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An Analysis of New York's Timber Resources

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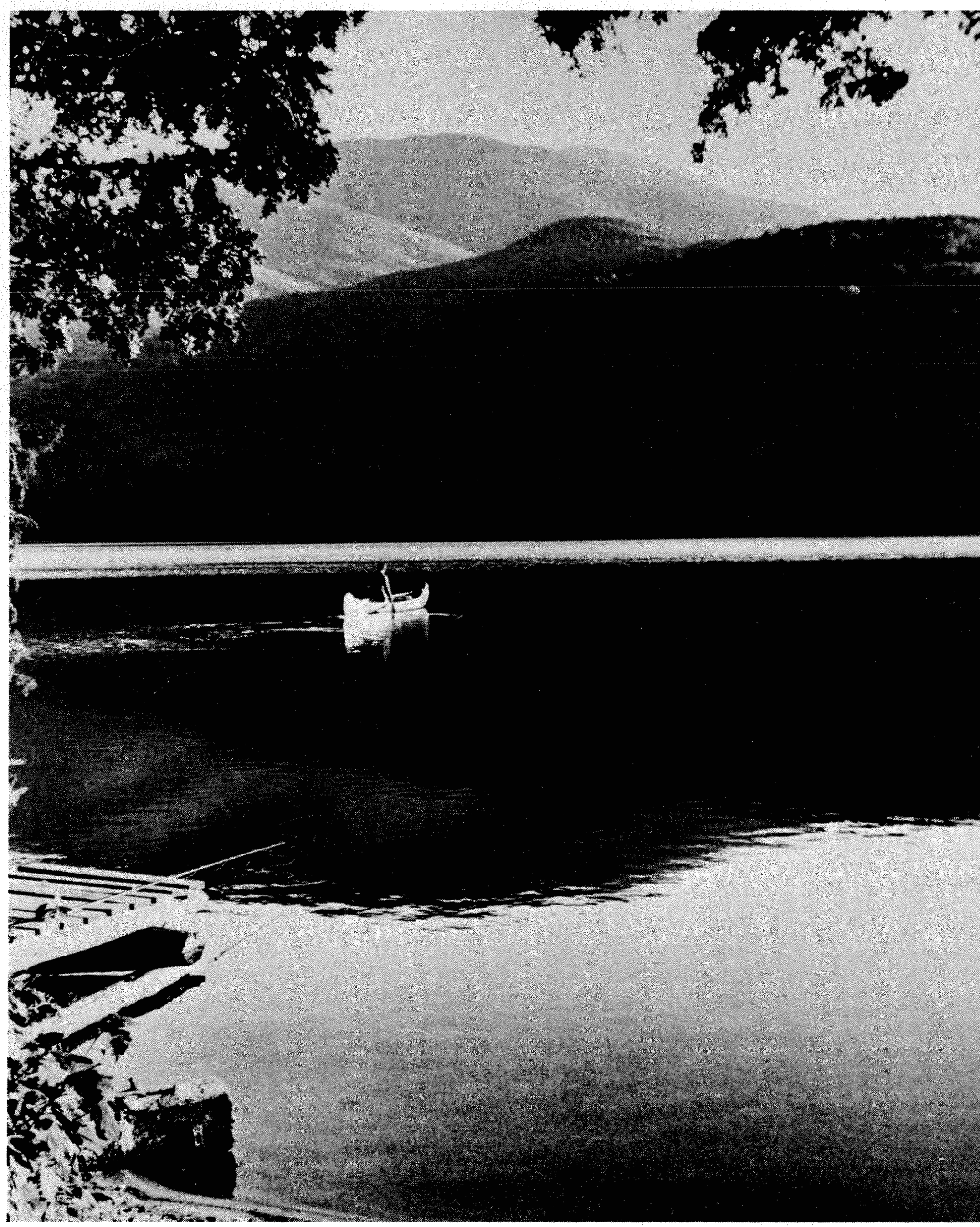

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Abstract

This report presents an analysis of the results of the third forest survey of New York as well as trends that have occurred since the previous surveys. Topics include forest area by ownership, stand size, and forest type; timber volume by species, location, and quality; biomass; timber products output for sawlogs, pulpwood, and fuelwood; and growth and removals. Forest area, volume, and growth and removals are projected through 2010. Also identified are forest management opportunities for increasing the production of major forest resources from New York's forests.

Cover Photo

Heart Lake in the scenic Adirondacks. Forested panoramas and a cool lake provide welcome relief from the stress of everyday life.

Courtesy: Mike Storey, Adirondack Park Agency

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Foreword

This analysis of New York's timber resource draws upon the results of three forest inventories conducted by the Forest Inventory and Analysis Unit at the Northeastern Forest Experiment Station, USDA Forest Service, in cooperation with the New York State Department of Environmental Conservation, Division of Lands and Forests.

Readers of this report should be aware of several items. First, this report will be included in the series of technical reports which make up the New York State Forest Resources Assessment. This Assessment was developed as part of a statewide forest plan for New York by the New York State Department of Environmental Conservation, Division of Lands and Forests.

To avoid duplicating published technical reports, several sections usually included in our analyses have been omitted. Readers familiar with our recent analyses will recognize that the sections on nontimber resources have been dropped. New York's nontimber resources have been very well covered in the Technical Reports published by the New York State Department of Environmental Conservation.

Second, readers should be aware of a discrepancy in some of the biomass information published in "Forest Statistics for New York" (Considine and Frieswyk 1982). See the Biomass discussion in the Timber Volume section for an analysis of this situation.

Third, data processing for the third forest survey of New York used new and improved methodologies as compared to those used for previous surveys. As a result, many estimates are more accurate than those from earlier surveys, but sometimes cannot be compared directly with earlier estimates. The section in the Appendix titled Processing the Data provides a detailed explanation of the technique refinements.

Finally, *readers are strongly urged* to familiarize themselves with the terms and definitions used in this report. See Definition of Terms in the Appendix.

A tremendous amount of data was collected during the preparation of this report. The author analyzed only what he believed were the most important aspects of New York's timber resources. Much additional data are available and further analyses possible. Should you desire further information contact: Project Leader, Forest Inventory and Analysis, Northeastern Forest Experiment Station, 370 Reed Road, Broomall, PA 19008 (telephone 215-461-3037).

Highlights

- New York is 61 percent forested. New York has 18.5 million acres of forest land, more than any other northeastern state.

- Forest-land area increased by nearly 1.2 million acres between 1968 and 1980. This increase continued a century-old trend of forest-land area increases.

- Eighty-three percent of New York's forest land, 15.4 million acres, is classed as commercial forest land. Most of the noncommercial forest land is in the state-owned forest preserve portion of the Adirondack and Catskill Parks.

- Ninety-four percent of New York's commercial forest land is privately owned. Private, nonfarming citizens own the largest amount of commercial forest land.

- New York's forests are maturing; as a result, the area covered by poletimber and sawtimber stands increased.

- Timber volumes also increased as a result of the woods' maturation. Growing-stock volume climbed 38 percent, and sawtimber volume climbed 53 percent between surveys.

- Hardwoods account for 76 percent of New York's growing-stock timber volume. Sugar maple remains the number one species in growing-stock and sawtimber volume.

- Hardwood sawlog quality is about the same as in 1968. Thirty-five percent of the hardwood sawtimber is in grades 1 and 2.

- Timber growth and removals increased between surveys. Annually, about 2.8 cubic feet of timber are being grown for every cubic foot of timber being cut.

- Thirty year projections show a slight decline in the area covered by forests but increasing timber volumes.

- While forest conditions are improving across much of New York, numerous forest management opportunities exist to further improve the condition of the woods.

Background

New York has a substantial forest empire—over 18½ million acres of sylvan settings. Sixty-one percent of the state, 3 out of every 5 acres, is tree covered. This means that New York has more forest land than any state east of the Rocky Mountains, with the exception of Georgia, Alabama, North Carolina, and Texas. That New York could have so much forest land may surprise some because the state is quite populated—second nationally in the 1980 census (U.S. Dep. Comm. 1981)—and has a substantial agricultural economy—third largest dairying state in terms of milk volume sold (Davis 1981). New York has a sizable forest resource because the state has a climate and geographical location that dictate forest cover unless the land is actively farmed or paved over (Hamilton et al. 1980).

Today's forest conditions are very much different from those in earlier times. New York's forests have not been static, they have been most dynamic. An analysis of current conditions would be incomplete without a review of those major events which shaped the state's present woods. New York's forest history has three segments: Pre-European Settlement Forests, Settlement and Exploitation, and Forest Recovery.

Pre-European Settlement Forests

Forest history for New York begins with the final retreat of the Wisconsin ice sheet that covered nearly all of New York 11,000 or 12,000 years ago. The glaciers destroyed whatever forests they covered and removed and relocated virtually all the soil as well. Many of today's soils and growing conditions are still strongly influenced by those glacial actions.

There can be no certain determination of what forests developed after the ice and snow melted, but pollen analysis from remaining, ancient bogs gives some clues. It seems that the climate remained cold for some time so that the first forests contained characteristically boreal species such as spruce, fir, and some birches (McCullogh 1939). The climate eventually entered a warming period. Pines, hemlock, and to a greater extent hardwoods such as maple, beech, and oak replaced the boreal species at many lower elevations. Indians first arrived around 7,000 B.C. and found the region almost entirely forested with a mixture of softwoods and hardwoods (Hamilton et al. 1980).

For 5,000 or 6,000 years the Indians lead a nomadic life, barely impacting the woods. From about 1,000 B.C. on, however, Indian lifestyles became increasingly complex. Two major groups of Indians emerged: the Iroquois and Algonquins. The Iroquois were actually five Indian Nations: the Mohawks, Oneidas, Onondagas, Cayugas, and Senecas. This powerful confederation existed for more than a century before the Europeans arrived. These Indians exemplified a well-developed culture. They practiced agriculture, established self government, and became masters of statesmanship. Their influence and power extended to the Carolinas and the Mississippi River.

Because of their shifting agriculture and practice of burning the woods for increased hunting and berry and herb production, Indians had a larger impact on the forests found by the Europeans than they are given credit for. They altered the species composition of the woods. Oaks and softwoods were more common than they would have been without the fires (Marquis 1975). Also, the vast expanse of virgin forest was broken up, especially in river valleys where the Indians settled. They created numerous openings and areas of immature timber (Robichaud and Buell 1973). The effect the Indians had on the forests, while noteworthy, paled next to the changes wrought on New York's forests by the European colonists and their descendants.

Settlement and Exploitation

Colonial settlements of any significance first appeared in the lower Hudson Valley around 1625, some 16 years after Henry Hudson first sailed upriver as far as he could (to present day Albany). In the period between initial colonization and the American Revolution, the spread of settlement was slow. By 1776, settlement reached up the Hudson Valley to north of Albany and west into the Mohawk Valley for some distance (Thompson 1966). Eighty percent of the state was still in forested wilderness. On the lands that were inhabited, large quantities of wood were destroyed. Some wood was used for houses, barns, furniture, fuel, and fencing, but by and large the forests were a hindrance to progress and were often cut and burned.

A modest lumber industry grew with the developing state. In early times, boards were hand hewn or cut by pit sawing. Early sawmills were crude and slow and were located in the settlements along streams so water power could drive the saw. Some export was accomplished by building rafts of logs, usually large white pines, and floating them down the Hudson and other large rivers.

Settlement and land clearing proceeded very rapidly after the conclusion of the American Revolution. The reasons were severalfold: land was given by the U.S. Government to soldiers as payment for fighting in the war, immigrants from Europe continued to arrive, and people poured in from New England seeking more fertile farmland. Through the late 1700's and into the 1800's, these waves of settlers cleared New York's forests at an increasing rate (Fig. 1).

The lumber industry grew to meet the needs of the growing Nation. A number of transportation developments greatly aided land settlement and the lumber industry. In 1813 log driving was developed. This process floated logs downstream; so sawmills did not have to move nearly as often to follow the timber supply. Larger sawmills were built, and the lumber market expanded noticeably.

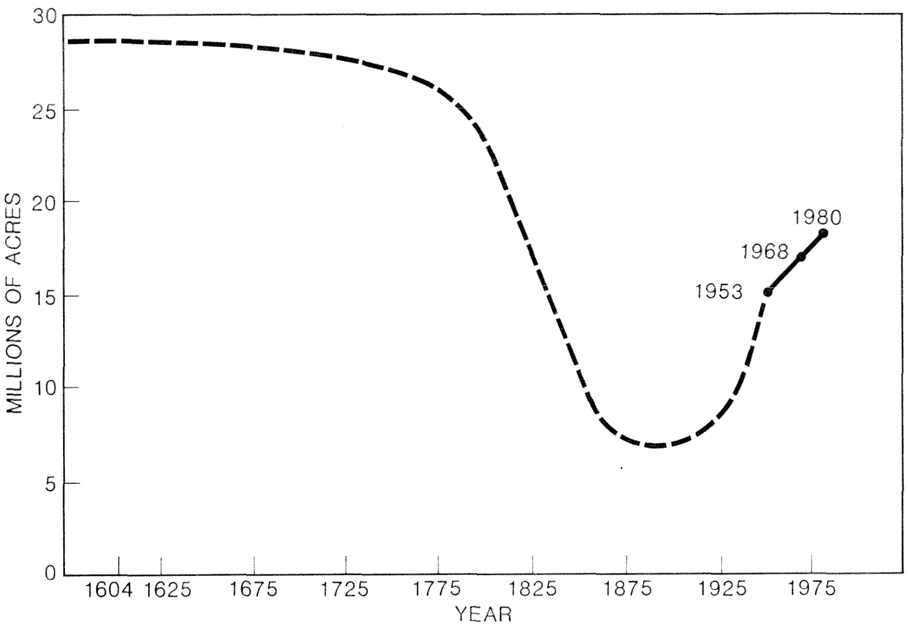


Figure 1.—Changes in forest-land area.

In the years gone by, a variety of methods were employed to get logs to the mill.

A second crucial transportation development was the digging of New York's canal system. The most famous was the Erie canal which took 8 years to finish and opened in 1825. It allowed direct water passage from Lake Erie to the Hudson River and on to New York City. Perhaps no other single event so opened up New York to development. The significance of the canal system can be seen in that many of New York's cities developed along the Erie Canal: Buffalo, Rochester, Syracuse, Utica, and Schenectady (Nutting 1927).

By the 1850's, New York's lumber industry was in full gear. Settlement farming often followed timber cutting operations. New York led the Nation in lumber production between 1850 and 1860, and Albany was a major lumber port. Softwoods accounted for 80 percent of the lumber shipped (Canham and Armstrong 1968).

The third significant transportation breakthrough was the invention of specialized logging railroad equipment. The first logging railroad was built around 1860 (Hamilton et al. 1980). Between 1880 and 1890, specially geared locomotives were developed that allowed remote areas of timber to be reached. It also allowed the cutting of hardwoods that were not cut previously because they did not float well. Logging railroads were most common in southwestern New York and the Western Adirondacks (personal communication, Hugh O. Canham, School of Forestry, Syracuse NY).

Cutting patterns changed as the railroads moved into the valleys and up the hills. Individual or scattered tree removal was often replaced by large scale clearcutting. Nearly everything was merchantable: hemlock bark for the tanning industry; logs for boards, lumber, railroad ties, furniture, charcoal, and other products; short bolts for pulp and paper mills and for the wood chemical industry; and fuelwood for many homes and power (Marquis 1975, Hamilton et al. 1980).

By 1880 land clearing and logging had taken their toll. Fires started by railroad engines and logging crews were not rare in cutover areas. Erosion was a problem on some watersheds. Forest land in 1880 reached its low point since the glaciers retreated many thousands of years before. Only 25 percent of the state remained forested. Since a significant amount of forest land was left in the high peaks of the Catskills and Adirondacks, certain areas of the state were almost totally deforested.

Forest Recovery

The time span from the 1880's to the present might best be titled the period of forest recovery, even though timber harvesting remained heavy into the early 1900's. During the period of forest recovery, a number of negative trends have been halted or reversed, and the woods have grown back. Although economic reasons were certainly involved, the politics of the forest problem played no small part in reversing the decline of the resource.

Public concern over the diminishing quantity and quality of forest land grew markedly during the 1880's. In 1885, the forerunner of today's Department of Environmental Conservation was created by the State legislature. It was called the Forest Commission, and its basic job was to protect what forest land was left, especially from fire.

The culmination of the attempts to remedy the forest degradation problem came in 1892 with the creation of the Adirondack Park. In 1894, an amendment to the State's constitution decreed that the state-owned forest lands within the boundary of the Park were ". . . to be forever kept as wild forest lands." The amendment was an attempt not only to end the damaging cutting practices of the time but also to protect the quality and quantity of the water supplies coming out of the mountains. These water supplies were critical to the canal system and to most of the state's major rivers including the Hudson, Mohawk, and St. Lawrence. Boundaries for the Catskill Park were set up soon after.

Changing economics in farming also reversed the depletion of the forests. In the late 1800's, farming became more mechanized, which required reasonably level land and larger farms. New York farms tended to be small and many were on hills; some quite steep. These farms were at a disadvantage compared to farms in other regions of the country.

The Industrial Revolution created city jobs that were an attractive alternative to the hard life of farming marginal land. The combined effect of these changes was to push land out of agricultural use and back into forest. The reversion process averaged about 40,000 acres per year between 1880 and 1920 when a nationwide agricultural depression hit the state and accelerated the rate of farm land abandonment. Through the 1920's and the Great Depression of the 1930's, the average rate of abandonment was more than 270,000 acres per year (Fedkiw 1959). The steepness of the slope of the line in Figure 1 around the 1920's and 1930's graphically represents the rapid increase in forest land. Many of New York's currently valuable forests originated during this period.

In 1928 and 1929 because of the large amounts of tax delinquent, abandoned farm land, the state and county governments undertook an aggressive land purchase and tree planting program. The intent was to return the lands to full timber production in as short a time as possible. Most of the trees planted were conifers such as red, white, and Scotch pine and Norway spruce. The State acquired the majority of today's more than 700,000 acres of State forests during the period between 1928 and 1943.

In 1926 the State recognized the value of protecting wildlife habitat and allowed the purchase of land for that purpose. To date, Fish and Wildlife Management Areas cover more than 150,000 acres, most of which are forested.

The tapering off of the state's abandoned land acquisition program around the end of World War II was tied to the increased interest by many private citizens to own forest land. In the decades following the war, many people gained successively higher levels of disposable income and leisure time. Seeking to escape the suburban and city life, many bought forested tracts. Since they typically owned the land for esthetic reasons, they tended to plant some trees and not cut much timber. In essence, the inactivity of many of the private landowners allowed the forests to continue growing back.

It was against this general framework of a century of forest land increases and forest recovery that we conducted our third forest survey. The common thread linking New York's forest history and many of the survey findings is change; change based on the actions of man and nature. Most of this report will be devoted to analyzing the forces of change and what they mean with respect to New York's timber resource.

Forest Surveys of New York

As mandated by the Renewable Resources Research Act of 1978 and the Renewable Resources Planning Act of 1974, the USDA Forest Service conducts periodic surveys of the Nation's forest resources to keep abreast of current forest conditions, monitor resource trends, and project future resource supplies. These acts repealed the previous enabling legislation titled the McSweeney-McNary Research Act of 1928.

New York has experienced three USDA Forest Service forest surveys; all done in cooperation with the New York State Department of Environmental Conservation. The first survey was conducted between 1949 and 1952 and was dated 1953 (Armstrong and Bjorkbom 1956). The second survey was conducted between 1966 and 1968 and was dated 1968 (Ferguson and Mayer 1970). The most recent survey was conducted between 1978 and 1979 and dated 1980.

Some of the results of the latest survey have been published in 96 statistical tables (Considine and Frieswyk 1982). A copy of the statistical report would be useful in following this analysis.

Eight Geographic Units

To provide regional as well as statewide information, New York was divided into eight geographic sampling units (Fig. 2). The unit boundaries were drawn to enclose reasonably distinct physiographic regions with fairly homogeneous forest conditions. Since the unit boundaries are identical to those of the 1968 survey, comparisons between the two surveys at this level are valid for timber volume and forest area (see Tables 92-96 in Considine and Frieswyk 1982).

Forest Area

New York's net land area, 30.2 million acres, is covered by four major land use classes (Fig. 3). In ascending order of area covered, they are: pasture—1.9 million acres (6 percent), crop and other farmland—4.8 million acres (16 percent), urban and miscellaneous lands—5.0 million acres (17 percent), and forest land—18.5 million acres (61 percent).

The large amount of forest land may surprise those familiar with the Gotham City and the state's other urban landscapes. However, the state is quite similar to its northeastern neighbors with respect to its ample forest base. Massachusetts is 51 percent forested, Pennsylvania is 58 percent forested, and Connecticut is 60 percent forested.

Forest land is not evenly distributed across the state (Fig. 4). As often occurs in other states, increasing amounts of forest land in New York are associated with increasingly steep topography. The most heavily forested counties are in the mountainous Adirondack (northern) and Catskill (southern) regions. Three of the Adirondack counties—Essex, Hamilton, and Warren—are over 90 percent forested. Other than the five boroughs of New York City, the most lightly forested counties are on Long Island and the relatively flat northern half of western New York; a physiographic region known as the Lake Plain (Fig. 5).

New York's forest land is broadly classified as either commercial or noncommercial. Noncommercial forest land accounts for 3.1 of the 18.5 million forested acres. While noncommercial lands are only 17 percent of the state's forested area, New York has a tremendous amount of noncommercial forest land in relation to most other states. Noncommercial forest land is composed of productive reserved, unproductive, Christmas tree plantation, and urban forest land (Fig. 6). The term noncommercial does not imply that the forest land has little value, rather it refers to the infeasibility of timber management on the land.

Noncommercial forest land is legally or administratively withdrawn from timber harvest or is not capable of growing at least 20 cubic feet per acre per year (about a quarter of a cord) of wood suitable for forest industry. Most of New York's noncommercial forest land is owned by the State of New York and is classed as productive reserved. It is capable of growing enough wood to qualify as commercial but has been withdrawn from timber harvest.

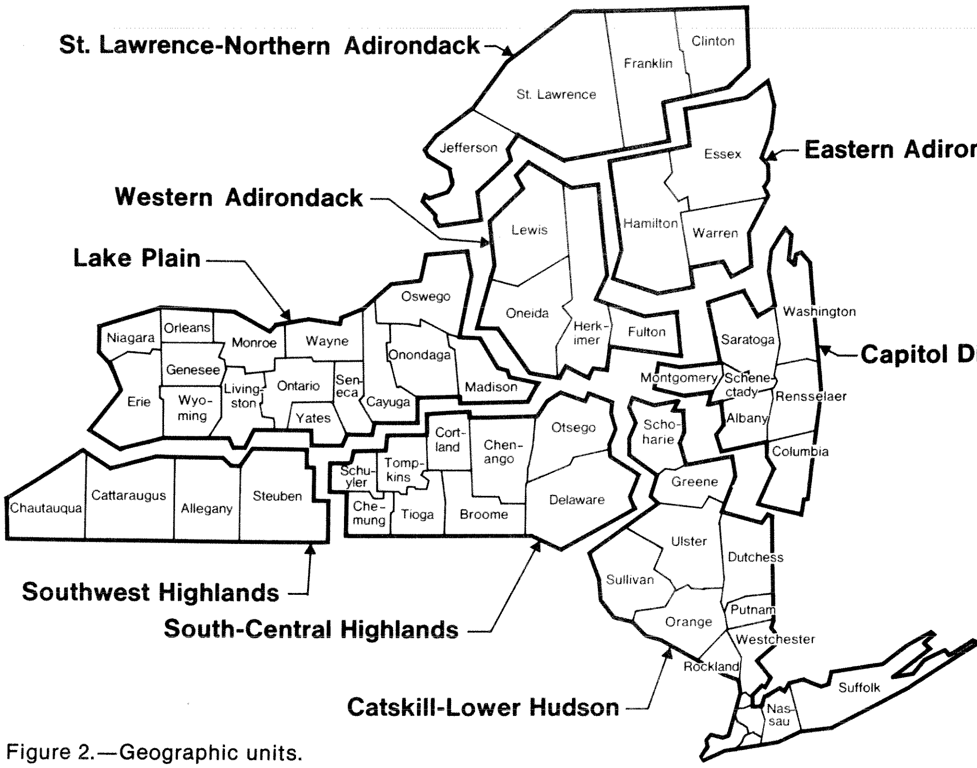


Figure 2.—Geographic units.

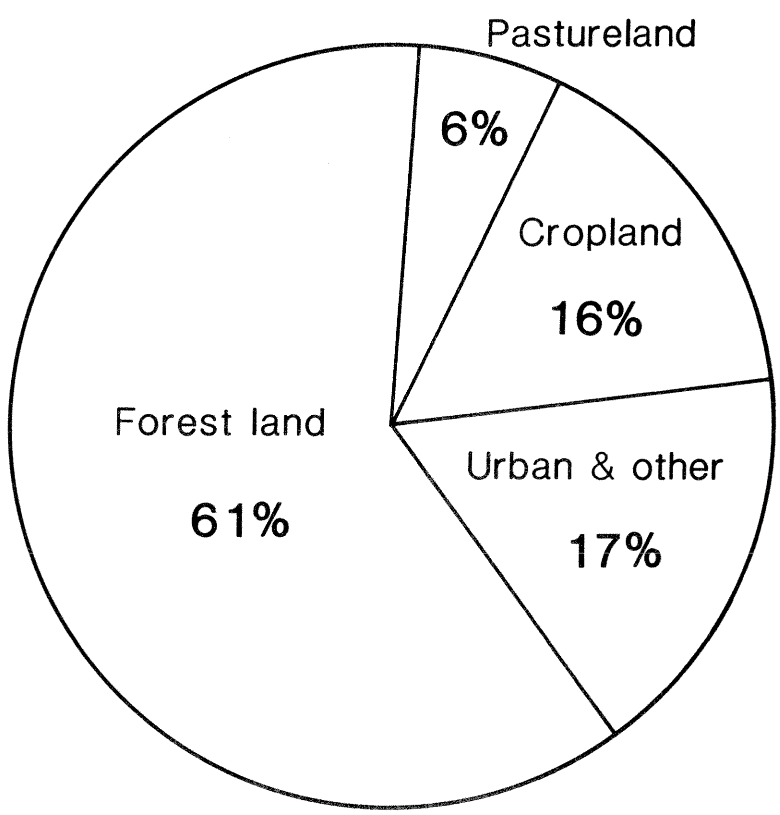


Figure 3.—Four major land uses, 1980.

FORESTED LAND

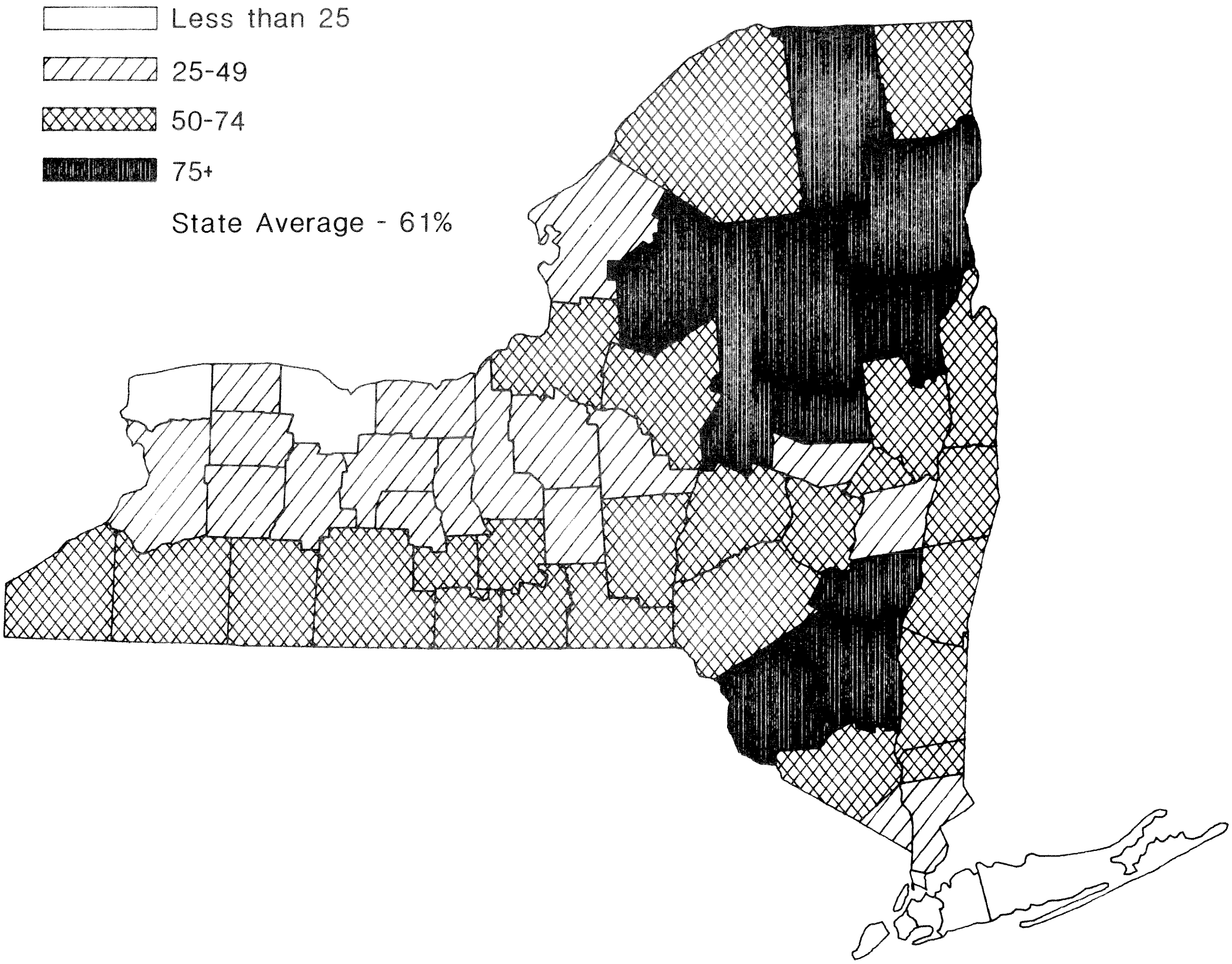


Figure 4.—Percentage of forest land, by county, 1980. (State average = 61 percent)

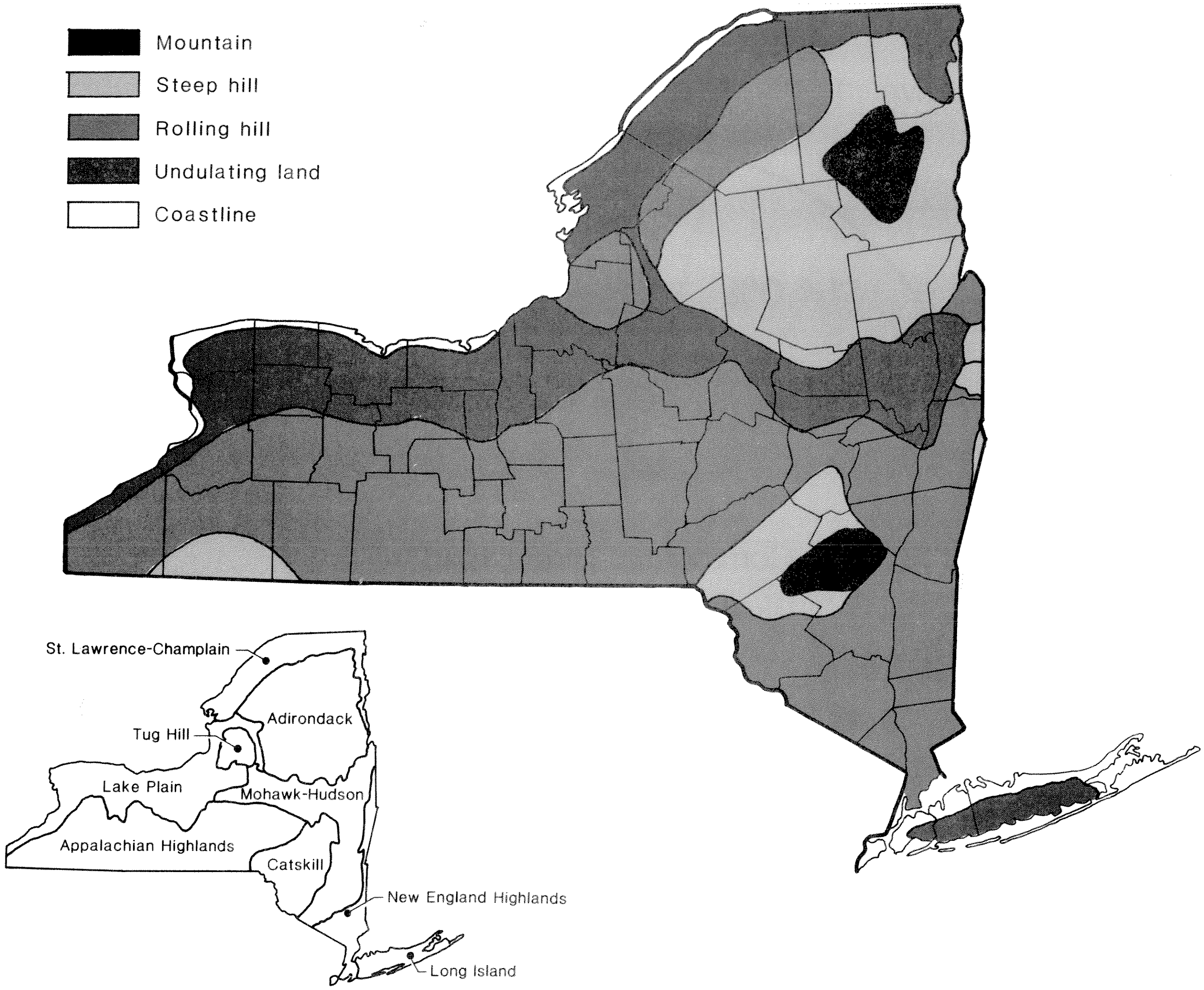


Figure 5.—Physiographic regions.

Courtesy: New York State Department of Environmental Conservation, Division of Lands and Forests

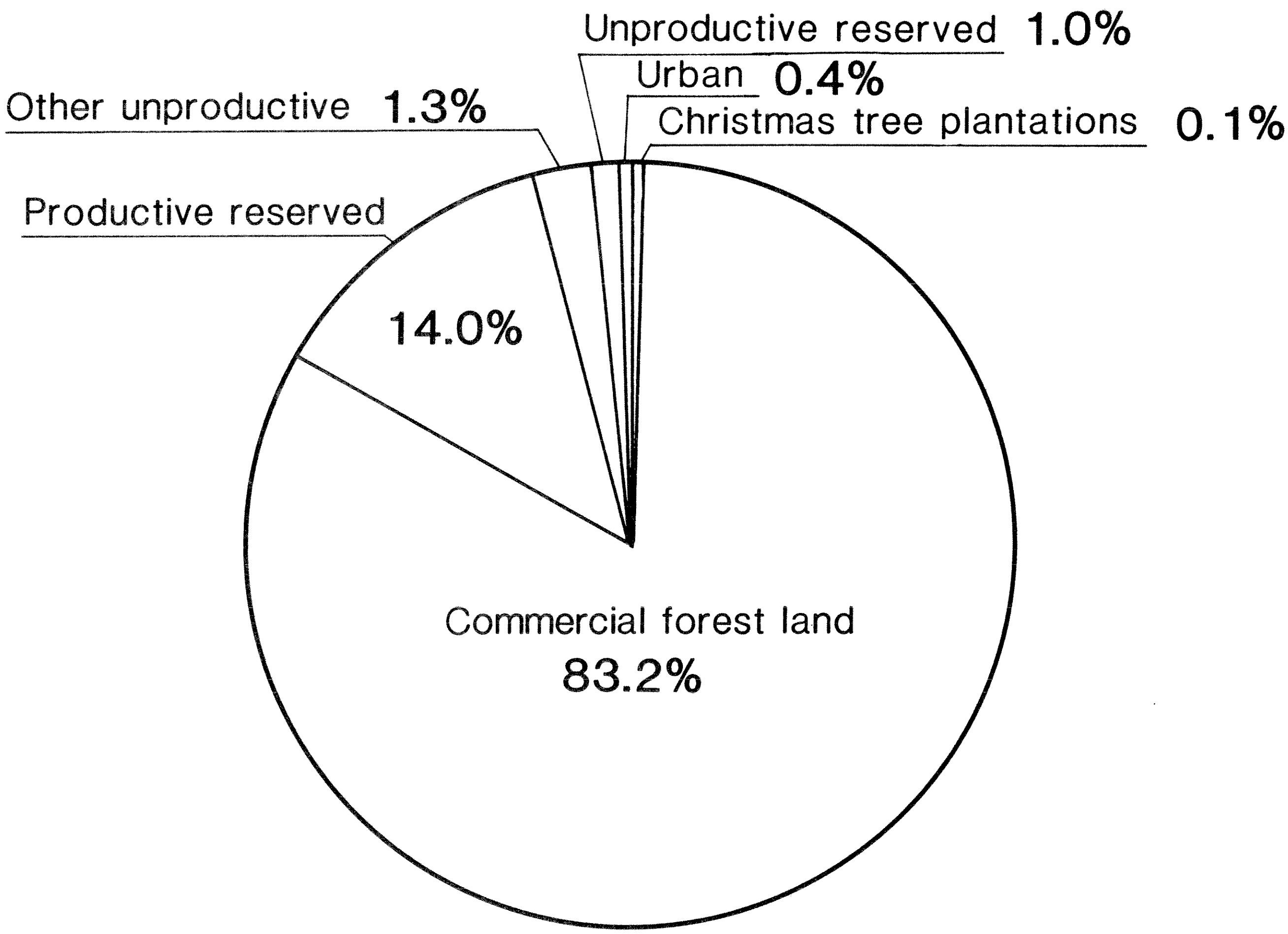


Figure 6.—Percentage of forest-land components, 1980.

The vast majority of the productive reserved land is in the world famous Adirondack and Catskill Parks. However, not all the forest land within the "blue lines" (the map boundaries of the Parks) is noncommercial. Of the more than 6 million acres in the Adirondack Park, about 40 percent is state owned and reserved while about 60 percent is privately owned. Virtually all of the privately held forest land is classed as commercial forest land (Fig. 7). In the Catskill Park the same proportions apply to the 690,000 acres within its boundary.

Urban forest land is a new category to the survey. It is forest land that would be classed as commercial except that it is surrounded by residential, commercial, or industrial development. Even though the five boroughs of New York City and Nassau County were not included in this forest survey, almost 69,000 acres of urban forest land were found outside of these heavily populated areas.

Though the noncommercial forest lands cannot be counted on for timber supplies, it is readily apparent they are often very valuable for recreation, watershed protection, and wildlife habitat. New York's forests are similar to many Northeastern forests in that nontimber benefits derived from some forest stands exceed the benefits derived from timber.

Commercial forest land is the dominant forest land class, covering 15.4 million acres and accounting for 83 percent of New York's forest land. It is the land use that this survey was designed for. Commercial forest land provides many nontimber benefits in

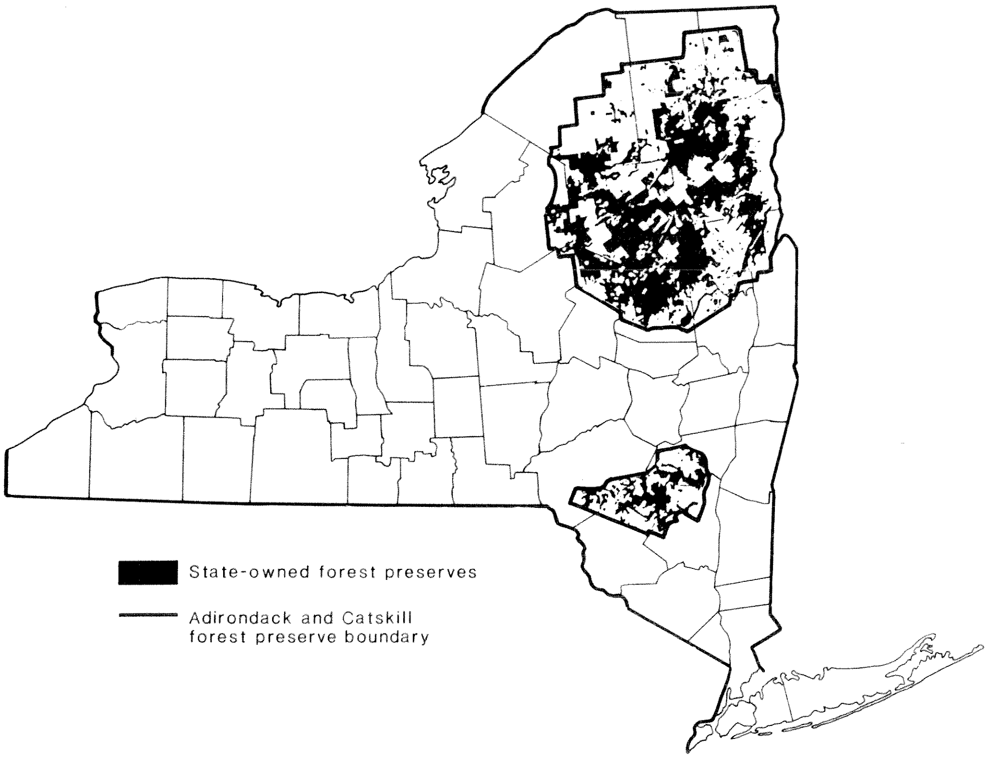


Figure 7.—The Adirondack and Catskill Preserves.

Courtesy: New York State Department of Environmental Conservation, Division of Lands and Forests

Watershed protection and recreational opportunities are important benefits of New York's woodlands.

addition to yielding the timber products that are so valuable for providing jobs in the wood industries and heat for people's homes.

Since commercial forest land accounts for so much of New York's forest land, its distribution pattern generally follows the total forest distribution shown in Figure 4. There are some notable exceptions in the heavily forested Adirondack and Catskill regions (Fig. 8). The reason for the disparity in the shading patterns for these counties is quite simple. Although only 17 percent of New York's forest land is noncommercial, it is quite heavily concentrated in the Adirondacks and Catskills. When the noncommercial land is subtracted from the forest land base, the counties in these areas suffer a noticeable drop in forest cover. For example, Hamilton county is 98 percent forested; clearly the most heavily forested county in the state when all forest land is included. But, when the reserved lands are subtracted, its percentage drops to 34, well below the 51 percent statewide average for commercial forest land.

COMMERCIAL FOREST LAND (percent)

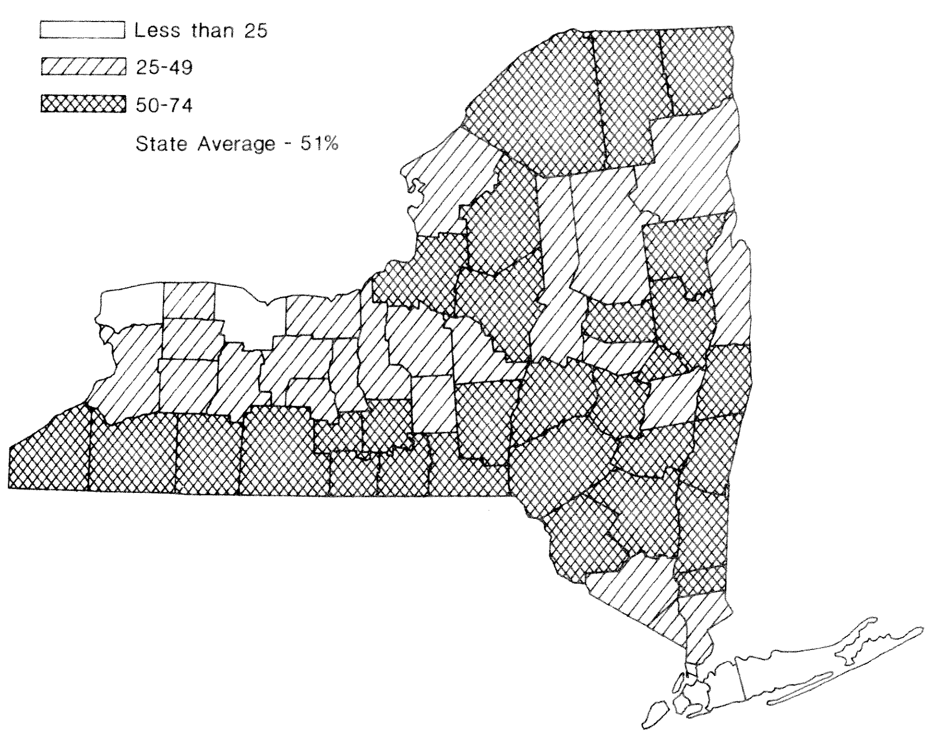


Figure 8.—Percentage of commercial forest land, by county, 1980. (State average = 51 percent)

Trends

The increasing forest land area trend which started in the late 1800's continued during the period between the first and second surveys (1950-68) and between the second and third surveys (1968-80). Meaningful analysis of the trends between surveys can be accomplished only if the data have been computed the same way.

In processing the 1980 data, we employed an improved method of calculating forest land area estimates. Extending the procedure to recalculate the 1968 and 1950 estimates provided improved and directly comparable estimates for those years. The estimates of forest area for the three surveys are:

Forest land	1950	1968	1980
		Acres	
Commercial	12,621,600	14,414,000	15,405,800
Noncommercial	2,448,000	2,902,600	3,100,400
Total	15,069,600	17,316,600	18,506,200

Forest land increases slowed in the 1968-80 period as compared to the 1950-68 period. The average annual increase between 1968 and 1980 was 99,000 acres versus 125,000 between 1950 and 1968. A slowing rate of increase has been the rule for a number of decades and is graphically seen in the flattening out of the curve in Figure 1.

Commercial forest land exhibited an increase of nearly a million acres between 1968 and 1980. The increase was the net effect of a gain of about 1.4 million acres of new forest land from abandoned agricultural land and a loss of slightly over 400,000 acres of commercial forest land to urban and other land uses (45 percent), noncommercial forest land (43 percent), water (7 percent), and farmland (5 percent).

Increasing commercial forest land was not the rule in all parts of the state. Nearly two-thirds of the million acre increase took place in two units: the Lake Plain and the South-Central Highlands. Despite its big increase, the Lake Plain remains the most lightly forested unit. The geographic units ranked from greatest to least commercial forest land (CFL) increase, 1968-80, are:

Unit	Thousand acres	Percent change	Percent of land area in CFL, 1980
Lake Plain	353.9	20	36
South-Central Highlands	274.0	13	60
Capitol District	125.0	10	53
St. Lawrence-Northern Adirondack	97.8	4	60
Western Adirondack	83.1	6	55
Southwest Highlands	63.6	4	56
Catskill-Lower Hudson	12.8	1	52
Eastern Adirondack	−18.4	−1	45

The largest source of new forest land was abandoned and reverting pastureland.

The decrease in the Eastern Adirondack unit was due mostly to the sale of a large block of commercial forest land to the State of New York and subsequent transfer to the productive reserved category. To the south, even though the Catskill-Lower Hudson unit posted a miniscule gain, over half the counties lost commercial forest land. In the counties close to New York City, forests were lost to land development or were reclassified as urban forest.

Looking at the land use changes that resulted in the commercial forest land increase provides a striking illustration of how the fortunes (or misfortunes) of one sector of the economy greatly influence a seemingly unrelated sector (Clawson 1981). In New York, the rise in forest land area in recent decades can be directly correlated with changes in the farm community, and in particular the dairy sector.


The largest cause of forest land loss was land clearing for urban or suburban development.

Since World War II, the farming industry nationwide has undergone a major revolution. The effects on the Northeast and New York in particular have been substantial. Between 1950 and 1978, New York's farmland declined by 6½ million acres or 41 percent (Fig. 9) (U.S. Dep. Comm. 1981). It is no coincidence that forest land rose 3.4 million acres (23 percent) during the same period.

Many factors are responsible for the change in farming in New York. They include: inflation, capital costs for new technologies, income and estate taxes, nonfarm employment opportunities, comparatively poor soil, and transportation costs (Schertz et al. 1979).

To summarize, the increasing application of new technology and machines dramatically improved productivity. It gave large farms an economic advantage over small farms based on their ability to distribute the fixed costs of the innovations over a larger production base. This trend put New York and New England at a disadvantage because taxes, inflation, and developmental pressure were working to keep the average farm small. Inroads into traditional New York markets were made by southern and western farms that took advantage of relatively inexpensive transportation, labor, and lower taxes.

Dairying was and still is an important segment of the state's agricultural community though it has been hit hard by the shakeout. Running a dairy farm is no simple or inexpensive task, and these difficulties are reflected in the continuous slide in the area covered by pasture (Fig. 9).

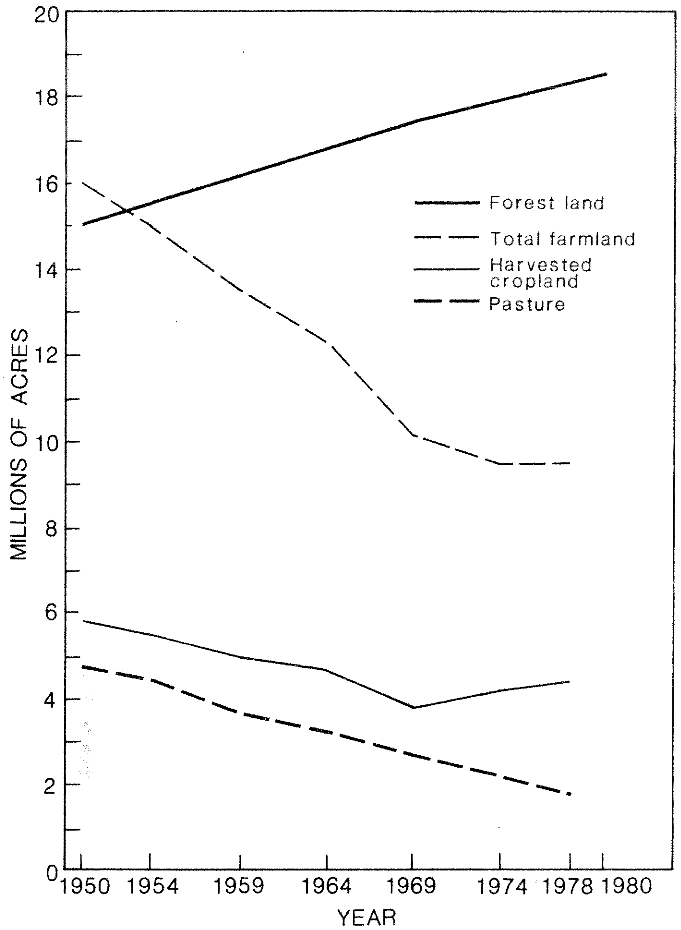


Figure 9.—Agriculture and forest-land use trends, 1950–80.

What does the future hold for the land use balance of New York? If past trends continue, we will see a further erosion in the dairy industry and in the area covered by pasture. A large uncertainty, and one that could change the picture considerably, is the future cost of energy. Higher energy prices could make New York's farms more competitive with farms in other parts of the country. New York is closer to many major food markets, and some southern and western farms depend greatly on energy-intensive irrigation.

Ownership

New York has over 500,000 forest-land owners. About 90 percent of the owners are individuals. The other 10 percent include forest products firms, government agencies, hunting and fishing clubs, water companies, and a variety of businesses and associations. New York's many owners of commercial forest land can be grouped into five ownership classes:

Geographic unit	Ownership class					
	Public	Forest industry	Farmer	Corporate	Misc. private	Total
	Thousand acres					
Lake Plain	110.4	7.7	915.5	61.6	1,069.2	2,164.4
Southwest Highlands	119.9	22.9	553.5	79.7	956.5	1,732.5
South-Central Highlands	241.7	81.3	793.8	80.0	1,220.1	2,416.9
St. Lawrence-Northern Adirondack	179.3	361.5	581.3	271.1	1,205.2	2,598.4
Western Adirondack	163.8	179.6	330.0	35.8	845.6	1,554.8
Eastern Adirondack	16.6	351.5	46.8	185.8	667.3	1,268.0
Capitol District	50.9	12.3	326.1	74.2	931.3	1,394.8
Catskill-Lower Hudson	96.4	17.9	398.6	329.8	1,433.3	2,276.0
Total	979.0	1,034.7	3,945.6	1,118.0	8,328.5	15,405.8

The miscellaneous private class is mostly individuals who are not farmers, but it also includes some unincorporated clubs and partnerships. Not only does this class own more forest land than any other group, its been the only one increasing its proportionate share of the ownership pie.

Farmers are the second largest block of forest-land owners. They own about 26 percent of the total but, as measured by Census of Agriculture data, farmers have owned successively less woodland in the years following World War II. Not only has farm woodland declined, but the total acreage of land in farms has declined as well.

Around the time of the first forest survey, farmer-owned woodland probably exceeded that owned by the miscellaneous private class. But with farm economies being squeezed from several sides and urban and suburbanites with more disposable income and leisure time, one trend has been that of some farmers selling or abandoning land to nonfarm owners.

Forest industry lands are heavily concentrated in the three Adirondack units. This means industry's presence, which is diluted at the state level, is much more pronounced in the Adirondacks where it owns about 16 percent of the commercial forest land total. Forest industry's land holdings have not changed much over the last 25 years, but because total commercial forest land increased, industry's proportionate share of the state total declined from 10 percent in 1953 to 7 percent in 1980.

Public agencies own the smallest amount (6 percent) of commercial forest land of any of the five ownership classes. This does not include the Preserve portions of the Adirondack and Catskill Parks. With three-quarters of the public land, the State is the biggest public landowner. State forests account for 70 percent of the State lands, while most of the remaining 30 percent is in State Wildlife Management Areas. The South-central Highlands Unit has, by far, more State commercial forest land than any other unit. Public lands increased by about 100,000 acres between the second and third survey largely because of purchases for wildlife management areas.

Because the private forest landowners are so numerous and important, an ownership study was conducted in conjunction with the forest survey. The purpose of the ownership study was to assess and analyze landowners' characteristics and attitudes (Birch 1983). Among the study's findings was a skewed pattern in the ownership size classes (Fig. 10). Those owning less than 9 acres comprise the majority of New York's forest land owners (53 percent), yet their total holdings are only 6 percent of the commercial forest land. At the other end of the scale are the owners with holdings of greater than 500 acres. They account for 0.3 percent of the owners yet hold 22 percent of the commercial forest land. This group includes the large forest industries.

The study also revealed the difficulty of describing the "typical" landowner. Retired was the largest employment category but only accounted for 20 percent of the owners. Over 40 percent of the owners are between 45 and 64 years old, but another quarter of them are between 25 and 44, and another quarter are over 65. The most frequent income category was under $10,000 annual income, but almost as frequent were owners making over $30,000 annually.

One characteristic of the private owners that does stand out is the relatively short period of time that they have owned forest land. Over a third of the owners acquired the land since 1970, and almost another third acquired the land between 1960 and 1970.

While benefits other than timber production are the primary reason most people own forest land, they are still usually willing to harvest timber. Nearly two-thirds of the owners are willing to cut timber sometime in the future. New York's diverse and sizable group of private landowners will be an important force in the future of the Empire State's forests.

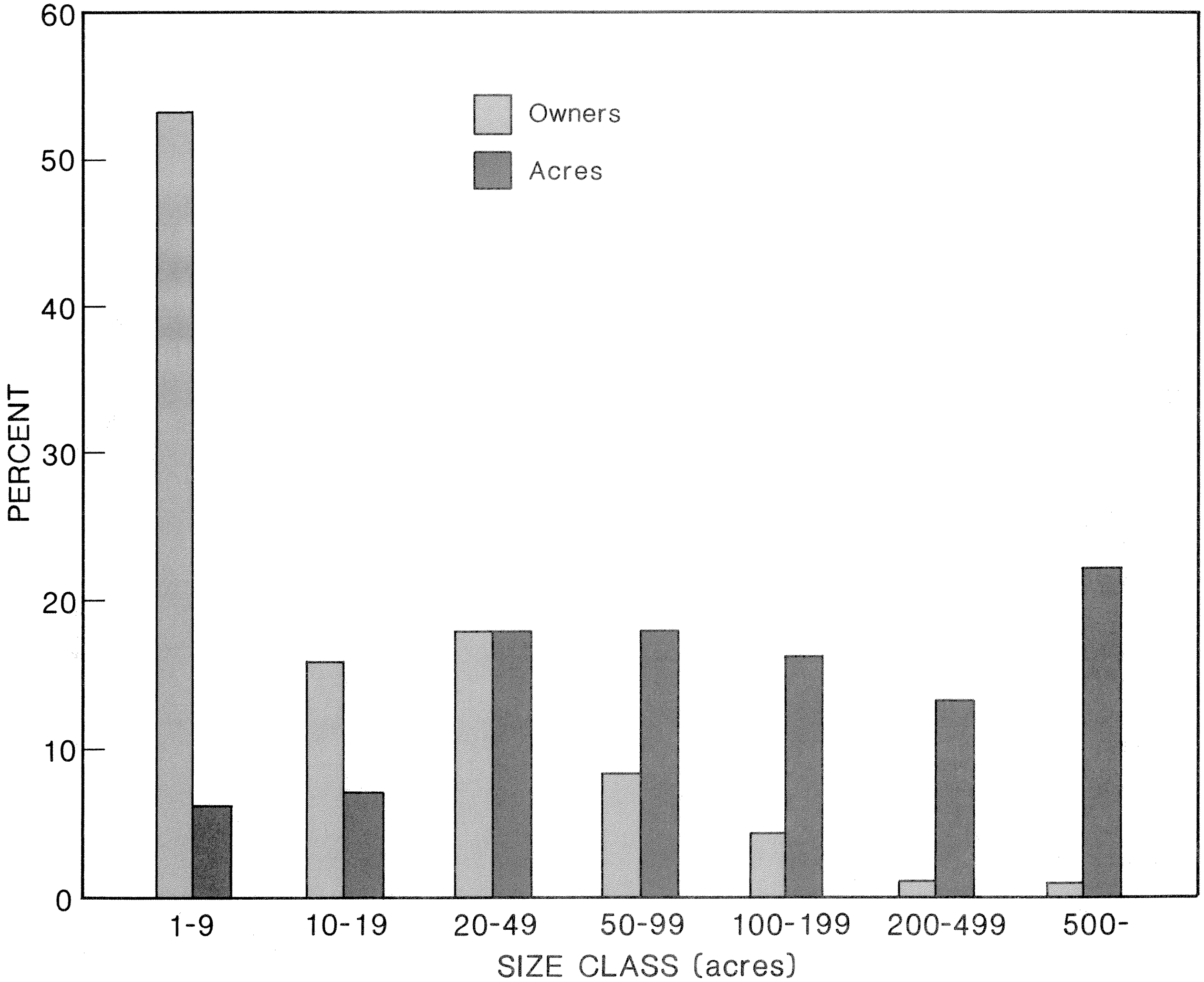


Figure 10.—Percentage of private ownerships, by size class, 1980.

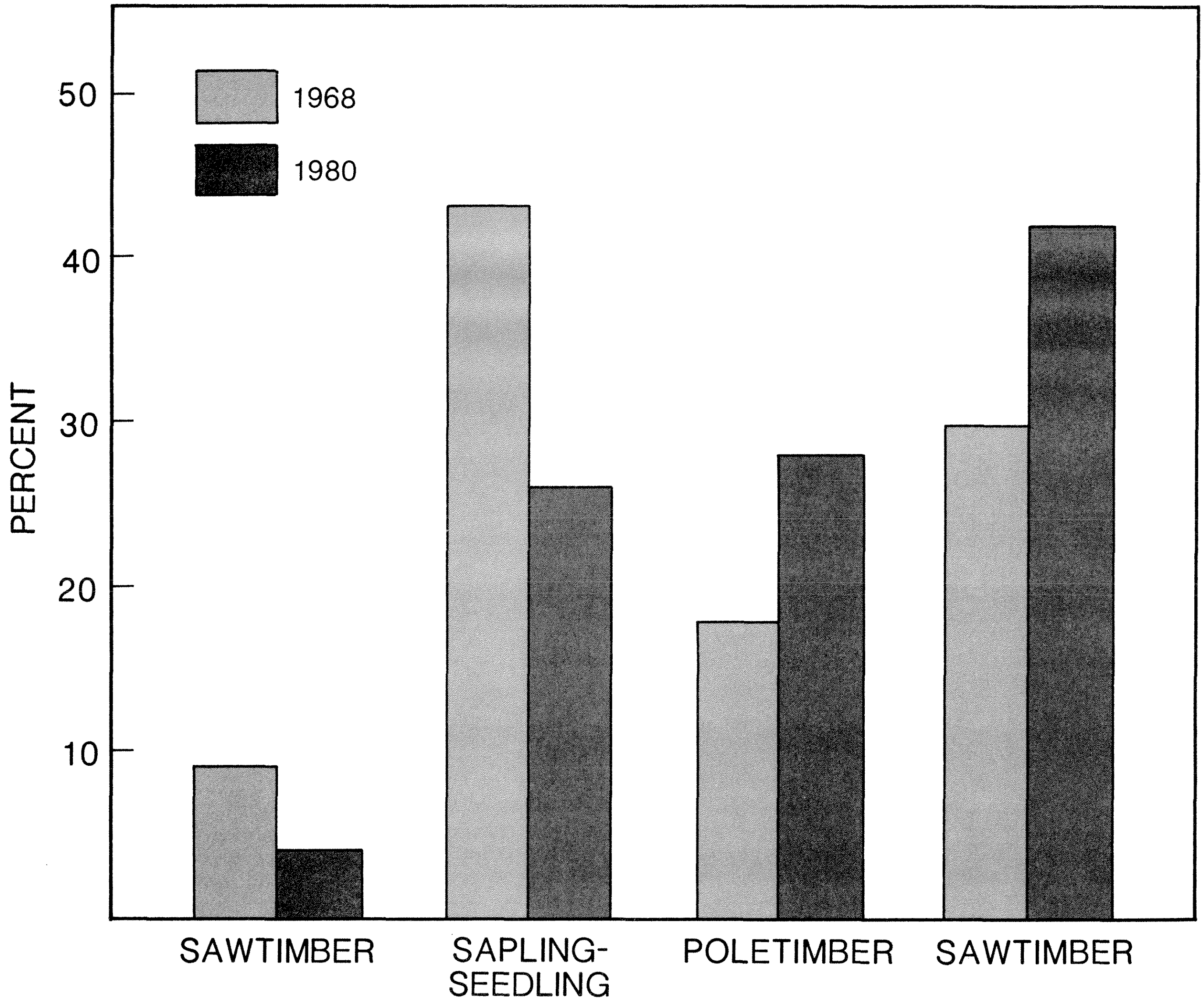


Figure 11.—Percentage of stand-size class on commercial forest land, 1968 and 1980.

Stand Size

New York has a more mature forest than it has had in many decades. Supporting evidence includes an increase in the area covered by older stands (pole and sawtimber) and a decrease in less mature sapling-seedling and nonstocked stands (Fig. 11). Stand-size data from the first survey should not be compared with the last two surveys because stand size was calculated differently during the first survey.

Sawtimber stands are the dominant stand size in New York, covering 42 percent (6.4 million acres) of the commercial forest land. Sought after because of their higher timber volumes and lower unit harvesting costs, sawtimber stands are a valuable asset in sustaining and attracting forest industries. Because they are easier to move in and are perceived to be more attractive, sawtimber stands also are valuable for recreational pursuits such as hiking, camping, and cross-country skiing (Brush 1979).

In decreasing order of area covered, the other stand sizes are: poletimber (28 percent), sapling-seedling (26 percent), and nonstocked (4 percent). At the time of the 1968 survey, sapling-seedling stands were the dominant stand-size—43 percent of commercial forest land (6.2 million acres). Again in descending order, the proportion of commercial forest land covered by other stand-sizes in 1968 was: sawtimber (30 percent), poletimber (18 percent), and nonstocked (9 percent).

The area covered by seedling-sapling stands dropped as New York's forests continue to mature.

In terms of acreage changes, remember that commercial forest land increased by nearly a million acres. This new forest land entered either the nonstocked or sapling-seedling categories. Despite the influx, nonstocked stands showed a net decline of over 700,000 acres and sapling-seedling stands had a net decline in excess of 2.1 million acres. Obviously, stands grew out of these categories much faster than they were being replaced.

The net gainers were poletimber (increase of 1.7 million acres) and sawtimber stands (increase of 2.1 million acres). Changes of this magnitude highlight the dynamic nature of New York's forests and reveal the woods to be more vigorous than usually imagined. Unless timber harvesting increases markedly, or some massive disturbance (e.g. hurricane or insect plague) occurs, the future will bring an even higher proportion of sawtimber stands and a lower proportion of immature stands. A plausible scenario of what New York's stand-size structure might be by 1990 may be derived from looking at neighboring Pennsylvania's situation. The stand-size distribution at the time of Pennsylvania's second survey (1965) showed a strong resemblance to New York's distribution in 1980.

The third survey of Pennsylvania (1978) showed that sawtimber stand concentration climbed from 44 to 48 percent of the commercial forest land base (Powell and Considine 1982). Extrapolating this trend to New York means that sawtimber stands would increase by 10 percent and cover about 46 percent of the commercial forest-land base by decade's end. Of course, a continued expansion of New York's forest land base would dilute the sawtimber stand percentage increase. Pennsylvania, in fact, had a slight decrease in commercial forest land between surveys.

The historical decline in farmland and the shift to a more mature stand-size distribution have a number of implications for the state's timber and nontimber resources. A summary of the effects of these trends includes: increasing timber volume, growth, and removals; reduced total wildlife habitat diversity; increased potential for forest related outdoor recreational activities such as hiking, camping, cross-country skiing, and hunting of "big woods" game such as bear and turkey. Hunting potential should decline for game species such as rabbits and grouse that prefer habitats of immature timber and forest-agriculture land mixtures.

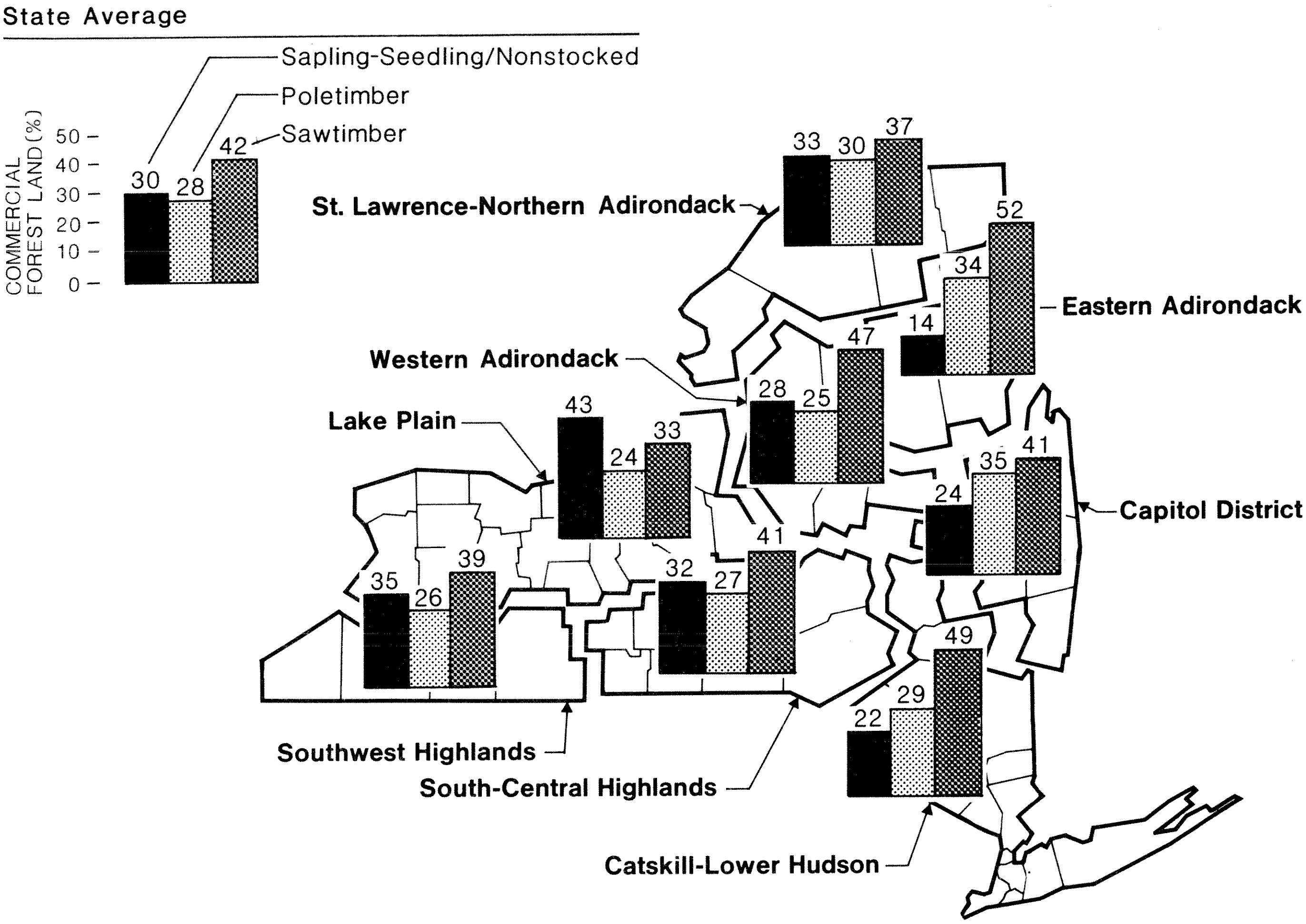


Figure 12.—Stand-size distribution, by geographic unit, 1980.

Considerable variation exists between the stand-size distributions of the eight geographic units (Fig. 12). The general trend is toward a more mature distribution as you move across the state from west to east. The Eastern Adirondack Unit has the highest proportion of sawtimber stands—52 percent—and the lowest proportion of sapling-seedling stands—14 percent. At the other end of the state and the stand-size distribution scale is the Lake Plain Unit. It has the lowest proportion of sawtimber stands—33 percent—and the highest proportion of sapling-seedling stands—35 percent.

The stand-size pattern of each unit results from its particular history of land use shifts and timber cutting practices. In the Lake Plain Unit, a combination of level terrain and good soils made it an agricultural center. Forest land was usually cleared to make way for crops, orchards, and pasture. In the last several decades the trend has reversed, especially in pasture land in the southeastern counties of the unit where land has been allowed to revert to forest. Because there was little forest to begin with, these recent increases meant there would be a high proportion of immature stands in the unit's distribution. It will be decades before the unit's timber resource is mature.

The stand-size distribution is very different in the Eastern Adirondacks. Sawtimber stands are more common here than anywhere else in the state. The reasons are closely tied to the unit's particular land use and cutting history and the species composition of the unit's forests.

The Eastern Adirondack Unit is very heavily forested—94 percent. Like many other units it received heavy timbering pressure around a century ago. Unlike other units, however, extensive farming has not kept many areas clear.

Steep slopes and harsh winter weather characterize the unit which contains the heart of the Adirondack Mountains. These severely limiting factors ensured the failure of the majority of agricultural attempts. Farmland abandonment was early and frequent; so, many forests in the Adirondacks have been growing longer than those in other parts of the state. Since they are typically older, there are more big trees and consequently more sawtimber stands.

Another factor in the stand-size distribution is the species composition of Eastern Adirondack forests. Softwoods are common, especially white pine which accounts for 25 percent of the sawtimber volume. Pine commonly seeded in on old fields and grew rapidly. The deep, sandy, glacial outwash soils found in parts of the unit are excellent for white pine growth. The abundance of pine and other softwoods is important to stand-size determination because softwoods qualify as sawtimber at a smaller diameter than hardwoods—9 versus 11 inches.

New York's five ownership classes have some interesting differences in stand-size distribution. Three of the ownerships—forest industry, public, and miscellaneous corporate—have sawtimber stand concentrations above the state average, while the other two ownerships—farmer and miscellaneous private—have below average sawtimber stand concentrations.

Forest industry land has the highest proportion of sawtimber stands (54 percent) and the lowest proportion of sapling-seedling stands (11 percent). At first glance this seems surprising given industry's need to cut timber to sustain its pulpmills and sawmills. However, it should not be a surprise to anyone who has looked at the history of real price increases for sawlogs and pulpwood in the Northeast. Real stumpage prices for pulpwood have declined or at best stayed even while the real prices for sawlogs, especially for valuable species such as red oak, black cherry, and sugar maple, have increased.

Managers in forest industries and public agencies, and some private citizens have realized the much greater value they can receive from their timber if they manage it to sawtimber size. In these cases, the astute owners have undertaken activities such as thinning and cull tree removal to hasten the growth of more vigorous trees.

Public lands have slightly over half their commercial forest area in sawtimber stands with the rest being about evenly split between poletimber and sapling-seedling stands. This is quite a change from a dozen years ago when each of the three major stand sizes accounted for one-third of the public forest land. While not the only reason, a contributing factor is the maturation of many softwood plantations established around the time of the Depression.

Farmers and miscellaneous private citizens are the two groups with below average sawtimber stand concentrations and above average sapling-seedling stand concentrations. In addition, these two groups have virtually all the nonstocked land. Farmer-owned lands have a higher proportion of immature stands because the million acres of new commercial forest land came largely from abandoned pasture land. Miscellaneous private lands show a higher than average proportion of immature timber because their owners have been buying forest and abandoned farmland from farmers and because their forests have supported more timber harvesting than commonly believed.

Since the sawtimber proportion on industry and public lands is more than 50 percent, increased timber harvesting is expected from these owners during the coming decade. However, timber cutting on public forests may be modified because of increased demands by the public for nontimber forest benefits from these lands. While the stand-size distribution on public and forest industry lands may mature some more, a more noticeable change is likely on lands owned by farmers and other private owners.

Substantial additions to the forest land base helped maintain the nonstocked and sapling-seedling proportion on farm and miscellaneous private ownerships. Because future increases should be smaller, the proportion of immature stands on these lands should drop. Combining this drop with the fact that growth exceeded removals means the proportion of pole and sawtimber stands should rise perceptibly over the next decade on farmer and miscellaneous private lands.

Stand-size class	Public	Forest industry	Farmer	Misc. corporate	Misc. private	Total
	Thousand acres					
Sawtimber	504.2	561.4	1,416.3	591.6	3,334.8	6,408.3
Poletimber	235.5	363.3	1,132.0	296.5	2,348.0	4,375.3
Sapling-seedling	227.5	110.0	1,096.2	214.4	2,365.9	4,014.0
Nonstocked	11.8	—	301.1	15.5	279.8	608.2
Total	979.0	1,034.7	3,945.6	1,118.0	8,328.5	15,405.8

Forest Type

Since the last survey, the forest typing procedure has been improved and changed enough that comparisons between the survey results should *not* be made.

New York's forests are quite diverse. Over 60 species of trees were encountered during the survey. The occurrence of the tree species in the forest is not random. Forest types based on groupings of certain trees can be recognized. Forty-one forest types were discovered, a strong indication of the forests' variety. To simplify data analysis, the types can be assigned to eight forest-type groups (Fig. 13).

The dominant type group is northern hardwood, which covers 61 percent of the commercial forest land. This type group is ubiquitous, being the most frequently occurring group in all eight units. It is usually outcompeted only under edaphic extremes (by white pine on deep sands) or physiographic extremes (by spruce/fir at high elevation).

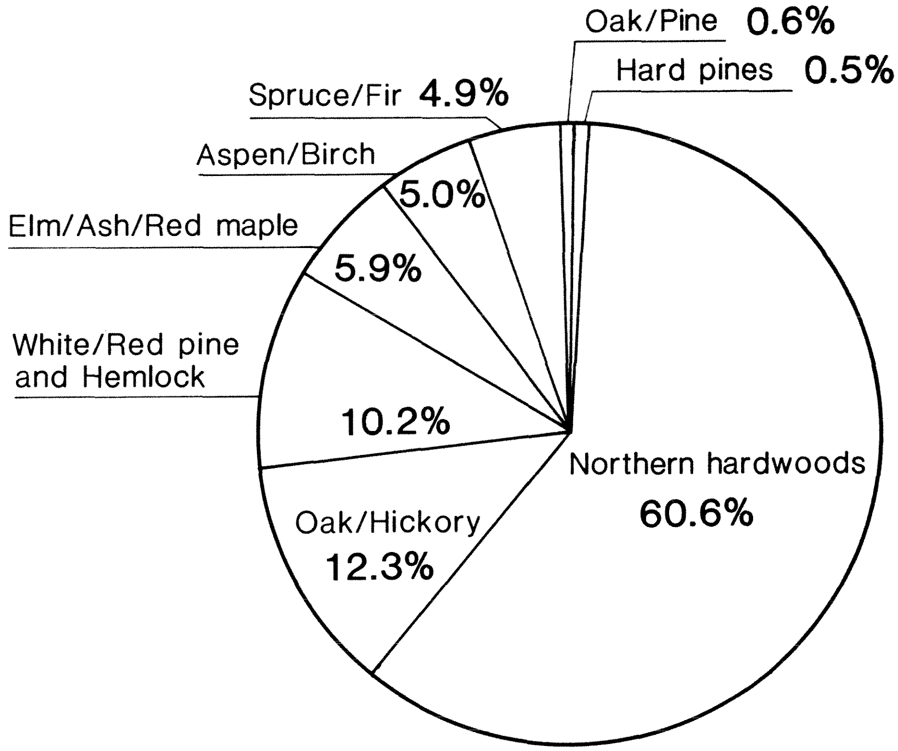


Figure 13.—Percentage of commercial forest land, by forest-type group, 1980.

The typically cool, moist climate of New York, combined with an abundance of glaciated soils, creates generally favorable growing conditions for northern hardwoods. Most of the state's valuable timber trees are common to this type group—sugar maple, yellow birch, black cherry, white ash, and basswood. Many of the same trees are responsible for the beautiful fall foliage seen across the state. Not all northern hardwood species are common throughout New York. White ash and basswood are common in the warmer southern part of the state, while yellow birch is more common in the cooler north.

Sugar maple/beech/yellow birch covers nearly 4½ million acres, and is the most common forest type in this or any other type group. All of the three species do not have to be present for a stand to be included in this type. In fact, much variation exists, with beech preferring drier sites and yellow birch preferring moister sites. Beech and yellow birch have not kept pace with red and sugar maple's development and have decreased in importance in many stands. Beech, especially in the Adirondacks, has been suffering for decades from beech bark disease mortality and anticipatory timber harvesting. Yellow birch has been heavily cut because of its value for veneer and sawtimber. Concurrently, yellow birch has rather exacting regeneration requirements which have not been met in many regenerating stands. The net result is that sugar and red maple are more dominant in many stands than they were at the time of the first survey.

It is worth noting that the sugar maple/beech/yellow birch forest type is more mature than many types, with nearly 60 percent of its area in sawtimber stands. In contrast, three out of the four remaining types in the northern hardwood type group have more sapling-seedling and nonstocked stands than saw and poletimber stands. These immature types are largely composed of shade intolerant species such as pin cherry that have seeded into abandoned fields or species such as red maple that may be residuals left after a disturbance. Over time, ecological succession will convert many of the undisturbed stands to the sugar maple/beech/yellow birch type (Fig. 14).

Oak/hickory is a distant second in the type-group ranking, covering 12 percent of the commercial forest land (Fig. 13). New York is on the fringe of the oak/hickory or Central Hardwood Region, which extends mostly south and west of New York. Oak/hickory's occurrence is not evenly spread across the state. Almost 40 percent of its area is found in the warmest part of the state, the Catskill-Lower Hudson Unit.

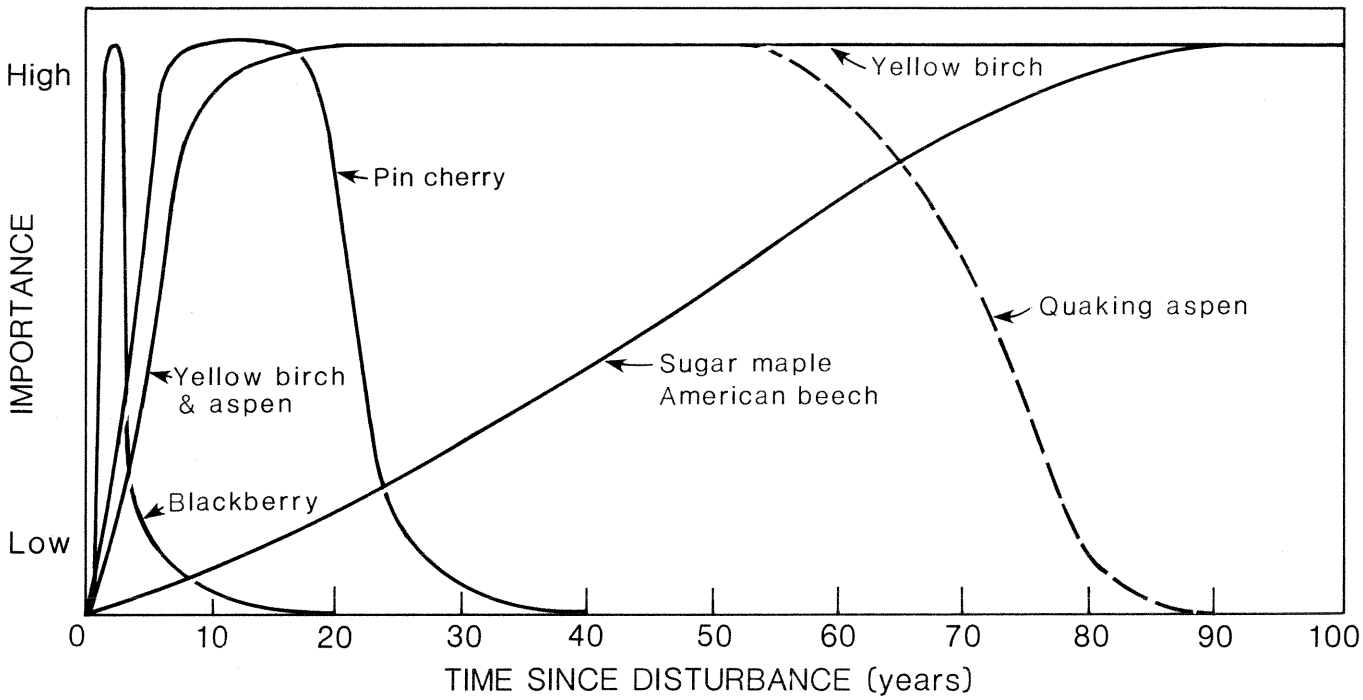


Figure 14.—Importance of different species along a time sequence following disturbance of a typical northern hardwood forest.

Adapted from: Marks 1974

The other parts of New York where oak/hickory stands are likely to be found are the Hudson River Valley up to Lake Champlain and the west-central part of New York between the Finger Lakes and the Pennsylvania border. Both of these regions are transition zones between oak/hickory and northern hardwoods. The oak/hickory stands often will be at the warmer, lower elevations or on drier, warmer south-facing slopes.

The oak/hickory type group is the most diverse type group. Included in its 12 forest types are yellow-poplar, black locust, and black walnut. The two dominants are the valuable northern red oak and white oak/red oak/hickory types, which split 45 percent of the group's area.

Like the sugar maple/beech/yellow birch type, the two oak types have more than half their area in sawtimber stands. Unlike the future of the maple/beech/birch type, the long range future of the oak types does not look too rosy. Insect attacks, mostly by the gypsy moth, have plagued oak stands and demand has been high for quality red and white oak timber. At the same time, oak regeneration in New York, as in neighboring states, has been poor. The likely result of these trends will be an increase in the area covered by the number three type in this type group—red maple/central hardwoods. In many stands in and outside of New York, where red maple was only a minor associate, disturbances to the stand are leaving red maple a much more important species (Powell and Erdmann 1980).

White/red pine and hemlock is the third most common type group. It covers 10 percent of the commercial forest land. The dominant type is white pine followed by hemlock, white pine/hemlock, red pine, Scotch pine and jack pine. The last three types account for less than 20 percent of the group's area.

Like the oak/hickory group, this group is not as widespread as the northern hardwoods. Over half the stands are in three eastern units, the Capitol District, Catskill-Lower Hudson, and Eastern Adirondack.

The white pine type is one of New York's most valuable timber types. It is concentrated in a strip of land running from Clinton County southward along the eastern edge of the Adirondacks into Saratoga County. White pine is commonly found on deep, glacially deposited sands or gravels. These soils support excellent white pine growth while limiting hardwood competition.

Another factor in white pine's distribution is the pattern of farmland abandonment in this region. Unlike western New York where cropland usually went to unimproved pasture before reverting to woodland, in the eastern part of the state, cropland usually reverted directly to forest land. The eastern pattern of farmland abandonment favored white pine because it faced little competition from hardwoods. Plowing and other active farming treatments had eliminated hardwood rootstock. In areas where cropland first goes to pasture and hardwoods become established, white pine does not do well (Oliver 1981).

The hemlock type occupies a smaller area than the white pine type, but this figure underestimates hemlock's abundance. Whereas white pine tends to be found in rather pure stands, hemlock often is not. Hemlock may form pure stands in cool, moist valleys, but it is also a common associate in northern hardwood stands (see the Timber Volume section).

Plantations cover only about 4 percent of New York's commercial forest land, but they are among the most conspicuous forest scenes. New York has been a leader among northeastern states in distributing seedlings and promoting this aspect of forest management. The vast majority of plantations contain softwood species, largely white, Scotch, and red pine.

These plantations contribute significantly to a meaningful characteristic of the white pine and hemlock group; namely, that it is more mature than the other type groups. One example of the maturity is the white/red pine and hemlock group which has 27 percent of its area in stands averaging over 6,000 board feet per acre. No other group has more than 13 percent of its area in these high-volume stands. Reasons for the maturity and high-volume characteristics of the white/red pine and hemlock group include the aging of many softwood plantations, the ability of softwood types to generally support higher stocking levels (especially when planted), and a lack of immature stands created by abandoned land not seeding into softwood species. As discussed, much of the new forest land is from abandoned pasture land that does not support softwood seedlings well.

Percentage of each forest-type group's commercial forest land area in stands averaging over 6,000 board feet per acre

White/red pine	27
Oak/hickory	13
Northern hardwoods	12
Spruce/fir	8
Elm/ash/red maple	2
Aspen/birch	—
Oak/pine	—
Hard pine	—

Elm/ash/red maple covers nearly 6 percent of the commercial forest land. It reaches its greatest concentration in the Lake Plain Unit where one-third of its area occurs and it accounts for 15 percent of the unit's commercial forest land. The Lake Plain is not a heavily forested unit because its soils and climate are favorable for agriculture. Yet some areas are too wet to farm and that is where this type group is found.

In contrast to the preceding type groups, elm/ash/red maple timber is immature. Two-thirds of its area is in sapling-seedling and nonstocked stands, in part because its been seeding in on wet, abandoned areas. This is also the most poorly stocked type group; only 20 percent of its stands are fully stocked. Because of the stocking and stand-size distribution, timber volumes per acre are low.

Of the three forest types in this group, black ash/elm/red maple accounts for three-quarters of the area. This has been a very dynamic type because Dutch elm disease has been eliminating the elm component and allowing the red maple to flourish. Black ash serves as an indicator species.

Aspen/birch covers 5 percent of the state's commercial forest land. After the turn of this century, when timber harvesting was intense and fires were common, this type group occurred much more frequently because it is a pioneer type group that seeds in after severe disturbance. The species are not long-lived and usually give way to northern hardwoods. In the meantime, this group provides valuable food and cover for a number of wildlife species.

Nearly 37 percent of this type group's area is found in the St. Lawrence-Northern Adirondack Unit. The reason for the concentration is related to this unit's combination of frequently occurring infertile soils and history of repeated timber cutting and fire.

Spruce/fir covers about 5 percent of the commercial forest land. Its area would have been much larger if the forest survey had included the Adirondack and Catskill Forest Preserve lands. Spruce/fir prefers the coolest parts of the state that are often at higher elevations on Preserve lands. Unlike aspen/birch, the spruce/fir group was not helped by the heavy timbering and intense fires earlier this century. In fact, the area covered by spruce/fir declined sharply because of its suitability for lumber and pulp and the repeated burnings that depleted the soils.

More than two-thirds of spruce/fir's area is found in two units—the St. Lawrence-Northern Adirondack and Eastern Adirondack—oftentimes on poorly drained soils. Nearly one-quarter of spruce/fir's area is in wet site types such as northern white-cedar, tamarack, and black spruce. Perhaps one-fifth of spruce/fir's area is in plantations, largely Norway and white spruce and larch. These tend to be more common in south-central and southwestern New York.

The last two type groups, oak/pine and hard pine, collectively account for barely 1 percent of the commercial forest land. In that respect, they are not significant. However, to the people of Long Island, one of these forest types (pitch pine) has very special significance. Rapid urban and suburban development, combined with improper waste disposal, has threatened Long Island's essential ground water supply. Portions of the aquifer are still covered by forest land, mostly the pitch pine type. Pressures to develop the land are great, but the realization that the remaining forest land serves as a living filter for the water supply has spurred preservation efforts.

There is a lesson to be learned from this struggle. A forest does not have to be highly productive in terms of wood fiber yield to have a significant impact on our quality of life. Long Island's pitch pine forest has been burned repeatedly, is not well stocked, is not growing rapidly, and is seemingly an impediment to progress. Yet without the forest, the sandy soils would allow the human wastes associated with development to leach into the very water supply the population depends on for survival (Egginton 1981).

Analysis of the forest-type group data by ownership reveals some interesting patterns. Northern hardwoods have the largest share of each ownership, covering from a low of 52 percent of miscellaneous corporate lands, to a high of 76 percent of forest industry lands.

Public lands have a higher than expected share of the white/red pine and spruce/fir groups, largely because of their active plantation program. Public lands have 6 percent of the commercial forest land but 9 percent of the white/red pine group and 13 percent of the spruce/fir group.

Forest industry has a higher than expected share of the spruce/fir group and lower than expected share of the white/red pine group and oak/hickory group. They own 7 percent of the commercial forest land, 21 percent of the spruce/fir area, and only 1 percent of the white/red pine and oak/hickory group.

The high proportion of spruce/fir can be traced to industry's desire years ago to own a portion of the resource needed to feed their mills. Over two-thirds of forest industry's lands in New York were acquired before 1900 (Birch 1983). At that time, lumber and pulpwood production were high. Pulpwood production peaked in 1905 when more than 100 pulpmills consumed 1.3 million cords, 90 percent of which was spruce and fir (Canham et al. 1981). With competition at such a frenzied level, there was an obvious need to control some of the resource.

The minute level of white/red pine is tied to industry's cutting most of the mature pine on its land. This usually resulted in conversion to a northern hardwood stand. Because white pine grew on farms and other private lands, there was little need for industry to manage for pine. Forest industry also was able to adapt and utilize the hardwoods that replaced the pines.

Farmer-owned forest land is distinguished by its higher than average acreage of elm/ash/red maple and aspen/birch. These type groups are the pioneer types that have been invading abandoned lands and some cutover areas. Farmers have the highest proportion of sapling-seedling and nonstocked stands; so, the proportionately high amount of land in pioneering type groups is consistent.

The miscellaneous private owners have higher than expected amounts of oak/hickory, white/red pine, and elm/ash/red maple. These owners have been increasing their share of the commercial forest land base mostly by acquiring farmer-owned lands. Because of this trend, the two ownerships share some common traits, including a higher than average amount of immature timber and acreage in pioneer type groups.

Forest-type group	Public	Forest industry	Farmer	Misc. corporate	Misc. private	Total
	Thousand acres					
White/red pine	135.8	23.2	424.5	86.5	899.3	1,569.3
Spruce/fir	100.1	157.8	75.7	92.3	328.7	754.6
Hard pine	—	—	39.5	6.0	40.4	85.9
Oak/pine	16.1	5.2	—	22.4	47.6	91.3
Oak/hickory	92.6	21.7	405.6	276.2	1,092.4	1,888.5
Elm/ash/red maple	34.3	14.0	278.5	31.1	549.1	907.0
Northern hardwoods	543.8	784.2	2,459.1	579.2	4,964.6	9,330.9
Aspen/birch	56.3	28.6	262.7	24.3	406.4	778.3
Total	979.0	1,034.7	3,945.6	1,118.0	8,328.5	15,405.8

Timber Volume

Not only did New York's forestland base expand between surveys, but growing-stock and sawtimber volumes increased 38 and 53 percent, respectively. Recent forest surveys in neighboring states show that timber volume increases are the norm as our northeastern forests continue to mature (Powell and Considine 1982, Dennis 1983).

The percentage gains translate to an increase of 4.3 billion cubic feet of growing stock and 13.3 billion board feet of sawtimber. A major reason for the large percentage gains is that they come on top of a small base. New York had many immature stands with little volume at the time of the second survey, many of which grew to pole or small sawtimber by the third survey. However, nearly one-third of New York's commercial forest land still remains in immature stands.

New York's commercial forest land now contains 15.8 billion cubic feet of wood. This enormous quantity of wood could be used to build a boardwalk that would be a foot thick, 1,000 feet wide, and stretch from New York City to Los Angeles. For those who work in terms of cords, New York's commercial forest land averages 12.8 cords of wood per acre. This assumes a conversion factor of 80 cubic feet of solid wood per cord.

While the increase in the average cubic-foot volume per acre of commercial forest land from 793 in 1968 to 1,024 in 1980 reflects the maturing of many stands, the current average shows the effect of the still common immature stands. New York's 1980 per acre average lags behind most neighboring states.

Future volume percentage gains are not likely to be as large because they are coming on top of a bigger base, but absolute gains of similar magnitude are possible.

A number of interrelated factors explain the substantial growing-stock and sawtimber increases. Tying the factors together is the theme of a maturing forest. The woods continue to grow after being logged, burned, or cleared and many stands have reached a stage of rapid growth. They have been allowed to grow because there has not been an historically strong timber market for young timber or for some species of any size (for example, red maple). Market development, including fuelwood, for these species has been a relatively recent occurrence.

Changing ownership patterns also fostered forest maturation. The ownership trend has been away from farm owners who viewed timber as a crop to be harvested as needed, to city and suburban owners who do not need wood for farm uses and generally wanted to own "green space." This does not imply that nonfarmers will not harvest timber, but they are probably more selective in when and how they cut.

Evidence of the maturing forest may be seen in Figure 15. Much information can be gleaned from this chart. First, the 1980 curve generally lies above and to the right of the 1968 curve. This indicates that average tree diameter is increasing (from 8.4 to 8.7 inches), a sign of the aging forest. The area between the two curves represents the 38 percent growing-stock increase.

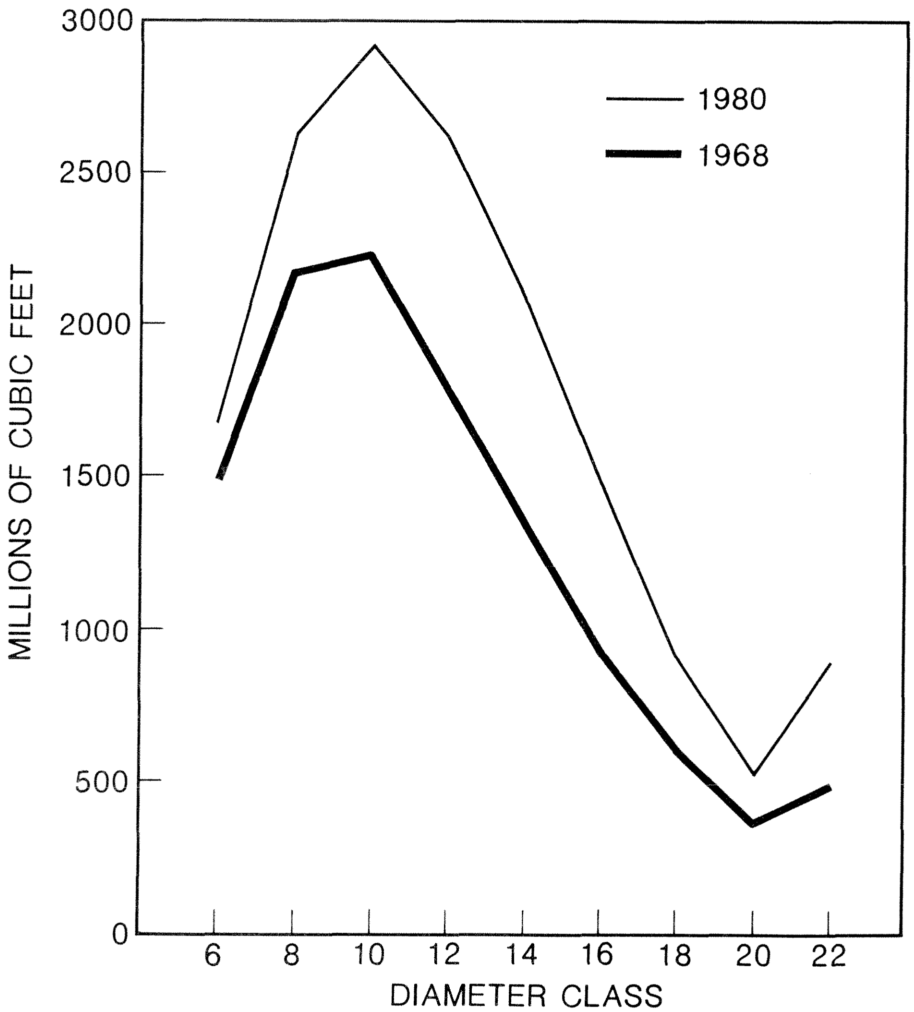


Figure 15.—Distribution by growing-stock volume, by diameter class, 1968 and 1980.

Second, there is an especially wide gap between the 1980 and 1968 curves in the 10- and 12-inch classes. These are the sawtimber entry points for softwoods (9 inches dbh) and hardwoods (11 inches dbh). The bulge explains the proportionately large 53 percent sawtimber volume increase. Many trees that were polesize during the last survey became large enough to qualify as sawtimber. Therefore, the substantial sawtimber increase does not mean that there is a lot of large sawtimber in the woods, rather it reveals the presence of a bountiful crop of young sawtimber that should increase in size and value as it ages.

Finally, the volume situation in the 6-inch class merits attention. The 1980 volume is quite close to the 1968 level. This too is due to the bulge of timber moving through the diameter classes. Since fewer saplings will be growing into this class, the next survey is likely to show a volume drop in the 6-inch class and possibly a drop in the 8-inch category.

Even though all the units did not have an increase in commercial forest land, they all had increases in growing-stock and sawtimber volume (Fig. 16). Generally, the larger units have more total volume and had larger volume increases. However, this does not mean that timber volume is more concentrated in larger units. For example, the Eastern Adirondack ranked seventh out of eight units in 1980 total growing-stock volume and had the second smallest volume increase (absolute and percentage) of any unit. However, when the effects of the land-base size are eliminated, the Eastern Adirondack Unit has the highest average volume per acre of any unit. It also had the highest average volume per acre during the last survey.

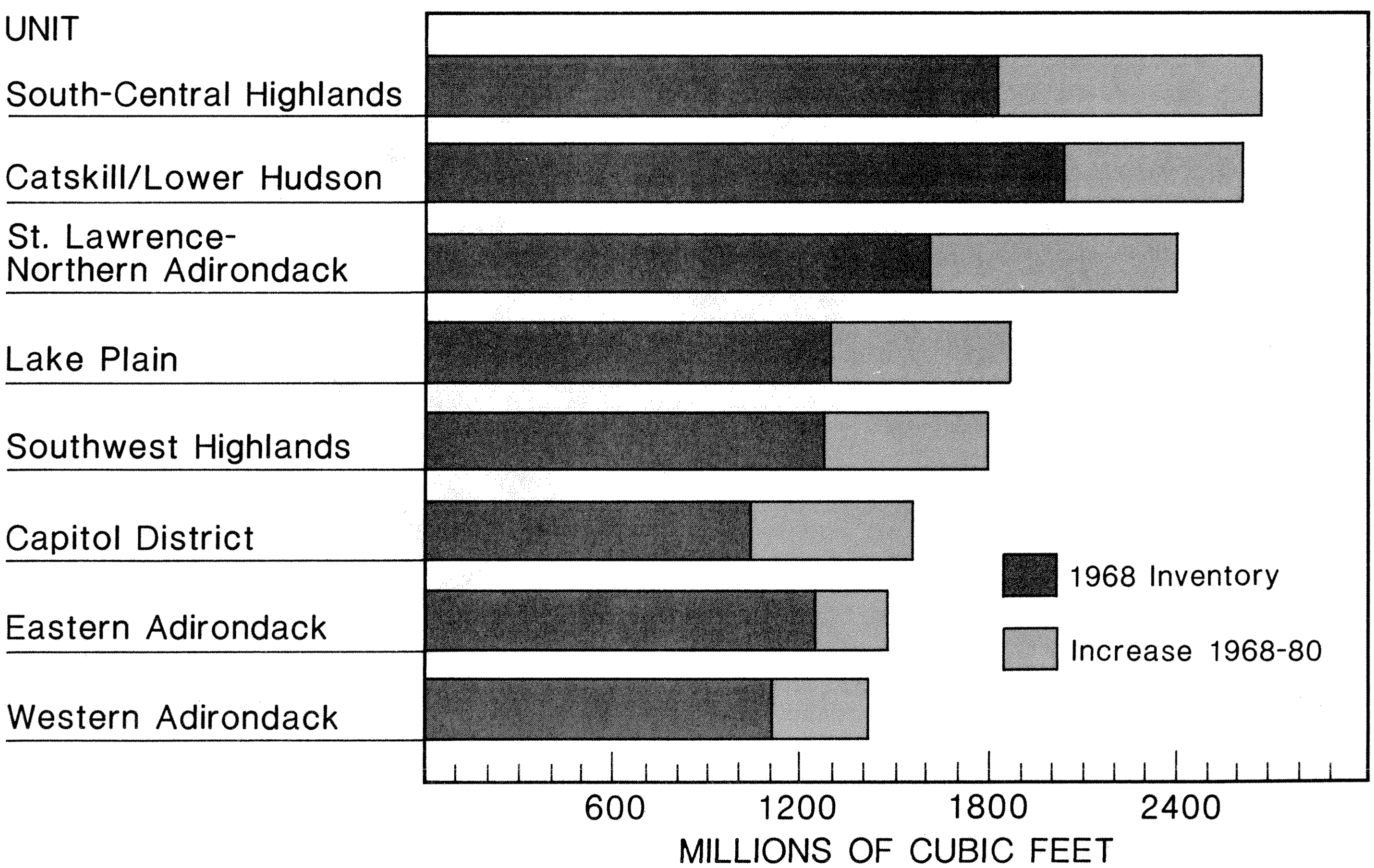


Figure 16.—Growing-stock volume, by geographic unit, 1968 and 1980.

In the earlier discussion of stand-size class distribution, it was noted that sawtimber stand proportions tend to be higher in eastern New York than western New York. Therefore, it is not surprising that average volume-per-acre estimates tend to be higher in eastern New York than western New York (Fig. 17).

GROWING-STOCK VOLUME, COMMERCIAL FOREST LAND (ft³/acre)

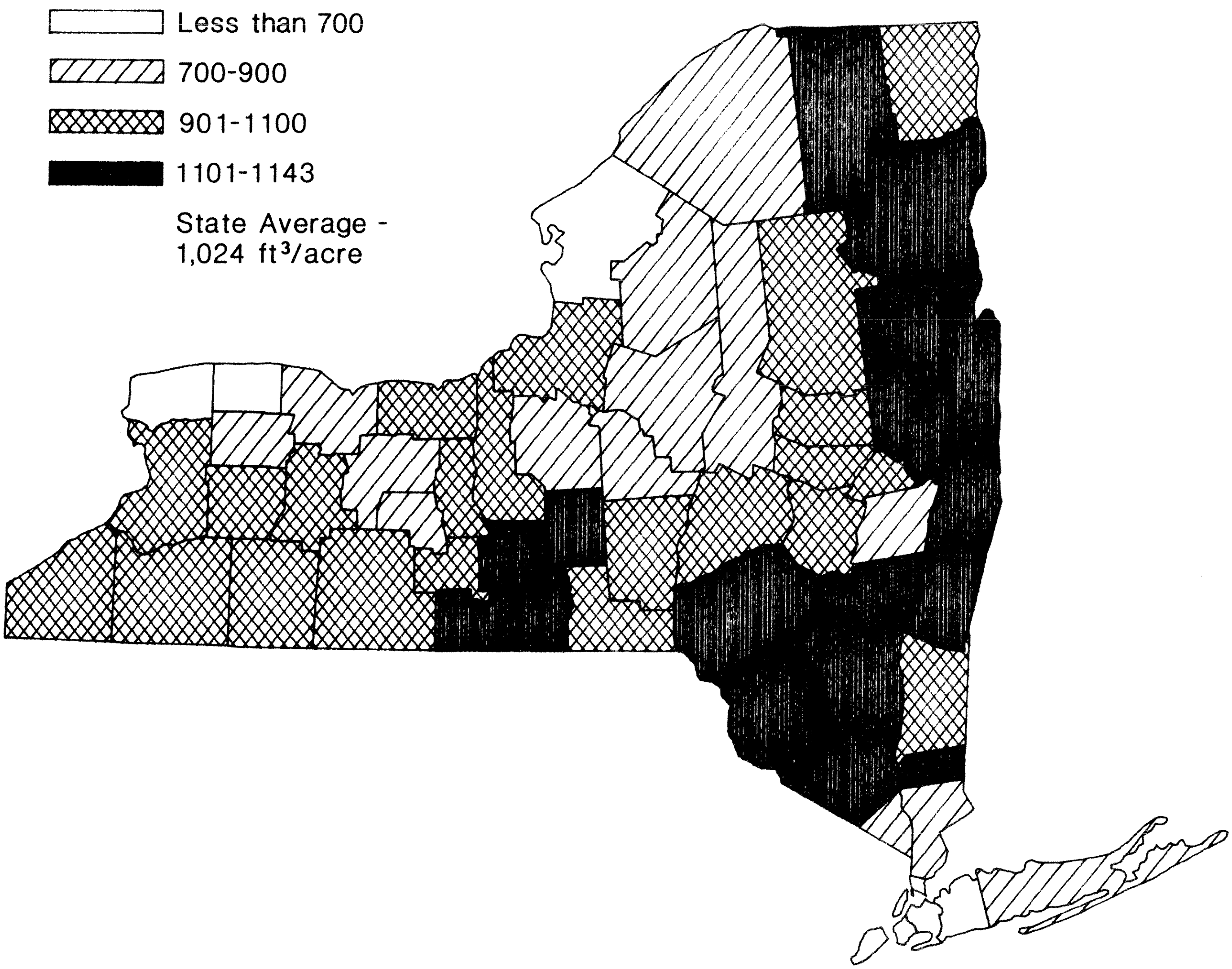


Figure 17.—Growing-stock volume per acre of commercial forest land, by county, 1980. (State average = 1,024 cubic feet per acre)

Significantly, almost three-quarters of New York's counties that average over 1,100 cubic feet per acre also are over 50 percent commercially forested. These are counties with significant timber concentrations. While no particular species dominates the volume in the high volume counties, softwoods seem to influence the averages. Softwoods account for 28 percent of the volume in these counties as opposed to 22 percent of the volume in all other counties. White pine is the top softwood in the high volume counties.

Species

New York's diverse forests contain over 60 tree species. Hardwoods account for 76 and 72 percent of New York's growing-stock and sawtimber volume, respectively. The hardwood share of the volume total increased slightly between surveys.

The most recent publication showing forest statistics for the Nation revealed that in 1977, New York's sugar maple volume was second only to Michigan's. New York is virtually tied with Pennsylvania for the lead in white ash volume. The Empire state ranked fourth in the amount of basswood volume (12 percent of the National total) and fourth in yellow birch volume (13 percent). Softwood rankings also fare well. New York is second in the Nation in eastern hemlock volume (15 percent) and third in eastern white and red pine volume (13 percent) (USDA Forest Service 1980).

With a variety of tree species, New York forests experienced a variety of species volume changes. To facilitate analysis of the species' performances, they have been ranked in descending order based on total growing-stock volume. Any species with over 1 billion cubic feet of volume will be analyzed separately. Other species will be lumped into either other softwoods or other hardwoods. It is worth noting that despite the many changes that New York forests have undergone, the order of the first seven of the top 10 species has not changed. The following shows the percentage change in growing-stock volume for the top seven species.

Changes in the Top 10 from 1968 to 1980

1968	1980	% INCREASE
SUGAR MAPLE	SUGAR MAPLE	36%
RED MAPLE	RED MAPLE	58%
HEMLOCK	HEMLOCK	35%
WHITE PINE	WHITE PINE	31%
NORTHERN RED OAK	NORTHERN RED OAK	32%
AMERICAN BEECH	AMERICAN BEECH	40%
WHITE ASH	WHITE ASH	60%
SPRUCE	BLACK CHERRY	
YELLOW BIRCH	ASPEN	
ELM	SPRUCE	
	ALL SPECIES	38%

Sugar maple. This species has been the state's number one tree (Fig. 18) in growing-stock and sawtimber volume for all three surveys. It is the official state tree. Coincidentally, sugar maple accounts for one-sixth of New York's growing-stock volume, and New York has one-sixth of the Nation's sugar maple volume (USDA Forest Service 1980). Sugar maple is the backbone of the state's lumber industry and is used in significant quantities by the pulp and paper industry. Sugar maple also provides esthetic benefits in the form of beautiful fall colors and palatable benefits by being the source tree for 1980's production of 243,000 gallons of maple syrup.

Sugar maple's volume is almost wholly concentrated in the northern hardwood type group where it is the number one species. It is not common in other type groups because they tend to occur more toward the extremes of drainage or temperature where sugar maple does not compete well. For example, sugar maple is not typically found at elevations above 2,500 feet in New York (Fowells 1965) because soils above that level tend to be thinner and less fertile and the climate becomes too cold.

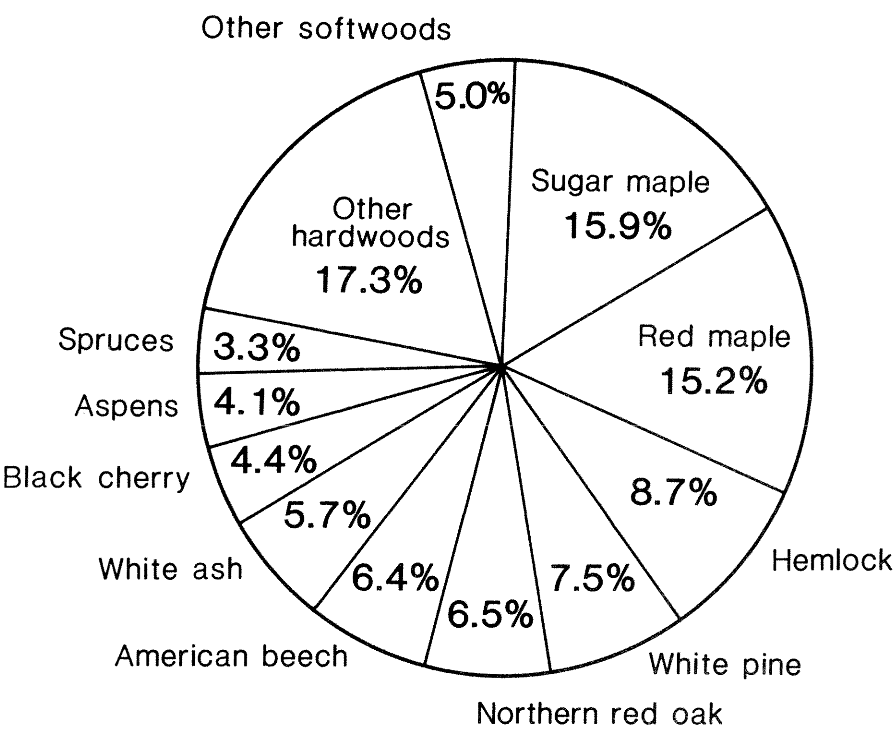


Figure 18.—Percentage of growing-stock volume, by species, 1980.

Sugar maple has more volume than any other tree species in New York.
Sugar maple sap can be collected in the spring and boiled to make maple syrup.

The period of forest recovery has benefited sugar maple. Despite its commercial value, sugar maple prospers because it grows well in New York's climate. Sugar maple's shade tolerance and rapid growth following release after many decades of suppression (Tubbs 1977), plus its stump sprouting ability, help explain why sugar maple is more common today than it was in virgin forests on most of the Allegheny Plateau (Braun 1950).

Sugar maple is widely distributed but not dominant across all of New York. Although it accounts for at least 11 percent of the growing-stock volume in each unit, it is first in growing-stock volume in only two out of New York's eight units. The previous survey showed sugar maple to be number one in six out of the eight units. Sugar maple's dominance decline is not serious because it is close to being number one in several units, but it does reflect the commercial value of the species and the fact that sugar maple volume is not increasing as quickly as some other species such as red maple. The following chart shows the proportional breakdown of growing-stock volume in each unit by species.

Distribution of growing-stock volume, by species, within the geographic units of New York, 1980
(In percent)

Species	Lake Plain	Southwest Highlands	South-Central Highlands	St. Lawrence-N. Adirondack	Western Adirondack	Eastern Adirondack	Capitol District	Catskill-Lower Hudson	All units
Balsam fir	W	0	W	5	2	3	W	0	1
Spruces	2	1	1	7	7	8	1	1	3
Red pine	3	1	3	4	1	1	1	1	2
White pine	3	2	4	4	6	20[a]	16[a]	9	8
Hemlock	7	7	9	4	11	11	15	9	9
Other softwoods	2	1	1	4	1	2	1	2	2
Red maple	17[a]	12	21[a]	17	19[a]	5	11	14[a]	15
Sugar maple	17	23[a]	17	17[a]	14	16	11	11	16
Yellow birch	2	1	1	5	7	8	1	2	3
Sweet birch	W	2	2	W	W	1	2	4	1
Paper birch	0	W	1	2	W	5	2	1	1
Hickories	4	2	1	1	1	W	2	3	2
American beech	5	9	8	8	9	8	2	3	6
White ash	9	9	7	3	5	1	4	6	6
Aspens (populus)	3	6	4	7	3	4	5	2	4
Black cherry	6	6	4	6	8	1	3	2	4
Select white oaks	2	2	1	W	W	W	1	4	2
Chestnut oak	1	0	2	0	0	W	4	6	2
Northern red oak	4	9	8	1	1	4	11	11	7
Other oaks	1	1	1	0	0	W	1	5	1
Basswood	5	4	3	2	2	1	1	1	2
Elms	1	W	W	1	1	1	3	1	1
Other hardwoods	6	2	1	2	2	W	2	2	2
All species	100	100	100	100	100	100	100	100	100

[a]Species with largest volume in unit.
W—Less than 0.5 percent.

Red maple. This is one of the most interesting trees in New York's forests. It has been number two in growing-stock volume for all three surveys but seems poised to take over the number one spot. The first survey showed red maple trailing the leader, sugar maple, by over 600 million cubic feet. By the time of the third survey, the lead narrowed to about 120 milion cubic feet. Red maple has been gaining about 18 million cubic feet a year on sugar maple. This increase means that by the time of the fourth survey late this decade New York should have a new growing-stock volume leader.

Neither red maple nor any other species is likely to overtake the sawtimber leader in the coming decade. Sugar maple has a commanding 1.6 billion board foot lead over number two red maple. Red maple has improved from sixth in the sawtimber ranking in 1953 to fourth in 1968 to second in 1980. How can sugar maple hold such a commanding lead in sawtimber (45 percent) and a narrow lead in growing stock (5 percent)? The answer lies in the diameter-class distribution of the growing-stock trees of the two species (Fig. 19). Since the entry point into hardwood sawtimber is 11.0 inches, it is clear that there are many more sawtimber-size sugar maples than red maples. The more narrow timber measure (sawtimber) shows sugar maple's dominance among bigger trees.

Growing stock is a more comprehensive and meaningful timber measure because it includes the pole-size trees in addition to the sawtimber-size ones. Sugar maple's dominance in bigger trees enabled it to overcome red maple's dominance in smaller trees and barely maintain its growing-stock lead.

Red maple is common throughout much of New York. It accounts for at least 11 percent of the growing stock in each unit except for the Eastern Adirondack (5 percent). Red maple is the number one species in growing-stock volume in four out of the eight geographic units and is one of the few species with growing-stock volume in every forest-type group.

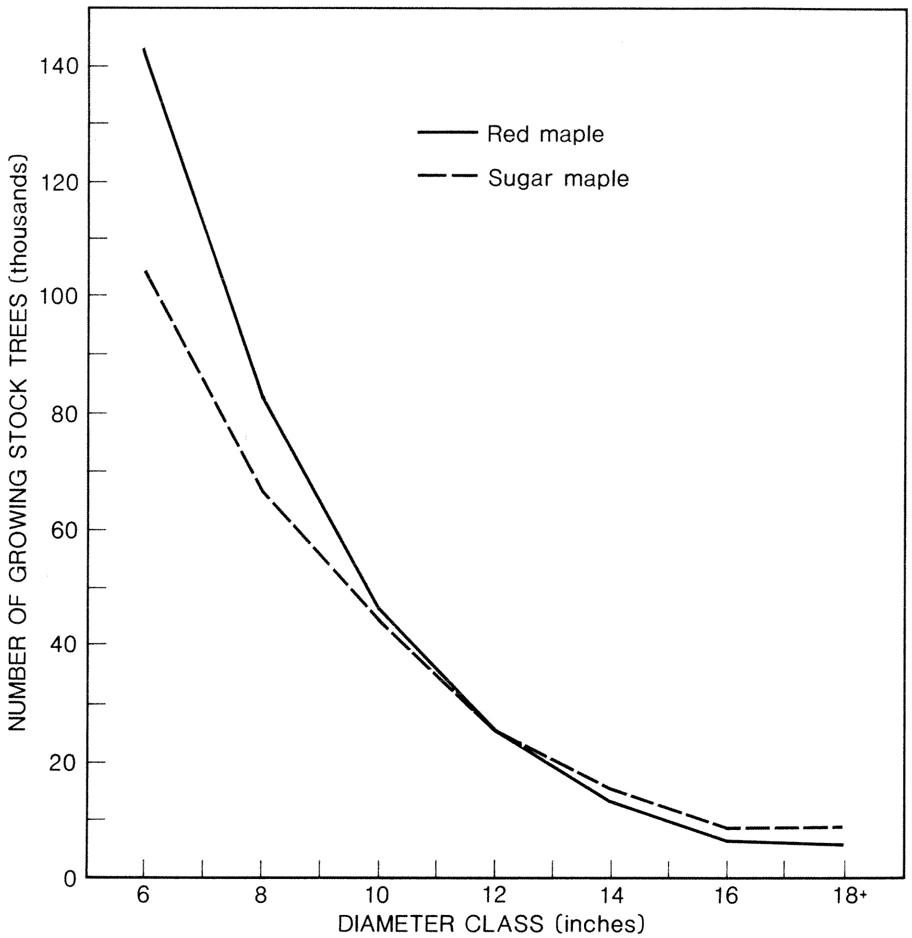


Figure 19.—Red maple and sugar maple diameter class distribution, 1980.

Three-quarters of red maple's volume is found in the northern hardwoods type group. Red maple has more volume than any hardwood in the white/red pine and hemlock and spruce/fir groups. There is more red maple volume than hickory, select white oaks, or other oak volume (excluding red and chestnut oak) in the oak/hickory group.

Red maple has been successful for several reasons. The species is a good competitor because of its vigorous sprouting ability and rapid growth through the poletimber stage. Unlike many species, red maple can grow well, not just exist, on a wide range of sites. About the only places you are not likely to find red maple in New York are at high elevations, on thin soils, and in the wettest areas with organic soils. Red maple also has not borne the burden of harvesting pressure that red oak, yellow birth, or sugar maple have. Nor has it suffered insect and disease attacks such as beech bark disease, Dutch elm disease, or gypsy moth. Red maple has been partly an opportunist, filling in gaps created by the removal of other trees.

Red maple's reputation for being a poor quality tree is not totally deserved, but the gradation of red maple from valuable to valueless because of defect is abrupt. Sugar maple and yellow birch, on the other hand, have variable rates of value reduction due to disease defect (Shigo 1965). Seventeen percent of all live red maples over 5 inches dbh in New York are cull. While this is a higher cull proportion than white ash (7 percent) or northern red oak (5 percent), it is better than beech (25 percent), yellow birch (23 percent), and black cherry (21 percent). On poor sites, red maple is apt to have many defects, but on good sites, red maple can be a high quality species producing sawlogs that command prices equal to or exceeding those paid for sugar maple.

Hemlock. This species is and has been New York's most abundant softwood for sometime. It placed third on the growing-stock list in 1968 and 1980, up from fifth in 1952. Hemlock also placed third on the sawtimber list in 1968 and 1980, up from fourth in 1953.

Hemlock and other softwoods are important to New York's forests. They provide wood products such as construction lumber and pulpwood; visual beauty, especially in winter time; and important wildlife benefits such as shelter for deer when winter snows get deep and roosting places for birds such as turkeys and owls.

Hemlock is mostly concentrated in the eastern half of the state. Nearly 60 percent of its volume is in four units: the Capitol District, Catskill-Lower Hudson, and Eastern and West-Adirondacks.

Other data from this survey portray hemlock in an interesting light. Softwoods are usually found in relatively pure associations. But this is not so for hemlock. Over half of its growing-stock volume is in northern hardwood stands. The reason for this distribution is closely tied to the history of disturbance in New York's forests.

Disturbances, mostly in the form of timber cutting and fire, drastically altered New York's virgin forests where hemlock was a dominant species. Hemlock was so frequent and important in the presettlement forests that Braun included most of New York in the Hemlock/White Pine/Northern Hardwood region (Braun 1950).

Hemlock was cut heavily during the 1800's and early 1900's for lumber and the tannin in its bark (used in tanning leather). In some portions of the state, all trees—softwoods and hardwoods—were removed in large scale clearcuts. Forest fire often accompanied the cutting and frequently spread into uncut areas. Fire is disastrous for hemlock because of its shallow root system and thin bark.

The forests that eventually grew back usually contained proportionately more hardwoods, such as maple and beech, and less hemlock. The hardwoods replaced hemlock after drastic disturbances because hardwoods typically grow faster and sucker or sprout after extensive shoot damage (David A. Marquis, Northeastern Forest Experiment Station, personal communication; Rogers 1978).

The period of forest recovery and maturation has benefited hemlock. Fire has been brought largely under control, and timber harvests have tended to be selective, removing hardwood trees of typically higher value. These conditions allowed hemlock to rebound and become more common in areas it once dominated. Because of its long life span, hemlock will again dominate some stands which remain undisturbed and are classed now as northern hardwoods (Berglund 1980).

White pine. A majestic and beautiful tree, white pine is also New York's most commercially important softwood. Two-thirds of its volume is concentrated in three eastern units. The following chart shows the proportion of each species' growing-stock volume across the geographic units.

White pine's fourth place in the statewide ranking (8 percent of the total volume) belies its dominance where it is most common. White pine is number one in volume in two units, the Eastern Adirondack and Capitol District. In these units, white pine accounts for 20 percent and 16 percent, respectively, of the unit's volume total. Unlike hemlock, 70 percent of white pine's volume is concentrated in the white/red pine and hemlock group. It is not a common associate in other types largely because it is not as shade tolerant and is more site demanding.

Thirty-one percent of white pine's volume is in stands that showed evidence of tree planting, the highest percentage for any major species. White pine was among the most frequently planted trees around the time of the Depression which helps explain the mature nature of the white pine resource. Three-quarters of its volume is in sawtimber stands, and it is third in the proportion of its volume (36 percent) in trees over 15 inches in diameter.

Softwoods usually have less cull than hardwoods. An interesting reversal of the normal situation is illustrated by white pine in New York. Sixteen percent of all live white pines over 5.0 inches in diameter were classed as cull, a proportion above that of many hardwoods. Few white pine culls are rotten trees; most are in the rough category.

The cause for most of the cull can be traced to a small insect called the white pine weevil that kills the pine's terminal leader. Crooks develop and a frequently weeviled pine may be labeled a "cabbage pine." Weevil damage is critical to white pine because it typically attacks trees under 20 feet tall and that can drastically reduce high-value sawtimber volume.

Although white pine had the lowest percentage growing-stock gain among major species, it still increased a healthy 31 percent. Future gains may not be so impressive because

Distribution of growing-stock volume, by species, across the geographic units of New York, 1980 (In percent)

Species	Lake Plain	Southwest Highlands	South-Central Highlands	St. Lawrence-N. Adirondack	Western Adirondack	Eastern Adirondack	Capitol District	Catskill-Lower Hudson	All units
Balsam fir	3	0	1	59[a]	11	26	W	0	100
Spruces	5	5	7	34[a]	18	23	3	5	100
Red pine	17	9	25	29[a]	5	6	3	6	100
White pine	5	3	9	9	7	25[a]	21	21	100
Hemlock	10	9	17	7	11	12	17[a]	17	100
Other softwoods	15	4	11	33[a]	5	10	3	19	100
Red maple	14	9	23[a]	17	11	3	7	16	100
Sugar maple	12	16	18[a]	17	8	10	7	12	100
Yellow birch	7	4	8	22[a]	20	25	5	9	100
Sweet birch	2	12	20	1	W	2	16	47[a]	100
Paper birch	0	2	6	25[a]	1	40	18	8	100
Hickories	27	15	9	5	4	1	11	28[a]	100
American beech	9	16	22[a]	18	12	12	4	7	100
White ash	19	18	20[a]	8	8	2	7	18	100
Aspens (populus)	7	15	16	27[a]	7	10	11	7	100
Black cherry	16	16	15	21[a]	15	2	6	9	100
Select white oaks	13	16	14	4	W	1	8	44[a]	100
Chestnut oak	4	0	17	0	0	1	21	57[a]	100
Northern red oak	8	16	22	3	1	6	17	27[a]	100
Other oaks	7	6	9	0	0	W	7	71[a]	100
Basswood	24	19	24[a]	11	6	4	4	8	100
Elms	13	2	6	19	8	5	32[a]	15	100
Other hardwoods	35[a]	10	4	14	7	2	9	19	100

[a]Unit where largest species volume occurred.
W—Less than 0.5 percent.

white pine still will be sought commercially, and the ingrowth of young trees seems to be slowing. Planting of white pine and most softwoods decreased in recent decades largely because of the termination of the Soil Bank Program in the late 1950's and a state budget crisis in 1971 that forced price increases at state nurseries. Furthermore, some natural pine stands that have been harvested have not regenerated to pine.

Currently there are fewer white pines in the 5.0- to 6.9-inch class than there were in 1968. Future supplies will depend on this class and the smaller diameter classes. White pine's decline in the 5.0- to 6.9-inch diameter class is in direct contrast with the situation of red maple and shade intolerants such as aspen, black cherry, and ash. All of these species had high proportionate growing-stock increases (between 58 and 136 percent). All had significant ingrowth into the 5.0- to 6.9-inch class and now have more volume in that class than they did in 1968 setting the stage for further increases. White pine is in no immediate danger, but increased forest management is needed to sustain its long run vitality as a commercial species.

Northern red oak. This species is the only Central hardwood representative among the major species. It ranks fifth in growing-stock and sawtimber volume, the same position it held in 1968. Red oak ranked seventh during the first survey.

In the last decade, red oak has become one of New York's most valuable forest trees reversing a history of low-value (Fig. 20). Increased export demand, largely by European furniture manufacturers, has been responsible for most of the price increase. Higher harvesting levels, along with reduced growth rates due to defoliation from insects such as the gypsy moth, helped keep red oak's increase "down" to 32 percent.

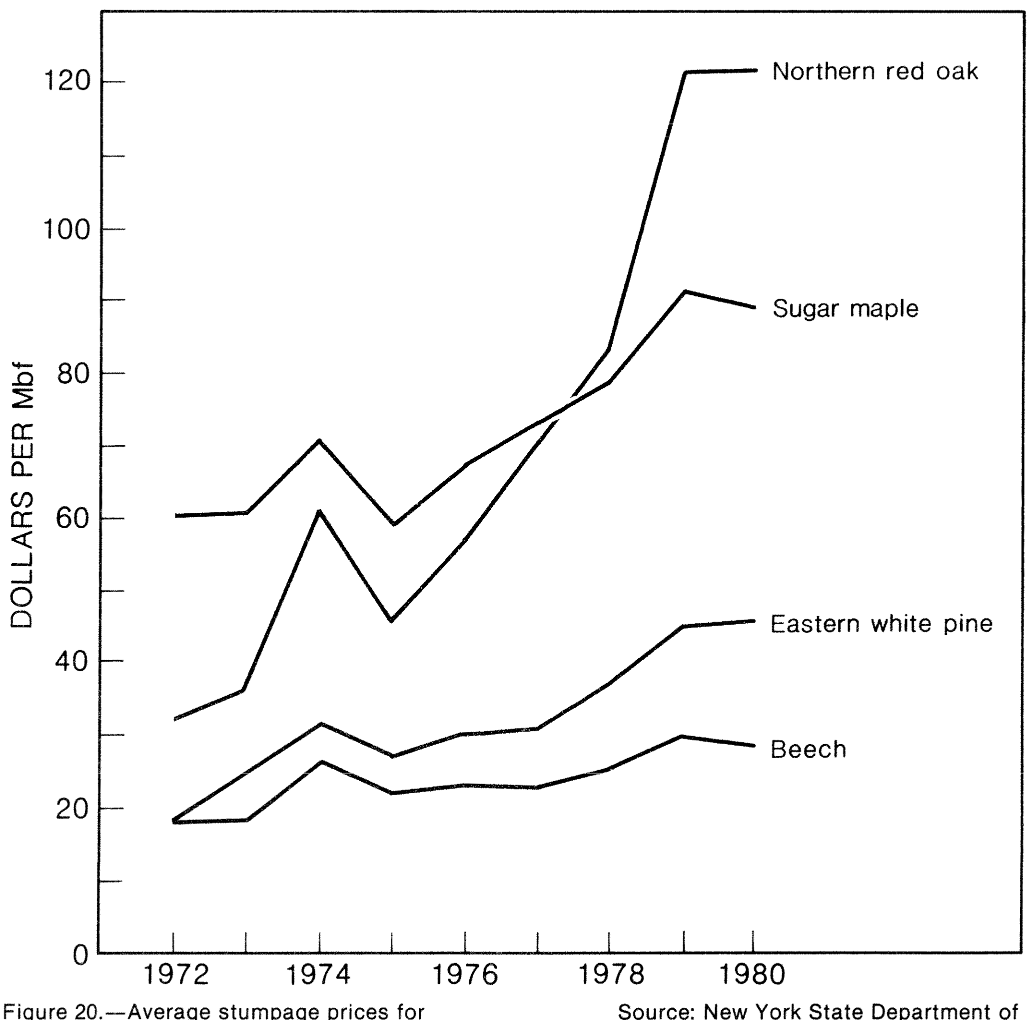


Figure 20.—Average stumpage prices for selected species, 1972-80.

Source: New York State Department of Environmental Conservation Marketing Bulletins

High quality trees like this oak are very much in demand.

New York has been an important supplier of red oak to European markets in part because of the quality of its red oak resource. Only 5 percent of the red oak trees more than 5.0 inches in diameter are classed as cull. Only balsam fir, the hickories, and red pine have lower cull proportions.

Red oak's diameter distribution is among the most mature of New York's species, exceeded only by the select white oaks. Thirty-eight percent of red oak's volume is in trees greater than 15 inches in diameter. This proportion is up from 1968 when 31 percent was in trees over 15 inches.

Not all the connotations of this diameter-class distribution are positive. The mature distribution means good times for red oak users in the short run, but problems in the long run. As with white pine, the number of red oaks in the 5.0- to 6.9-inch class decreased between surveys. Contrast the number of small red oaks with the number of small trees of other species (Fig. 21). Red oak accounts for 8 percent of the live trees greater than 15 inches dbh, but only 3 percent of the saplings.

In other eastern and central states, concern has been expressed about the adequacy of oak regeneration following disturbances. Oak regeneration difficulties in neighboring Pennsylvania were attributed to a variety of causes including: a lack of viable acorns due to acorn insect attacks, rodent damage to the acorns, and deer eating seedlings that emerged (Marquis et al. 1976).

Red oak's volume distribution mostly follows the area distribution of the oak/hickory type group. More than 80 percent of its volume is in four southern and eastern units. It is most concentrated in the Capitol District and Catskill-Lower Hudson Units where it ranks third in volume and has 11 percent of each unit's volume.

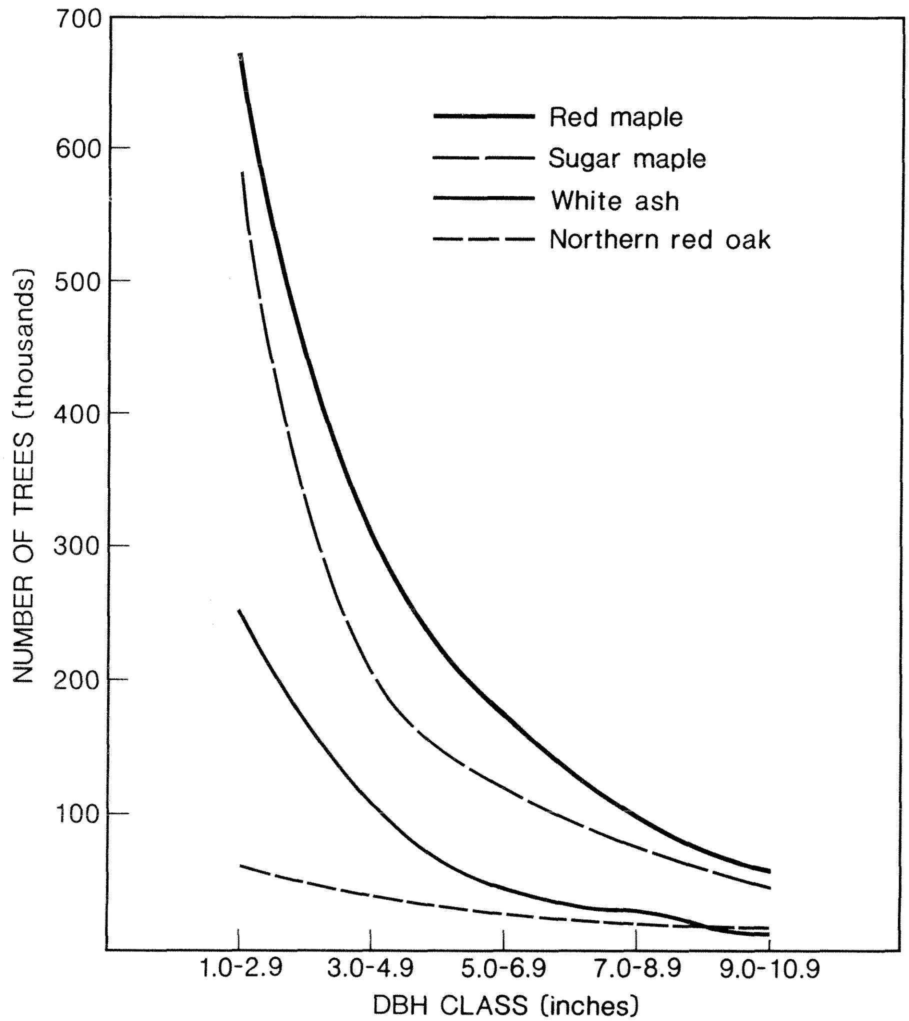


Figure 21.—Number of live trees, by selected species and diameter class, 1980.

An interesting characteristic of red oak is that its range extends farther north than any other oak (Fowells 1965). This helps explain why our survey showed nearly one-quarter of red oak volume in northern hardwood stands, and why red oak has the second most volume of any hardwood (behind red maple) in the white/red pine group. Red oak's occurrence in these groups benefits wildlife because of the hard mast acorns the oak provides. Acorns are a high-energy food source that is used by small mammals such as mice, chipmunks, and squirrels as well as larger creatures such as deer, turkey, bear, and even wood ducks. Except for beech, northern hardwood and softwood forest types usually suffer from a lack of hard mast trees. Beech, especially large, nut-producing ones, have suffered from beech scale-nectria complex in certain parts of New York. So, oak's role in providing an important fall, winter, and early spring wildlife food is even more important.

Red oak is also an important food source in oak/hickory stands even though these stands typically have a higher number of nut producers. Red oak acorns take a year longer than white oak acorns to mature, that is, red oak acorns that formed in the spring of 1982 will mature and drop in the fall of 1983. White oak acorns mature in one growing season; so, those forming in the spring of 1982 would have dropped in the fall of 1982. Because red and white oaks are often found in the same timber stand and have acorns that mature at different times, they can combine to prevent a complete lack of mast for a particular year.

Beech. An analysis of beech is a study of contrasts. With its silvical characteristic of high tolerance and history of low commercial value, we would normally expect beech to have done well. In portions of New York, beech has done quite well. However, in other parts of the state beech is having significant difficulties.

Statewide, beech ranks sixth in growing-stock and sawtimber volume, the same position it held in 1968. This is a drop from 1953 when beech was third in growing-stock and second in sawtimber volume. Beech volume dipped between 1953 and 1968 but was up between 1968 and 1980. Unfortunately for beech's ranking, most other species increased between all surveys.

Beech suffered in eastern and central New York where mortality, cull, and removals (including salvage and presalvage) have been much higher than normal. The cause is an insect-disease complex that is generally known as beech bark disease. More specifically it is an invasion by fungi, especially *Nectria coccinea* var *faginata,* of beech bark altered by the feeding activities of an insect, the beech scale, *Cryptococcus fagisuga.*

The forest goes through three stages of attack: (1) the advancing front, (2) the killing front, and (3) the aftermath zone (Shigo 1972). The disease probably entered southeastern New York about four or five decades ago. Since then, it has moved northward, westward, and southward. In New York, forests now represent each of the three stages.

The advancing front is in western New York and northern Pennsylvania. This area has the scale insect but not the disease. The killing front is in central New York, behind the advancing front (Miller-Weeks 1983). This is the zone where both the scale and *Nectria* fungi occur in abundance and where trees are actively being killed. The fungi often appear 3 to 5 years after the scale insect. Death of infected trees may be rapid or may take 2 to 5 years of fungus infection.

The aftermath zone follows the killing front stage. Many beech stands in eastern New York are now in this stage. In some of these stands, dense thickets of beech root suckers have appeared which may be attacked and rendered highly defective when they get large enough (Houston 1975).

Beech bark disease will continue to spread. The killing front will encompass western New York. Because the northern hardwood type group extends southward along the Appalachian mountains, those states lying astride the mountains can expect trouble for their beech resource. The disease also should spread westward through Ontario and the Lake States.

Volume change data for the region, in front of and behind the killing front, reveal the extent of the beech bark disease damage. The region behind the front might be called the Northern region; it includes the three Adirondack units. Growing-stock volume increased by about 90 million cubic feet (25 percent) since 1968, but sawtimber increased by only about 30 million board feet (3 percent).

These changes highlight two significant characteristics of the disease: (1) that it does not kill all beech trees and (2) sawtimber-size trees are more susceptible than smaller trees. Two points that these statistics do not show, but that have been observed, are that all stands are not equally damaged and some of beech's low volume increase may be traced to increased presalvage activities by knowledgeable landowners.

Another effect of the disease is to cause varying amounts of cull in many of the trees it does not kill. Partly because of this, beech is the most cull-ridden of New York's commercial species. Fully 25 percent of all live beeches over 5.0 inches dbh are cull, and three-quarters of these are rotten.

New York's western region includes three units: the Lake Plain, Southwest Highlands, and South-Central Highlands. Most of this region has not been hit by the disease, and timber volume increases were larger here than in the Northern region both in absolute and percentage terms. Beech growing-stock volume increased by 170 million cubic feet (55 percent) from the 1968 level, and sawtimber was up more than 600 million board feet (95 percent). There is now more beech in this region than in the Northern region.

It is uncertain how long this lead will last because the disease is spreading west. Most of New York may have experienced the killing stage by decade's end. It is unfortunate that the disease cannot be controlled other than by cutting infected and susceptible trees, because in recent decades beech has become more valued for its timber and appreciated for its contribution of hard mast to wildlife food supplies. The main hope for the species may lie in the resistance to beech scale shown by some infrequently occurring beech trees (Houston 1983).

Other species. Even though there are no other species with more than 1 billion cubic feet of growing-stock volume, a brief commentary on two is included because of what is judged to be a unique characteristic or trend.

Starting with a softwood, we find that red pine exemplifies a maturing timber resource better than any other species in New York. Initially, it was a tree not common to the state's woodlands, but it was often planted around the time of the Depression. Today it is possible to find "naturalized" red pine, but still 87 percent of its volume is in stands that show evidence of tree planting.

This pine is not planted nearly as frequently as in decades past. It is more site sensitive than originally thought, developing what is known as "wet feet" on poorly drained and heavy soils. An insect, the red pine scale (*Matsucoccus resinosae*), and a disease, Scleroderris canker (*Gremmeniella abietina*), are two other problems seriously affecting red pine management.

The result of red pine's planting history is that it has a classical age-class imbalance (Fig. 22). Little new timber has entered the 5.0- to 6.9-inch class and enough has been cut to pretty much offset growth. Hence, growing-stock volume increased a paltry 5 percent between 1968 and 1980.

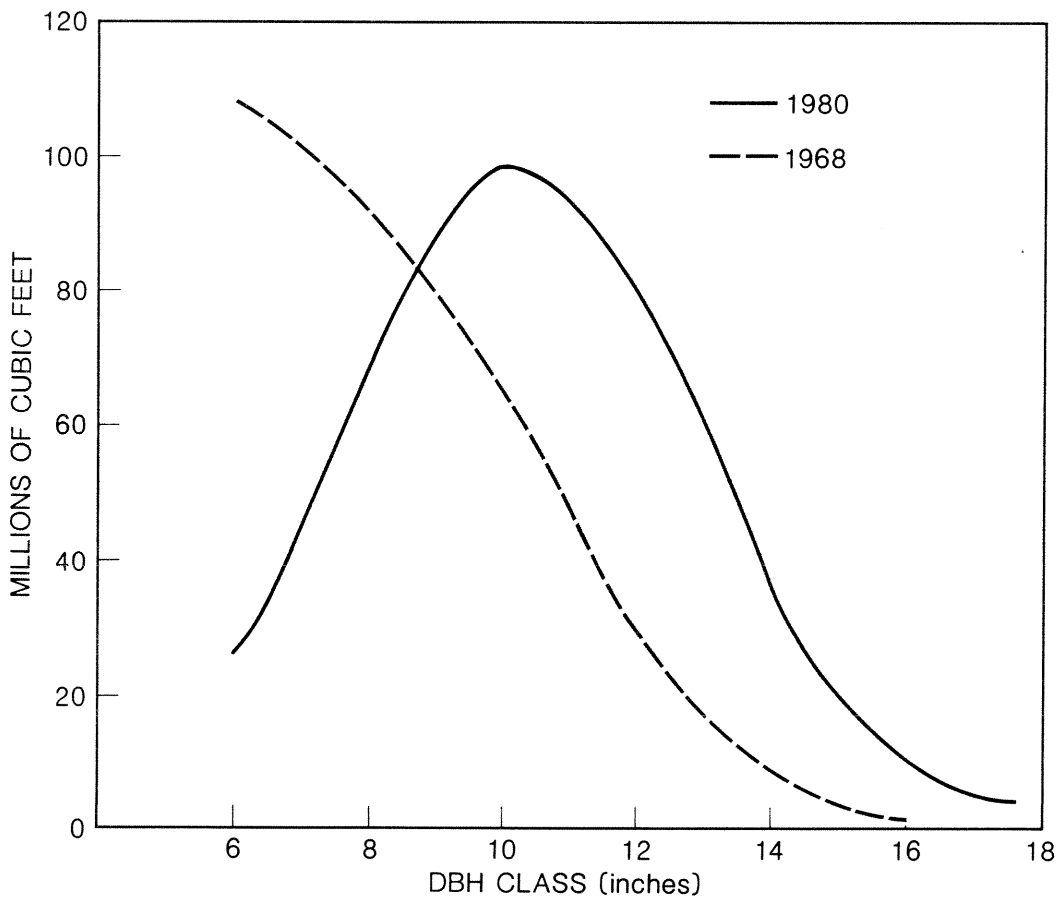


Figure 22.—Distribution of red pine growing-stock volume, by diameter class, 1968 and 1980.

Red pine's sawtimber increase, however, was dramatic due to the redistribution of growing-stock volume from poletimber to small sawtimber size. This accounts for the 113 percent increase in sawtimber volume between 1968 and 1980. It also means a resource is developing for those interested in utilizing a species well suited for lumber, posts, poles, and pulpwood. Future increases of this magnitude should not be counted on because there are not enough young trees to sustain it.

American elm is the one species that is unequivocally declining. Dutch elm disease was first found in America in Ohio around 1930, and has now thoroughly infested the elms in New York. Elm volume declined between the first and second surveys by 20 percent, but enough remained for elm to hold onto its number 10 ranking. Between 1968 and 1980, the bottom fell out for elm as its volume plunged 66 percent. It is no longer even in the top 20.

Elm's decline is unfortunate because it means the loss of timber with strength, and bending and shock-bearing properties. But the biggest loss cannot be perceived from these forest surveys, because the disease has literally wiped clean areas we never inventory—the city and town streets and parks and college campuses that were once lined with huge, stately elms. Those elms still alive are mostly a result of costly management and chemical treatments undertaken by people concerned about retaining the elms' ornamental beauty.

Wet sites are elm's natural home. This species used to be the key member in the elm/ash/red maple forest-type group. Its continued decline will relegate it to an indicator species status. The poorly stocked condition of many elm/ash/red maple stands can be partly attributed to openings created by the demise of elm. Red maple is the most likely species to eventually fill in these gaps.

Ownership

New York's diverse forest-land owners were characterized briefly in the forest area section. An examination of the timber volume on these lands reveals several interesting patterns.

An ownership's total timber volume is closely related to its total commercial forest land (Tables 1 and 2, Appendix). Those who own much land tend to own much volume. But size can mask important differences between ownerships. A pattern emerges when the five ownership classes are ranked by average growing-stock and board-foot volume per acre of commercial forest land. Per-acre analyses are useful in washing out the effects of different-size ownership bases.

Owner	*Growing stock rank*	*Average ft³/acre*	*Sawtimber rank*	*Average board foot/acre*
Public	1	1,280	1	3,268
Forest industry	2	1,205	3	3,051
Corporate	3	1,202	2	3,107
Misc. private	4	1,004	4	2,419
Farmer	5	903	5	2,224

While public lands are the smallest ownerships in terms of commercial forest land owned, they have the highest per-acre growing-stock and board-foot averages, a position also held in the previous survey. Pennsylvania's public lands hold a similar position.

Average volume per acre should be positively correlated with the proportion of an ownership's commercial forest land in sawtimber stands. With a slight twist, this is true for New York owners. More than 51 percent of the public forest land is classed as sawtimber stands. This is a substantial percentage but is not the highest. Forest industry has more than 54 percent of its land in sawtimber stands.

The frequent occurrence of plantations on public lands is one reason why the public forests have the highest average volume per acre of commercial forest land, despite not having the highest percentage of sawtimber stands. These plantations typically have higher stocking levels and higher volumes than natural stands of similar age. The forest management philosophy of the public land managers also contributes to the high averages on public lands. Most of the public lands are in state forests and are managed under conservative multiple-use principles. Timber is considered but one of many forest products. Longer timber rotations and resulting higher average volumes per acre are logical under multiple use management because more mature stands have a definite value for recreation, esthetics, and certain wildlife species.

The species composition of the public forests is influenced by the numerous plantations. Planted softwoods seem to account for at least half of the softwood volume on public lands. Softwoods account for more than one-third of the growing-stock and sawtimber volume on public lands, by far the highest percentage among ownership classes. Public lands have about 40 percent of the growing-stock and sawtimber volume of red pine.

Forest-industry lands rank second in growing-stock and third in board-foot volume per acre. Industry foresters, like public foresters, are committed to managing their lands. They strive to ensure that suitable lands are kept productive, a major reason why industry does not have any nonstocked lands and why their per-acre volume averages are high.

The species found on industry lands reflect the fact that most of its land holdings are in northern New York. Red and sugar maple, beech, yellow birch, and the spruces account for two-thirds of forest industry's growing-stock volume. Industry owns one-third of balsam fir's total volume and one-quarter of the spruce and yellow birch total volume.

Little can be said about the other corporate ownership group because it is so diverse. This group includes hunting clubs, utilities, forest-land management companies, real estate speculation companies, and light and heavy industry. Because these owners' goals and objectives run the gamut from commercial development to preservation, there is no obvious explanation for its ranking.

Neither can much be said about the fourth-ranked group—the miscellaneous private sector. This very large, diverse group owns more than 50 percent of the total growing-stock and sawtimber volume. However, the volume per-acre estimates for this group show a sharp drop off from the first three ownerships, which were all closely spaced.

Two factors partially explain the low estimates. First, this group has been buying much of the farmland that has been sold or auctioned. It is reasonable to assume that a fair proportion of this land is in low volume, reverting field status.

Second, more timber is being cut from this group than commonly believed. It is often said, and quite correctly, that this group is not greatly interested in managing their land for timber. However, this does not mean that these owners will not cut timber. They have been harvesting substantial amounts of fuelwood, sawlogs, and pulpwood, and 23 percent of these owners plan to harvest timber in the next decade (Birch 1983).

Farm owners rank last in the growing-stock and sawtimber averages. They have the lowest proportion of sawtimber stands and the highest proportion of immature stands. Quite a few of the low-volume stands are reverting pastures that will probably remain poorly stocked for a while. Hawthorn and pin cherry are common species in these reverting fields, and both are nongrowing-stock species.

Even mature farm woodlots tend to be in poor shape because they typically sustain frequent cuttings for farm and commercial wood products. Cattle grazing and tapping for maple syrup further reduces the vigor of many farm stands.

Biomass

Tree biomass data is a new output of our forest inventory process. This information is important because it provides a more complete picture of our timber resource than does growing stock or the even more limited sawtimber measure. Because tree biomass data needs are relatively new, research continues to develop better sampling, estimation, and analytical methods.

The tree biomass estimates in this report and in "Forest Statistics for New York, 1980" are based on research conducted in New York by the College of Environmental Science and and Forestry of the State University of New York (Monteith 1979). The biomass tables in "Forest Statistics for New York, 1980", represent an attempt to relate the net growing-stock volume of certain components of the resource to their associated green weight. Since the publication of "Forest Statistics for New York, 1980", some concern arose about the validity of publishing the two types of estimates side by side.

An examination of the data does reveal a discrepancy. The problem is that the weight per cubic foot of growing-stock volume is too high. For example, Table 17 in "Forest Statistics for New York, 1980" shows the net growing-stock volume in sawtimber trees as 9,238.0 million cubic feet. The total estimated weight of the sawtimber is 400.4 million green tons. Dividing the weight by the volume reveals that the average cubic foot of wood seemingly weighs about 87 pounds. This is well above the 55 to 60 pounds per cubic foot that would be expected.

An analysis of the methods used to derive the two types of estimates revealed two differences between the methods. First, Monteith included bark in his weight equations while we did not include bark in our volume equations. In addition, Monteith's tree sample included almost ideal trees so that his equations do not reflect typical cull losses or heights of average trees.

Both the volume and biomass estimates are independently valid and highly usable, but to put them on a more common base, users may wish to reduce the biomass data by the following reduction factors which attempt to net out the effects of bark, cull, and height differences. The bark reduction factor is 14 percent, and is based on information from the New York State Department of Environmental Conservation.

As for a cull and height adjustment factor, one study that examined predicted versus actual biomass yields in a northern hardwood stand found that predicted overstated actual yields by an average of 19 percent (Hornbeck and Kropelin 1983). The authors felt that the difference was largely due to the ideal nature of the trees used to develop the predictive values versus the "real" type of trees encountered in most stands. When taken together, these two adjustment factors seem to explain much of the per-cubic-foot weight discrepancy.

Despite the fact that the two data types are not directly comparable, tree biomass data reveals how much more wood fiber is in our forests than described by the traditional timber measure called growing stock. Whereas the boles of growing-stock trees account for 90 percent of the net cubic-foot volume in trees over 5 inches dbh, growing-stock boles account for 56 percent of the green weight of all live trees on New York's commercial forest land. Other significant components of the tree biomass resource are: tops of growing-stock trees (18 percent), saplings (15 percent), rotten trees (2 percent), and stumps (1 percent).

From a utilization standpoint, nearly all of these fiber sources could be chipped or cut for wood products or fuel, but from a conservation standpoint, nearly all the saplings and many culls should be left uncut. Saplings will comprise the next generation of growing stock. Cull trees have high value for wildlife. Some forest-land managers, in their haste to promote the growth of growing stock, have removed all cull trees from their property. This may be detrimental to wildlife. Tops of already harvested growing-stock trees represent the most logical source of additional fiber. Use of this material for pulpwood and fuelwood has been increasing.

One other interesting statistic from Table 17 in "Forest Statistics for New York, 1980" is the ratio of bole weight to total weight for growing-stock and cull trees. The bole, or main stem in growing-stock trees accounts for more than 75 percent of the total weight of the tree. This is significantly higher than the ratio of 63 percent for cull trees. Since growing-stock trees are of typically better form than cull trees, less growing-stock biomass is in the crown.

Additional biomass data are available from our Broomall office, and a report is being prepared on New York's biomass resource.[1] For an example of what is available, see Table 3 (Appendix). Several observations can be made about these data.

It is interesting to note that in New York, softwoods and hardwoods both have nearly 25 percent of their growing-stock biomass in tops. These group averages mask some divergent species proportions, but they do show that on the average a significant amount of extra fiber is available in the types of trees most commonly harvested for wood products. Obviously, certain products such as sawlogs cannot be cut from tops but fuel, fiber, and pulp products can. Utilization of tops from growing-stock trees for suitable products, where markets exist, should mean less cutting of remaining trees. In turn, this would hasten the development of larger trees that are valued for sawtimber and amenity values.

[1]Wharton, E. Identifying aboveground wood fiber potentials in New York, 1980. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; (in preparation).

The softwood group contains spruce and white pine which have the highest (36 percent) and lowest (16 percent) ratio, respectively, of topwood to total growing-stock weight of any major species. Several resource characteristics are helpful in understanding why this range exists.

One factor that seems relevant is the particular species' shade tolerance. Other factors being equal, shade intolerant species (for example, aspen, paper birch, and white pine) have smaller crowns (and topwood ratios) than those of shade tolerant trees (for example, beech, spruce, and hemlock). This factor seems to explain many, but not all, of the differences in the ratios. Another factor is the maturity of the species, as represented by its diameter-class distribution. Again, other factors being equal, for most of a tree's life, topwood becomes a smaller part of a tree's biomass as the tree ages. We would expect, therefore, to see mature species with lower topwood ratios than younger species. This factor explains most of the ratios that are not explained by the shade tolerance factor, particularly those of sugar maple and red oak.

Sawlog Quality

Sawlog quality is an important component in the assessment of the timber resource. Although several markets that have relied on high-quality trees are being increasingly satisfied by reconstituted or fiber products, high-quality trees are still in demand and provide strong financial returns to the forest-land owner.

Softwoods are not graded except for red and white pine. The pine's quality is not very good under the standards imposed by the grading system. For example, about 80 percent of the white pine volume is in the two lowest grades. Any weevil damage or overgrown knots exceeding 1½ inches puts logs into these lower categories. Both causes of degrade are common.

All of the hardwood species encountered in the survey were graded. There is more high-quality grade 1 and 2 material now than in 1968, but the proportionate amount of grade 1 and 2 slipped slightly because the lower quality grades increased at a faster rate (Fig. 23). It may be said that there are more high-quality trees now, but they are better hidden among the more common, lower quality trees.

An influx of young sawtimber and heavier harvesting pressure on high-quality timber are largely responsible for the proportionately bigger increase of lower quality sawtimber. To be classed as Grade 1, a tree must reach a minimum dbh of about 15.5 inches in addition to meeting defect standards. Young sawtimber trees may be straight, tall, and defect-free, but if they do not meet the dbh standard, they are lowered in quality.

Currently, 13 percent of hardwood sawtimber is in Grade 1, 22 percent in Grade 2, 50 percent in Grade 3, and 15 percent in Grade 4. Importantly, many of New York's commercially valuable trees have better quality distributions than that of the all-species average. In decreasing order, red oak has 26 percent of its sawtimber in Grade 1, white ash—20 percent, basswood—19 percent, white oak—17 percent, sugar maple—16 percent, and yellow birch—14 percent.

The proportion of grade 1 material increased slightly for red oak, sugar maple, white ash, and basswood. The grade 1 proportion declined for yellow birch (from 19 to 14 percent) and white oak (from 21 to 17 percent). New York's hardwood sawtimber quality is slightly better than that for the Northeast as a whole. This slight advantage also is evident for the commercially valuable species. The explanation for the higher than average quality of valued species is closely tied to the fact that except for white ash they all also have higher than average amounts of sawtimber in trees greater than 15 inches dbh.

The proportion of the hardwood sawtimber resource greater than 15 inches dbh is a crucial statistic for many sawmillers because this timber size is so closely tied to log quality. There is substantially more timber greater than 15 inches now than in the last survey, but the proportion of the total sawtimber resource in this class is still about 47 percent (Fig. 24).

With sawtimber growth exceeding removals and average tree diameter increasing, an increase in overall sawtimber quality and quantity is expected. The picture for the commercially valuable species is less clear. The last decade saw some sizable jumps in demand for particular species. Should the demand for quality logs from species such as oak continue to increase, future quality gains for these species could be minimal or nonexistent.

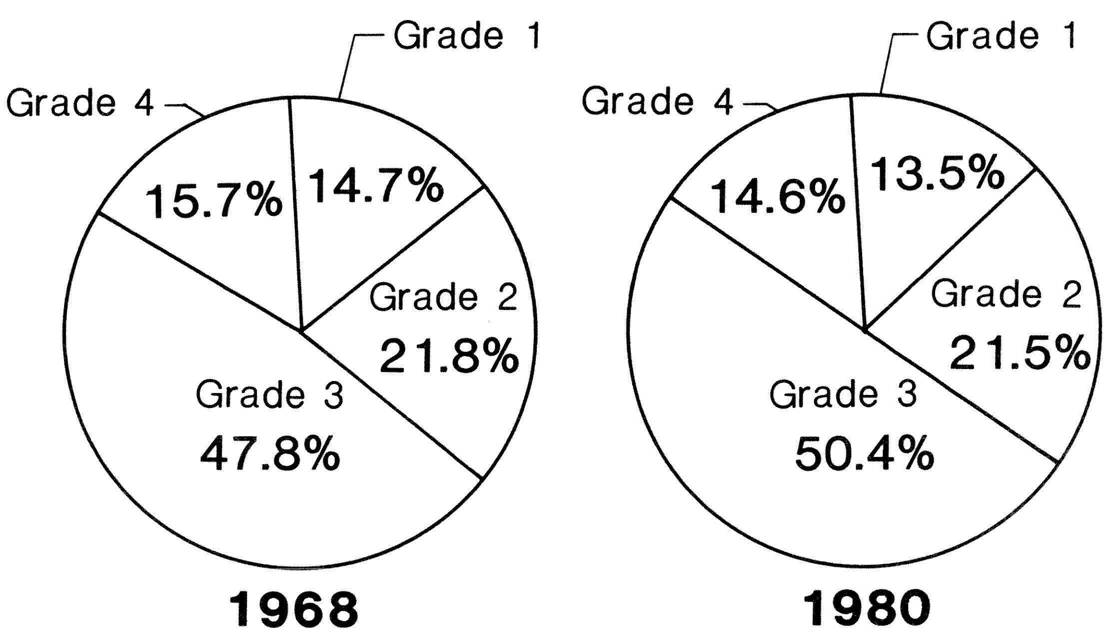


Figure 23.—Hardwood sawtimber quality distribution, 1968 and 1980.

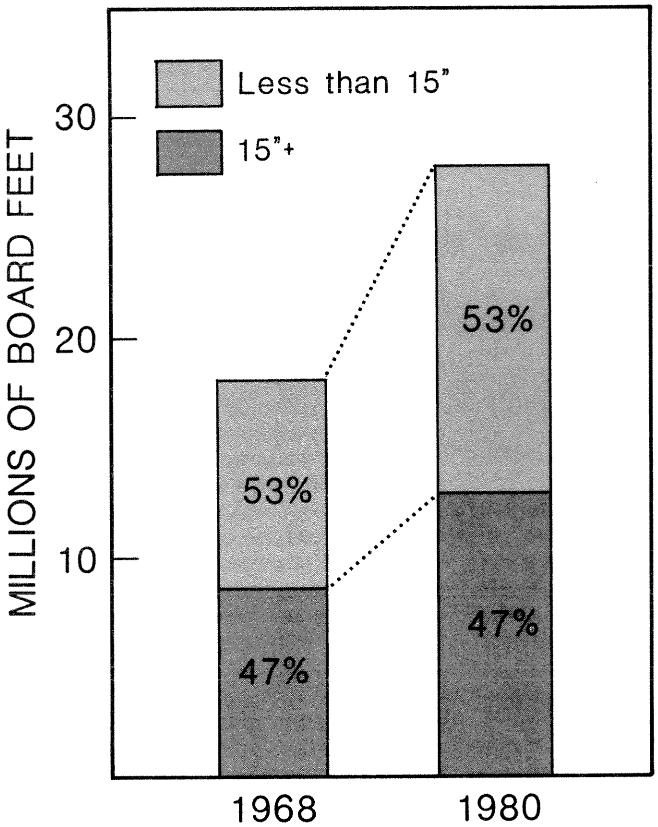


Figure 24.—Distribution of large and small hardwood sawtimber, 1968 and 1980.

Growth and Removals

As we have seen, New York experienced a sizable increase in growing-stock and sawtimber volumes between surveys. An examination of the components of inventory change will help our understanding of the changes and provide a glimpse at what the future might hold.

Between the second and third surveys, average annual growing-stock net growth for all species was 558 million cubic feet, and average annual removals were 196 million cubic feet. The ratio of growth to removals was more than 2.8 to 1. Timber growth averaged about 37 cubic feet per acre per year.

The average annual removal figure of 196 million cubic feet is just that, an estimate of the average removals for a year between 1967 and 1979. Current removal levels are in all probability higher than this average annual removals figure because fuelwood harvesting picked up significantly in the mid to late 1970's.

Growth and removals are at a higher level for the 1968 to 1980 period than for the period between the first and second surveys. Encouragingly, growth increased at a faster rate than removals, so the gap between growth and removals widened. Average annual growth increased from 245 to 558 million cubic feet. Average annual removals went from 134 to 196 million cubic feet. Average annual per-acre growth doubled from 18 to 37 cubic feet per acre per year as many immature stands grew to merchantable size and many merchantable stands were allowed to grow.

New York's growth trend is quite favorable when compared to neighboring Vermont and Pennsylvania. Vermont's growth is low, averaging only 24 cubic feet per acre per year. While Pennsylvania's per-acre growth matches that of New York, its total and per-acre growth have been slipping downward. Pennsylvania has a larger oak resource than New York which has borne the brunt of several severe insect and disease attacks.

The growth figures used so far refer to net growth—which is gross growth minus cull increment and mortality. Cull increment is the volume of growing-stock trees that become rough or rotten between surveys. Gross growth is the sum of accretion (growth on the initial inventory) and ingrowth (volume of trees that become larger than 5.0 inches dbh between surveys).

Ideally, mortality and cull increment would be negligible so that net growth would virtually equal gross growth. The ideal situation does not exist in New York. Insect and disease attacks, logging damage, weather, and a variety of other factors reduced average annual gross growth (787 million cubic feet) by 29 percent (229 million cubic feet). Mortality was twice as important as cull increment in reducing growth.

Even though cull increment and mortality were higher for this period than for the period between the first and second survey, the proportion of gross growth lost to these agents dropped from 39 to 29 percent. While New York has improved its proportionate loss and is better off than Vermont (41 percent loss), it still loses proportionately more timber to cull and mortality than Pennsylvania (21 percent).

Average annual inventory change is derived by subtracting timber removals from net growth. Timber removals are more than timber cut for products (Fig. 25). In 1979, timber-product removals accounted for 68 percent of all growing-stock removals. This proportion is lower than the estimate of 82 percent from the previous survey largely because we are better able to quantify timber volume lost to nonproduct uses such as land clearing and reclassification of commercial forest land.

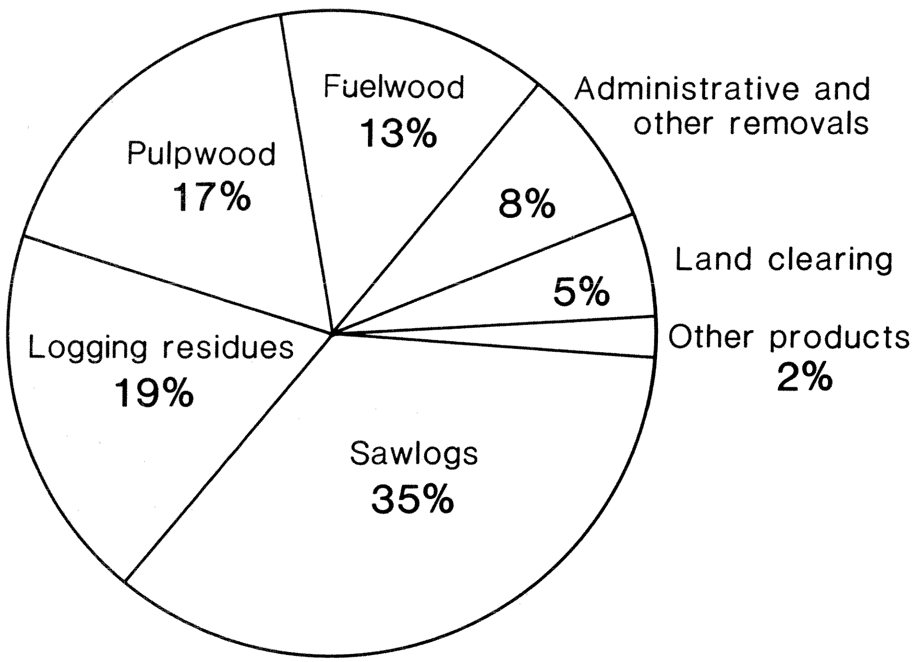


Figure 25.—Timber removals from growing stock, 1979.

Whether we talk about the previous or current survey, logging residues are a significant type of removal. Logging residues, as we calculated them, exceeded the pulpwood harvest from growing stock. But this estimate must be used cautiously because of the way we calculated it.

As part of the survey, field crews conduct timber utilization studies at logging jobs throughout New York. They typically spend about 2 days at each site recording the utilization of harvested material. Any utilization of growing-stock residue, such as upper stems or trees knocked down, that takes place after the crews leave is not tallied. Yet some activities, such as fuelwood cutting, often take place after harvesting is completed.

In all likelihood, our estimate of logging residues overestimates what is left in the woods because some portion of it, perhaps a high portion, has been subsequently cut for fuelwood or other products. This means that a higher proportion of growing-stock removals is going into products and less is wasted than we report.

How much fiber is involved cannot be stated precisely because post-harvest cuttings may be spread over several years. Because logging residues were 18 percent of growing-stock removals at the time of the second survey and because studies have indicated increased utilization rates in recent years (Wharton and Bones 1980), we would expect the current residue proportion to be lower than that of the second survey. For example, if we assume that utilization rates improved a modest 10 percent, the current residue proportion should be 16 percent. The published residue proportion is 22 percent (when land clearing and reclassification have been netted out). So, even under a modest improvement assumption, we are probably overstating residues by quite a bit (13 million cubic feet), and the overstatement increases as the assumed rate of utilization improvement increases.

On a statewide basis, the growth/removals relationship for almost all of New York's species looks favorable. This is understandable considering the often substantial species volume increases discussed earlier. Only elm has negative growth. Many of the commercially valued species enjoyed growth rates that were at least double their respective removals rates.

Most commercially prized species had annual growth rates between 3.0 and 3.5 percent of their respective 1980 inventory. One exception was the select white oaks, which are highly prized for timber products and highly susceptible to gypsy moth defoliation and mortality. The select white oaks had a low 1.8 percent annual growth rate. The growth rate of oaks in general was below that of the maples and other northern hardwoods. Insect attacks on the northern hardwoods were not common, but the 1970's saw the oaks suffer a number of defoliations. Some species, such as aspen, which showed substantial ingrowth, had probably unsustainable annual growth rates of about 5 percent.

At geographic levels below the state level, growth and removals data rapidly begin to lose reliability, especially for less common species. Average annual regional growth and removals for some selected species and regional totals for 1967-79 are:

Selected species	Northern		Southwest		Southeast	
	Growth	Removals	Growth	Removals	Growth	Removals
	Million cubic feet					
White & red pine	22	8	6	2	19	12
Hemlock	10	5	15	6	20	5
Red maple	36	12	35	3	20	3
Sugar maple	37	18	33	13	24	7
Red oak	3	4	18	5	13	5
Regional total	198	87	217	57	143	52

The positive growth/removals relationships at the state level for these species are evident at the regional level except for red oak in the Northern region. Our best estimates show a slight red oak volume decline for the combined three Adirondack units. Fortunately, this slight decline is more than offset by increases in the Southeast region (Capitol District and Catskill-Lower Hudson units), and the Southwest region (Lake Plain, Southwest Highlands, and South-Central Highlands units).

A common concern about our data is that growth and removals data are not presented with the same detail as forest area and timber volume data. A discussion of priorities in conducting our surveys should explain why we cannot publish detailed growth information.

For many decades, the Forest Service and many state forestry organizations have been worried about potential shortfalls in timber supply. Remember how New York forests were cut over and cleared about a century ago? The Forest Inventory units around the country were set up to monitor the timber resources of the various states and sound a warning if timber depletion was detected.

Concern about current timber inventory levels definitely influenced the way forest surveys have been conducted. If you enter a state to do an inventory after being absent for 10 to 15 years and if the current status of the timber resource is the major concern, you design your survey to see what is in the woods at that particular time.

Research based on this priority indicated that we should use a sampling design called *S*ampling with *P*artial *R*eplacement (SPR), which is a very cost-effective estimator of current conditions (Bickford, Mayer, Ware 1963). Under SPR you use relatively many new ground (newly established) plots and relatively few remeasured plots. The numerous new ground plots are the basis for forest area and timber volume estimates but provide no growth data since they were put in during the current survey. Remeasured plots contribute to the area and volume estimates and are the primary source for growth and removals estimates. Because remeasured plots are outnumbered by a wide margin (2,502 forested new ground plots versus 698 remeasured 1/5-acre plots), the remeasured plot estimates are less reliable and cannot be published in as much detail as estimates based primarily on new ground plots.

Over the last several decades, forest surveys have shown a timber surplus not only in New York but also in many eastern states. The luxury of a timber surplus allows us to ask questions like "Where is the resource now headed?" To answer these questions, we need growth and removals data. We now recognize the need for this data and are taking a number of steps to improve the reliability of our growth data. Research is being conducted on methods to derive growth data from another type of remeasured plot—the 10-point prism plot. And starting in Maine, the next state after New York to be surveyed, we established many more plots suited for remeasurement for growth and removals. Unfortunately, this will not help New York during the next survey. Our best hope for improving growth data for the next survey is likely to involve the technique using 10-point remeasured plots.

Timber Products Output

Data on the output of timber products in New York come from a variety of sources. The most significant source was a survey of the primary timber industry in 1979 (Nevel et al. 1982). Based on data from that survey and from surveys conducted of New York logging operations[2] and residential fuelwood consumers (NYS 1981), four tables were developed to show timber products output. These tables are numbered 35 to 38 and may be found in "Forest Statistics for New York, 1980" (Considine and Frieswyk 1982). You need a copy of the statistical report to follow this section. Comparisons with 1967 data are based on Tables 23 to 27 in Ferguson and Mayer (1970).

Only in this section will I refer to specific products output tables (35 to 38) in the statistical report to help relieve the confusion surrounding their use and value.

Because they are developed from several sources, some confusion exists about the timber products output tables. A brief explanation of their function may be beneficial. Table 35 presents the timber products output for each type of product by the two major fiber sources—roundwood and manufacturing residues. Because roundwood is a broad category that includes growing stock, Table 36 breaks down the timber products output from just roundwood by type of product (as in Table 35) and type of roundwood. The table total for Table 36 (417,894 thousand cubic feet) is a column total in Table 35.

Most of the forest inventory process is concerned with growing stock. Table 37 adds the growing-stock information on products to estimates of other removals from growing stock (and sawtimber). These other removals, the bottom three categories in Table 37, are used to round out our picture of total growing-stock removals *for the year* that the industry survey was conducted. The total growing-stock removal shown in Table 37 will differ from the average annual removals figure in other tables because Table 37 shows data for a specific year.

As you progress from Table 35 to 37, you are continually focusing on a narrower segment of the timber products output and its sources. Table 38 is useful in tracking the efficiency of resource use and the level of primary processing production. It shows how much residue is available at several categories of primary processing facilities.

Starting with the broadest picture, Table 35 reveals that the total removal of timber products from all sources came to about 455 million cubic feet in 1979. This was more than a 200 percent increase from the 1967 level of 150 million cubic feet. As shown later, a dramatic increase in fuelwood consumption was largely responsible for this gain.

The 1979 and 1967 figures used in this section are different from the removals figures mentioned in the growth and removals section because the figures used here are *not* average annual figures. The figures here are for a specific year and help determine whether current removals are above or below the average for the period between surveys. They also show the products that the removals were made into, which is something the average annual removals do not show.

About 92 percent of the 1979 production came from roundwood sources that include tree tops and whole-tree chips. The remaining 8 percent came from manufacturing residues that are mostly sawmill waste wood.

The use of manufacturing residues for products increased markedly between 1967 and 1979, from 17 to 37 million cubic feet. Paper companies and fuelwood burners have recognized the value of clean, heretofore economical chips produced from sawmill slabbings and edgings. Demand for this fiber material is high as shown by the following. While sawlog production increased from 56 million cubic feet in 1967 to 92 million cubic feet in 1979 (a 64 percent increase), the volume of unused sawmill residue dropped from 7.7 to 2.7 million cubic feet (a 65 percent decline). Increased utilization of sawmill waste is beneficial from several aspects. For example, less standing timber has to be cut and this extends our timber supply.

Although the increased use of residues accounts for some of the increased timber output, the increased use of roundwood accounts for a far greater share. Roundwood consumption increased by 285 million cubic feet versus 20 million cubic feet for the residues.

Table 36 shows timber products output from the various types of roundwood. The bole of growing-stock trees was the largest roundwood source. It accounted for 41 percent of the roundwood production and 37 percent of total production. Remember, roundwood *and* manufacturing residues equal total production. In descending order, salvable dead trees (29 percent), other sources (24 percent), and cull trees (6 percent) account for the remaining roundwood production. The sizable proportion attributable to salvable dead trees is due to the apparent fuelwood consumption which is more fully described later. A variety of timber products come from New York woods. For many decades, industrial products like lumber, pulp, veneer, posts, poles, and pilings exceeded the production of fuelwood. Apparently, this trend dramatically reversed itself with the energy crisis in the 1970's. Table 35 shows that fuelwood production in 1979 accounted for 63 percent of New York's total product output. In descending order, the industrial products, which account for the remaining share, were sawlogs (20 percent), pulpwood (16 percent), and miscellaneous products (1 percent). The majority of the fuelwood is reported to have come from salvable dead trees (NYS 1981).

[2]Wharton, E.; Birch, T. Changing patterns of timber use: the situation in New York. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; (in preparation).

Readers may remember that Figure 25 showed several types of removals that ranked ahead of fuelwood. Figure 25 was solely for removals from growing stock and is based on data from Table 37. Since most of the fuelwood harvest comes from dead trees, it seems that the sizable fuelwood harvest is not having a significant impact on the growing stock.

Less clear is how long the deadwood resource can support such harvesting levels. Naturally, once this resource is exhausted, other sources such as growing stock would be tapped. Many birds and mammals would be negatively affected by the elimination or severe reduction of the deadwood resource which they use for nesting and feeding.

No estimate of the size of the deadwood resource is available, but Table 33 shows average annual mortality to be 152 million cubic feet. The fuelwood harvest from salvable dead trees in Table 36 is estimated to be 119 million cubic feet. If I assume that some dying timber is simply unavailable for whatever reason, it would seem that fuelwood harvesters are now just about harvesting the amount that dies each year. This is a difficult hypothesis to accept.

If it is true that most of the trees currently dying are being harvested, then the next forest survey of New York should show a sharp decline in the number of standing snags, since few new ones will replace those that fall. The implications for wildlife will be severe if this is true.

I have been cautious about using the fuelwood data. To show why, an explanation of the fuelwood data is required. The fuelwood data are a combination of the timber industry survey (industrial consumption) and a phone sample conducted by the New York State Department of Environmental Conservation (residential consumption). The Forest Inventory and Analysis unit exercised no control over the phone survey. The results of this phone survey are responsible for the huge fuelwood estimate which greatly influenced the production total.

Although we included it in our production figure, we have concerns about the fuelwood data and urge caution in using it. The estimate seems to be high in relation to total industrial production.

If the fuelwood estimate is right, it exceeds industrial production by 115 million cubic feet (68 percent). This possibility does not seem likely because of New York's active and substantial forest industry. One potential problem with the survey is that respondents were asked how much wood they burned without being tested to see if they knew how much wood was in a cord. People tend to underestimate the amount of wood in a cord, so the survey results likely overestimated true consumption. Overestimation of consumption would mean the fuelwood estimate and our total removals figures for 1979 are too high.

Much more confidence can be placed in the data on the industrial products. An indepth discussion of the current timber industry is contained in a report by Nevel and others (1982). An historical perspective is presented by Canham and others (1981). A summary of the industrial timber product situation would state that sawlogs continue to be the number one industrial product, and, as expected with a maturing resource, sawlog production has increased. A similar trend exists for pulpwood, the number two product. Unlike fuelwood, virtually all the sawlogs (96 percent) and most of the pulpwood (60 percent) came from growing stock (Table 36). Importantly, even though production of sawlogs and pulpwood jumped, both growing-stock and sawtimber volumes increased. There is room yet for more timber harvesting.

Timber Outlook

For the most part, the 12 years since the previous survey of New York have been good times for the state's forests. The outlook for the next 30 years is favorable based on our projections of commercial forest-land area and growing-stock growth, removals, and inventory to the year 2010. The projections resulted in the following estimates for the coming decades:

Resource category	*1980*	*1990*	*2000*	*2010*
	Thousand acres			
Commercial forest land	15,406	16,194	15,402	14,649
	Million cubic feet			
Softwoods				
Growth	118	124	118	112
Removals	44	56	65	76
Inventory	3,867	4,799	5,157	5,349
Hardwoods				
Growth	440	463	440	418
Removals	152	215	274	350
Inventory	11,903	15,305	16,614	16,693
All species				
Growth	558	587	558	530
Removals	196	271	339	426
Inventory	15,770	20,104	21,771	22,042

Commercial forest land is projected to continue to increase for about the next decade and decline for the following two decades. The increase will be caused by the same factors that have been at work throughout the last several decades. However, the increases will be at a slower rate because there is not as much marginal farmland as before. The increases will not occur in all counties. As happened between 1968 and 1980, the counties around cities should experience further forest-land decreases.

After another decade of increases, the New York forest-land base will start to slide downward because more forest land will be cleared for housing and business developments. The decline is not expected to be as sharp as it was in the 1800's, but it will be noticeable because it is likely to be more rapid in suburban counties around metropolitan areas. Because of where the losses will occur, they will impact outdoor recreation opportunities, esthetics, and suburban wildlife populations more than the timber supply, which tends to come from more rural counties.

The assumptions used to develop the volume projections were considered realistic but conservative. Growth per acre of commercial forest land is not assumed to increase even though New York's forests are growing at 36 cubic feet per acre per year but are capable of growing almost twice as much. Removals are assumed to increase between 3 and 4 percent per year, which is slightly below the rate between 1968 and 1980. Removals are not expected to increase at the rapid 1968-80 pace because fuelwood use is expected to level off. Fuelwood accounted for much of the increase in the removals rate between surveys.

Under these conservative assumptions of flat growth per acre and increasing removals, timber inventories continue to build. Even in 30 years, removals will not equal growth. Any improvement in growth or slowing of removal increases will only build timber inventories faster.

Many factors can change during the course of three decades that could invalidate the projections. Perhaps then the most realistic analysis should be to see what the projections show for only the coming decade. The basic assumptions are less likely to radically change during this shorter time frame.

If the projections are valid, New York will have about 25 percent more growing-stock volume in 1990 than in 1980. Average volume per acre estimates will increase from 1,024 to 1,241 cubic feet. The growth/removals ratio will be narrowing but still will be more than 2 to 1. These indicators are all positive.

The species mix of New York forests is likely to continue to change during the decade. Hardwood volume is increasing at a faster rate than softwood volume so that the past trend of hardwoods assuming a larger share of the volume total will continue. Elm is one species that is almost certain to record another volume drop; and red pine, select white oaks, and basswood are vulnerable to volume dips because of low-volume increases throughout the last decade.

The majority of species, however, should continue to post volume increases. Red maple's increase is likely to propel it to the number one spot on the growing-stock volume list. Sugar maple and some other northern hardwoods such as aspen, cherry, and ash should increase faster than average; but beech, because of disease problems, and yellow birch, because of commercial demand, should have below average increases.

The oaks, especially the quality species such as red and white, are likely to show lower than average increases. The reasons for the underperformance of oaks are the boom market for quality oak and the gypsy moth. Oaks then are likely to have a smaller share of the volume total in 1990 than they currently do.

We probably will see a continuation of the trend of farmer-owned forest lands being sold to private individuals. Parcelization of the forest land is likely to continue, especially in developing areas. Awareness of the forest as a resource that supplies us with essential commodities will increase, as will the pressures to increase the supply of these commodities. This means that landowners will see more public recreational pressure on their lands and more interest from loggers trying to purchase their timber.

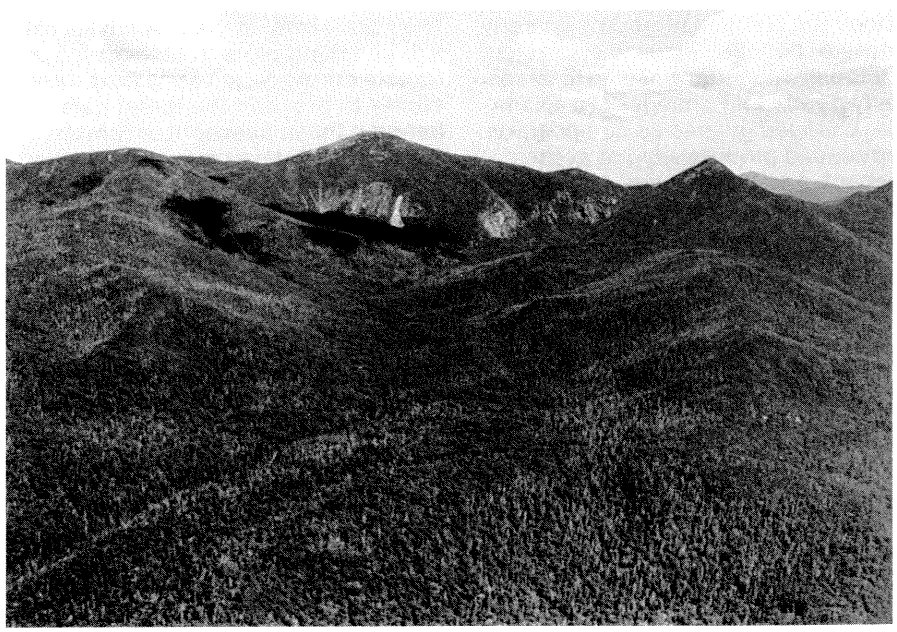
New York's closeness to many major markets and its adequate wood supply point to a promising future for existing forest industries unless state tax, labor, and land use constraints become too severe. Under favorable conditions, there also seems to be room for increasing the forest-industry base, either by expanding the capacity of current facilities or opening new mills. Opportunities are present to utilize high-quality wood, but there are even more opportunities to utilize low-quality wood. This is because the supply of high-quality wood is much tighter than the supply of low-quality wood. New York's diverse forests still contain underutilized tree species.

Recent technological advances in low-quality wood processing and price increases for competing products have put many products made from low-quality wood in a favorable position. Two particularly successful examples are pallets and reconstituted panel products. Beside generating jobs and tax dollars, mills using low-quality fiber would provide sorely needed markets for landowners wishing to practice cost-effective forest management.

One potential threat to some forests and waters in New York and the Northeast is acid deposition. Acid deposition includes acidic rain, snow, fog, aerosols, and cloud moisture. Acid deposition has been hypothesized to be the cause for the disappearance of fish and other aquatic life from a number of lakes and the decline of red spruce in some high-elevation forests. In New York, these environmental problems have been mostly observed in the Adirondack Mountain region.

The effects of acid deposition on New York waters are beyond the scope of this report, so the rest of this discussion will focus on the imperfectly understood impacts of acid deposition on forest land. Research designed to assess and explain the effects of acid deposition on forest land mostly has been carried out in high-elevation, boreal forests of spruce and fir. These forests are thought to be among the most sensitive to acid deposition.

In New York, high-elevation, boreal forests typically occur in the Adirondacks and Catskills, on state-owned, preserved lands of the parks. Because the Forest Inventory and Analysis unit did not take plots on preserved lands, we have no trend data for these types of forests and will rely, therefore, on data summarized by other researchers (Johnson and Siccama 1983).



The High Peaks of the Adirondacks. Mount Marcy is in the center and is the state's tallest mountain. Dead spruce trees are common in the photo. The mortality is probably linked to acid precipitation.

Courtesy: Mike Storey, Adirondack Park Agency

What their data show is a decline of mostly red spruce in the high-elevation forests over the last 15 to 20 years. Red spruce declined in basal area and density and across all diameter classes. On some plots, tree species such as balsam fir and paper birch also declined, but on other plots these two species increased. So the concern is mostly with red spruce. Because spruce was a significant component of these forests, the overall health of these forests has declined. For the sake of comparison, spruce volume (all species) increased by 20 percent on Forest Inventory and Analysis plots taken at lower elevations.

Several questions arise from the observations of these researchers concerning spruce decline. First, "Does the dieback represent an early phase of pollution-induced ecosystem destabilization that will lead to essentially permanent changes (for example, changes in species composition or reduced productivity), or is the dieback a relatively short-term periodic phenomenon that occurs naturally in ecosystems that are stable when viewed over longer time spans?" (Johnson and Siccama 1983). This is an important question because diebacks of trees at high elevations have been noted before, as long ago as the 1800's. Second, "If acid deposition is negatively impacting high-elevation forests, what other forests are susceptible?"

The answers to these questions do not exist at the present time, but insights have been gained from the research. Briefly, it seems that the mortality probably is related to an environmental stress or combination of stresses. Acid deposition may be a contributing stress factor, but several noted researchers have concluded that acid deposition *alone* is not causing the dieback. As mentioned, diebacks have been seen previously. Drought is thought to be a significant factor, as are secondary agents such as diseases (Johnson and Siccama 1983).

These researchers also agree that adequate data are not available to make conclusions about ecosystem destabilization. They agree that more research is needed, and indeed, acid-deposition research is increasing in the Northeast. The USDA Forest Service, Northeastern Forest Experiment Station, is directing several phases of acid-deposition research. The Forest Inventory and Analysis unit will be taking plots in high-elevation forests during New York's next forest survey to broaden the forest data base on these susceptible forests. Existing plot data on lower elevation forests are currently available to researchers. Also, Forest Service research units in five northeastern states have research programs studying the effect of acid deposition on forest water quality, tree diseases, forest soil conditions, and forest ecosystem health.

It is obvious that New York forests are dynamic and subject to many changes. Some changes cannot be halted, but men and women have the ability to exert a significant impact on the quality of the New York forest resource. These opportunities are discussed in detail in the next section.

Forest Management Opportunities

The forests of New York are generally not the result of forest management but the result of natural forces that regenerated the land after the extensive cutting and widespread fires that occurred about a century ago. The projections we have made for the next 30 years show timber volume continuing to increase under today's minimal management levels. The state seems to be adequately endowed with water, fish, wildlife, and recreation resources and opportunities. If today's forests cannot be attributed to forest management, why should we discuss forest management opportunities?

Two major and related reasons why New York landowners should consider forest management are: (1) despite the overall positive findings of the third survey, some problems still exist in New York's woods and, (2) through forest management, individual landowners and society can increase the level of forest benefits. Forest-land management usually results in multiple benefits, that is, an increase in timber production, wildlife habitat, recreational opportunities and possibly water quantity. Here are some of the opportunities that landowners have.

Wood, whether for sawlogs, firewood, or some other product, is one of New York's foremost forest resources. Although net growth is more than twice the volume of removals, and inventories are increasing each year, there are opportunities to increase timber yields and improve timber quality for those landowners who may wish to do so.

One approach is to increase net growth by reducing cull increment and mortality (the two factors that reduce gross growth to net growth). For the period from 1967 to 1979, the annual loss due to cull increment was 77 million cubic feet, and the annual loss due to mortality was 152 million cubic feet. Management can be useful in reducing losses from the three major causes of mortality and cull increment: wildfire, disease, and insect attack.

Fire protection has been very successful in the last 50 years. The total number of forest fires and acres burned decreased, and the number of fires larger than 10 acres fell significantly. The major threat of fire is in the spring. There is a second, less severe, fire season in the fall.

Since most wildfires are caused by man, landowners can take steps to prevent such fires. One approach is through education of landowners and the people who may use their forest land. Owners should learn to recognize and eliminate hazardous conditions, both natural and manmade. Owners can clean out heavy accumulations of dead and fallen trees and remove debris along roads or in-use areas. Burning of debris such as leaves or brush should be done carefully, and only after consulting local forestry officials on fire danger conditions. Roads and trails can be constructed to open inaccessible areas and to serve as barriers to the spread of a fire. Safety strips around public-use areas, railroad rights-of-way, and public access roads are other means of preventing fire.

Not all fire is harmful to forests. Skilled application of a controlled fire can reduce hazardous accumulations of fuel, help control insects and diseases, prepare planting sites, eliminate undesirable plant species, and improve wildlife habitat. Such prescribed burning should be planned and conducted only by people trained in the use of this management tool.

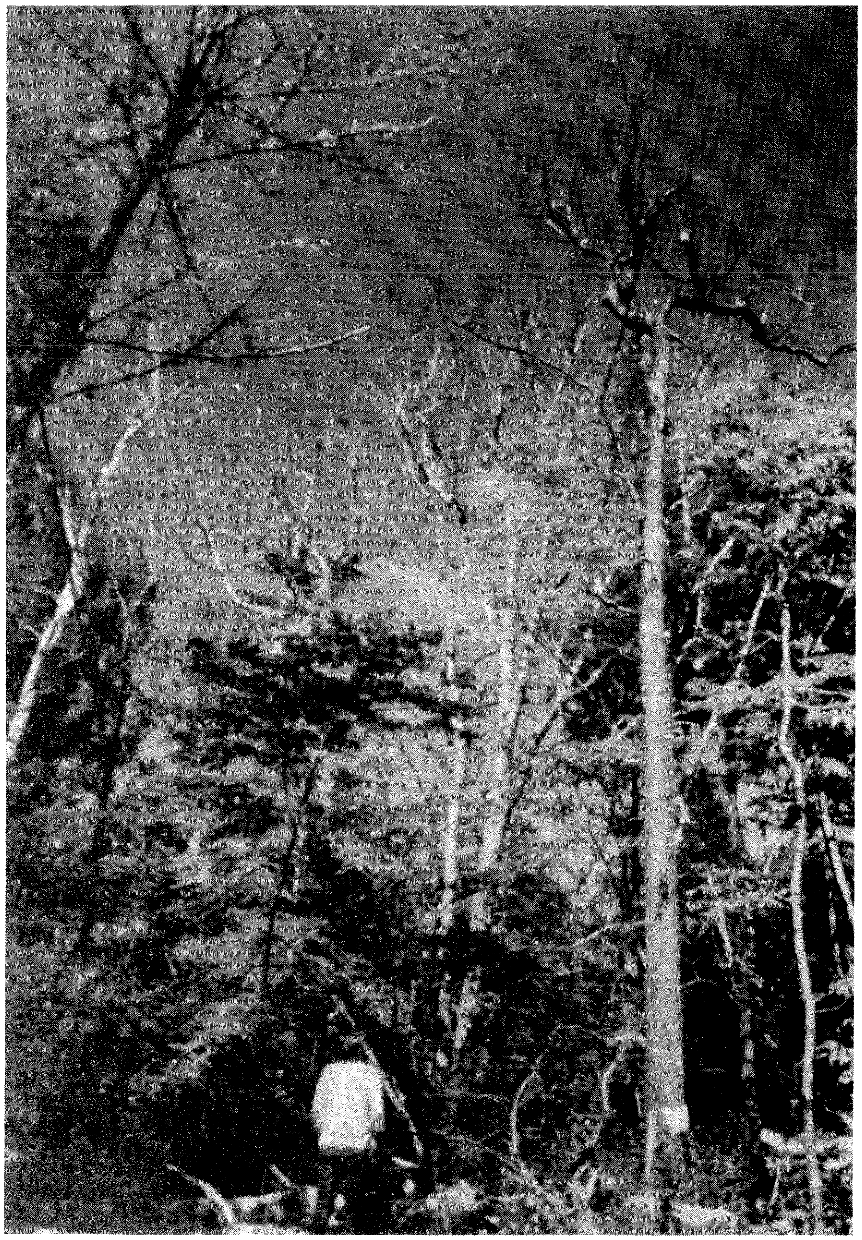
Disease of forest trees contributes much to cull increment and mortality. There are many diseases that infect hardwood species, but the major problems result from heart rots, root rots, and stem cankers. Most diseases enter a tree through an infection court such as a scar, a branch stub, or a stump. It is important, therefore, to harvest trees and haul them from the woods carefully so as not to damage remaining trees. Fire is closely related to disease in that it damages many hardwoods by burning away enough of the bark to create entrances for disease. Decay also is common in trees that originated from sprouting high on a stump.

Several management activities can reduce the impact of disease. Maintaining a healthy, vigorous, and fast-growing stand is beneficial. The faster a tree grows, the sooner open wounds will heal which shortens the time that such wounds will be susceptible to attack. Improvement cuts to eliminate diseased trees and thinnings to stimulate growth will help. Eliminating decayed trees and shifting the growth potential to sound trees will result in a higher usable yield of wood volume at the time of final harvest. In selecting a potential crop tree from a group of sprouts, choose a fast-growing stem that has a low origin (at or below ground level). When cutting trees, stumps should be kept as low as possible to minimize high-stump sprouting.

Thinning a timber stand lets the remaining trees grow faster, stimulates shrub growth on the forest floor, and usually provides wood products like firewood.

Insect pests also have created problems. Northern hardwood stands have suffered attacks from the forest tent caterpillar (late 1970's), saddled prominent (late 1960's), and cherry scallop shell moth (first seen 1969). Pine stands suffer attacks from the red pine scale and white pine weevil. But the insect receiving the greatest attention is probably the gypsy moth.

Gypsy moth was first seen in New York in 1922. Populations of the bug have fluctuated over the years, but the early and late 1970's were times of high-population levels and extensive tree defoliation. In 1980, New York had nearly 2.5 million acres of forest land defoliated (USDA Forest Service 1981).



Gypsy moth and other insects and diseases are changing the species composition of some forest stands.

Despite their lifeless appearance while defoliated, most trees do not die from a single defoliation. A study in Pennsylvania's Pocono Mountains in the early 1970's showed that cumulative mortality from gypsy moths was 13 percent over a 5-year period. During the subsequent 5-year period, growth more than made up for mortality in most stands. Some stands suffered heavy mortality, but most had more volume and value at the end of the decade than before the infestation (Gansner and Herrick 1979).

This study covered one cycle of defoliation. Because many trees were not killed, it is likely that the cycle will be repeated; so, concern exists about the long-range impact of the insect. Concern exists because the gypsy moth's preferred foods include some highly valuable species (adapted from Houston and Valentine 1977):

Most Preferred Trees

Class 1

Chestnut oak
White oak

Class 2

Black oak
Northern red oak
Scarlet oak
Scrub oak

Class 3

Adler
American basswood
Apple
Bigtooth aspen
Gray Birch
Paper birch
Post oak
Quaking Aspen

Intermediately Preferred Trees

Class 4

American beech
American chestnut
American elm
American hornbeam
Black cherry
Blackgum
Black walnut
Butternut
Common persimmon
Cucumbertree
Eastern hemlock
Eastern hophornbeam
Eastern white pine
Flowering dogwood
Hackberry
Hickory
Pitch pine
Red maple
Red pine
Sassafras
Slippery elm
Sugar maple
Virginia pine
Witch-hazel

Least Preferred Trees

Class 5

Black locust
Eastern redcedar
Red spruce
Scotch pine
White ash
Yellow-poplar

As long as oaks account for about 25 percent of a forest stand's composition, that stand probably will be susceptible to defoliation. New York still has many stands of relatively pure oak, particularly in the southeastern part of the state, so future defoliation cycles are expected. These defoliations will continue to be a great nuisance because southeastern New York is a high-population area, and few people enjoy having thousands of caterpillars crawl over their property or denuding favored forested recreational settings.

Landowners have several options to reduce the threat of defoliation. They can have their land sprayed with chemical or biological agents during the proper time of the year, or they can reduce the number of preferred food trees in their woodlot. Spraying can buy time for the landowner to allow timber harvest of valuable trees, but it is not a long-term solution because it is expensive and it keeps susceptible trees alive. Timber harvesting to alter the forest type is a better long-run solution. Nature may alter the forest type if the landowners do not. Landowners should not eliminate all oak and aspen from their woodlot as these trees are valuable for wildlife and several oak species yield very valuable timber. Foresters from private consulting firms, forest industry, and the New York State Department of Environmental Conservation can help landowners choose what is best for their land.

Sometimes there is little that the landowner can do to reduce tree mortality on his or her forest land. If the area should sustain heavy mortality and there are markets available, salvaging the dead material as quickly as possible will allow at least something to be recouped from the loss. There may be difficulties where access to dead material is inadequate or where the dead material is scattered throughout the stand. Where possible, salvage is an important timber management practice.

Besides reducing the impact of insects, diseases, and wildfires, landowners can further improve the vigor of their woods by concentrating growth on select trees. This is done by adjusting the stocking of the timber stand, which involves removing some cull and low-value trees. Many of these trees are suitable for fuelwood. Some cull trees should be kept because they are home to many forms of wildlife. The stocking level for maximum growth is fairly broad, but for high-quality sawtimber, is usually in the category that Forest Inventory and Analysis calls medium stocking (60 to 99 percent).

If trees of any size or quality are considered, very little (6 percent) of New York's forest land is poorly stocked (Fig. 26). A much greater portion (33 percent) is overstocked—where timber growth may be slowed because of too many trees.

For those concerned with timber production, stocking analysis based solely on growing-stock trees is more meaningful. Such an analysis shows that the woods do not appear to be in as good a shape as when all trees were considered. Using only growing-stock trees in the stocking calculation shows that nearly one-fifth of the forests (2.7 million acres) are poorly stocked. Cull-tree removal on these acres would improve the chance of developing acceptable stocking of growing-stock trees.

At the other end of the spectrum are those stands with too many growing-stock trees. About 8 percent of the forest land (1.3 million acres) is overstocked with growing-stock trees. Here cull-tree removal would be useful, but more important would be a thinning to reduce the number of growing-stock stems so bigger trees could be grown faster. Fully stocked stands cover more than one-third of the forest land (5.3 million acres). Many of these stands could probably be thinned to improve the quality of their growth, but it is not as urgent as for the overstocked stands.

The largest amount of land (39 percent) is covered with medium-stocked stands. These are the ones with the proper stocking for high-quality sawtimber growth. Other than thinning to focus growth on particular trees, these stands could be left alone.

To gain a general picture of the timber management practices needed in New York forests, our field crews placed each forested new ground plot they measured into one of four recommended treatment classes. They also evaluated past management practices on the plot. The following table shows that 41 percent of New York's commercial forest land is in good enough shape to be left alone as far as timber growth is concerned. This just about equals the above mentioned proportion of stands with medium stocking.

The fact that our crews gave these acres a recommendation of no treatment necessary for timber does not mean that landowners could not pursue management activities for other forest benefits. Recommendations for improving nontimber benefits were not made by our field crews.

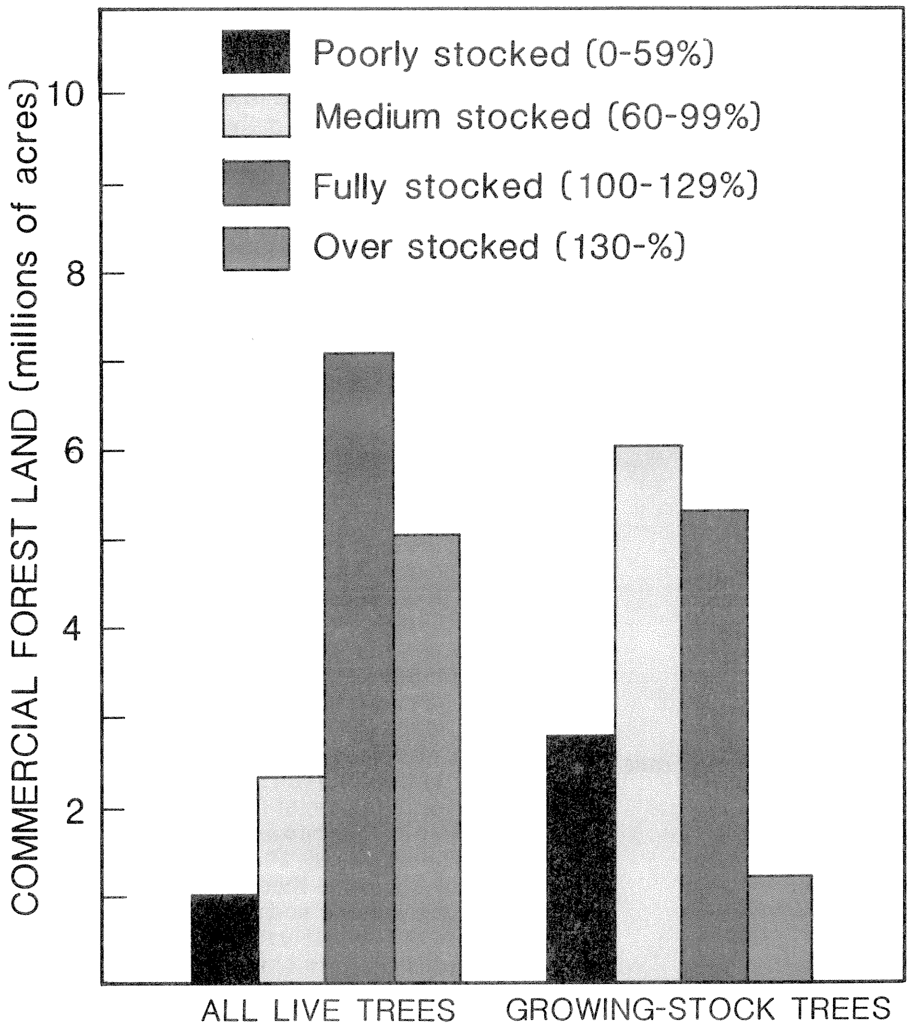


Figure 26.—Comparison of stocking based on all live trees versus growing-stock trees.

Past treatment	Recommended treatment				
	Harvest mature stand	Timber stand improvement	Stand conversion	Stand on schedule	Total
	Thousand acres				
Clearcut	74.9	352.2	26.2	432.7	886.0
Selective cut	653.5	1,247.0	163.4	1,470.1	3,534.0
No evidence of harvest in 25 years	1,601.9	3,234.0	1,608.4	4,474.1	10,918.4
Reserved from cutting by owner	19.3	18.3	18.0	11.8	67.4
Total	2,349.6	4,851.5	1,816.0	6,388.7	15,405.8

Surprisingly perhaps, most hardwood stands seem to need less cultural treatment than softwood stands. Over half of the area in oak/hickory, aspen/birch, and elm/oak/red maple stands can be left alone. Only 30 percent of white and red pine and hemlock could receive no treatment. We will see shortly what treatments they need.

Nearly 5 million acres could use some form of timber stand improvement (TSI). Cull tree removal and thinning to get more acres into medium stocking were the most frequently recommended treatments. Softwood types such as white and red pine and hemlock (37 percent) and spruce/fir (38 percent) have the highest proportion of stands needing TSI. Most of these would need thinning as opposed to cull tree removal.

More than 2.3 million acres were felt to be mature enough to be recommended for harvest. As with the TSI recommendation, white and red pine and hemlock had a higher land-area proportion in this recommended class (24 percent) than that of oak/hickory (17 percent) or northern hardwoods (16 percent). These proportions should not be a surprise because we have already seen that the white and red pine and hemlock type is quite mature. It had the highest proportion of its area in stands averaging more than 6,000 board feet per acre (27 percent) and had two-thirds of its area in sawtimber stands.

Finally, the first data entry in the table requires an explanation because it is not readily apparent how a stand that has been clearcut can be ready for harvest. Actually several plots had been severely highgraded with only snags and whips left. The crews felt that these were "commercial" clearcuts and that the best treatment was to harvest or knock down what was left and start over.

This discussion of recommended treatment opportunities is no substitute for an on-the-ground inspection by a professional forester. Private consultants, the Division of Lands and Forests, USDA Forest Service, USDA Soil Conservation Service, and forest industries are some of the most important people and agencies that a landowner can turn to for assistance on all aspects of forest management. Our field crews provided this information to portray broad management opportunities for timber production only at this extensive level.

Timber-growing guides based on research by the USDA Forest Service have been published for northern hardwoods (Leak et al. 1969), paper birch (Safford 1983), oak/hickory (Roach and Gingrich 1968), white pine (Lancaster and Leak 1978), spruce/fir (Frank and Bjorkbom 1973), and Allegheny hardwoods (Roach 1977, Marquis and Bjorkbom 1982).

Another important way in which a landowner can increase wood production is to strive for greater utilization when trees are cut. This means using the logging residues, such as branches and other wood above the merchantable bole, as much as possible. Material that is unacceptable for pulpwood may be useful for firewood, and if not useful for firewood, perhaps it can be chipped for pulp, fuel, mulch, bedding, or any of the many uses that cellulose has.

However, it is not always economical to use residues because of high extraction and transportation costs. There is nothing inherently wrong with leaving some or all residues onsite because these residues have several positive values. Residues supply the soil with nutrients and organic matter, act as physical barriers to erosion, and ameliorate soil temperatures (Staebler 1979). Nonetheless, the recent trend has been a growing appreciation by loggers and wood processors of this previously ignored resource, and utilization rates have been increasing.

Management practices to enhance wildlife populations are often compatible with those needed for timber production, but modifications of the timber harvesting plan may be necessary. Forest management for some game and nongame species may be desirable because a maturing forest means changing habitats for animals and birds (Keller 1982). Because each species of wildlife has its particular needs for food and shelter, a landowner often has to consider what kind of wildlife habitat is on surrounding land when planning wildlife habitat work. A number of publications are available detailing the habitat requirements of various species and ways to achieve better wildlife habitat (Decker et al. 1983, Kelley et al. 1981, Hassinger et al. 1979, Hassinger et al. 1981).

Esthetic enjoyment of forest land is the most important single benefit that private forest-land owners derived in the last 5 years and the one that they expect will be the most important over the next 5 years (Birch 1983). Natural stand development, particularly as the trees become relatively large in diameter and height, can produce stands that are scenic and attractive. A variety of management practices can be applied to forest land to enhance the esthetic enjoyment derived from viewing wooded environments. In fact, managed stands generally have been found to be more attractive than unmanaged stands.

The aspect of esthetics that forest management can control most easily is the structure of forest stands. Three-dimensional spaces can be shaped by varying stand density and canopy height. A variety of forest spaces are possible, ranging from open clearings to dense thickets. To produce forests containing an attractive mixture of stands with a variety of sizes, ages, height, and species composition commonly requires some form of even-age management. Timber production and wildlife habitat management are compatible with this approach.

Openings are very important in a mature forest landscape. The option to determine the number, size, shape, orientation, spacing, and timing of openings provides the landowner or manager with great flexibility in enhancing the esthetic characteristics of the landscape. Generally, the shape of an opening is more pleasing if it is free form and not geometrical. The edges should be feathered (partial cutting of trees near edge to create a transition in heights between areas) so that the openings will blend well with the surrounding area. It is helpful to retain some residual trees in an opening, either in groups or scattered across the areas. In some instances, it may be important to reduce the visibility of openings (especially during the first year or two until they revegetate satisfactorily) through the use of screening or by taking advantage of the natural topography. In other instances, openings can be used to create or enhance scenic vistas of meadows, lakes, streams, rock formations, or distant views. A guide on how to develop trails was published recently (Mapes 1982).

Another type of landscape that can be created by the selection system of management is an unbroken forest with a high percentage of large trees (18 to 30 inches in dbh) in mixture with smaller trees. Large stems are attractive to many people, but unless they are already present in the stand it will take many decades for them to develop. If timber production also is a goal, the normal age used to select trees for cutting will need to be increased so as to grow trees to larger size before individual stems can be harvested. A minimum of 20 years extension normally is required to achieve a significant increase in the size of hardwoods.

Cutting and logging are effective tools in forest management, but they also can result in temporarily unsightly conditions. Logging and skid roads should be carefully planned, constructed, maintained, and even-

Many people believe that cutting trees accelerates erosion of forest soil. This effect, however, usually is slight. Erosion on ill-managed logging roads far exceeds soil losses resulting from other uses of forest land.

tually revegetated unless permanent access is desired. Logging equipment should be compatible with soil and site conditions. Also, several cutting practices to reduce the negative visual impact of logging residues should be employed.

New York's forestry community, represented by the Empire State Forest Products Association, the Department of Environmental Conservation, and The New York Section of the Society of American Foresters, has developed a set of timber harvesting guidelines designed to promote environmentally sound timber cutting practices. Copies of the guidelines and more information on proper harvesting techniques are available from the Empire State Forest Products Association in Schenectady and Department of Environmental Conservation offices around the state.

In conclusion, as society continues to make increased demands on New York's forests, there are many opportunities to manage our renewable forest resources to meet these needs. The Empire State's forests are resilient and dynamic. We have as much chance of stopping our forests from changing as we do of stopping the ocean's tides (Campbell 1981). With proper management though, we can help our forests to continue to provide the plentiful and desirable benefits that our society has become accustomed to.

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Appendix

Definition of Terms

Accretion. The estimated net growth of growing-stock trees that were measured during the previous inventory, divided by the length of the period between surveys. It includes the growth on trees that were cut during the period, plus those trees that died and were used.

Average annual net growth. The change, resulting from natural causes, in growing-stock or sawtimber volume of sound wood in growing-stock or sawtimber trees during the period between surveys, divided by the length of the period. Components of average annual net growth include the increment in net volume of trees that are present at the beginning of the period and that survive to the end (accretion), plus average annual ingrowth, minus average annual mortality, and minus the net volume of trees that became rough or rotten during the period (cull increment).

Average annual removals. The net growing-stock or sawtimber volume of trees harvested or killed in logging, cultural operations—such as timber stand improvement—or land clearing, and also the net growing-stock or sawtimber volume of trees neither harvested nor killed but growing on land which was reclassified from commercial forest land to noncommercial forest land during the period between surveys. This volume is divided by the length of the period.

Board foot. A unit of lumber measurement 1 foot long, 1 foot wide, and 1 inch thick, or its equivalent.

Coarse residues. Manufacturing residues suitable for chipping, such as slabs, edgings, and veneer cores.

Commercial forest land. Forest land producing or capable of producing crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization.

Commercial species. Tree species presently or prospectively suitable for industrial wood products. Excludes species of typically small size, poor form, or inferior quality, such as hawthorn and sumac.

Cull increment. The net volume of growing-stock trees on the previous inventory that became rough or rotten trees in the current inventory, divided by the length of the period between surveys.

Diameter at breast height (dbh). The diameter outside bark of a standing tree measured at 4½ feet above the ground.

Farmer-owned lands. Lands owned by farm operators, whether part of the farmstead or not. Excludes land leased by farm operators from nonfarm owners.

Federal lands. Lands (other than National Forests) administered by Federal agencies.

Fine residues. Manufacturing residues not suitable for chipping, such as sawdust and shavings.

Forest industry lands. Lands owned by companies or individuals operating primary wood-using plants.

Forest land. Land at least 10 percent stocked with trees of any size or that formerly had such tree cover and is not currently developed for nonforest use. The minimum area for classification of forest land is 1 acre.

Forest type. A classification of forest land based on the species forming a plurality of live-tree stocking. The many forest types in New York were combined into the following major forest-type groups:

a. *White/red pine*—forests in which white pine, red pine, or hemlock, singly or in combination, comprise a plurality of the stocking; in New York common associates include red maple, oak, sugar maple, and aspen.

b. *Spruce/fir*—forests in which red, white, black or Norway spruces, balsam fir, northern white-cedar, tamarack, or planted larch, singly or in combination, comprise a plurality of the stocking; in New York common associates include white pine, red maple, yellow birch, and aspens.

c. *Hard pine*—forests in which eastern redcedar, or pitch pine, singly or in combination, comprise a plurality of the stocking; in New York common associates include white pine, paper birch, sugar maple, and basswood.

d. *Oak/pine*—forests in which hardwoods (usually hickory or oak) comprise a plurality of the stocking but where white pine or eastern redcedar comprise 25 to 50 percent of the stocking.

e. *Oak/hickory*—forests in which upland oaks, hickory, yellow-poplar, black locust, sweetgum, or red maple (when associated with central hardwoods), singly or in combination, comprise a plurality of the stocking and in which white or hard pines, or eastern redcedar comprise less than 25 percent of the stocking; in New York common associates include white ash, sugar maple and hemlock.

f. *Elm/ash/red maple*—forests in which elm, willow, cottonwood, or red maple (when growing on wet sites), singly or in combination, comprise a plurality of the stocking; in New York common associates include white ash, sugar maple, aspens, and oaks.

g. *Northern hardwoods*—forests in which sugar maple, beech, yellow birch, black cherry, or red maple (when associated with northern hardwoods), singly or in combination, comprise a plurality of the stocking; in New York common associates include white ash, hemlock, basswood, aspens, and red oak.

h. *Aspen/birch*—forests in which aspen and paper or gray birch, alone or in combination, comprise a plurality of the stocking; in New York common associates include red maple, white pine, red oaks and white ash.

Growing-stock trees. Live trees of commercial species classified as sawtimber, poletimber, saplings, and seedlings; that is, all live trees of commercial species except rough and rotten trees.

Growing-stock volume. Net volume, in cubic feet of growing-stock trees 5.0 inches dbh and larger, from a 1-foot stump 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. Net volume equals gross volume, less deduction for cull.

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

Industrial wood. All roundwood products except fuelwood.

Ingrowth. The estimated net volume of growing-stock trees that became 5.0 inches dbh or larger during the period between inventories, divided by the length of the period between surveys.

International ¼-inch rule. A log rule, or formula, for estimating the board-foot volume of logs. The mathematical formula is:

$$(0.22D^2 - 0.71D)(0.904762)$$

for 4-foot sections, where D = diameter inside bark at the small end of the section. This rule is used as the USDA Forest Service Standard Log rule in the Eastern United States.

Land area. (a) Bureau of Census: The area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river flood plains; streams, sloughs, estuaries, and canals less than 1/8 statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area. (b) Forest Inventory and Analysis: same as (a) except that the minimum width of streams, etc., is 120 feet, and the minimum size of lakes, etc., is 1 acre.

Logging residues. The unused portions of growing-stock trees harvested or killed in the process of logging.

Manufacturing plant residues. Wood materials that are generated when converting round timber (roundwood) into wood products. This includes slabs, edgings, trimmings, bark, miscuts, sawdust, shavings, veneer cores and clippings, and pulp screening. If these residues are used, they are referred to as plant byproducts.

Miscellaneous private lands. Privately owned lands other than forest industry and farmer-owned lands.

Mortality. The estimated net volume of growing-stock trees on the previous inventory that died from natural causes before the current inventory, divided by the length of the period between surveys.

National Forest lands. Federal lands legally designated as National Forests or purchase units and other lands administered as part of the National Forest System by the USDA Forest Service.

Noncommercial forest land. Productive-reserved, urban, and unproductive forest land.

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

Nonforest land. Land that has never supported forests, or land formerly forested but now in nonforest use such as cropland, pasture, residential areas, and highways.

Nonstocked areas. Commercial forest land that is stocked with less than 10 percent of minimum full stocking with growing-stock trees.

Plant byproducts. Wood products, such as pulp chips, recycled from manufacturing plant residues.

Poletimber stands. Stands stocked with at least 10 percent of minimum full stocking with growing-stock trees with half or more of such stocking in poletimber or sawtimber trees or both, and in which the stocking of poletimber exceeds that of sawtimber.

Poletimber trees. Live trees of commercial species meeting regional specifications of soundness and form and at least 5.0 inches in dbh, but smaller than sawtimber trees.

Productive-reserved forest land. Forest land sufficiently productive to qualify as commercial forest land, but withdrawn from timber utilization through statute, administrative designation, or exclusive use for Christmas tree production.

Primary wood manufacturing plant. A plant that converts round timber into wood products such as woodpulp, lumber, veneer, cooperage, and dimension products.

Pulpwood. Roundwood converted into 4- or 5-foot lengths or chips, and chipped plant byproducts that are prepared for manufacture into woodpulp.

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

Rough trees. (a) The same as rotten trees, except that rough trees do not meet regional specifications for freedom from defect primarily because of roughness or poor form, and (b) all live trees of noncommercial species.

Roundwood products. Logs, bolts, total tree chips, or other round timber generated by harvesting trees for industrial or consumer uses.

Saplings. Live trees 1.0 through 4.9 inches dbh.

Sapling-seedling stands. Stands stocked with at least 10 percent of minimum full stocking with growing-stock trees with half or more of such stocking in saplings or seedlings or both.

Sawlog. A log meeting regional standards of diameter, length, and defect, including a minimum 8-foot length and a minimum diameter inside bark of 6 inches for softwoods and 8 inches for hardwoods.

Sawlog portion. That part of the bole of a sawtimber tree between the stump and the sawlog top; that is, the merchantable height.

Sawlog top. The point on the bole of a sawtimber tree above which a sawlog cannot be produced. The minimum sawlog top is 7.0 inches diameter outside bark (dob) for softwoods and 9.0 inches dob for hardwoods.

Sawtimber stands. Stands stocked with at least 10 percent of minimum full stocking with growing-stock trees with half or more of such stocking in poletimber or sawtimber trees or both, and in which the stocking of sawtimber is at least equal to that of poletimber.

Sawtimber trees. Live trees of commercial species at least 9.0 inches dbh for softwoods or 11.0 inches for hardwoods containing at least one 12-foot sawlog or two noncontiguous 8-foot sawlogs, and meeting regional specifications for freedom from defect.

Sawtimber volume. Net volume in board feet, International ¼-inch rule, of sawlogs in sawtimber trees. Net volume equals gross volume less deductions for rot, sweep, and other defects that affect use for lumber.

Seedlings. Live trees less than 1.0 inch dbh that are expected to survive.

Site class. A classification of forest land in terms of inherent capacity to grow crops of industrial wood. Classifications are based on the mean annual growth of growing-stock trees attainable in fully stocked natural stands at culmination of mean annual increment.

Softwoods. Coniferous trees, usually evergreen and having needles or scalelike leaves.

Stand. A group of forest trees growing on forest land.

Stand-size class. A classification of forest land based on the size class (that is, seedlings, saplings, poletimber, or sawtimber) of growing-stock trees in the area.

Standard cord. A unit of measure for stacked bolts of wood, encompassing 128 cubic feet of wood, bark, and air space. Fuelwood cord estimates can be derived from cubic-foot estimates of growing stock by applying an average factor of 80 cubic feet of solid wood per cord. For pulpwood, a conversion of 85 cubic feet of solid wood per cord is used because of the more uniform character of pulpwood.

State lands. Lands owned by the State or leased to the State for 50 years or more.

Stocking. The degree of occupancy of land by trees, measured by basal area and/or number of trees in a stand compared to the basal area and/or number of trees required to fully use the growth potential of the land (or the stocking standard). In the Eastern United States this standard is 75 square feet of basal area per acre for trees 5.0 inches dbh and larger, or its equivalent in numbers of trees per acre for seedlings and saplings.

Two categories of stocking are used:

All live trees—these are used to classify forest land and forest types.

Growing-stock trees—these are used to classify stand-size classes.

Timber products. Manufacturing plant byproducts and roundwood (round timber) products harvested from growing-stock trees on commercial forest land; from other sources, such as cull trees, salvable dead trees, limbs, tops and saplings; and from trees on noncommercial forest and nonforest lands.

Timber removals. The growing-stock or sawtimber volumes of trees removed from the inventory for roundwood products, plus logging residues, volume destroyed during land clearing, and volume of standing trees growing on land that was reclassified from commercial forest land to noncommercial forest land.

Trees. Woody plants that have well-developed stems and are usually more than 12 feet in height at maturity.

Unproductive forest land. Forest land that is incapable of producing 20 cubic feet per acre per year of industrial wood under natural conditions, because of adverse site conditions.

Unproductive reserved forest land. Forest land that is classed as unproductive, is publicly owned, and is withdrawn from timber harvest.

Unused manufacturing residues. Plant residues that are dumped or destroyed and not recovered for plant byproducts.

Upper-stem portion. That part of the main stem or fork of a sawtimber tree above the sawlog top to a diameter of 4.0 inches outside bark or to the point where the main stem or fork breaks into limbs.

Urban forest land. Noncommercial forest land within urban areas that is completely surrounded by urban development (not parks), whether commercial, industrial, or residential.

Planning and Designing the Survey

New York's third forest survey was planned and designed to satisfy national, regional, and state information needs in an efficient manner. We used the 1953 and 1968 inventories while capitalizing on the new survey. Stratified double sampling with partial replacement (SPR) was the sampling design used to accomplish this task (Bickford, Mayer, Ware 1963). By remeasuring a subsample of the previous surveys, we were able to update the 1953 survey and the 1968 survey area and volume estimates to 1980. Taking these updated inventory estimates and combining them with estimates based only on data from new plots, we developed statistically improved estimates of forest area and timber volume. The next section on processing provides more detail. For the same cost, SPR yields more statistically accurate estimates than other methods.

In developing the estimates for the current survey, a sample was established on aerial photography dating from 1967 to 1978, the most recent photography available. Each aerial plot (first phase) was classified into one of several photo-interpretation (PI) strata. The strata were based on land use and, if forested, timber volume. For each stratum a ground plot subsample (second phase) was chosen randomly from the photo plot sample. In New York, the photo sample consisted of 86,170 plots. A subsample of 4,299 was selected to be observed on the ground.

Approximately 58 percent of the photo plots were photo-interpreted as forested and thus in one of four timber-volume classes. Each timber-volume stratum was sampled with equal intensity, using a selection rule known as proportional allocation. This represented a change from the second survey when optimal allocation was employed. Under optimal allocation higher timber-volume strata were sampled more heavily.

On the ground, land use was verified, and on the forested plots tree data were recorded. The plots consisted of a cluster of 10 prism points systematically arranged to cover approximately 1 acre. At each point, trees 5 inches in diameter and larger were selected for tally by using a prism with a basal-area factor of 37.5 square feet per acre.

The other sets of independent estimates based on updating the 1953 and 1968 surveys required the remeasurement of 698 1/5-acre fixed-radius forested plots originally established during the first survey and 487 10-point forested plots originally established during the second survey. The fixed-radius plots were measured for the third time and were used in the growth and removals calculations.

Processing the Data

Since the 1968 survey, some definitions and procedures have changed as a result of refinements and improvements in forest inventory and data-processing techniques. Three significant changes are: (1) a new procedure for developing county-level estimates, (2) a new forest-land area estimation procedure, and (3) a set of new volume estimation equations.

The first change was the refinement of our data-processing system to develop, in many cases, estimates of forest area and timber volume at the county level. In the past the data were developed at the unit level and prorated to the county level based on the distribution of photo-interpretation points. Development of county-level data helps users interested in more accurate local data but can make trend analysis at the county level uncertain, at least until the next survey.

All counties were not individually estimated. Those counties that did not have at least 60,000 acres of commercial forest land were felt to not have enough plots to stand alone and were grouped with a neighboring county to produce a "supercounty". New York has two supercounties, West Chester/Rockland and Cayuga/Seneca.

The second major change, a new forest-land area estimation procedure, involves an analysis of previously published commercial forest-land estimates. This process has two parts: a reexamination of all remeasured plots for proper land use assignment (forest vs. nonforest) and recalculation of the change in commercial forest land between surveys. The combination of these changes enabled us to estimate more accurately a county's 1968 commercial forest-land base and which counties had significant changes in that base. Recalculation of the 1968 commercial forest-land base produced a statewide estimate that was 133,000 acres larger than the published figure. This represented a change of 0.9 percent from the published total.

The third major change was the development of a set of new timber volume estimation equations for both growing stock and sawtimber (Scott 1979, 1981). Basically, the volumes are now estimated using a nonlinear method; previously linear regression was used. Nonlinear estimation yields data with smaller errors between predicted and actual values and so is deemed more fit. The effect of these revised volume estimators was to lower 1968 published estimates by about 12 percent for softwoods and 6 percent for hardwoods. Volume estimates on small diameter classes were affected more than large diameter-class estimates.

Table 1.—Net volume of growing stock on commercial forest land by species and ownership class (Million cubic feet)

Species	Public	Forest industry	Farmer	Corporate	Misc. private	Total
Balsam fir	7.6	69.5	4.6	24.7	92.1	198.5
Spruces	95.5	121.7	15.0	70.0	221.7	523.9
Red pine	125.1	2.8	37.9	29.7	124.9	320.4
White pine	98.7	34.6	245.6	109.4	689.8	1,178.1
Hemlock	61.5	65.9	374.6	70.3	797.2	1,369.5
Other softwoods	54.0	12.1	50.2	22.0	138.5	276.8
Total softwoods	442.4	306.6	727.9	326.1	2,064.2	3,867.2
Red maple	151.8	250.4	415.7	221.2	1,354.0	2,393.1
Sugar maple	213.0	205.6	710.5	152.3	1,232.2	2,513.6
Yellow birch	20.2	113.6	71.6	62.0	231.8	499.2
Sweet birch	15.0	8.1	57.6	19.2	132.4	232.3
Paper birch	6.2	27.9	15.6	12.9	133.6	196.2
Hickories	13.9	1.2	108.0	14.5	157.4	295.0
American beech	68.2	123.6	299.3	87.1	431.6	1,009.8
White ash	79.0	40.6	247.5	51.7	477.1	895.9
Aspens (populus)	49.1	49.4	182.9	40.2	331.3	652.9
Black cherry	65.0	63.9	138.9	70.4	354.3	692.5
Select white oaks	13.2	2.9	59.5	61.3	128.5	265.4
Chestnut oak	10.6	—	30.1	58.0	174.5	273.2
Northern red oak	56.9	35.0	198.2	101.4	639.6	1,031.1
Other oaks	7.5	1.7	19.2	13.0	131.5	172.9
Basswood	20.7	13.9	158.0	23.0	137.4	353.0
Elms	4.2	—	33.7	10.7	72.2	120.8
Other hardwoods	16.5	2.0	90.6	18.5	178.2	305.8
Total hardwoods	811.0	939.8	2,836.9	1,017.4	6,297.6	11,902.7
All species	1,253.4	1,246.4	3,564.8	1,343.5	8,361.8	15,769.9

Table 2.—Net volume of sawtimber on commercial forest land by species ownership class (Million board feet)

Species	Public	Forest industry	Farmer	Corporate	Misc. private	Total
Balsam fir	5.6	113.8	3.8	51.5	140.9	315.6
Spruces	192.7	310.4	44.9	179.9	463.5	1,191.4
Red pine	381.0	5.4	82.4	73.6	326.0	868.4
White pine	309.4	152.4	739.7	371.7	2,319.3	3,892.5
Hemlock	174.5	228.1	1,068.1	237.9	2,469.0	4,177.6
Other softwoods	141.7	31.0	68.2	68.4	228.6	537.9
Total softwoods	1,204.9	841.1	2,007.1	983.0	5,947.3	10,983.4
Red maple	312.6	498.0	796.5	423.9	2,639.5	4,670.5
Sugar maple	572.0	475.7	1,956.5	399.5	2,903.0	6,306.7
Yellow birch	48.9	357.5	124.6	210.1	566.6	1,307.7
Sweet birch	29.6	22.9	104.6	49.3	218.8	425.2
Paper birch	15.3	52.6	14.3	7.7	184.7	274.6
Hickories	17.5	—	248.8	36.0	246.3	548.6
American beech	227.0	340.2	828.5	204.0	1,001.6	2,601.3
White ash	187.5	93.0	498.1	109.8	986.7	1,875.1
Aspens (populus)	58.9	146.1	296.1	78.8	527.8	1,107.7
Black cherry	150.0	195.3	275.0	216.4	879.6	1,716.3
Select white oaks	37.2	10.1	207.4	154.1	408.5	817.3
Chestnut oak	15.9	—	42.4	140.4	298.3	497.0
Northern red oak	177.5	90.2	584.2	299.3	2,046.0	3,197.2
Other oaks	12.5	7.5	41.4	43.8	365.3	470.5
Basswood	75.4	21.9	441.8	76.8	413.7	1,029.6
Elms	13.9	—	79.6	20.5	86.2	200.2
Other hardwoods	43.1	5.2	229.2	20.6	425.2	723.3
Total hardwoods	1,994.8	2,316.2	6,769.0	2,491.0	14,197.8	27,768.8
All species	3,199.7	3,157.3	8,776.1	3,474.0	20,145.1	38,752.2

Table 3.—Aboveground green weight[a] of live trees by species and source, New York, 1979 (Thousand green tons)

Species	Growing stock: Merchantable[b] stem	Growing stock: Tree tops	Growing stock: Total	Rough and rotten trees[c]	Stumps[d]	Saplings[e]	All sources
Balsam fir	7,092.9	2,897.9	9,990.8	222.5	126.4	6,144.4	16,484.1
Spruces	17,467.9	9,608.9	27,076.8	1,332.5	324.8	7,141.9	35,876.0
Red pine	14,560.9	4,276.9	18,837.8	280.5	256.4	363.0	19,737.7
White pine	51,316.0	10,089.9	61,405.9	8,913.6	1,041.4	6,044.1	77,405.0
Hemlock	57,654.3	21,293.2	78,947.5	7,160.1	1,120.3	9,440.9	96,668.8
Other softwoods	10,913.3	3,915.9	14,829.2	1,949.3	222.4	5,439.1	22,440.0
Total softwoods	159,005.3	52,082.7	211,088.0	19,858.5	3,091.7	34,573.4	268,611.6
Red maple	92,411.1	30,370.0	122,781.1	16,633.5	2,450.6	23,026.5	164,891.7
Sugar maple	110,655.6	33,011.1	143,666.7	14,615.3	2,812.3	19,975.9	181,070.2
Yellow birch	19,376.9	7,993.3	27,370.2	5,177.1	552.7	3,598.6	36,698.6
Sweet birch	9,888.4	3,088.1	12,976.5	937.2	242.9	1,359.5	15,516.1
Paper birch	8,442.5	2,760.4	11,202.9	772.0	206.7	1,340.7	13,522.3
Hickories	14,214.9	4,511.0	18,725.9	893.4	338.7	1,677.0	21,635.0
American beech	43,617.5	16,773.2	60,390.7	14,326.8	1,305.6	13,260.8	89,283.9
White ash	31,364.0	8,213.9	39,577.9	2,160.8	751.5	8,378.0	50,868.2
Aspens (populus)	23,655.9	5,946.5	29,602.4	1,905.9	573.2	5,978.9	38,060.4
Black cherry	23,161.7	12,143.5	35,305.2	5,231.4	638.7	3,481.0	44,656.3
Select white oaks	13,615.0	3,995.4	17,610.4	1,390.3	336.7	686.8	20,024.2
Chestnut oak	14,839.3	4,538.4	19,377.7	857.9	351.8	465.7	21,053.1
Northern red oak	52,893.0	14,926.2	67,819.2	2,168.6	1,233.5	2,241.5	73,462.8
Other oaks	8,809.2	2,628.8	11,438.0	461.2	207.7	710.3	12,817.2
Basswood	13,339.0	3,911.9	17,250.9	1,599.7	335.3	1,345.4	20,531.3
Elms	4,846.8	2,200.1	7,046.9	1,120.2	134.3	4,127.8	12,429.2
Other hardwoods	12,851.4	4,317.4	17,168.8	17,985.3	701.2	43,383.4	79,238.7
Total hardwoods	497,982.2	161,329.2	659,311.4	88,236.6	13,173.4	135,037.8	895,759.2
All species	656,987.5	213,411.9	870,399.4	108,095.1	16,265.1	169,611.2	1,164,370.8

[a]Includes bark and sound cull; excludes rotten cull.
[b]Bole portion of trees 5.0 inches dbh and larger.
[c]Includes bole portion and tree tops.
[d]Of all live trees 5.0 inches dbh and larger, between ground level and a 1-foot stump height.
[e]Includes entire tree aboveground.

Metric Equivalents

1 acre = 4,046.86 square meters or 0.404686 hectares
1,000 acres = 404.686 hectares
1,000,000 acres = 404,686 hectares
1,000 board feet = 3.48 cubic meters[a]
1 cubic foot = 0.028317 cubic meters
1,000 cubic feet = 28.317 cubic meters
1,000,000 cubic feet = 28,317 cubic meters
1 cord (wood, bark, and airspace) = 3.6246 cubic meters
1 cord (solid wood, pulpwood) = 2.4069 cubic meters
1 cord (solid wood, other than pulpwood) = 2.2654 cubic meters
1,000 cords (pulpwood) = 2,406.9 cubic meters
1,000 cords (other products) = 2,265.4 cubic meters
1 ton (short) = 907.1848 kilograms or 0.9071848 metric tons
1,000 tons (short) = 907.1848 metric tons
1 inch = 2.54 centimeters or 0.0254 meters
1 foot = 30.48 centimeters or 0.3048 meters
Breast height = 1.4 meters above ground level
1 mile = 1.609 kilometers
1 square foot = 929.03 square centimeters or 0.0929 square meters
1 square foot per acre basal area = 0.229568 square meters per hectare

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[a]While 1,000 board feet is theoretically equivalent to 2.36 cubic meters, this is true only when a board foot is actually a piece of wood with a volume of 1/12 of 1 cubic foot. The International ¼-inch log rule is used by the USDA Forest Service in the East to estimate the product potential in board feet. When a conversion is used, the reliability of the estimate will vary with the size of the log measure. The conversion given here, 3.48 cubic meters, is based on the cubic volume of a log 16 feet long and 15 inches in diameter inside bark (dib) at the small end. This conversion could be used for average comparisons when accuracy of 10 percent is acceptable. Since the board-foot unit is not a true measure of wood volume and since products other than dimension lumber are becoming important, this unit may eventually be phased out and replaced with the cubic-meter unit.

Considine, Thomas J., Jr. **An analysis of New York's timber resources.** Resour. Bull. NE-80. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 70 p.

A comprehensive analysis of the current status and trends of the forest resources of New York. Topics include forest area, timber volume biomass, timber products, timber growth, and removals. Forest management opportunities for increasing the production of major forest resources and enhancing the benefits derived from New York forests are identified.

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