	--	--	--
Total softwoods	494	494	--	--	--	--	--	--	--
Hardwoods									
Bur oak	13,621	--	6,990	3,369	1,387	601	728	546	--
Basswood	2,698	--	803	--	425	--	1,470	--	--
Elm	10,951	--	2,810	1,264	1,192	1,754	1,381	2,550	--
Green ash	13,751	--	6,761	2,040	1,751	1,693	360	--	1,146
Cottonwood	7,496	--	1,121	1,258	--	502	--	3,652	963
Hackberry	607	--	--	--	--	--	607	--	--
Balsam poplar	561	--	--	415	146	--	--	--	--
Quaking aspen	3,126	--	2,537	240	349	--	--	--	--
Paper birch	304	--	304	--	--	--	--	--	--
Other hardwoods 2	8,532	--	1,405	1,234	1,441	790	1,397	2,265	--
Total hardwoods	61,647	--	22,731	9,820	6,691	5,340	5,943	9,013	2,109
All species	62,141	494	22,731	9,820	6,691	5,340	5,943	9,013	2,109

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 42. -- Current annual net growth of growing stock and sawtimber on timberland, 1980 and 1993, and average annual net growth of growing stock and sawtimber, 1980-1993 by softwoods and hardwoods, North Dakota

Softwoods and hardwoods	Growing stock: Current annual net growth 1980	Growing stock: Average annual net growth 1980-1993	Growing stock: Current annual net growth 1993	Sawtimber: Current annual net growth 1980	Sawtimber: Average annual net growth 1980-1993	Sawtimber: Current annual net growth 1993
	(In thousand cubic feet)			*(In thousand board feet)1*		
State total						
Softwoods	155	107	161	766	115	854
Hardwoods	6,509	6,556	7,584	24,014	24,735	25,242
Total	6,664	6,663	7,745	24,780	24,850	26,096

1 International 1/4-inch rule.

Table 43. -- Average annual net growth of growing stock on timberland by species group and local forest type, North Dakota, 1980-1993

(In thousand cubic feet)

Species group	All types	Local forest type							
		Ponderosa pine	Rocky Mountain juniper	Bur oak	Cottonwood	Elm-ash-cottonwood	Basswood	Aspen-birch	Elm-ash
Softwoods									
Ponderosa pine	23	23	--	--	--	--	--	--	--
Other softwoods	84	--	54	--	3	--	--	--	27
Total softwoods	107	23	54	--	3	--	--	--	27
Hardwoods									
Bur oak	1,021	--	--	639	--	13	75	210	84
Basswood	133	--	--	17	--	12	75	--	29
Elm	-436	--	--	-46	4	-149	-79	35	-201
Green ash	2,063	--	7	426	81	24	28	271	1,226
Cottonwood	1,163	--	--	--	992	87	--	--	84
Hackberry	18	--	--	--	--	--	1	--	17
Balsam poplar	453	--	--	-15	--	--	--	475	-7
Quaking aspen	1,844	--	--	3	--	--	--	1,849	-8
Paper birch	-48	--	--	-25	--	--	--	-23	--
Other hardwoods 1	345	--	--	--	61	51	11	--	222
Total hardwoods	6,556	--	7	999	1,138	38	111	2,817	1,446
All species	6,663	23	61	999	1,141	38	111	2,817	1,473

1 All other hardwood volume is boxelder.

Table 44. -- Average annual net growth of sawtimber on timberland by species group and local forest type, North Dakota, 1980-1993

(In thousand board feet)1

Species group	All types	Local forest type: Ponderosa pine	Bur oak	Cottonwood	Elm-ash-cottonwood	Basswood	Aspen-birch	Elm-ash
Softwoods								
Ponderosa pine	88	88	--	--	--	--	--	--
Other softwoods	27	--	--	--	--	--	--	27
Total softwoods	115	88	--	--	--	--	--	27
Hardwoods								
Bur oak	3,805	--	2,336	--	72	571	301	525
Basswood	1,058	--	399	--	-9	464	--	204
Elm	-2,491	--	-343	--	-353	-286	133	-1,642
Green ash	6,816	--	450	155	63	169	427	5,552
Cottonwood	6,660	--	--	5,730	458	--	--	472
Hackberry	6	--	--	--	--	6	--	--
Balsam poplar	2,454	--	-25	--	--	--	2,319	160
Quaking aspen	5,551	--	66	--	--	--	5,456	29
Paper birch	-36	--	--	--	--	--	-36	--
Other hardwoods 2	912	--	--	37	92	26	--	757
Total hardwoods	24,735	--	2,883	5,922	323	950	8,600	6,057
All species	24,850	88	2,883	5,922	323	950	8,600	6,084

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 45. -- Current annual net growth of growing stock on timberland by species group and local forest type, North Dakota, 1993

(In thousand cubic feet)

Species group	All types	Local forest type							
		Ponderosa pine	Rocky Mountain juniper	Bur oak	Cottonwood	Elm-ash-cottonwood	Basswood	Aspen-birch	Elm-ash
Softwoods									
Ponderosa pine	77	77	--	--	--	--	--	--	--
Other softwoods	84	--	54	--	3	--	--	--	27
Total softwoods	161	77	54	--	3	--	--	--	27
Hardwoods									
Bur oak	1,017	--	--	634	--	24	49	194	116
Basswood	192	--	--	52	--	19	99	--	22
Elm	71	--	--	41	8	-41	-20	-1	84
Green ash	2,432	--	7	677	85	34	24	264	1,341
Cottonwood	727	--	--	--	661	17	--	--	49
Hackberry	14	--	--	--	--	--	1	--	13
Balsam poplar	480	--	--	-5	--	--	--	455	30
Quaking aspen	1,962	--	--	34	--	--	--	1,758	170
Paper birch	212	--	--	12	--	--	--	200	--
Other hardwoods 1	477	--	--	--	78	183	7	--	209
Total hardwoods	7,584	--	7	1,445	832	236	160	2,870	2,034
All species	7,745	77	61	1,445	835	236	160	2,870	2,061

1 All other hardwood volume is boxelder.

Table 46. -- Current annual net growth of sawtimber on timberland by species group and local forest type, North Dakota, 1993

(In thousand board feet)1

Species group	All types	Local forest type: Ponderosa pine	Bur oak	Cottonwood	Elm-ash-cottonwood	Basswood	Aspen-birch	Elm-ash
Softwoods								
Ponderosa pine	540	540	--	--	--	--	--	--
Other softwoods	314	--	--	--	--	--	--	314
Total softwoods	854	540	--	--	--	--	--	314
Hardwoods								
Bur oak	3,930	--	2,602	--	135	423	164	606
Basswood	1,232	--	393	--	58	656	--	125
Elm	-1,360	--	-53	8	-278	-81	-44	-912
Green ash	9,530	--	980	206	289	167	327	7,561
Cottonwood	3,819	--	--	3,395	96	--	--	328
Hackberry	137	--	--	--	--	6	--	131
Balsam poplar	1,687	--	-25	--	--	--	1,564	148
Quaking aspen	4,815	--	24	--	--	--	4,759	32
Paper birch	103	--	--	--	--	--	103	--
Other hardwoods 2	1,349	--	--	7	146	4	7	1,185
Total hardwoods	25,242	--	3,921	3,616	446	1,175	6,880	9,204
All species	26,096	540	3,921	3,616	446	1,175	6,880	9,518

1 International 1/4-inch rule.

2 All other hardwood volume is boxelder.

Table 47. -- Current annual net growth, current annual mortality, and current annual removals of growing stock and sawtimber on timberland by species group, North Dakota, 1993

	Growing stock			Sawtimber		
Species group	Current annual net growth 1 1993	Current annual mortality 1993	Current annual removals 2 1993	Current annual net growth 1 1993	Current annual mortality 1993	Current annual removals 2 1993
	(In thousand cubic feet)			*(In thousand board feet)3*		
Softwoods						
Ponderosa pine	77	--	5	540	--	27
Other softwoods	84	--	--	314	--	--
Total softwoods	161	--	5	854	--	27
Hardwoods						
Bur oak	1,017	4	309	3,930	35	472
Basswood	192	62	95	1,232	279	474
Elm	71	612	165	-1,360	2,826	590
Green ash	2,432	338	128	9,530	529	288
Cottonwood	727	855	583	3,819	3,500	2,877
Hackberry	14	--	--	137	10	--
Balsam poplar	480	342	4	1,687	685	*
Quaking aspen	1,962	1,981	218	4,815	3,475	195
Paper birch	212	35	7	103	67	*
Other hardwoods 4	477	181	49	1,349	569	144
Total hardwoods	7,584	4,410	1,558	25,242	11,975	5,040
All species	7,745	4,410	1,563	26,096	11,975	5,067

*** Less than 500 board feet.**

1 An estimate of current gross growth may be computed by adding current mortality to current net growth.

2 Based on data from a 1994 pulpwood survey, a 1993 survey of other primary wood-using mills, a 1993 residential fuelwood survey, regional logging utilization studies, and land-us change estimates from the new inventory.

3 International 1/4-inch rule.

4 All other hardwood volume is boxelder.

Table 48. -- Current annual removals for 1980 and 1993, and average annual removals for 1980-1993 from growing stock and sawtimber on timberland, by softwoods and hardwoods, North Dakota

Softwoods and hardwoods	Growing stock: Current annual removals 1980 1	Growing stock: Average annual removals 1980-1993 2	Growing stock: Current annual removals 1993 1	Sawtimber: Current annual removals 1980 1	Sawtimber: Average annual removals 1980-1993 2	Sawtimber: Current annual removals 1993 1
	(In thousand cubic feet)			*(In thousand board feet)3*		
State total						
Softwoods	7	--	5	43	--	27
Hardwoods	1,491	1,573	1,558	2,900	4,262	5,040
Total	1,498	1,573	1,563	2,943	4,262	5,067

1 Based on data from mill surveys and regional logging utilization studies for given years and land use change estimates from the plot inventory.

2 Average of field plot level removals between the study periods

3 International 1/4-inch rule.

Table 49. -- Current annual mortality for 1980 and 1993, and average annual mortality for 1980-1993 of growing stock and sawtimber on timberland by softwoods and hardwoods, North Dakota

Softwoods and hardwoods	Growing stock			Sawtimber		
	Current annual mortality	Average annual mortality	Current annual mortality	Current annual mortality	Average annual mortality	Current annual mortality
	1980	1980-1993	1993	1980	1980-1993	1993
	(In thousand cubic feet)			*(In thousand board feet)1*		
State total						
Softwoods	--	--	--	--	--	--
Hardwoods	4,061	4,639	4,410	9,576	9,998	11,975
Total	4,061	4,639	4,410	9,576	9,998	11,975

1 International 1/4-inch rule.

Table 50. -- Current annual removals of growing stock and sawtimber on timberland by species group, product, logging residue, and other removals, North Dakota, 1993

Species group	All removals	Growing stock: Product: All product removals	Saw logs	Composite products 1	Fuelwood	Posts, poles, & pilings	Misc. products	Nonproduct removals: Logging residue	Other removals
	(In thousand cubic feet)								
Softwoods									
Ponderosa pine	5	5	1	--	--	--	4	*	--
Total softwoods	5	5	1	--	--	--	4	*	--
Hardwoods									
Bur oak	309	14	13	--	1	--	--	2	293
Basswood	95	16	16	--	--	--	--	3	76
Elm	165	9	4	--	5	--	--	1	155
Green ash	128	8	8	--	--	--	--	1	119
Cottonwood	583	397	394	--	3	--	--	79	107
Balsam poplar	4	--	--	--	--	--	--	--	4
Quaking aspen	218	156	1	155	--	--	--	10	52
Paper birch	7	*	--	--	--	*	--	*	7
Other hardwoods 3	49	--	--	--	--	--	--	--	49
Total hardwoods	1,558	600	436	155	9	*	--	96	862
All species	1,563	605	437	155	9	*	4	96	862

Species group	All removals	Sawtimber: Product: All product removals	Saw logs	Composite products 1	Fuelwood	Posts, poles, & pilings	Misc. products	Nonproduct removals: Logging residue	Other removals
	(In thousand board feet)2								
Softwoods									
Ponderosa pine	27	27	5	--	--	--	22	*	--
Total softwoods	27	27	5	--	--	--	22	*	--
Hardwoods									
Bur oak	472	75	73	--	2	--	--	4	393
Basswood	474	86	86	--	--	--	--	11	377
Elm	590	38	25	--	13	--	--	3	549
Green ash	288	44	44	--	--	--	--	2	242
Cottonwood	2,877	2,105	2,095	--	10	--	--	259	513
Balsam poplar	*	*	--	*	--	--	--	--	--
Quaking aspen	195	185	3	182	--	--	--	10	--
Paper birch	*	*	--	--	--	*	--	--	--
Other hardwoods 3	144	--	--	--	--	--	--	--	144
Total hardwoods	5,040	2,533	2,326	182	25	*	--	289	2,218
All species	5,067	2,560	2,331	182	25	*	22	289	2,218

*** Less than 1/2 unit of measure.**

1 Includes chip board, wafer board, particle board, engineered lumber, etc.

2 International 1/4-inch rule.

3 All other hardwood volume is boxelder.

Table 51. -- Total volume of wood fiber used by product, softwoods and hardwoods, and source of material, North Dakota, 1993

Product and softwoods and hardwoods	Standard units	Total		Source of material: Roundwood products: Growing stock		Source of material: Roundwood products: Nongrowing stock		Source of material: Plant byproducts 1	
		Number of units	Thousand cubic feet 2	Number of units	Thousand cubic feet	Number of units	Thousand cubic feet	Number of units	Thousand cubic feet
Saw logs									
Softwoods	Thousand	5	1	5	1	*	*	--	--
Hardwoods	board feet 3	2,605	457	2,497	436	108	21	--	--
Total		2,610	458	2,502	437	108	21	--	--
Composite products4									
Hardwoods	Standard	2,500	187	2,067	155	433	32	--	--
Total	cords	2,500	187	2,067	155	433	32	--	--
Fuelwood									
Softwoods	Standard	1,482	103	--	--	1,462	102	20	1
Hardwoods	cords	35,571	2,491	125	9	32,608	2,283	2,838	199
Total		37,053	2,594	125	9	34,070	2,385	2,858	200
Posts, poles and pilings									
Hardwoods	Thousand	17	17	*	*	17	17	--	--
Total	cubic feet	17	17	*	*	17	17	--	--
Miscellaneous products									
Softwoods	Thousand	4	4	4	4	*	*	--	--
Hardwoods	cubic feet	73	73	--	--	--	--	73	73
Total		77	77	4	4	*	*	73	73
All products									
Softwoods	Thousand				5		102		1
Hardwoods	cubic feet				600		2,353		272
Total					605		2,455		273

*** Less than 1/2 unit of measure.**

1 Includes coarse and fine wood residues.

2 Column should not be added to avoid double counting volume.

3 International 1/4-inch rule.

4 Includes chip board, wafer board, particle board, engineered lumber, etc.

Table 52. -- Output of roundwood products by product, softwoods and hardwoods, and source of material, North Dakota, 1993

(In thousand cubic feet)

Product by softwoods and hardwoods	All sources	Source of material			
		Growing stock			Non-growing stock
		Total	Sawtimber	Poletimber	
Saw logs					
Softwoods	1	1	1	*	*
Hardwoods	457	436	411	25	21
Total	458	437	412	25	21
Composite products1					
Hardwoods	187	155	30	125	32
Total	187	155	30	125	32
Fuelwood					
Softwoods	102	--	--	--	102
Hardwoods	2,292	9	5	4	2,283
Total	2,394	9	5	4	2,385
Posts, poles and pilings					
Hardwoods	17	*	*	*	17
Total	17	*	*	*	17
Miscellaneous products					
Softwoods	4	4	4	*	*
Total	4	4	4	*	*
All products					
Softwoods	107	5	5	*	102
Hardwoods	2,953	600	446	154	2,353
Total	3,060	605	451	154	2,455

*** Less than 500 cubic feet.**

1 Includes chip board, wafer board, particle board, engineered lumber, etc.

Table 53. -- Timber products from roundwood by species group and product, North Dakota, 1993

Species group	All products	Product							
		Saw logs		Composite products 1		Fuelwood		Posts, poles, and pilings	Misc. products
	Thousand cubic feet	Thousand cubic feet	Thousand board feet 2	Thousand cubic feet	Standard cords	Thousand cubic feet	Standard cords	Thousand cubic feet	Thousand cubic feet
Softwoods									
Ponderosa pine	5	1	5	--	--	--	--	--	4
Other softwoods	102	--	--	--	--	102	1,462	--	--
Total softwoods	107	1	5	--	--	102	1,462	--	4
Hardwoods									
Bur oak	264	13	80	--	--	247	3,524	4	--
Basswood	17	17	96	--	--	--	--	--	--
Elm	784	5	29	--	--	779	11,124	--	--
Green ash	403	8	48	--	--	382	5,453	13	--
Cottonwood	1,044	413	2,349	--	--	631	9,019	--	--
Willow	17	--	--	--	--	17	242	--	--
Quaking aspen	235	1	3	187	2,500	47	670	--	--
Paper birch	49	--	--	--	--	49	706	*	--
Other hardwoods	118	--	--	--	--	118	1,679	--	--
Total hardwoods	2,931	457	2,605	187	2,500	2,270	32,417	17	--
Noncommercial species	22	--	--	--	--	22	317	--	--
All species	3,060	458	2,610	187	2,500	2,394	34,195	17	4

*** Less than 500 cubic feet.**

1 Includes chip board, wafer board, particle board, engineered lumber, etc.

2 International 1/4-inch rule.

Table 54. -- All live tree aboveground biomass on timberland by species group and local forest type, North Dakota, 1994

(In green tons)

		Local forest type									
Species group	All types	Ponderosa pine	Rocky Mountain juniper	Bur oak	Cottonwood	Elm-ash-cottonwood	Wiillow	Basswood	Aspen-birch	Elm-ash	Non-stocked
Softwoods											
Ponderosa pine	68,761	68,761	--	--	--	--	--	--	--	--	--
Other softwoods	133,592	294	68,958	--	10,333	--	--	--	--	54,007	--
Total softwoods	202,353	69,055	68,958	--	10,333	--	--	--	--	54,007	--
Hardwoods											
Bur oak	4,438,411	--	--	3,001,174	--	63,379	--	182,231	607,981	583,646	--
Basswood	590,178	--	--	120,005	--	28,722	--	355,555	--	85,896	--
Elm	1,866,757	--	--	89,499	9,375	171,868	--	44,698	86,307	1,465,010	--
Green ash	5,476,259	4,321	8,348	757,249	191,230	256,702	--	86,199	478,654	3,693,556	--
Cottonwood	3,499,651	--	--	--	2,520,162	97,977	--	--	59	881,453	--
Hackberry	41,242	--	--	--	--	--	--	3,795	--	37,447	--
Balsam poplar	1,033,351	--	--	39,426	--	--	--	--	923,096	70,829	--
Quaking aspen	5,175,772	--	--	96,040	247	--	--	--	4,837,396	242,089	--
Paper birch	278,779	--	--	35,281	--	--	--	--	243,498	--	--
Other hardwoods	2,278,563	--	--	41,773	253,086	287,565	--	30,741	44,866	1,620,532	--
Total hardwoods	24,678,963	4,321	8,348	4,180,447	2,974,100	906,213	--	703,219	7,221,857	8,680,458	--
Noncommercial species	629,752	--	--	14,627	46,119	42,413	206,778	2,528	20,782	296,505	--
All species	25,511,068	73,376	77,306	4,195,074	3,030,552	948,626	206,778	705,747	7,242,639	9,030,970	--

Table 55. -- All live tree aboveground biomass on timberland by species group and tree biomass component, North Dakota, 1994

(In green tons)

		Tree biomass component						
			Growing-stock trees			Non-growing-stock trees		
Species group	All components	All live 1-5-inch trees	Stumps	Boles	Tops and limbs	Stumps	Boles	Tops and limbs
Softwoods								
Ponderosa pine	68,761	4,800	4,063	50,268	6,354	214	2,726	336
Other softwoods	133,592	15,327	4,780	35,700	12,276	5,391	45,975	14,143
Total softwoods	202,353	20,127	8,843	85,968	18,630	5,605	48,701	14,479
Hardwoods								
Bur oak	4,438,411	287,832	184,308	1,805,573	588,395	113,981	1,098,628	359,694
Basswood	590,178	7,632	24,560	312,771	88,601	8,920	116,161	31,533
Elm	1,866,757	183,544	62,293	644,679	187,989	55,790	562,023	170,439
Green ash	5,476,259	466,555	176,115	2,028,253	673,234	130,112	1,513,008	488,982
Cottonwood	3,499,651	50,964	187,605	2,031,865	554,154	39,872	531,762	103,429
Hackberry	41,242	2,368	1,674	16,977	5,379	856	11,087	2,901
Balsam poplar	1,033,351	76,630	36,364	620,575	202,060	4,158	71,296	22,268
Quaking aspen	5,175,772	480,472	167,614	2,445,682	638,557	69,472	1,109,932	264,043
Paper birch	278,779	23,996	11,248	150,020	51,679	2,256	29,303	10,277
Other hardwoods	2,278,563	171,248	36,183	357,449	122,077	105,893	1,135,379	350,334
Total hardwoods	24,678,963	1,751,241	887,964	10,413,844	3,112,125	531,310	6,178,579	1,803,900
Noncommercial species	629,752	70,784	--	--	--	36,211	395,742	127,015
All species	25,511,068	1,842,152	896,807	10,499,812	3,130,755	573,126	6,623,022	1,945,394

Table 56. -- Sampling errors1 for county group totals for area of timberland, volume, average annual net growth, and average annual removals on timberland, North Dakota, 1994

(Sampling error in percent)

		Growing stock			Sawtimber		
County group	Area	Volume	Average annual net growth	Average annual removals	Volume	Average annual net growth	Average annual removals
Red River 2	13.1	16.5	34.3	65.6	17.0	27.1	46.7
Devils Lake & James River 3	23.7	46.2	52.0	--	69.2	*	--
Souris River 4	16.7	20.5	31.7	*	26.1	34.9	92.7
Missouri River 5	12.2	21.2	26.0	95.4	24.3	34.5	*
Statewide	6.2	8.8	12.8	35.5	10.5	15.0	31.2

*** Indicates a sampling error over 99.9 percent.**

1 Sampling error is not calculated when the estimate removals is equal to 0.

2 Red River includes: Barnes, Cavalier, Cass, Eddy, Grand Forks, Griggs, Nelson, Pembina, Ransom, Richland, Sargent, Steele, Traill, and Walsh Counties.

3 Devils Lake & James River includes: Benson, Dickey, Foster, La Moure, Stutsman, Ramsey, Towner, and Wells Counties.

4 Souris River includes: Bottineau, Burke, Divide, McHenry, Pierce, Renville, Rolette, and Ward Counties.

5 Missouri River includes: Adams, Billings, Bowman, Burleigh, Dunn, Emmons, Golden Valley, Grant, Hettinger, Kidder, Logan, McIntosh, McLean, McKenzie, Mercer, Morton, Mountrail, Oliver, Sioux, Sheridan, Slope, Stark, and Williams Counties.

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The third inventory of North Dakota's forests reports 44.1 million acres of land, of which 673 thousand acres are forested. This paper contains detailed tables related to area, volume, growth, removals, mortality, and ownership of North Dakota's forests.

KEY WORDS: Forest area, timber volume, growth, removals, mortality.