TRENDS IN HARDWOOD TIMBER RESOURCES FOR THE NORTHERN STATES

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Abstract: The forests of the 20-state Northern Region are maturing. The portion of timberland covered by sawtimber-size stands has increased and the area in the sapling/seedling-size stands has decreased. Growing-stock volume has doubled since the early 1950's. Most of the recent gains in volume have occurred on sawtimber-size trees, resulting in large increases in sawtimber volume. Individual species are growing and being removed at different rates, causing changes in the species composition of the forest. For example, red maple (*Acer rubrum* L.) is increasing at a faster rate than many of the more desirable species, such as oaks (*Quercus* spp.).

INTRODUCTION

The hardwood forest resource of the 20-state Northern Region of the United States (Figure 1) has continued to mature following intensive harvesting and land-clearing activities during the late 1800's and early 1900's[3]. Maturing of the forest has brought about changes in the structure, size, value, species composition, and use of the forest. With the maturation of the resource come additional opportunities to influence change.

Forest inventories conducted by the USDA Forest Service in the study region have tracked the maturing of the hardwood resource. In this paper we present the most current statistical data compiled by the Northeastern and North Central Forest Experiment Stations' Forest Inventory and Analysis (FIA) units, and describe trends in the hardwood timber resource in the Northern Region.

Sources for the data used in this report are the individual state resource reports published by FIA units (see References section) as well as a national assessment of timber supply (Powell and others 1993). The date for each inventory varies from state to state, as do the number of years between inventories. To identify trends, comparisons are made between the most current and previous inventories. The inventory cycle for the region is about 14 years, though this interval is shorter for many states with large hardwood resources.

Although we know that all types of forest produce important benefits, categorizing forest land is helpful in organizing forest management. Forest land is categorized by the USDA Forest Service as noncommercial; which includes reserved forest land, unproductive forest land and urban forests; or as timberland. Reserved forest land is unavailable for harvest due to administrative or legislative restrictions. Unproductive forest land is not capable of growing 20 cubic feet of wood annually when managed, which is the minimum growth necessary to qualify as timberland. Urban forests are removed from the timber resource base because of their location in urban and community areas and thus are unlikely to be managed for timber products. Timberland, previously referred to as commercial forest land, is physically capable of growing timber crops and is potentially available for harvesting.

While all forest lands produce multiple benefits, timberland is the resource base upon which a large and growing timber industry relies to maintain it's product flow. The future area of forest land in the noncommercial category is expected to increase over time as more and more forest lands are "set aside" for specific uses such as parks and

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[3] The 20 state Northern Region comprised of the Northeast and North Central subregions is defined by the Resource Planning Act (RPA) Assessment Update, Forest Resources of the United States, 1992 (Powell and others 1993). Although Ohio is inventoried by the inventory work unit at the Northeastern Forest Experiment Station, it is included in the North Central subregion.

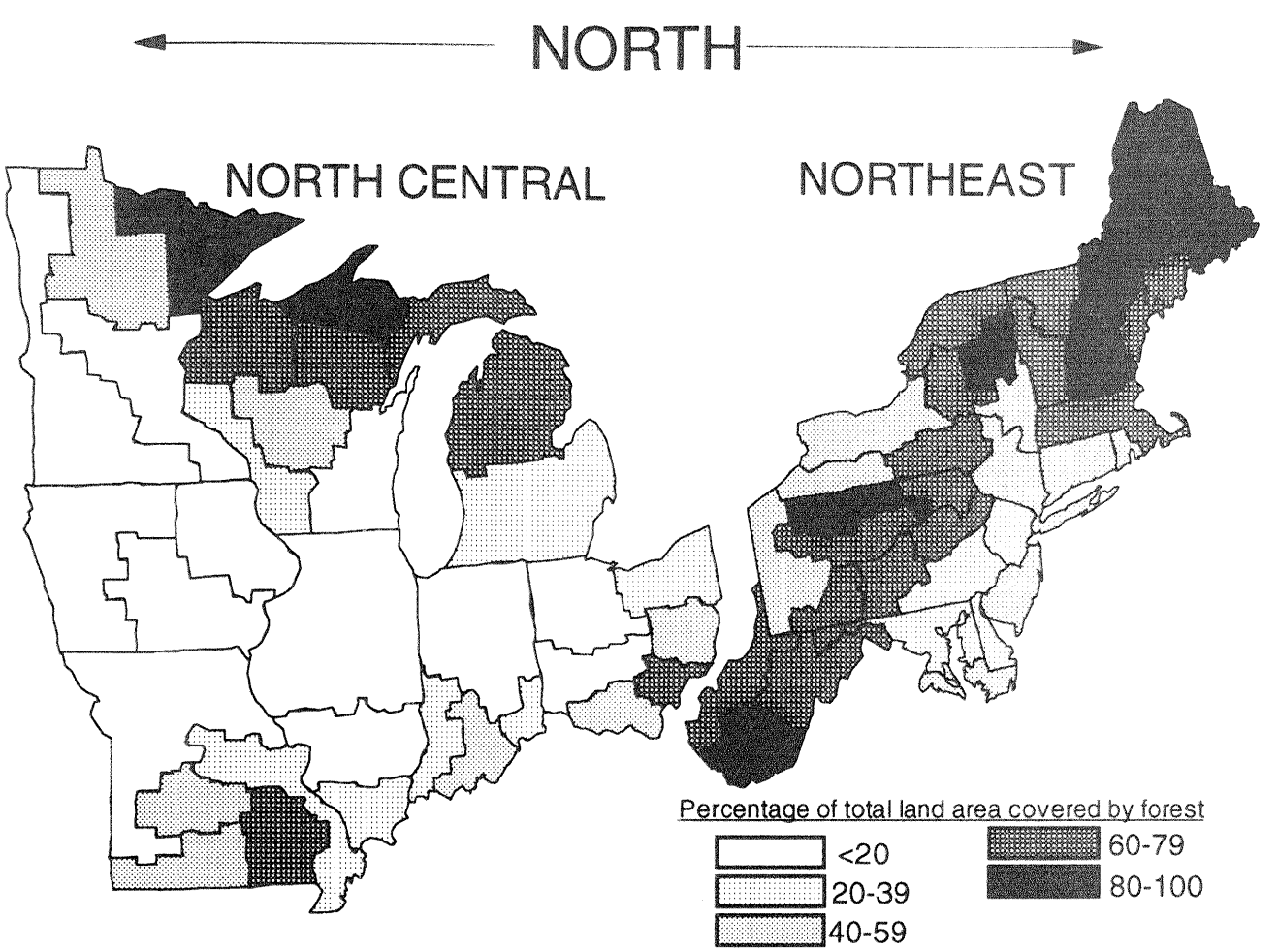

Figure 1. Northern Region and subregions used by the RPA Assessment and percentage of land area covered by forest, by FIA geographic unit, current inventory.

preserves or urban forests. The future area of unproductive forest is expected to remain relatively static over time as this category is more dependent on site capability than land use. Thus, future fluxes (both positive and negative) in the area of forest land are expected to occur in the timberland category. However, despite FIA classifications and definitions related to timberland, timber production often is not the primary reason for ownership for many timberland owners (Birch 1996). Because of this, it is important to determine the extent and character of today's timberland to improve future forest management decisions.

FOREST-LAND AREA

The most recent estimates of forest-land area by FIA units reveal that there are 169.4 million acres of forest land in the 20 northern states—85.5 million in the 12 Northeastern states and 83.9 million in the 8 North Central states. These forests cover 67 percent of the land area in the Northeast and 29% of the land in the North Central states. Recent inventories have shown increases in forest land area since the previous inventory in most states across the Northern Region, the exceptions being the most recent inventories of Connecticut and Delaware, where forest land decreased—by 2 and 1%, respectively. In the Northeast, recent increases in forest have been a continuation of past trends. Whereas, in many of the North Central states forest area has been rebounding after declining between 1952 and 1977.

Recent changes in land-use (primarily agricultural) practices and policies have more than offset losses due to development for nonforest uses. Examples of such changes include the abandonment of cropland/pasture and subsequent reversion to forest; reduction in the number of farming operations and subsequent increase in average farm size, resulting in less intensive management of noncultivated areas and enabling the reestablishment of forest;

changes in livestock grazing management that include greater reliance on feedlots rather than fields and pastures; increased wildfire control; and government programs, such as the Conservation Reserve Program, which remove highly erodible lands from crop production and enable the land to revert to forest or grassland. For the entire Northern Region, forest-land area has increased between the most current and previous inventories by an average of 3.5%. This includes increases of 1.5% in the Northeast and 5.7% in the North Central states.

TIMBERLAND AREA

Timberland represents 94% the total area of forest land in the Northern Region. Recent inventories in the Northeast have found a slowing in the amount of farm land being abandoned while the forest acreage reserved from cutting or classified as urban forest has increased steadily with each new inventory. These shifts out of timberland and into the noncommercial forest category, along with the continued loss of forests to development for nonforest uses, have reduced the amount of timberland in many Northeastern states (Table 1). Although difficult to predict, shifts of timberland into a reserved or noncommercial category may significantly influence the future timber resource in some Northeastern states. In densely populated states such as New Jersey and Connecticut significant amounts of forest land could be reclassified as urban forest by future inventories.

In the North Central states, the area of forest land and timberland has increased during the latest inventory period. For example, the 1993 inventory of Michigan reported an increase of more than a million acres in timberland. Most of this increase was due to changes in agricultural practices, primarily abandoned cropland reverting to forest land. Whether these regional trends will continue depends on a number of factors. Also significant in Michigan and Minnesota, a large amount of land classified by earlier inventories as nonproductive forest (not timberland) was reclassified as marginally productive timberland during the most current inventory.

Table 1. Current estimates of timberland area and changes in timberland area between the current and previous inventory, Northern Region.

Northeastern states/ inventory period	Acres of timberland	Percent change	North Central states/ inventory period	Acres of timberland	Percent change
	(Millions)			(Millions)	
Connecticut 1972-85	1.8	-1.6	Illinois 1962-85	4.0	+1.2
Delaware 1972-86	0.4	-2.1	Indiana 1967-86	4.3	+10.3
Maine 82-95	16.9	-1.1	Iowa 1974-90	1.9	+33.2
Maryland 1976-96	2.4	-3.9	Michigan 1980-93	18.6	+6.5
Massachusetts 1972-85	2.9	+4.7	Minnesota 1977-90	14.7	+8.2
New Hampshire 1973-83	4.8	+2.6	Missouri 1972-89	13.4	+8.2
New Jersey 1974-87	1.9	+0.4	Ohio 1979-91	7.6	+9.4
New York 1980-93	15.4	-0.3	Wisconsin 1968-83	14.8	+1.5
Pennsylvania 1978-89	15.9	-0.3	**Total North Central**	**79.3**	**+6.8**
Rhode Island 1972-85	0.4	-6.0			
Vermont 1973-83	4.4	-0.2	**Northern Region**	**158.5**	**+3.6**
West Virginia 1975-89	11.9	+3.8			
Total Northeastern	**79.1**	**+0.3**			

Timberland in the Northern Region is dominated by hardwood forest types that cover 81% of the regions timberland. Hardwood forest-type groups include the following: Oak/Pine, Oak/Hickory, American Elm/Green Ash, Oak/Gum/ Cypress, Northern Hardwoods (Maple/Beech/Birch), and Aspen/Birch. Current inventories show large increase in area for the Northern Hardwood group across the region.

Timberland can be classified according to the size of the trees growing on the land: sawtimber stands, poletimber stands, sapling/seedling-stands, and nonstocked areas (Figure 2). These size classes are based on commercial uses for forest products and also relate to the seral stage of the forest and habitat requirements of wildlife species. Sawtimber stands, which have the majority of their stocking in sawtimber-size trees, cover 52% of hardwood typed timberland in the Northeast Region and 49% of the hardwood-typed timberland in the North Central states. Sawtimber-size stands have increased in extent primarily because poletimber stands have grown into the sawtimber-size class. Sawtimber stands are most attractive to forest industry because of the high volume and value associated with potentially higher quality trees (size is a major factor in determining quality for hardwood trees). Stands dominated by large trees are aesthetically pleasing—people enjoy hiking and camping in such stands because they are easier to move around in and are perceived to be more attractive. Sawtimber stands also benefit a variety of wildlife species that require stands with large trees for at least part of their habitat or life cycle.

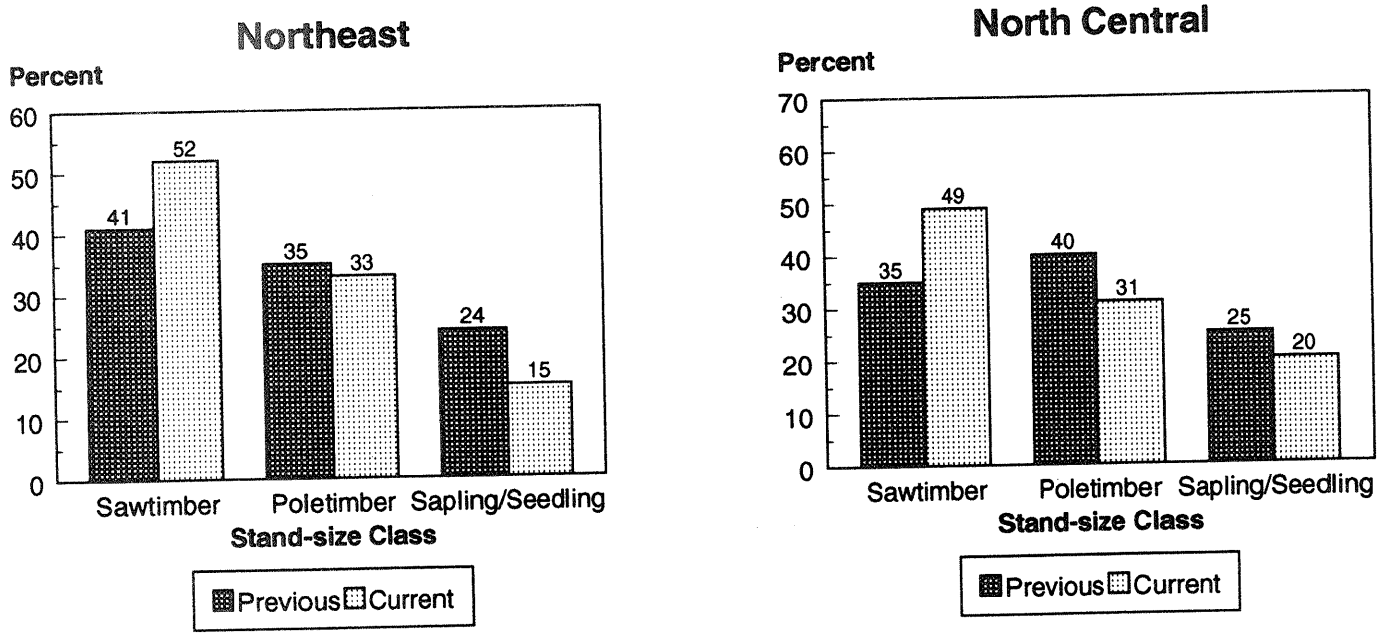

Figure 2. Change in stand-size class between previous and current inventories, on timberland classified in a hardwood forest type, Northeast and North Central subregions.

Poletimber-size stands cover about a third of the timberland in the Northeastern and North Central states. Poletimber stands have the potential for rapid increases in value as they grow into sawtimber stands. Silvicultural treatments in these stands focus primarily on enhancing future value. Historically, crop tree release, thinnings, and improvement treatments in hardwoods have not been common in the Northern Region. Poletimber-size stands are associated with fewer wildlife species than either regenerating stands (sapling-seedling class) or sawtimber stands (DeGraaf and others 1992). Trees in these stands often lack the maturity to produce hard mast or to provide opportunities for species that use the boles of trees. Also, the dense closed overstory can inhibit the growth of herbaceous plants and shrubs that provide food and cover for wildlife.

Sapling-seedling stands and nonstocked areas usually result from clearcutting, salvage cutting, or agricultural land that has been abandoned. Such stands decreased in both the Northeastern and North Central states, relative changes were -36% and -19%, respectively. Across the Region, growth of these stands into the poletimber class was not offset by regeneration harvests or farmland reverting to forest land. In the North Central states the reversion of farm

land offset growth into larger-size stands to a greater extent than in the Northeastern states. The nature and extent of harvesting activities across the Northern Region are not well documented, but FIA plot information reveals that contemporary harvesting activities are not reducing many stands to these early successional stages. In an analysis of FIA plot data in Pennsylvania for 1978-1989 (Gansner and others 1993), they found that on 90% of timberland, removals amounted to less than 40% of the original basal area. As the abandonment of farm land slows and clearcutting becomes even less favored as a harvesting method, the area in sapling-seedling stands will continue to decrease.

The reduction in sapling-seedling stands represents a decrease in the area of early successional stage forest. Because some wildlife species depend on these stages as nesting or feeding sites, it is desirable to have a portion of the forest in sapling/seedling-size stands. The decline of early successional forests across the Northeast Region is of concern to many wildlife biologists. For example, Brooks (1993) stated that in eastern North America, declines are occurring in several bird species that breed in young forests. He added that "although the loss of young and old-field, or shrubby, thicket-type forests cannot be solely blamed for the declines, loss of summer-breeding habitats is certainly a partial cause of these trends." Across a large region it is also desirable to have a mix of stand sizes. A forest with a balanced distribution of size classes provides diverse habitats and an even flow of forest products, and also may be more resistant to insects and diseases than less balanced forests.

CHANGES IN TIMBER VALUE

The value of the timber resource depends on the total volume of wood available and the character of the trees. Key characteristics in valuing the hardwood resource are species, tree size, and quality.

The fundamental measure of timber volume used by FIA is the net cubic-foot volume of wood in the main stem of well-formed sound trees that are 5 inches or more in diameter—growing-stock volume. As hardwoods are the predominate species group in the North, they represent three-fourths of the growing-stock volume. The volume of hardwoods has increased steadily in both the Northeastern and North Central States: the current estimated volume of hardwood growing-stock in both areas is more than twice what it was in 1952 (Figure 3).

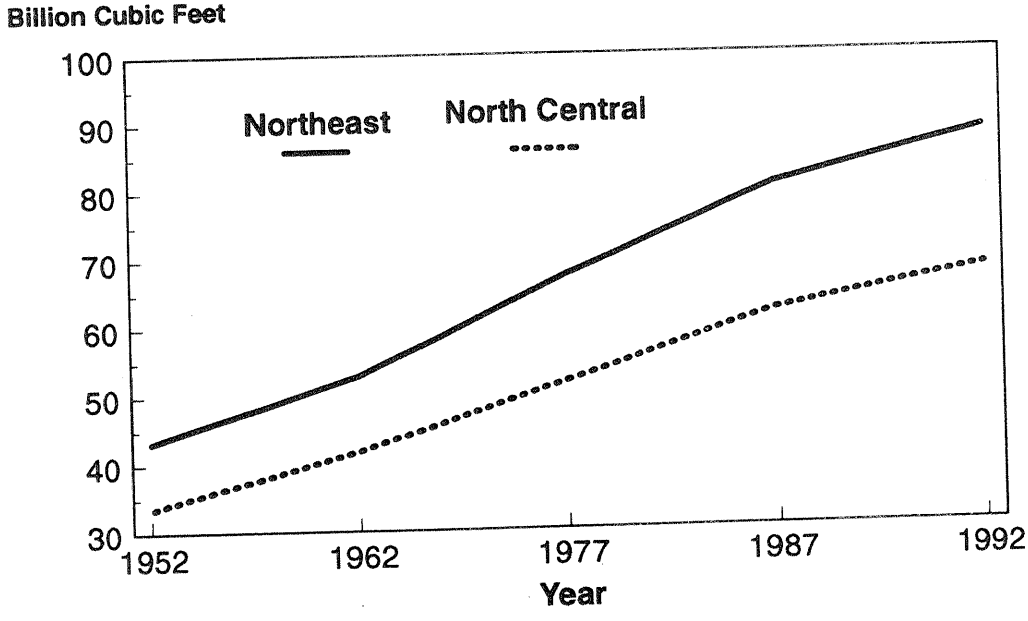

Figure 3. Hardwood growing-stock volume on timberland, Northeastern and North Central states.

Putting volume on a per-acre basis allows comparison of areas with different amounts of timberland (Figure 4). The highest hardwood volumes per acre are in the Appalachians, particularly on the Allegheny Plateau in northwestern Pennsylvania. High per acre volumes are also found near some of the more heavily populated areas of the Northeast. This implies that trees in these areas are valued for their nontimber benefits and that access to them by harvesters is more difficult than in more rural areas. This clash in forest values can be seen in the rise in the number of local cutting ordinances enacted by many communities. Farm woodlots across northern Ohio and southern Michigan also have large amounts of hardwoods, though these acreages are small. Lower hardwood volumes are found where forests are primarily conifers, such as in Maine and the northern areas of Michigan, Wisconsin, and Minnesota, and also where trees give way to shrubs and grasses due to climatic factors, for example, prairie regions in western Minnesota, Iowa, and Missouri.

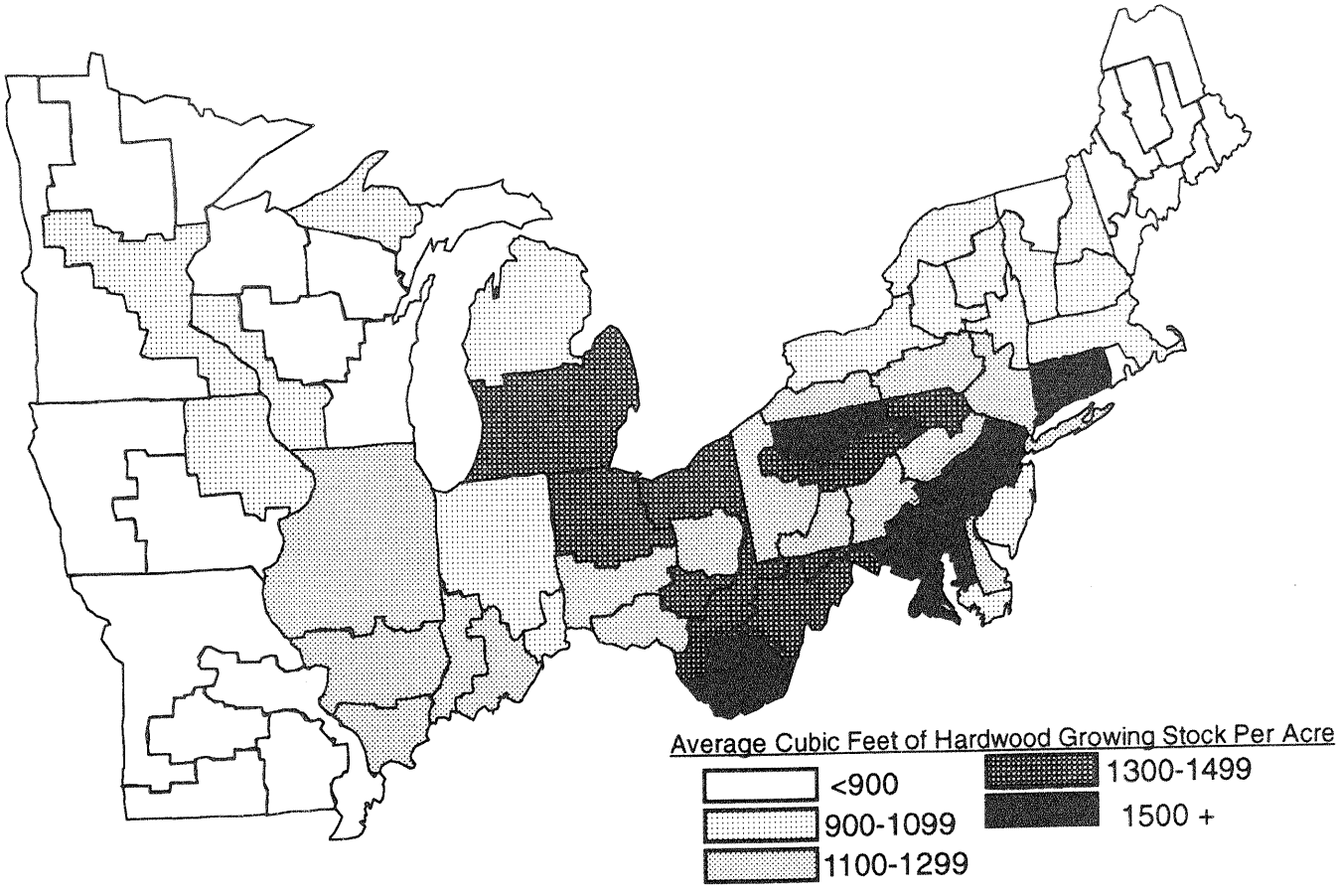

Figure 4. Average hardwood growing-stock volume per acre of timberland, by FIA geographic unit, Northern Region, current inventory.

Figure 5 shows the volume for all hardwood species by diameter class using FIA data compiled for the 1992 Resource Planning Act Assessment (Powell and others 1993). Since 1952, hardwood volume has increased steadily with each new assessment period. The increase in volume has not been distributed evenly across diameter classes. Volume increases were concentrated on sawtimber-size trees. Volume decreased in the 6-inch class for the two most recent assessments. In general, the larger the diameter, the larger the percentage increase in volume. This is characteristic of a maturing resource. The primary reason for the decrease in volume in the 6-inch diameter class was most likely due to a lack of recruitment into this small-diameter class, which probably has resulted from increased competition from larger size trees. Recent inventories show the portion of volume growth coming from

accretion on remeasured trees has increased and the portion of volume growth coming from the ingrowth of new trees into the lower diameter classes has decreased.

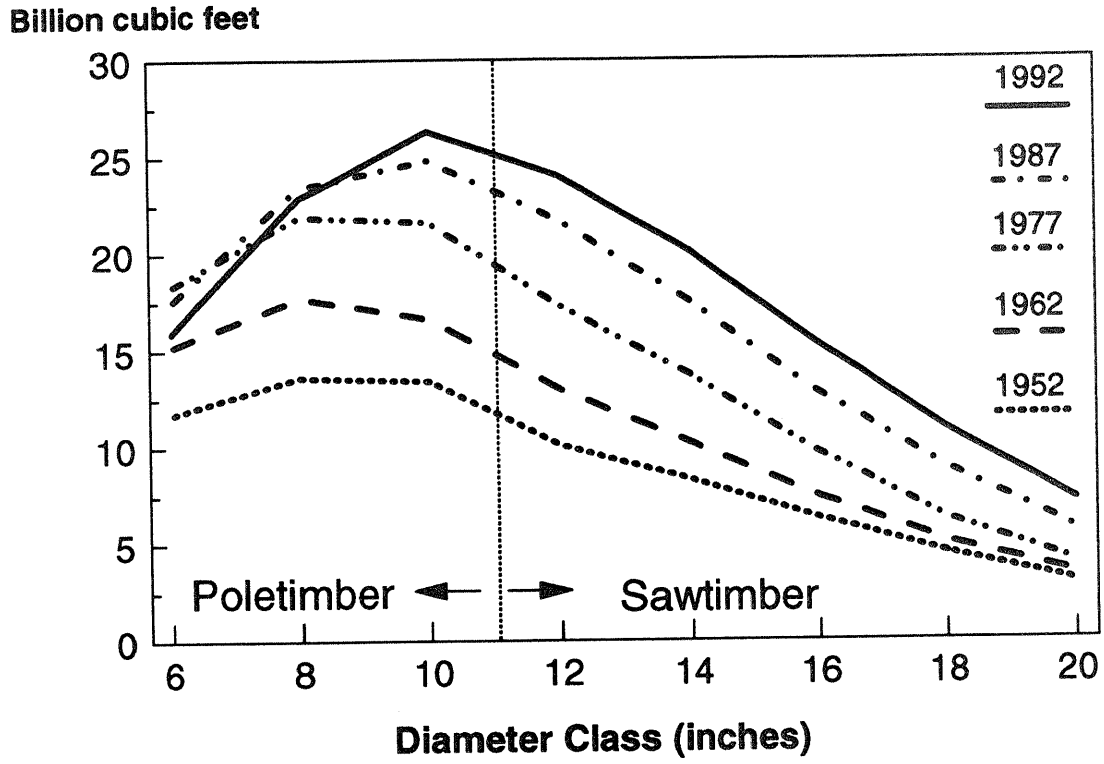

Figure 5. Hardwood growing-stock volume by diameter class, Northern Region.

From 1987 to 1992, 94% of the increase in growing-stock volume was in trees large enough to be sawn into lumber. Because so much of the growth is now occurring on large trees, the sawtimber portion of the resource, expressed in board feet (International 1/4-inch rule), has soared in many states (Table 2). This has added tremendous value to the hardwood resource. To a large extent, the quality of small diameter hardwoods is determined by diameter alone. The large numbers of trees growing into the sawtimber-size class and also small-sawtimber-size trees moving into the larger-sawtimber sizes has overwhelmed many of the negative effects of high-gradeing by the selective logging of large trees over the Region.

More than 100 species of hardwoods grow in the Northern Region. It is not uncommon to find many hardwood species growing on the same acre or in the same stand. However, the 10 leading species and species groups in terms of volume account for two-thirds of the total hardwood volume (Figure 6). The volume for all hardwood species increased by 32% over the last inventory cycle, but the increase was not distributed evenly across all species. The different rates of change for individual species indicate that the species composition of the forest is changing.

Table 2. Current hardwood board foot volume and percentage change from previous inventory

Northeastern states	Current volume (Billions of board feet)*	Percent change	North Central states	Current volume	Percent change (Billions of board feet)*
Connecticut	6.3	+48	Illinois	17.2	+57
Delaware	1.3	+31	Indiana	18.6	+51
Maine	17.1	+9	Iowa	5.7	+53
Maryland	11.1	+22	Michigan	48.3	+58
Massachusetts	5.8	+66	Minnesota	22.7	+43
New Hampshire	8.5	+50	Missouri	23.1	+49
New Jersey	4.4	+40	Ohio	29.3	+66
New York	43.6	+46	Wisconsin	25.1	+60
Pennsylvania	59.5	+37	**Total North Central**	**189.1**	**+55**
Rhode Island	0.7	+57			
Vermont	8.9	+29	**Northern Region**	**410.3**	**+47**
West Virginia	**54.0**	**+61**			
Total Northeastern	**221.2**	**+41**			

*International 1/4-inch rule

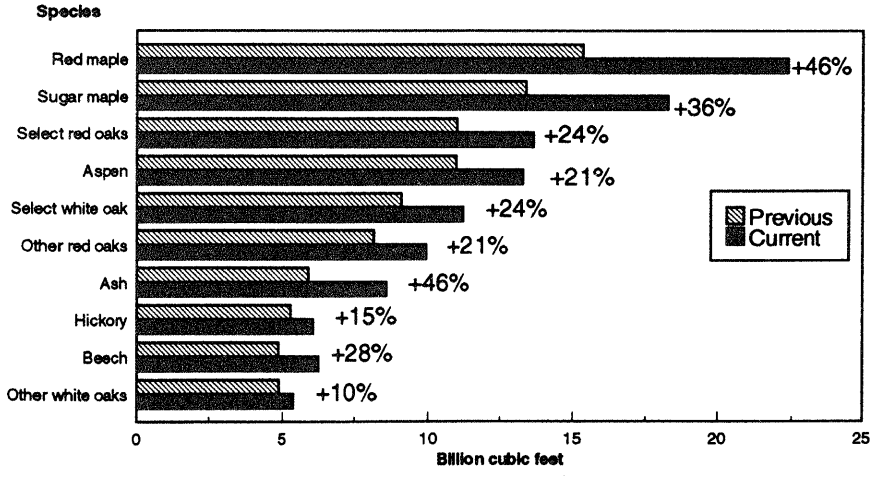

Figure 6. Change in growing-stock volume between previous and current inventories, for selected species and species groups in the Northern Region.

Red maple (*Acer rubrum* L.) led the region in volume at both the most current and previous inventory periods, accounting for 14% of the total volume of all species. Red maple is distributed widely, is an aggressive competitor, and is not heavily cut. It had the largest percentage increase (46) as well as the largest increase in magnitude (7.0 billion cubic feet). Sugar maple (*Acer saccharum* Marsh.) also had larger increases in volume both in percent (36) and magnitude (4.9 billion cubic feet). Together, maples increased as a proportion of the total resource—representing 24% of the previous inventory versus 26% of the current. The four groups of oak species had smaller increases. Across the region, high mortality and reductions in growth have had negative impacts on the oaks. Some reasons for reductions in the growth of oaks are defoliation by the gypsy moth caterpillar, high cutting rates, and low ingrowth due to poor regeneration. Few stands in the Alleghenies (Allegheny Plateau and Allegheny Mountain sections of the mid-Atlantic states) contain sufficient numbers of oak seedlings to adequately regenerate oak after cutting (Marquis and others 1992)

The use of the timber resource for timber products is determined largely by the tree quality. The best trees are used for the manufacture of furniture, cabinets, and other millwork, and lower quality trees are used for pallets, pulpwood, and particle board. Quality is indicated by the grade assigned to each tree on inventory sample plots. Tree grade is based on the number of clear surfaces, amount of cull, and diameter of the butt log of the tree. Tree Grade 1 yields the most high-grade lumber and Tie/Timber Grades the least. The quality of trees varies with species. Figure 7 compares tree grades for five major species in Ohio. Only trees greater than 15 inches in diameter are used in order to reduce the influence that size alone has on the quality of small sawtimber-size trees. Ohio data are used here as an example of trends taking place across the Northern Region. Ohio is similar to the Northern Region as a whole in that the portion of total volume of sugar and red maple has increased at the expense of more desirable species such as red and white oaks.

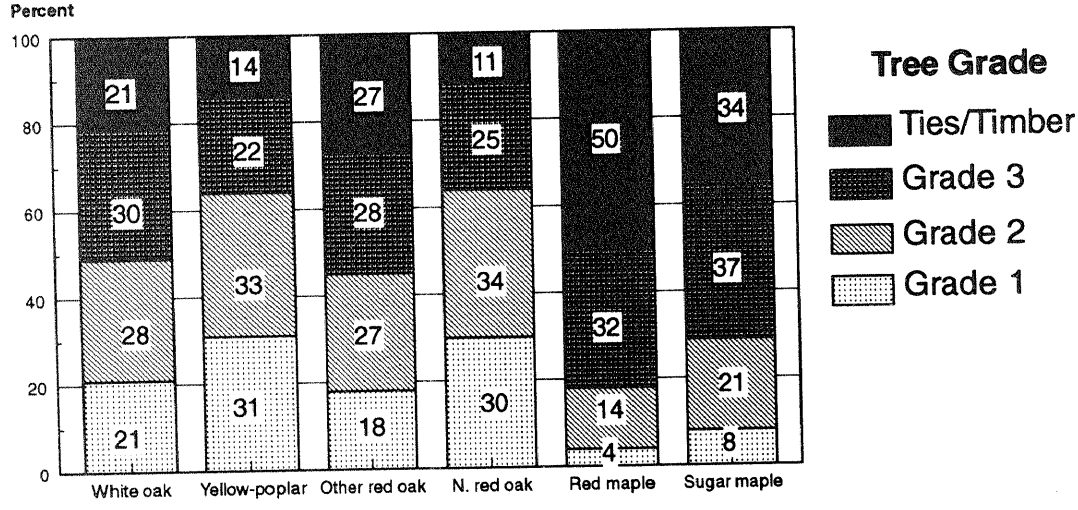

Figure 7. Percentage of sawtimber volume in each tree grade for trees 15 inches and larger in diameter, for selected species, Ohio, 1991.

Sixty-four percent of the northern red oak (*Quercus rubra*) volume was in Tree Grade 2 or better trees, whereas only 18% of the red maple volume is in the better grades. These differences in grade between species have important implications for future supplies of high-quality lumber. Because future forests will contain significantly more red maple sawtimber volume and a lower proportion of volume in oak species, the yield of high-quality lumber from these forest will not increase proportionally with increases in total volume due to differences in species characteristics.

Shade-tolerant species tend to retain their lower limbs longer, thereby reducing the yield of high-quality lumber; whereas shade-intolerant species naturally prune their limbs at an earlier age, which results in fewer and smaller knots. In general, the more shade-tolerant species, such as red maple do not grade out as well as intolerant species such as red oak. The utilization of low-quality hardwood trees has caused persistent problems for forest managers, and these problems will probably continue as long as red maple continues to increase in volume. Although great strides have been made in utilization in recent years, there remain tremendous challenges and opportunities.

GROWTH AND REMOVALS

A look at the relationship between net growth and removals of growing-stock volume helps in understanding the sizable increase in hardwood growing-stock volume (Figure 8). Average annual net growth includes accretion (growth on the initial inventory), ingrowth (volume of trees that grew large enough to measure), mortality, and changes in cull volume. Red maple surpassed all other species in net growth, accounting for 17% of the total volume of net growth for the region. Net growth for the four oak species groups combined accounted for 22% of total net growth. Because of the higher removals rate for the oaks, the net change (net growth minus removals) for red maple was greater than for the oaks combined (551 million cubic feet for red maple versus 336 million cubic feet for all oaks combined).

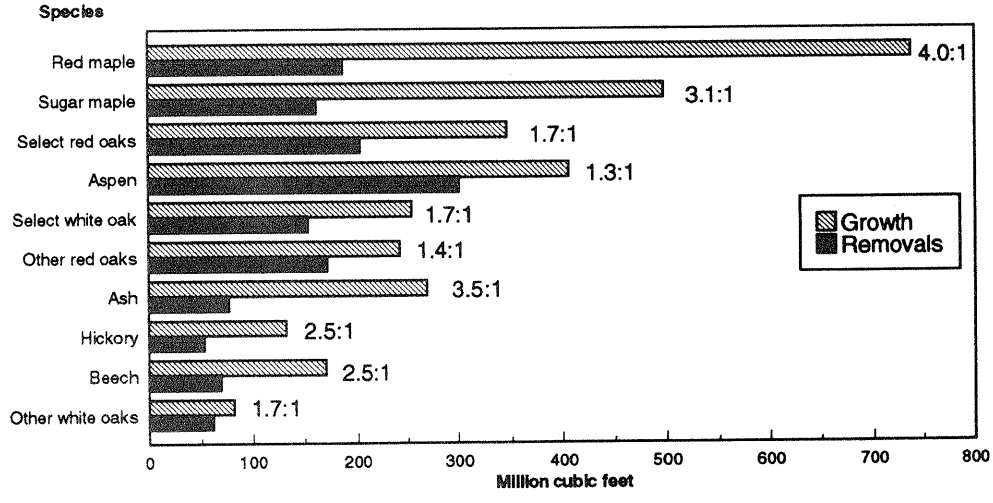

Figure 8. Average annual growth and removals of growing stock in the Northern Region, 1979-1991.

Dividing average net annual growth by average annual removals gives a ratio of growth to removals. Across the Northern Region, this ratio for hardwoods is 2.2:1. Ratios vary considerably between species. Red maple's high growth and relatively low removals result in a ratio of growth-to-removals of 4.0:1. This is almost twice the average for all hardwood species, and much higher than for the oaks (1.7:1 for both select red oaks and select white oaks). Comparing individual species to the average for all hardwood species (2.2:1) gives an indication of which species are increasing in importance, and which are decreasing. Red maple clearly will play a larger role in forests of the Northern Region, especially if the oaks continue to fade in importance.

Ratios of net growth to removals also vary considerably among states (Table 3). Although more hardwood volume is grown each year than is being cut in all states, the ratios are lower for the North Central than the Northeastern states. This reflects more intensive use of the resource in the North Central states.

Table 3. Ratio of growing stock growth to removals by state

Northeastern states	Ratio of growth/ removals	North Central states	Ratio of growth/ removals
Connecticut	2.5:1	Illinois	1.4:1
Delaware	2.0:1	Indiana	1.6:1
Maine	1.6:1	Iowa	1.8:1
Maryland	1.9:1	Michigan	2.7:1
Massachusetts	4.5:1	Minnesota	1.7:1
New Hampshire	3.8:1	Missouri	2.2:1
New Jersey	4.9:1	Ohio	2.3:1
New York	2.9:1	Wisconsin	1.6:1
Pennsylvania	2.0:1	**Total North Central**	2.0:1
Rhode Island	2.9:1		
Vermont	4.1:1	**Northern Region**	2.2:1
West Virginia	3.7:1		
Total Northeastern	**2.6:1**		

SUMMARY

Forests in the Northern region are maturing, as evidenced by increasing area of sawtimber stands, increases in the number of larger trees, higher volumes per acre, and changes in species composition toward more shade-tolerant species such as red and sugar maple. Although it is natural for tolerant species to increase in a maturing forest, higher cutting rates for the intolerant oaks probably have accelerated this process. Large increases in sawtimber volume have brought increases in the timber value of the resource, though changing species composition will slow such increases. Because red maple has increased its share of the total resource at the expense of the more desirable oaks, increases in volume have not been accompanied by proportional increases in timber value.

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