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The Forests of the Green Mountain State

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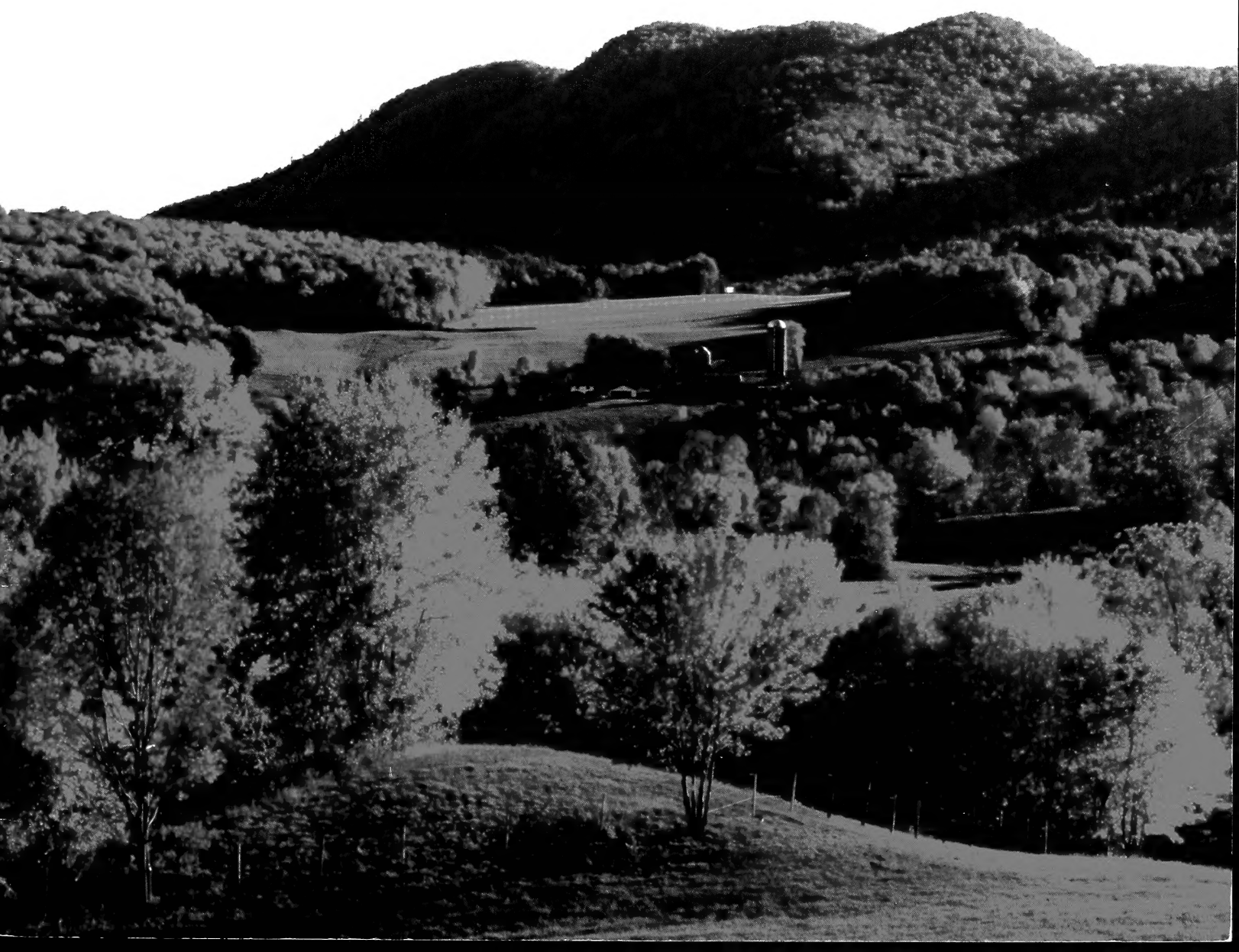

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THE FORESTS OF THE GREEN MOUNTAIN STATE

This is the forest primeval.
The murmering pines and the hemlocks,
Bearded with moss, and in garmets green, indistinct in the twilight,
Stand like Druids of eld, with voices sad and prophetic,
Stand like harpers hoar, with beards that rest on their bosoms.

Henry Wadswordth Longfellow
Evangeline, 1847

The village of Brattleboro is peculiar for the nearness of the primitive wood and the mountain ... But, above all, this everlasting mountain is forever lowering over the village, shortening the day and wearing a misty cap each morning ... The most interesting sight I saw in Brattleboro was the skin and skull of a panther ... I was surprised at its great size and apparent strength. It gave one a new idea of our American forests and the vigor of nature here.

Henry David Thoreau
Journal, 9 September 1856

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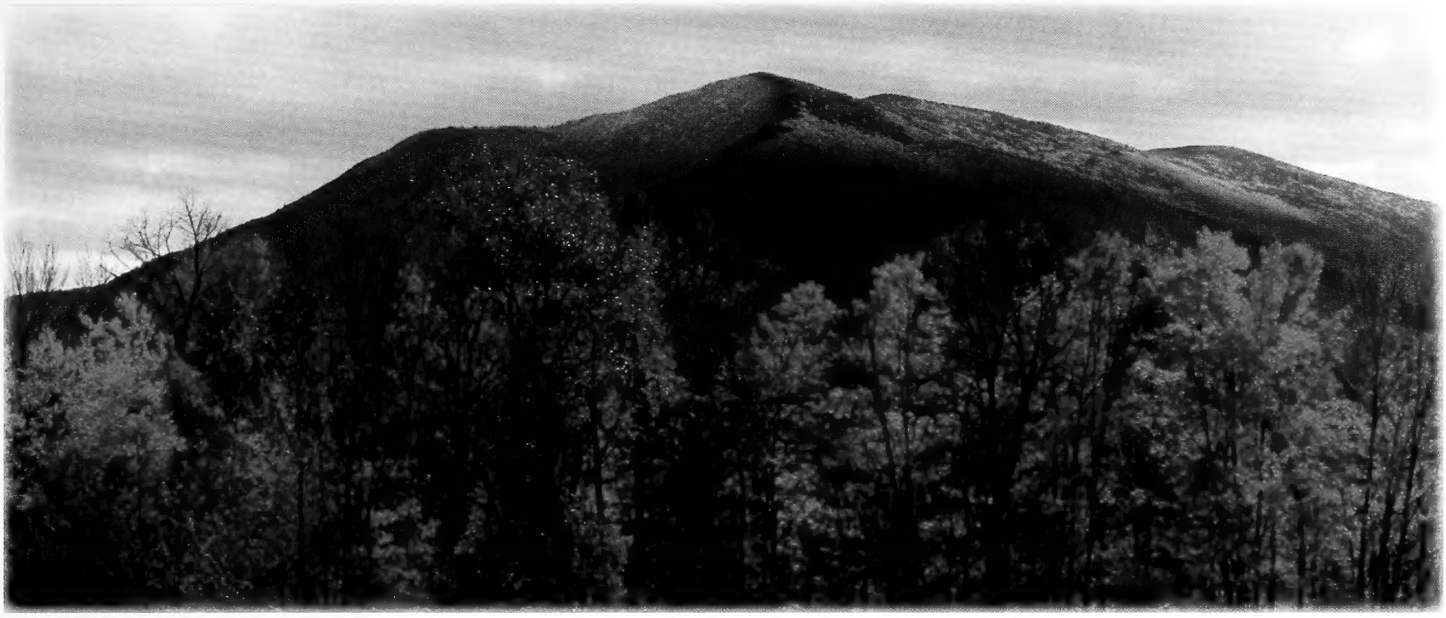
Northeastern Research Station, Forest Inventory and Analysis
Newtown Square, Pennsylvania

Vermont Department of Forests, Parks, and Recreation
Montpelier, Vermont



Danby, Vermont

Vermont's Resilient Forests

Forests provide wood and other forest products, watershed protection, wildlife habitat, biodiversity, a setting for recreation, and much more. They have played a major role in the history and culture of Vermont. The early settlers found nearly all of the State covered by forests. The initial clearing of these woodlands was slow as most colonists established small subsistence farms. Forest clearing became widespread around 1800 as Vermont's farmers began supplying food and wool to a rapidly growing nation. The thousands of small farms created a strong agriculture-based economy. The city of Burlington, Vermont, became a major producer of timber during this time.

By 1880, only about a third of Vermont remained forested. As early as 1845, George Perkins Marsh warned Vermont farmers about the damage that results from clearing forests. Eventually, those who once assumed that the State's forest resource was unlimited were faced with timber shortages. Soil erosion from farm land increased and silt now muddied creeks that once ran clear. And because of the rapid runoff of storm water, springs that previously flowed year round were dry during the summer. As Vermont's forests diminished, so did once abundant populations of important species of wildlife, for example, the beaver, black bear, white-tailed deer, wild turkey, and wolf.

During the Industrial Revolution, much of the cleared land in Vermont became unsuitable for continuous agricultural crops and was abandoned as farmers left marginal hillside farms to find work in the cities. Through the years, trees become established and what were "old fields" reverted to forest land. The opening of the West following the Civil War hastened the pace of farm abandonment across New England. The consequent decline in farming allowed much of the State to revert to forests. The amount of forested acreage in Vermont has doubled since 1880, though the sturdy stone walls one finds throughout the State's woodlands are reminders of the decline in farm acreage that continues today.

Absent interference by humans, vegetation in abandoned fields undergoes a series of changes. Plants with seed distributed by wind or birds are the first to become established. In Vermont, these include such common wildflower species as golden rod, aster, Queen Ann's lace, and blackberry.

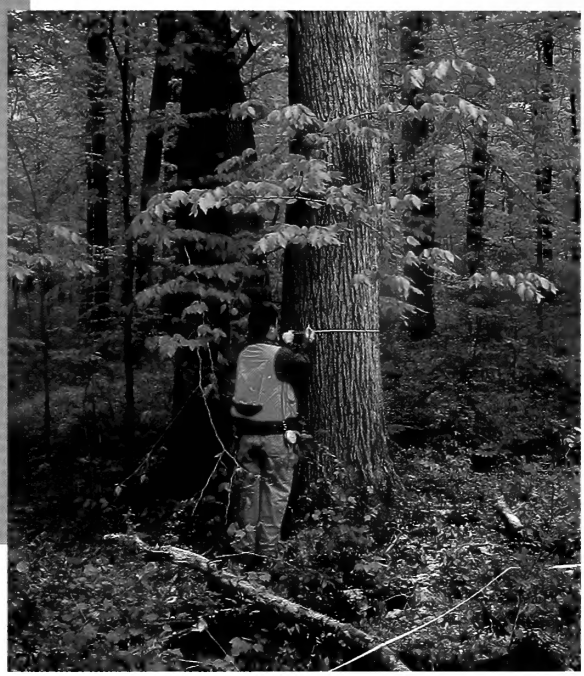
New Forest Inventory

Early in the 20th century, widespread land abuse in the Eastern United States prompted Congress to enact legislation that in part mandated the USDA Forest Service to periodically survey all states and report on the state of the nation's forest resources. As part of this legislation, the Green Mountain National Forest was established in western Vermont.

In 1997, the fifth inventory of Vermont's unique forest resource was conducted by the Forest Inventory and Analysis (FIA) unit of the Northeastern Research Station in cooperation with the Vermont Department of Forests, Parks, and Recreation. Previous inventories were conducted in 1948, 1965, 1973, and 1983. The results of the most recent survey detail the condition and extent of these extensive and diverse forests, and document their recovery. Highlighted here are significant trends during the last 50 years.

How was the Inventory Conducted?

Because it is impossible to count every tree in Vermont, FIA personnel used a scientifically designed sampling method. First, photo interpreters studied aerial photographs of the entire State. Next, a grid of nearly 22,000 points was overlaid on the photos. If forested, each point was classified according to land use and tree size. From this information, a sample of 926 plots was selected for measurement by FIA field crews. The sample included plots that were established during previous forest inventories; plots established in 1948 were measured for the fifth time. The remeasurements yielded valuable information on how individual trees grow. Field crews also collected data on the number, size, and species of trees, and related forest attributes. All of this information was used to generate reliable estimates of the condition and health of Vermont's forest resource, and how it is changing over time.



Following data collection for the 1997 inventory, a series of ice storms devastated forested areas in parts of northern New England and New York State. The storms damaged an estimated 940,000 acres in Vermont alone. To quantify these losses, plots were selected within the most heavily damaged areas. During 1998, the field plots were revisited, new measurements were taken, and the entire inventory was recalculated to include data on ice damage. Detailed statistical tables were published, as was information on Vermont's private forest-land owners and the State's forest products industry.[1] [2]

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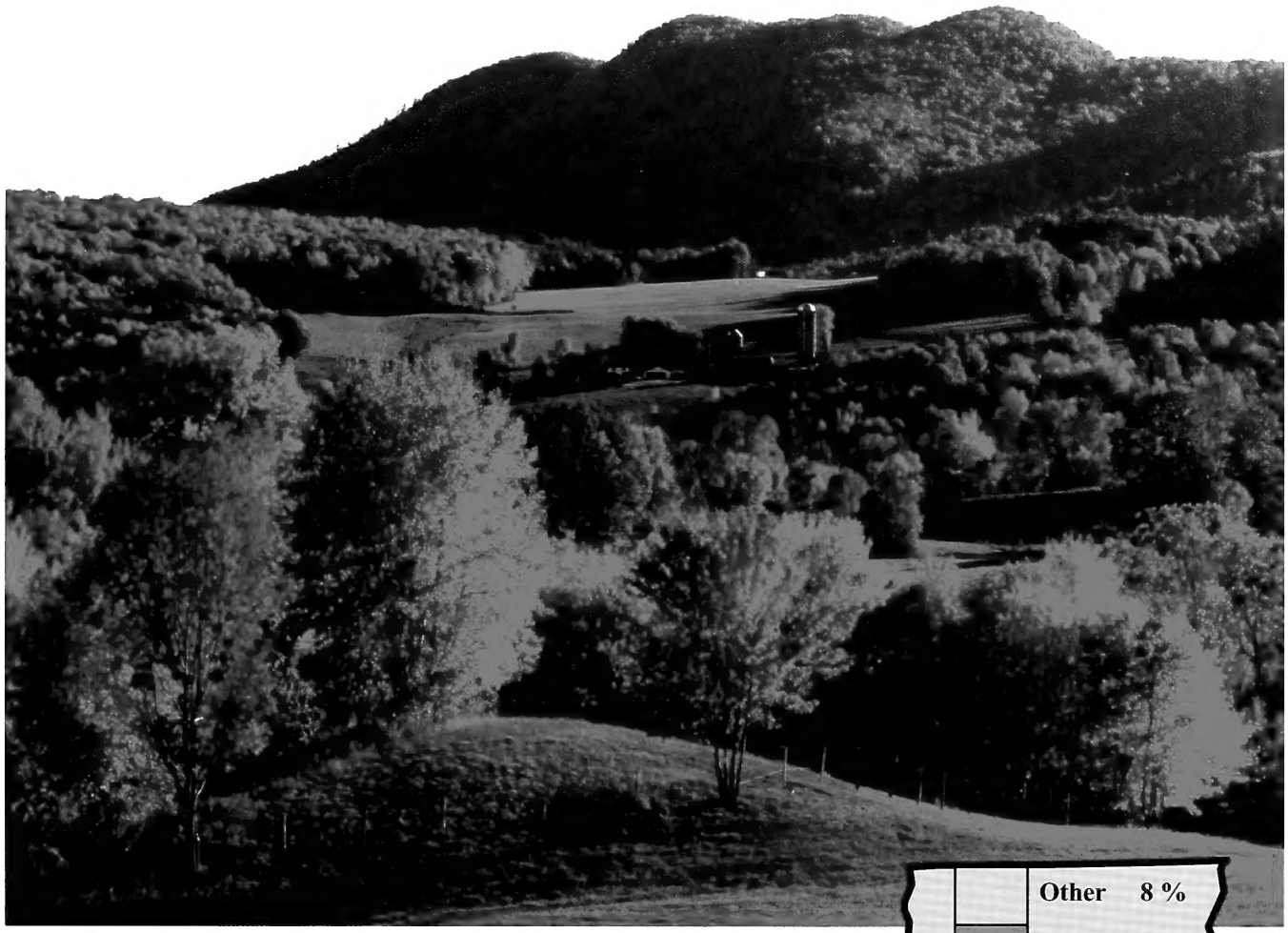
[1]Frieswyk, Thomas S.; Widmann, Richard H. 2000. **Forest statistics for Vermont: 1983 and 1997.** Resour. Bull. NE-145. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 130 p.

[2]Birch, Thomas W. 1996. **Private forest-land owners of the Northern United States, 1996.** Resour. Bull. NE-136. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 293 p.

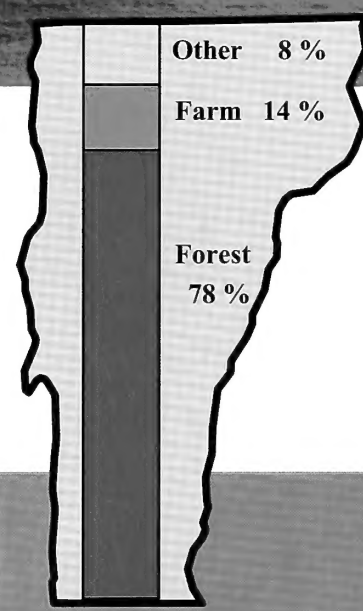


Farm Meets Forest in Ira, Vermont

Vermont's Forests Today

Forests account for nearly 8 of every 10 acres of land in Vermont, or roughly 4.6 million acres. The remaining 2 acres comprise cropland, improved pasture, and other nonforest land, e.g., housing, commercial and industrial facilities, rights-of-way, wetlands, and recreational areas. As mentioned earlier, by the middle of the 19th century, two-thirds of Vermont's original forests had been converted to farm land. Since then, the State's forests have revealed their resilience. Today, forests blanket more of Vermont than at any other time in the last 100 years. Between 1948 and 1966 when the first two FIA inventories were conducted, forest land increased by about 16 percent, from 3.7 to 4.3 million acres. During the next 30 years, forested areas continued to increase, though only by 7 percent.

Forest land does not exist in a vacuum but in concert with competing land uses. And Vermont's forests returned at the same time the State's population was expanding. Today, urban development, which is showing few signs of slowing, is draining the forest-land base and causing it to fragment into ever smaller ownerships.



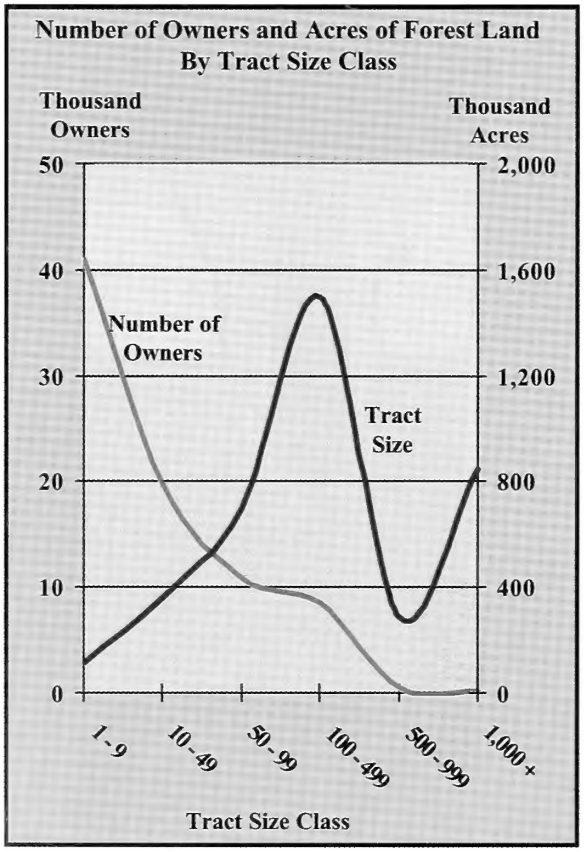
Cropland and pastures cover 14 percent of Vermont but these land uses have declined from previous inventories. The remaining nonforest land, which accounts for 8 percent of the State's land cover, continues to increase. This includes tracts for housing, and, as mentioned earlier, for urban development, for example, rights-of-way, industrial and commercial facilities, churches, and schools.

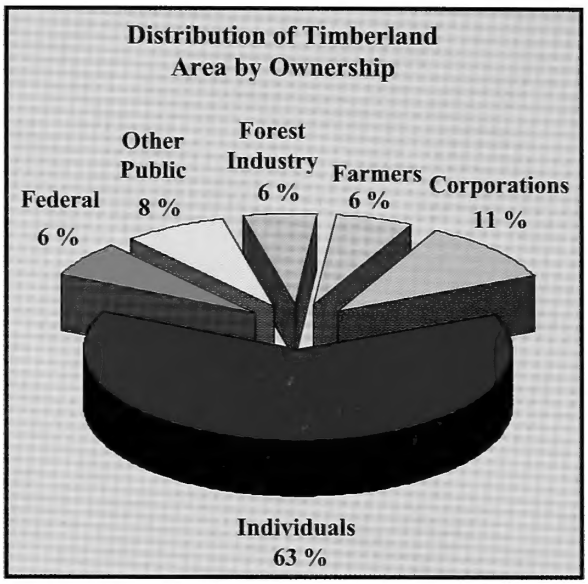
Forest Ownership

Private owners account for nearly 80 percent of Vermont's timberland. Nonindustrial private landowners hold 63 percent of the timberland. The remaining 37 percent is owned by individuals (other than farmers), corporations (other than forest industry), farmers, and miscellaneous owners, e.g., hunting clubs and trust funds.

Public lands accounted for 13 percent of the timberland base in 1997 compared to 9 percent in 1983. Altered perceptions about how the State's forests should be managed have caused more timberland than ever to be reserved for public goods and services. Public land is the primary source of forest-related recreation. With all but 5,300 acres in southern Vermont, the Green Mountain National Forest contributed 6 percent of total timberland acreage. The State of Vermont also holds 6 percent or nearly 275,000 acres. Counties and municipalities own about 72,000 acres.

There are about 80,500 nonindustrial private forest-land owners in Vermont with average holdings ranging from 100 to 500 acres. Nearly 70 percent of the timberland is held by nonindustrial private landowners with tracts larger than 100 acres; however, these owners account for only 11 percent of all ownerships.





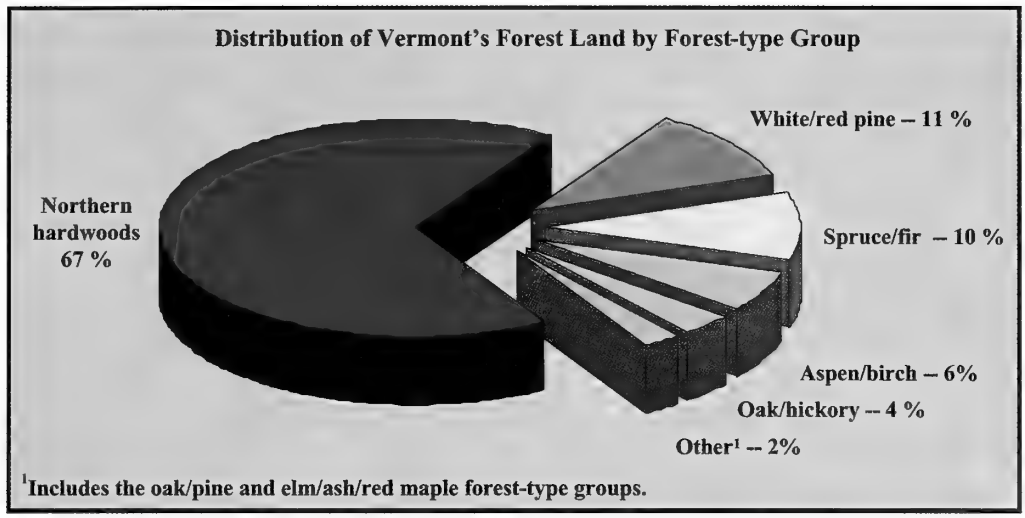
Characteristics and Trends

Location and Distribution

The forests of Vermont extend northward from [maple/beech/birch] forests to the south, across the central mountains of the New England Plateau, and into forests dominated by spruce/fir that border the Upper Connecticut River Valley. Of the five counties along this corridor, Orange County is the least forested at nearly 80 percent. Essex County is the most heavily forested at 95 percent; Chittenden County is the least forested (61 percent). Since the most recent FIA survey, forest acreage has increased in Caledonia and Orleans Counties and declined in Addison and Chittenden Counties.

The importance of Vermont's natural resource varies with the abundance and character of its forests. A common characteristic that helps describe the landscape is the distribution of forest types or forest-type groups. Their distribution depends on factors such as terrain position, soil depth, and climate. Northern hardwoods, specifically, the northern hardwoods forest-type group, accounts for 67 percent of Vermont's 4,628,900 acres of forest land. The next most abundant forest-type groups are white/red pine and spruce/fir, which account for 11 and 10 percent of the State's forest land, respectively.

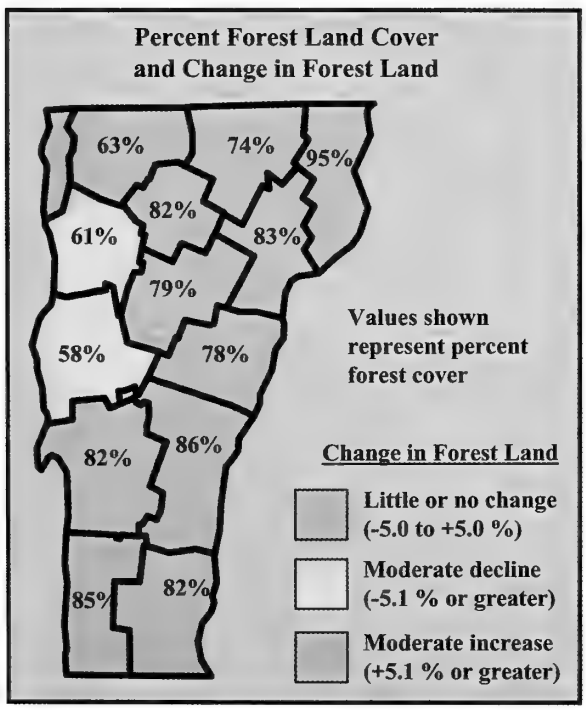
Forest-type groups vary in distribution throughout the State. Each helps define the character of forests that occur across Vermont's mountains and valleys. For example, the oak/hickory forest-type group is far more

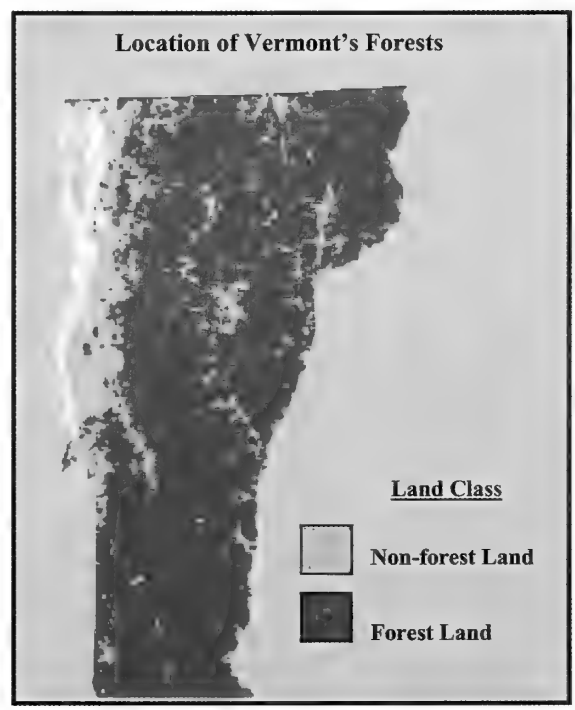


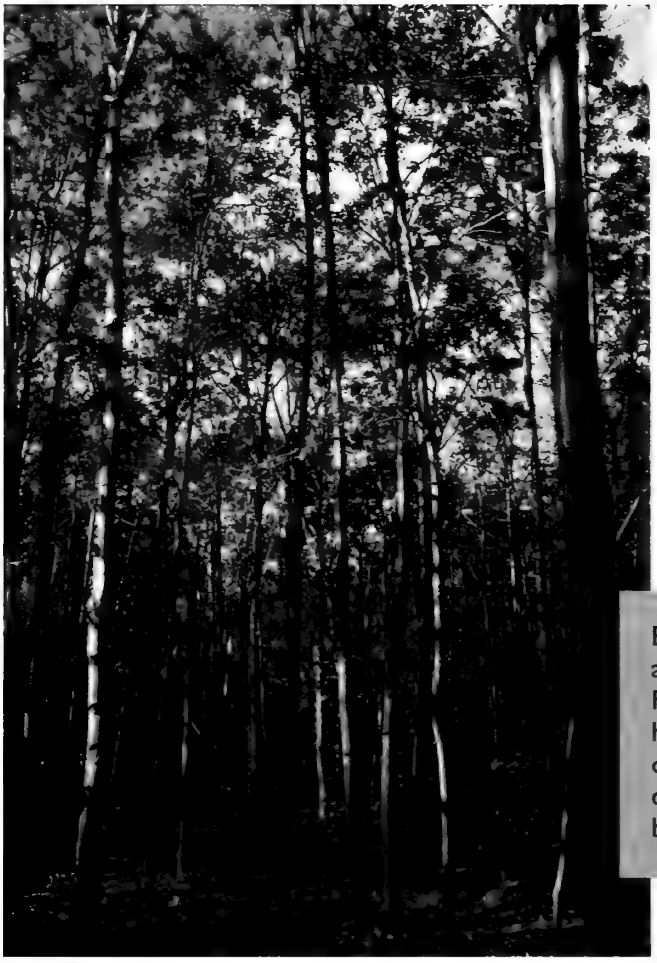
important component in the southern counties, while the spruce/fir group is more common primarily in the northern countries. However, political boundaries often limit the use of forest-resource data. Over the years, different criteria have been pressed into service to better classify the forest landscape. Biophysical regions were proposed in the early 1990's and refined in 1995.

Vermont contains a diverse mixture of these regions, or ecological units, which, in turn, contain blends of forest-type groups.[3] Eight biophysical regions have been identified: Taconic Mountains, Vermont Valley, Southern Green Mountains, and Southern Vermont Piedmont that stretch across the State's southern tier, and Champlain Valley, Northern Green Mountains, Northern Vermont Piedmont, and Northeastern Highlands, which encompass nearly all of the 10 northern counties.

[3]Keys, J., Jr.; Carpenter, C.; Hooks, S.; Koenig, F.; McKlab, W.H.; Russell, W.E.; Smith, M-L. 1995. **Ecological units of the Eastern United States—first approximation.** Publ. R8-TP 21. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southern Region.



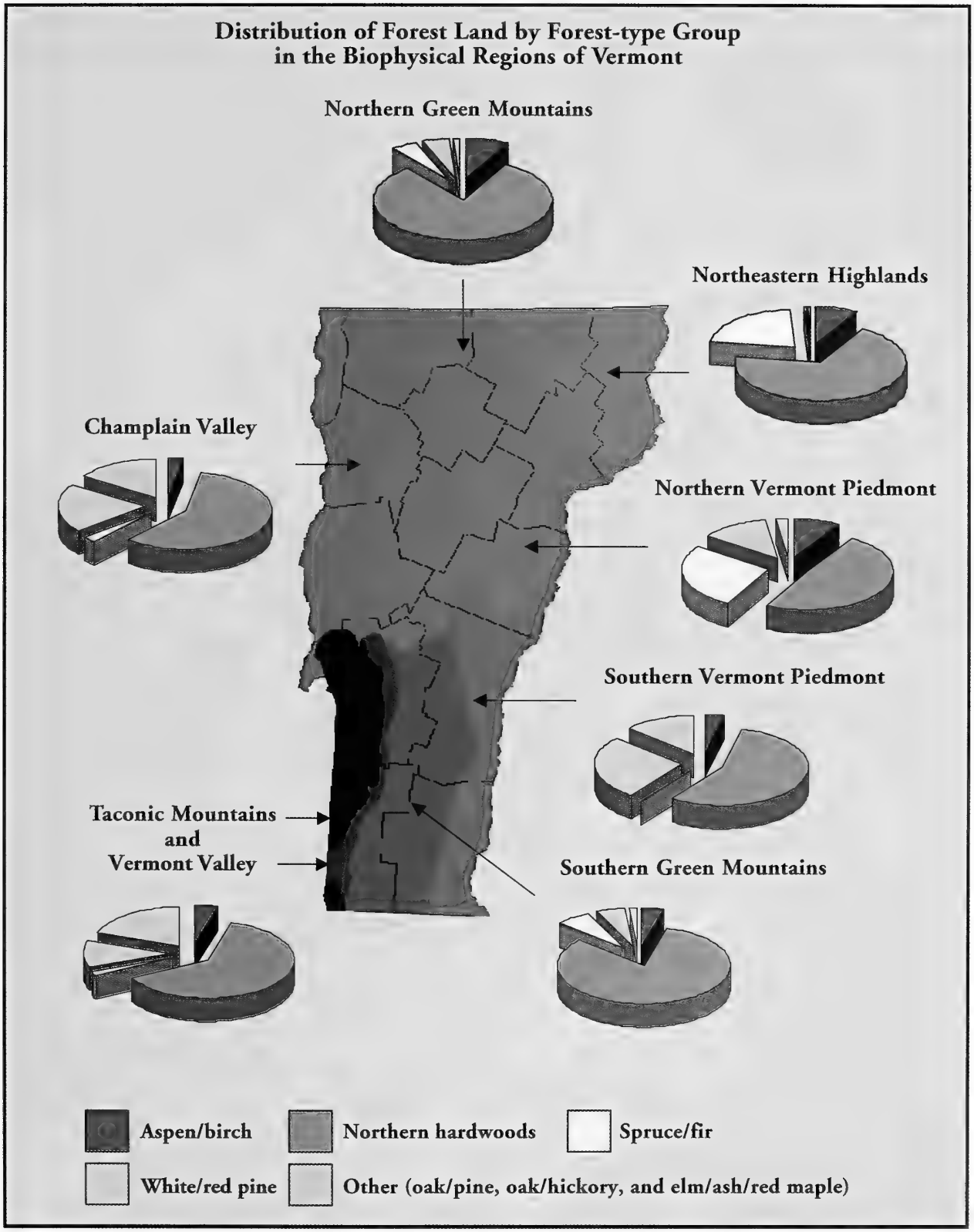




Each forest-type group comprises a diverse collection tree species. For example, within the northern hardwoods group are pure stands of black cherry and those that contain a mixture of maple, beech, birch, and other deciduous species.

Mixed Stand of Oak, Maple and Birch, Harvard Forest, Massachusetts

Autumn in Central Vermont



Northern hardwoods predominate in every region of Vermont, but account for only about half of the forest-land area in the two Piedmont regions, each of which has a significant proportion of white/red pine. The Northern Vermont Piedmont and Northeastern Highlands also contain substantial amounts of spruce/fir and aspen/birch, while the oak/hickory and oak/pine forest-type groups account for about 52 and 12 million acres, respectively, in the Southern Piedmont.

Area of Forest Land by Forest-type Group and Geophysical Region (in millions of acres)

Biophysical Region	White and red pine	Spruce and fir	Oak and pine	Oak and hickory	Elm, ash, red maple	Northern hardwood	Aspen, birch	All types
Champlain Valley	100.5	11.4	10.8	20.0	44.9	285.9	13.0	486.5
Northern Green Mountains	1.8	106.4	0.0	0.0	3.2	340.5	38.9	490.7
Northeastern Highlands	49.0	48.0	0.0	1.1	9.6	800.1	77.6	985.4
Northern Vermont Piedmont	109.3	235.0	0.0	12.9	6.8	425.7	73.9	863.6
Southern Green Mountains	48.8	58.1	0.0	11.6	0.0	708.5	37.7	864.7
Southern Vermont Piedmont	132.7	0.0	12.4	51.6	1.7	275.7	18.2	492.3
Taconic Mountains	49.1	6.5	6.1	59.2	3.7	215.7	19.1	359.4
Vermont Valley	0.5	0.0	5.4	6.6	4.8	58.2	0.0	75.5
Total, all regions	491.7	465.4	34.7	163.1	74.8	3,110.1	278.3	4,618.1

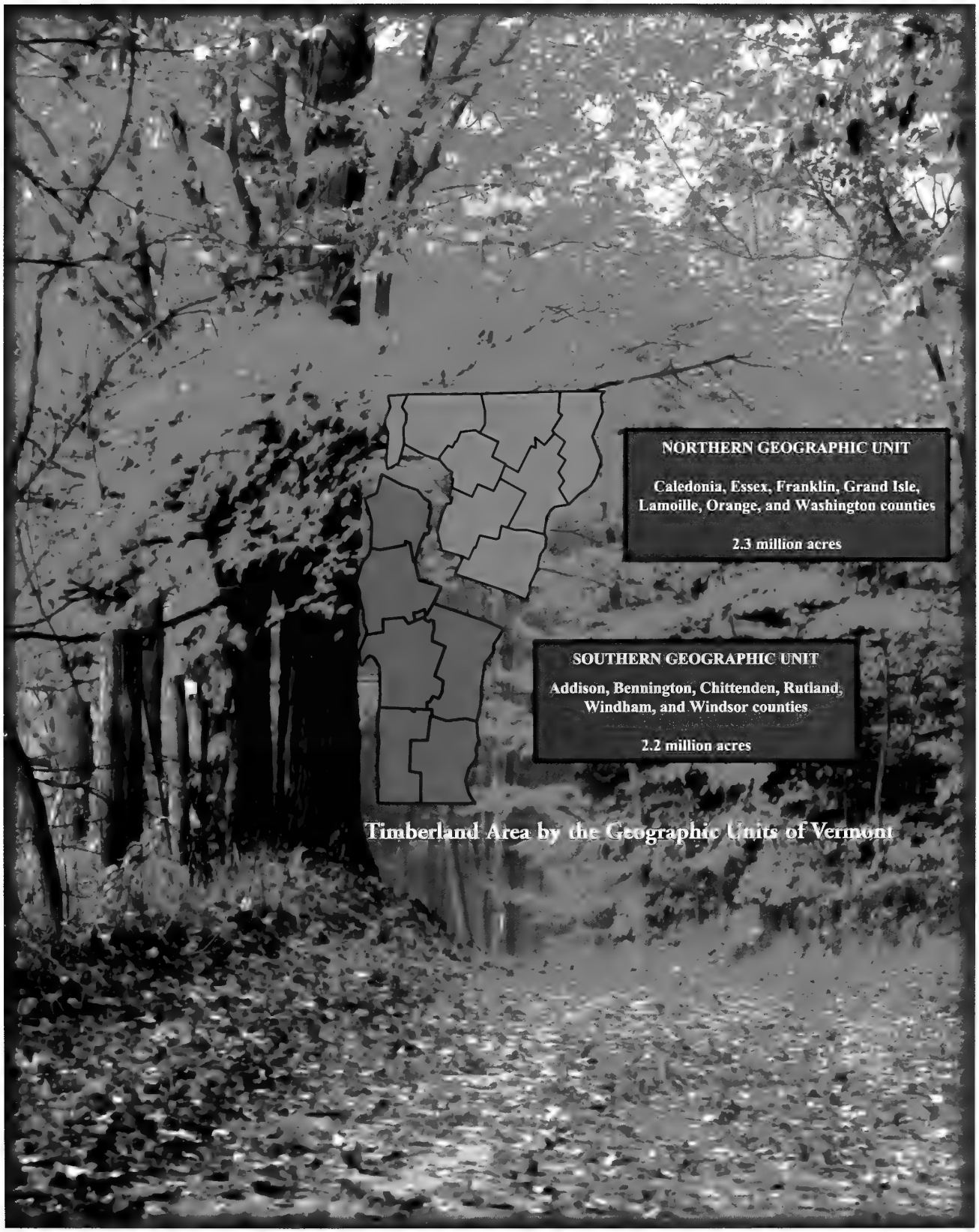
The classification of timberland on the basis of its capacity for producing industrial products does not limit its use for other purposes. Vermont has enacted laws that regulate the harvesting of timber so as to limit its impact on the environment. Today, timberland is managed differently in suburban settings—it is an important base for recreation and a considerable portion has been designated as wildland for posterity.

Timberland Area

Timberland is forest land that is capable of producing commercial crops of timber. In Vermont, timberland accounts for 97 percent of all forest land. In 1997, the timberland base totaled 4,482,500 acres, an increase of less than 70,000 acres potentially available for harvesting.

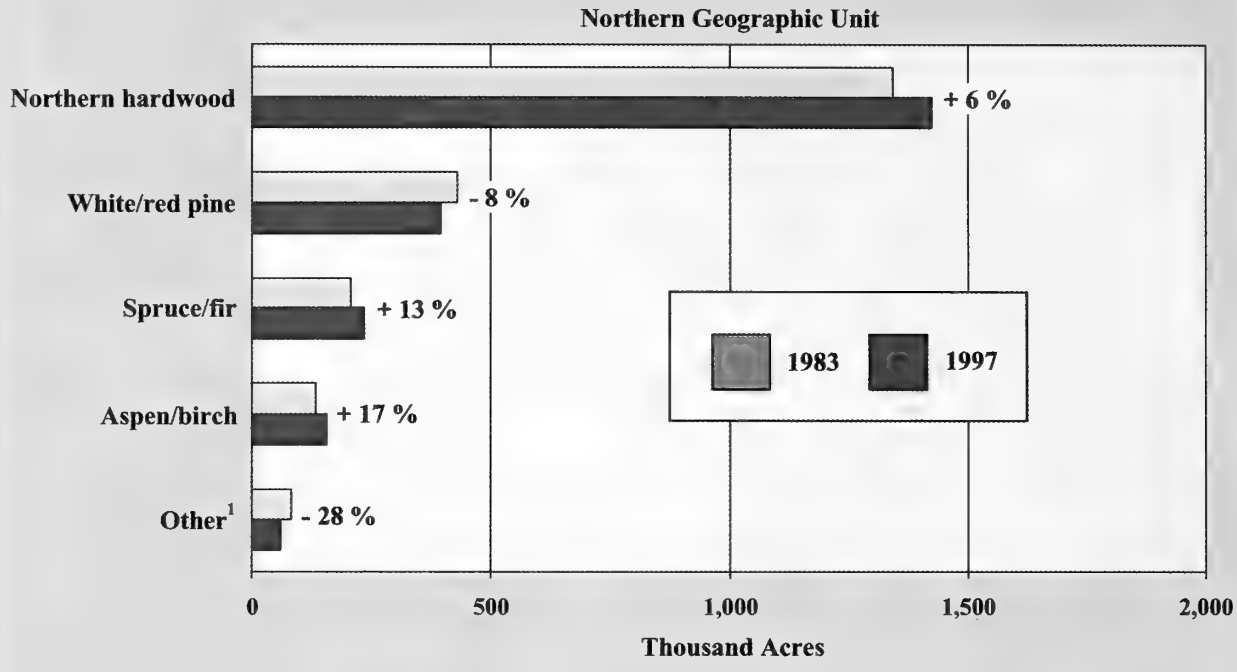
Largely on the basis of cover types, the State's forest land can be divided into two geographic units: the beech/birch/maple forests of southern Vermont and the spruce/fir forests of the northeastern region. The Northern Geographic Unit contained 2,265,600 acres of timberland in 1997, an increase of 3 percent over 1983. The Southern Unit contained 2,216,800 acres of timberland in 1997, a decline of less than 0.05 percent from 1983.

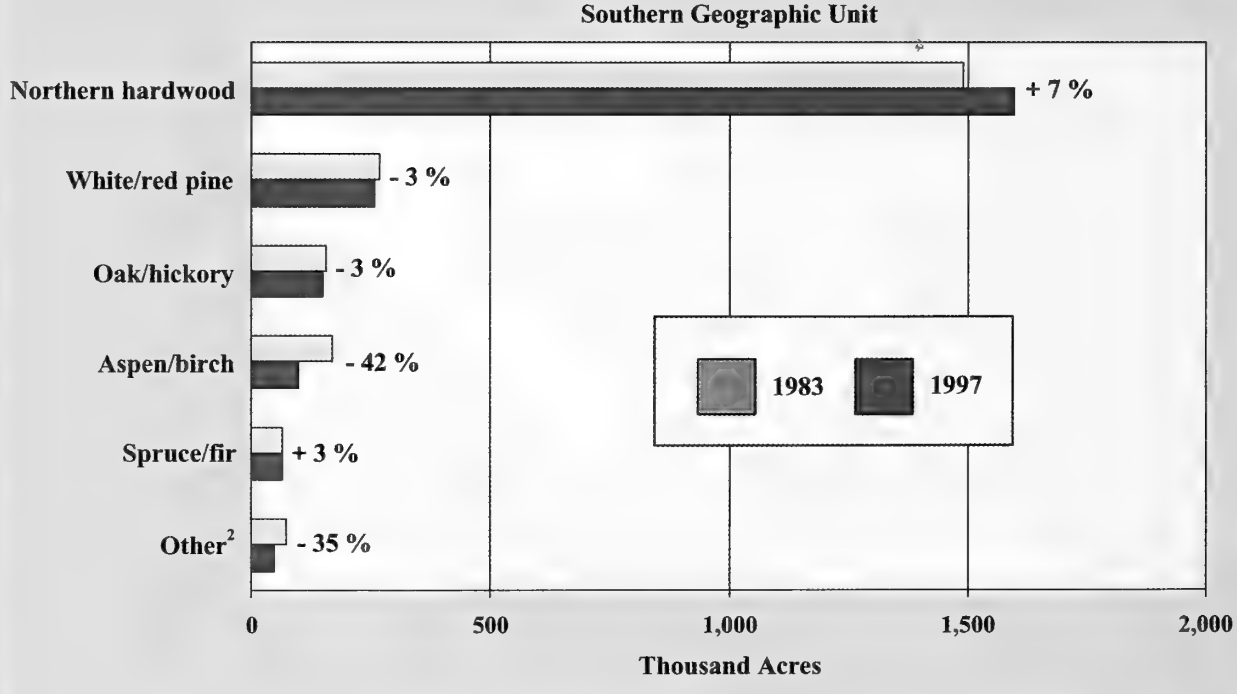
In the Northern Unit, the amount of spruce/fir and [aspen/birch] has increased by 13 and 17 percent, respectively, since 1983. Only the combination of oak/pine, oak/hickory, and elm/ash/red experienced a significant decline. This resulted from a significant drop in the elm/ash/red maple component, which was reduced by nearly half from 1983 to 1997 (65,000 to 33,000 acres). There were similar declines in the Southern Unit as elm/ash/red maple declined from 67,000 acres in 1983 to 28,000 in 1997. Aspen/birch showed a similar decline in timberland area, dropping by 42 percent during the same period. By contrast, the northern hardwoods forest-type group increased by 7 percent.



Autumn Colors in Wallingford, Vermont

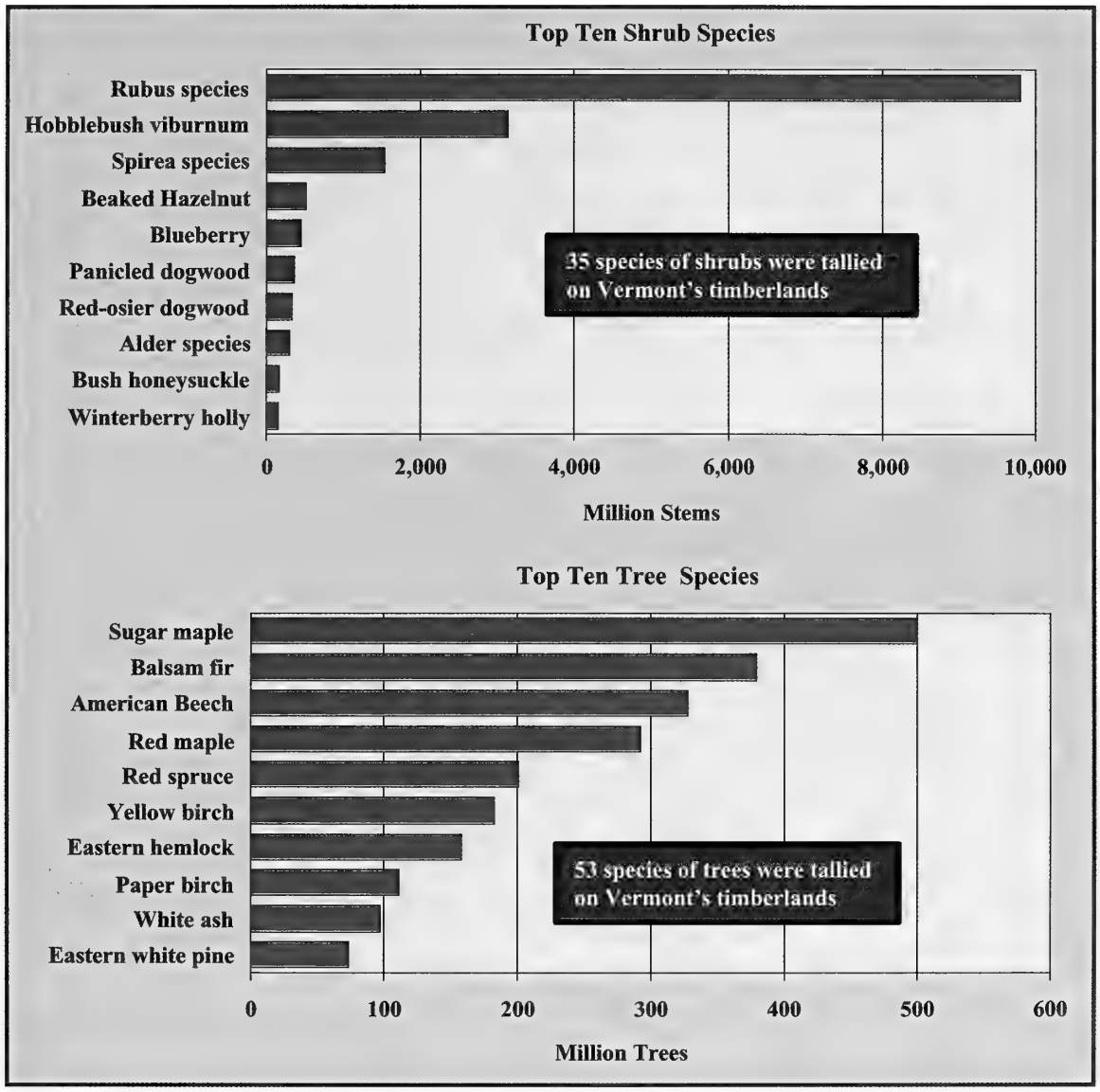
Change in Timberland Area by Geographic Unit and Forest-type Group





[1]Includes the oak/pine, oak/hickory, and elm/ash/red maple forest-type groups.

[2]Includes the oak/pine and elm/ash/red maple forest-type groups.



Composition and Structure

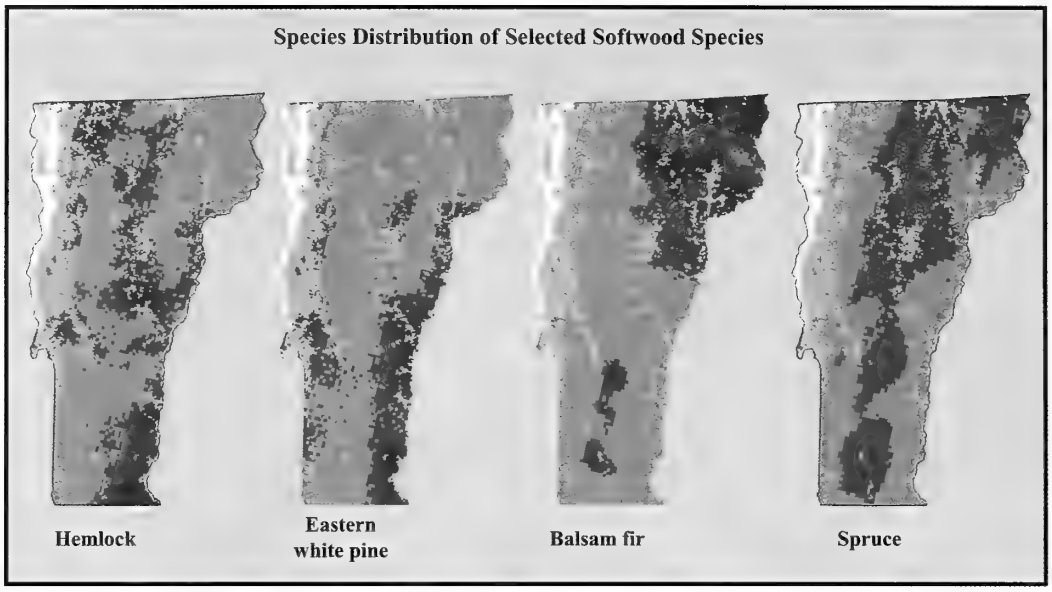
Species Diversity

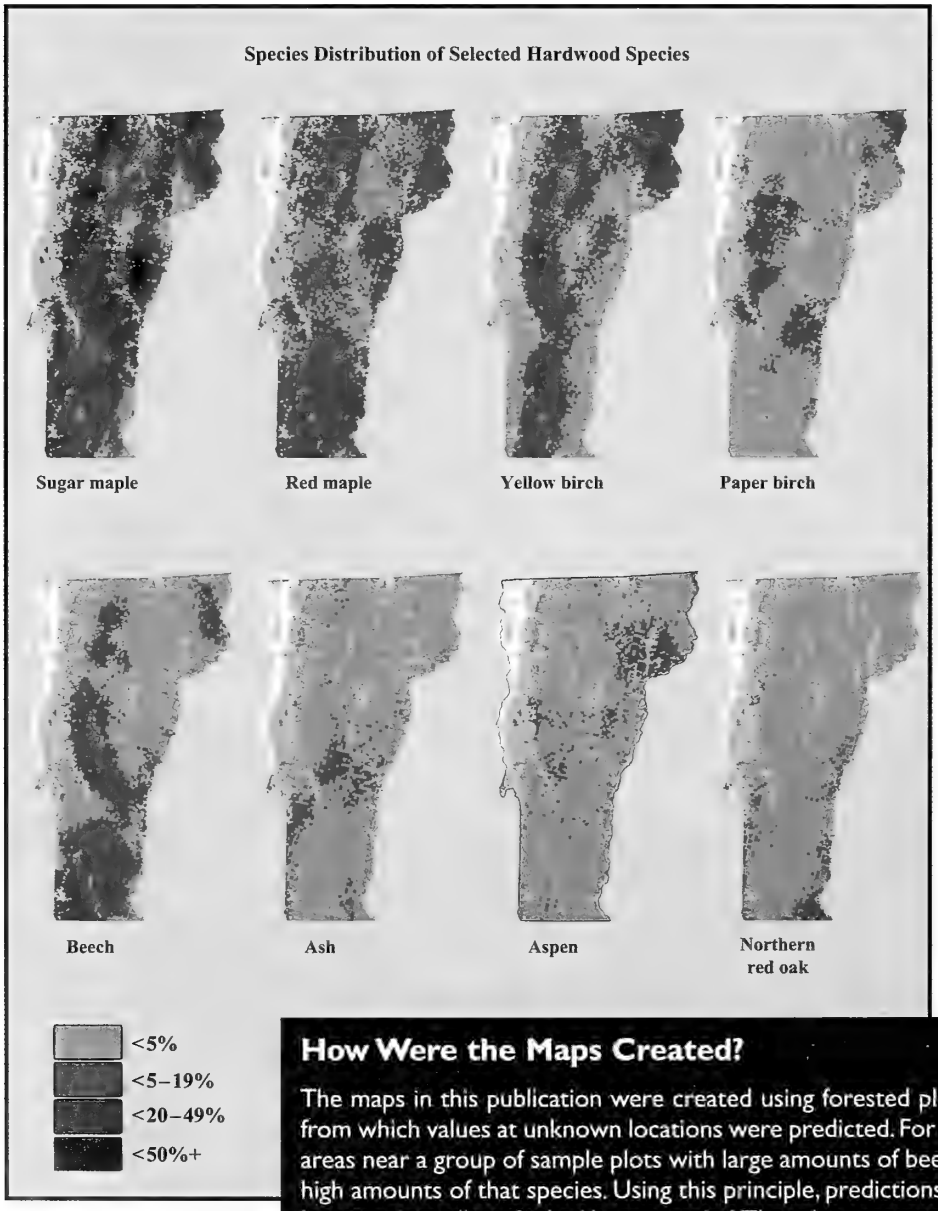
The Green Mountain State itself is a rich tapestry of biological diversity. Forest vegetation—living trees and shrubs, dead and downed woody stems, microflora, lichens, mosses, and herbaceous plants—provide diverse habitat for wildlife in the form of forage and shelter for both forest-dwelling species and those that inhabit forest-dependent aquatic systems.

Such diversity is evident in the number and variety of wildlife species encountered in the State's woodlands. The most recent FIA inventory identified 88 different tree and shrub species, the most common of which are beech, birch, maple, ash, aspen, oak, fir, spruce, hemlock, brambles, raspberry hobblebush, viburnum, and spirea. Hemlock is the leading softwood species, often found growing with eastern white pine. Balsam fir and spruce are the primary species used in the manufacture of wood fiber. Of the hardwood species, sugar maple is the most prevalent, followed by American beech, red maple, yellow and paper birch, and white ash.

Distribution of Tree Species

In Vermont's forests, hardwood species outnumber softwood species by a ratio of 2 to 1. Sugar maple is the most prevalent tree species, reaching concentrations as high as 50 percent in the Northern Piedmont region and 20 to 50 percent in the northern Green Mountains and Champlain Valley. Red maple also is prevalent





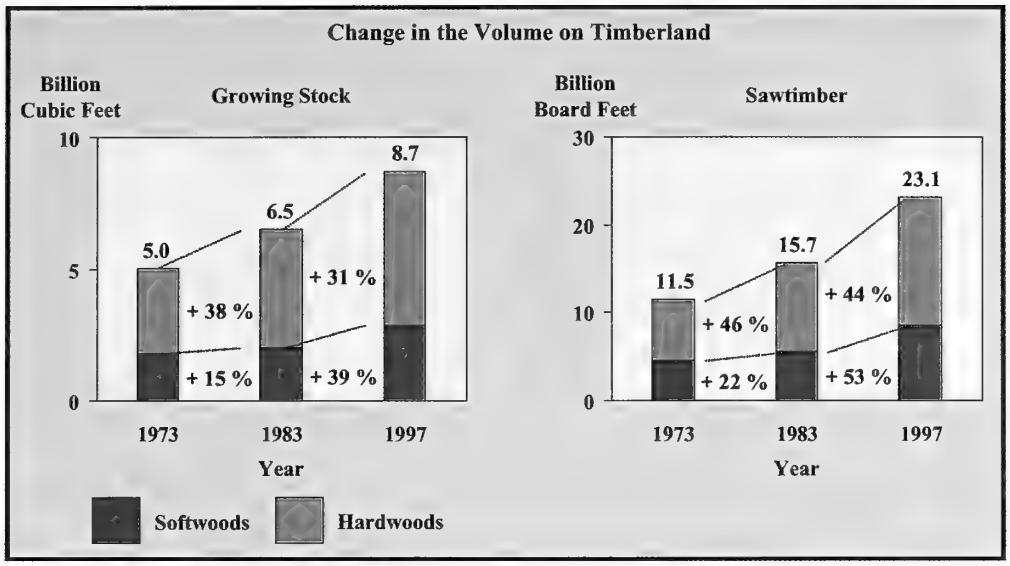
throughout Vermont, particularly in the southern region. Paper birch extends primarily along the entire range of the Green Mountains, and yellow birch is found mostly along the same range but at higher elevations.

Hemlock is the leading softwood species and is concentrated in the southwestern corner of the state, northern Green Mountains, and north of Lake Champlain. This species often grows in conjunction with eastern white pine, which is found primarily along the Connecticut River in southern Vermont. Balsam fir is distributed primarily in the Northeastern Highlands and Northern Piedmont, while spruce is prevalent throughout the southern Green Mountains.

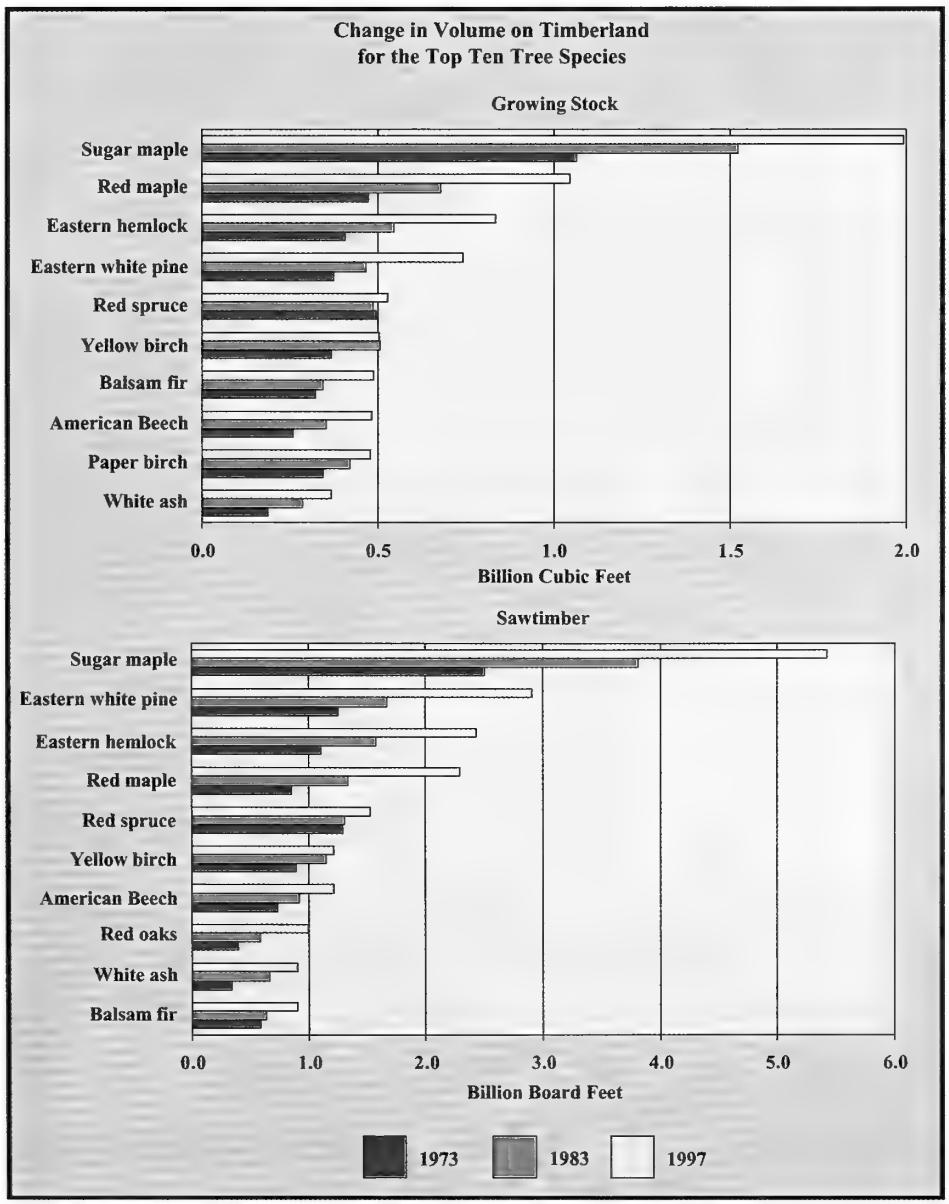
Other common tree species in Vermont include ash, aspen, beech, and northern red oak. Of these species, only beech is found in concentrations as high as 20 to 50 percent.

How Were the Maps Created?

The maps in this publication were created using forested plots as "known" data from which values at unknown locations were predicted. For example, unsampled areas near a group of sample plots with large amounts of beech would likely have high amounts of that species. Using this principle, predictions are made for every location, regardless if it had been sampled. The values represent the percentage of a given area's basal area that is composed of a certain species' basal area.



Growing-stock volume is the net cubic-foot volume in trees 5.0 inches or larger in diameter at breast height (d.b.h.), between a 1-foot stump and a 4-inch top diameter outside the bark (d.o.b.). Sawtimber volume is the net board-foot volume: for softwoods it is in trees 9.0 inches or larger in d.b.h. to a 7-inch top d.o.b.; for hardwoods it is in trees 11.0 inches or larger in d.b.h. to a 9-inch top d.o.b.



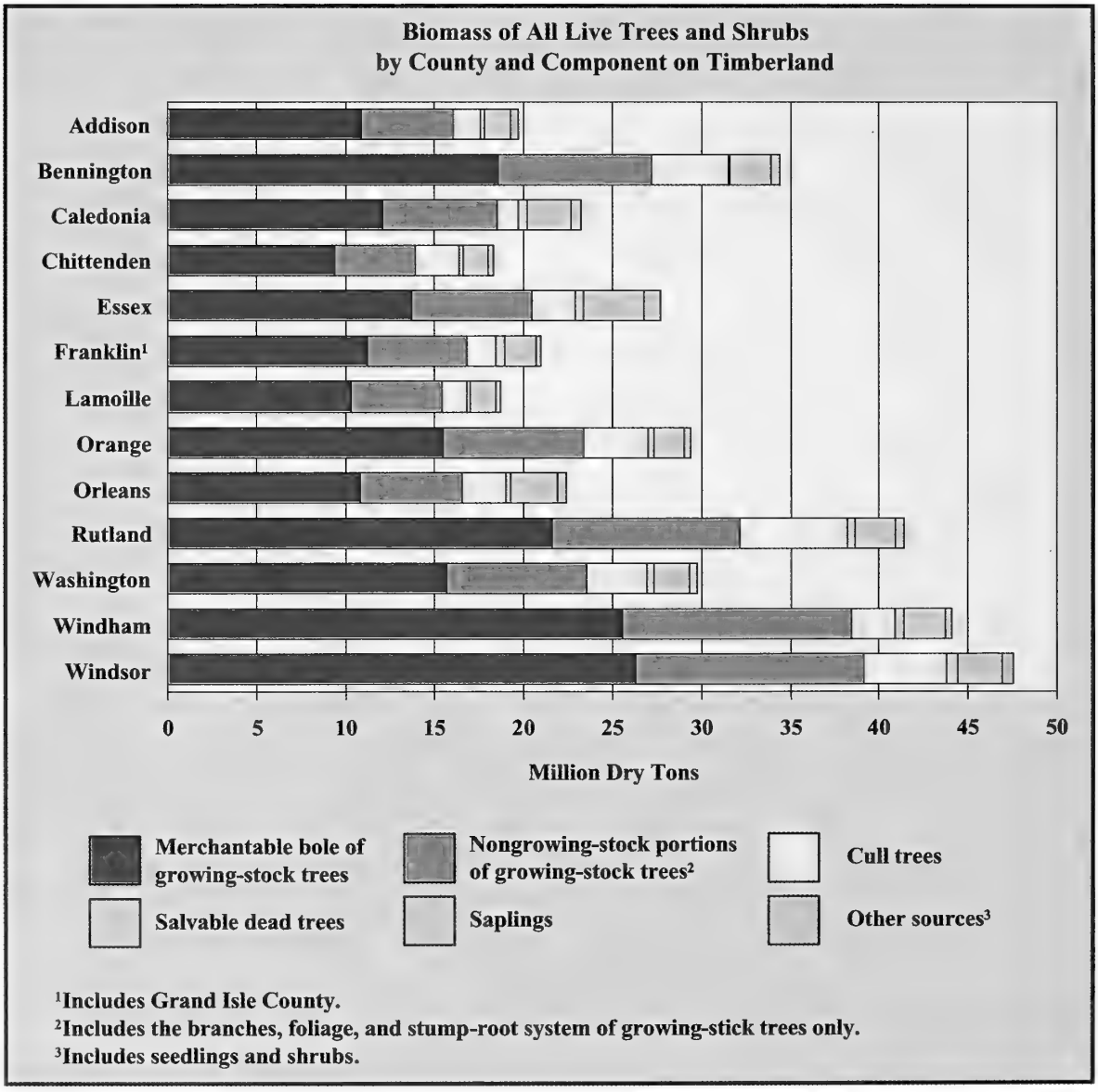
Timber Volume

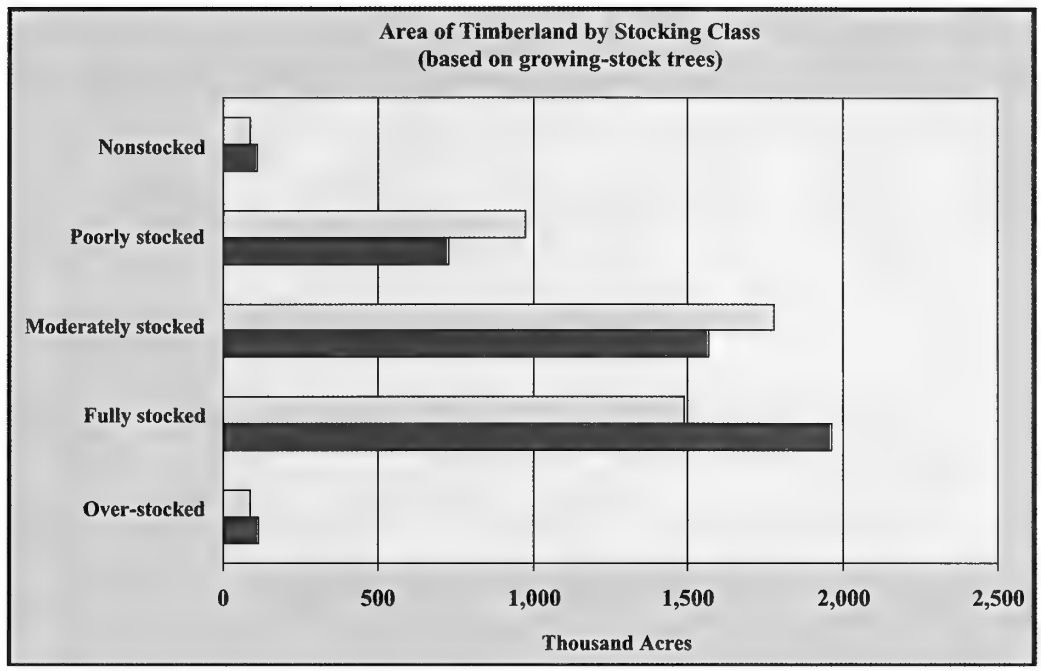
The volume of timber in Vermont has increased by nearly 75 percent over the past three decades, from 5.0 billion cubic feet of growing stock in 1973 to 8.7 billion cubic feet today. Initially, most of this increase was in hardwoods, but both softwoods and hardwoods increased at nearly the same rate between 1983 and 1997. The trend was similar for sawtimber, which doubled from 1973 to 1997. During that time, hardwood sawtimber increased by nearly 45 percent, though softwoods increased at a faster rate between 1983 and 1997.

Sugar maple leads all species in both growing-stock and sawtimber volume. Vermont's sugar mapling industry is an excellent example of a sustained forest use that does not require tree removal.

Distribution of the Total Resource

Standard means of measuring the forest, e.g., in cubic feet or board feet, can exclude as much as half of the total quantity of trees and shrubs. One way to capture this material is by measuring its weight of biomass. In 1997, the forests of Vermont contained more than 375 million dry tons of tree and shrub material. The bulk of this biomass (54 percent) was in growing stock. The remainder was in nongrowing-stock components: portions of growing-stock trees outside of the merchantable bole (26 percent), cull trees (10 percent), saplings between 1.0 and 5.0 inches in diameter at breast height (d.b.h.) (7 percent), seedlings and shrubs (2 percent), and salvable dead trees (1 percent).





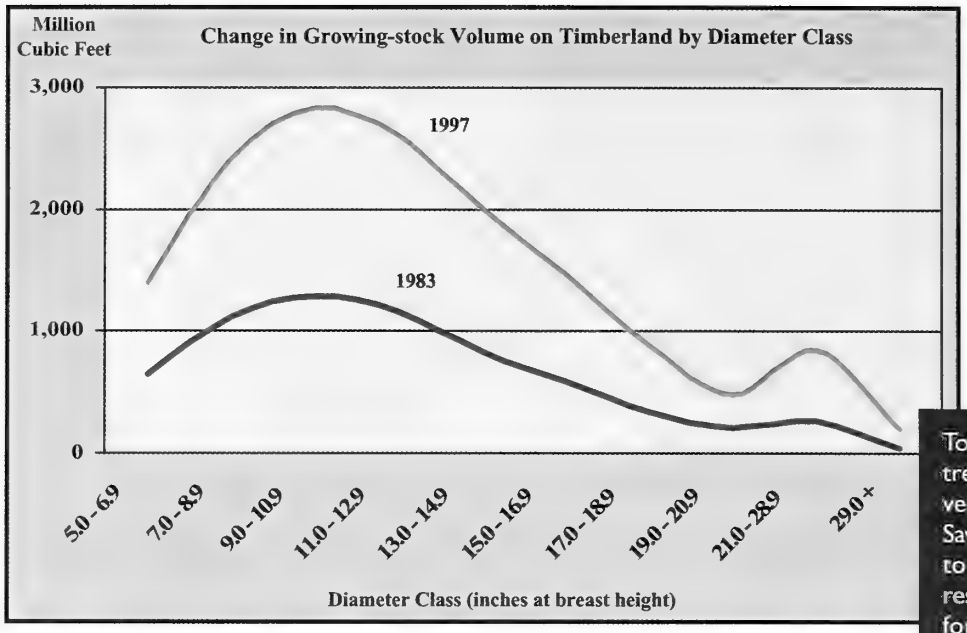
Timber Supply

Stocking Levels

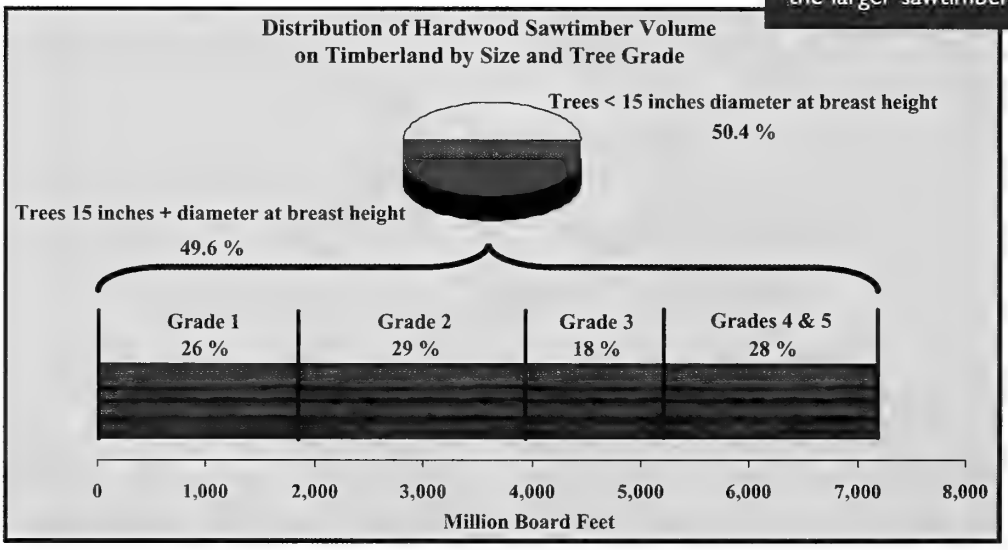
Forests use tree size and number per acre to determine how well a stand is stocked. Measures of stocking in growing-stock trees indicate how well a site is being used to grow trees of economic value. In fully stocked stands, trees are fully using the potential of the site. If allowed to grow, these stands eventually will become overstocked. In overstocked stands, trees become crowded and growth slows. Such trees are less vigorous and more susceptible to insect and disease attacks than less crowded stems. If not thinned or removed, commercial trees will die and their value for timber products will be lost.

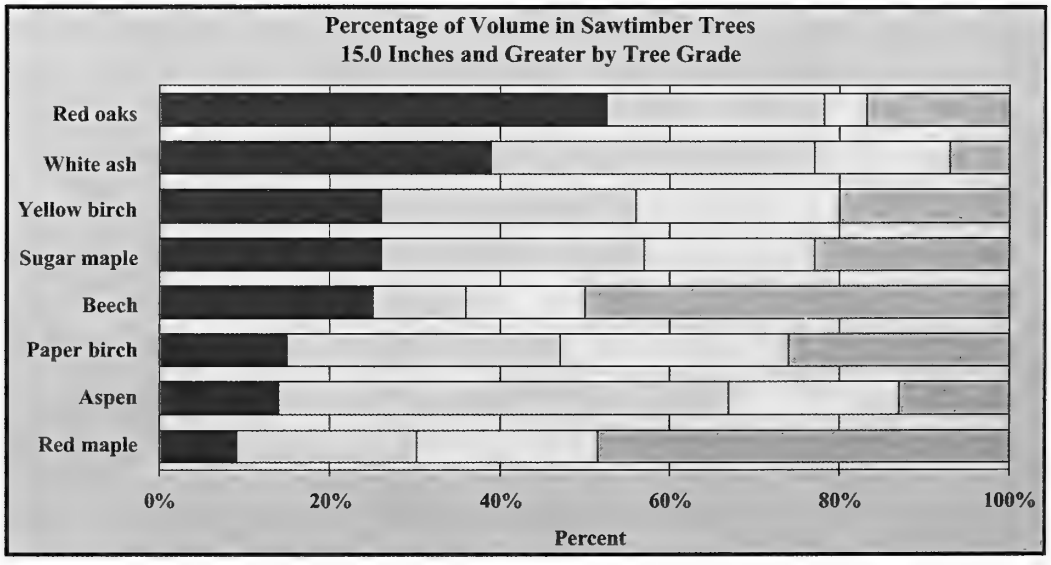
Poorly stocked stands have widely spaced trees or trees with little or no commercial value. These stands often are the result of removing the largest and most vigorous trees and leaving those with poor form or that are otherwise weakened. This creates gaps in the forest canopy.

Historically, Vermont's forests have increased in stocking levels. The number of acres of poorly and moderately stocked stands has decreased while fully stocked stands have increased. The abundance of these stands presents opportunities for management without reducing forest growth, and for preventing overstocking.



To be classified as sawtimber, hardwood trees must be at least 11.0 inches in d.b.h. versus at least 9.0 inches for softwoods. Sawlogs must be at least 15.0 inches in d.b.h. to quality as grade 1 logs. In a maturing resource such as Vermont's forests, curves for diameter-class distribution reveal an increase in volume while moving toward the larger sawtimber-size classes.





Timber Quality

The value of a tree for timber products rises as the tree becomes large enough to produce high-value products. Value increases first as trees grow large enough to produce small sawlogs, and again as the trees become large enough to produce high-grade sawlogs or veneer logs. Small trees that can be used to produce pulpwood (cord wood) typically are sold by landowners for about $10 per cord. If the same amount of wood were sold as high-grade, quality sawlogs, the landowner could realize 500 or more times as much.

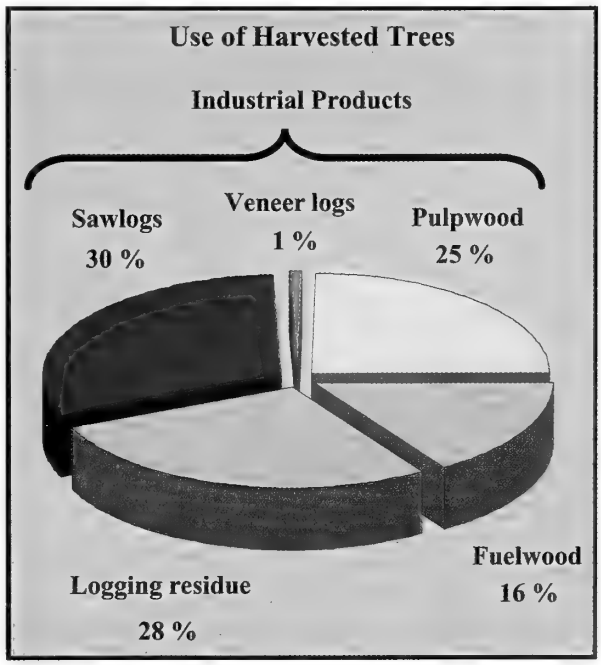
Birch Sawlogs at Vermont Sawmill

Although the timberland base remained essentially unchanged from 1983 to 1997, the inventory of growing-stock volume, increased significantly, up 33 percent since 1983. Today, as much as 71 percent of this volume is in poletimber and small sawtimber (less than 15.0 inches in d.b.h.). However, the volume of trees larger than 15.0 inches in d.b.h. increased by nearly 70 percent from 1983 to 1997.

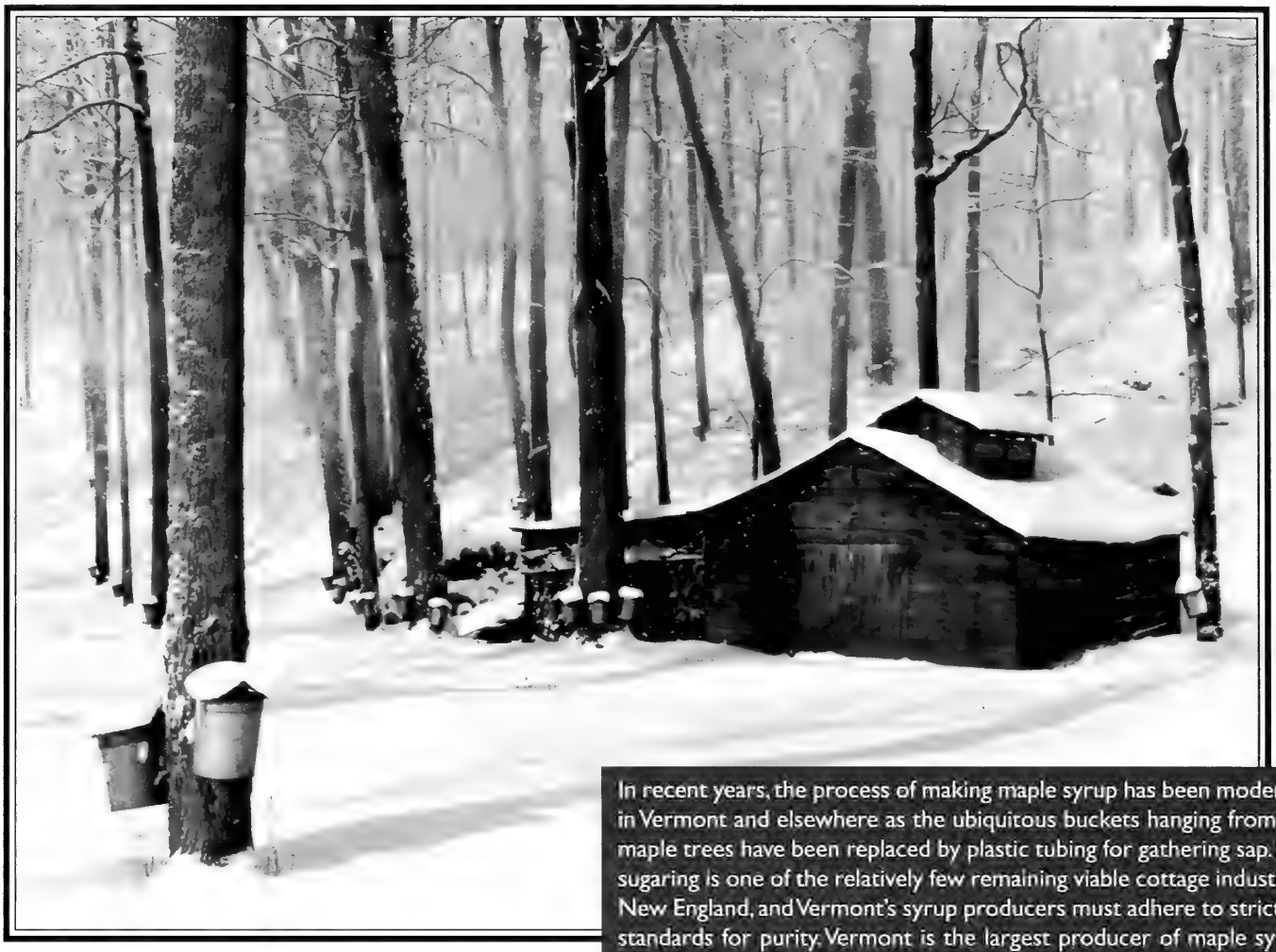
Northern red oak has the greatest percentage of trees that are 15.0 inches or larger in d.b.h., followed by white ash, yellow birch, and sugar maple. Half of these large red oak trees were grade 1 versus 9 percent for large red maple trees. Increases in board-foot volume for red maple and hemlock have outpaced those of some of the more valuable tree species.

Products from Vermont's Forests

Unlike coal and oil reserves, the forest resource renews itself, that is, trees can be thought of as a crop—stands can be harvested today and again by future generations. Vermont's forests have been harvested repeatedly for a variety of wood products, yet the State's forests remain productive and continue to provide a host of benefits. Except for parks and preserves, nearly all forests have been harvested at least three times. The keys to this remarkable sustainability are sensible regulation and the adoption of Best Management Practices by timber harvesters.



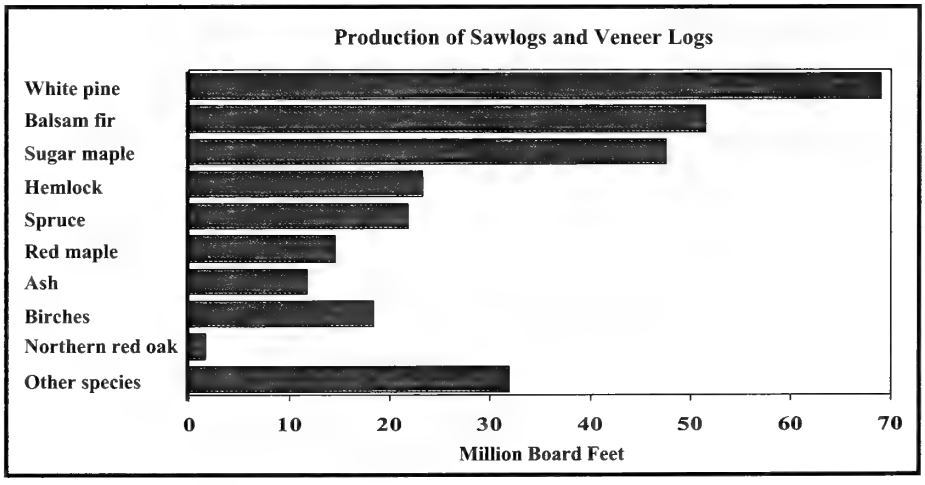
Typically, when a tree is harvested, the high-quality lower trunk is used for lumber and veneer while the upper stem and large branches are used for pulpwood and firewood, as are small trees and undesirable species. Parts of the tree are left in the woods as logging residue, which aids in returning nutrients to the soil for future tree growth. In Vermont, 56 percent of the total volume of harvested trees is used for industrial products, 28 percent is logging residue, and 15 percent is converted to fuelwood.



Sugar Shack in Mendon, Vermont

In recent years, the process of making maple syrup has been modernized in Vermont and elsewhere as the ubiquitous buckets hanging from sugar maple trees have been replaced by plastic tubing for gathering sap. Maple sugaring is one of the relatively few remaining viable cottage industries in New England, and Vermont's syrup producers must adhere to strict state standards for purity. Vermont is the largest producer of maple syrup in New England (55 percent) and the nation (37 percent). In 1998, the value of syrup produced within the State exceeded $10 million.

Sawlogs, veneer logs and pulpwood are the primary industrial uses for wood harvested in Vermont. Wood used for specialty products such as dowels and turning stock is included with sawlogs. Furniture manufacturers from around the world have recognized the State for its high-quality hardwood lumber, particularly that from sugar maple. Also valued is lumber produced from Vermont's white pine, spruce, white ash, red maple, and birches. In 1996, 281.6 million board feet of sawlogs and 9.4 million board feet of veneer logs were harvested. Pulpmills in neighboring states and Canada provide important markets for low-value wood. About 415,000 cords of pulpwood—divided nearly equally between hardwoods and softwoods—were shipped out of the State in 1996.

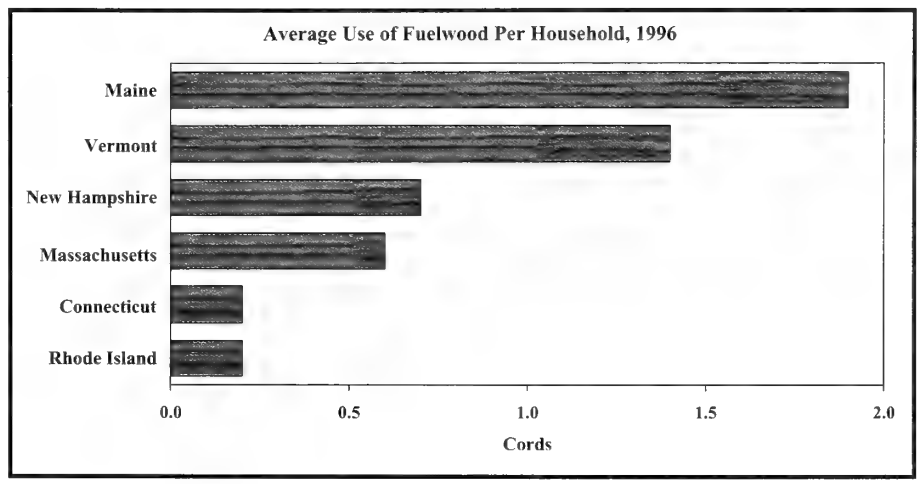


Besides commercially valuable timber, Vermont's forests produce maple syrup and candy, boughs, cones, and floral

Firewood Stacked in Belmont, Vermont

greenery, weaving and dyeing materials, botanical flavorings and medicinal herbs, mushrooms and berries, and specialty and novelty items. Early settlers relied on forests as an essential source of raw materials needed for daily life. Today, commercial markets provide substitutes for most of these products. Nevertheless, a substantial number of Vermonters continue to gather or make them as a means of supplementing the family income.

Fuelwood includes that which is burned by many Vermont homeowners for heat as well as wood burned in commercial boilers. In 1996, more than 285,000 cords of wood—mostly hardwoods—were used for fuelwood. On average, each household in the State used 1.4 cords, second only to homeowners in Maine. About 75 percent of the fuelwood in Vermont is from dead and cull forest trees and trees from yards and fence rows.



Average Annual Net Growth and Removals

Top 12 species	Net growth (Million cubic feet)	Removals (Million cubic feet)	Growth To Removals Ratio
Sugar maple	35.4	(15.5)	2.3 : 1
Red maple	23.0	(8.7)	2.6 : 1
Hemlock	20.6	(6.1)	3.4 : 1
White pine	19.0	(15.0)	1.3 : 1
Balsam fir	12.2	(8.7)	1.4 : 1
Ash	11.1	(3.6)	3.1 : 1
Spruce	8.8	(9.5)	0.9 : 1
Oaks	6.6	(2.5)	2.7 : 1
Beech	6.2	(5.3)	1.2 : 1
Yellow birch	6.0	(6.2)	1.0 : 1
Aspen	4.7	(3.1)	1.5 : 1
Paper birch	2.6	(4.2)	0.6 : 1
State total	164.8	(92.9)	1.8 : 1

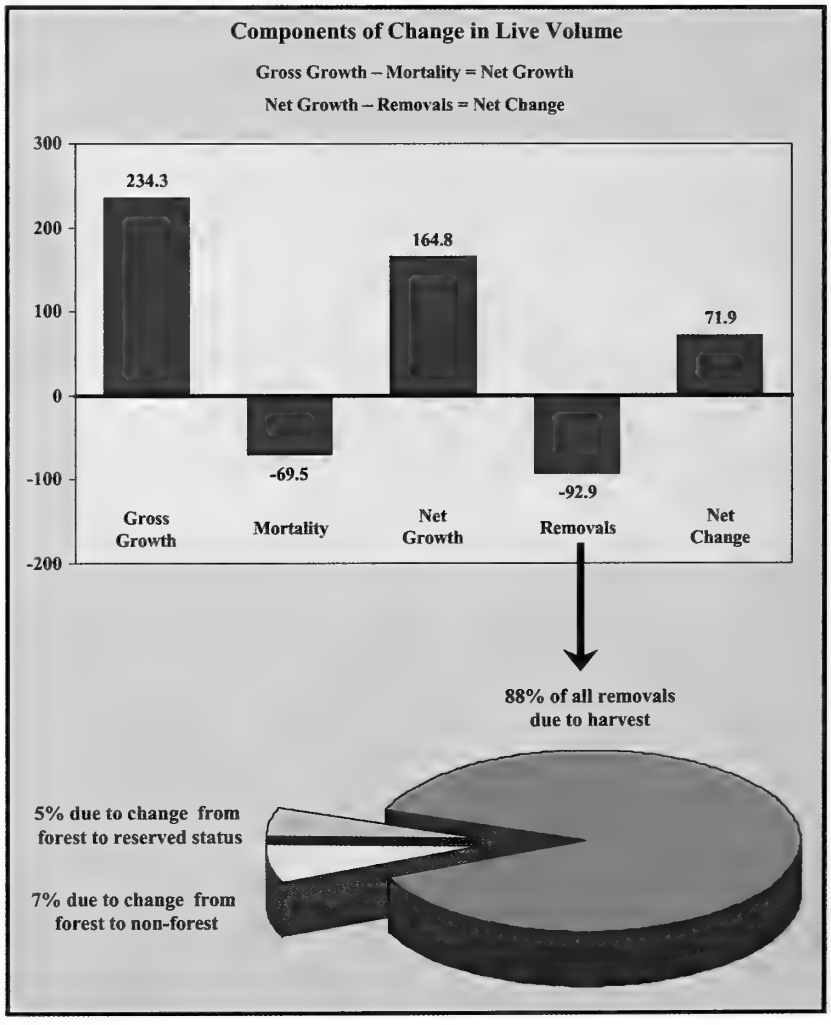
• Estimates of growth and removals are made from only remeasured plots.

• These estimates can differ from volume change estimates that are made using all plots.

Sustainability

The self-sustaining nature of forests is measures by their ratio of growth to removals. Net growth is the total growth of trees plus gains from land coming into forest, minus losses to mortality to insects and disease outbreaks and disturbances such as wind and ice storms. Removals include harvesting plus losses due to changes in land use. In Vermont, the net growth of trees has exceeded removals since the first FIA inventory in 1948. Between 1983 and 1997, annual net growth averaged 164.8 million cubic feet versus an average of 92.9 million cubic feet in annual removals. Eighty-eight percent of removals is due to harvesting, 7 percent to the conversion of forests to nonforest uses, and 5 percent to the reclassification of forest land to the reserved or other noncommercial categories.

This surplus growth amounts to an annual net increase of 71.8 million cubic feet (0.8 percent), and underscores increases in tree numbers, size, and volume. During the past decade, the ratio of net growth to removals has been about 1.8 to 1, that is, nearly two times as much wood was grown as was harvested. In Vermont, tree species with the most favorable growth-to-removals (G/R) ratio are, in order, hemlock, ash, the oaks, red maple, sugar maple, and aspen. Historically, more softwoods (other than hemlock) than hardwoods have been cut in Vermont. From 1983 to 1997, the G/R ratio for spruce and paper birch was 0.9 and 0.6 to 1, respectively.



Hemlock Woolly Adelgid Infestation

Forest Health

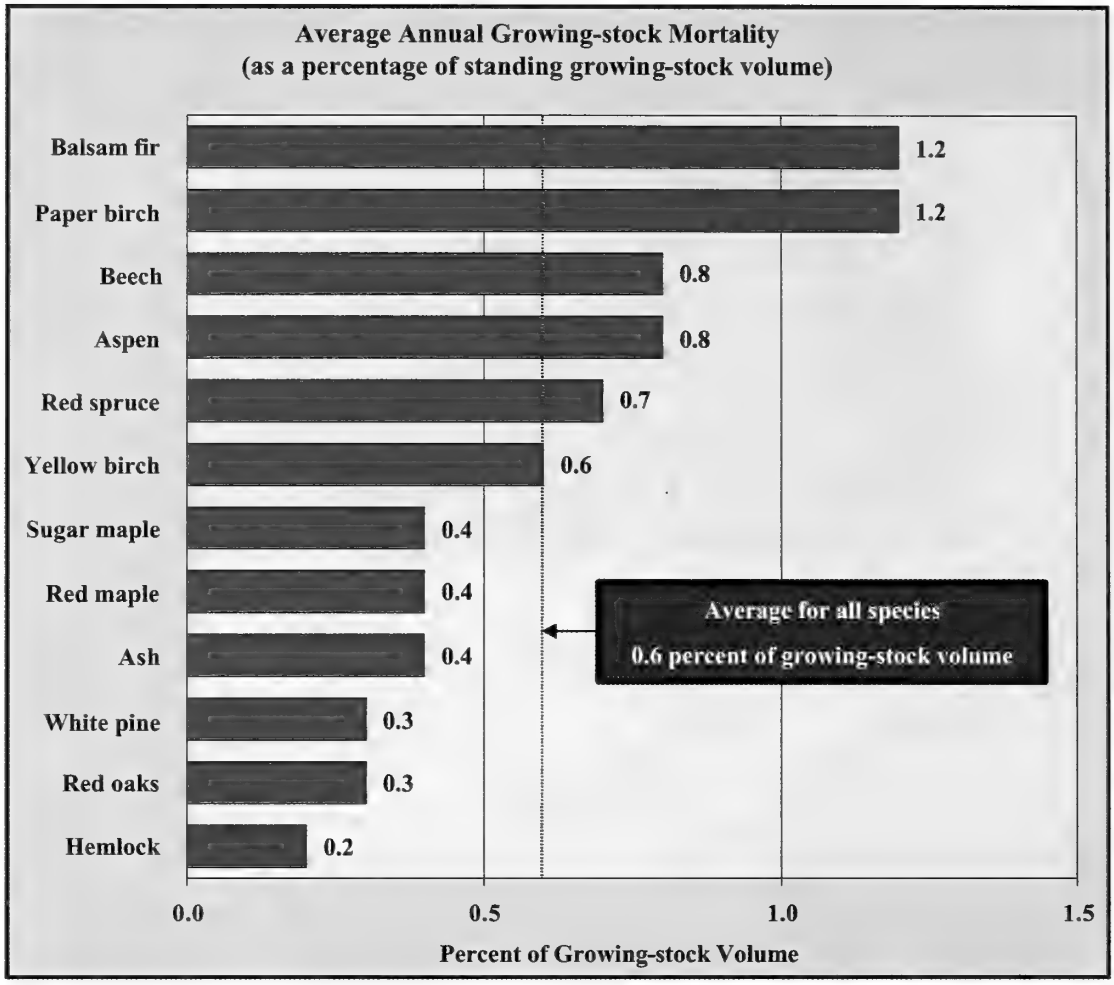
Insects and Diseases

In 1997, sugar maple, spruce, and fir incurred considerable dieback from attacks by a variety of biotic and abiotic agents. Thousands of acres of Vermont's hardwood forests were killed or declined due to the effects of frost, drought, or flooding (the latter attributed to beaver dams). In 1990, the State experienced a small infestation of the hemlock woolly adelgid (HWA), which sucks the sap from young twigs. Such trees become weakened and die within several years. Since the initial HWA outbreak, state officials have imposed a quarantine on nursery stock, though recent infestations by HWA in surrounding states have been a cause of concern among scientists and land managers.

The widespread damage incurred by oaks in Vermont and neighboring states due to gypsy moth has been well documented. By the early 1930's, this insect pest had reached the eastern portion of the State. Today, the gypsy moth is found nearly everywhere in Vermont. Only persistent control efforts have helped minimize its adverse effects. Conversely, little can be done under forest conditions to control the *Strumella* canker, which attacks the oaks, particularly white oak.

Although elm is a minor species in Vermont's forests, its graceful charm and ability to grow well in compacted soils and under polluted conditions have made it a favorite in urban settings. But since the 1930's when Dutch elm disease made its way to the United States via diseased logs brought here from Europe, millions of elms have been killed and those that remain are threatened. Control is impractical under forest conditions as sanitation (removal) is the only effective treatment.

Other agent that damage the State's forest trees include white pine blister rust, which causes dieback in mature trees and kills seedlings and saplings; Bruce spanworm, which has been found on sugar maple; birch leafminer, which in 1997 defoliated 4,500 acres, most of which were in the Green Mountains; spruce gall adelgid, commonly found in nurseries, Christmas tree plantations, and urban settings, maple leafcutter, which defoliated or caused decline in more than 9,500 acres in 1997; beech bark disease, which continues to cause scattered mortality; and eastern dwarf mistletoe, which damages spruce.



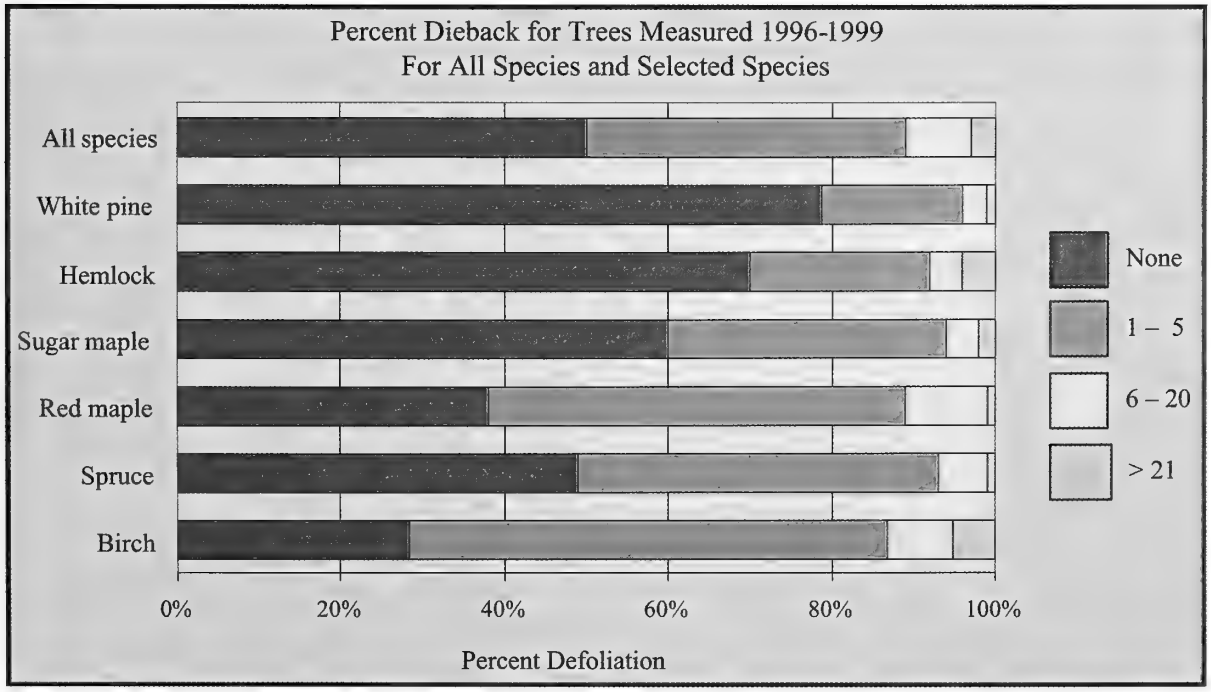
Mortality

Fire, wind, ice, insects, diseases, and other destructive agents contribute to tree mortality. From 1983 to 1997, average annual mortality was nearly 48 million cubic feet of growing stock, or 0.6 percent of the standing growing-stock volume of 1997. Trees incurring the most mortality were balsam fir, paper birch, beech, aspen, and red spruce. The high mortality of fir and spruce is attributed to an outbreak of spruce budworm that lasted from 1974 to 1984; beech trees across New England and New York were devastated by beech bark disease. The high mortality rate for some species was caused by the ice storm that ravaged the area during the winter of 1997-98. And many of the surviving trees that sustained heavy damage likely will die prematurely. The mortality of the relatively short-lived paper birch and aspen is related more to natural changes that occur in a forest. Despite this widespread mortality, the primary forest-tree species of Vermont are healthy and vigorous. Even elm mortality is only 19.9 percent of its growing-stock volume.

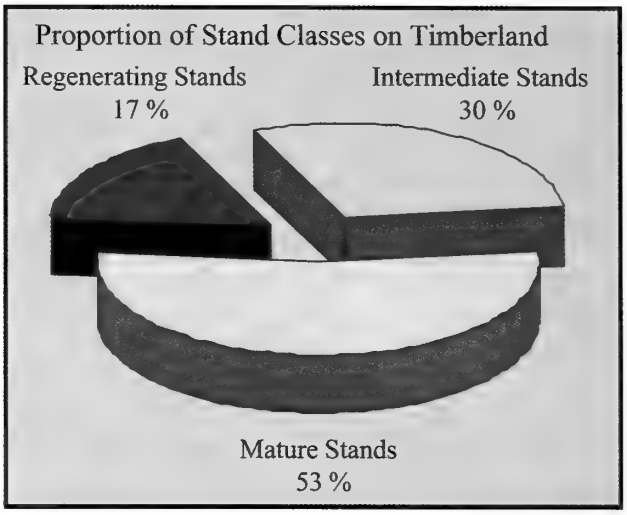
Crown Dieback

Simply tracking mortality due to damaging agents such as insects and diseases does not provide a complete picture of forest health. Vermonters have long been inundated with prophesies of withering vegetation, heavy defoliation, and denuded hillsides from exotic agents ranging from acid rain to global climate warming. In response to these dire warnings, the National Forest Health Monitoring Program looked at a wide set of indicators that reflect forest conditions, including crown dieback. Eighty percent of the forest trees in Vermont that were measured by Program scientists had no or little dieback and only 3 percent had more than 20-percent dieback.

Evidence of Crown Dieback in Sycamore

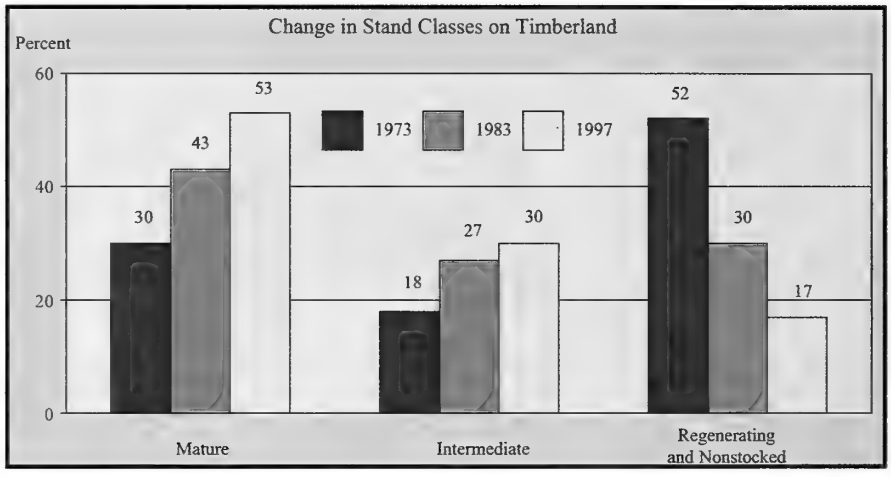


Vermont's Changing Forest



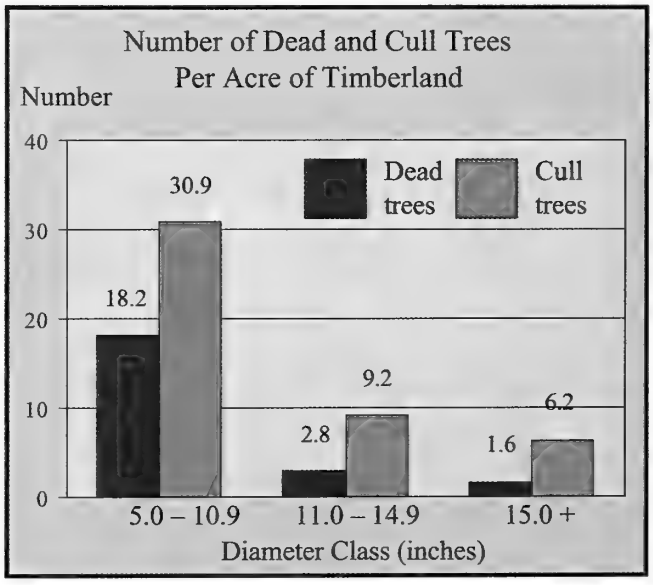
Stand Size

The number of wildlife species that inhabit a forest environment change as the forest matures. In sapling-seedling stands that regenerate following major disturbances such as fire, clearcutting, and land abandonment, some wildlife species use the low-growing and shrub vegetation. In Vermont, examples include the song sparrow, American goldfinch, cedar waxwing, eastern cottontail, and moose. The area in such regenerating stands has declined in the State because most of the farm land that was abandoned has reverted to forest. Among the wildlife species that inhabit mature stands, which have increased as a result of the overall growth and maturing of Vermont's forests, are the pileated woodpecker, porcupine, black bear, and fisher, beaver, white-tailed deer, and wild turkey.



Wildlife Habitat

Hard mast such as nuts and hard seeds produced by overstory trees is an important source of forage for forest wildlife in Vermont. Wildlife species that depend on acorns and other mast include bear, deer, turkey, ruffed grouse, red-headed woodpecker, blue jay, squirrel, chipmunk, gray fox, and striped skunk. Beech and the oaks are important mast-producing tree species. Since 1983, oak and beech trees that are 11 inches or more in diameter at breast height (4.6 feet above the ground) have increased by 26 and 50 percent, respectively. Standing dead and cull trees are important feeding and nesting sites for wildlife. Cavities in these trees are used by the woodpecker, other cavity-nesting birds, and small mammals.



In Vermont, 11 percent of all standing trees are dead. There are 24 dead trees per acre of timberland in trees 5.0 inches or larger in diameter, and 1.6 dead trees per acre in those 15.0 inches or larger in diameter, Sugar maple and beech have the most large-diameter dead trees; balsam fir has the most dead trees with a diameter of 5.0 to 10.9 inches. Cull trees are those that exceed maximum allowances for defects for the manufacture of timber products. Yet some of the characteristics that make these trees undesirable for forest products are beneficial to wildlife. Besides cavities, these include broken tops, pockets of rot, and tree boles with numerous forks and limbs. On average, there are 21 cull tree per acre of timberland in Vermont.

Fading Autumn in Danby, Vermont

Vermont's Future Forests

Over the past half century in Vermont, the amount of abandoned farm land that has reverted to forests has more than offset losses of forest land due to development. It is doubtful that this trend will continue because there are fewer farms and continued development pressure from a growing State population. Population increases also influence how forests are used as greater demands are placed on them to produce both traditional and nontraditional benefits. At the same time, the parcelization of timberland into smaller holdings has made it more difficult to use the forest in traditional ways. Landowners with small holdings are less likely to manage their forest tracts for timber products. Also, many of these small parcels are home sites, which makes it unlikely that owners will allow others to use their land.

Vermont's valuable forests have been maturing since 1948. These forests have more and larger trees and by all measures and despite repeated attack by damaging agents ranging from ice to insects are healthy and vigorous. There have been subsequent changes in species composition, through cutting has interfered with this natural process. Low cutting rates and shaded conditions on the forest floor have promoted the growth of hemlock and red maple throughout the State. Currently, species that require full sunlight to reproduce, e.g., aspen, paper birch, and white pine, are at a distinct disadvantage in the more prevalent shaded forested areas.

For more information contact:

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  (610) 557-4051; www.fs.fed.us/ne/fia/
- Vermont Department of Forests, Parks, and Recreation,
  103 South Main Street, Waterbury, Vermont 05671-0601
  (802) 241-3670; www.state.vt.us/anr/fpr/index.htm

Wharton, Eric H.; Widmann, Richard H.; Barnett, Charles H.; Frieswyk, Thomas S.; Lister, Andrew J.; DeGeus, Bob. 2003. **The forests of the Green Mountain State.** Resour. Bull. NE-158. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 25 p.

A report on the fifth forest inventory of Vermont conducted in 1996-98 by the Forest Inventory and Analysis unit of the Northeastern Research Station. Explains the current condition and changes from previous inventories for forest area, timber volume, biomass, growth and removals, and harvesting. Graphics depict data at the state and geographic-unit level and, where appropriate, by biophysical region and county.

Keywords: forest inventory; volume; biomass; growth and removals; Vermont.

Headquarters of the Northeastern Research Station is in Newtown Square, Pennsylvania. Field laboratories are maintained at:

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