New York's Forests 2007

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Abstract

This report summarizes the first full annual inventory of New York's forests, conducted in 2002-2007 by the U.S. Forest Service, Northern Research Station. New York's forests cover 19.0 million acres; 15.9 million acres are classified as timberland and 3.1 million acres as reserved and other forest land. Forest land is dominated by the maple/beech/birch forest type that occupies more than half of the forest land. The volume of growing stock on timberland has been rising and currently totals 29.2 billion cubic feet, enough to produce saw logs equivalent to 87.1 billion board feet. On timberland, average annual growth of growing stock outpaced removals by a ratio of 2.0:1. The net change in growing-stock volume averaged 1.2 percent per year in 1993-2007. This report includes additional information on forest attributes, land use, forest fragmentation, forest ownership, forest health indicators, timber products, and statistics and quality assurance of data collection. Detailed information on forest inventory methods and data quality estimates is included in a DVD at the back of this report. Tables of population estimates and a glossary are also included.

Acknowledgments

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Cover: Adirondacks, St. Regis Canoe Area. Photo by Richard H. Widmann.

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Contents

Little Tupper Lake. Photo by Richard H. Widmann.

Highlights

On the Plus Side

Statewide forest land area, now totaling 19.0 million acres, continues to increase, although the 377,000-acre increase (2 percent) in forest area since 1993 represents a slowing of this trend. Of the 19.0 million acres, 15.9 million are classified as timberland and 3.1 million as reserved and other forest land. The State is 63 percent forested.

In much of New York, forest land occurs as a relatively contiguous forest matrix including urban development, agriculture, roads, and other nonforest areas.

Nearly a fourth of New York's forest land is in public ownership (does not include publicly owned easements on private land).

Across the State, forests have continued to mature as large amounts of timberland have grown to sawtimber size. Accompanying this is a shift in the species composition of forest to more shade-tolerant species. Overall, most species that are well represented by large trees are also well represented in the sapling size class, indicating only small changes in the composition of New York's forest. The maturing of forests and the shift to more shade-tolerant species is most evident on the State-owned reserved forest in the Adirondacks.

The volume of growing stock on timberland has been rising and currently totals 29.2 billion cubic feet; that portion is large enough to produce saw logs equivalent to 87.1 billion board feet or 16.6 billion cubic feet.

Average annual growth outpaced removals by a ratio of 2.0:1.

As a percentage of current volume, net growth was 2.4 percent per year and removals was 1.2 percent, resulting in an annual increase in volume of 1.2 percent.

Issues to Watch

The 3.1 million acres (20 percent) of timberland that is poorly stocked or nonstocked with commercially important species represents a loss of potential growth, although these forests still provide other benefits such as habitat diversity and watershed protection.

Continued losses of sapling/seedling stands could be problematic for species such as ruffed grouse that prefer dense patches of young trees for at least part of their life cycle.

Written management plans exist on just 9 percent of the family owned forest land, although plans exist on roughly a fifth of the State's timberland across all ownerships.

The relatively high number of family forest owners who have actually harvested trees (53 percent of owners holding 67 percent of family forests) shows that when conditions are right most landowners will harvest trees, although the low priority given to timber production probably means that these harvests are not part of a long-term management plan.

The high number of owners who are 65 years or older (44 percent) and the large amount of land held by owners who are planning to transfer ownership in the next 5 years (10 percent of owners holding 15 percent of the family forest land) foretell a large turnover of forest land.

Regeneration of some important timber species (northern red oak, white pine, and black cherry) lags behind that of other species.

It is unlikely that many young beech trees will reach large size because of beech bark disease. This limits the

Down woody material. Photo by Richard H. Widmann.

value of beech for producing hard mast for wildlife and for timber products. High numbers of beech saplings in some areas are interfering with the reproduction of other species.

Emerald ash borer, a lethal pest found in New York, will increase ash mortality in both urban and forested landscapes. It will likely cause significant financial costs to municipalities, property owners, and the forest products industries in the State.

New York has more hemlock volume than any other state. As the hemlock woolly adelgid continues spreading north and west into the rest of the State (likely over the next two decades), it will move into forests where densities of eastern hemlock are much higher than where it has already been.

Introduction

This inventory was a cooperative effort of the Northern Research Station, the New York Department of Environmental Conservation, and landowners of New York. It is the culmination of the first complete inventory of New York's forests using FIA's annualized forest inventory system. Previous inventories were completed in 1953 (Armstrong and Bjorkbom 1956), 1968 (Ferguson and Mayer 1970), 1980 (Considine and Frieswyk 1982), and 1993 (Alerich and Drake 1995). These inventories provided a snapshot of the forest for specific periods in time after which no new information was available until the next full inventory of the State. Henceforth, inventory data for the State will be updated annually and full remeasurement of all inventory plots will occur on a 5-year cycle. This inventory includes, for the first time, estimates for State-owned forest land in the Catskill and Adirondack Preserves. FIA is the only forest inventory that uses a permanent network of ground plots spanning the entire U.S. Data are collected consistently across the Nation enabling comparisons among states and regions. Having current inventory information always available should help in making better decisions about New York forests and in planning for the future.

FIA groups counties that have similar forest cover, soil, and economic conditions into geographic units. New York is subdivided into eight geographic units (Fig. 4). Because of the larger number of plots used to make estimates at the unit level and because plots were stratified at the unit level into estimation units, unit level estimates are more accurate than county level estimates. Analysis in this report is presented at the state and unit levels. County level data, which are included in a DVD at the back of this report or available by querying the database using online tools, should be used with caution.

More details on forest area estimation and other estimation procedures are included in the Data Sources and Techniques section at the back of this report and on the accompanying DVD.

Background

Indian Lake. Photo by Richard H. Widmann.

A Beginners Guide to the Forest Inventory

What is a tree?

The FIA program of the U.S. Forest Service defines a tree as a perennial woody plant species that can attain a height of at least 15 feet at maturity.

What is a forest?

FIA defines forest land as land that is at least 10 percent stocked by trees of any size or formerly having been stocked and not currently developed for nonforest use. The area with trees must be at least 1 acre in size and 120 feet wide.

What is the difference between timberland, reserved forest land, and other forest land?

New York's forest land is broadly classified into three components that describe the potential of the land to grow timber products: reserved forest land, timberland, and other forest land. Two criteria are used to make these designations: site productivity (productive/unproductive) and reserved status (reserved/unreserved). Forest land, where harvesting is restricted by statute or administrative designation, is classified as reserved forest land regardless of its productivity class. Most land in this category is State-owned land in the Adirondack and Catskill Parks, the Allegheny State Park, and various state and national parks. FIA does not use the harvesting intentions of private owners as a criterion for determining whether forests should be classified as reserved. Timberland is forest land without legal harvesting restrictions and capable of growing trees at a rate of at least 20 cubic feet per acre (equivalent to about ¼ cord) per year. The other forest land category is unreserved and low in productivity. It is incapable of growing trees at a rate of 20 cubic feet per acre per year. In New York, this includes mainly wet areas where water inhibits tree growth and some mountain tops with extremely thin soils. These categories help increase our understanding of the availability of forest resources and in forest management planning.

The 2007 inventory of New York includes the first complete measurement of plots in the Adirondack and Catskill Parks that are State owned. Because there are no previous measurements for these plots, estimates of change for these areas cannot be made. Previous inventories did include privately owned forests within these areas.

How is forest land area estimated?

FIA has established a set of permanent inventory plots across the U.S. that are periodically revisited. Each plot consists of four 24-foot-radius subplots for a total area of approximately one-sixth of an acre.

Each plot is randomly located within a hexagon that is approximately 6,000 acres in size. Therefore, each plot represents about 6,000 acres of land and can be used to generate unbiased estimates, and associated sampling errors, for attributes such as total forest land area. For information on sampling errors, see the Statistics, Methods, and Quality Assurance DVD at the back of this report. Full details of all estimation procedures are available in Bechtold and Patterson (2005)

How do we estimate the number of trees?

On the forested portions of each plot, all trees that have diameters of at least 5.0 inches at breast height (4.5 feet) are tallied. Because the total area sampled is known and the number of trees counted in this area, estimates of the number of trees can be made.

Saplings, trees between 1.0 and 4.9 inches, and seedlings are inventoried on 6.8-foot-radius microplots nested within each subplot. The estimation procedure is analogous to that described above.

How do we estimate a tree's volume?

The volume for a specific tree species is determined by the use of volume equations developed specifically for a given species. Several volume equations have been developed at the Northern Research Station for each tree species found in the region. Models have been developed from regression analysis to predict volumes within a species group. We produce individual tree volumes based upon species, diameter, and merchantable height. Tree volumes are reported in cubic-foot scale and International ¼-inch rule board-foot scale.

What do stocking levels mean?

Stocking is the degree of occupancy of land by trees relative to the growth potential of the site being utilized. It is expressed as a percent of the "normal" value presented in yield tables and stocking guides. Two categories of stocking are used in this report: all live trees and growing-stock trees. The relationships between the classes and the percentage of the stocking standard are nonstocked (0 to 9), poorly stocked (10 to 34), moderately stocked (35 to 59), fully stocked (60 to 100), and overstocked (greater than 100). Current stocking levels should not be compared to those in previous periodic inventories because of changes in the stocking algorithm.

How much does a tree weigh?

Specific gravity values for each tree species or group of species were developed at the U.S. Forest Service's Forest Products Laboratory and applied to FIA tree volume estimates for developing merchantable tree biomass (weight of tree bole). To calculate total live-tree biomass, we have to add the biomass for stumps (Raile 1982), limbs and tops (Hahn 1984), and belowground stump and coarse roots (Jenkins et al. 2004). We do not currently report live biomass for foliage. FIA inventories report biomass weights as oven-dry short tons. The oven-dry weight of a tree is the green weight minus the moisture content. Generally, 1 ton of oven-dry biomass is equal to 1.9 tons of green biomass.

How do we compare data from different inventories?

New inventories are commonly compared with older datasets to analyze trends or changes in forest growth, mortality, removals, and ownership acreage over time. A pitfall occurs when the comparison involves data collected under different schemes or processed using different algorithms. Recently, significant changes were made to the methods for estimating tree-level volume and biomass (dry weight) for the northeastern states, and the calculation of change components (net growth, removals, and mortality) was modified for national consistency. These changes have focused on improving the ability to report consistent estimates across time and space—a primary objective for FIA. Regression models were developed for tree height and percent cull to reduce random variability across datasets.

Because of changes in how growing-stock volume is calculated, we recommend that those wishing to analyze trend information use the current estimates of annual growth, removals, and mortality instead of comparing inventory volumes in this report to previous inventories. These annual estimates of change, presented in Figures 52 though 57, are based on the current algorithms and are a better estimate of change since 1993. Trends presented in these figures should be considered more accurate than those shown by comparing volumes for 1993 and 2007 volumes.

Before the Component Ratio Method (CRM) was implemented, volume and biomass were estimated using separate sets of equations (Heath et al. 2009). With the CRM, determining the biomass of individual trees and forests has become simply an extension of our FIA volume estimates. This allows us to obtain biomass estimates for growth, mortality, and removals of trees from our forest lands, not only for live trees, but also for their belowground coarse roots, standing deadwood, and down woody debris.

Another new method, termed the "midpoint method," has introduced some differences in methodology for determining growth, mortality, and removals to a specified sample of trees (Westfall et al. 2009). The new approach involves calculating tree size attributes at the midpoint of the inventory cycle (2.5 years for a 5-year cycle) to obtain a better estimate for ingrowth, mortality, and removals. Although the overall net change component is equivalent under the previous and new evaluations, estimates for individual components will be different. For ingrowth, the midpoint method can produce a smaller estimate because the volumes are calculated at the 5.0-inch threshold instead of using the actual diameter at time of measurement. The actual diameter could be larger than the 5.0-inch threshold. The estimate for accretion is higher because growth on ingrowth, mortality, and removal trees is included. As such, the removals and mortality estimates will also be higher than before (Bechtold and Patterson 2005).

A word of caution on suitability and availability

Other than the broad categories of reserved forest land, timberland, and other forest land, FIA does not attempt to identify which lands are suitable or available for timber harvesting especially because suitability and availability are subject to changing laws and ownership objectives. Simply because land is classified as timberland does not mean it is suitable or available for timber production. Forest inventory data alone are inadequate for determining the area of forest land available for timber harvesting because laws and regulations, voluntary guidelines, physical constraints, economics, proximity to people, and ownership objectives may prevent timberland from being available for production.

Forest Features

Stand of hemlock and yellow birch. Photo by Richard H. Widmann.

Dynamics of the Forest Land Base

Background

The amounts of forest land and timberland are vital measures for assessing forest resources and making informed decisions about their management and future. These measures are the foundation for estimating numbers of trees, wood volume, and biomass. Trends in forest land area are an indication of forest sustainability, ecosystem health, and land use practices. Gains and losses in forest area directly affect the amount of goods and services, including wood products, wildlife habitat, recreation, and watershed protection that forests can provide.

Most of the forests of New York are in some stage of recovery from the impact of humans (Thompson 1966). In 1880, the year when farm acreage peaked in the State, there were 24 million acres in farms, or almost five-sixths of the total area. By the beginning of the 20th century, an estimated 20 percent of New York State was forested. If not farmed, most land was at least cut over for lumber.

What we found

New York's forests have increased in area by 2 percent since 1993 to now total 19.0 million acres and occupy 63 percent of the State's land area (Figs. 1, 2). Successive inventories have shown forest land area increasing, although most of the increase occurred before 1980. The 377,000-acre increase (2 percent) in forest area since 1993 represents a slowing of this trend. This net change does not mean that there were not losses in forest land in some areas. During the period 1993 to 2007, plot data show that about 4 percent of forest land was lost to nonforest uses, but that loss was more than offset by gains from nonforest areas going into forest. Increases in forest land have corresponded with decreases in farm land. Since 1950, the amount of land in farms has decreased by 8 million acres (including farm woodlots), while forest land has increased by 4.5 million acres (Fig. 3).

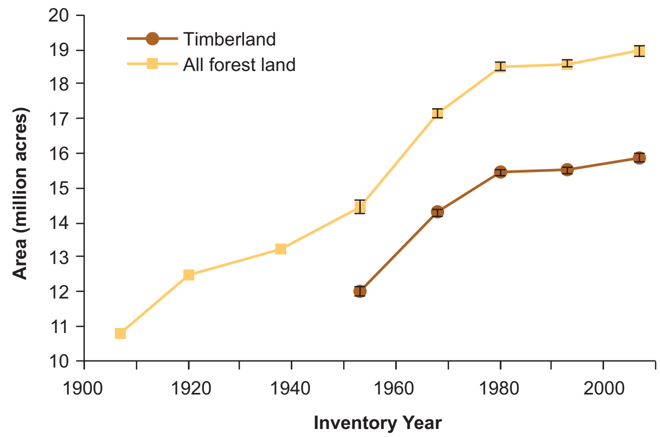


Figure 1.—Area of forest land and timberland in New York by inventory year, 1953, 1968, 1980, 1993, and 2007 with approximations of forest land area given for 1907, 1920, and 1938 (Smith et al. 2009) (error bars represent 68-percent confidence intervals around the estimates).

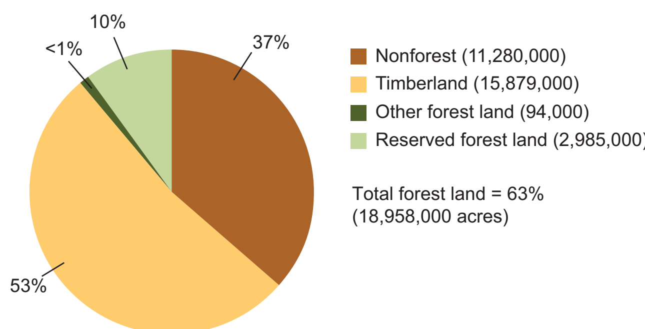


Figure 2.—Land area (in acres) by major use, New York, 2007.

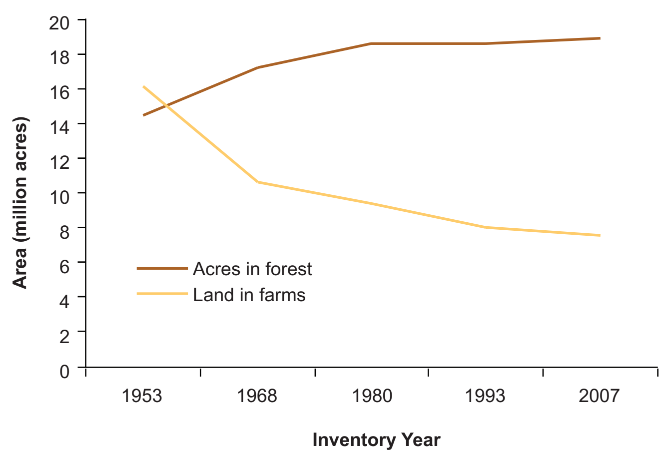


Figure 3.—Acreage in forest land and in farms (includes farm woodlots), New York, 1950-2005 (source: National Agriculture Statistics Service).

The percentage of land in forest cover varies with the topography (Fig. 4). Areas where the land is too rough to farm or develop have higher portions in forest. The

Eastern Adirondack unit has the highest portion of its area in forest at 93 percent followed by the Western Adirondack unit with 74 percent (Fig. 5). The Lake Plain unit has the least forest at 40 percent.

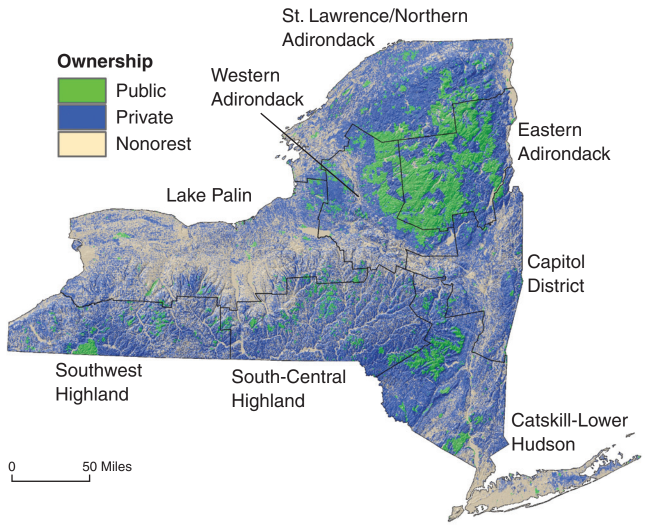


Figure 4.—Distribution of forest land in New York by ownership and FIA units, based on the Multi-Resolution Land Characteristics project, 2001. The MRLC uses data from the Landsat satellite to map land across the Nation.

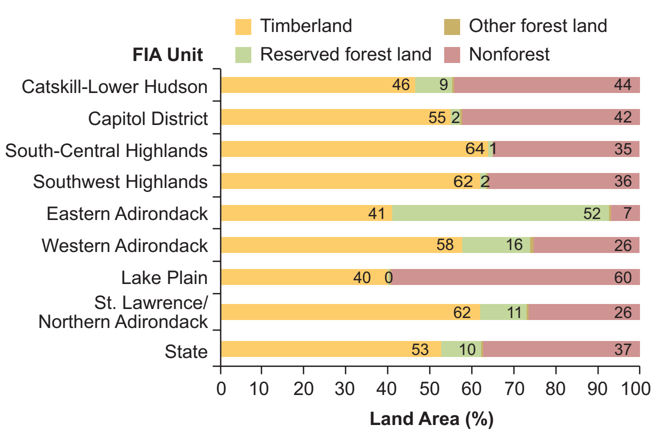


Figure 5.—Percentage of land by major use and FIA unit, New York, 2007.

The largest gains in forest land occurred along the southern tier of counties in the Southwest Highlands and South-central Highlands units, in the Western Adirondack unit, and the St. Lawrence/Northern Adirondack unit as farm land continued to decline in these units (Fig. 6). These regions had large increases in forest land in previous inventories. In most other units, forest land area either remained stable or declined. Forest area in the Lake Plain unit declined, although this unit had large increases in forest land in previous inventories.

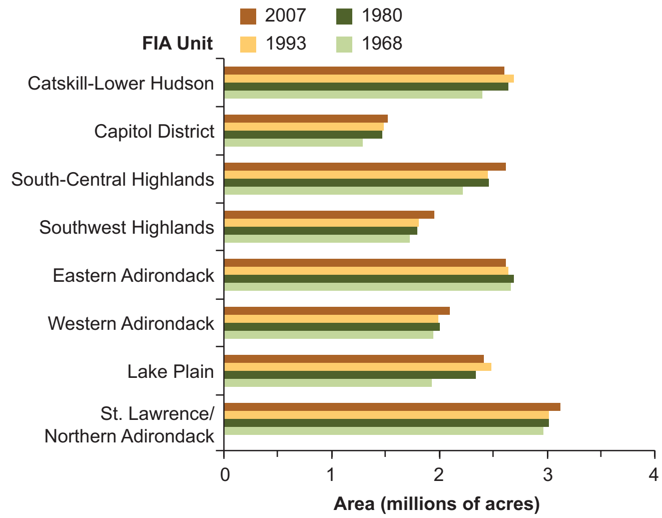


Figure 6.—Trends in forest land area by FIA unit, New York, 1968, 1980, 1993, and 2007.

Eighty-four percent of New York's forest land, 15.9 million acres, is classified as timberland, an increase of 374,000 acres since 1993 (Fig. 1). The amount of forest land reserved from harvesting has slowly increased with each successive inventory to 3 million acres and now represents 16 percent of forest land or 10 percent of the State's total land area. Other forest land is relatively rare and amounts to about a half a percent of total forest land.

What this means

Across the State, losses of forest land due to development have been more than offset by gains in forest land mainly due to farm land reverting to forests through natural regeneration. Because of increased development and a slowing in farm land losses, gains in total forest land have slowed. These trends may indicate that the area of forest land in New York may be nearing a peak. Also, recent interest in growing grasses and willows for biofuels production may further slow the reversion of marginal agricultural land to forest land. Future changes in New York's forest land will depend on the pace of land development and to a great extent on the economics of farming.

Trees growing on timberland represent the resource base upon which the forest products industry relies and are considered potentially available for harvesting. Discussions later in this report on urbanization and the woodland owner study provide more details on how much timberland is actually available and being actively managed for timber products. Much of the focus of this report is on trees growing on the 15.9 million acres of timberland.

Ownership of Forest Land

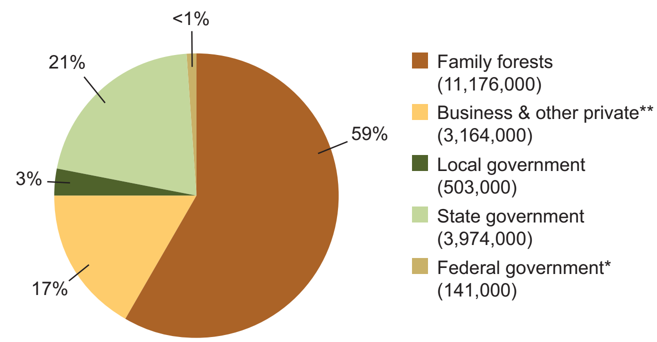
Background

How land is managed is primarily the owner's decision. Public and private owners often have different goals that reflect their priorities and management practices. Owners decide who they will allow on their land and what types of activities will take place. Therefore, to a large extent, the availability and quality of forest resources are determined by landowners, including recreational opportunities, timber, and wildlife habitat. Owners' decisions are influenced by their management objectives, size of land holdings, and form of ownership. Family forest owners are further influenced by their age, education, and life experiences. The National Woodland Owner Survey (NWOS) conducted by the Forest Service studies private forest landowners' attitudes, management objectives, and concerns (Butler 2008).

What we found

Public owners hold 4.6 million acres, or 24 percent of New York's forest land. This does not include publicly owned easements on private land. The State holds nearly 4.0 million acres, amounting to 21 percent of the forest land in New York (Fig. 7). Included in this total are State-owned forests in the Adirondack and Catskills Preserves. The Federal Government holds 141,000 acres (1 percent) in various agencies, including the Fish and Wildlife Service, Department of Defense, and the Finger Lakes National Forest. Local governments hold 503,000 acres (3 percent). Public ownership of forest land has increased by a fifth since 1953. Public ownership is not distributed evenly across the State: in the Eastern Adirondack unit 57 percent of the forest land is in public ownership, whereas in the Lake Plain unit only 10 percent is publicly owned (Figs. 8, 9).

An estimated 687,000 private individuals and enterprises own more than 14.3 million acres of forest land—76 percent of the State's total forest land.



* Includes 17,800 acres in the Finger Lakes National Forest.
** Includes corporations, nonfamily partnerships, tribal lands, nongovernmental organizations, clubs, and other nonfamily private groups.

Figure 7.—Ownership of forest land (in acres), by major ownership category, New York, 2006.

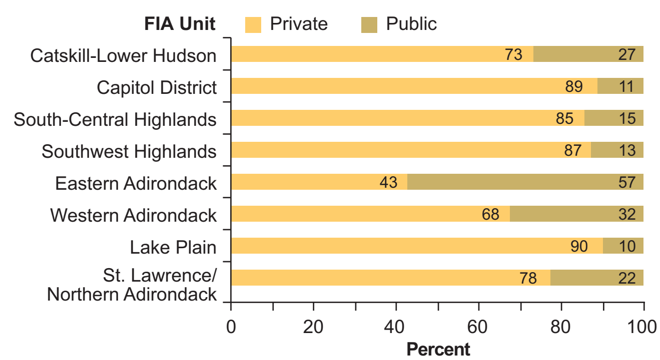


Figure 8.—Percentage of forest land in public and private ownerships by FIA unit, New York, 2007.

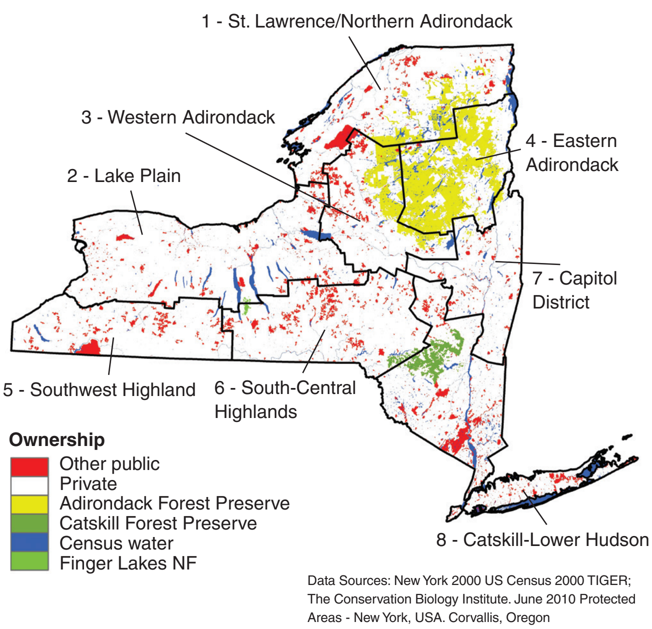


Figure 9.—Location of major ownerships, New York.

Of this, businesses hold an estimated 3.2 million acres—17 percent of the forest land. This category includes corporations, nonfamily partnerships, tribal lands, nongovernmental organizations, clubs, and other private nonfamily groups. Representing the largest ownership category, family forest owners hold 11.2 million acres, accounting for 59 percent of the State's forest land.

The NWOS found there are 614,000 family owned forests in New York (Fig. 10). This category is represented by individuals, farmers, and small family corporations and partnerships. Eighty-nine percent of these owners hold fewer than 50 acres. These small holdings total 4.7 million acres and make up 42 percent of the family forest land in the State. Owners with 50 to 100 acres hold 2.5 million acres and number 37,000. About a third of the family forest acreage (4.1 million acres) is held by about 24,000 owners with forested holdings that exceed 100 acres. Since 1993, the number of owners and acreage in family forest holdings of fewer than 50 acres have increased by 42 and 12, percent respectively, while acreage in holdings of 50 acres and larger has decreased (Birch 1996, Butler 2008). From a list of 12 reasons for owning forest land, "aesthetics" ranked first followed by "part of my home or cabin" by both number of ownerships and area owned (Fig. 11). Owning forest land for privacy and for nature protection also ranked high. Timber production ranked low in importance to New York's family forest owners; it was ranked as important or very important by only 9 percent of owners, but collectively they hold 23 percent of the acreage. However, 53 percent of owners holding 67 percent of the family forest land reported harvesting trees and 17 percent of owners, holding 44 percent of the family forest land, had harvested saw logs (Fig. 12).

Figure 10.—Number of family forest owners and acres of forest land by size of forest land holdings, New York, 2006.

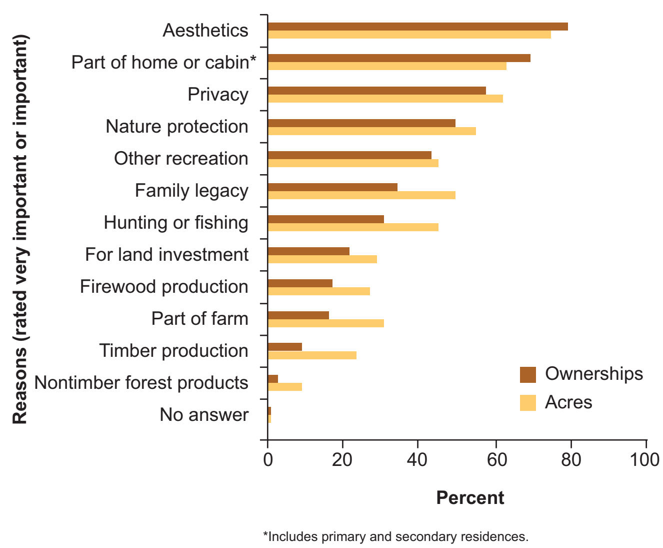


Figure 11.—Percentage of family forest owners and acres of forest land by reasons given for owning forest land ranked as very important or important (categories are not exclusive), New York, 2006.

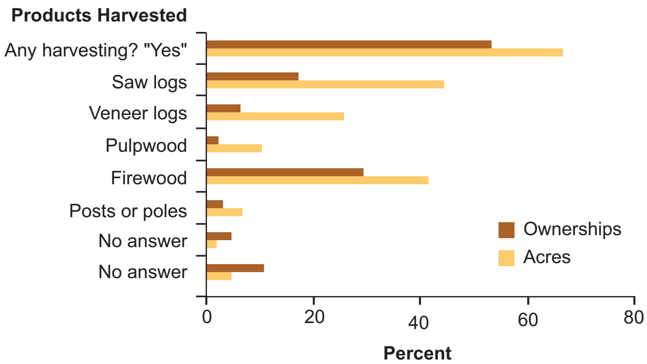


Figure 12.—Percentage of family forest owners and acres of forest land by harvesting experience and products harvested (categories are not exclusive), New York, 2006.

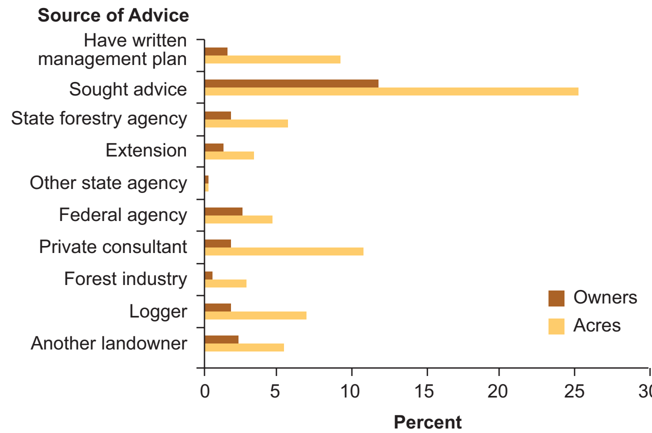


Figure 13.—Percentage of family forest owners, and acres of forest land, who have a written management plan, who have sought advice, and advice source (categories are not exclusive), New York, 2006.

Written management plans exist on just 9 percent of the family owned forest land, although plans exist on roughly a fifth of the State's timberland across all ownerships (assuming that plans exist on most publicly owned timberland and large corporate ownerships). Only 12 percent of the family forest owners holding 25 percent of the family forest acreage have sought management advice (Fig. 13). Private consultants led as a source of management advice. Family owned forests are frequently associated with a residence or farm. Seventy-three percent of owners with 64 percent of family forest acreage said that their forests are associated with their primary residence. Forty-four percent of New York's family forest owners are at least 65 years old (Fig. 14). This group controls 45 percent or 5.0 million acres of family forest acreage. The tenure of family forest owners is fairly long: 45 percent of the acreage has been held for 25 years or longer and 7 percent has been held for 50 years or longer. Chief concerns of family forest owners were high property taxes, family legacy, trespassing, dumping, and insects/diseases. When owners were asked about activities taking place on their land in the past 5 years, private recreation and posting land ranked high. And, when asked about future activity planned for their land in the next 5 years, 10 percent of owners holding 15 percent of the family forest land said they plan to transfer it, and 52 percent of owners with 29 percent of the area indicated "minimal activity" (Fig. 15). Harvesting firewood was planned on 41 percent of the land and harvesting either saw logs or pulpwood on 26 percent.

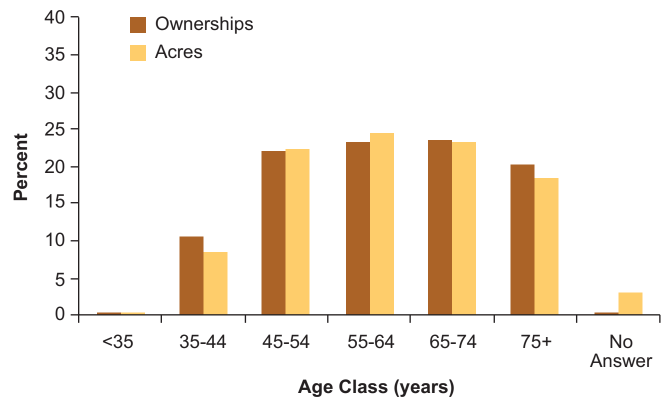


Figure 14.—Percentage of family forest owners and acres of forest land by age of owners, New York, 2006.

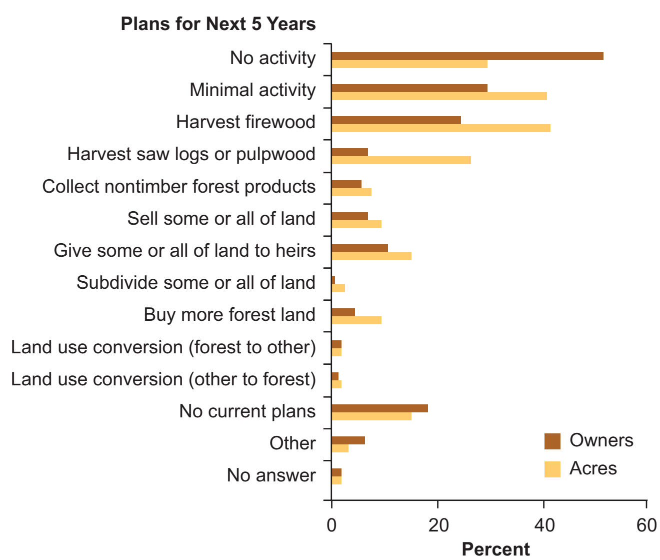


Figure 15.—Percentage of family forest owners and acres of forest land by plans for next five years, New York, 2006.

What this means

Nearly a quarter of New York's forest land (4.6 million acres) is publicly owned. Because management of publicly owned forests is typically restricted by more rules and regulations than management of privately owned forest, public ownership brings a higher level of protection for these forests, although they are still vulnerable to acid deposition, climate change, and invasion by exotic insects and diseases. This is especially true for forest land in the Adirondack and Catskill Preserves that are constitutionally protected from harvesting and in State parks that are protected by policy from commercial tree cutting. These areas account for most of the 3 million acres that are categorized as reserve forest. The majority of the other 1.6 million acres of public forests are in State forests, State wildlife management areas, or owned by the Federal Government. These forests are professionally managed for a broad range of goods and services and allow the sustainable use of natural resources.

Because most of New York's forest land is held by thousands of private landowners, decisions by these owners will have a great influence on New York's future forest. To promote forest sustainability in the State, private land owners need to be encouraged to practice stewardship and conservation. Family forest ownerships with 100 acres or more make up 36 percent of the family forest acreage but represent only 4 percent of the number of owners. Targeting government programs toward these owners would be more cost efficient than trying to reach all owners, but would exclude the 7.2 million acres of forests in ownerships of less than 100 acres. Since 1993, some parcelization of large ownerships into smaller ownerships has occurred. Continuation of this trend will make future access to New York's forest resources more difficult for timber industries and for recreation. Compared to owners of large tracts, owners of small parcels of land are less likely to manage their forests or allow access to their land by others for activities such as hiking, hunting, and fishing (Birch and Butler 2001).

The low priority given by landowners to timber production does not mean that landowners will not harvest trees. The relatively high number of family forest owners that have actually harvested trees (53 percent of owners holding 67 percent of family forests) shows that when conditions are right, most landowners will harvest trees, although the low priority given to timber production probably means that these harvests are not part of a long-term management plan.

The high number of owners who are 65 years or older (44 percent) and the large amount of land held by owners who are planning to transfer ownership in the next 5 years (10 percent of owners holding 15 percent of the family forest land) foretell a large turnover of forest land. At the time ownership is transferred, forest land becomes vulnerable to unsustainable harvesting practices and division into smaller parcels. The turnover of forest land to new owners will increase the need for services to family forest owners such as advice on how to manage forest sustainability.

Urbanization and Fragmentation of Forest Land

Background

The expansion of urban lands that accompanies human population growth often results in the fragmentation of natural habitat (Wilcox and Murphy 1985). Forest fragmentation and habitat loss is recognized as a major threat to animal populations worldwide (Honnay et al. 2005, Rosenberg et al. 1999), particularly for species that require interior forest conditions for all or part of their life cycle (Donovan and Lamberson 2001) and species that are wide ranging, slow moving, and/or slow reproducing (Forman et al. 2003). Forest fragmentation can also affect forest ecosystem processes through changes in microclimate conditions, and it affects the ability of tree species to move in response to climate change (Iverson and Prasad 1998).

Honnay et al. (2005) and others have also pointed out that the spatial/physical fragmentation of habitats is only one of the human-induced processes affecting natural habitats and their biodiversity. Urbanization increases the proximity of people, development, and other anthropogenic pressures to natural habitats, and changes the ways in which humans use those natural habitats. It can also lead to overexploitation of species, environmental/habitat deterioration, changes in hydrology, and introduction of exotic species, to name a few. In addition to the negative effects on forested ecosystems, the fragmentation and urbanization of forest land may have direct economic and social effects. For example, smaller patches of forest or those in more populated areas are less likely to be managed for forest products (e.g., Kline et al. 2004, Wear et al. 1999) and are more likely to be "posted" (i.e., not open for public use) (Butler et al. 2004), potentially affecting local forest industry, outdoor recreation opportunities, and local culture. Forest land is also a significant factor in the protection of surface water and groundwater, and fragmentation and urbanization of that forest land has been observed to affect both water quality and quantity (e.g., Hunsaker et al. 1992, McMachon and Cuffney 2000, Riva-Murray et al. 2010).

The measures presented here relate to some aspect of urbanization or fragmentation that is suspected of or documented as having an effect on the forest, its management, or its ability to provide ecosystem services and products (Riemann et al. 2008). These measures are forest edge versus interior, proximity to roads, patch size, local human population density, and extent of houses intermixed with forest.

This section is based on analysis of NLCD 2001 data rather than FIA plot data. In this analysis, Long Island is separated from the Catskill-Lower Hudson unit.

What we found

In New York, 68 percent of the forest land is more than 300 feet from an agriculture use or developed edge. This ranges from only 31 percent in heavily urbanized Long Island to 91 percent in the Eastern Adirondacks (Table 1).

Figures 16 and17 show where and to what extent forest land is affected by roads. As Forman (2000) and Riitters and Wickham (2003) reported, these effects can be quite extensive, even in areas that appear to be continuous forest land from the air. Exceptions to this in New York are areas of the Adirondacks and Catskills. In New York State as a whole, 35 percent of the forest land is within 650 feet of a road of some sort and 61 percent is within 1,310 feet. Individual units range considerably. In the Eastern Adirondacks, 20 percent of the forest area is within 650 feet of a road of some sort, while on Long Island, 72 percent of the forest falls in that category (Table 1).

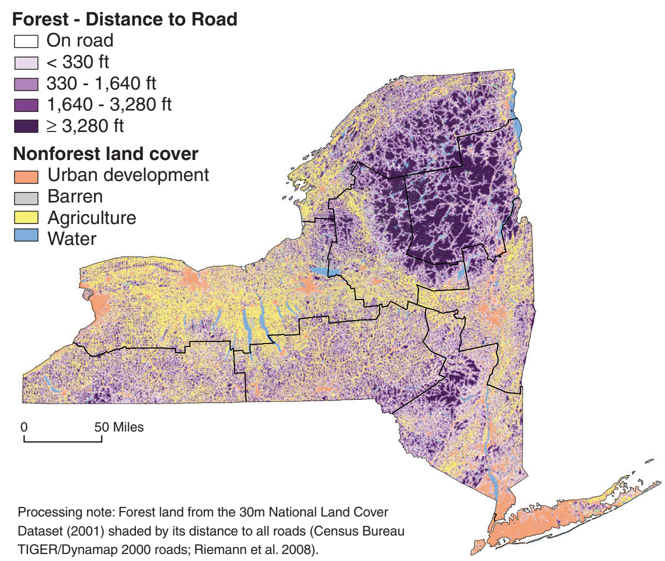


Figure 16.—Forest land by distance to nearest road, New York, 2000, 2001.

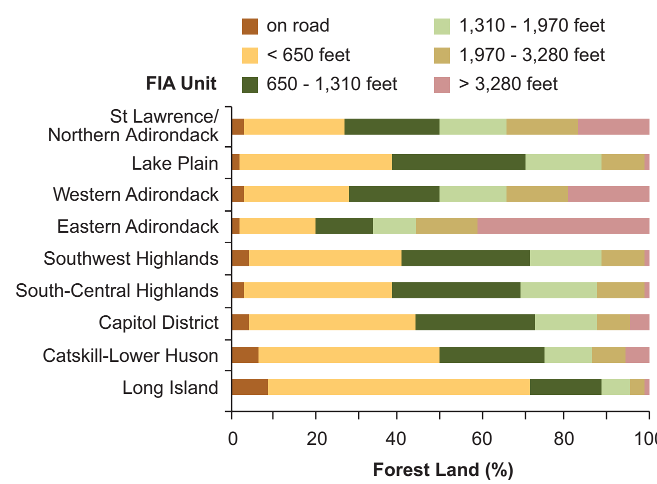


Figure 17.—Percentage of forest land by distance to nearest road and FIA unit, New York, 2001.

Table 1.—The distribution of forest land with respect to several urbanization and fragmentation factors, expressed as a percent of the total forest land area in each unit, New York

Unit name	% Forest land in county [a]	Forest land > 300 feet (90m) from an ag or developed edge[b]	Forest land > 650 ft from a road[c]	Forest land located in patches > 100 acres in size[d]	Forest land with house density > 15.5 per sq. mile[e]	Forest land located in a block with population densities > 150/sq. mi (57.9/sq. km)[f]
St. Lawrence/ Northern Adirondack	73	80	73	96	16	2
Lake Plain	38	46	61	80	56	15
Western Adirondack	70	83	72	95	19	4
Eastern Adirondack	94	91	80	99	10	1
Southwest Highlands	62	60	60	94	28	3
South-Central Highlands	65	62	62	95	33	5
Capitol District	59	54	56	90	51	13
Catskill-Lower Hudson	72	63	51	94	58	19
Long Island	21	31	28	62	74	56
New York	63	68	65	93	33	8

[a] Percent forest estimate based on NLCD 2001. Values are generally higher than estimates from FIA plot data.
[b] Approximating the forest land undisturbed by edge conditions.
[c] Approximating the forest land outside the effects of roads.
[d] Approximating the forest land with potentially enough core area for sustainable interior species populations.
[e] Approximating the forest land potentially affected by underlying development.
[f] Approximating the forest land not available for commercial forestry.

In much of New York, forest land occurs as a relatively contiguous forest matrix within which urban development, agriculture, roads, and other nonforest areas occur (Riitters et al. 2000). The Lake Plain unit contains largely forest land in a predominately agricultural matrix, and the western Long Island unit and the southern Catskill-Lower Hudson unit present a predominately urban matrix in which forest occurs. As a result, forested areas containing higher proportions of small patches (patches <100 acres) occur in more urbanized Long Island and the more agricultural Lake Plain unit (Figs. 18, 19). Most other units in New York have less than 10 percent of their forest land in small patches under 100 acres. Examining the forest in terms of the proportion of core/interior forest vs. edge conditions, we can consider 68 percent of the forest in New York as interior forest—i.e., more than 300 feet from an agricultural or developed edge—and 14 percent within 100 feet of such an edge (Fig. 20, Table 1).

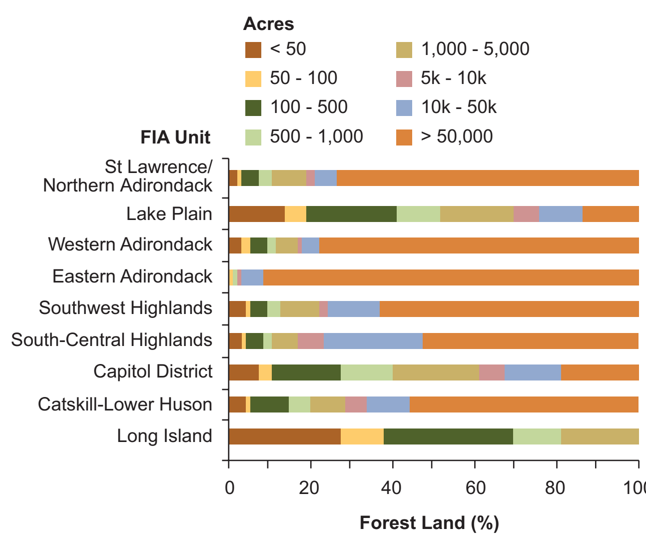


Figure 18.—Percentage of forest land by patch size and FIA unit, New York, 2000, 2001.

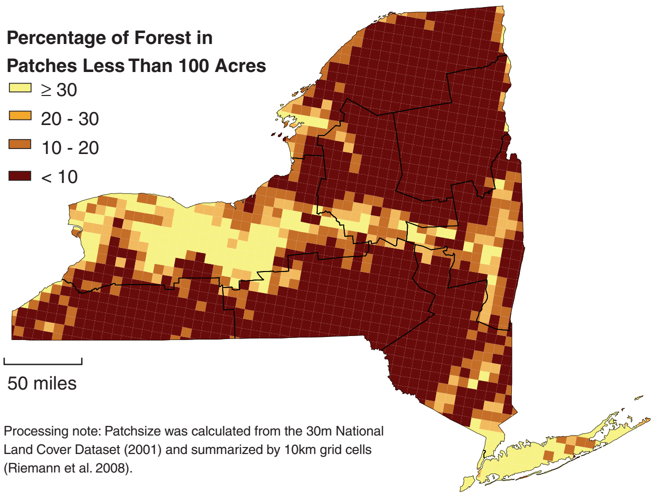


Figure 19.—Percentage of forest land in patches of less than 100 acres, New York, 2001.

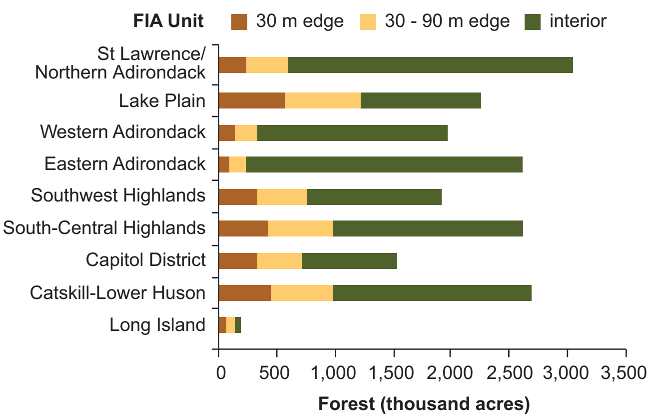


Figure 20.—Acres of forest land by distance to forest edge and interior forest, by FIA unit, New York, 2001.

The Wildland Urban Interface (WUI), commonly described as the zone where human development meets or intermingles with undeveloped wildland vegetation, is associated with a variety of human-environment conflicts (Radeloff et al. 2005). Radeloff et al. (2005) define this area in terms of the density of houses (more than 15.5 houses per square mile), the percentage of vegetation coverage present, and the proximity to developed areas. In New York, 33 percent of the forest land is affected by underlying house densities greater than the threshold of 15.5 houses per square mile (Figs. 21, 22), with individual units ranging from 10 percent of the forest land (Eastern Adirondacks) to 74 percent (Long island). Close proximity between humans and forest land has also been observed to affect the viability of commercial forestry in the surrounding area, and this viability has been described most clearly to be related to local human population density near forested areas (Wear et al. 1999). In New York, 8 percent of the forest land is located in a U.S. census block with population densities above 150 people per square mile (Table 1); however, this percentage varies considerably across the State, from 56 percent on Long Island to 5 percent or less in the Adirondack and Highland units, with all remaining units falling between 10 and 20 percent.

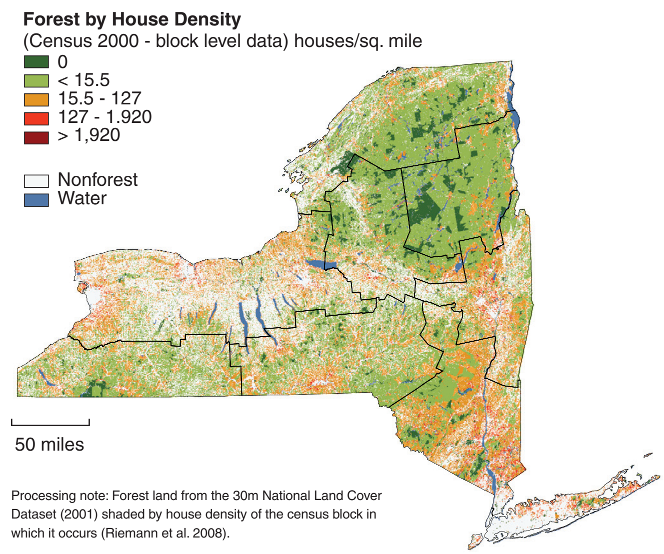


Figure 21.—Forest land by house density of the census block it is located in (U.S. Census Bureau 2000), New York, 2001.

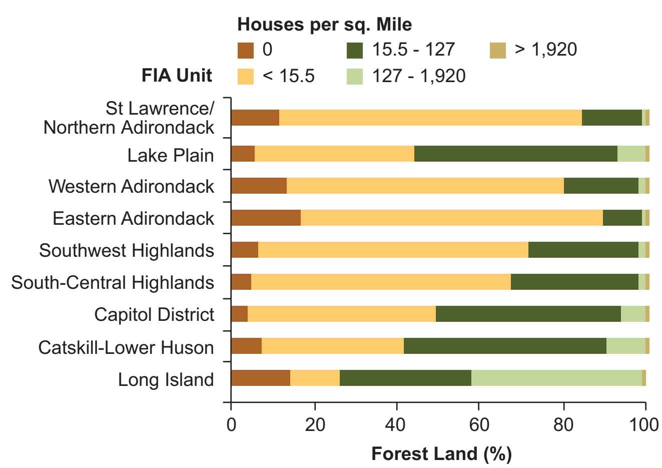


Figure 22.—Forest land by house density of the census block it is located in (U.S. Census Bureau 2000) and FIA unit, New York, 2001.

Table 1 brings many of these factors together and presents the extent to which the current forest land base is being influenced by one or more of the factors. For example, in the South-Central Highland unit, which is 65 percent forested, 95 percent of that forest occurs in large patches (>100 acres), and only 5 percent occurs in census blocks with population densities so high that forest management may be affected. However, 33 percent of that forest is potentially affected by house densities greater than 15.5 per square mile, 38 percent is within 300 feet of an agricultural or developed edge, and 38 percent is less than 650 feet from a road of some sort. In the Eastern Adirondack unit, which is 94 percent forested, 10 percent of that forest land is potentially affected by house densities greater than 15.5 per square mile, while 91 percent of the forest land is far enough from an edge to be considered interior forest conditions. Nearly all of the forest land is in large patches (>100 acres), but only 80 percent is more than 650 feet from a road. In the Capitol District unit, which is 59 percent forested and also occurs in large patches 90 percent of the time, 51 percent of that forest has underlying house densities of >15.5 per sq. mile, 21 to 46 percent can be considered edge vs. interior forest conditions, 44 percent is less than 650 feet from a road, and 13 percent is located in census blocks with enough local population densities high enough to potentially affect forest management options there.

What this means

Forest health, sustainability, management opportunities, and ability of forest land to provide the products and ecosystem services we often require of it are affected to varying degrees and in different ways by changes in the fragmentation and urbanization of that forest land. Edge effects vary somewhat with distance from forest edge, depending on the type of effect and species of vegetation or wildlife, (e.g., Chen et al. 1992, Flaspohler et al. 2001, Rosenberg et al. 1999), but 100 to 300 feet is frequently used as a general range for the “vanishing distance” or the distance into a patch where the edge effect disappears and interior forest conditions begin.

Figures 16 and 17 depict the pervasiveness of roads in the landscape, except for some large roadless areas remaining in the Catskills and Adirondacks. Ecological road effects diminish when distances range from about 650 feet for secondary roads (a rough estimate of a highly variable zone), 1,000 feet for primary roads in forest (assuming 10,000 vehicles per day), and 2,650 feet from roads in urban areas (50,000 vehicles per day) (Forman 2000). Roads have a variety of effects, including hydrologic, chemical (salt, lead, nutrients), sediment, noise, as vectors for the introduction of invasive species, habitat fragmentation, and increases in human access, impacting forest ecosystem processes, wildlife movement and mortality, and human use of the surrounding area. From Riitters and Wickham’s analysis (2003), the Catskills and the northern New York-New England forest region represents some of the few remaining areas in the eastern United States with less than 60 percent of their land area within 382 feet of the nearest road. However, with 61 percent of New York’s forest land within 1,310 feet of a road, cumulative ecological impacts from roads should be a very real consideration. Actual ecological impacts of roads will vary by the width of the road and its maintained right-of-way, number of cars, level of maintenance (salting, etc.), number of wildlife-friendly crossings, hydrologic changes made, imperviousness of road surfaces, location with respect to important habitat, etc. These variables also suggest some of the changes that can be made to moderate the impact of roads on the forest (Charry 2007, Forman 2000, Forman et al. 2003).

Habitat requirements for wildlife vary by species, but for reporting purposes it is often helpful to summarize forest-patch data and edge-interior data using general guidelines. Many wildlife species prefer contiguous forest patches of at least 100 acres. This patch area is often used as a minimum size that still contains enough interior forest to be a source rather than a sink for populations of some wildlife species. If we do not consider the impact of roads or houses that do not substantially break the tree canopy, 93 percent of New York’s forest land is in patches larger than 100 acres. Given the pervasiveness of houses and roads within the forest landscape in many parts of

New York, patch size alone will not be a good indicator of wildlife habitat quality. It is, however, another indicator of the extent to which the people of New York live within a primarily forested landscape.

Human population is generally recognized as having a negative effect on the viability and practice of commercial forestry (Barlow et al. 1998, Kline et al. 2004, Munn et al. 2002, Wear et al. 1999). Working in Virginia, Wear et al. (1999) identified a threshold of 150 people per square mile as that population density at which the probability of commercial forestry dropped to practically zero. In New York, 8 percent of forest land occurs within census blocks that exceed that threshold of 150 people per square mile.

Forest intermixed with houses represents areas of forest cover most likely to be in nonforest land use, and/or more likely to be experiencing pressures from recreation, invasive plant species, and other local human effects. This intermix area also represents a challenge to managing forest fires. A threshold of 15.5 houses per square mile represents the approximate density at which firefighting switches from “wildland” to “structure” firefighting techniques and costs (Radeloff et al. 2005). Although the other pressures from high housing densities are likely to be more of an issue than forest fires in New York, thresholds with respect to those issues are less developed at this point. Therefore, the map should be interpreted as identifying where areas of increased pressure from intermixed residential development are likely to occur (Fig. 21). Looking into the future, Theobald (2005) and Hammer et al. (2004) have forecast nationwide increases in lower density “exurban” development particularly at the urban fringe and in amenity-rich rural areas, both of which describe many areas in New York.

Forest Resource Attributes

Old-growth stand in the Adirondacks. Photo by Richard H. Widmann.

Forest Structure—How Dense are the Woods?

Background

How well forests are populated with trees is determined by measures of trunk diameter (measured at 4 ½ feet above the ground and referred to as diameter at breast height (d.b.h.)) and the number of trees. The number of trees is a basic measurement in forest inventories, whether it is the total trees in a forest or trees per acre. It is generally straightforward to estimate, reliable, objective, and comparable with past estimates. In spite of their simplicity, estimates of the number of trees by size are valuable in showing the structure of New York forests and the changes that are occurring.

Numbers of trees per acre and their diameters are used to determine levels of stocking. Stocking levels indicate how well a site is being utilized to grow trees. Stocking levels are calculated in this report using two methods, one using all live trees and the other using only growing-stock trees. Growing-stock trees are economically important and do not include noncommercial species (e.g., hawthorn, striped maple, and eastern hophornbeam) or trees with large amounts of cull (rough and rotten trees). In fully stocked stands, trees are using all of the space and resources (light, water, nutrients) of the site to grow. As stands become overstocked, trees become overcrowded, growth begins to slow, and mortality increases. In poorly stocked stands, trees are widely spaced, or if only growing-stock trees are included in the stocking calculations, the stands can contain many trees with little or no commercial value. Poorly stocked stands can develop on abandoned agricultural land or result from ice and wind storms, wildfires, or poor harvesting practices. Poorly stocked stands are not expected to grow into a fully stocked condition in a reasonable amount of time whereas moderately stocked stands are. Comparing stocking levels of all live trees with that of growing-stock trees shows the effect cull and noncommercial species are having on stocking levels. These trees can occupy substantial amounts of growing space that otherwise could be used to grow trees of commercial value, although they still contribute ecological value.

The seedling-sapling stage (small-diameter stands) follows major disturbances such as clearcutting and reversion of farm land to forest. In this stage many wildlife species use low-growing herbaceous and shrub vegetation. Typically found in such stands are early successional, pioneer tree species, such as aspen, pin and black cherry, white ash, and a variety of herb and shrub plants that thrive in full sunlight. These stands provide unique nesting and feeding habitat for wildlife. As stands grow into the poletimber (medium-diameter stands) and sawtimber (large-diameter stands) size, much of the low-growing vegetation is shaded out and species that depend on early successional vegetation decline in number as species that use the boles of trees increase. Bole characteristics that develop as a stand matures include bark flaps and cavities.

What we found

Trees have increased in size and number on timberland in New York. Of all trees 5.0 inches and larger in d.b.h., the average diameter has increased from 9.0 to 9.3 inches since 1993 (Fig. 23). The average number of trees per acre of timberland has increased from 156 to 166 trees (Fig. 24). Since the 1980 inventory, the number of trees classified as rough, rotten, and noncommercial species has decreased from 25 to 21 per acre.

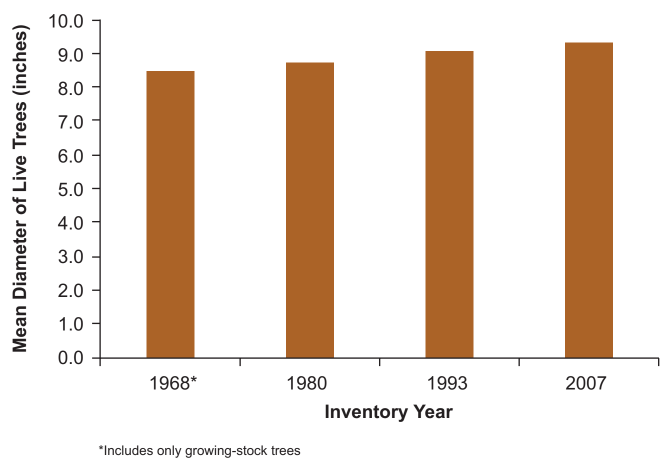


Figure 23.—Average diameter of live trees (5.0 inches and larger in d.b.h.) on timberland by inventory year, New York.

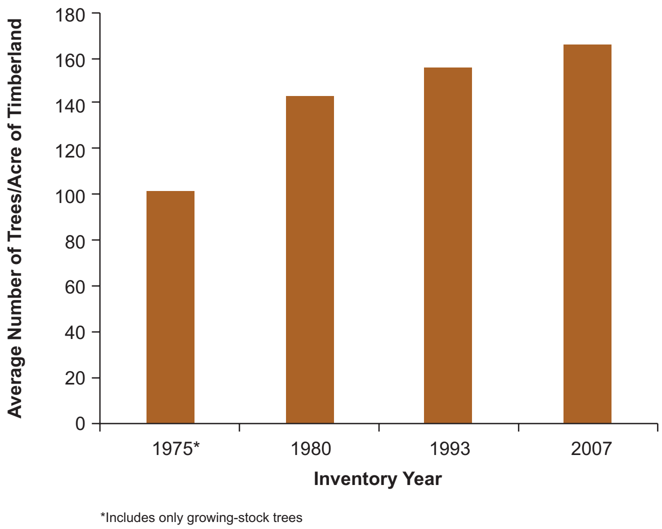


Figure 24.—Average number of trees per acre (5.0 inches and larger in d.b.h.) by inventory year, New York.

The Lake Plain unit has the lowest average number of trees per acre (150), and these trees have the smallest average diameter (7.2 inches) of the units in the State (Fig. 25). The largest average diameters were found in the Capitol District (9.6) and South-Central Highlands (9.6) units, although the highest number of trees per acre was in the Eastern Adirondack unit (181).

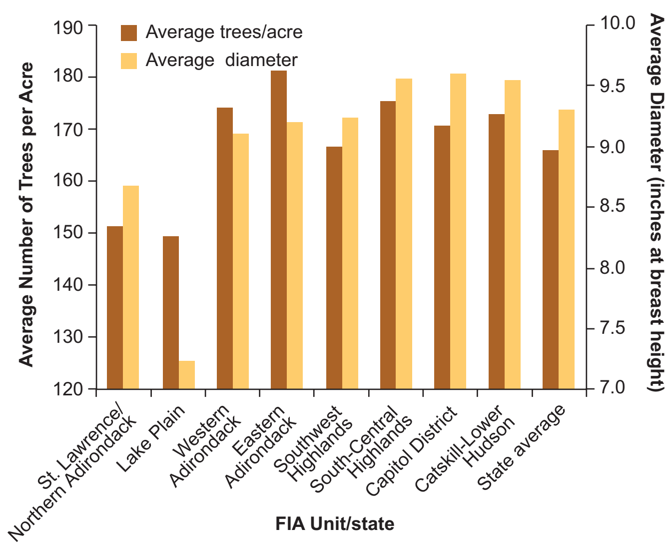


Figure 25.—Average number and diameter of trees 5.0 inches and larger on timberland, by FIA unit, New York.

Charting the number of trees by diameter class yields a reverse "J" shaped curve (Fig. 26). Although this resembles the diameter distribution of an uneven-age forest, it is a composite of New York's entire forest and is comprised of stands of many different ages and stand-size classes. Many of the smaller diameter trees are actually much older than their size alone would indicate. Each successive inventory shows a shift in numbers of trees toward the larger diameter class. Increases in numbers of trees have occurred across all diameter classes, although as a percentage, increases have been greater in the larger diameter class for both 1983 to 1993 and 1993 to 2007 (Fig. 27). Generally, the larger the diameter class, the larger the percentage increase in number of trees.

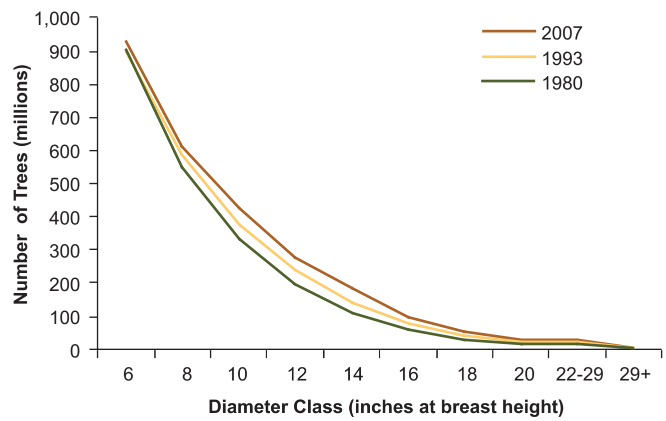


Figure 26.—Number of growing-stock trees by diameter class and inventory year, New York, 1980, 1993, and 2007.

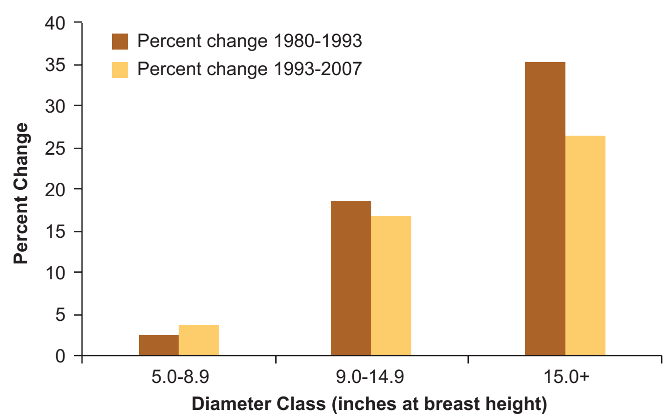


Figure 27.—Percent change in the numbers of trees by broad diameter class, New York, 1980-1993 and 1993-2007.

In New York, 8.5 million acres (53 percent) of timberland are fully stocked or overstocked with live trees, and 1.9 million acres (12 percent) are either poorly stocked or nonstocked (Fig. 28). If only the commercially important growing-stock trees are considered, which excludes rough and rotten cull trees and trees of noncommercial species in calculating stocking, the area in the poor and nonstocked classes increases by 70 percent to 3.1 million acres.

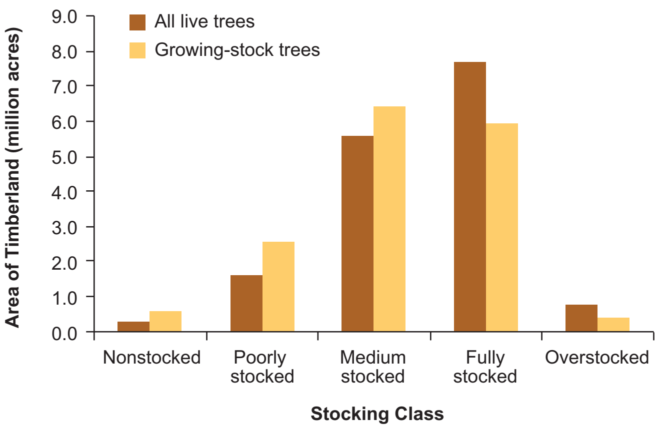


Figure 28.—Area of timberland by stocking class of live trees and growing-stock trees, New York, 2007.

Poorly stocked stands are distributed across all age and stand-size classes. Of the 2.6 million acres (does not include nonstocked stands) that are poorly stocked with growing-stock trees, 51 percent are in stands that are more than 40 years old and in either the medium or large stand-size class (Fig. 29). The Lake Plain unit has the largest percentage of its timberland in poorly stocked and nonstocked stands (25 percent) and the Eastern Adirondack unit has the least (11 percent) (Fig. 30).

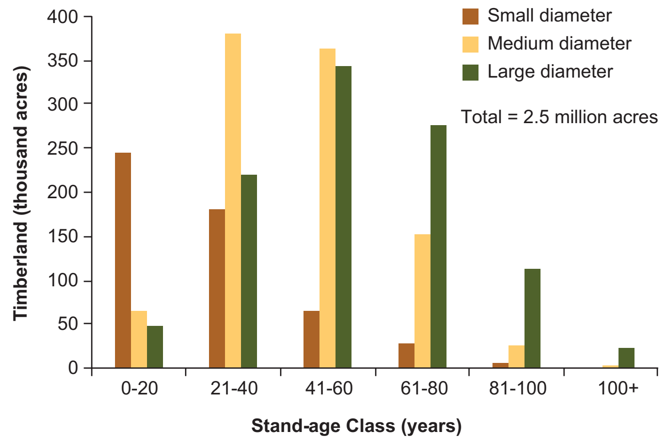


Figure 29.—Area of timberland that is poorly stocked with growing-stock trees by stand age and stand-size class, New York, 2007.

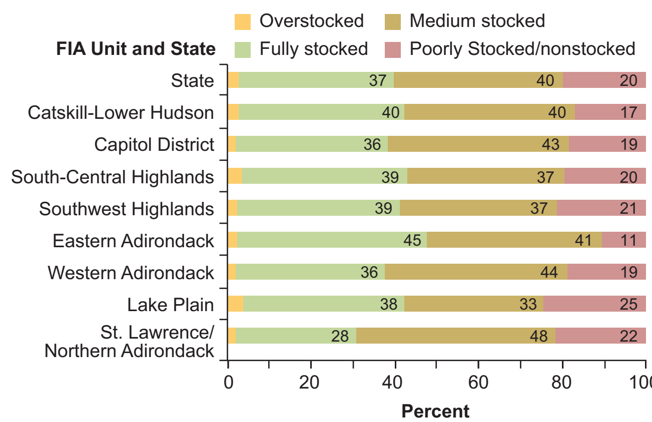


Figure 30.—Percentage of timberland by stocking class of growing-stock trees, by FIA unit, New York, 2007.

Across the State, forests have continued to mature as large amounts of timberland have grown to sawtimber size. Sawtimber-size stands now occupy 56 percent of the timberland—8.8 million acres. Since 1968, the area in sapling/seeding-size and nonstocked stands has steadily declined, now representing 14 percent of the timberland (Fig. 31). New York has a high percentage of timberland in the sapling/seedling and nonstocked stand-size classes when compared to surrounding states: Massachusetts (4 percent), Connecticut (5), Vermont (9), and New Jersey (10), and is similar to Pennsylvania (11). In New York, the Lake Plain unit has the highest percentage of timberland in seedling/sapling and nonstocked stands at 19 percent, and the Eastern Adirondack unit has the least at 5 percent (Fig. 32).

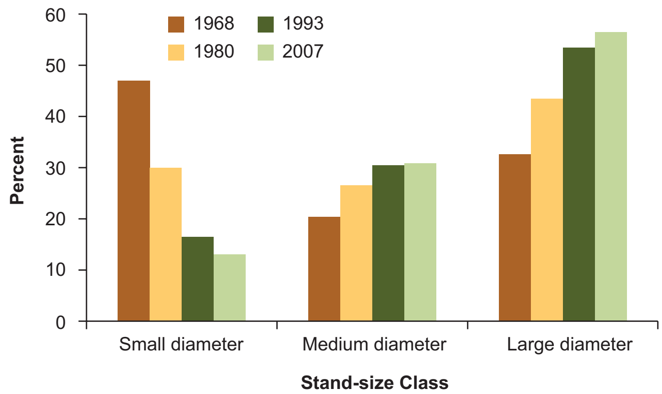


Figure 31.—Percentage of timberland by stand-size class, New York, 1968, 1980, 1993, and 2007.

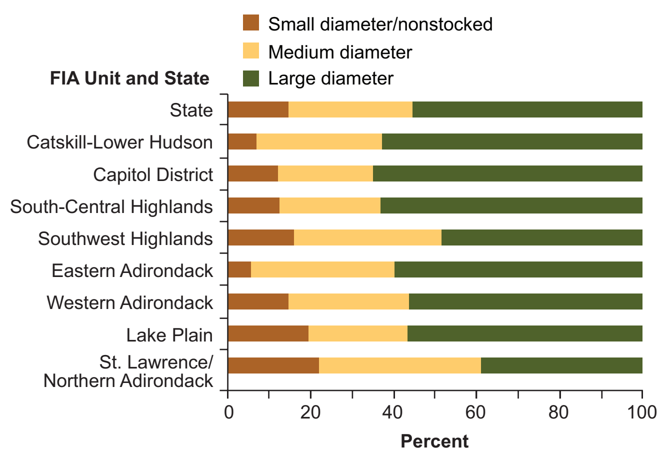


Figure 32.—Percentage of timberland by stand-size class and FIA unit, New York, 2007.

What this means

The recent increase in the average number of trees per acre and the increase in average diameter mean that stocking levels in New York have improved although measures of stocking cannot be compared to previous measurements because of changes in procedures. Most stands are well stocked with trees whether based on all live trees or just on growing-stock trees. The large area of fully stocked and overstocked stands presents opportunities for forest management without diminishing forest growth. Managing these stands can keep them growing optimally by preventing them from becoming overstocked. The 3.1 million acres (20 percent) of timberland that is poorly stocked or nonstocked with commercially important species can represent a loss of potential growth, although these forests still provide other benefits such as contributing to habitat diversity and watershed protection. These stands may have originated as agricultural land that has reverted to forest or from harvesting. The estimate of poorly stocked stands includes 1.3 million acres that are more than 40 years old and dominated by medium and large trees. These stands may be the result of poor harvesting practices, although they could stem from acceptable forestry practices such as shelterwood or seed tree harvesting methods being used to regenerate the stand. The larger percentage of poorly stocked stands in the Lake Plain unit is from land reverting to forest because this area had large increases in forest land in previous inventories. Poorly stocked stands represent a challenge to forest managers because they contain little value to pay for needed timber stand improvements. Stands that are poorly stocked with trees are probably more susceptible to invasion by nonnative species, such as multifora rose and honeysuckle, than fully stocked stands, because of their more open growing conditions (Huebner and Tobin 2006). Low levels of stocking could affect future sawtimber availability and negatively affect future cash flows to the forest owners.

New York's forests have a variety of stand-size classes that provide diverse habitats for wildlife. The shift in stand size to more sawtimber-size stands is evidence that New York's forests are maturing, although most of these stands are relatively young (less than 80 years) and have not developed the vertical diversity that typifies late successional forests. Declines in sapling and seedling-dominated forests are likely to continue as more stands mature into larger size classes while decreasing amounts of farm land are allowed to revert to forest land. Also, the timber management methods often used in New York do not create these early successional habitats. Continued losses of sapling/seedling stands could be problematic for species such as ruffed grouse that prefer dense patches of young trees for at least part of their life cycle (DeGraaf and Yamasaki 2001, Thompson and Dessecker 1997). Besides offering diverse habitats and providing a steady flow of wood products, forests that contain all stand sizes might be more resistant to devastating outbreaks of insects and diseases.

Forest Composition

Background

The species composition of a forest is the result of the interaction between climate, soils, disturbance, competition among trees species, as well as other factors over time. Causes of forest disturbance in New York include wildfires, ice and wind storms, logging, droughts, insects and diseases (e.g., beech bark disease), and land clearing followed by abandonment. Also, as forests mature, changes in growing conditions favor the regeneration of shade-tolerant species over shade-intolerant species in the understory, unless forest management practices intervene to work toward the perpetuation of shade intolerants. Forest attributes that describe forest composition include forest type, forest-type group, and number of trees by species and size. Forest types describe groups of species that frequently grow in association with one another and dominate the stand. Similar forest types are combined into forest-type groups. Changes in area by forest type are driven by changes in the species composition of large-diameter trees, and while large trees represent today's forest, the composition of the smaller diameter classes represents the future forest. Comparisons of species composition by size can provide insights into future changes in overstory species.

The species composition of reserve acreage differs from that of timberland because of differences in physiographic characteristics, and in management objectives. Because harvesting is prohibited on these reserved acres, they serve as prime examples of how natural processes affect forests over long periods and how old growth characteristics develop.

FIA has mapped species distributions by linking plot data to MODIS satellite pixels. The highest category represents areas where a single species represents more than 20 percent of the stocking of live trees. Although only a few maps are shown here, FIA has produced these types of maps for nearly all tree species growing in the State. They are available upon request.

What we found

The 2007 inventory of New York identified 104 tree species, 60 forest types, and 14 forest-type groups. The maple/beech/birch forest-type group covers 53 percent (8.3 million acres) of New York's timberland, and the oak/hickory group covers 14 percent (2.9 million acres) (Fig. 33). Since 1993, there has been a small shift in area by forest-type group, although some of these changes may reflect changes in estimation procedures.

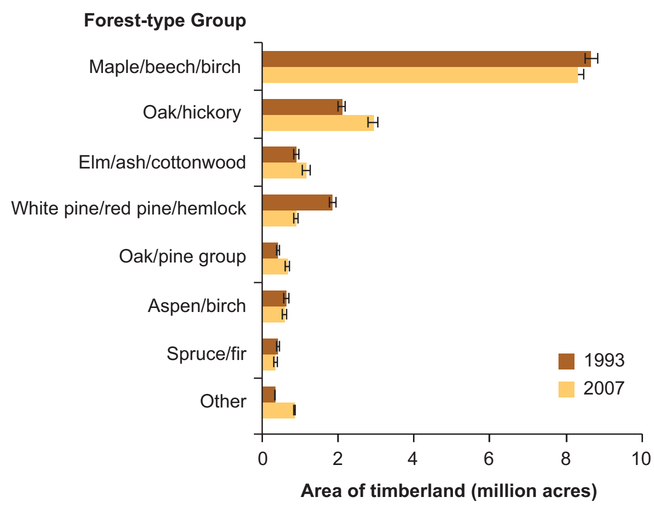


Figure 33.—Area of timberland by forest-type group, New York, 1993 and 2007 (error bars represent 68-percent confidence intervals around the estimates).

Since 1980, nearly all the major species in the State have increased in numbers of trees 5 inches d.b.h. and larger (Fig. 34). Exceptions to this have been the numbers of northern red oak, spruce, and aspen. Numbers of these species have been flat to decreasing since 1980. Comparing the ranking by number of trees 5.0 inches and larger in Figure 34 to that of sapling ranking in Table 2 indicates how well these species are reproducing. Again, most of the major species had increases in numbers of saplings. Species with large increases in saplings include beech, ash, black birch, and red spruce. Important species that decreased in numbers of saplings include hemlock, black cherry, white pine, northern red oak, and northern white-cedar.

Table 2.—Species ranked by number of saplings (trees at least 1 inch and less than 5 inches d.b.h.), 2007 and 1993, total number of stems 2007, and percent change 1993-2007, New York

Rank 2007	Rank 1993	Species	Millions of stems 2007	Percent change 1993-2007
1	1	Red maple	960	-5
2	2	Sugar maple	857	1
3	3	Beech	855	24
4	4	Ash	682	28
5	8	Balsam fir	333	14
6	6	E. hophornbeam	328	4
7	5	Hawthorn spp.	308	-6
8	7	Hemlock	273	-10
9	11	Striped maple	226	2
10	9	A. hornbeam	216	-15
11	10	Black cherry	209	-11
12	12	Yellow birch	189	-2
13	19	Red spruce	185	63
14	17	Serviceberry spp.	181	37
15	14	White pine	169	-11
16	15	American elm	165	-8
17	16	Quaking aspen	131	-9
18	18	Gray birch	114	-10
19	13	Apple spp.	99	-48
20	23	Black birch	91	24
21	22	Hickory	82	11
22	20	N. white-cedar	80	-28
23	21	N. red oak	69	-13
24	25	A. basswood	65	49
25	24	Paper birch	50	-15
26	38	Silver maple	34	117
27	26	Pin cherry	32	-12
28	28	Bigtooth aspen	28	-7
29	29	E. redcedar	23	-20
30	34	Chokecherry	22	10

Red maple is the most numerous sapling (1.0 to 4.9 inches d.b.h.) followed by sugar maple and beech (Fig. 35). Together red and sugar maple represent a fourth of all saplings on timberland, 32 percent of trees 5 to 10.9 inches d.b.h., and 31 percent of trees larger than 11 inches d.b.h. In the current inventory, white pine makes up 15 percent of trees in the 20-inch class and larger, but only 2 percent of saplings. Similarly, northern red oak and eastern hemlock are well represented in

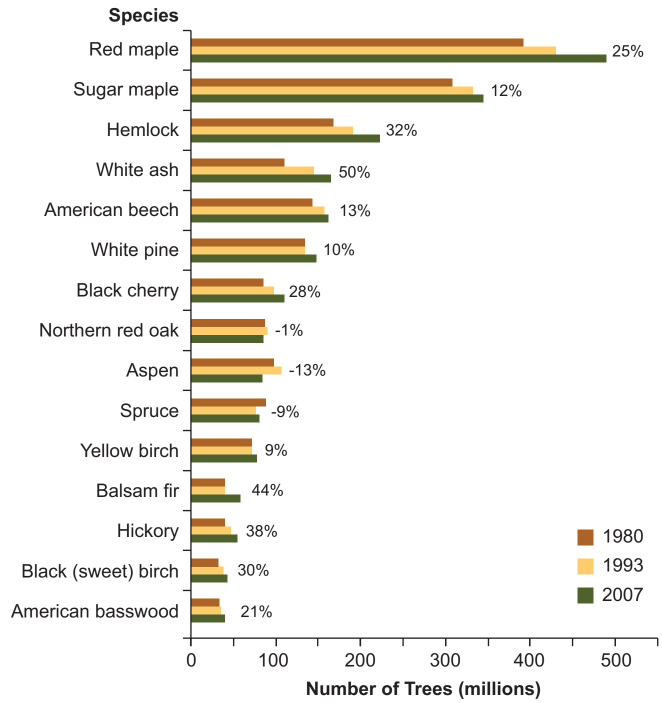


Figure 34.—Top 15 species ranked by the numbers of trees 5.0 inches in diameter and larger in 2007, with estimated number of trees in 1980, 1993, and 2007, and percent change from 1980 to 2007, New York.

the large-diameter class but represent only 1 and 4 percent of saplings, respectively. Conversely, beech has a disproportionate share of trees in the sapling-diameter classes—12 percent of all saplings trees—compared to its presence in the larger diameter classes—5 percent of trees 11 inches d.b.h. and larger.

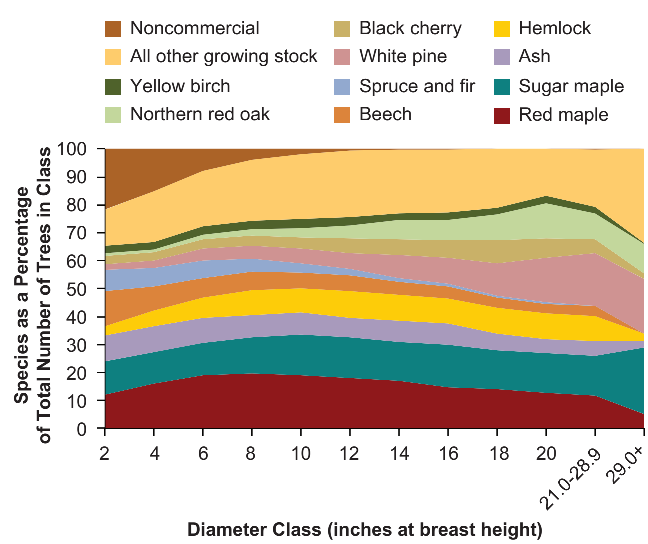


Figure 35.—Species composition by diameter class on timberland, New York, 2007.

In addition to trees on timberland are trees on reserve acreage. Although FIA does not specifically identify the Adirondack Preserve in its database, we can filter out the Preserve acreage by using ownership and reserve status. Figure 36 represents the species composition on State-owned reserved forest land in the three Adirondack units. Noteworthy here is the contrast between the composition of sapling-size trees and those 11 inches d.b.h. and larger. Beech, red spruce, and balsam fir make up 72 percent of all saplings, whereas sugar maple, yellow birch, and red maple are the dominant trees in diameter classes 12 inches and larger. White pine represents less than a half a percent of saplings and 5 percent of trees in the 12-inch diameter class and larger. Ash is a minor species on these reserved acres, representing less than 1 percent of all trees.

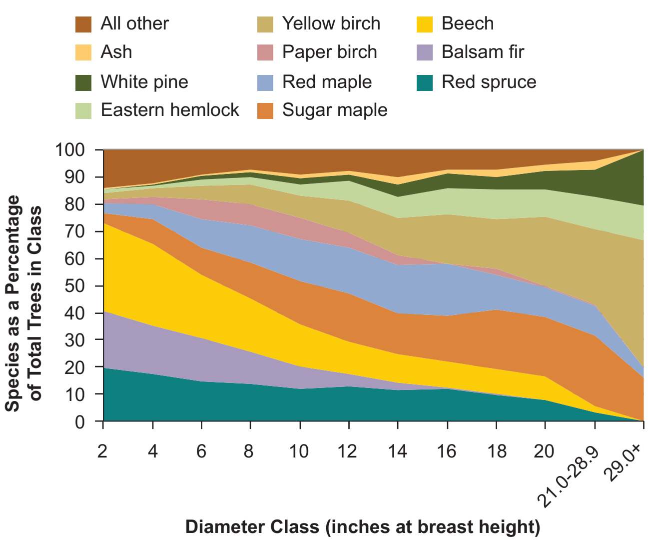


Figure 36.—Species composition by diameter class on reserve forest land in the Adirondack units, New York, 2007.

Species distribution maps produced by FIA show where trees species are likely to be found. Red and sugar maple are the most widely distributed species in the State and frequently represent more than 20 percent of the stand basal area. Ash species are also widely distributed, but rarely make up more than 20 square feet of basal area (Fig. 37). White pine and hemlock appear to grow better on the edge of the Adirondacks than in the more mountainous and higher elevation interior Adirondacks, while beech reaches its highest concentrations in the interior Adirondacks.

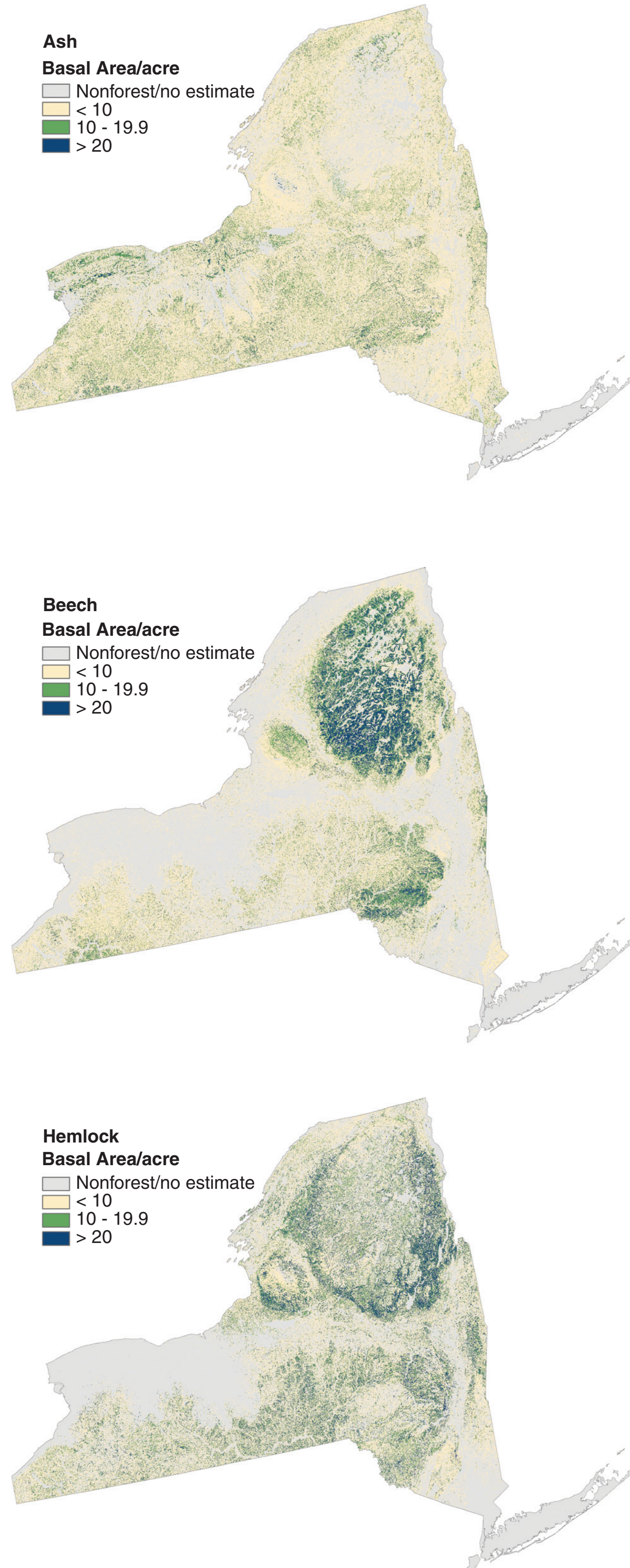
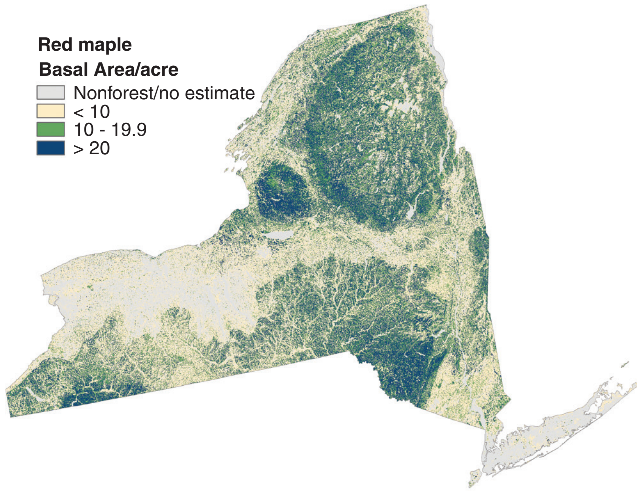
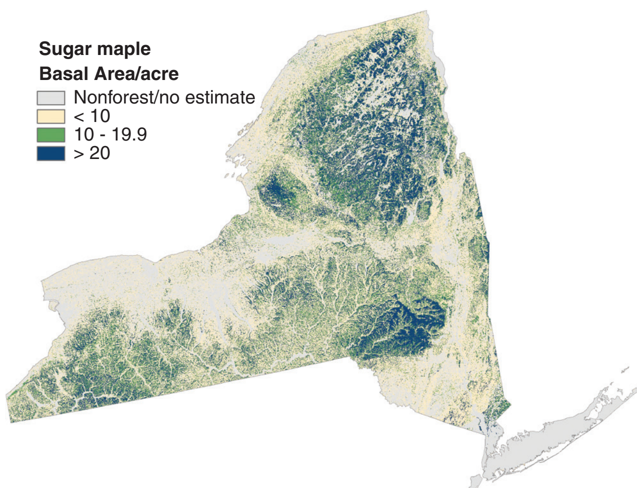
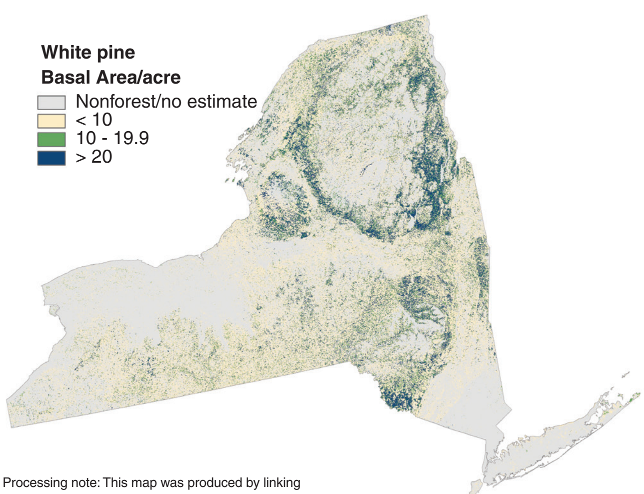


Figure 37.—Distribution maps of common tree species (sugar maple, red maple, ash species, beech, eastern hemlock, and white pine) on forest land, New York, 2007.







Processing note: This map was produced by linking FIA plot data to MODIS satellite pixels using gradient nearest neighbor techniques.

What this means

New York is dominated by the maple/beech/birch forest type. The small shift in area by forest-type group does not fully depict the underlying shifts occurring in individual species. Because forest type is heavily influenced by large-diameter trees, changes in the composition of small-diameter trees that occupy the understory are not adequately reflected in changes by forest-type group; they also do not show changes in individual species.

On timberland, red maple and sugar maple lead in numbers of trees 5 inches and larger d.b.h. Because they also lead in numbers of sapling-size trees, these species will continue to dominate New York's forests well into the future. Species that have declined since 1980 in both numbers of saplings and trees 5 inches and larger include white pine, northern red oak, and the aspen group, indicating that the composition of New York forests is shifting away from these species. Other species with declining numbers of saplings are black cherry, paper birch, gray birch, pin cherry, and redcedar. These species are shade intolerant and need full sunlight to thrive. Reduced numbers of saplings in these species are an indication of forests maturing. Consistent with this maturing are increases in numbers of sugar maple, red spruce, balsam fir, and beech. Overall, most species that are well represented by large trees are also well represented in the sapling size class, indicating only small changes in the composition of New York's forest. However, regeneration of some important timber species—northern red oak, white pine, and black cherry—lags behind that of other species. Numbers of ash trees have increased across all diameter classes, but this species is threatened by the emerald ash borer, discussed later in this report, that could cause large decreases in the number of this important species.

The maturing of forests and shift to more shade-tolerant species is most evident on the State owned reserved forest in the Adirondacks. Here there is a large contrast between the composition of the smaller understory trees and the larger overstory trees. The understory is primarily composed of just three species—balsam fir, red spruce, and beech—whereas the composition of the larger trees is more evenly distributed across more species. Notable is the low percentage of white pine, yellow birch, hemlock, and sugar maple in the 2- and 4-inch diameter classes, indicating poor regeneration of these species. If only stands in the maple/beech/birch forest type are considered, 48 percent of the saplings are beech, 19 percent red spruce, 7 percent sugar maple, 6 percent balsam fir, and 3 percent red maple. Lacking major disturbance, Adirondack Preserve forests will likely lose diversity in their mix of trees species as large trees die and are replaced by just a few species. The large presence of yellow birch in diameter classes 20 inches and larger is characteristic of old growth forests in this region. Also, increases in red spruce and beech in the overstory would indicate a return to pre-settlement conditions in the region. Beech bark disease, discussed later in this report, is the likely cause of the uneven distribution of beech across diameter classes, causing high mortality of large beech and promoting the sprouting of numerous beech saplings. Because of beech bark disease, it is unlikely that many young beech will reach large size, which limits the value of beech for producing hard mast for wildlife. The large number of beech saplings is also interfering with the reproduction of other species.

Sound Volume and Growing-Stock Volume of Live Trees on Timberland

Background

Measurement of wood volume on timberland is important in assessing the volume of wood available for commercial products. Classifying this wood by tree class, species, size, and tree grade is important in determining how trees can be utilized.

Growing-stock volume includes only trees of commercially important species and is the net volume after deductions are made for defects. Growing-stock volume is the resource base upon which the forest products industry depends. Measures of growing-stock volume are useful in making comparisons to older inventories where only estimates of growing stock are available. However, because of some changes in procedures, trends in growing-stock volume should be considered as just rough estimates of change. Discussed later in this report, the annual change estimates for growth, removals, and mortality are better estimates of change. Growing-stock trees must have at least one-third of their volume meeting grade, contain one merchantable 12-foot log or two non-contiguous merchantable 8-foot logs now for sawtimber-size trees or potentially for poletimber, and be of a commercial species. These trees are favored in silvicultural treatments, although some species and trees graded as tree grades 4 and 5 are not.

The use of the timber resource for sawn timber products is determined largely by tree quality, species, and utilization standards. The best trees are used in the manufacture of grade lumber for use in furniture, cabinets, and other millwork that command high prices. Lower quality trees are used for pallets, pulpwood, and fuelwood, as well as many other products. Quality varies by species due to differences in average diameter, growth characteristics, and past management practices. FIA assigns tree grades to sawtimber-size trees as a measure of quality. Tree grades are based on the amount of knot-free bole, amount of cull, and tree diameter. Trees need to be at least 13.0 inches d.b.h. to be considered for grade 2 and 16.0 inches d.b.h. for grade 1. Trees in the grade 1 category have the fewest defects and yield the most high quality lumber. Trees assigned to the tie/local use grade are the lowest quality and yield low value products.

What we found

Eighty-two percent of the sound wood volume on timberland is categorized as growing-stock volume, amounting to 29.2 billion cubic feet (Fig. 38). Also contained within these growing-stock trees is an additional 3.0 billion cubic feet categorized as sound cull volume. This wood is in the upper bole of the trees and in portions of the bole that have been culled due to defects such as forks and large amounts of sweep. Trees not meeting growing-stock standards either because of large amounts of defect or are noncommercial species are classified as rough and rotten cull trees. Noncommercial species in New York include hawthorne, eastern hophornbeam, hornbeam, and striped maple. (A complete list of noncommercial species can be found in the database users manual on the DVD accompanying this report, appendix F, species group 43). Rough and rotten trees account for 3.5 billion cubic feet or 9 and 1 percent of total sound volume on timberland, respectively. Not included in Figure 38 are 8.5 billion cubic feet of sound wood growing on reserved and other forest land.

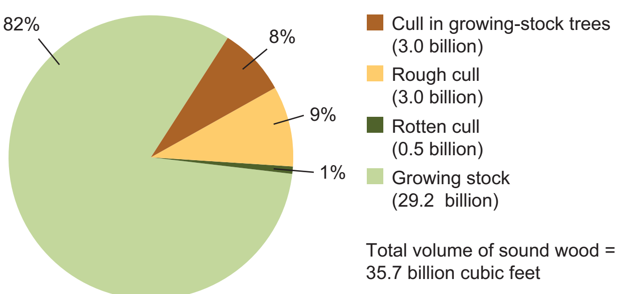


Figure 38.—Distribution of sound wood volume (cubic feet) in live trees by tree class on timberland, New York, 2007.

Growing-stock volume on New York's timberland has steadily increased since 1950 (Fig. 39). The 2007 estimate of 29.2 billion cubic feet is 34 percent more than the 1993 estimate. The portion of volume large enough to produce saw logs has increased by 41 percent to 87.1 billion board feet or 16.6 billion cubic feet. The State averages 1,838 cubic feet of growing-stock volume per acre. Volume estimates were lowest in the St. Lawrence/Northern Adirondack unit—1,325 cubic feet per acre—and highest in the South-Central Highlands unit—2,072 cubic feet per acre (Fig. 40).

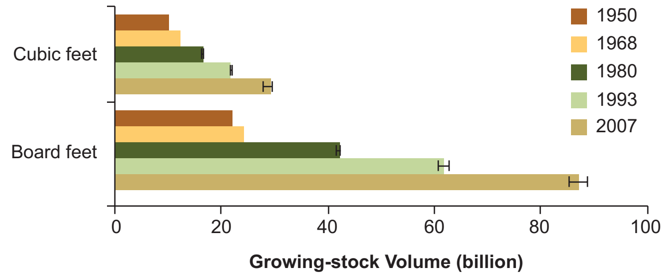


Figure 39.—Growing-stock volume in terms of cubic feet and board feet, New York, 1950, 1968, 1980, 1993, and 2007 (error bars represent 68-percent confidence intervals around the estimates).

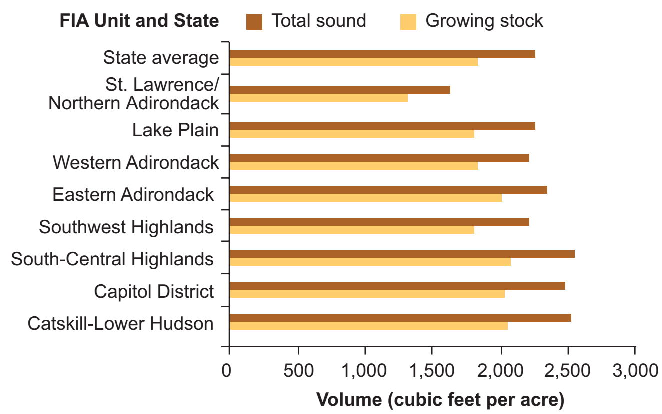


Figure 40.—Total sound and growing-stock volume of live trees per acre of timberland, by FIA unit, New York, 2007.

Red maple and sugar maple lead in growing-stock volume on timberland followed by white pine, ash species, and hemlock (Fig. 41). The top species ranked by growing stock differ little from those ranked by board-foot volume (Fig. 42). Figure 41 shows an increase in beech growing-stock volume, although within sampling error. Because a large portion of beech trees only marginally qualify as growing stock, small changes in how they are graded by field crews can cause large numbers of trees to change tree class, cull to growing-stock trees or vice versa. The annual components of change data, presented later in this report, use a consistent tree class when estimating change. These data show annual decreases in beech growing-stock volume from 1993 to 2007 and are a better estimate of change than comparing inventories by year.

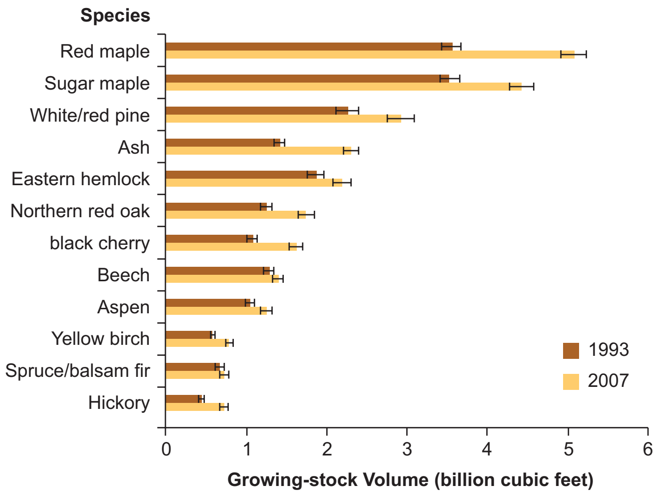


Figure 41.—Growing-stock volume on timberland, by species group, New York, 1993 and 2007 (error bars represent 68-percent confidence intervals around the estimates).

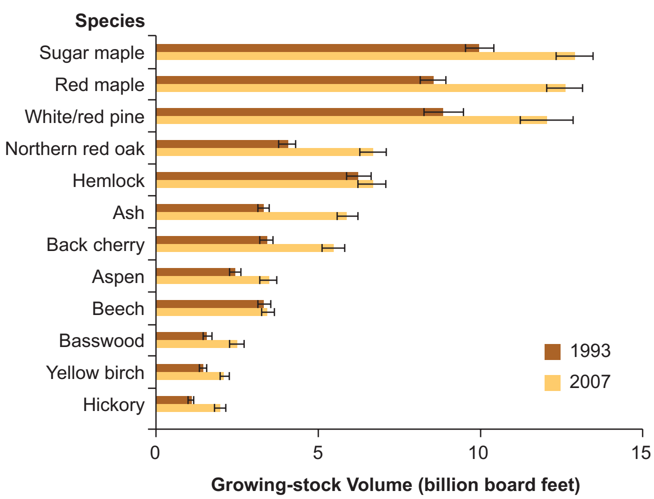


Figure 42.—Board-foot volume on timberland, by species group, New York, 1993 and 2007 (error bars represent 68-percent confidence intervals around the estimates).

The distribution of hardwood sawtimber by tree grade changed very little between the 1993 and 2007 inventories. Thirty-two percent of hardwood sawtimber volume was contained in trees graded 1 and 2 in 1993, compared to 35 percent in 2007 (Fig. 43). In absolute terms, the volume in grades 1 and 2 increased by 61 percent to 33 billion board feet, while volume in the lowest grade (tie/local use) increased by 88 percent to 10 billion board feet. Of the major species in the State, northern red oak and basswood have the largest percentage of their volume in grades 1 and 2, each with more than half their volume in these valuable grades (Fig. 44). Sugar maple is the leading species in board-foot volume and has a third of its volume in grades 1 and 2. Among the other major species in the State, beech had the lowest portion of volume in grades 1 and 2 (7 percent) and the highest portion in the low tie and local use grade (69 percent).

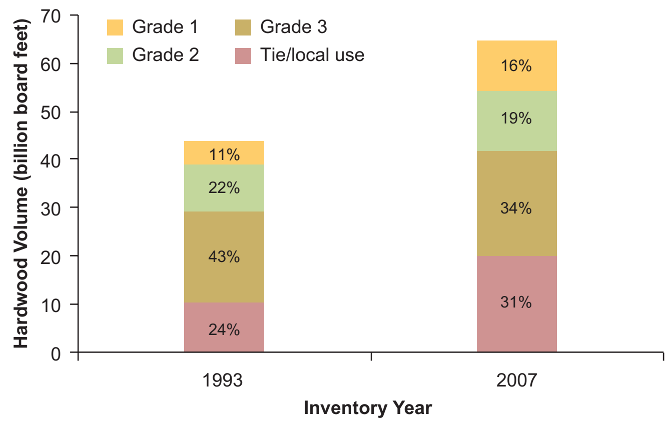


Figure 43.—Hardwood board-foot volume by tree grade, New York, 1993 and 2007.

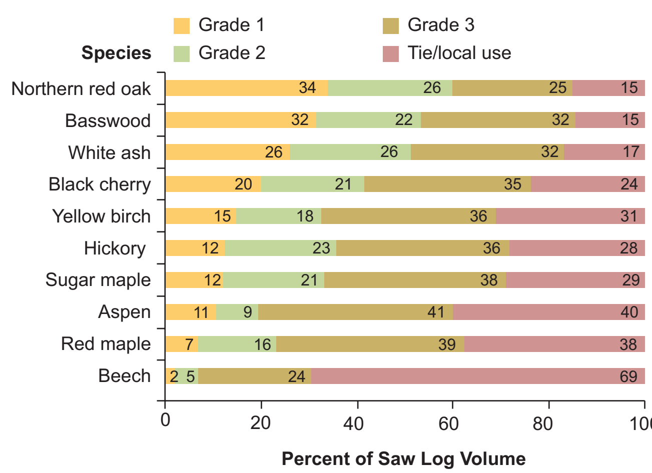


Figure 44.—Percentage of saw log volume by tree grade for major species, New York, 2007.

The ranking of species by volume on all forest land is similar to that on timberland, although beech and red spruce rank higher on forest land because of their higher occurrence on reserved forest land (Fig. 45). On all forest land, red maple and sugar maple ranked in the top five species by sound volume in every unit in the State (Fig. 46).

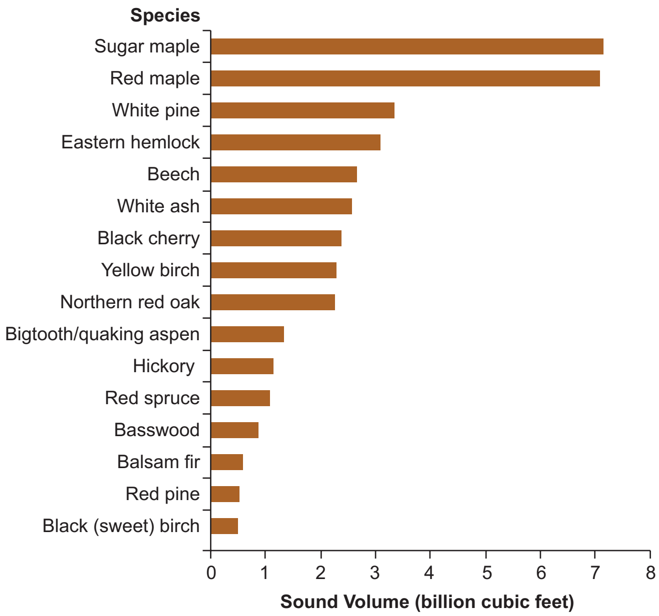


Figure 45.—Top species ranked by sound volume of live trees found on forest land, New York, 2007.

What this means

Since 1950, continuous increases in volume have brought New York's timber resource to record levels in both terms of total growing-stock volume and board-foot volume. Most of the volume is in trees that meet minimum requirements to qualify as growing-stock trees. Timber growth is concentrated on sawtimber-size trees, which explains why increases in board-foot volume (+41 percent) were higher than increases in cubic-foot volume (+34 percent). As trees grow into sawtimber size, their value for timber products can increase abruptly because they can now be used for higher value products. Despite the substantial increase in sawtimber volume, trends in tree quality, species composition, and sustainability of some high value species raise concern.

Volume increases occurred across all tree grades, but the large increases in volume in the poorest grade negatively affect the value of the resource. Trees graded as tie/local

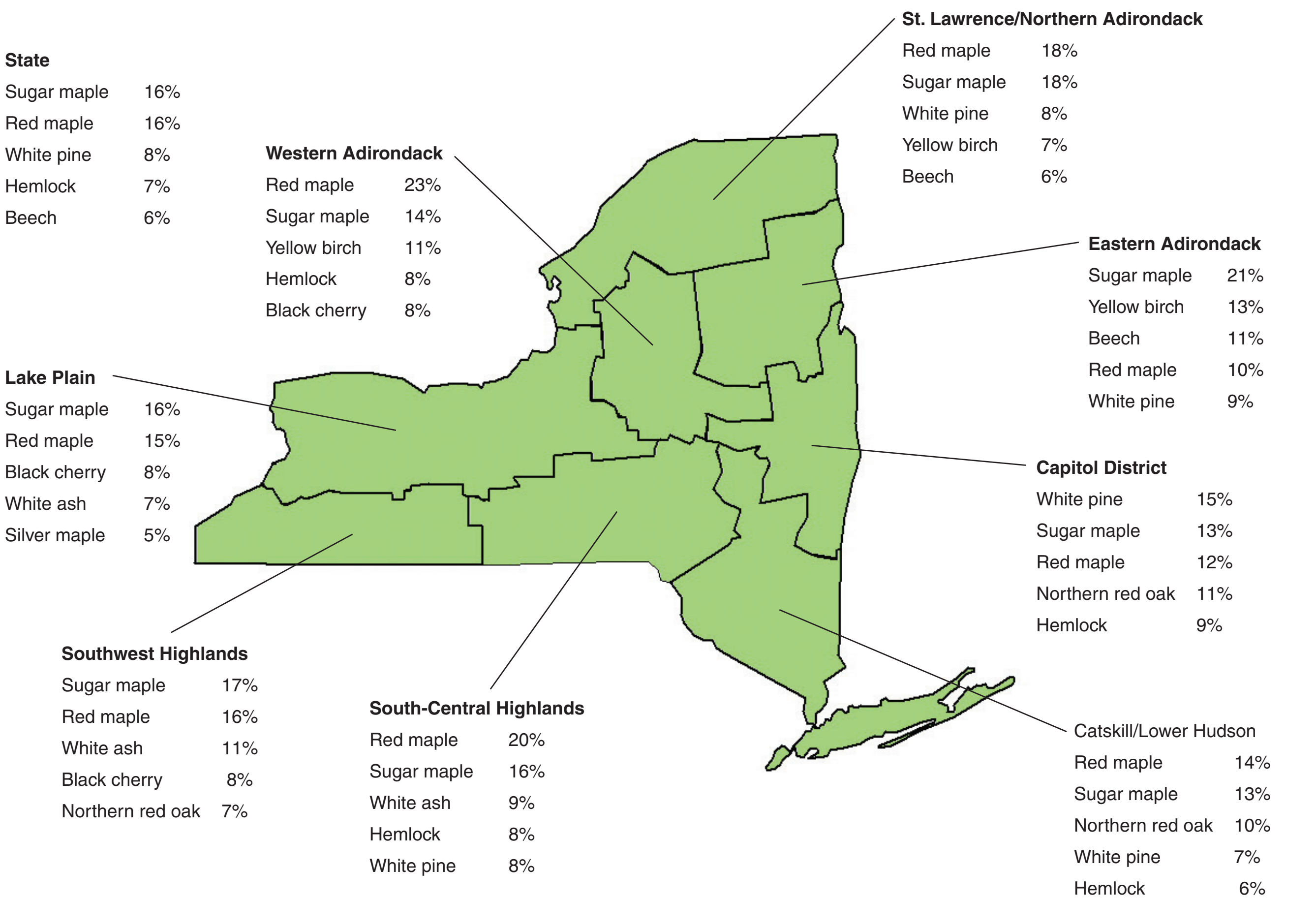


Figure 46.—Top five species ranked by all live sound volume and percentage of total volume in unit on forest land, by FIA unit, New York 2007.

use nearly doubled in volume and now represent 31 percent of the total sawtimber volume. Tree quality is affected by changes in species composition. In New York there is a shift in composition toward lower valued species. Red maple, which typically grades poorer than other species, is the leading species by growing-stock volume. It has had the largest increase in volume since 1993 and is the most numerous sapling (Table 2). And, although beech has decreased in board-foot volume since 1993, it is the third most numerous sapling species. Because of the large amount of defect in beech, the large numbers of beech saplings should be a concern to forest managers. And, while white pine, northern red oak, and black cherry had large increases in sawtimber volume, these increases are probably not sustainable because of declining numbers of these trees in the lower diameter classes.

In addition to growing-stock volume is the volume in the cull sections of growing-stock trees and trees classified as rough and rotten. Wood in these cull classes represent opportunities for increased utilization of low value wood, much of which is now left in the woods during harvesting operations. Although cull trees have low value for wood products, they are of high value for wildlife habitat. Many of the same features that lower their value for products increase their value for wildlife, such as bole cavities, large amounts of rot, and broken tops.

In New York, 42 percent of hardwood sawtimber volume is in trees less than 15.0 inches in d.b.h. These trees are too small to be rated grade 1 and are given a low grade in many cases because of size alone. Forest land owners can receive high financial returns by practicing sustainable forestry and thinning around trees with the potential to grow into higher quality grade 1 and 2 trees. By using silvicultural tools that promote high value species and increase tree quality, landowners can receive financial compensation from the harvest and the residual forest is healthier. Having markets for products such as pallets, wood pellets, and biomass energy, which can utilize poor quality timber, can promote the use of best practices by landowners in managing their forest resource.

Biomass Volume of Live Trees

Background

Trees play an important role in the world's carbon cycle. They act as a sink for carbon, removing it from the atmosphere in the form of carbon dioxide (a greenhouse gas) and storing it in wood. In this role, forests help mitigate the effect of burning fossil fuels and the resulting global climate change associated with increased levels of carbon dioxide in the atmosphere. New York's forests contribute greatly to the sequestration of carbon dioxide due to increases in tree volume. Estimates of biomass are important for knowing not only the amount of stored carbon but also the potential amount of biomass available for energy uses.

Tree biomass is the total weight of both live and dead trees, including branches, roots, and stumps. Typically the carbon content of biomass is equal to half the biomass weight measured in dry tons.

What we found

Biomass of all trees standing in New York's forests equals 1.1 billion dry tons—an average of 57 tons per acre. The greatest portion (52 percent) is found in the merchantable boles of growing-stock trees (Fig. 47). This component can be converted to high value wood products, although the potential for using the tie/local use grade tree portion for high value products is low. Other portions of tree biomass on timberland are underutilized and can be considered as potential sources of fuel for commercial power generation and heating and as wood for producing fuel pellets.

Biomass on reserved and other forest land, although not available for use for products, serves as a sink for carbon. Examining the distribution of biomass across the State shows the highest volumes of biomass per acre are associated with reserved forest land (Fig. 48). This is especially noticeable in the Southwest Highlands unit where high biomass volumes are associated with the Allegany State Park. Biomass averaged 68 dry tons per acre on reserved forest land and 55 tons on timberland.

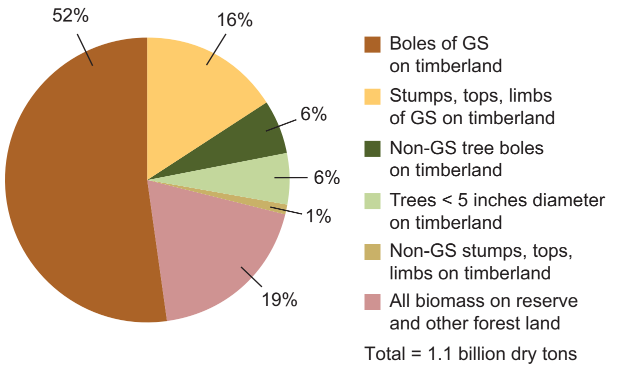


Figure 47.—Live-tree biomass on reserved forest land, and other forest land, and timberland, broken out by tree components, on timberland, New York, 2007. (Note: GS refers to growing-stock trees while Non-GS refers to non-growing-stock trees including rough and rotten cull and nongrowing-stock species).

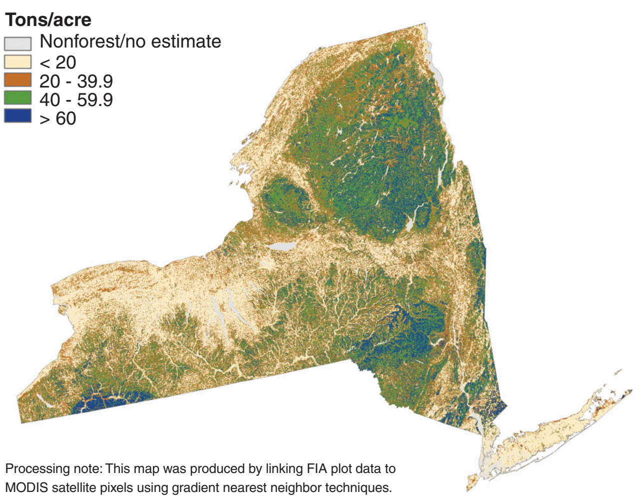


Figure 48.—Distribution of biomass per acre on forest land in New York, 2007.

What this means

New York's forests have accumulated substantial amounts of biomass. These stores of carbon will receive increasing attention as the Nation seeks sources of renewable energy and ways to offset carbon dioxide emissions. Because biomass is a renewable source of energy, it can help reduce the Nation's dependence on fossil fuels. Using biomass for fuel would provide markets for low grade and underutilized wood. As biomass markets develop, forest managers will have the opportunity to integrate the harvesting of biomass into their management plans.

Carbon Stocks

Background

Collectively, forest ecosystems represent the largest terrestrial carbon sink on earth. The accumulation of carbon in forests through sequestration helps mitigate emissions of carbon dioxide to the atmosphere from sources such as burning of fossil fuels and forest fires. The FIA program does not directly measure forest carbon stocks in New York. Instead, a combination of empirically derived carbon estimates (e.g., standing live trees) and models (e.g., carbon in soil organic matter is based on stand age and forest type) are used to estimate New York's forest carbon. Estimation procedures are detailed by Smith et al. (2006).

What we found

New York forests currently contain more than 1.5 billion tons of carbon. Live trees and saplings represent the largest forest ecosystem carbon stock in the State at more than 42 percent (646 million tons), followed by soil organic matter (SOM) at more than 40 percent (608 million tons) (Fig. 49). Within the live tree and sapling pool, merchantable boles contain the bulk of the carbon (25 percent) followed by roots (7 percent) and tops and limbs (6 percent). The majority of New York's forest carbon stocks are found in relatively young stands, 41 to 80 years old. Early in stand development most forest ecosystem carbon is in the SOM (Fig. 50). As forest stands mature, the ratio of aboveground to belowground carbon shifts, and by age 41 to 60 years the aboveground components represent the majority of ecosystem carbon. This trend continues well into stand development as carbon accumulates in live and dead aboveground components. A look at carbon by forest-type group on a per unit area basis found that 6 of the 10 types have between 64 and 83 tons of carbon per acre (Fig. 51). Despite the similarity in per acre estimates, the distribution of forest carbon stocks by forest type is quite variable. In the oak/hickory group, for example, 55 percent (35 tons) of the forest carbon is in live biomass, whereas in the elm/ash/cottonwood group, only 32 percent is in live biomass.

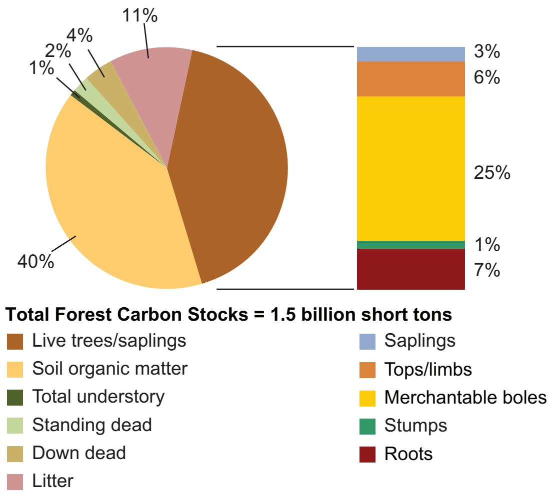


Figure 49.—Estimated total carbon stocks on forest land by forest ecosystem component, New York, 2002-2007.

Figure 50.—Estimated carbon stocks (oven-dry tons) per acre on forest land by component groups and stand age class, New York, 2007.

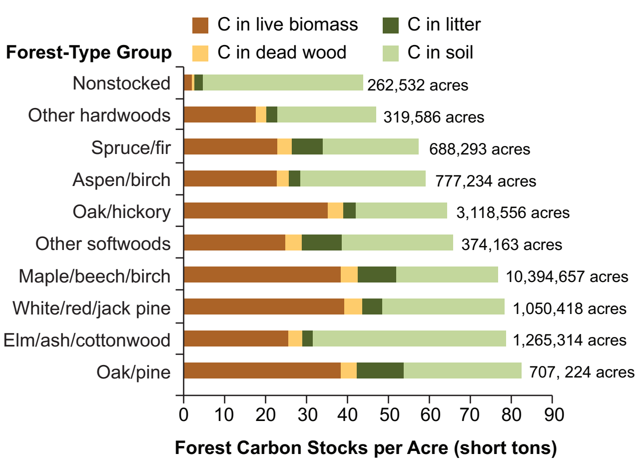


Figure 51.—Estimated carbon stocks on forest land by forest-type group and carbon pool per acre, New York, 2007.

What this means

Carbon stocks in New York's forests have increased substantially over the last several decades. Nearly half the forest stands in New York are less than 60 years old and dominated by relatively long-lived species, suggesting that New York's forest carbon will continue to increase as stands mature and accumulate carbon in aboveground and belowground components. Given the age class structure and species composition of forests in New York, there are many opportunities to increase forest carbon stocks. That said, managing for carbon in combination with other land management objectives will require careful planning and creative silviculture beyond simply managing to maximize growth and yield.

Components of Annual Volume Change: Growth, Removals, and Morality

Background

Well-tended forests supply a continuous flow of products and other services without impairing long-term productivity. One way to judge the sustainability of a forest is to examine the components of annual change in inventory volume: growth, removals, and mortality. Removals includes trees harvested on land that remains in timberland, trees on timberland that has been reclassified to reserved forest land, and trees lost because the forest was developed for a nonforest use. Analysis of these individual components can help us better understand what is influencing net change. Annual net change is net growth minus removals and is the amount of wood added or subtracted from total inventory volume each year.

The volume of trees that die from natural causes such as insects, diseases, fire, wind, and suppression from other trees is reported as mortality; harvested trees are not included. Tree mortality is a natural process that occurs in a functioning ecosystem although dramatic increases in mortality from catastrophic events can indicate problems in forest health.

About the data: Annual growth, removals, and mortality data in this report have been processed using current methods to compute annual changes in volume since 1993. It is recommended that users use these measures of change rather than inventory volume estimates to analyze trends. Annual change data are not available for reserved forest land because plots in these areas have only been measured once. After completion of the next measurement cycle of plots, trend data will be available for reserved land. Also, after completion of the next measurement cycle, sampling errors will be lower for growth, removals, and mortality, because annual change estimates are now based on a subset of plots whereas future estimates will be based on remeasurement of all plots.

What we found

During the last 50 years in New York, the growth of trees has greatly outpaced mortality and removals. The most recent inventory revealed that since 1993, on an annual basis, gross growth has totaled 950 million cubic feet (Fig. 52). Annual mortality has averaged 253 million cubic feet, resulting in a net growth of 697 million cubic feet. The removals of trees due to both harvesting and land use change averaged 341 million cubic feet, leaving an annual surplus or net increase of 356 million cubic feet on New York's timberland. Eighty-three percent of the removals was due to the harvesting of trees and the remainder was due to changes in land use—13 percent due to timberland changing to nonforest land, and 4 percent to timberland being reclassified as reserve forest land. As a percentage of the current inventory, gross growth was 3.3 percent, mortality—0.9 percent, net growth—2.4 percent, and removals—1.2 percent, resulting in a net change of 1.2 percent annually (Table 3). This average net change in volume was lower than the 1.8 percent annual increase reported for the period 1980 to 1993.

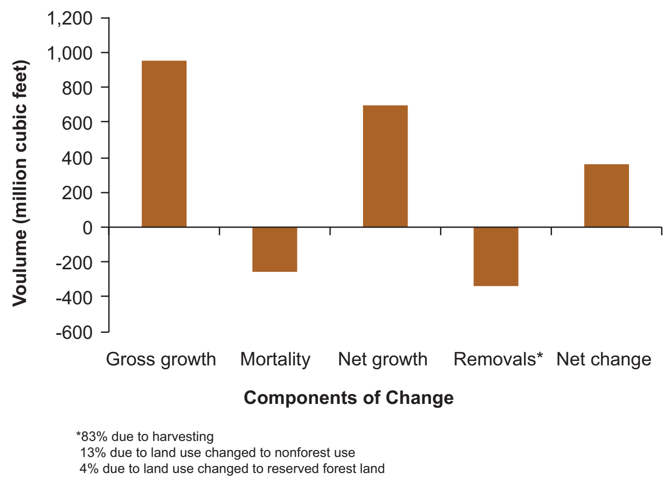


Figure 52.—Average annual components of change in growing-stock volume on timberland, New York, 1993-2007.

Table 3.—Average annual net growth, removals, and net change (1993-2007) as a percentage of current volume on timberland, New York

Unit	Gross growth	Mortality	Net growth	Removals	Net change
		----------(percent)----------			
State average	3.3	-0.9	2.4	-1.2	1.2
St. Lawrence/Northern Adirondack	3.2	-1.5	1.8	-2.1	-0.3
Lake Plain	3.5	-1.0	2.6	-1.1	1.5
Western Adirondack	3.1	-1.1	2.0	-1.3	0.7
Eastern Adirondack	3.1	-1.3	1.9	-1.6	0.3
Southwest Highlands	3.7	-0.5	3.2	-1.3	1.9
South-Central Highlands	2.7	-0.6	2.1	-0.8	1.4
Capitol District	3.3	-0.6	2.7	-1.1	1.6
Catskill-Lower Hudson	3.5	-0.8	2.7	-0.7	2.0

The ratio of total growth-to-removals (G/R) averaged 2.0:1 on timberland from 1993 to 2007, but varied considerably between units (Fig. 53). Net growth exceeded removals in all units except for the St. Lawrence/Northern Adirondack unit where the G/R was 0.8:1 and the average annual net change in volume was -0.03 percent. Overall, the three Adirondack units had smaller net changes in volume than other areas of the State because they had lower growth rates, higher harvesting activity, and greater mortality than the average for the State. Growth exceeded removals by the widest margin in the Catskill/Lower Hudson unit where the G/R ratio was 4.1:1.

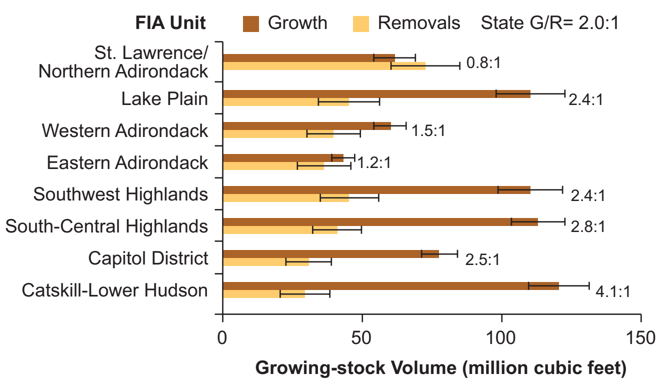


Figure 53.—Average annual growth and removals of growing-stock volume on timberland and G/R ratio by FIA unit, New York, 1993-2007.

Red and sugar maple had the largest amount of growth followed by ash, northern red oak, and white pine. Together, red and sugar maple accounted for a third of all removals, although growth of these species still outpaced removals by a ratio of 2.3 to 1 and 1.7 to 1, respectively. Removals exceeded growth for beech, red pine, and aspen (not shown) (Fig. 54). These species experience annual losses in volume (Fig. 55) and had the highest mortality rates of major species in the State (Fig. 56). Black birch has the highest annual percentage increase in volume—2.7 percent—followed by ash and black cherry at 2.2, and 1.7 percent, respectively. The St. Lawrence/Northern Adirondack unit had the highest mortality rate at 1.5 percent annually while the Southwest Highlands unit had the lowest—0.5 percent (Fig. 57).

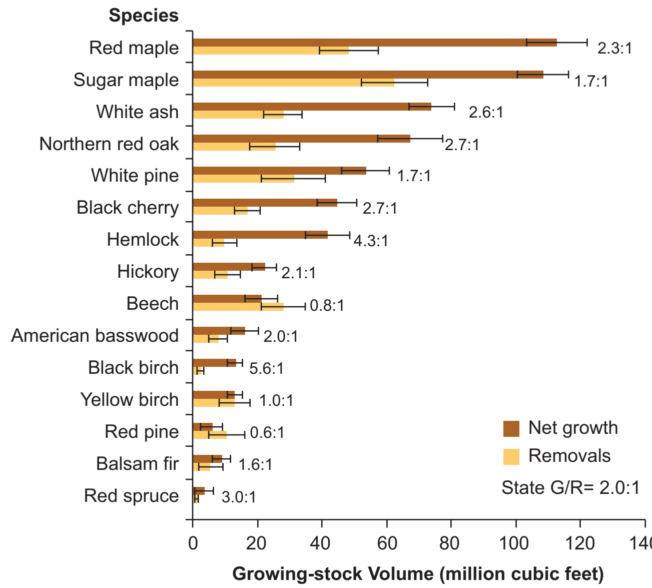


Figure 54.—Average annual net growth and removals of growing stock, and growth-to-removals (G/R) ratio for major species groups on timberland, New York, 2000-2008.

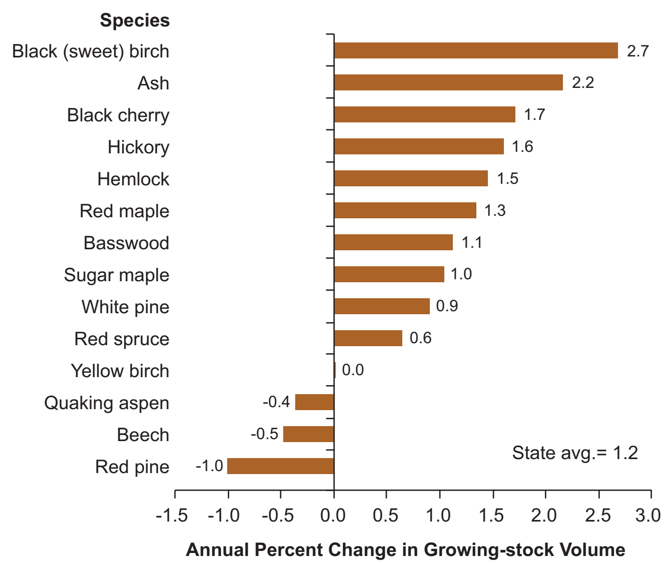


Figure 55.—Average annual net change in growing-stock volume as a percent of current inventory, by major species on timberland, New York, 1993-2007.

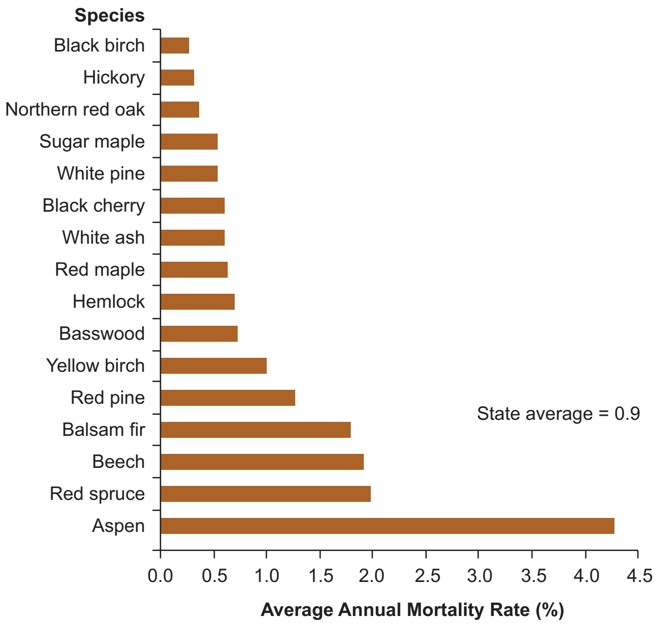


Figure 56.—Average annual mortality rate, as a percent of current inventory, for major species on timberland, New York, 1993-2007.

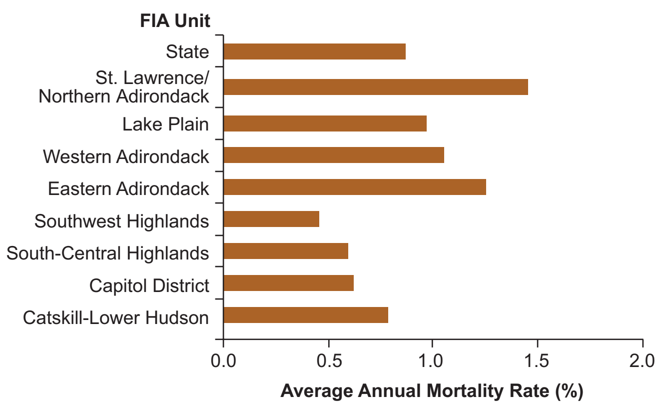


Figure 57.—Average annual mortality rate, as a percent of current inventory, on timberland, by FIA unit, New York, 1993-2007.

At the more local unit level, growth has exceeded removals for some important species in some of the Adirondack units since 1993. In the Eastern Adirondack unit, sugar maple had an annual net change of -1.5 percent. And, in the Western Adirondack unit, yellow birch and red maple volume declined annually by 2.1 percent and 0.5 percent, respectively.

What this means

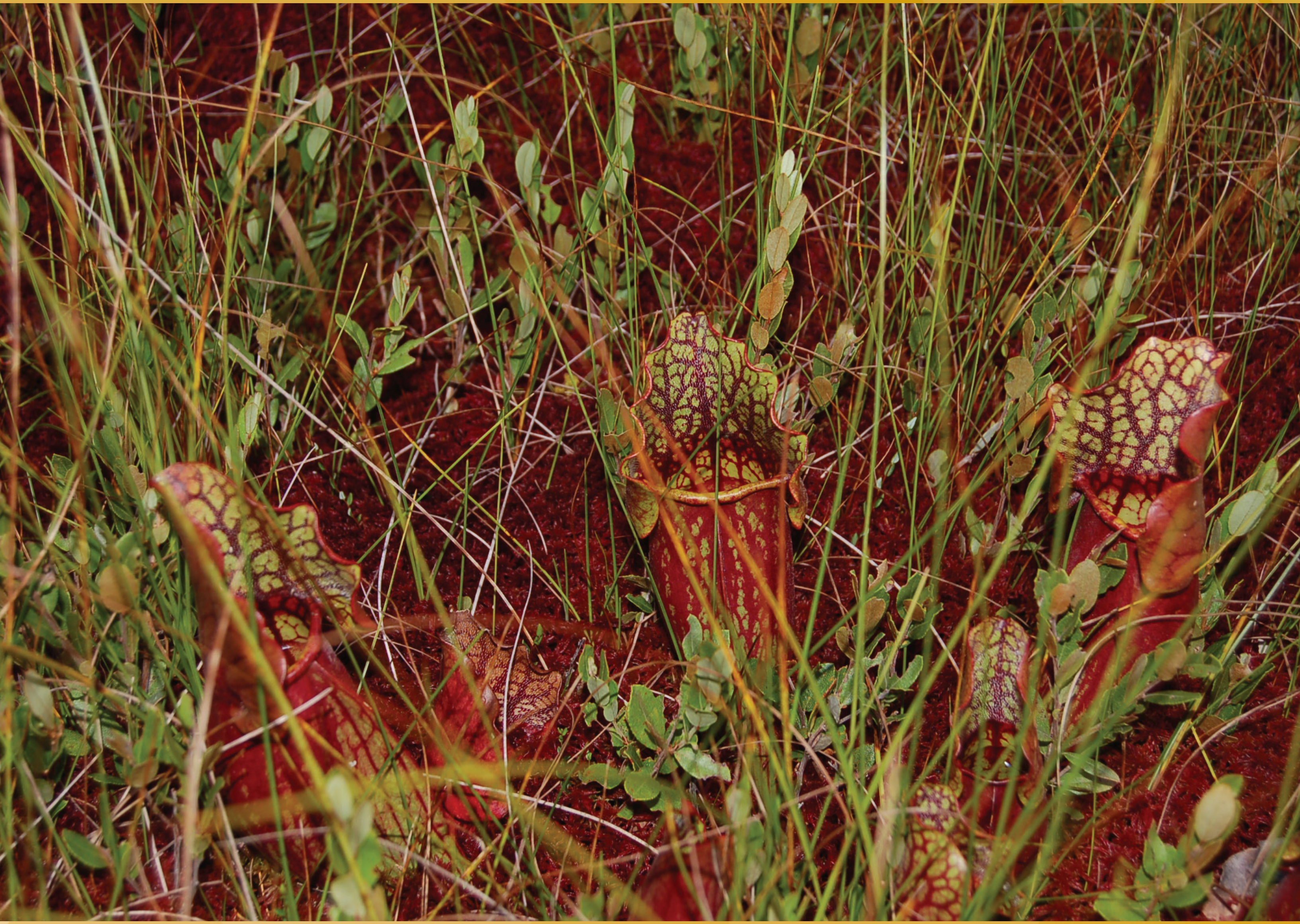
Today's well-stocked forests are a product of growth consistently outpacing removals and mortality during the last half century and the surplus accumulating in the forest. Since 1993, net growth has been twice that of removals, with the net change amounting to an annual increase of 1.2 percent in inventory volume. This finding implies that the current level of removals is sustainable and that increases in timber volumes will continue at the State level, although surpluses of growth over removals are small or negative in the Adirondack units. In the St. Lawrence/Northern Adirondack unit, high rates of mortality, likely caused by the 1998 ice storm, reduced growth. This lowered the growth rate in this unit, and when combined with a high removals rate, resulted in an annual reduction in inventory volume of 0.3 percent. Rates of growth and removals were unevenly distributed by species, resulting in removals exceeding growth at the unit level for some important species.

Comparing the growth-to-removals ratios of individual species to the average ratio for all species (2.0:1) reveals which species are increasing in the portion of total volume they represent and which are decreasing. The high growth-to-removals ratio for black birch indicates that this species will represent a larger share of total volume in New York's future forest.

Much of the mortality in New York can be explained by stand dynamics, insects and diseases that target specific species, and disturbances such as the ice storm of 1998 that hit the Northern Adirondack/St. Lawrence unit particularly hard. Quaking aspen is a pioneer species that declines quickly as stands mature. In maturing forests such as New York's, high mortality rates for quaking and other aspen species are to be expected. Red pine was widely planted throughout the State, and as these stands have matured, mortality rates have increased. Eighty-three percent of red pine volume is growing in plantation, mostly in large-diameter stands. As the pine in these plantations die or are harvested, these plantations will likely convert to natural forest conditions, which for most pine plantations is hardwoods. High mortality rates for beech are caused by beech bark disease, discussed later in this report.

In 1998, a severe ice storm affected 4.6 million acres of forest land in New York (USDA Forest Service 1999). The footprint of this storm corresponds very well to the boundaries of the St. Lawrence/Northern Adirondack unit that has an estimated 4.5 million acres of forest land. Assessments after the storm determined that crowns on 55 percent of the trees in the footprint were affected, with 15 percent receiving severe damage (loss of 80 to 100 percent of the crown). In addition, salvage operations following the storm likely increased removal rates in the unit. By removing overstory trees, ice storms such as the one that occurred in 1998 can advance forest succession by releasing shade-tolerant understory trees.

Forest Health



Pitcher plant in Adirondack bog. Photo by Richard H. Widmann.

Crown Health

Background

The crown condition of trees is influenced by various biotic and abiotic stressors. Abiotic stressors include drought, flooding, cold temperatures or freeze injury, nutrient deficiencies, soil physical properties affecting soil moisture and aeration, and toxic pollutants. Biotic stressors include native or introduced insects, diseases, invasive plant species, and animals.

Seasonal or prolonged drought periods have long been a significant and historical stressor in New York. Droughts occurred in some regions during 2002; alternatively, one of the wettest years on record was recorded in 2007 (Fig. 58; NCDC 2011). These extreme precipitation events can produce conditions that facilitate insect and/or disease outbreaks and can be even more devastating to trees stressed by pest damage or other agents.

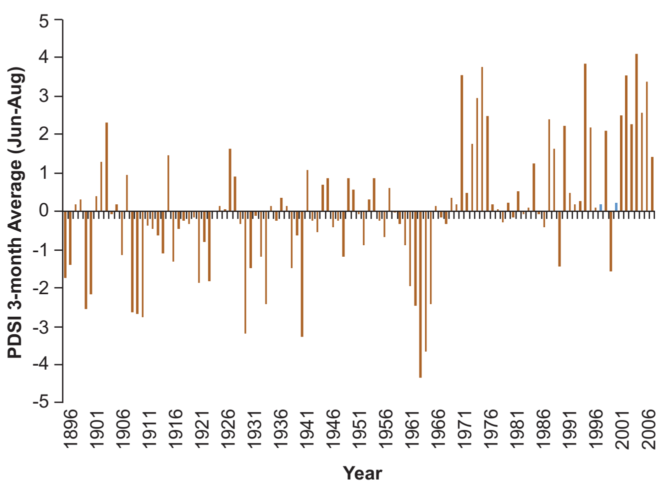


Figure 58.—Palmer Drought Severity Index 3-month average (June-August), New York, 1895-2007.

Invasions by exotic diseases and insects are one of the most important threats to the productivity and stability of forest ecosystems around the world (Liebhold et al. 1995, Pimentel et al. 2000, Vitousek et al. 1996). Over the last century, New York's forests have suffered the effects of well-known exotic and invasive agents such as Dutch elm disease (*Ophiostoma ulmi*), chestnut blight (*Cryphonectria parasitica*), European gypsy moth (*Lymantria dispar*), beech bark disease complex, and hemlock woolly adelgid (*Adelges tsugae*). More recent invasions include emerald ash borer (*Agrilus planipennis*) and *Sirex* wood wasp (*Sirex noctilio*).

Tree-level crown measurements are collected on forest health plots. They include vigor class, crown ratio, light exposure, crown position, crown density, crown dieback, and foliage transparency. Three factors were used to determine the condition of tree crowns: crown dieback, crown density, and foliage transparency. Crown dieback is defined as recent mortality of branches with fine twigs and reflects the severity of recent stresses on a tree. Secondly, crown density is defined as the amount of crown branches, foliage, and reproductive structures that block light visibility through the crown and can serve as an indicator of expected growth in the near future. Finally, foliage transparency is the amount of skylight visible through the live, normally foliated portion of the crown. Changes in foliage transparency can also occur because of defoliation or from reduced foliage resulting from stresses during preceding years. A crown was labeled as "poor" if crown dieback was greater than 20 percent, crown density was less than 35 percent, or foliage transparency was greater than 35 percent. These three thresholds were based on preliminary findings by Steinman (2000) that associated crown ratings with tree mortality.

What we found

The three species with the highest proportion of live basal area containing poor crowns are American beech, eastern white pine, and black cherry at 18, 14, and 12 percent, respectively. Conversely, the occurrence of poor crowns in northern red oak, yellow birch, and sugar maple was very low (Table 4).

The occurrence of poor crowns in New York for all species combined is evenly distributed across the State (Fig. 59). The high proportions of American beech basal area containing poor crowns were found in the eastern half of New York in the Adirondack and Catskill Mountains (Fig. 59).

Table 4.—Percent of live basal area with poor crowns, New York, 2007

Species	Percent of Basal Area with Poor Crowns
American beech	18
Eastern white pine	14
Black cherry	12
Eastern hemlock	7
White ash	7
Red spruce	7
Red maple	6
Sugar maple	5
Yellow birch	4
Northern red oak	4

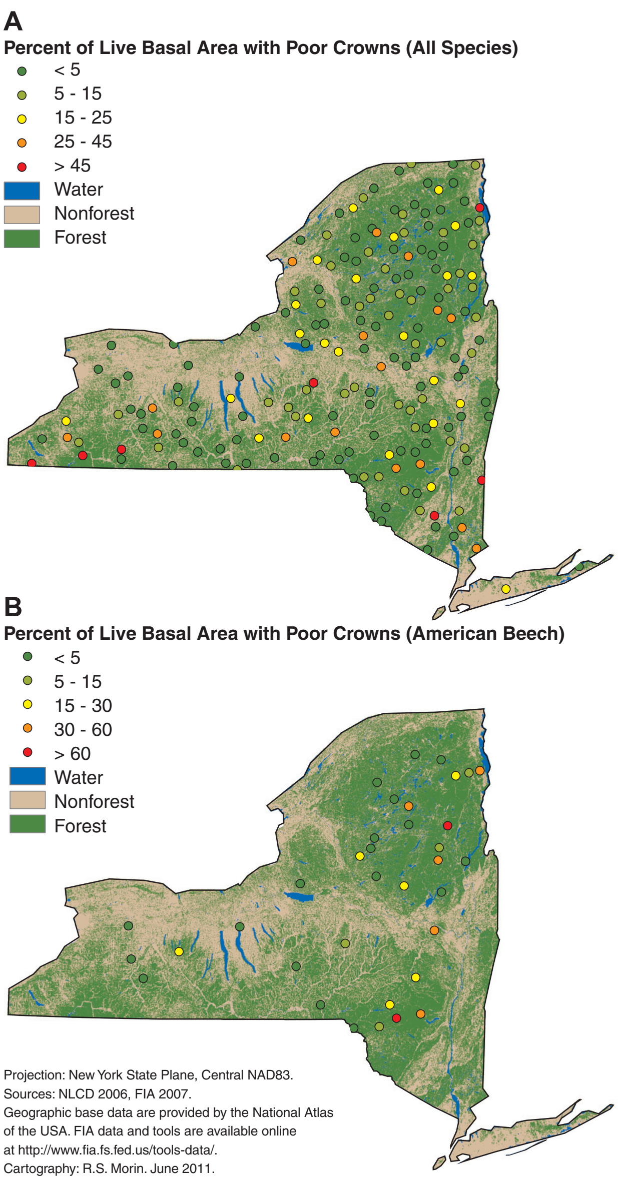


Figure 59. Percent of live basal area with poor crowns by (A) all species and (B) American beech, New York, 2007.

What this means

American beech is the most numerous tree species in New York and contains the sixth highest volume of wood. It is an important species due to its value for wildlife and for timber products. Levels of American beech mortality have been high since the 1993 inventory, 1.9 percent of volume per year (Fig. 56). The high mortality and occurrence of poor crowns are likely to be related to the impacts of beech bark disease. This relationship is explored further in a subsequent section.

Poor crowns in eastern white pine were probably due to the nature of how this species grows. White pines are usually tall and can have widely spaced limbs resulting in poor crown rating, although they can still be healthy. The incidence of poor crowns in eastern white pine does not appear to be associated with the current range of *Sirex* wood wasp in New York. However, crown health and mortality of eastern white pine should be monitored in the future as the range of *Sirex* expands. Crown health of black cherry may be related to defoliation by the native insect pests eastern forest tent caterpillar (*Malacosoma americanum*) and cherry scallopshell moth (*Hydria prunivorata*).

Down Woody Materials

Background

Down woody materials, including fallen trees and branches, fill a critical ecological niche in New York's forests. They provide valuable wildlife habitat in the form of coarse woody debris, contribute to forest fire hazards via surface woody fuels, and contribute to carbon stocks in the form of slowly decaying large logs.

What we found

The fuel loadings and subsequent fire hazards of dead and down woody material in New York's forests are relatively low and are similar to the nearby states of Vermont and Pennsylvania (Fig. 60). The size distribution of coarse woody debris (diameter larger than 3 inches) is overwhelmingly dominated (78 percent) by pieces less than 8 inches in diameter (Fig. 61A). Moderately decayed coarse woody pieces (decay classes 2, 3, and 4) constituted 85 percent of the decay class distribution (Fig. 61B). The carbon stocks of coarse woody debris appear to slightly increase with increasing standing live-tree basal area on New York's forest land to a peak of more than 2.5 tons/acre of carbon in well-stocked stands (Fig. 62).

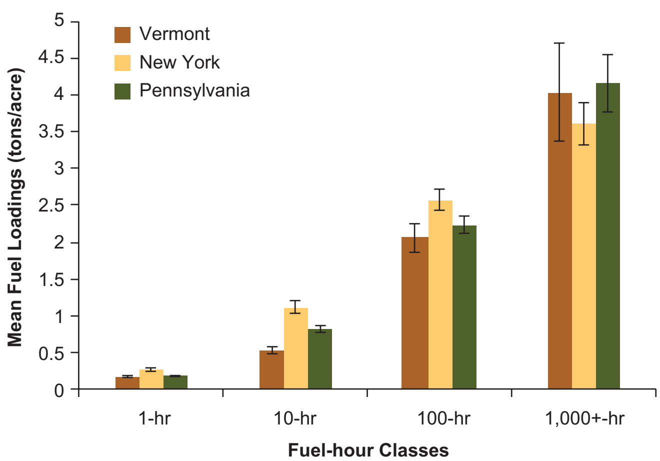


Figure 60.—Means and associated standard errors of fuel loadings (tons/acre, time-lag fuel classes) on forest land in New York and nearby states, 2007.

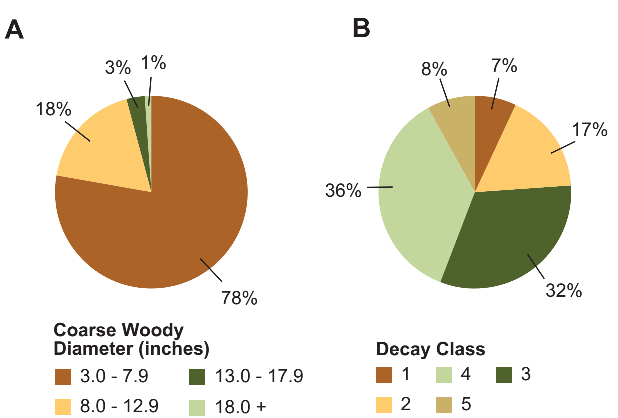


Figure 61.—Mean proportions of coarse woody debris by (A) transect diameter (inches) and (B) decay classes, on forest land in New York, 2007.

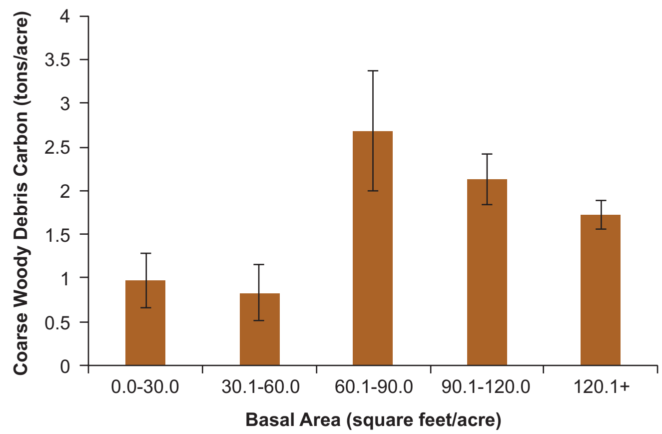


Figure 62.—Means and associated standard errors of coarse woody debris volumes (tons/acre) on forest land in New York, 2007.

What this means

The fuel loadings of downed woody material can be considered a forest health hazard only in times of drought or in isolated stands with excessive tree mortality. The ecosystem services (e.g., habitat for fauna or shade for tree regeneration) provided by down woody materials exceed any negative forest health aspects. The population of coarse woody debris across New York consists mostly of small pieces that are moderately decayed. Due to this, coarse woody debris constitutes a small, albeit important carbon stock across New York's forests. Compared to nearby states, the population of down woody materials in New York's forests appears stable while providing valuable ecosystem services.

Forest Soils

Background

Rich soils are the foundation of productive forest land, and they are also one of the major carbon stocks. Soils develop in response to several factors (climate, local vegetation, topography, parent material, and time), and these factors can be used to identify soil regions that were related to particular native forests. Today, the forest soil inventory illustrates the unique niches that different forests now occupy to maximize their competitive advantage. By identifying the soil properties associated with various forest types, the data collected by FIA provide critical baseline information to document changes in forest health resulting from natural or human influences.

Soil holds about half the carbon stored by forests in New York. Therefore, it is a major contributor in the carbon cycle. The study of soil carbon is in its infancy. We need more measurements quantifying the soil carbon pool across different land types, and we need more information on soil carbon flux over time. Annual inventories of FIA soil plots will provide this type of information. The results presented here are based upon observations in New York and compared with forests in the neighboring states of Connecticut, Massachusetts, New Jersey, Pennsylvania, and Vermont. These neighboring states were sampled to identify stands found in the same forest-type groups and in the same ecological provinces.

What we found

Substantial commonalities exist in soil characteristics between New York and its neighbors. The forest floor thickness in New York is hard to distinguish from similar neighboring forests, but there is variation between forest-type groups within New York (Fig. 63). The thinnest forest floor is found under the elm/ash/cottonwood forest-type group.

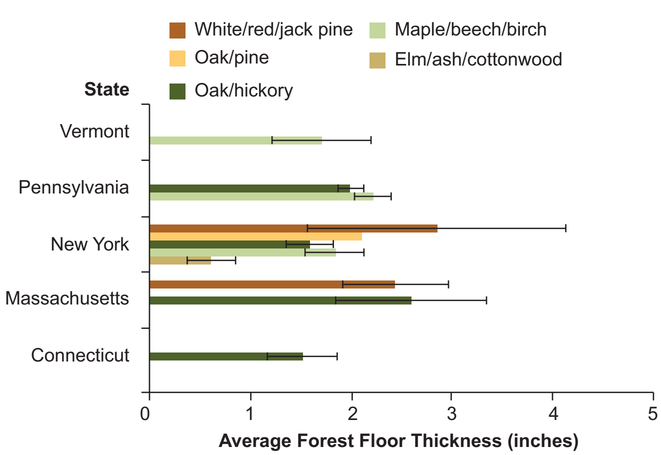


Figure 63.—Average forest floor thickness in forests of New York and its immediate neighbors.

Although there are similarities in total forest floor accumulation, some forest-type groups found in New York do not have forest floor carbon stocks similar to those in neighboring states; the oak/hickory forests in New York store less forest floor carbon than their neighbors (Fig. 64). Maple/beech/birch forests are on the lower end as well. The same is not true when evaluating mineral soil carbon stocks (Fig. 65). Shallow soils (0-4 inches) store more carbon than deep soils (4-8 inches), and New York's white/red/jack pine forests store more carbon in deep soils than similar forests found in Massachusetts.

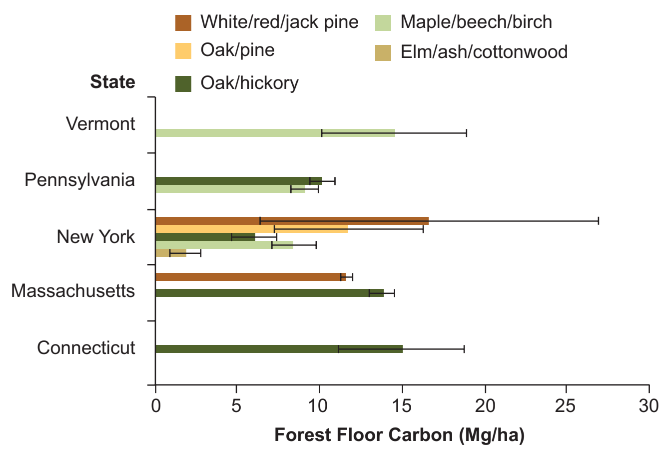


Figure 64.—Forest floor carbon stocks in forests of New York and its immediate neighbors.

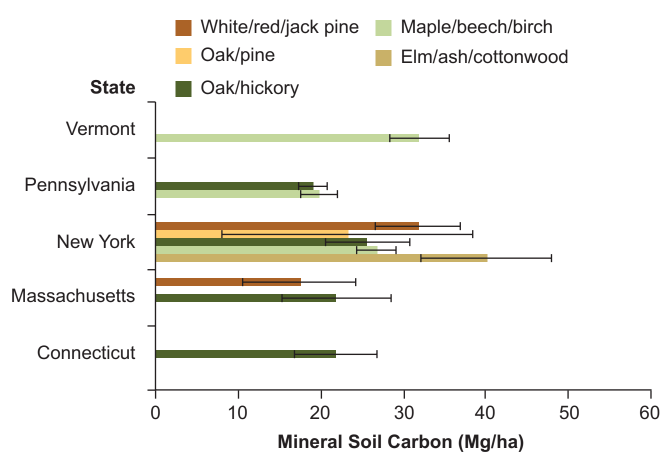


Figure 65.—Mineral soil carbon stocks (4-8 inches) in forests of New York and its immediate neighbors.

Overall soil quality in New York appears better able to support forest growth than soils found in neighboring states. This can be considered from at least two related perspectives. First, the forests in New York are found on soils with higher cation exchange capacities (mineral nutrients) than most of its neighbors (Fig. 66). Additionally, the Al:Ca ratio of mineral soil underlying New York's forests was generally less than 2.0; only Vermont has a greater fraction of its forest landscape with low to moderate aluminum enrichment (Fig. 67).

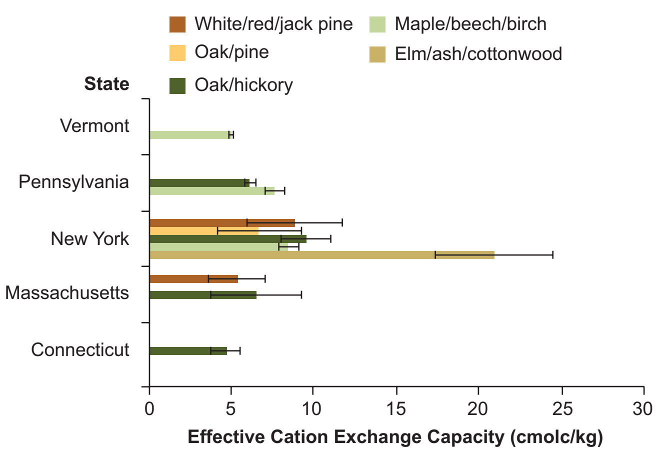


Figure 66.—Effective cation exchange capacity (0-4 inches) in forests of New York and its immediate neighbors.

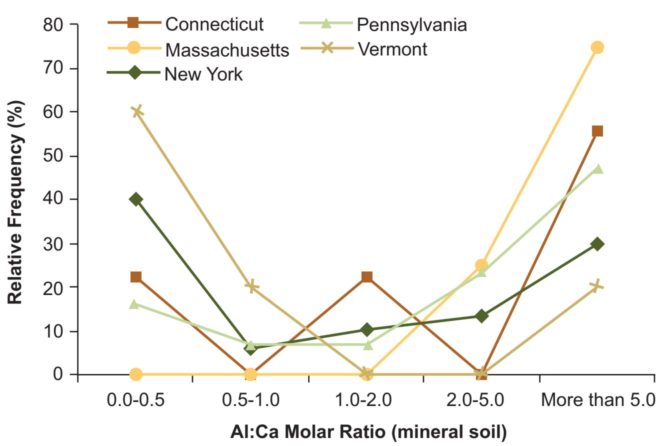


Figure 67.—Al:Ca molar ratio (0-4 inches) in forests of New York and its immediate neighbors.

What this means

The forest floor develops from the slow accumulation of organic matter. Carbon is the primary component of soil organic matter that has a number of important functions. These include increasing water holding capacity, retaining some nutrients by cation exchange (e.g., Ca^{2+}, Mg^{2+}, K+), releasing other nutrients as it decays (e.g., N, P, and S), and capturing potential toxic agents (e.g., Hg) (McBride 1994). Carbon in the forest floor and soil is also inventoried to track the sequestration of certain greenhouse gases. It traps nutrients and improves water holding capacity. Thicker forest floors generally contribute toward greater carbon storage. Direct measurements of carbon and the functions it provides are essential in better understanding the carbon cycle.

Atmospheric deposition of nitrogen and sulfur alters the soil by leaching essential minerals from the soil (Driscoll et al. 2001). Historically, the problem of acid deposition was particularly severe in the upper Ohio River basin (see National Atmospheric Deposition Program, http://nadp.sws.uiuc.edu/amaps2/), but while the emissions that lead to acid deposition have declined, the effects persist (Driscoll et al. 2001). Effective cation exchange capacity (ECEC) is calculated as the sum of five key mineral elements: sodium, potassium, calcium, magnesium, and aluminum. High ECEC values are associated with higher fertility. The molar ratio of Al to Ca is a useful indicator of stress in forest ecosystems, particularly that caused by acid deposition (Cronan and Grigal 1995), and high Al:Ca ratios (greater than 2.0) indicate an increased likelihood of negative impacts on tree growth. Additionally, deposition of nitrogen increases litter decay rates (Kuperman 1999) with the potential to negatively affect the forest through nitrogen saturation (Aber 1992).

Lichen Communities

Background

Lichens are symbiotic, composite organisms made up of members from as many as three kingdoms. The dominant partner is a fungus. Fungi are incapable of producing their own food, so they typically provide for themselves as parasites or decomposers. The lichen fungi (kingdom *Fungi*) cultivate partners that manufacture food by photosynthesis. Sometimes the partners are algae (kingdom *Protista*), other times cyanobacteria (kingdom *Monera*), formerly called blue-green algae. Some enterprising fungi associate with both at once (Brodo et al. 2001).

Lichen community monitoring is included in the FIA P3 inventory to address key assessment issues such as the impact of air pollution on forest resources, or spatial and temporal trends in biodiversity. This long-term lichen monitoring program in the U.S. dates back to 1994. The objectives of the lichen indicator are to determine the presence and abundance of lichen species on woody plants and to collect samples. Lichens occur on many different substrates (e.g., rocks), but FIA sampling is restricted to standing trees or branches/twigs that have recently fallen to the ground. Samples are sent to lichen experts for species identification.

A close relationship exists between lichen communities and air pollution, especially acidifying or fertilizing nitrogen- and sulfur-based pollutants. A major reason lichens are so sensitive to air quality is their total reliance on atmospheric sources of nutrition. By contrast, it is difficult to separate tree-growth responses specific to air pollution (McCune 2000).

What we found

A total of 92 lichen species (gamma diversity) were sampled on the lichen plots in New York (Table 5). The most common lichen genera, *Phaeophyscia*, were present on 15 percent of the plots (Table 6). The genus with the highest number of species sampled was *Cladonia* (14 species).

The easiest way to measure species diversity is to count the number of species at a site; this measure is termed species richness. However, species richness does not provide a complete picture of diversity in an ecosystem because abundance is excluded. Richness values fell into the low to high categories across New York (Table 5). The spatial distribution of lichen species richness scores are shown in Figure 68. In general, species richness scores were highest in the northern region of the State. The lichen species richness and diversity scores reported here will serve as baseline estimates for future monitoring at the state and regional levels.

Table 5.—Lichen communities summary table for New York, 1995-2003

Parameter	New York, 1995-2003
Number of plots surveyed	118
Number of plots by species richness category	
0-6 species (low)	32
7-15 species (medium)	73
>16 species (high)	13
Median	10
Range of species richness score per plot (low-high)	1-23
Average species richness score per plot (alpha diversity)	9.9
Standard deviation of species richness score per plot	4.7
Species turnover rate (beta diversity)[a]	15.8
Total number of species per area (gamma diversity)	92

[a]Beta diversity is calculated as gamma diversity divided by alpha diversity.

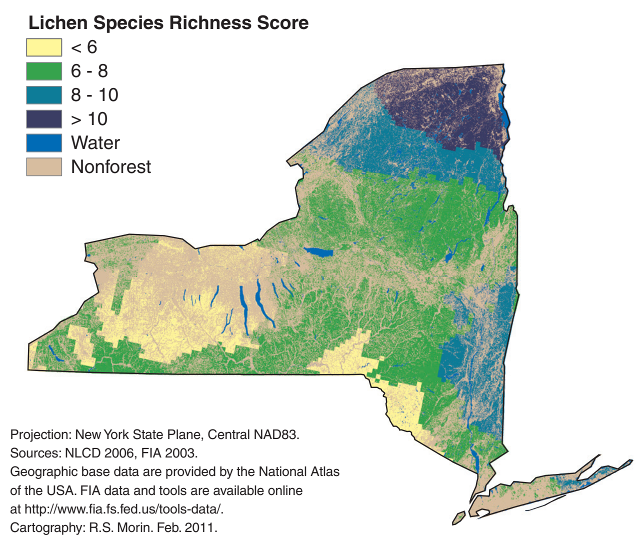


Figure 68.—Estimated lichen species richness, New York, 2000-2003.

Table 6.—Percentage of specimens and number of species for lichen genera sampled, New York, 1995-2003

Genus	All specimens	All species
Phaeophyscia	14.6	7
Physcia	12.2	5
Parmelia	10.8	3
Cladonia	8.3	14
Punctelia	8.0	4
Melanelia	7.7	8
Flavoparmelia	6.6	1
Hypogymnia	5.8	4
Myelochroa	4.2	2
Cetraria	4.1	6
Evernia	4.0	1
Physconia	3.6	4
Usnea	2.5	3
Candelaria	2.3	1
Bryoria	0.6	4
Flavopunctelia	0.6	2
Parmeliopsis	0.6	3
Cetrelia	0.5	1
Imshaugia	0.5	1
Lobaria	0.5	2
Platismatia	0.5	2
Unknown	0.3	3
Pyxine	0.3	1
Xanthoria	0.3	2
Physciella	0.2	2
Anaptychia	0.1	1
Heterodermia	0.1	1
Parmotrema	0.1	1
Pseudevernia	0.1	1
Ramalina	0.1	1
Vulpicida	0.1	1
Total	100	92

What this means

Due to the sensitivity of many lichen species to airborne pollution, it is useful to look at acid deposition levels. Showman and Long (1992) reported that mean lichen species richness was significantly lower in areas of high sulfate deposition than in low deposition areas. Sulfate deposition levels are highest in the southern half of New York and are relatively high compared to other areas in the northeastern United States (Fig. 69). A general pattern of lower lichen species richness scores in high deposition areas and vice versa is evident (Fig. 70). But other factors may affect the distribution of lichen species including intrinsic forest characteristics and long-term changes in climate.

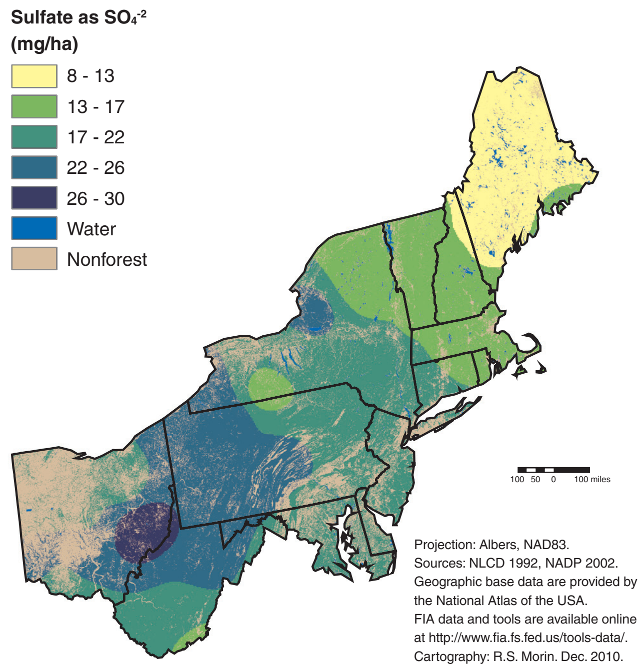


Figure 69.—Mean sulfate ion wet deposition, northeastern U.S., 1994-2002. Data source: National Atmospheric Deposition Program.

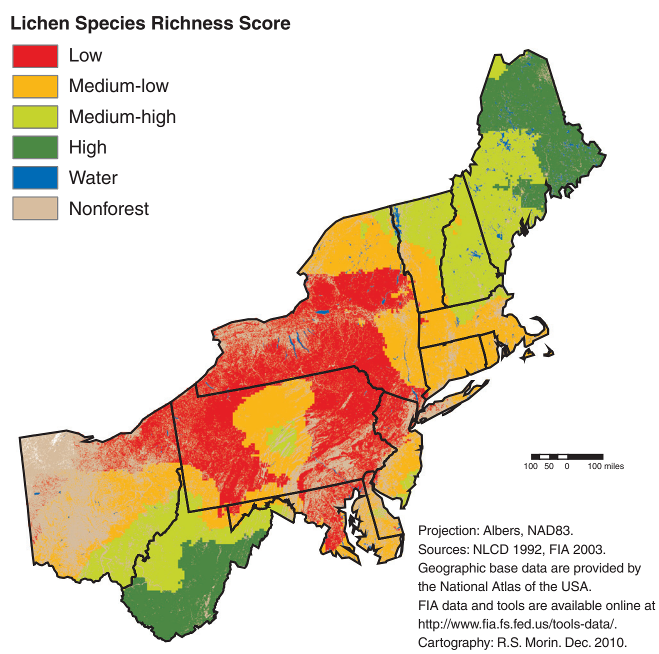


Figure 70.—Estimated lichen species richness, northeastern U.S., 2000-2003.

Ozone Bioindicator Plants

Background

Ozone is a byproduct of industrial development and is found in the lower atmosphere. Ozone forms when nitrogen oxides and volatile organic compounds go through chemical transformation in the presence of sunlight (Brace et al. 1999). Ground-level ozone is known to have detrimental effects upon forest ecosystems. Certain plant species exhibit visible, easily diagnosed foliar symptoms to ozone exposure. Ozone stress in a forest environment can be detected and monitored by using these plants as indicators. The FIA program uses these indicator plants to monitor changes in air quality across a region and to evaluate the relationship between ozone air quality and the indicators of forest condition.

The ozone-induced foliar injury on indicator plants is used to describe the risk of impact within the forest environment using a national system of sites (Smith et al 2003; Smith et al. 2007). These sites are not co-located with FIA samples. Ozone plots are chosen for ease of access and optimal size, species, and plant counts. As such, the ozone plots do not have set boundaries and vary in size. At each plot, between 10 and 30 individual plants of three or more indicator species are evaluated for ozone injury. Each plant is rated for the proportion of leaves with ozone injury and the mean severity of symptoms using break points that correspond to the human eye's ability to distinguish differences. A biosite index is calculated based on amount and severity ratings where the average score (amount * severity) for each species is averaged across all species at each site and multiplied by 1,000 to allow risk to be defined by integers (Smith et al. 2007).

What we found

The majority of the plants sampled were milkweed, white ash, blackberry, and spreading dogbane (Table 7). The findings for New York indicate that risk of foliar injury due to ozone has generally been low other than spikes in 2002, 2004, and 2007 (Table 8 and Fig. 71). Ozone exposure levels were stable and relatively low during this period—1999 to 2007 (Figs. 72, 73).

Table 7.—Distribution of plants sampled for ozone injury by species, New York, 1999-2007

Species	Number	Percent
Milkweed	8,365	28.4
White ash	5,756	19.5
Blackberry	5,037	17.1
Spreading dogbane	4,944	16.8
Black cherry	3,866	13.1
Pin cherry	937	3.2
Big leaf aster	391	1.3
Yellow-poplar	78	0.3
Sassafras	40	0.1
Sweetgum	30	0.1
Total	29,444	100.0

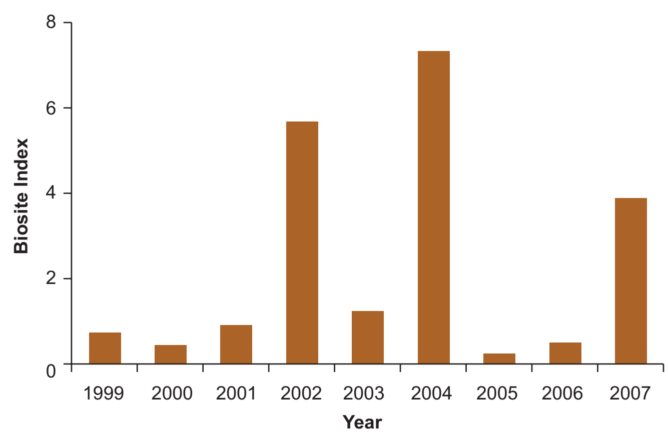


Figure 71.—Biosite index, New York, 1999-2007.

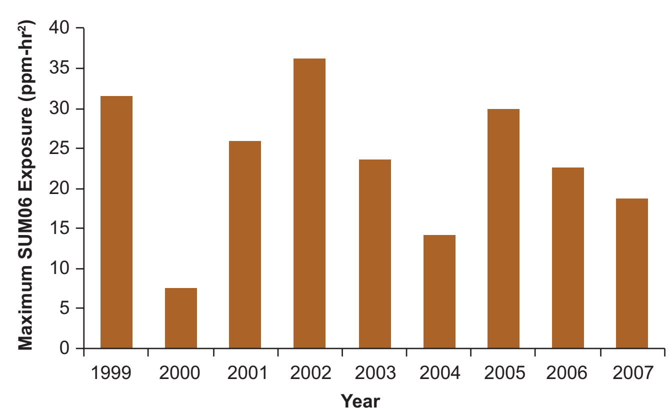


Figure 72.—Maximum SUM06 exposure levels (ppm-hr)², New York, 1999-2007.

Table 8.—Region-level summary statistics for ozone bioindicator program, New York, 1999-2007

Parameter	1999	2000	2001	2002	2003	2004	2005	2006	2007
Number of biosites evaluated	85	9	56	37	37	36	35	35	38
Number of biosites with injury	12	3	14	16	11	15	5	13	12
Average biosite index score	0.74	0.44	0.9	5.67	1.24	7.31	0.24	0.49	3.89
Number of plants evaluated	3582	474	5679	3415	3087	3271	3055	3476	3405
Number of plants injured	99	12	66	169	73	167	16	53	115
Maximum SUM06 value (ppm-hr)[2 a]	31.47	7.44	25.97	36.14	23.65	14.1	29.92	22.51	18.69

[a] Averaged from State values

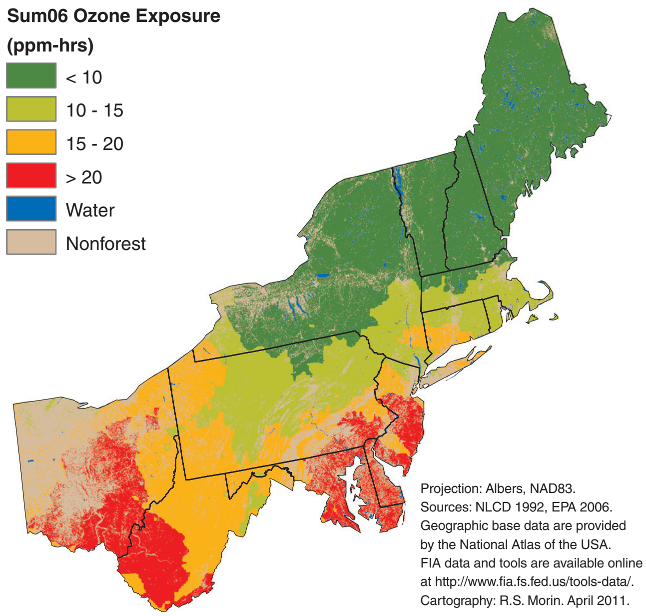


Figure 73.—Typical June through August 12-hour SUM06 ozone exposure rates in the northeastern U.S., 2000-2006.

What this means

The risk of ozone damage on foliage in New York's forests is generally low. This is in contrast to evidence of medium and high risk in portions of the Mid-Atlantic region (Coulston et al. 2003).

A typical summer O_3 exposure pattern for the northeastern U.S is shown in Figure 73 (USDA For. Serv. 2002). The term SUM06 is defined as the sum of all valid hourly ozone concentrations that equal or exceed 0.06 ppm. Controlled studies have found that high ozone levels (shown in orange and red) can lead to measurable growth suppression in sensitive tree species (Chappelka and Samuelson 1998). Smith et al. (2003) reported that even when ambient ozone exposures are high, the percentage of injured plants can be reduced sharply in dry years.

Vascular Plants and Invasive Species

Background

The diversity of plant life is an essential foundation of terrestrial forest ecosystems. Because plants are able to convert the sun's energy through photosynthesis, most animals (including humans) are dependent on plants, directly or indirectly, as a source of energy. Some animals are species-specific and require the presence of a certain plant to survive (e.g., various butterfly larvae). Plants can also help filter pollutants, stabilize soil, and increase nitrogen availability. A survey of the plant community can provide information about disturbance, nutrient availability, and depth to water table. In New York, P3 vegetation data have been collected on about 6.25 percent of field plots in 2007 and 2008, resulting in a complete vegetation survey on 81 plots.

What we found

New York's forests support many plant species. In the 2007 and 2008 inventories, 663 identifiable species were found. Of the 663 species, the largest percentage was classified as forbs/herbs (45 percent, Fig. 74), based on the USDA's Natural Resources Conservation Service's PLANTS Database. Graminoids, trees, and shrubs also contained a large number of the total species recorded on P3 plots at 18, 14, and 11 percent, respectively. Classifying the origin of the species found on the P3 plots, we found that 76 percent were native to the United States, 14 percent were introduced, and the remaining 10 percent were unclassified or indeterminate (Fig. 75).

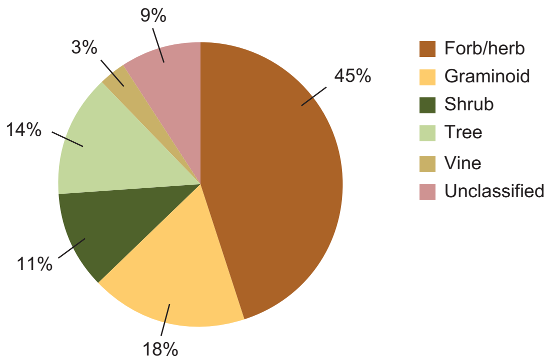


Figure 74.—Percentage of species on New York P3 plots by growth habit category (per PLANTS Database, USDA Natural Resources Conservation Service), 2007-2008.

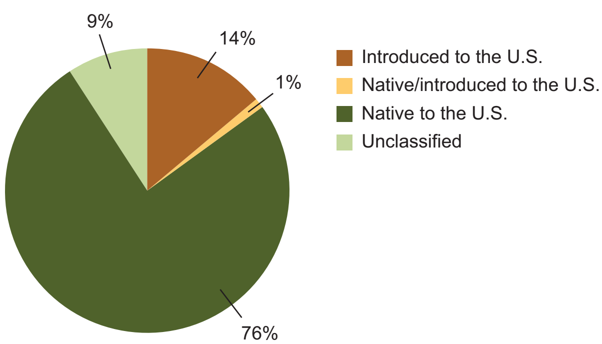


Figure 75.—Percentage of species on New York P3 plots by domestic or foreign origin (per PLANTS Database, USDA Natural Resources Conservation Service), 2007-2008.

Table 9.—The top 21 plant species, undifferentiated genera, or categories found on New York P3 plots, the number of plots species were found on (in parentheses), and the mean number of tree seedlings and saplings per acre on those plots, 2007-2008

Tree seedlings per acre	Species name	Tree saplings per acre
2,290	Red maple (65)	421
2,813	Sugar maple (56)	394
2,624	White ash (50)	392
2,555	Canada mayflower (50)	446
2,993	American beech (50)	455
2,731	Black cherry (40)	409
2,694	Sedge (36)	354
1,794	Sensitive fern (36)	372
2,507	Starflower (34)	499
2,444	Eastern hemlock (33)	433
2,311	Eastern hayscented fern (32)	394
2,930	Striped maple (32)	495
2,943	American red raspberry (30)	442
2,176	Yellow birch (30)	507
2,087	Common ladyfern (28)	408
2,408	Partridgeberry (27)	411
2,191	Wrinkleleaf goldenrod (26)	334
2,501	Virginia creeper (26)	350
3,459	Northern red oak (26)	406
3,251	Common yellow oxalis (25)	308
3,863	Allegheny blackberry (25)	364

On P3 plots in New York, there was an average of 42 species of plants identified with one plot containing 104 species. Of the species found, the 21 most frequently observed are listed in Table 9. The top three species were trees: red maple, sugar maple, and white ash. Of the 21 species, none are classified as nonnative, except for "sedge," which may or may not include nonnative sedge species.

The presence of nonnative plant species in the forest community is a concern. Differing from invasive plant species, which can be native or nonnative and are discussed in the next section of this report, the list of nonnative plant species contains only species that have been introduced. The most frequently observed nonnative plant species was common dandelion; it was present on 24 plots (Table 10). Multiflora rose and Morrow's honeysuckle were also present on a large number of P3 plots, recorded on 18 and 14 plots, respectively. Woody growth forms were represented by 3 of the top 5 and 4 of the 18 most common nonnative plant species. Plants of other growth forms included 10 herbaceous species and 4 graminoids. Comparing Table 10 (nonnative plant species) to Table 9 (the most commonly found plant species), the numbers of tree seedlings and saplings per acre were approximately equal, averaging 2,529 and 371 versus 2,646 and 409 tree seedlings and saplings per acre, respectively.

What this means

New York's forests support a diverse plant community that comprises five growth habits (forb/herb, graminoid, shrub, tree, and vine). These growth habits are represented by the 663 identifiable plant species that were observed on P3 plots and consist of both native and nonnative species. The presence of nonnative

Table 10.—The 18 most commonly occurring nonnative plant species found on New York P3 plots, the number of plots species were found on (in parentheses), and the mean number of tree seedlings and saplings per acre on those plots; some plots may have multiple nonnative plant species and thus may be double-counted in the table

Species	Tree Seedlings per acre	Tree Saplings per acre
Common dandelion (24)	2,952	415
Multiflora rose (18)	2,572	297
Morrow's honeysuckle (14)	2,177	333
Broadleaf helleborine (9)	3,305	505
Common buckthorn (9)	1,424	252
Common yarrow (9)	3,291	348
Garlic mustard (9)	3,724	330
Spotted snapweed (9)	2,014	512
Tall buttercup (9)	2,987	337
Climbing nightshade (8)	2,139	374
Creeping jenny (8)	827	350
Orchardgrass (8)	1,480	540
False baby's breath (7)	3,469	309
Kentucky bluegrass (7)	1,438	129
Sweet vernalgrass (7)	3,338	624
Timothy (7)	3,622	268
Japanese barberry (6)	1,122	422
Queen Anne's lace (6)	3,649	338

and invasive plants within the forest community is problematic because they can displace the native plants that fauna depend on. The invasive plants, which are discussed in the next section, are a widespread concern because they have characteristics, such as high seed production and rapid growth, that allow them to quickly spread through the forest understory.

Gathering data on the vegetation communities provides key information on site quality and species distribution. Obtaining future survey data on the presence and abundance of nonnative and invasive plant species will provide information on spread and facilitate management decisions through improving our understanding of how forest communities change and increasing our knowledge of the factors that influence the presence of various species.

Invasive Plants

Background

Invasive plant species (IPS) can supplant native species and change plant communities. They are often very aggressive colonizers that readily establish from vegetative propagules (e.g., multiflora rose) and often produce copious amounts of seed (e.g., purple loosestrife). After establishment in an area, some IPS can change the soil chemistry by altering nutrient availability (e.g., common buckthorn), which can displace native species and support their spread. IPS have spread throughout the United States, costing billions of dollars for inspection, monitoring, and eradication. Forest Inventory and Analysis has been monitoring the distribution, spread, and abundance of these species on New York's P2 Invasive plots since 2007. During the 2007-2008 inventory, invasive species data were collected on 255 forested plots (about 20 percent of the P2 field plots). Gathering data on IPS helps individuals and land managers understand the distribution and abundance of these species. Future data will increase our understanding of how these species have spread, their impact to the forest community, and factors that influence their presence.

What we found

Data from New York's P2 Invasive plots suggest that invasive species are present throughout the State. The list of IPS monitored by the Northern Research Station's Forest Inventory and Analysis program is shown in Table 11. Of the 43 species monitored, 27 were present on New York's P2 Invasive plots. The most commonly found species are shown in Table 12; these are species found on five or more plots. The species recorded on the greatest number of plots was multiflora rose (70 plots), followed by Morrow's honeysuckle (43 plots) and common buckthorn (40 plots); all three have a woody growth form. The high number of woody plants observed reflects the large number selected for monitoring on the P2 Invasive plots. In general, the average cover[1] of the IPS found on the P2 Invasive plots was less than 10 percent, except for a few species (e.g., common buckthorn [10.1 percent] and black locust [10.7 percent]).

The distributions of the two most common IPS found on P2 Invasive plots are shown in Figures 76 and 77. Figure 76 shows the statewide distribution of multiflora rose. This species was not found on plots in

Table 11.—Invasive plant species target list for NRS-FIA P2 Invasive plots, 2007 to present

Tree Species

Acer platanoides (Norway maple)
Ailanthus altissima (tree-of-heaven)
Albizia julibrissin (silktree)
Elaeagnus angustifolia (Russian olive)
Melaleuca quinquenervia (punktree)
Melia azedarach (Chinaberry)
Paulownia tomentosa (princesstree)
Robinia pseudoacacia (black locust)
Tamarix ramosissima (saltcedar)
Triadica sebifera (tallow tree)
Ulmus pumila (Siberian elm)

Woody Species

Berberis thunbergii (Japanese barberry)
Berberis vulgaris (common barberry)
Elaeagnus umbellata (autumn olive)
Frangula alnus (glossy buckthorn)
Ligustrum vulgare (European privet)
Lonicera x.bella (showy fly honeysuckle)
Lonicera maackii (Amur honeysuckle)
Lonicera morrowii (Morrow's honeysuckle)
Lonicera tatarica (Tatarian bush honeysuckle)
Rhamnus cathartica (common buckthorn)
Rosa multiflora (multiflora rose)
Spiraea japonica (Japanese meadowsweet)
Viburnum opulus (European cranberrybush)

Vine Species

Celastrus orbiculatus (Oriental bittersweet)
Hedera helix (English ivy)
Lonicera japonica (Japanese honeysuckle)

Herbaceous Species

Alliaria petiolata (garlic mustard)
Centaurea biebersteinii (spotted knapweed)
Cirsium arvense (Canada thistle)
Cirsium vulgare (bull thistle)
Cynanchum louiseae (black swallow-wort)
Cynanchum rossicum (European swallow-wort)
Euphorbia esula (leafy spurge)
Hesperis matronalis (dames rocket)
Lysimachia nummularia (creeping jenny)
Lythrum salicaria (purple loosestrife)
Polygonum cuspidatum (Japanese knotweed)
Polygonum x.bohemicum (P. cuspidatum/P. sachalinense hybrid)
Polygonum sachalinense (giant knotweed)

Grass Species

Microstegium vimineum (Japanese siltgrass)
Phalaris arundinaceae (reed canarygrass)
Phragmites australis (common reed)

Table 12.—The most commonly observed identifiable invasive species on New York P2 Invasive plots, the number of plots species were found on (in parentheses), and the mean cover, tree seedlings, and tree saplings per acre on those plots, 2007-2008

Species name	Cover	Tree Seedlings per acre	Tree Saplings per acre
Multiflora rose (70)	4.2	2,019	384
Morrow's honeysuckle (43)	6.2	2,420	384
Common buckthorn (40)	10.1	1,653	307
Garlic mustard (27)	7.9	1,866	335
Reed canarygrass (20)	6.4	1,990	316
Japanese barberry (18)	2.5	947	258
Creeping jenny (16)	6.2	1,845	430
Glossy buckthorn (12)	3.4	5,229	334
Dames rocket (11)	0.8	2,475	217
Bull thistle (10)	0.5	1,917	603
Black locust (8)	10.7	266	1,474
Canada thistle (7)	0.8	178	2,256
Norway maple (6)	9.1	210	633
Autumn olive (5)	3.1	235	1,248
Japanese siltgrass (5)	9.6	405	3,643
Purple loosestrife (5)	3.2	177	663
Tatarian honeysuckle (5)	5	200	725

[1] Calculated for each invasive species observed on P2 Invasive plots by summing the average plot coverage for each plot the species occurred on and then dividing by the total number of plots where the species occurred.

the northeastern part of the State or on Long Island. However, it was distributed fairly homogeneously throughout the rest of the State. The statewide distribution of Morrow's honeysuckle is shown in Figure 77. This species was most frequently observed in the central part of New York.

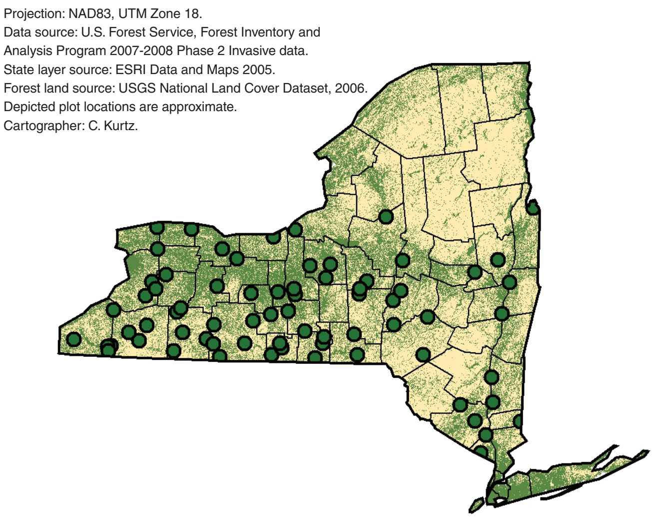


Figure 76.—Distribution of multiflora rose in New York observed on 2007-2008 FIA P2 Invasive plots; depicted plot locations are approximate.

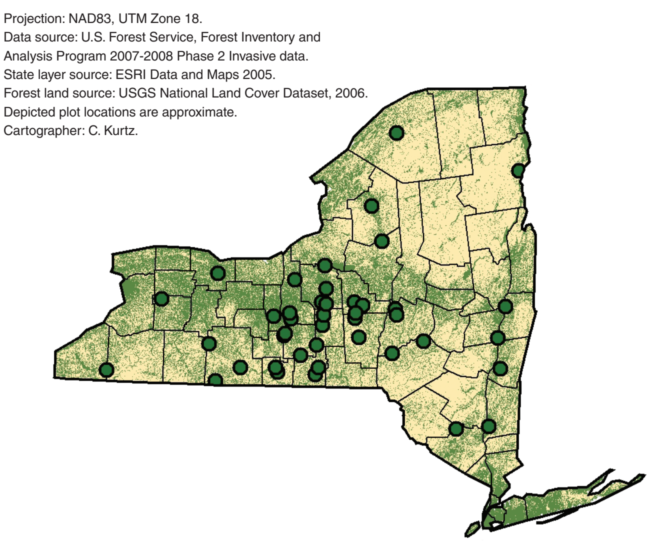


Figure 77.—Distribution of Morrow's honeysuckle in New York observed on 2007-2008 FIA P2 Invasive plots; approximate plot locations depicted.

What this means

IPS were found on FIA plots throughout the State. These data suggest that IPS are a threat to most of the forest ecosystems of New York. These species can degrade the quality of the forest by reducing forage, displacing native species, altering nutrient and hydrologic properties, and changing plant communities. Aside from the ecological damage IPS cause, they can also have economic impacts, through lost revenues that would have been derived from the displaced species and through the costs of monitoring, management, and remediation. Monitoring of these species in future inventories will allow managers to observe abundance and spread as well as help determine what site characteristics influence their presence, with the goal of creating forested conditions that minimize the invasion and impact of IPS.

American Beech and Beech Bark Disease

Background

American beech is a major component of the maple/beech/birch forest-type group, which makes up 55 percent of the forests in New York. New York has more beech volume than any other state. Forests with the highest proportion of American beech basal area are in the most mountainous portions of the State (Fig. 78). American beech is important to wildlife and used for forest products. Beech bark disease (BBD) is an insect-fungus complex involving the beech scale insect (*Cryptococcus fagisuga* Lind.) and the exotic canker fungus *Neonectria coccinea* (Pers.:Fr.) var. *faginata* Lohm. or the native *Neonectria galligena* Bres. that kills or injures American beech. Three phases of BBD are generally recognized: (1) the "advancing front," which corresponds to areas recently invaded by scale populations; (2) the "killing front," which represents areas where fungal invasion has occurred (typically 3 to 5 years after the scale insects appear, but sometimes as long as 20 years) and tree mortality begins; (3) the "aftermath forest," which are areas where the disease is endemic (Houston 1994, Shigo 1972).

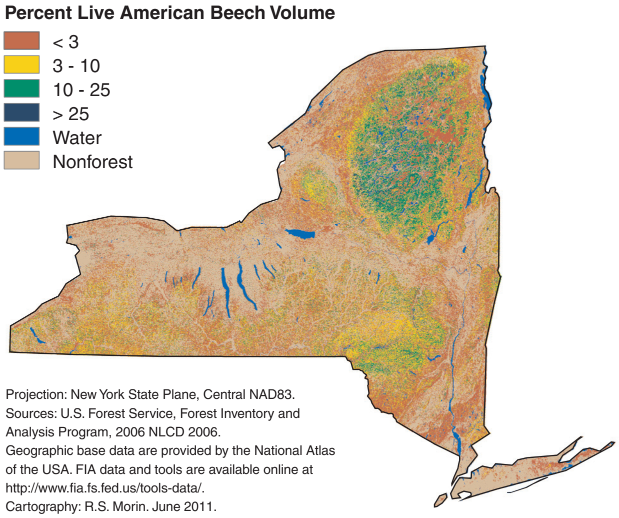


Figure 78.—Percent American beech volume, New York, 2006.

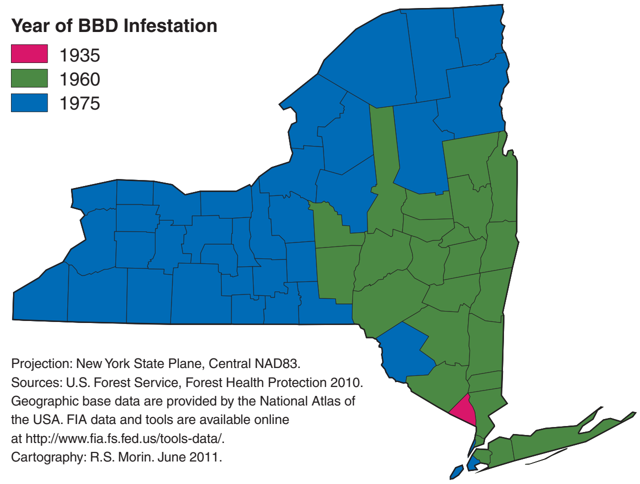


Figure 79.—Spread of beech bark disease infestation, New York.

What we found

BBD was inadvertently introduced via ornamental beech trees into North America at Halifax, Nova Scotia, in 1890 and then began spreading across New England. By 1960 eastern New York was infested and by 1975 the entire State was infested (Fig. 79). Currently, amounts of standing dead beech are not significant in New York (Fig. 80). The annual mortality rate for American beech is about 1.9 percent in New York, and the rate does not vary much by duration of BBD infestation. Since 1993 numbers of American beech trees in the smaller diameter classes have increased as numbers in classes above 9 inches have decreased (Fig. 81). Beech trees above 15 inches in diameter have become increasingly rare in New York.

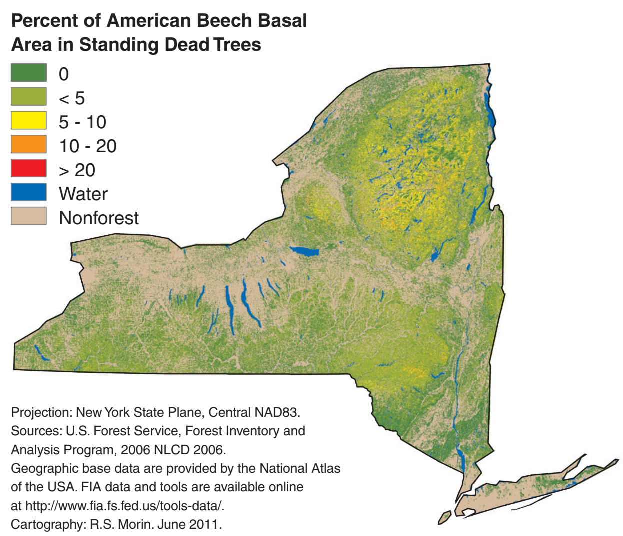


Figure 80.—Percent of American beech basal area in standing dead trees, New York, 2006.

What this means

Since the entire State has been infested by BBD for more than 30 years, beech forests in New York are in the aftermath phase of BBD. Aftermath forests are often characterized by a dearth of large beech trees due to past BBD mortality, which is associated with large numbers of beech seedlings and saplings. This condition, often

Figure 81.—Number of American beech trees by diameter class, New York, 1993 and 2007.

referred to as "beech brush," is highly susceptible to BBD and is often made up of trees with low vigor and slow growth that often succumb to the disease before making it into the overstory. When these beech thickets form, they impact the regeneration of other species.

Eastern Hemlock and Hemlock Woolly Adelgid

Background

Eastern hemlock is a major component of the forest resource in New York. It is ranked fifth in volume in the State, and New York has more hemlock volume than any other state. Eastern hemlock is valued for wildlife habitat and the unique niche it fills; in riparian areas it is an ecologically important species. It is also heavily used for pulpwood. Forests with the highest proportion of hemlock basal area occur in the foothills of more mountainous areas of the State (Fig. 37). Hemlock woolly adelgid (HWA) is native to East Asia and was first noticed in the eastern United States in the 1950s (Ward et al. 2004). Since then, it has slowly expanded its range; in areas where populations have established, they often reach high densities, causing widespread defoliation and sometimes mortality of hosts (McClure et al. 2001, Orwig et al. 2002).

What we found

HWA was first observed on Long Island in 1984. By 2006, the insect had been discovered in 29 counties including most of southeast New York and Monroe County on Lake Ontario (Fig. 82). Unlike many other states that have been impacted by HWA, in New York the annual mortality rate for eastern hemlock (0.7 percent) has seemingly been unaffected.

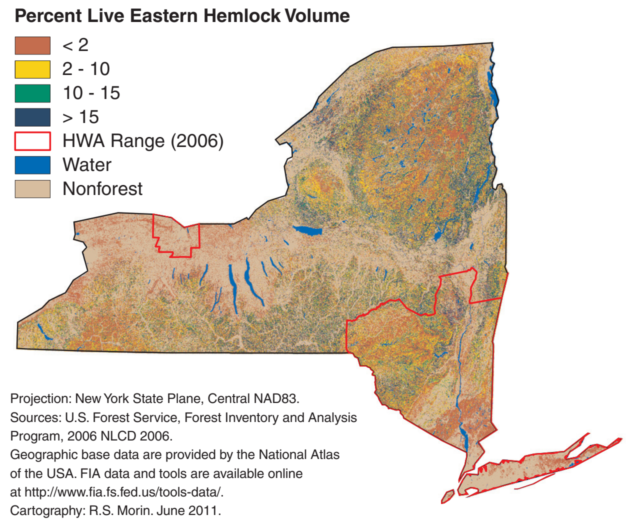


Figure 82.—Percent eastern hemlock volume, New York, 2006, and range of HWA infestation, New York, 2006.

What this means

HWA has not yet spread into the forests of New York where hemlock is the most prolific. Morin et al. (2009) estimated that HWA is spreading at a rate of between 9.7 and 14.5 km/year in the northwest and north directions. However, cold winter temperatures can cause considerable HWA mortality and trigger dramatic population declines (Skinner et al. 2003). Therefore, the rate of spread of HWA into northern New York may be impacted by temperature. As HWA continues spreading north and west into the rest of the State (likely over the next two decades), it will move into forests where densities of eastern hemlock are much higher. It will be important to continue monitoring for increased mortality in the high density eastern hemlock forests over the coming decade.

Ash and Emerald Ash Borer

Background

The emerald ash borer (EAB; *Agrilus planipennis* Fairmaire), an exotic bark-boring beetle native to Asia, was discovered in Detroit, MI, in 2002 (Kovacs 2010). It is especially dangerous because there is no known treatment for EAB infestations. Since 2002, EAB has spread and killed millions of ash trees in Michigan and Ohio. Currently, it has been detected in six counties in western New York (Cattaraugus, Erie, Genesee, Livingston, Monroe, and Steuben) and two eastern counties (Greene and Ulster). EAB represents a major threat to the State's ash resource. All ash species, regardless of tree vigor, are at risk.

What we found

Ash species are common on forest land throughout much of New York and are also widely planted in urban areas. About 7 percent of the wood harvested in the State is ash. Ash species represent 6.9 percent of the total volume of trees in New York (Fig. 83). Ash makes up the largest share of total volume in the Lake Plain unit, although high volumes per acre can also be found in the southern tier of counties along the Pennsylvania border.

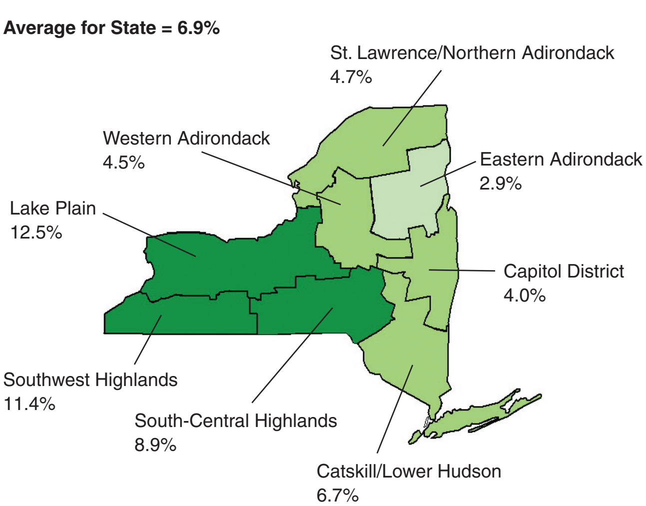


Figure 83.—Ash species as a percentage of total live volume by FIA unit, New York, 2007.

What it means

Emerald ash borer, a lethal pest found in New York, will increase ash mortality in both urban and forested landscapes. It will likely cause significant financial cost to municipalities, property owners, and the forest products industries in the State. Because white ash is the leading species in the Lake Plain and Southwest Highlands units of the State, future mortality caused by the emerald ash borer will likely be significant in these areas. When an emerald ash borer infestation is found, quarantine procedures are put in place to limit the spread of the pest by human behavior (moving firewood, transporting logs, purchasing infested plants, etc.). Currently, infested counties have been placed under a quarantine that restricts the export of hardwood firewood of all species to other counties and requires a permit to ship ash logs to mills in other counties. Additionally, New York restricts the movement of any untreated firewood to 50 miles or less from its source, and requires a receipt stating the source when being transported. It is believed that the movement of firewood is a major cause of the spread of EAB. By restricting firewood movement, it is hoped that EAB will be contained until biological or other controls are found.

The loss of ash will have an impact on wildlife species and the forest products industry. Landowners should be vigilant about the spread of EAB. A first step for landowners would be to assess their ash resource to determine their potential risk. They may choose to harvest valuable trees proactively before this infestation reaches their area, but should seek professional advice before doing so.

Timber Products Output

Background

The harvesting and processing of timber products produces a stream of income shared by timber owners, managers, marketers, loggers, truckers, and processors.

The wood products and paper manufacturing industries in New York employed more than 49,000 people, with an average annual payroll of more than $1.9 billion and a total value of shipments of $9.8 billion (2007 Economic Census). These economic benefits have a large impact on rural communities where unemployment is prevalent. To better manage the State's forests, it is important to know the species, amounts, and locations of timber being harvested.

What we found

Surveys of New York's wood-processing mills are conducted periodically to estimate the amount of wood volume that is processed into products. This is supplemented with the most recent surveys conducted in surrounding states that processed wood harvested from New York. In 2006, active primary wood-processing mills in New York were surveyed to determine what species were processed and where the wood material came from. These mills processed 131.4 million cubic feet of industrial wood products harvested in New York and an additional 13.1 million cubic feet of wood imported from other states. Also harvested in New York was an additional 59.1 million cubic feet that was exported to neighboring states and Canada.

A total of 190.5 million cubic feet of industrial roundwood was harvested from New York in 2006. Saw and veneer logs accounted for 60 percent and pulpwood made up another 29 percent of the industrial roundwood harvested (Fig. 84). Industrial fuel and other miscellaneous products accounted for the remaining 11 percent. Five species represented 70 percent of the saw log harvest: sugar maple (25 percent), red maple (13), white pine (11), northern red oak (11), and black cherry (10) (Fig. 85). Major pulpwood species were sugar maple, red maple, hemlock, and white pine. In addition to the industrial wood harvest, wood is harvested for residential fuelwood. Based on a 2003 residential fuelwood study by the Department of Energy, approximately 77 million cubic feet of residential fuelwood is harvested annually.

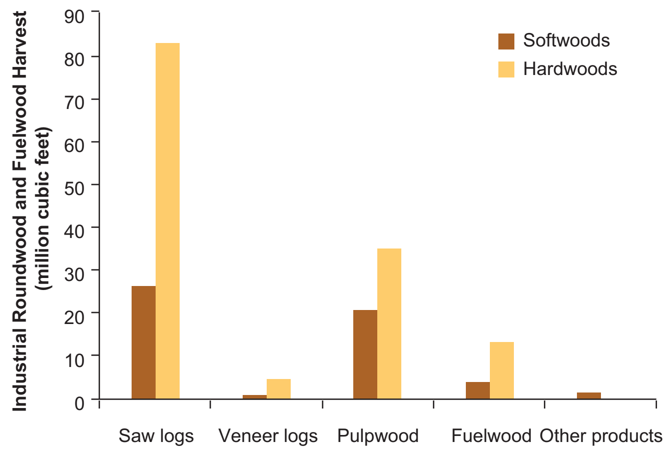


Figure 84.—Industrial roundwood production by product and softwoods and hardwoods, New York, 2006.

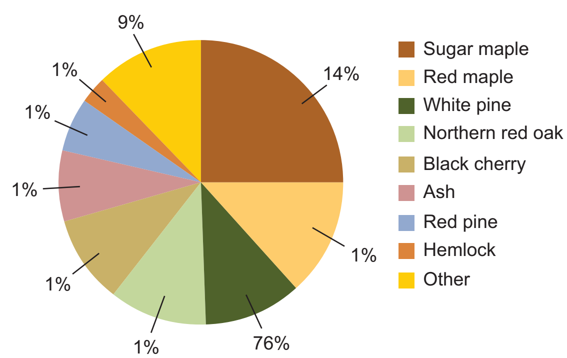


Figure 85.—Species composition of saw log harvest, New York, 2006.

In the process of harvesting industrial roundwood, 87 million cubic feet of harvest residues were left on the ground. More than 80 percent of the logging residue came from non-growing-stock sources such as crooked or rotten trees, tops and limbs of growing-stock trees, and non-commercial species. The processing of industrial roundwood in the State's primary wood-using mills generated another 1.3 million green tons of wood and bark residues. Twenty-seven percent of the mill residues were used for fiber products such as pulp and particleboard (Fig. 86). Miscellaneous uses, mainly animal bedding, at 22 percent, and mulch, at 21 percent, were the other main uses of the mill residues generated. Less than 5 percent of the mill residues generated were not used for other secondary products.

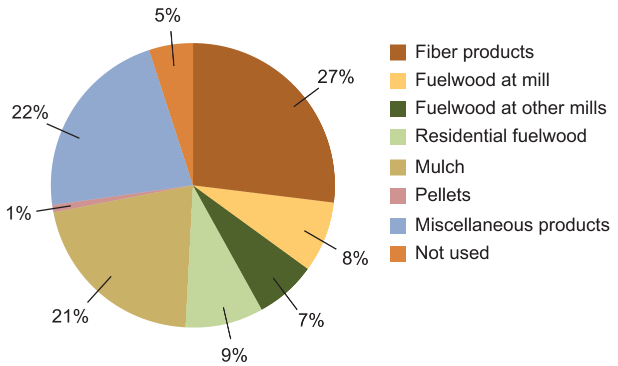


Figure 86.—Disposition of mill residues generated by primary wood-using mills, New York, 2006.

What this means

Most of the wood-processing facilities in New York are sawmills processing primarily State-grown saw logs. These mills provide woodland owners with an outlet to sell timber and provide jobs in some of the rural areas. In addition, forest landowners received approximately $300 million in stumpage payments in 2007 from the harvest of their timber. An important consideration for the future of the primary wood-products industry is its ability to retain industrial roundwood processing facilities. Although the number of wood processing mills has been steadily declining over the last 6 to 10 years, milling capacity has remained more or less unchanged as some large mills have expanded. Also, portable mills have emerged to fill the role of processing logs into lumber for local use. These changes reflect mills adapting to changing demands for wood products and not to a lack of timber. Despite the loss of some sawmills, New York's mills continue to provide landowners a competitive market for their timber. The income landowners receive from selling timber is an incentive to keep land in forest; it can help pay property taxes and help pay for forest management activities such as wildlife habitat improvements and the control of invasive species

Another important issue is the volume of harvest residues that are generated in the State that go unused. Almost 20 percent of the harvest residue is from growing-stock sources that could be used to make products. Improved pulpwood markets should lead to better utilization of merchantable trees. The use of logging slash and mill residues, as well as underutilized trees, for industrial fuelwood at cogeneration facilities or in strictly heating applications and pellet mills could also result in better utilization of the forest resource. However, specialized integrated logging methods are needed to ensure that removing the tops and limbs does not damage residual stands when skidded out. In addition, the benefits that residues provide to wildlife would be lost if all residues were removed.

Data Sources and Techniques

Forest Inventory

The FIA sampling design is based on a grid of hexagons superimposed on a map of the United States with each hexagon approximately 6,000 acres in size and at least one permanent plot established in each hexagon. In Phase 1 (P1), of FIA's multi-phase inventory, the population of interest is stratified and plots are assigned to strata to increase the precision of estimates. In Phase 2 (P2), tree and site attributes are measured for forested plots established in each hexagon. P2 plots consist of four 24-foot fixed-radius subplots on which standing trees are inventoried. During Phase 3 (P3), forest health indicators are measured on a 1/16th subset of the entire FIA ground plot network so that each plot represents approximately 96,000 acres. The forest health indicators are tree crown condition, lichen communities, forest soils, vegetation diversity, down woody material, and ozone injury.

A detailed set of tables, along with information on statistical reliability, are included in Part B of this report, which is on the accompanying DVD. Tools to access data, previous reports, and additional information are available at: www.nrs.fs.fed.us/fia.

National Woodland Owner Survey

The National Woodland Owner survey is conducted annually by the Forest Service to increase our understanding of private woodland owners—the critical link between society and forests. Questionnaires are mailed to individuals and private groups who own the woodlands where FIA has established inventory plots (Butler et al. 2008). About 6,000 owners are contacted each year. Results in New York are based on responses received during 2002-2006.

Timber Products Inventory

The timber products inventory study was a cooperative effort between the New York Department of Environmental Conservation and the Northern Research Station. The study canvassed all primary wood-using mills within the State using mail questionnaires designed to determine the size and composition of New York's primary wood-using industry, its use of roundwood, and its generation and disposition of wood residues. DEC personnel contacted nonresponding mills through additional mailings, telephone calls, and personal contacts. Data on New York's industrial roundwood receipts have been supplemented with data on out-of-State uses of State roundwood to provide a complete assessment of New York's timber product output.

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DVD Contents

New York's Forests 2007 (PDF)

New York's Forests: Statistics, Methods, and Quality Assurance (PDF)

New York Inventory Database (CSV file folder)

New York Inventory Database (Access file)

Field guides that describe inventory procedures (PDF)

Database User Guides (PDF)

Widmann, Richard H.; Crawford, Sloane; Barnett, Charles; Butler, Brett J.; Domke, Grant M.; Griffith, Douglas M.; Hatfield, Mark A.; Kurtz, Cassandra M.; Lister, Tonya W.; Morin, Randall S.; Moser, W. Keith; Perry, Charles H.; Riemann, Rachel; Woodall, Christopher W. 2012. **New York's Forests 2007**. Resour. Bull. NRS-65. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 64 p. [DVD included].

This report summarizes the first full annual inventory of New York's forests, conducted in 2002-2007 by the U.S. Forest Service, Northern Research Station. New York's forests cover 19.0 million acres; 15.9 million acres are classified as timberland and 3.1 million acres as reserved and other forest land. Forest land is dominated by the maple/beech/birch forest type that occupies more than half of the forest land. The volume of growing stock on timberland has been rising and currently totals 29.2 billion cubic feet, enough to produce saw logs equivalent to 87.1 billion board feet. On timberland, average annual growth of growing stock outpaced removals by a ratio of 2.0:1. The net change in growing-stock volume averaged 1.2 percent per year in 1993-2007. The report includes additional information on forest attributes, land use, forest fragmentation, forest ownership, forest health indicators, timber products, and statistics and quality assurance of data collection. Detailed information on forest inventory methods and data quality estimates is included in a DVD at the back of this report. Tables of population estimates and a glossary are also included.

KEY WORDS: forest resources, forest health, forest products, volume, biomass

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