The Status of Timber Resources in the North Central United States

FOREST PRODUCTIVITY

The Status of Timber Resources in the North Central United States

A summary of forest conditions, growth, removals, consumption, and opportunities in the 7-State North Central Region

Executive Summary

The North Central Region has 73 million acres of timberland, 14 percent of the Nation's total. The heaviest concentrations of forest are in the northern Lake States and in southern Indiana, Illinois, and Missouri, but the more fragmented forests in the central agricultural belt are also of great importance for timber, wildlife, recreation, watershed protection, and biodiversity.

The volume of standing timber in the region has more than doubled in the past five decades (from 37 to 84 billion cubic feet of growing stock on timberland) because annual growth has substantially exceeded reductions due to mortality, timber harvest, and land conversion. This pattern is consistent for each of the seven states in the region. Annual net growth of growing stock on timberland is 2.3 billion cubic feet and annual removals are 1.1 billion cubic feet. Thus the rate of timber growth is twice the rate of harvest.

There are more than 2,000 primary wood-processing mills in the region (sawmills, pulp mills, veneer mills, stave mills, particleboard mills, post and pole mills). Approximately one-third of the harvested timber is used for saw logs, one-third is used for pulp, and the remaining third is used primarily for veneer, composite materials, and fuel.

The region has 46 million people who each consume the equivalent of 73 cubic feet of wood each year, wood that is used for paper, packaging, lumber, plywood, particle board, housing, fuel, and shipping. The net result is a demand for 3.4 billion cubic feet of wood annually or about 17 percent of the Nation's total consumption. That is far more wood than we currently grow, harvest, or process in the region.

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Most of us don't think very much about the relationship between our consumption of forest products and the related impacts on forests. Yet the relationship is direct: wood is harvested to supply the products that we rely upon for daily living. In the next 50 years U.S. demand for wood and wood fiber is expected to increase by 40 percent, primarily due to an increasing population rather than increasing per capita consumption. The southern U.S. is expected to remain the Nation's major wood-producing region, and net imports of wood and wood products (the net balance of imports less exports) are expected to increase from 9 to 18 percent of total consumption.

The combination of domestic production and imports is expected to meet our future demand for wood and fiber, but our regional patterns of wood production and consumption have implications for forest sustainability. Forest sustainability issues (inclusive of wildlife, water, recreation, biodiversity, and environmental services) will continue to be raised in each of the major wood-producing regions of the U.S. and the world. What role and responsibility do we have in the North Central Region for meeting the current and future wood demands of people who live here?

In the North Central Region, we have 17 percent of the Nation's population and 14 percent of its timberland, and we consume 17 percent of the Nation's wood. Yet we grow only 10 percent of the Nation's wood and harvest only 7 percent of its wood. How much wood *could* we produce in the North Central Region under

different management strategies? Could we produce a volume of wood and fiber that is commensurate with what we consume? Or alternatively could we produce a volume of wood that is commensurate with our proportion of the Nation's timberland? A failure to balance growth and harvest with consumption of forest resources in one region shifts the impacts of harvesting and production to other regions of the U.S. or to other countries. When those of us who live in the North Central Region consume wood or wood products from other regions of the U.S. or other nations, we also export the environmental and social consequences associated with timber harvesting and processing (both positive and negative consequences).

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In the North Central Region, we cannot expect to be able to produce all of the many different kinds of forest products that we consume, but we can consider what proportion of the total volume of wood that we consume could be produced within the region (on a volume equivalent basis rather than for individual products). If we grow and process more timber in the North Central Region, how will our forests be affected? In our discussions of sustainability, we could begin to consider the implications of various levels of regional forest growth and harvest relative to consumption of wood products. Linking growth, removals, and consumption of forest products provides a broad framework for discussing issues of timber productivity and forest sustainability locally, regionally, and nationally.

There are many ways to alter the current balance among growth, harvest, and consumption of timber. Consumers, resource managers/owners, manufacturers, and elected officials can all have an impact. Research has a role in providing relevant information about tradeoffs and new technologies.

Consumers can

- Consume less
- Recycle more
- Increase or decrease consumption of wood realtive to alternative products and commodities

Resource managers/owners can

- Increase forest growth per acre through improved management of natural forests
- Increase forest growth per acre through intensive plantation culture
- Increase the number of forested acres in production through tree planting and agro-forestry
- Change the amount of wood they sell

Manufacturers can

- Increase the efficiency of converting wood into products
- Engineer products that extend the utility of a given amount of harvested timber

Elected officials can enact laws or establish policies that

- Affect forestry practices
- Affect the economics of forest management, timber harvesting, or manufacturing
- Affect consumers
- Affect research and information delivery

All of us can work on formulating and discussing the issues.

Introduction

In 2000, the North Central Research Station established the Forest Productivity Integrated Research Program. This program combines the efforts of scientists from across the Station's 14 research work units to examine the current condition of the forests in the North Central Region and their prospects for producing wood and fiber. The integrated program is designed to

- Characterize current patterns of forest productivity and forest product consumption within the North Central Region
- Assess and evaluate environmental and social consequences of forest production practices and opportunities in the North Central Region
- Implement research and develop new technologies to increase forest productivity

In the coming decades the demand for wood, fiber, and other forest products and amenities will increase as our population grows. Americans will consume ever-increasing quantities of timber products, many with the knowledge that wood and wood fiber are recyclable and more environmentally benign than most other materials that are commonly used as substitutes. At the same time, changes in land use patterns and social preferences will affect the area of lands managed for forest products and will affect methods of management.

We depend on forests to provide a myriad of values. These include traditional values such as wood products, wildlife, recreation, aesthetics, and clean water as well as environmental services such as conserving biodiversity and moderating global climate change. Resource managers try to ensure that none of these benefits are diminished over time. Nevertheless, land managers—particularly managers of public lands—often face disagreements about suitable forest management and timber harvesting practices. What is our role, at the regional and State level, in supplying the current and future timber needs of the Nation? How much wood do the forests in the region grow each year? How much is harvested and made into products? How does that volume compare with the volume of wood and wood fiber we consume? What is the current relationship among timber growth, harvest, consumption, and sustainability in the North Central Region? In the coming decades as our increasing population requires more wood and fiber, what are our opportunities for meeting those needs, and what are our responsibilities?

This paper provides information relevant to discussion of these questions. It is an overview of timber resources in the North Central Region and a first product of the Forest Productivity Integrated Research Program. This document examines the wood and fiber that the forests of the North Central Region currently provide. It also examines consumption of wood products by the people who live in the region and the balance among growth, harvest, and consumption. Currently the people who live in the North Central Region consume a far greater volume of wood than is harvested and processed within the region. Consequently, the environmental and economic impacts of that consumption (both positive and negative) are shifted to other wood-producing regions of the U.S. and to other nations. This document helps frame the timber productivity trends in the North Central Region in a national context. More importantly it suggests some different ways to think about the timber resources of the region and our local role (current and future) in providing wood, fiber, and other forest products and amenities for the Nation.

Statistics used in this assessment were compiled from several sources. Primary sources are the periodic State forest inventory reports and online databases produced by the Forest Inventory and Analysis unit of the North Central Research Station. Additional statistics were drawn from national reports produced at the USDA Forest Service Forest Products Laboratory in Madison, Wisconsin, and from documents prepared to meet the Resources Planning Act (RPA) requirements. These and other references are listed at the end of this document.

Research on forest productivity at the North Central Research Station.

At the North Central Research Station, much of our work is directed at improving forest productivity for the wide range of commodities and amenities that forests provide. Much of that research is carried out in cooperation with universities and other agencies. New and ongoing research aimed at increasing timber productivity includes

- *developing new inventory and analysis methods that provide more timely estimates of forest growth and harvest*
- *developing short-rotation, intensive-culture techniques that vastly increase the amount of wood fiber that can be produced per acre*
- *testing methods to efficiently establish forests in flood plains and on former agricultural lands*
- *designing management practices to increase wood production on millions of acres of natural forests*
- *assessing benefits of applying best management practices to riparian forests*
- *measuring the effects of soil compaction and loss of organic matter on forest growth*
- *understanding public perceptions and acceptance of alternative management practices*
- *understanding the effects of climate and micro-climate on forest regeneration and growth*
- *quantifying potential insect and disease impacts on forest productivity*
- *developing techniques to minimize losses to insects and disease*
- *applying genetic selection to increase tree disease resistance, growth, and value*
- *understanding the effects of suburban and rural development on forest resources*
- *creating timely methods to deliver knowledge to forest owners and managers*

Where Is The Timber Resource?

Thirty percent of the seven-State North Central Region is covered by forest (figure 1). That proportion is similar to the rest of the United States (33% forested), North America (26% forested), and the world (30% of land area forested).

Timberlands are concentrated in the northern Lake States and in southern Missouri, Illinois, and Indiana. The North Central Region has 14 percent of the Nation's timberland.

Of the North Central Region's 77 million acres of forest land, 73 million acres (95%) are classified as timberland (figure 2). Timberland[1] is forest land that is productive enough to grow trees of commercial value where timber harvesting is not restricted by legislation or administrative action. The timberlands are concentrated in the northern Lake States and in southern Missouri, Illinois, and Indiana. Here the combination of soils, topography, and climate are not amenable to agriculture, which dominates the central portion of the region.

The proportion of timberland in the North Central Region (28 percent of all land) is somewhat greater than for the Nation as a whole because forests in the region have relatively high productivity and comparatively few areas where harvesting is restricted (e.g., parks and wilderness) (figure 3). Thus, the North Central Region includes 11 percent of the Nation's land area, 10 percent of the Nation's forest land, and 14 percent of the Nation's timberland (table 1). This resource exists in a region that has 17 percent of the Nation's population.

In 1630, an estimated 60 percent of the region was covered by forest. Today, forest cover is half that amount, reduced over the years by conversion of forests to agriculture and to residential and commercial development. However, over the past 50 years, the area of forest land in the region has increased by 1 percent (0.6 million acres) because cleared lands, grasslands, and wooded pastures have developed forest cover. This process has been facilitated by the control of wildfires and fluctuations in agricultural markets. The latest National projections from the Resources Planning Act (RPA) anticipate a decrease of 4 percent in timberland area in the region through 2050, due in large part to urban and suburban development and parcelization of rural timberland.

Forests provide many values other than timber, including wildlife habitat, recreation, clean water, and ecological services such as storing carbon or harboring biodiversity. These functions also tend to be concentrated in the northern and southern parts of the region. However, due to the lack of forest land in the central part of the region, forests there are particularly important in increasing local biodiversity. There the forests are often associated with streams or rivers, and the location of major river systems in the central part of the region can be identified in the linear patterns of forest cover (figure 1).

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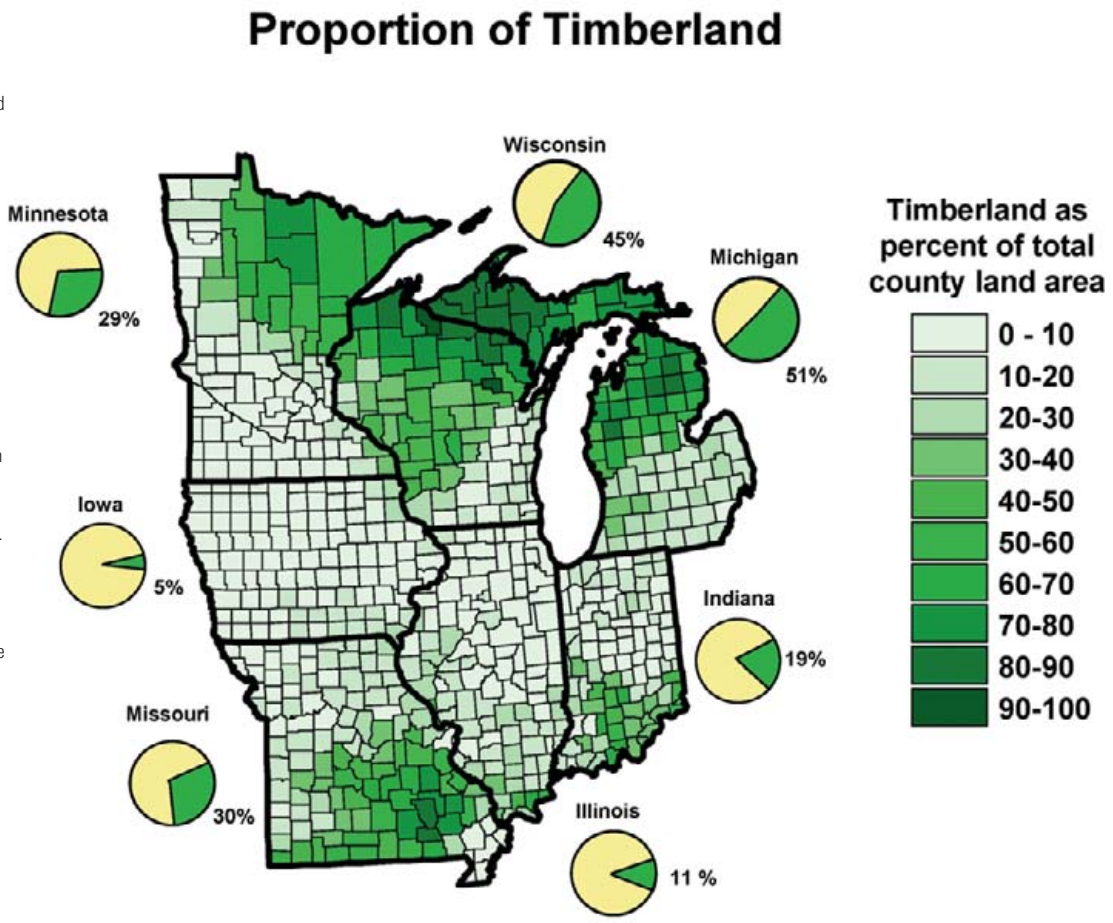
[1]*See the glossary for a full definition of this and other technical terms.*

Figure 1.—Forest cover in the North Central Region. Forest land (shaded) covers 77 million acres or 30 percent of the land in this region. Corridors of riparian (riverside) forest are visible throughout the agricultural zones in the central part of the region. Riparian forests are very important ecologically even though they represent a small portion of the total area of forest land.

Figure 2.—Timberland as a proportion of county land area. Timberland is forest land that is capable of growing commercial crops of timber and not legislatively or administratively restricted from that purpose. In the North Central Region, 73 million acres are classified as timberland with the greatest concentrations in the northern Lake States and in southern Missouri, Illinois, and Indiana. Timberland covers 28 percent of the total land area, a greater proportion than for the Nation as a whole. County names are shown in the appendix.



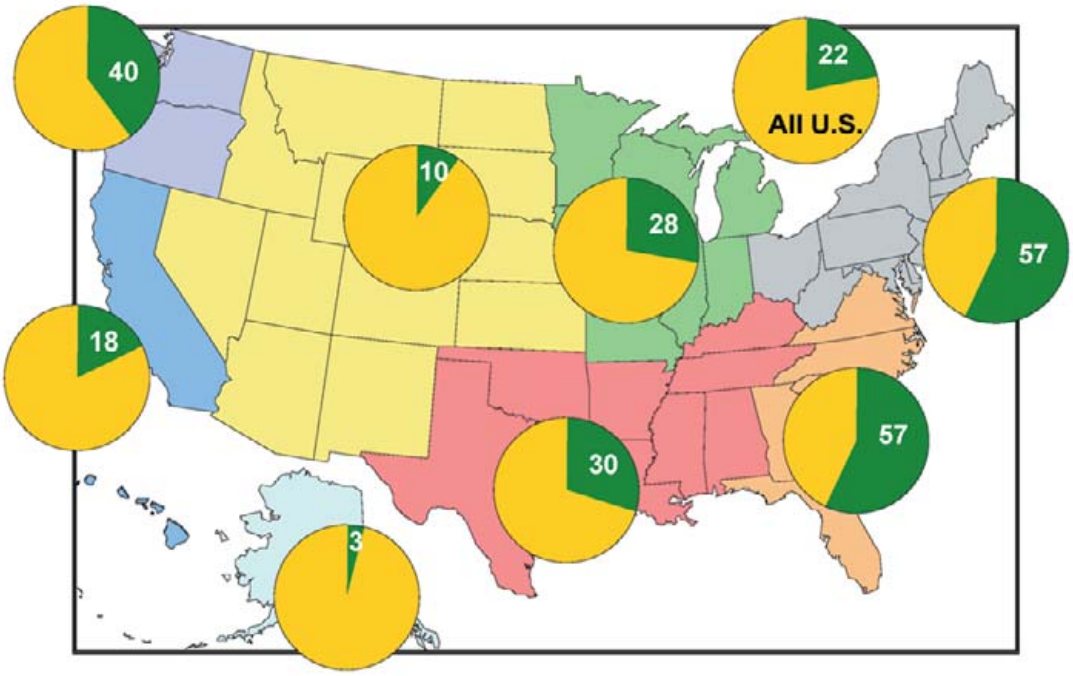


Figure 3.—Timberland as a proportion of all land for major regions of the United States. The proportion of timberland area ranges from 10 percent or less in Alaska and the interior west to 57 percent in the Northeast and the Southeast.

Table 1.—Area of forest land, timberland, and agricultural land in the North Central Region. Table entries are ordered from greatest to least timberland area.

Region	Total land area [a]	Forest land area [a]	Timberland area [a]	Cropland area [b]	Pasture area [b]	Timberland proportion	Rank among U.S. States in timberland area
	- - - - - - - - - -		*Million acres*	- - - - - - - - - -		*Percent*	
Michigan	36	19	19	9	2	51	5th
Wisconsin	35	16	16	11	3	45	14th
Minnesota	51	17	15	21	3	29	17th
Missouri	44	14	13	13	12	30	20th
Indiana	23	5	4	14	2	19	35th
Illinois	36	4	4	24	3	11	37th
Iowa	36	2	2	25	4	5	40th
NC Region total	260	77	73	117	29	28	N/A
U.S. total	2,263	747	504	499	155	22	N/A
NC as % of U.S.	11%	10%	14%	23%	19%	N/A	N/A

[a] From Resources Planning Act statistical summaries, 1997.

[b] From Summary Report 1997 National Resources Inventory, Natural Resources Conservation Service, December 2000.

Who Owns The Timber Resource?

There are more than 1.2 million private nonindustrial forest owners who own 63 percent of the region's timberland. However the 20 percent of owners with the largest holdings control more than 50 percent of that acreage.

Private individuals own 62 percent of the timberland in the North Central Region, but the proportion by State varies from 39 percent in Minnesota to more than 80 percent in the Central States of Illinois, Indiana, Iowa, and Missouri (figure 4). In the Lake States, public lands make up between 30 and 57 percent of the timberland. Industry timberland is also more prevalent in the Lake States (5 to 8 percent of the total). These ownership patterns reflect the consolidated area of timberland in the northern Lake States, and they affect the way timber is managed and processed in the Lake States relative to the Central States. Throughout the Central States, forests tend to be more dispersed.

There are more than 1.2 million private nonindustrial forest owners in the North Central Region. The sheer number of private owners has always presented challenges to understanding their varied reasons for owning timberland and to disseminating resource management information relevant to their interests. The majority of nonindustrial private timberland owners in the region own fewer that 20 acres each (53% of owners in the Lake States; 67% in the Central States). However, in combination, these numerous small ownerships make up less than 15 percent of the total area of nonindustrial private timberland. More than half of the acres owned by private nonindustrial owners are held by the 20% of owners with the largest holdings.

Although the forest management objectives for public and industrial timberlands are usually clearly articulated, nonindustrial private timberland owners vary greatly in their motivation for owning timberland. The primary reasons that these owners list for holding timberland include recreation and association with a farm or residence. Timber production was indicated as the primary reason of ownership for only 1 percent of individual nonindustrial private owners who control about 12 percent of the acreage. Nevertheless, regardless of their primary reason for ownership, a majority of owners controlling a majority of the nonindustrial private acreage indicate that they do plan to harvest timber in the future.

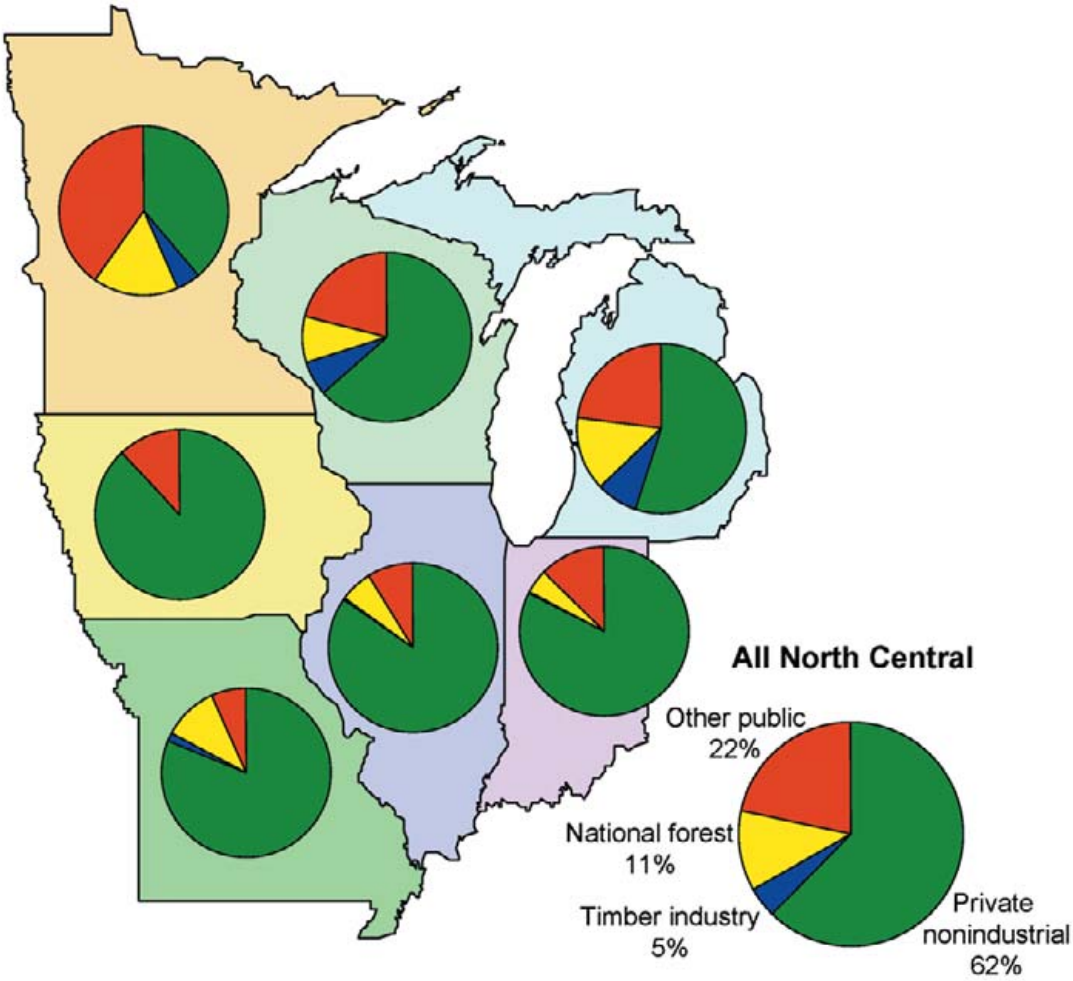


Figure 4.—Proportion of timberland by owner group. The ratio of private to public timberland is substantially greater in the Central States than in the Lake States where State and county ownerships are substantial.

What Are The Dominant Species And Where Do They Occur?

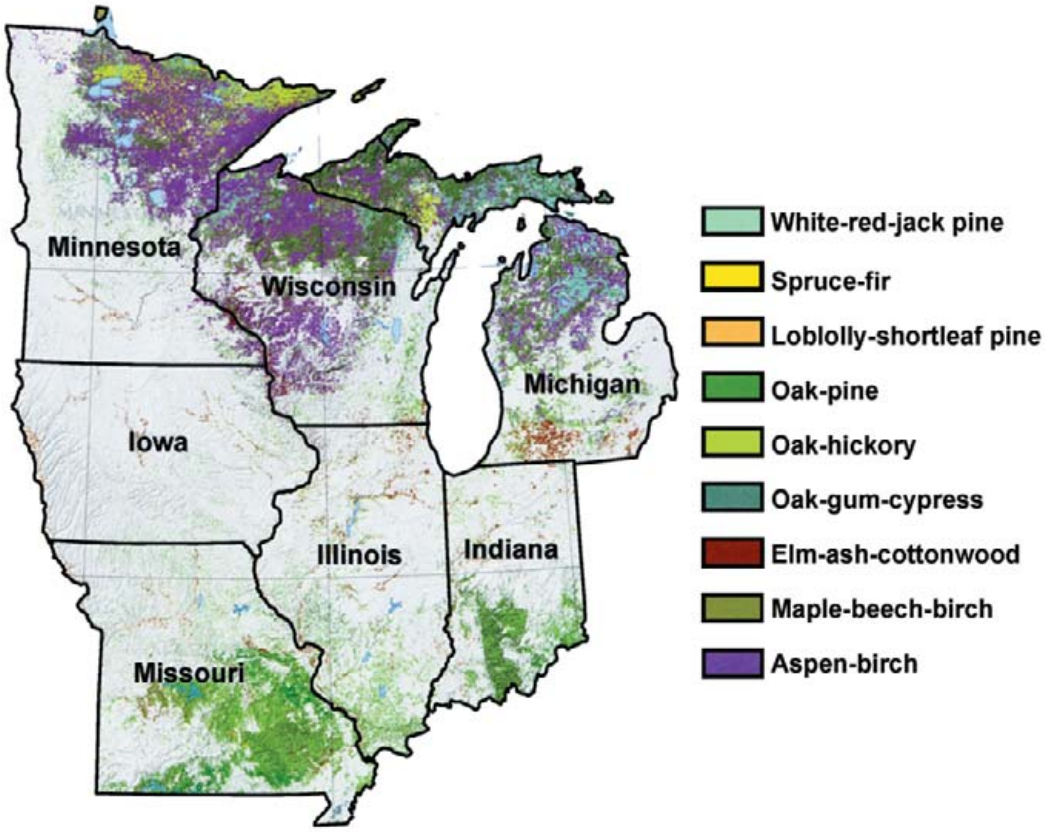
In combination the oak-hickory, maple-beech-birch, and aspen-birch forest types dominate 70 percent of the region's timberland.

Ninety-five percent of the timberland area in the southern part of the region is dominated by hardwood species. In the northern part of the region, the forests include a mix of hardwoods (75%) and conifers (25%). Trees of different species naturally grow together in associations called forest types that are named for the dominant tree species (figure 5).

Oak-hickory is the most abundant forest type in the North Central Region (figure 6) as well as in the U.S. The maple-beech-birch forest type is also abundant throughout the region; it is the most common forest type in Michigan, Wisconsin, and Indiana. Aspen-birch is the most abundant forest type in Minnesota (table 2).

Forest inventories conducted by the North Central Research Station have recorded 124 tree species on timberland in the seven-State region. The tree species that occur with the greatest frequency (trees at least 5 inches in diameter) include quaking aspen (*Populus tremuloides* Michx.), sugar maple (*Acer saccharum* Marsh.), red maple (*Acer rubrum* L.), northern white-cedar (*Thuja occidentalis* L.), white oak (*Quercus alba* L.), and paper birch (*Betula papyrifera* Marsh.). More information on individual tree species and their occurrences can be found in *Silvics of North America* (Burns and Honkala 1990, or online at http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm).

Figure 5.—Spatial distribution of forest cover types in the North Central Region (USDA Forest Service and U.S. Geological Survey).



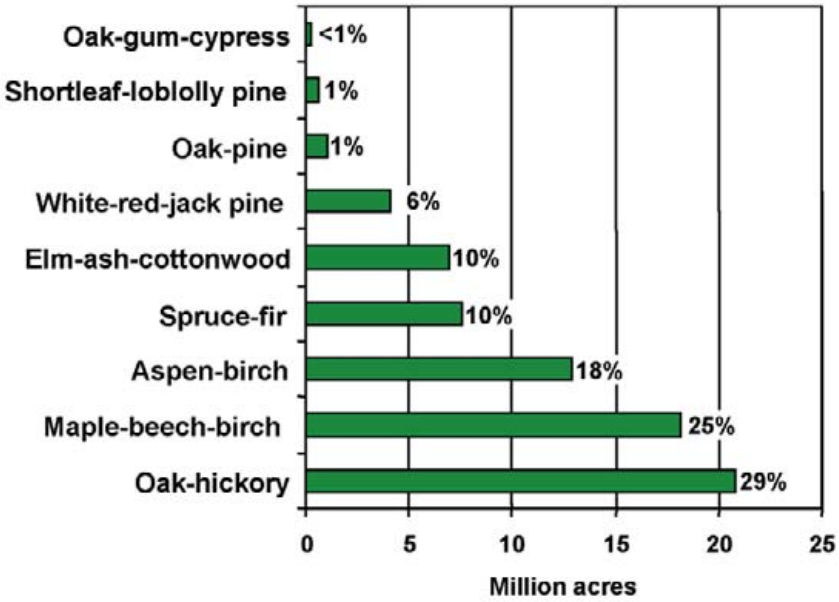


Figure 6.—Area and percentage of timberland by forest cover type in the North Central Region.

Table 2.—Area of timberland (thousand acres) by State and forest type. States are ordered from greatest to least total timberland area.

State (inventory year)	Forest type										
	All	Oak-hickory	Maple-beech-birch	Aspen-birch	Spruce-fir	Elm-ash-cottonwood	White-red-jack pine	Oak-pine	Shortleaf-other pine	Oak-gum-cypress	Non-stocked
	Thousands acres										
Michigan (1993)	18,616	1,982	7,161	3,157	2,673	1,627	1,977	0	0	0	39
Wisconsin (1996)	15,701	2,885	5,300	3,408	1,341	1,528	1,182	0	0	0	57
Minnesota (1990)	14,723	1,166	1,393	6,317	3,556	1,290	897	0	0	0	104
Missouri (1989)	13,371	10,287	993	0	0	618	0	860	458	114	41
Indiana (1998)	4,342	1,597	1,728	7	0	660	30	157	88	43	32
Illinois (1998)	4,087	2,078	866	0	0	906	36	43	31	93	34
Iowa (1990)	1,944	809	576	7	0	495	6	24	24	0	3
North Central total	72,784	20,804	18,018	12,896	7,570	7,124	4,129	1,084	601	250	309

How Much Wood Is In The Forests Of The North Central Region?

The volume of timber on timberland in the North Central Region totals 98 billion cubic feet[2] or about 11 percent of the volume of wood in the U.S. (table 3). If this wood were stacked end-to-end as blocks measuring 1 foot on each side (each block measuring 1 cubic foot of volume), it would reach to the moon and back 39 times. Of that total volume, 84 billion cubic feet or 86 percent is in trees classified as growing stock. These are trees of commercial species that are at least 5 inches in diameter, are free from excessive defect or rot, and currently contain or have the potential to produce at least one 12-foot or two 8-foot logs. The remainder of the volume is in non-growing-stock trees that have shorter boles, are noncommercial species, have poor form, or have substantial decay or defect. Nevertheless, many non-growing-stock trees are also used for products and fuel.

The North Central Region has 98 billion cubic feet of timber, or about 11 percent of the volume of wood in the United States.

Wood is typically measured in cubic feet or board feet. Cubic volume is a good way to measure the total quantity of wood fiber in the merchantable portion of the tree, and cubic foot volume is usually measured for trees larger than 5 inches in diameter[3]. Board foot volume is calculated for growing-stock trees that have reached a minimum diameter (typically 9 to 11 inches d.b.h., depending on species and local markets) (table 4). Board foot volume is a measure of the amount of lumber that could be sawn as solid boards. Weight or biomass of trees is sometimes used to indicate the total amount of fiber or stored carbon; these estimates typically include all trees, regardless of species, size, or wood quality.

Michigan has the greatest volume of wood among States in the North Central Region (ranks ninth in U.S.). Wisconsin, Minnesota, and Missouri fall near the middle among U. S. States in timber volume; Indiana, Illinois, and Iowa rank in the lower third. The volume of wood per county is distributed across the North Central Region in a pattern similar to the area of timberland (figure 7A). However, because counties vary in size and in timberland area, the volume of wood per acre of timberland is also an informative indicator of the character of the forests. Although southern Indiana and Illinois have a relatively low total acreage of timberland, the average volume of wood on each acre of timberland is among the highest in the region because of the high site quality and maturity of the forests there (figure 7B). High quality hardwoods from this part of the region often command a premium price in the market for lumber and veneer.

On a cubic foot basis, the growing-stock volume of quaking aspen and sugar maple exceeds that of all other species, but in combination the volume of oaks is greater than that of any other group of similar species. In terms of board feet, northern red oak, sugar maple, white oak, and quaking aspen have the greatest volume, followed by black oak, red maple, and red pine (table 5).

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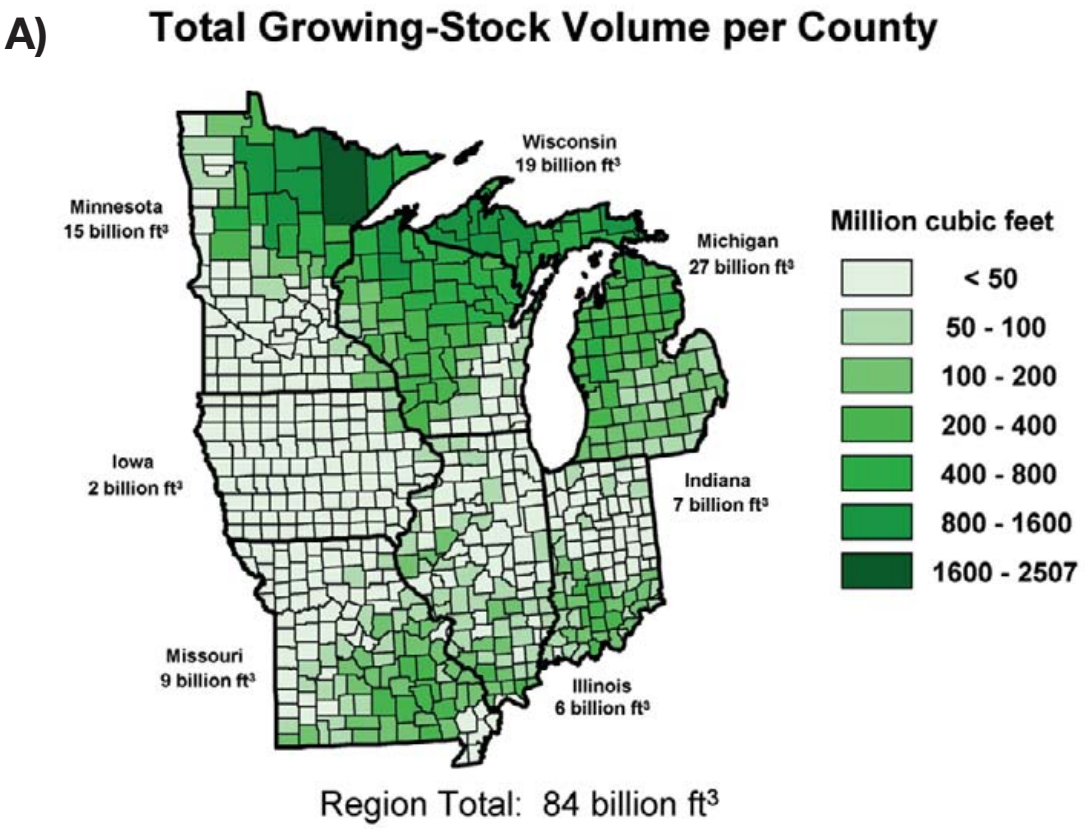
[2] Includes net volume of all trees 5-inches d.b.h. and larger.
[3] By convention, tree diameters are measured at a height of 4.5 feet above the ground. This is commonly termed diameter at breast height or d.b.h.



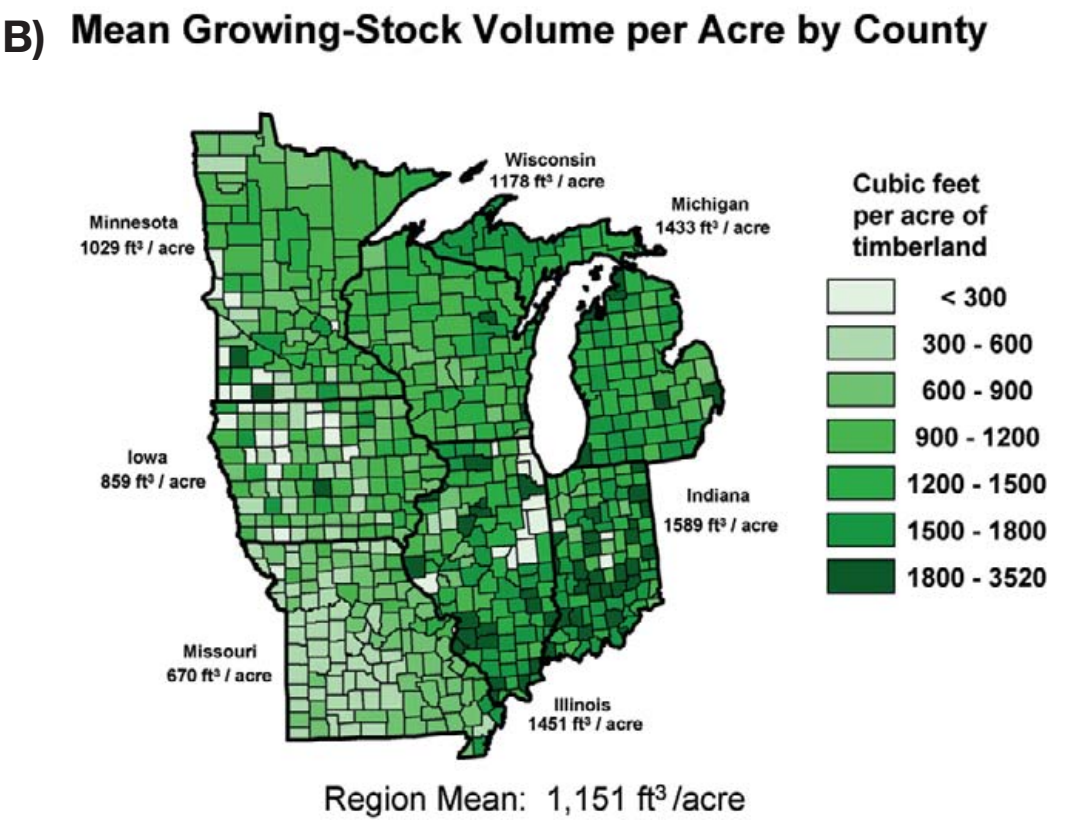


Figure 7.—Regional patterns and variation in volume of growing stock on timberland in the North Central Region. (A) Total volume per county. Totals are influenced by the area of timberland in a county and the volume per acre. (B) Mean volume per acre of timberland. Volumes per acre tend to be largest in Indiana and Illinois where mature forests are growing on highly productive sites. Although the volume of wood per acre of timberland is high, there are relatively few acres of timberland compared to other parts of the region. County names are shown in the appendix.

Table 3.—Cubic foot volume of growing-stock and non-growing-stock trees on timberland by State. States are sorted by decreasing growing-stock volume.

State (inventory year)	Growing-stock volume	Non-growing-stock volume	Total volume	Mean growing-stock volume per acre	Non-growing-stock as proportion of total volume	Rank among 50 States for growing-stock volume
	- - - - *Billion ft³*	- - - -		*ft³*	*Percent*	
Michigan (1993)	27	3	29	1,433	9	9th
Wisconsin (1996)	19	2	21	1,178	11	20th
Minnesota (1990)	15	2	17	1,029	11	25th
Missouri (1989)	9	5	14	670	35	29th
Indiana (1998)	7	1	8	1,589	12	33rd
Illinois (1998)	6	1	7	1,451	11	37th
Iowa (1990)	2	1	3	859	34	42nd
North Central Region	84	14	98	1,151	14	N/A
U. S. [a]	836	50	886	1,760	6	N/A
NC as a % of U.S.	10%	28%	11%	65%	N/A	N/A

[a] From Resources Planning Act statistical summaries, 1997.

Table 4.—Board foot (bd ft) volume (International 1/4-inch scale) and stored carbon in growing-stock trees on timberland by State.

State (inventory year)	Total volume	Average volume per acre	Rank among U.S. States for total bd ft volume	Stored carbon in trees, above and below ground
	Billion bd ft	*Bd ft*		*Million tons*
Michigan (1993)	71	1,928	14th	563
Wisconsin (1996)	48	3,065	22nd	409
Minnesota (1990)	35	2,373	26th	331
Missouri (1989)	26	1,928	32nd	302
Indiana (1998)	26	6,045	30th	170
Illinois (1998)	22	5,353	36th	118
Iowa (1990)	6	2,980	42nd	57
North Central Region	234	3,212	N/A	1,949
U. S. [a]	3,235	6,420	N/A	14,715
NC as a % of U.S.	7%	50%	N/A	13%

[a] From Resources Planning Act statistical summaries, 1997.

Table 5.—Total cubic and board foot volume on timberland for the top 10 species in the North Central Region.[a] Species are sorted in order of decreasing cubic foot volume of growing stock. In combination, these 10 species make up 57 percent of the total cubic foot volume of growing stock and 55 percent of the total board foot volume.

Species	Cubic foot volume of growing-stock trees	Cubic foot volume of non-growing-stock trees	Total cubic foot volume[b]	Non-growing-stock as a proportion of total	Board foot volume[c]
	Billion ft³			*Percent*	*Billion bd ft*
Sugar maple	8	1.0	9	12	18
Quaking aspen	8	0.9	8	10	17
Red maple	6	0.8	6	13	11
Northern red oak	5	0.7	6	12	20
White oak	5	1.3	6	20	18
Black oak	4	1.0	5	23	12
Red pine	3	0.0	3	1	11
Northern white-cedar	3	0.5	4	13	9
Paper birch	3	0.3	3	9	4
American basswood	3	0.3	3	9	8
Total for top 10	47	6.9	54	13	127
All other species	36	7.3	44	17	107

[a] Composite of individual State inventories made between 1989 and 1998.

[b] Includes volume of growing-stock and non-growing-stock trees.

[c] Includes only growing-stock trees. International 1/4-inch scale.

How Much New Wood Do The Forests Grow Each Year?

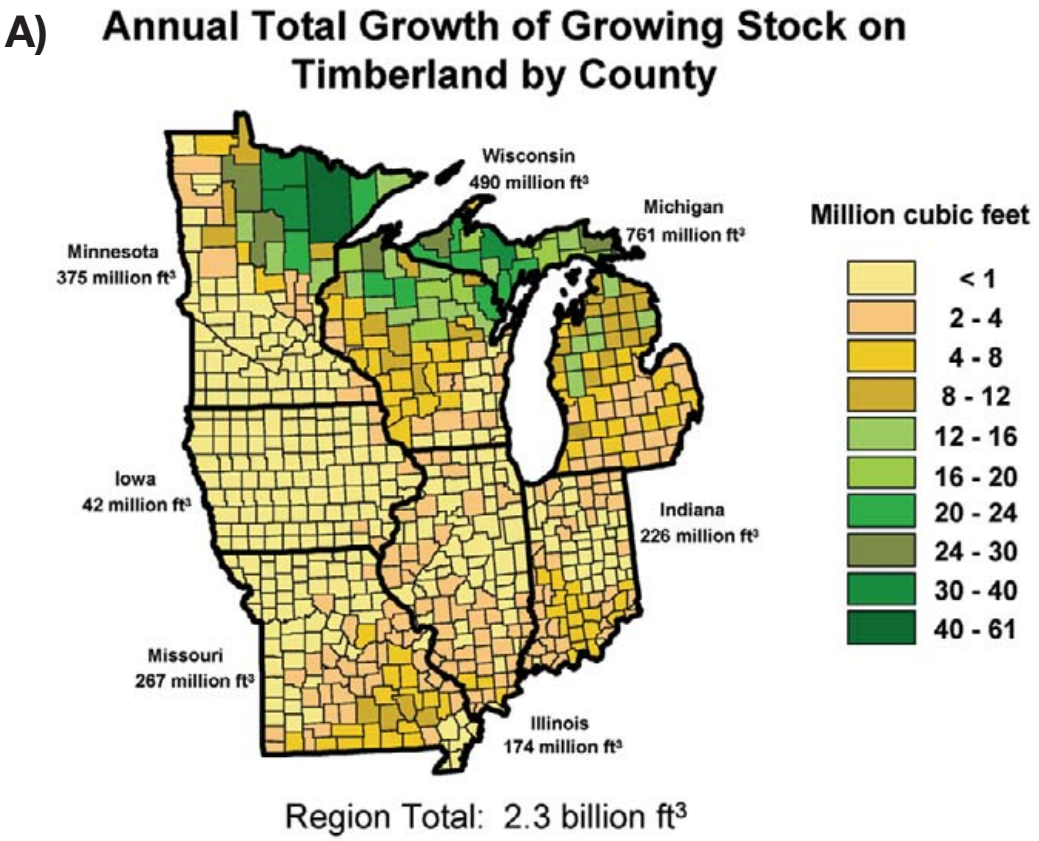
Forests in the North Central Region grow an additional 2.3 billion cubic feet (8.5 billion board feet) of wood on growing-stock trees each year (tables 6 and 7). The growth estimate is adjusted to eliminate trees that died and trees with defects, but not trees that were harvested. In later sections of this report, the amount of timber harvest is discussed and compared with the amount of growth.

Average annual growth has exceeded average annual harvest in the North Central Region since at least 1953. Consequently, the standing volume of timber more than doubled between 1953 and 1997.

For a given State, total volume growth is greatly affected by the number of forested acres. For example, Michigan, with 19 million acres of timberland, will always have more total volume growth than Indiana with only 4 million acres of timberland (figure 8). Growth expressed per acre of timberland or as a percent of the standing volume are two other informative statistics that indicate conditions on an average acre of timberland, regardless of the total number of acres.

Forests in the region had an average annual net growth (adjusted for mortality but prior to adjustments for harvest) of 32 cubic feet per acre of timberland. Measured in board feet, the increase averaged 116 per acre (International 1/4-inch scale). On a percentage basis the annual increase was 2.9 percent for cubic foot growth and 3.8 percent for board foot growth.

As described in more detail in the following section, average annual growth has exceeded average annual harvest in the North Central Region since at least 1953. Consequently, the standing volume of timber more than doubled between 1953 and 1997 (figure 9). As the region's forests continue to mature, the annual rate of growth is expected to be slower in the next 50 years than in the previous 50 years. Nevertheless, at the anticipated rates of growth and removals, inventories of hardwoods and softwoods are projected to increase through 2050.



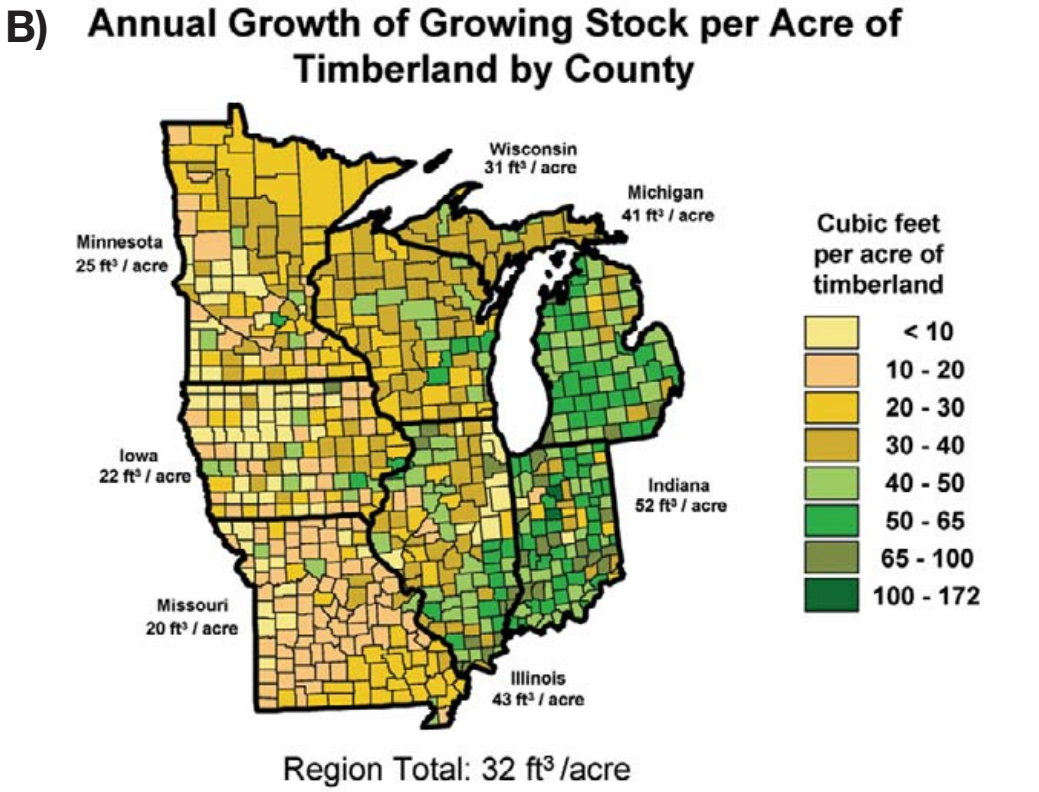


Figure 8. —Annual net growth of growing-stock trees on timberland by county (adjusted for mortality but prior to adjustments for harvest). (A) Total growth per county. Totals are influenced by the area of timberland in a county and the volume per acre. (B) Mean growth per acre of timberland. Growth per acre tends to be largest in Indiana, southern Illinois, and southern Michigan where site quality is comparatively high. County names are shown in the appendix.

Figure 9.—Total cubic volume of growing stock by State, 1953-1997. In each of the seven States, growth exceeded harvest and mortality over this period, and the volume of standing timber (growing stock) increased from 37 to 84 billion cubic feet. For a given State and year, the colored area between two lines indicates the total volume. The total volume for the seven-State region is shown by the combined height of the filled area.

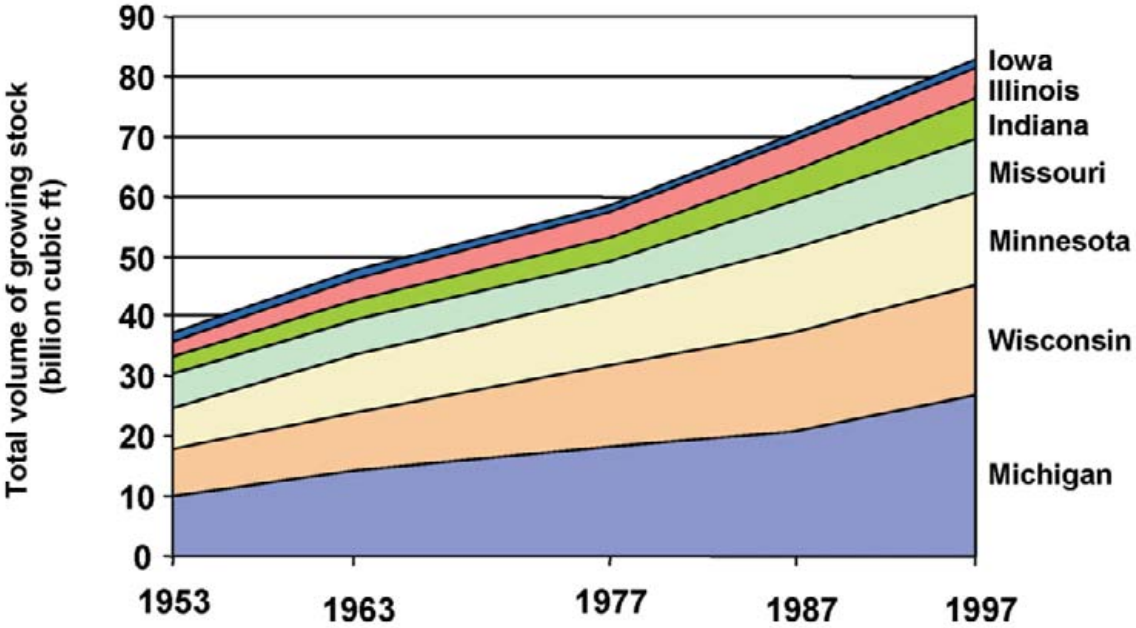


Table 6. —Estimated net growth in cubic feet of growing stock on timberland. This estimate of average annual net growth has been reduced for losses due to mortality and defect, but it has not been reduced for trees that were harvested. Harvesting is addressed in the next section. Entries are sorted by decreasing net growth of growing stock.

State (inventory year)	Net growth of growing stock	Total growing-stock volume	Annual increase in growing-stock volume	Rank among U.S. States in net growth of growing stock	Average net growth per acre timberland
	- - - - *Million ft³*	- - - -	*Percent*		*Ft³/acre*
Michigan (1993)	761	26,661	2.9	12th	41
Wisconsin (1996)	490	18,513	2.6	21st	31
Minnesota (1990)	375	15,147	2.5	24th	25
Missouri (1989)	267	8,989	3.0	27th	20
Indiana (1998)	226	6,900	3.3	29th	52
Illinois (1998)	174	5,943	2.9	35th	43
Iowa (1990)	42	1,669	2.5	44th	22
North Central Region	2,335	83,822	2.8	N/A	32
U.S. [a]	23,549	906,190	2.6	N/A	47
NC as a % of U.S.	10%	9%	N/A	N/A	76%

[a] U.S. total for 1997 from Resources Planning Act statistical tables.

Table 7.—Estimated net growth in board feet (International 1/4-inch scale) of growing-stock trees on timberland and net increase (growth) in stored carbon for all trees at least 5 in. d.b.h. Net growth estimates have been adjusted to remove trees that died or have excessive defect, but not trees that were harvested. Harvest is reported and compared with growth in later sections.

State (inventory year)	Net growth of sawtimber	Total sawtimber volume	Average annual net increase in sawtimber	Average annual net increase in sawtimber per acre	Increase in stored carbon above and below ground
	- - *Million bd ft*	- -	*Percent*	*Bd ft/ac*	*Million tons*
Michigan (1993)	2,670	71,012	3.8	143	14.4
Wisconsin (1996)	1,683	48,118	3.5	107	9.3
Minnesota (1990)	1,320	34,942	3.8	90	6.9
Missouri (1989)	1,000	25,884	3.9	75	5.7
Indiana (1998)	941	26,248	3.6	217	4.9
Illinois (1998)	662	21,876	3.0	162	3.8
Iowa (1990)	190	5,791	3.3	98	1.0
North Central Region	8,467	233,871	3.6	116	46.1
U.S. [a]		3,232,530			381.3

[a] U.S. total for 1997 from Resources Planning Act statistical tables.

How Much Wood Is Harvested Each Year?

Timber removals collectively include trees harvested for wood products and trees cut for other reasons such as land clearing or improving wildlife habitat. In the North Central Region, approximately 1.1 billion cubic feet (3.4 billion board feet) of growing stock were removed annually for the decade preceding the latest statewide inventories (the period directly comparable to the preceding growth estimates) (tables 8 and 9). Volume growth of growing stock on timberland over the same period was double the volume of removals (figure 10). Average annual removals equate to 15 cubic feet of growing-stock volume per acre of timberland (47 board feet per acre). Annual removals of growing stock on timberland during the mid-1990s are estimated at 1.4 billion cubic feet or 1.6 times removals. The spatial patterns of removals by county and removals per acre of timberland per county are similar to those illustrated for volume growth in figure 8.

Small diameter hardwoods to be processed into wood chips for making paper.

In the North Central Region, about 85 percent of harvested growing-stock volume (an estimated 1.2 billion cubic feet in 1996) is used for products or fuel; the remainder is left as logging residue or was removed for other reasons such as land clearing (table 10). In addition to the removals of growing-stock trees on timberland, each year many non-growing-stock trees (e.g., trees with poor form, defect, or of a species generally considered to be noncommercial) are cut, and some of these are also utilized for products. In 1996 the estimated volume of non-growing-stock trees used for products was 0.4 billion cubic feet (table 10). Non-growing-stock trees are often used for low-value products such as pallets, railroad ties, and paper or for fuel. Harvest and utilization of non-growing-stock trees is usually considered beneficial from a productivity standpoint. In addition to providing products, removal of non-growing-stock trees often results in faster growth of the remaining trees or conversion to more desirable species. Trees harvested from lands not classified as timberland (e.g., shelterbelts or suburban areas) are also occasionally used for products.

Across an entire State or an entire region, a positive ratio of growth to harvest is an important broad indicator of sustainability. However, it does not necessarily ensure that wood supplies are abundant for the most desirable species nor that they will remain so in the future. Nor does it ensure that timber owners are willing to sell. For example, resource managers and wood-using industries have expressed concerns about future supplies of available aspen in the Lake States although total aspen growth across the region currently exceeds harvest (table 11). Harvest exceeds growth for paper birch and jack pine. These two species became widely established following forest disturbances a century ago, and the growrh rate of these trees is slowing as a large proportion reach maturity.

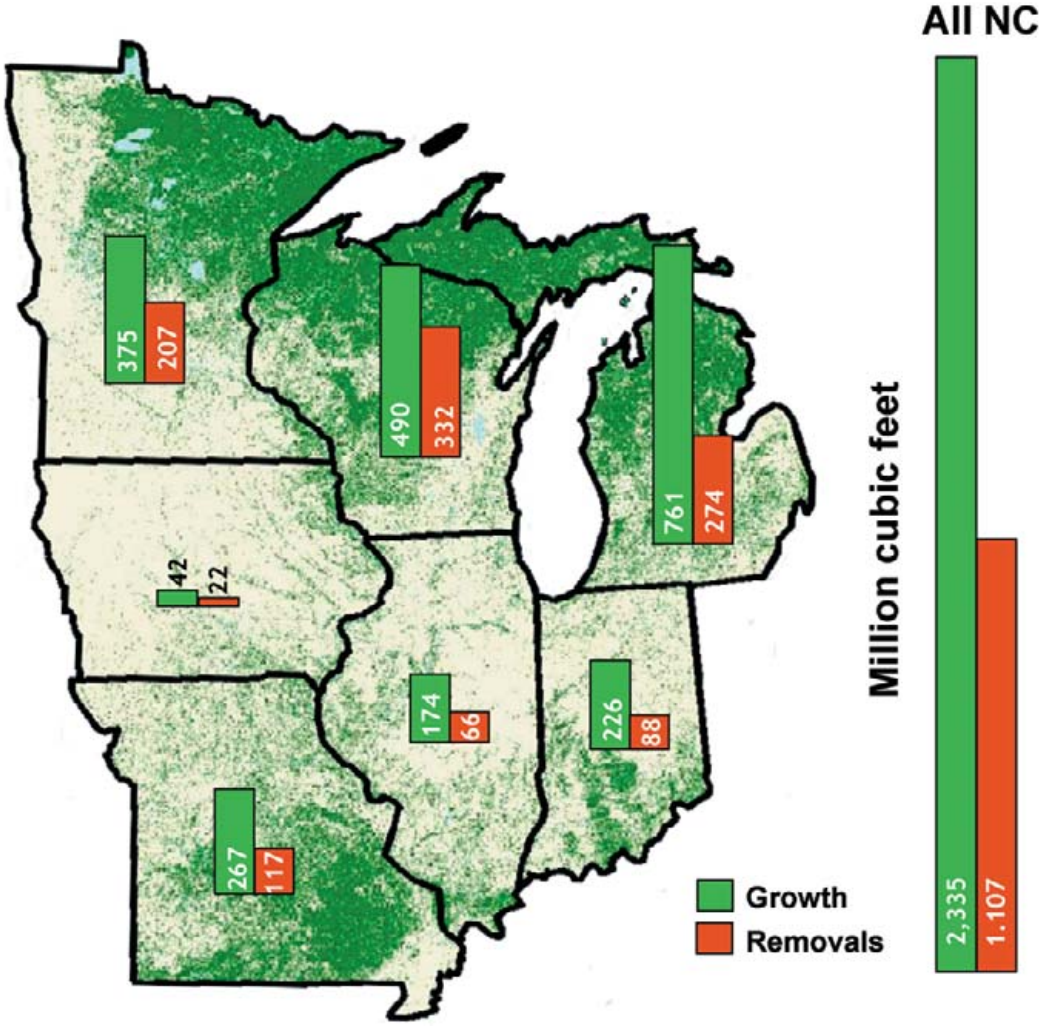


Figure 10.—Comparison of average annual net growth and removal of timber by State (million cubic feet of growing stock on timberland). Values shown are for the most recent individual statewide field inventories conducted between 1989 and 1998. See also table 8. Additional data can be summarized electronically at http://www.ncrs.fs.fed.us/4801/FIADB/index.htm.

Table 8.—Standing volume, average annual removals, and average annual net growth in cubic feet of growing stock on timberland for the most recent complete State inventories. The ratio of growth to removals ranges from 1.5 in Wisconsin to 2.8 in Michigan.

State (inventory year)	Total growing-stock volume	Removals of growing stock[a]	Net growth of growing stock[b]	Net growth less removals	Ratio of growing-stock growth to removals	Rank among U.S. States in total removals	Removals per acre of timberland
	- - - - - - *Million ft³*		- - - - - -				*Ft³/acre*
Michigan (1993)	26,661	274	761	487	2.8	17th	15
Wisconsin (1996)	18,513	332	490	158	1.5	16th	21
Minnesota (1990)	15,147	207	375	168	1.8	18th	14
Missouri (1989)	8,989	117	267	150	2.3	25th	9
Indiana (1998)	6,900	88	226	138	2.6	30th	20
Illinois (1998)	5,943	66	174	108	2.6	32nd	16
Iowa (1990)	1,669	22	42	20	1.9	34th	11
North Central Region	83,822	1,107	2,335	1,228	2.1	N/A	15
U.S.[c]	906,190	16,021	23,549	7,528	1.5	N/A	32
NC as % of U.S.	9%	7%	10%	N/A	N/A	N/A	47%

[a] Mean annual removals over a period of approximately 10 years prior to the inventory year.

[b] From table 6. Adjusted (reduced) for mortality and defects, but not for harvest.

[c] U.S. total for 1997 from Resources Planning Act statistical tables.

Table 9.—Standing volume and average annual removals in board feet of growing stock on timberland for the most recent complete State inventories.

State (inventory year)	Total growing-stock volume	Removals of growing stock[a]	Net growth of growing stock[b]	Net growth less removals	Ratio of growing-stock growth to removals	Removals per acre of timberland
	- - - - - - *Million bd ft*		- - - - - -			*Bd ft*
Michigan (1993)	71,012	783	2,670	1,887	3.4	42
Wisconsin (1996)	48,118	1,012	1,683	671	1.7	64
Minnesota (1990)	34,942	513	1,320	807	2.6	35
Missouri (1989)	25,884	409	1,000	591	2.4	31
Indiana (1998)	26,248	373	941	568	2.5	86
Illinois (1998)	21,876	258	662	404	2.6	63
Iowa (1990)	5,791	78	190	112	2.4	40
North Central Region	233,871	3,426	8,467	5,041	2.6	47
U.S.[c]	3,232,530	N/A	N/A	N/A	N/A	N/A

[a] Mean annual removals over a period of approximately 10 years prior to the inventory year.

[b] From table 7. Adjusted (reduced) for mortality and defects, but not for harvest.

[c] U.S. total for 1997 from Resources Planning Act statistical tables.

Table 10.—Fate of harvested trees in the North Central Region, 1996 estimate.

	Growing stock	Non-growing stock	Total
	- - - - - - -	Billion ft³ - - - - - - -	
Trees harvested and…			
used for products and fuel	1.2	0.4	1.6
left as logging residue	0.1	0.5	0.6
not utilized for other reasons	0.1	0.1	0.2
Total	1.4	1.0	2.4

Table 11.—Average annual growth and removals for the 16 species that individually account for at least 2 percent of total removals for the region. In combination, these 16 species account for three-fourths of the annual harvest of growing stock. Across the North Central Region, the combined annual growth of these species is nearly double their combined annual removals, but removals exceeded growth for paper birch and jack pine. These summaries cover the period of approximately 10 years preceding each of the most recent State inventories (see table 8 for inventory dates).

Species	Growing-stock removals	Percent of all removals	Growing-stock growth	Percent of all growth	Growth minus removals	Ratio of growth to removals	Total growing-stock volume	Removals as a percent of standing volume
	Million ft³	*Percent*	*Million ft³*	*Percent*	*Million ft³*		*Million ft³*	*Percent*
Quaking aspen	168	16	226	10	58	1.3	7,529	2.2
Northern red oak	99	9	139	6	39	1.4	5,445	1.8
Sugar maple	69	6	218	9	149	3.2	7,569	0.9
White oak	62	6	123	5	61	2.0	5,179	1.2
Bigtooth aspen	59	5	72	3	13	1.2	2,325	2.6
Black oak	54	5	90	4	36	1.7	3,553	1.5
Paper birch	53	5	45	2	-8	0.8	3,140	1.7
Red maple	46	4	191	8	144	4.1	5,602	0.8
Jack pine	43	4	34	1	-9	0.8	1,547	2.8
Red pine	30	3	149	6	119	4.9	3,230	0.9
Balsam fir	29	3	38	2	9	1.3	2,258	1.3
Eastern white pine	29	3	75	3	46	2.6	2,200	1.3
American basswood	26	2	65	3	39	2.5	2,952	0.9
American elm	22	2	21	1	0	1.0	1,118	1.9
Yellow-poplar	20	2	33	1	13	1.7	871	2.2
White ash	17	2	54	2	37	3.1	1,538	1.1
Total for top 16 species	826	76	1,572	68	746	1.9	56,058	1.5
Remaining species	281	24	763	32	482	2.9	27,824	0.9
Total, all species	1,107	100	2,335	100	1,228	2.1	83,882	1.3

Where Does The Timber Harvest Occur?

Nationally, the greatest volume of wood comes from the South and the Pacific Northwest (figure 11). There the intensity of annual timber harvest can exceed 60 cubic feet per acre of land area. The South, Southeast, and the Pacific Northwest jointly account for 60 percent of the wood harvested (growing-stock material). The North Central Region contributes 7 percent.

Nationally, we export the equivalent of 2.2 billion cubic feet of wood and import 3.9 billion cubic feet. On balance, the volume of imports over exports amounts to 9 percent of total consumption. Our largest import is softwood lumber; one-third of the softwood lumber we use comes from Canada. Our largest net exports (on a volume basis) are logs and wood chips (for making paper). Recycling currently contributes about 45 percent of the material used for domestic paper and pulp products. That is nearly double the proportion of recovered paper 25 years ago.

Private individuals own 57 percent of the region's timberland, and their lands account for 55 percent of the timber harvested.

Within the North Central Region, private individuals own 57 percent of the timberland and their lands account for 55 percent of the timber harvested (figure 12). As a group, private owners exert great influence on the management and the harvest of the region's timber. As individuals, they differ greatly in their management objectives and in their attitudes about growing and harvesting timber. The primary reasons they most often list for timberland ownership are recreation or ownership in association with a residence or farm. The majority of private owners say they intend to harvest timber in the future, but owners with small tracts are less likely to do so. The trend in parcelization of timberland into smaller tracts and more owners is likely to limit the total area available for timber production because more tracts will be too small to efficiently manage for timber and other values will dominate (e.g., for recreation or home sites).

The volume harvested per acre of timberland is greatest on industry-owned lands where the intensity of timber management is also generally greater. On industry timberland the annual timber harvest is nearly equal to annual growth.

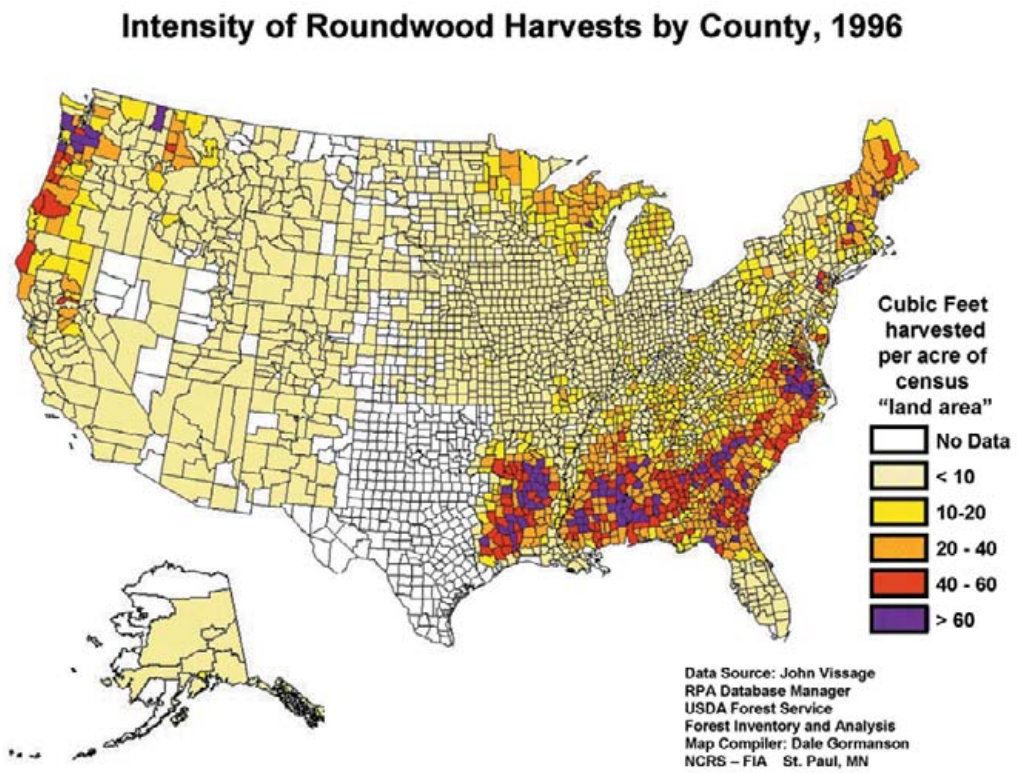


Figure 11.—Intensity of harvest activity by county, 1996, measured as volume of harvest per acre of county land area. Nationally, harvest activity is concentrated in the South and the Pacific Northwest. Within the North Central Region, harvest activity is concentrated in the Lake States.

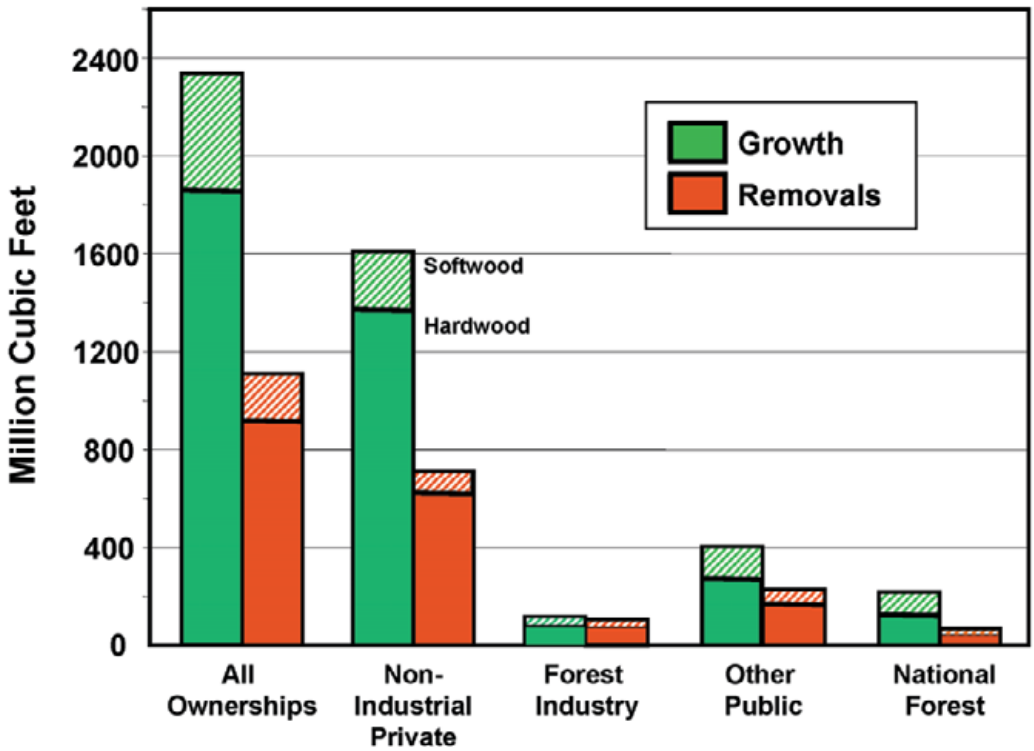


Figure 12.—Average annual growth and removals by owner group. On forest industry lands growth and removals are nearly equal. Elsewhere growth is approximately double removals.

What Products Are Produced?

Mills in the North Central Region annually process 1.6 billion cubic feet of timber into products. These range from fenceposts to construction lumber to paper to fine veneers. In the seven-State region, there are more than 2,000 primary wood-processing facilities (table 12). The vast majority of these are sawmills, but due to the large volume of wood processed in in the region's pulp mills, pulp production and saw log production consume nearly equal volumes of wood (figure 13). Pulp mills are concentrated in the Lake States; lumber production occurs throughout the areas that have timberland.

The majority of processing facilities are sawmills, but due to the large volume of wood processed in in the region's pulp mills, pulp production and saw log production consume nearly equal volumes of wood.

Product categories and some common uses include the following:

Saw logs — softwood lumber (15%) for construction and hardwood lumber (85%) for flooring, furniture, cabinetry, pallets, railroad ties, and other solid wood products. Principal species: oaks, maples, aspen, red pine.

Pulpwood — softwoods (30%) and hardwoods (70%) used in the manufacture of a variety of papers and packaging. Recycled material contributes about 45 percent of the content of pulp products. Principal species: aspen, maples, jack pine, red pine, birch, fir.

Composites — softwoods (6%) and hardwoods (94%) used for particleboard, oriented strandboard, and similar products. Principal species: aspen, jack pine, birch.

Veneer — softwoods (2%) and hardwoods (98%) used to create veneers for furniture, plywood, packaging, and disposable ice cream spoons. Principal species: maple, aspen, birch, oaks, black walnut.

Fuelwood — softwoods (4%) and hardwoods (96%) used for residential heating or burned for energy at processing facilities (mostly in the form of residues). Principal species: oaks, elm, maples, aspen.

Other — softwoods (38%) and hardwoods (62%) used for posts, poles, pilings, cooperage, cedar closet lining, and novelty items. Principal species: cedar, pines, oaks, aspen.

Hardwoods make up slightly more than 80 percent of the region's timber harvest. In the next 50 years, the volume of softwood harvest in the North Central Region is expected to decrease while the harvest of hardwoods is expected to increase. Nationally, however, the greatest increases in demand are anticipated to be for softwoods and for smaller (younger) trees used for wood fiber.

Table 12.—Number of primary wood-processing mills in the North Central Region.

State (year)	Sawmill	Veneer mill	Pulp mill[a]	Other mill	Total
Michigan (1994)	244	5	11	24	284
Wisconsin (1994)	268	12	21	29	330
Minnesota (1992)	568	1	16	11	596
Missouri (1997)	417	1	1	39	458
Indiana (1995)	192	12	3	2	209
Illinois (1996)	102	1	--	4	107
Iowa (1994)	69	1	1	--	71
Total	1,860	33	53	109	2,055

[a]Also includes particleboard, flakeboard, and oriented strandboard mills.

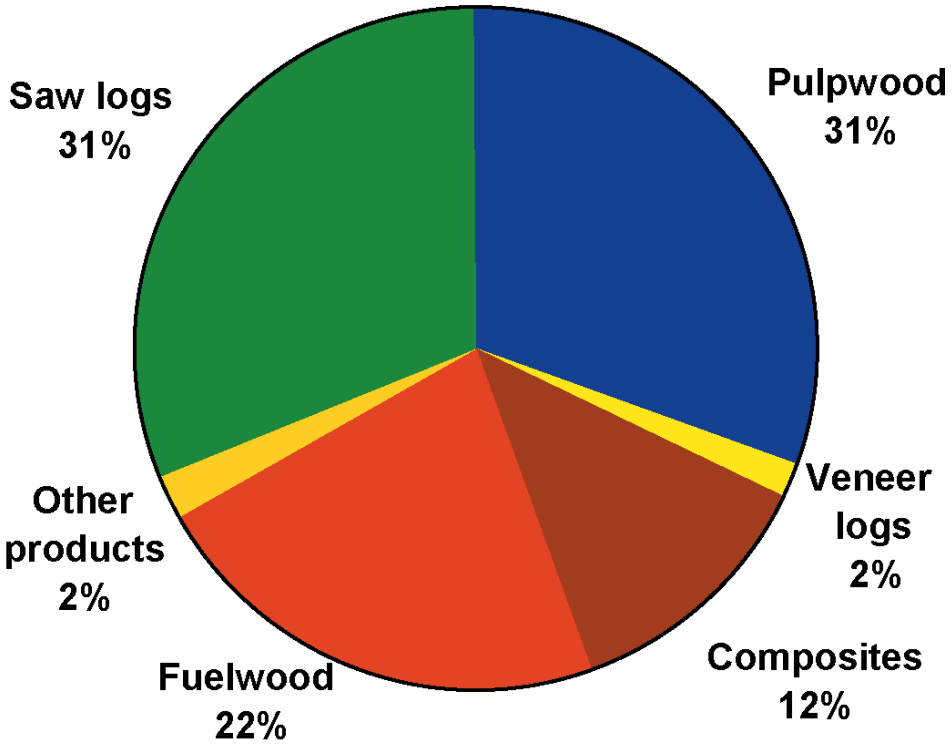


Figure 13.—Utilization of wood harvested for products in the North Central Region. Total utilization is 1.6 billion cubic feet annually of which 1.2 billion cubic feet come from growing stock. See also table 10.

How Much Wood Do We Consume?

On average we each consume the equivalent of 73 cubic feet of wood each year. Increasing population will lead to an increasing demand for wood products. Nationally, consumption of new wood is expected to increase by about 40 percent in the next 50 years

On average we annually consume the equivalent of 73 cubic feet of new wood per capita. This national per capita estimate of consumption excludes recycled material and takes into account national imports and exports of wood and wood products. This 73 cubic feet of wood is roughly equivalent to two trees that are 18 inches in diameter and 50 feet tall, which would weigh about 2 tons when harvested. As a solid block, it would fill the bed of a pickup truck. As firewood, it would be nearly equivalent to one standard cord: a stack 8 feet long, 4 feet high, and 4 feet deep.

This wood supplies our annual per capita consumption of a wide variety of products including:

- 410 pounds of paper
- 330 pounds of boxes, packaging, and other pulp-based products
- 75 square feet of plywood
- 25 square feet of particleboard and fiberboard
- 235 board feet of lumber
- 2 shipping pallets
- 1 new house for every 62 households
- 9 cubic feet of fuelwood (including wood and residues used for energy at mills)

Nearly 90 percent (64 cubic feet) of our per capita consumption comes from domestic sources. The United States is a net importer of wood and wood products, so the remaining per capita consumption (9 cubic feet) is the net balance of imports over exports. For these comparisons, imports and exports were converted to the equivalent amount of new wood (roundwood) needed to produce them.

Consumption occurs largely where people live and work (figures 14 and 15). Seventeen percent of the U.S. population lives in the North Central Region, a disproportionately large share of people relative to total land area and forest land area in the region. State population densities range from fewer than 60 people per square mile in Iowa and Minnesota to more than 165 people per square mile in Indiana, Michigan, and Illinois. The people who live in the region consume roughly 3.4 billion cubic feet of wood products annually (table 13).

Increasing population will lead to an increasing demand for wood products. Nationally, consumption of new wood is expected to increase by about 40 percent in the next 50 years, from 20 billion cubic feet in 1997 to 27.5 billion cubic feet in 2050, primarily due to increased population. By 2050, the U.S. per capita consumption of new wood (exclusive of recycled material) is expected to decrease from 73 to about 68 cubic feet. However, with the anticipated greater reliance on recycled material, the total per capita consumption of wood products—including recycled fiber—is expected to increase. The biggest impact on future consumption of new and recycled wood and fiber will be due to overall population growth rather than changes in the amount the average person consumes. At the same time, other demands will be placed on forest resources for non-timber values such as recreation, wildlife habitat, or biodiversity. Our demand for timber products often conflicts with our desire for other social and ecological benefits from forests.

By adding an estimate of consumption to the growth and removals estimates shown in figure 10, we get an indication of how much of our regional consumption could be met (on a volume basis) by current levels of growth and harvest (figure 16). The types of products produced in the North Central Region differ from those consumed by the people who live here. For example, about 63 percent of per capita wood and fiber consumption is from softwood species that are commonly used for paper and construction lumber. However, only about 20 percent of the North Central Region's growth and removals come from softwood trees. The majority of the region's timber products are derived from hardwoods. Obviously, as part of a global economy,

the people in the North Central Region will continue to consume wood that comes from other regions and other nations, but this comparison helps put our consumption in perspective. Such comparisons are complicated by the different types and dates of inventories that must be combined to create them, but they provide an overall picture of the relative balance among growth, removals, and consumption.

The United States per capita consumption of wood products (73 cubic feet annually) is nearly 3.5 times greater than the world per capita consumption of 21 cubic feet. Those figures include wood used for fuel. Fuelwood constitutes more than half of the wood consumed globally, but only 13 percent of U.S. consumption. Excluding fuelwood, U.S. per capita consumption of industrial roundwood used for wood and paper products is seven times the global average.

Table 13.—Population and estimated annual consumption of wood products for States in the North Central Region, 2000. Consumption estimates are based on the U.S. annual consumption of 73 cubic feet per capita.

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State	Population	Population rank among U.S. States	Annual consumption
	Millions		*Million ft³*
Michigan	10	8th	730
Wisconsin	5	18th	389
Minnesota	5	21st	353
Missouri	6	17th	405
Indiana	6	14th	440
Illinois	12	5th	897
Iowa	3	30th	212
North Central total	46		3,426
U.S. total	276		20,179
World	6,106		116,523

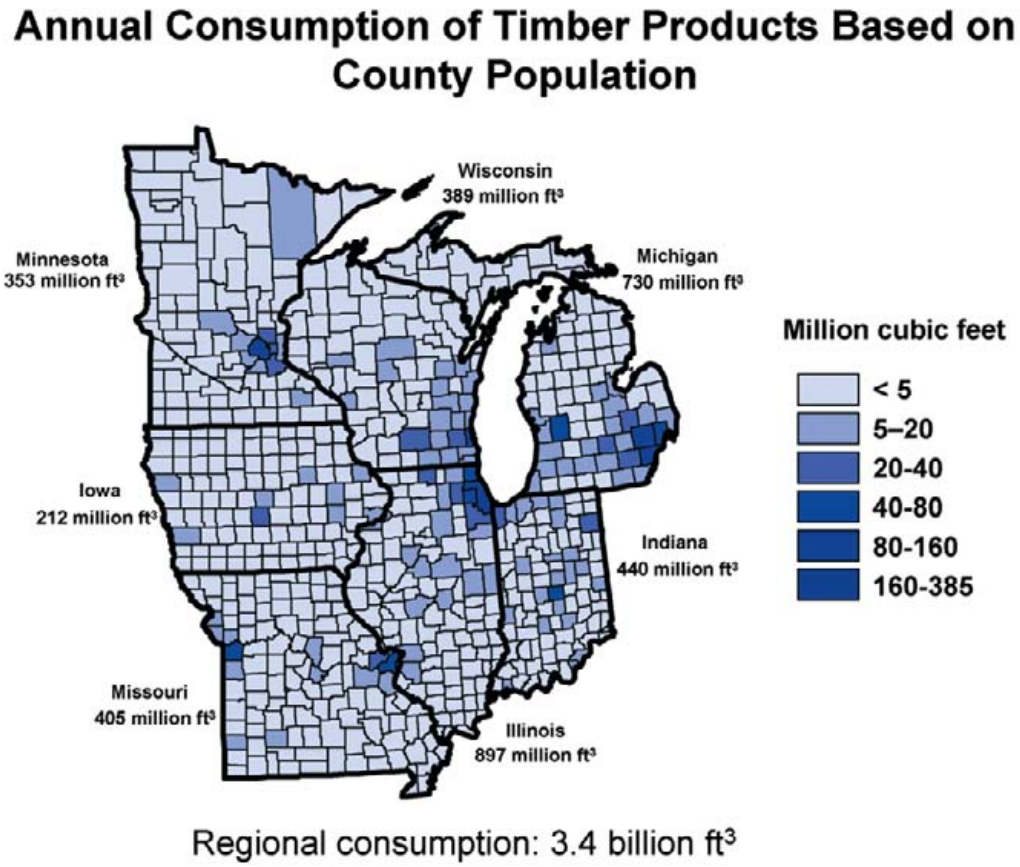
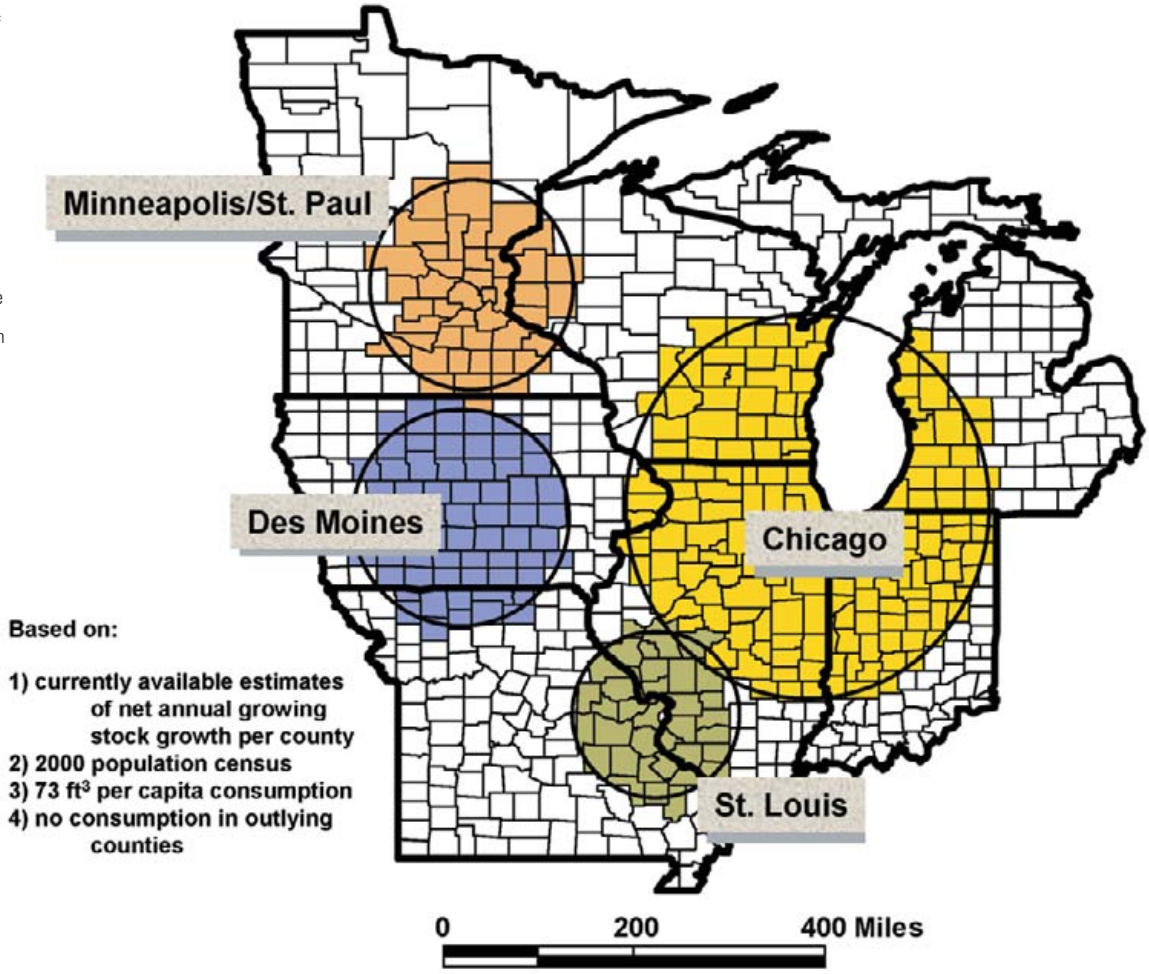


Figure 14.—Consumption of timber products by county, based on county population. We each consume the equivalent of 73 cubic feet of new wood annually. County names are shown in the appendix.

Figure 15.—The long reach of consumption: a conceptual view. The circles indicate the approximate area that would be required if the cubic foot volume of wood consumed by inhabitants of these metropolitan areas were to be satisfied by the annual growth of growing-stock trees on the surrounding timberland. The circles take into account the acreage and conditions of forests surrounding the metropolitan areas and assume that the consumption of people living outside the named metropolitan areas would be satisfied by some other source.



Globally, increasing population will decrease the amount of forest area per capita and increase the total consumption of wood products. The greatest increases in wood consumption are likely to occur in developing countries where both per capita consumption and population are both expected to increase.

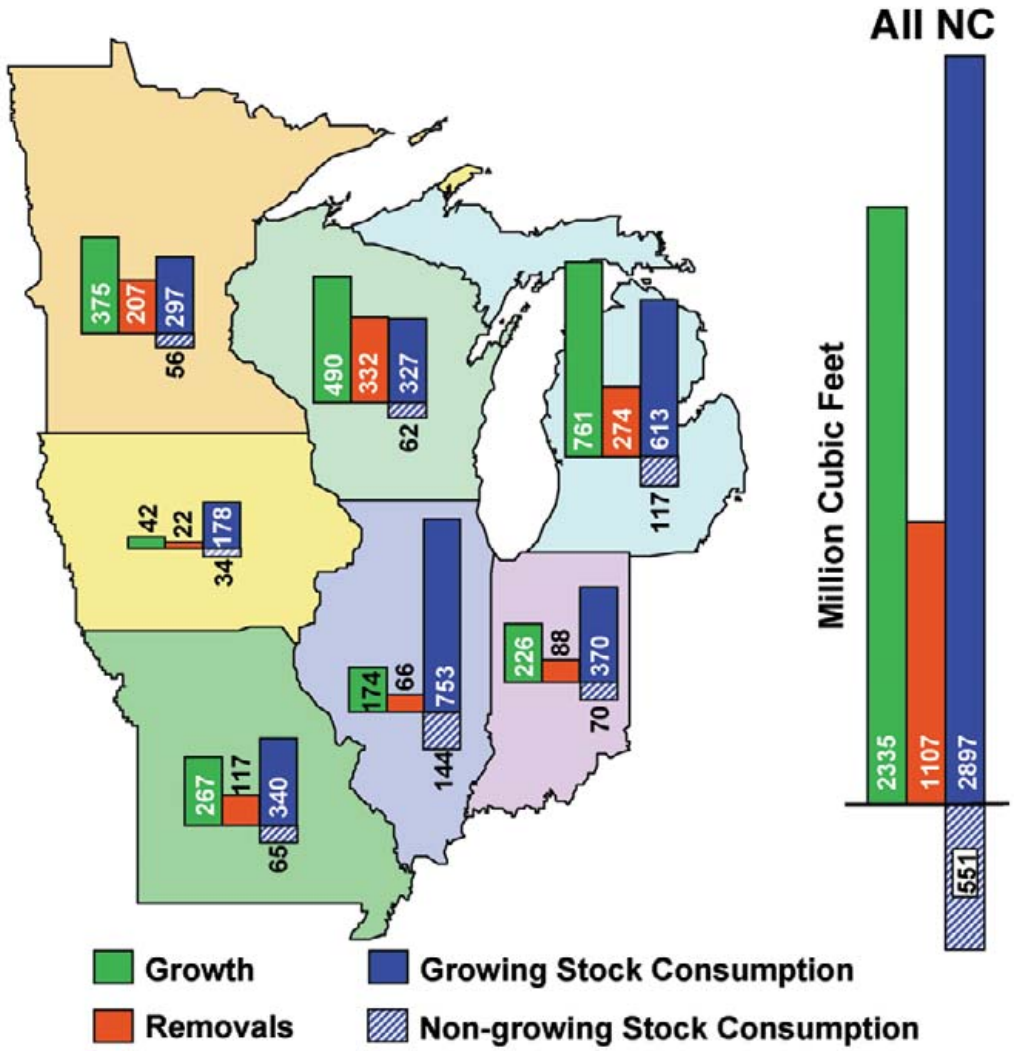


Figure 16.—Growth, removals, and consumption by State in the North Central Region. Growth (green bars) and removals (red bars) are for growing-stock trees on timberland. Consumption (blue bars) is estimated as the national per capita consumption of new wood multiplied by the population. Consumption is broken into two components: (a) that met by products derived from growing-stock volume (about 84 percent nationally, shown as solid portion of blue bars) and (b) that met by products derived from non-growing-stock volume (16 percent, hatched portion of blue bars). The solid portion of the consumption bar is an amount that, for comparison purposes, is consistent with the growth and removals bars.

Are We Currently Overharvesting Our Forests?

The simple answer is no; not from the standpoint of timber. In the North Central Region, the net growth of growing-stock trees on timberland (adjusted for losses to mortality) is one and a half to two times the volume harvested annually. Over the past 50 years, the total volume of wood in our forests has increased steadily because growth has consistently exceeded harvest and mortality in each of the seven States (figure 9). The total area of timberland has increased slightly. This is not to say that all species and grades of timber are equally abundant or that all timber in the North Central Region is available and economic to utilize. Some of these timber issues are explored more fully in the projections made as part of the 2000 Resources Planning Act (RPA) Timber Assessment.

The simple answer is no. Over the past 50 years the total volume of wood in the region's forests has increased because growth has consistently exceeded harvest.

Forest managers, whether working on public or private lands, are charged with ensuring the long-term sustainability of forests. Forest sustainability includes many factors other than simple wood production. Due to this complexity, sustainability is difficult to define quantitatively for many non-timber forest values. Although virtually everyone agrees that over the long run total forest growth must meet or exceed harvest, people sometimes disagree on where or how timber harvests should (or should not) take place and on how timber harvest would impact non-timber resources. The amount of timber growth and harvest relative to our consumption gives us another way to think about sustainability at the local scale as well as the national and international scale.

Other important issues related to the sustainable timber production include

- Wildlife populations and their management
- Rare, threatened, endangered, or sensitive plants and animals
- Recreation
- Water quality
- Economics
- Environmental services such as storing carbon or maintaining biodiversity

Assessing the relationship among these factors and sustainable production of all forest commodities and amenities is much more complicated than assessing that relationship for timber alone and often requires consideration of many local and regional factors.

What Is A Sustainable Balance Among Timber Growth, Harvest, And Consumption?

Most of us don't think very much about the relationship between our consumption of forest products and the related impacts on forests. Yet the relationship is direct—wood is harvested to supply the products that we rely upon for daily living. Compared to other resources that can be used for construction, manufacturing, and energy (for example, steel, concrete, plastics, coal, oil), wood is environmentally friendly. Forests protect soil and water, store carbon, produce oxygen, provide wildlife habitat, and provide recreational opportunities. Wood is a renewable resource, and wood products are biodegradable, recyclable, and require comparatively little energy to produce.

How much wood *could* we produce in the North Central Region under different management strategies? Could we produce a volume of wood and fiber that is commensurate with consumption by the people who live here—about 17 percent of the national total? Could we produce a volume commensurate with our share of the Nation's timberland—about 14 percent of the national total? Currently, in the North Central Region, we grow 10 percent of the Nation's wood and harvest 7 percent of the Nation's wood. Nationally, net imports of wood and wood products (i.e., imports minus exports converted to a comparable volume basis) are expected to increase from 9 to 18 percent of total U.S. consumption in the next five decades. A failure to balance growth and harvest with consumption of forest resources in one region shifts the impacts of harvesting and production to other regions of the U.S. or other countries (figure 17). Such shifts may or may not result in sustainable forestry elsewhere. When those of us who live in the North Central Region consume wood or wood products from other regions of the U.S. or other nations, we also export the environmental and social consequences associated with the timber harvest (both positive and negative consequences).

It is not realistic to think that in the North Central Region we could be self-sufficient in the many different kinds of forest products that we consume, but it is resonable to consider what proportion of the total volume of wood that we consume could be produced within the region (on a volume equivalent basis rather than for individual products). If we grow and process more timber in the North Central Region, how will our forests be affected? In our discussions of sustainability, we could begin to consider the implications of various levels of regional forest growth and harvest relative to consumption of wood products. Linking growth, removals, and consumption of forest products provides a broad framework for discussing issues of timber productivity and forest sustainability locally, regionally, and nationally. Although we have laws and policies that govern environmental impacts related to forest management, environmental impacts associated with our consumption of forest products are rarely considered (for example, see MacCleery 2000).

In the next 50 years, population increases are expected to increase consumption of new wood in the United States by approximately 40 percent. At the same time population increases will reduce forest land per capita in the U.S. and abroad. In developing countries, simultaneous increases in per capita wood consumption and in population are expected to increase total wood consumption at a rate faster than in developed countries.

The largest increases in U.S. consumption and imports are anticipated for softwoods. National RPA projections anticipate an increasing reliance on southern forests for meeting U.S. demand for softwoods and fiber. That prospect has raised some environmental concerns related to southern forest ecosystems (for example, see the Southern Forest

In the North Central Region could we produce a volume of wood equivalent to our proportion of the Nation's timberland—about 14 percent of the national total? Currently we grow 10 percent of the Nation's wood and harvest 7 percent of the Nation's wood.

In the next 50 years, population increases are expected to increase consumption of wood in the United States by approximately 40 percent

Resource Assessment at http://www.srs.fs.fed.us/sustain/). Hardwood consumption is expected to increase, but at a slower rate.

What is our role in meeting this increased demand for wood and fiber? To some extent our contributions are influenced by the nature of our resources—a maturing, predominantly hardwood resource. The majority of that resource is held by nonindustrial private owners with widely varying attitudes toward timber production. A trend toward parcelization of nonindustrial timberland is resulting in more owners and smaller tracts that are less likely to be managed for timber. Our future contributions toward meeting demand for wood are also influenced by our collective attitudes toward sustainablility, by research and technology, and by the social, political, and economic factors that affect forest management, wood production, and wood consumption.

There are many ways to alter the current balance among growth, harvest, and consumption of timber. Consumers, resource managers/owners, manufacturers, and elected officials can all have an impact. Research has a role in providing relevant information about tradeoffs and new technologies.

- Consumers can
  - —Consume less
  - —Recycle more
  - —Increase or decrease consumption of wood relative to alternative products and commodities
- Resource managers/owners can
  - —Increase forest growth per acre through improved management of natural forests
  - —Increase forest growth per acre through intensive plantation culture
  - —Increase the number of forested acres in production through tree planting and agroforestry
  - —Change the amount of wood they sell
- Manufacturers can
  - —Increase the efficiency of converting wood into products
  - —Engineer products that extend the utility of a given amount of harvested timber
- Elected officials can enact laws or establish policies that
  - —Affect forestry practices
  - —Affect the economics of forest management, timber harvesting, or manufacturing
  - —Affect consumers
  - —Affect research and information delivery
- All of us can work on formulating and discussing the issues.

Although the total wood supply in the United States is abundant and increasing, we will certainly need to be more concerned about the application of management practices leading to sustainable forests and the transfer of environmental, social, and economic impacts to other regions. How much wood can we sustainably produce in the North Central Region? What could be our future role in supplying wood and fiber for the people who live here? Should we produce more wood? What would be the local environmental and social consequences of doing so? What would be the national and global environmental and social consequences of not doing so? What are alternatives for doing so efficiently and sustainably? These questions are certainly worthy of our attention.

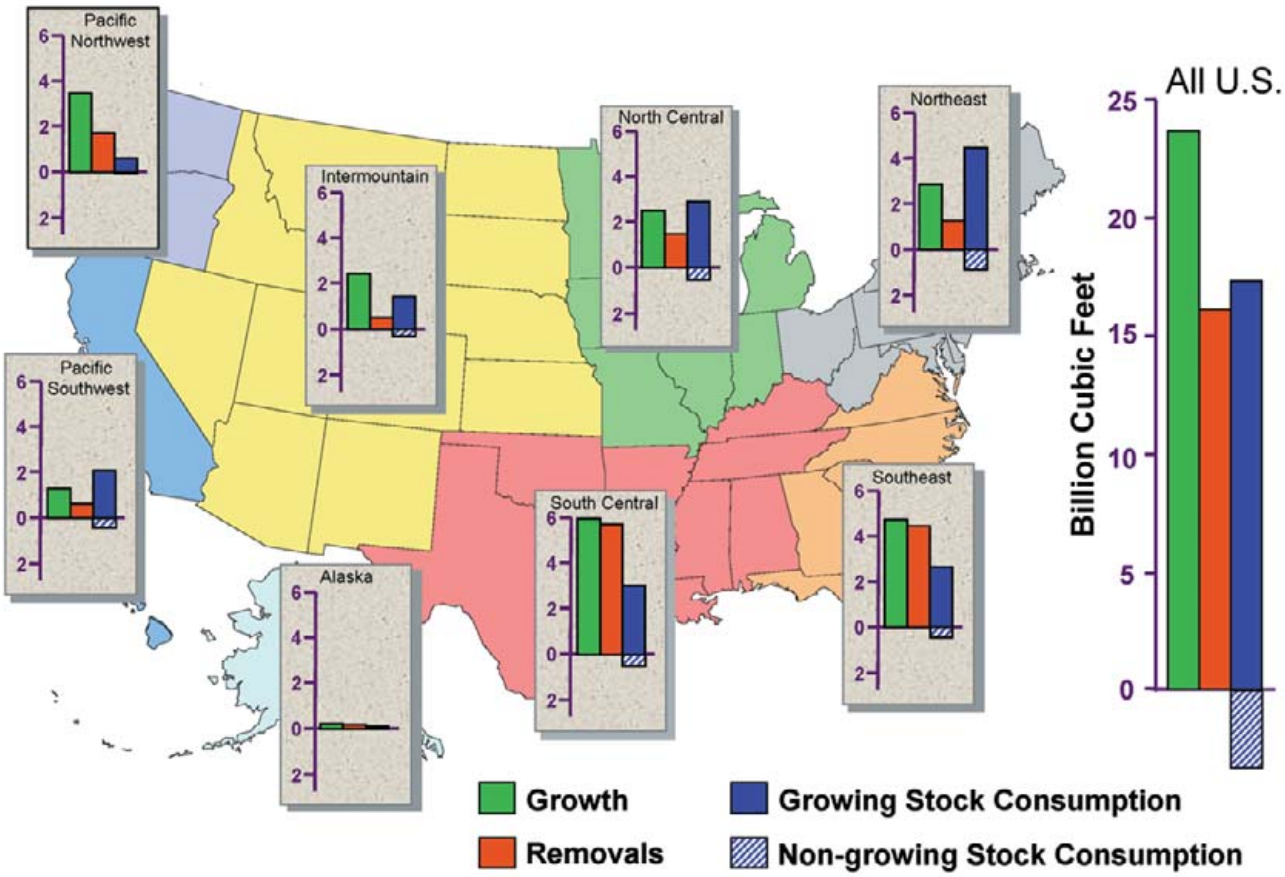


Figure 17.—Regional balance of growth, removals, and consumption of timber. Growth and removals are for growing-stock trees on timberland. Consumption also includes wood from non-growing-stock trees that are used for products (see glossary for definitions). The solid portion of the blue consumption bars indicate the approximate level of the growing-stock volume consumed and provides the best comparison to growing-stock growth and removals (solid green and red bars). The hatched portion of the blue bars represents the portion of the region's timber products that are produced from non-growing-stock trees. All charts show values in billion cubic feet per year.

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Glossary Of Terms

Average annual removals—The average volume of either growing stock or sawtimber removed from the inventory in one year by harvesting, cultural operations (such as timber stand improvement), land clearing, or changes in land use for the time period between two successive forest inventories.

Average net annual growth—The average change in volume of either growing stock or sawtimber in one year for the time period between two successive forest inventories minus the average annual volume lost to mortality from natural causes (average annual mortality). In the Western States, this variable represents the annual growth at the time of the current inventory.

Board foot—A measure of product potential that relates to the amount of lumber that is 1 foot long, 1 foot wide, and 1 inch thick (or the equivalent) that can be obtained from a tree. Board feet in these tables are reported using the International 1/4-inch rule.

Commercial species—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam, Osage-orange, and redbud.)

Composite products—Roundwood products manufactured into chips, wafers, strands, flakes, shavings, or sawdust and then reconstituted into a variety of panel and engineered lumber products.

Cord—Unit of measure applied to roundwood, usually bolts or split wood. It relates to a stack of roundwood 4 feet high, 4 feet wide, and 8 feet long, containing 128 cubic feet of wood, bark, and air space.

Diameter at breast height (d.b.h.)—The diameter of a tree outside bark expressed in inches, to the last one-tenth inch, and usually measured at 4.5 feet above the ground on the uphill side of the tree.

Fiber products—Byproducts used in the manufacture of pulp, paper, paperboard, and composite products, like waferboard, chipboard, etc.

Forest industry—An ownership class of private lands owned by companies or individuals operating primary wood-using plants.

Forest land—Land at least 16.7 percent stocked 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.

Forest type—A classification of forest land in which the named species, either singly or in combination, makes up a plurality of live tree stocking. These types are based on a standard set of local forest types in the Forest Service Handbook and have been logically organized into broader forest type groups to facilitate reporting.

Fuelwood—Roundwood products and mill residue byproducts used to produce some form of energy (heat, steam, etc.) in residential, industrial, or institutional settings.

Growing-stock removals—The growing-stock volume removed from poletimber and sawtimber trees in the timberland inventory. (Note: Includes volume removed for roundwood products, logging residues, and other removals.)

Growing-stock tree—Live timberland trees of commercial species that contain at least one 12-foot saw log or two saw logs 8 feet or longer. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume—Net volume 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.

Hardwoods—Dicotyledonous trees, usually broad-leaved and deciduous.

Industrial roundwood products—Roundwood products (e.g., saw logs, pulpwood, veneer logs, etc.) intended to be processed into primary wood products (e.g., lumber, wood pulp, sheathing, etc.) at primary wood-using mills.

International 1/4-inch rule—A log rule or formula for estimating the board foot volume of logs, allowing one-half inch of taper for each 4-foot length and one-fourth inch of kerf.

Logging residue—The unused portions of trees cut, or killed by logging, and left in the woods.

National forest—An ownership class of Federal lands, designated by Executive order or statute as national forests or purchase units, and other lands under administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

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

Noncommercial species—Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial roundwood 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, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 39.9-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, improved roads and nonforest strips must be more than 120 feet wide and more than 1 acre to qualify as nonforest land.)

Non-growing-stock removals—The net volume removed from the non-growing-stock portions of poletimber and sawtimber trees (stumps, tops, limbs, cull sections of central stem) and from any portion of a rough, rotten, sapling, dead, or nonforest tree.

Nonindustrial private—An ownership class of private lands where the owner does not operate wood-using plants.

Other products—A miscellaneous category of roundwood products (cooperage, excelsior, shingles, etc.) and mill residue byproducts (charcoal, bedding, mulch, etc.).

Other removals—Unutilized wood volume of trees cut or otherwise killed by cultural operations (e.g., precommercial thinnings) or land clearings to nonforest uses. Does not include volume removed from the inventory by reclassification of timberland to productive reserved forest land.

Ownership—A classification of forest land based on the legal owner at the time of the current inventory. Also indicates private lands leased to forest industry. Individual ownerships are logically organized into ownership groups and classes for reporting purposes.

Posts, poles, and pilings—Roundwood products milled (cut, peeled, etc.) into standard sizes (lengths and circumferences) to be put in the ground to provide vertical and lateral support in buildings, foundations, utility lines, and fences. May also include nonindustrial (unmilled).

Primary wood products—The rough and finished products (lumber, wood pulp, veneer sheathing, handles, etc.) manufactured from roundwood products at primary wood-using mills.

Primary wood-using mills—Mills that convert roundwood products (saw logs, veneer logs, pulpwood, etc.) into primary wood products, like lumber, sheathing, wood pulp, etc.

Pulpwood—Roundwood logs, bolts, or chips reduced to individual wood fibers by chemical or mechanical means for the manufacture of a variety of paper and paperboard products.

Roundwood products—Logs, bolts, or chips cut from trees for industrial and nonindustrial uses (saw logs, veneer logs, pulpwood, fuelwood, etc.).

Saw log—A roundwood product, usually 8 feet in length or longer, processed into a variety of sawn products (lumber, cants, blocks, squares, etc.).

Sawtimber removals—The net volume removed from the merchantable central stem (growing-stock portion) of sawtimber trees.

Sawtimber tree—A growing-stock tree 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. and hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume—Net volume in the saw-log portion of sawtimber trees.

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

Timber product output—The total volume of roundwood products harvested from all sources plus the volume of byproducts recovered from mill residues.

Timber removals—The total volume of trees removed by harvesting roundwood products, conducting cultural activities, and clearing forest lands. (Note: Includes roundwood products, logging residues, and other removals).

Timberland—Forest land that is producing, or is capable of producing, in excess of 20 cubic feet per acre per year of industrial roundwood products under natural conditions, is not withdrawn from timber utilization by statute or administrative regulation, and is not associated with urban or rural development.

Veneer log—A roundwood product peeled, sliced, stamped, or sawn into a variety of veneer products (sheathing, plywood, panels, containers, sticks, etc.).

Volume of growing stock—The net volume in cubic feet of growing-stock trees at least 5.0 inches in diameter from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem or to the point where the central stem breaks into limbs.

Volume of live trees—The net volume in cubic feet of growing-stock, rough, and rotten trees at least 5.0 inches in diameter from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem or to the point where the central stem breaks into limbs.

Volume of sawtimber—The net volume in board feet (International 1/4-inch rule) of the saw log portion of sawtimber trees.

Volume of timber—The net volume in cubic feet of growing-stock, rough, rotten, and salvable dead trees at least 5.0 inches in diameter from a 1-foot stump to a minimum 4.0-inch top d.o.b. of the central stem or to the point where the central stem breaks into limbs.

Appendix

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21	Christian
23	Clark
25	Clay
27	Clinton
29	Coles
31	Cook
33	Crawford
35	Cumberland
37	De Kalb
39	Dewitt
41	Douglas
43	Dupage
45	Edgar
47	Edwards
49	Effingham
51	Fayette
53	Ford
55	Franklin
57	Fulton
59	Gallatin
61	Greene
63	Grundy
65	Hamilton
67	Hancock
69	Hardin
71	Henderson
73	Henry
75	Iroquois
77	Jackson
79	Jasper
81	Jefferson
83	Jersey
85	Jo Daviess
87	Johnson
89	Kane
91	Kankakee
93	Kendall
95	Knox
99	La Salle
97	Lake
101	Lawrence
103	Lee
105	Livingston
107	Logan
115	Macon
117	Macoupin
119	Madison
121	Marion
123	Marshall
125	Mason
127	Massac
109	Mc Donough
111	Mc Henry
113	Mc Lean
129	Menard
131	Mercer
133	Monroe
135	Montgomery
137	Morgan
139	Moultrie
141	Ogle
143	Peoria
145	Perry
147	Piatt
149	Pike
151	Pope
153	Pulaski
155	Putnam
157	Randolph
159	Richland
161	Rock Island
165	Saline
167	Sangamon
169	Schuyler
171	Scott
173	Shelby
163	St Clair
175	Stark
177	Stephenson
179	Tazewell
181	Union
183	Vermillion
185	Wabash
187	Warren
189	Washington
191	Wayne
193	White
195	Whiteside
197	Will
199	Williamson
201	Winnebago
203	Woodford

Indiana

1	Adams
3	Allen
5	Bartholomew
7	Benton
9	Blackford
11	Boone
13	Brown
15	Carroll
17	Cass
19	Clark
21	Clay
23	Clinton
25	Crawford
27	Daviess
33	De Kalb
29	Dearborn
31	Decatur
35	Delaware
37	Dubois
39	Elkhart
41	Fayette
43	Floyd
45	Fountain
47	Franklin
49	Fulton
51	Gibson
53	Grant
55	Greene
57	Hamilton
59	Hancock
61	Harrison
63	Hendricks
65	Henry
67	Howard
69	Huntington
71	Jackson
73	Jasper
75	Jay
77	Jefferson
79	Jennings
81	Johnson
83	Knox
85	Kosciusko
87	La Grange
91	La Porte
89	Lake
93	Lawrence
95	Madison
97	Marion
99	Marshall
101	Martin
103	Miami
105	Monroe
107	Montgomery
109	Morgan
111	Newton
113	Noble
115	Ohio
117	Orange
119	Owen
121	Parke
123	Perry
125	Pike
127	Porter
129	Posey
131	Pulaski
133	Putnam
135	Randolph
137	Ripley
139	Rush
143	Scott
145	Shelby
147	Spencer
141	St Joseph
149	Starke
151	Steuben
153	Sullivan
155	Switzerland
157	Tippecanoe
159	Tipton
161	Union
163	Vanderburg
165	Vermillion
167	Vigo
169	Wabash
171	Warren
173	Warrick
175	Washington
177	Wayne
179	Wells
181	White
183	Whitley

Missouri

1	Adair
3	Andrew
5	Atchison
7	Audrain
9	Barry
11	Barton
13	Bates
15	Benton
17	Bollinger
19	Boone
21	Buchanan
23	Butler
25	Caldwell
27	Callaway
29	Camden
31	Cape Girardeau
33	Carroll
35	Carter
37	Cass
39	Cedar
41	Chariton
43	Christian
45	Clark
47	Clay
49	Clinton
51	Cole
53	Cooper
55	Crawford
57	Dade
59	Dallas
61	Daviess
63	De Kalb
65	Dent
67	Douglas
69	Dunkin
71	Franklin
73	Gasconade
75	Gentry
77	Greene
79	Grundy
81	Harrison
83	Henry
85	Hickory
87	Holt
89	Howard
91	Howell
93	Iron
95	Jackson
97	Jasper
99	Jefferson
101	Johnson
103	Knox
105	Laclede
107	Lafayette
109	Lawrence
111	Lewis
113	Lincoln
115	Linn
117	Livingston
121	Macon
123	Madison
125	Maries
127	Marion
119	Mc Donald
129	Mercer
131	Miller
133	Mississippi
135	Moniteau
137	Monroe
139	Montgomery
141	Morgan

Missouri (continued)

143 New Madrid
145 Newton
147 Nodaway
149 Oregon
151 Osage
153 Ozark
155 Pemiscot
157 Perry
159 Pettis
161 Phelps
163 Pike
165 Platte
167 Polk
169 Pulaski
171 Putnam
173 Rallis
175 Randolph
177 Ray
179 Reynolds
181 Ripley
195 Saline
197 Schuyler
199 Scotland
201 Scott
203 Shannon
205 Shelby
183 St Charles
185 St Clair
187 St Francois
189 St Louis
186 Ste Genevieve
207 Stoddard
209 Stone
211 Sullivan
213 Taney
215 Texas
217 Vernon
219 Warren
221 Washington
223 Wayne
225 Webster
227 Worth
229 Wright
510 City Of St Louis

Michigan

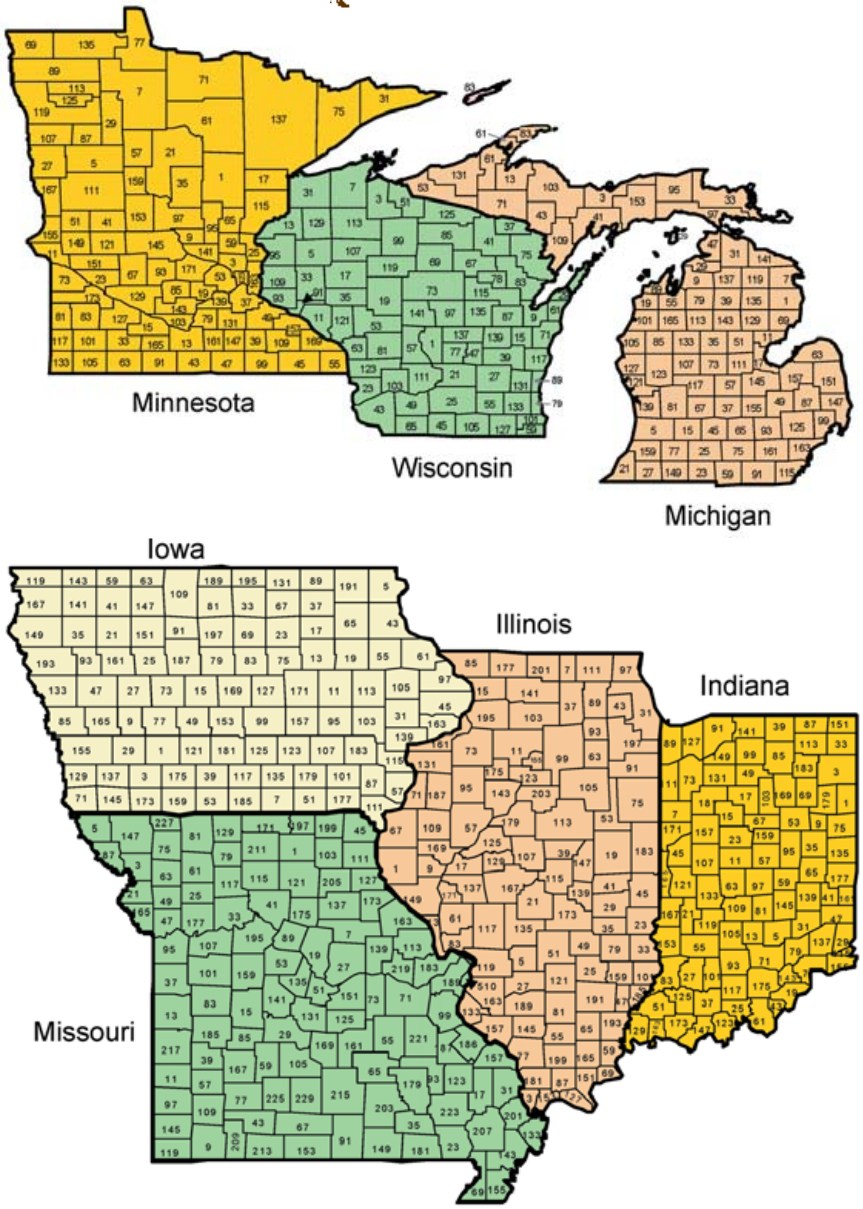
1 Alcona
3 Alger
5 Allegan
7 Alpena
9 Antrim
11 Arenac
13 Baraga
15 Barry
17 Bay
19 Benzie
21 Berrien
23 Branch
25 Calhoun
27 Cass
29 Charlevoix
31 Cheboygan
33 Chippewa
35 Clare
37 Clinton
39 Crawford
41 Delta
43 Dickinson
45 Eaton
47 Emmet
49 Genesee
51 Gladwin
53 Gogebic
55 Grand Traverse
57 Gratiot
59 Hillsdale
61 Houghton
63 Huron
65 Ingham
67 Ionia
69 Iosco
71 Iron
73 Isabella
75 Jackson
77 Kalamazoo
79 Kalkaska
81 Kent
83 Keweenaw
85 Lake
87 Lapeer
89 Leelanau
91 Lenawee
93 Livingston
95 Luce
97 Mackinac
99 Macomb
101 Manistee
103 Marquette
105 Mason
107 Mecosta
109 Menominee
111 Midland
113 Missaukee
115 Monroe
117 Montcalm
119 Montmorency
121 Muskegon
123 Newaygo
125 Oakland
127 Oceana
129 Ogemaw
131 Ontonagon
133 Osceola
135 Oscoda
137 Otsego
139 Ottawa
141 Presque Isle
143 Roscommon
145 Saginaw
151 Sanilac
153 Schoolcraft
155 Shiawassee
147 St Clair
149 St Joseph
157 Tuscola
159 Van Buren
161 Washtenaw
163 Wayne
165 Wexford

Minnesota

1 Aitkin
3 Anoka
5 Becker
7 Beltrami
9 Benton
11 Big Stone
13 Blue Earth
15 Brown
17 Carlton
19 Carver
21 Cass
23 Chippewa
25 Chisago
27 Clay
29 Clearwater
31 Cook
33 Cottonwood
35 Crow Wing
37 Dakota
39 Dodge
41 Douglas
43 Fairbault
45 Fillmore
47 Freeborn
49 Goodhue
51 Grant
53 Hennepin
55 Houston
57 Hubbard
59 Isanti
61 Itasca
63 Jackson
65 Kanabec
67 Kandiyohi
69 Kittson
71 Koochiching
73 Lac Qui Parle
75 Lake
77 Lake Of The Wood
79 Le Sueur
81 Lincoln
83 Lyon
87 Mahnomen
89 Marshall
91 Martin
85 Mc Leod
93 Meeker
95 Mille Lacs
97 Morrison
99 Mower
101 Murray
103 Nicollet
105 Nobles
107 Norman
109 Olmsted
111 Otter Tail
113 Pennington
115 Pine
117 Pipestone
119 Polk
121 Pope
123 Ramsey
125 Red Lake
127 Redwood
129 Renville
131 Rice
133 Rock
135 Roseau
139 Scott
141 Sherburne
143 Sibley
137 St Louis
145 Stearns
147 Steele
149 Stevens
151 Swift
153 Todd
155 Traverse
157 Wabasha
159 Wadena
161 Waseca
163 Washington
165 Watonwan
167 Wilkin
169 Winona
171 Wright
173 Yellow Medicine

Wisconsin

1 Adams
3 Ashland
5 Barron
7 Bayfield
9 Brown
11 Buffalo
13 Burnett
15 Calumet
17 Chippewa
19 Clark
21 Columbia
23 Crawford
25 Dane
27 Dodge
29 Door
31 Douglas
33 Dunn
35 Eau Claire
37 Florence
39 Fond Du Lac
41 Forest
43 Grant
45 Green
47 Green Lake
49 Iowa
51 Iron
53 Jackson
55 Jefferson
57 Juneau
59 Kenosha
61 Kewaunee
63 La Crosse
65 Lafayette
67 Langlade
69 Lincoln
71 Manitowoc
73 Marathon
75 Marinette
77 Marquette
78 Menominee
79 Milwaukee
81 Monroe
83 Oconto
85 Oneida
87 Outagamie
89 Ozaukee
91 Pepin
93 Pierce
95 Polk
97 Portage
99 Price
101 Racine
103 Richland
105 Rock
107 Rusk
111 Sauk
113 Sawyer
115 Shawano
117 Sheboygan
109 St Croix
119 Taylor
121 Trempeleau
123 Vernon
125 Vilas
127 Walworth
129 Washburn
131 Washington
133 Waukesha
135 Waupaca
137 Waushara
139 Winnebago
141 Wood



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Summarizes forest area, ownership, volume, growth, harvest, products, product consumption, trends, and sustainability for the North Central United States including Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, and Wisconsin.

Key Words: timber, forest area, volume, growth, harvest, removals, forest products, consumption, sustainability.

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