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Abstract

This report constitutes the third full report of annualized inventory on New York forest land and summarizes field data collected from 2011 through 2017. New York has 18.7 million acres of forest land on which 94 tree species and 55 forest types were identified. Net cubic-foot, growing-stock, and sawtimber volumes continued to increase, as did the area occupied by large diameter stands. The net growth-to-harvest removals ratio increased from 2.3:1 in 2012 to 2.8:1 in 2017. Substantial forest health challenges, including invasive insect pests and invasive plant species, continue to impact the forest resources of the State. Additional information on land-use change, fragmentation, ownership, forest composition, structure, age, carbon stocks, reserved land, and regeneration of New York forests is also presented. Supplemental resources are available online at https://doi.org/10.2737/NRS-RB-121 and include: (1) tables that summarize quality assurance and (2) a core set of tabular estimates for a variety of forest resources.

Acknowledgments

The authors would like to thank those who contributed to the publication of this report. The dedicated field staff who took the measurements upon which this analysis is based are John Minutilli, Paul Natiella, Dave Berger, Tony Olsen, Charlie Butler, Chris Coolbaugh, Ryan Nowak, Chris Mueller, Glen Summers, Corey McCarty, Kenneth Binder, and James Halleran. Additional thanks are due to the Northern Research Station's Forest Inventory and Analysis staff who contribute in a multitude of ways. We also owe a debt of gratitude to our reviewers, Peter Smallidge (Cornell University), Steven Bick (Northeast Forests, LLC), Sloane Crawford (New York Department of Environmental Conservation), and Thomas Goff (USDA Forest Service), for their efforts to ensure that we are providing clear, useful information.

Cover: Mount Tom State Forest in Washington County, New York. Photo by Rachel Riemann, USDA Forest Service.

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Contents

Highlights

On the Plus Side

- The extent of forest land in New York remains relatively stable at 18.7 million acres and covers 62 percent of the land area across the State.
- The 94 tree species and 55 forest types identified on New York forest land puts it among the most diverse resources in the region.
- Net volume on timberland increased 10 percent from 2007 to 2017, totaling 34.7 billion cubic feet.
- Sawtimber volume on timberland rose 16 percent in 10 years to 101 billion board feet in 2017.
- Hardwood sawtimber quality, as expressed in tree grades, has generally improved, with 20 percent of sawtimber volume in grade 1 trees.
- New York has not suffered from the vast proliferation of cull and noncommercial trees seen in some adjacent states.

Issues to watch

- Development and urbanization remain a concern, with about one third of the forest land lost being converted to developed land uses.
- Private landowners own the overwhelming majority of timberland, but relatively few (9 percent) have written management plans for their land.
- Cull volumes have increased at a higher pace than growing-stock volumes and have grown to 11 percent of timberland volume.
- The net growth to harvest removals ratio increased from 2.3:1 in 2012 to 2.8:1 in 2017.
- Browse impacts remain a challenge to successful regeneration.
- Numerous forest health issues, including beech bark disease, hemlock woolly adelgid, and emerald ash borer, continue to affect the forests of New York.
- Invasive plant species were found on over half of forested P2+ plots.

Azalea in understory. Photo by Thomas Albright, USDA Forest Service.

Background

American chestnut seedling and sapling, remnants of forests past. Photo by Thomas Albright, USDA Forest Service.

An Overview of Forest Inventory

What is FIA?

The USDA Forest Service's Forest Inventory and Analysis program, commonly referred to as FIA, is the Nation's forest census. It was established by the U.S. Congress to "make and keep current a comprehensive survey and analysis of the present and prospective conditions of and requirements for the renewable resources of the forest and range lands of the United States" (Forest and Rangeland Renewable Resources Planning Act of 1974; 16 USC 1601 [note]). FIA has been collecting, analyzing, and reporting on the Nation's forest resources for more than 80 years, with the first FIA inventory of New York forests completed in 1952. Information is collected on the status, trends, extent, composition, structure, health, and ownership of the forests. This information is used by policy makers, resource managers, researchers, and the public to better understand forest resources and to make more informed decisions about their future.

What is this report?

This report is a summary of the findings from the seventh survey of the forest resources of New York conducted by FIA and the second full cycle remeasurement of plots on the annualized system. Data for this survey were collected from 2011 through 2017 and are referred to throughout this report as inventory year 2017. Periodic inventories of New York were completed in 1952 (Armstrong and Bjorkbom 1956), 1968 (Ferguson and Mayer 1970), 1980 (Considine 1984, Considine and Frieswyk 1982), and 1993 (Alerich and Drake 1995). Full cycle inventory reports of the State on the annual system were completed in 2007 (Widmann et al. 2012) and 2012 (Widmann et al. 2015).

This document consists of sections that focus on topics such as forest features, attributes, and health. A glossary of terms commonly used in FIA reports is available at https://www.nrs.fs.fed.us/fia/data-tools/state-reports/glossary/. Supplemental tables summarizing the results reported for New York forests are available online at https://doi.org/10.2737/NRS-RB-121.

A Guide to Forest Inventory

What is a tree?

A tree is a perennial woody plant with a central stem and a distinct crown. FIA defines a tree as any perennial woody plant species that can attain a height of 15 feet at maturity. A complete list of the tree species measured in New York during this inventory is included in the appendix. Throughout this report, the size of a tree is usually expressed as diameter at breast height (d.b.h.), in inches. This is the diameter, outside the bark, at a point 4.5 feet above the ground.

What is a forest?

A forest is a collection of trees, and while most people would agree on what a forest is, in order for statistics to be reliable and comparable, a definition must be created to avoid ambiguity. FIA defines forest land as land that has at least 10 percent canopy cover of trees of any size or that formerly has had such tree cover and is currently not developed or maintained for nonforest use. The minimum area to be classified as a forest is 1 acre in size and 120 feet wide. There are more specific criteria for defining forest land near streams, rights-of-way, and shelterbelt strips (USDA Forest Service 2015).

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

FIA defines three types of forest land:

- Timberland is forest land that is producing or is capable of producing crops of industrial wood and is not withdrawn from timber utilization by statute or administrative regulation. These areas are capable of producing at least 20 cubic feet per acre of industrial wood (equivalent to the solid wood content of about ¼ cord) per year. Areas that may be inaccessible and inoperable are included in timberland acreage estimates as FIA makes no determination on the feasibility of management activities outside of recognizing statutory and policy restrictions.

- Reserved forest land is forest land withdrawn from timber utilization through statute without regard to productive status (e.g., state parks, natural areas, national parks, and Federal wilderness areas). All reserved forest land is in public ownerships.

- Other forest land consists of forest land that is not capable of growing 20 cubic feet per acre per year and is not restricted from harvesting (e.g., some surface-mined areas with extremely degraded soil and some poorly drained areas where water inhibits tree growth). Sometimes such forest lands are referred to as being “less productive” or “unproductive” with respect to wood fiber production.

With the implementation of the annual inventory design in New York in 2002, reporting statistics on all forest land is possible. As a result, there is now one set of remeasured plots across all forest land with associated estimates of growth, removals, and mortality. Before the 2002-2007 inventory cycle (referred to as the 2007 inventory) in New York, for most attributes, FIA included only data collected on timberland plots. Therefore, trend analyses that use data prior to 2002 are limited to timberland for many attributes.

A word of caution on suitability and availability

FIA does not attempt to identify those timberlands suitable or available for timber harvesting, particularly since such suitability and availability is subject to changing laws, economic and market constraints, physical conditions, adjacency to human populations, and ownership objectives. Therefore, classifying land as timberland does not necessarily 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 production. Additional factors, such as those listed above, need to be considered when estimating the timber supply base, and these factors may change over time.

How do we estimate a tree’s volume?

To estimate a live tree’s volume, FIA uses volume equations developed for each tree species group found within the northeastern United States. Individual tree volumes are based on species, diameter, and height. FIA reports volume in cubic feet and board feet (International ¼-inch rule). Board-foot volume measurements are applicable only for sawtimber-size trees, that is, softwood trees greater than 9 inches d.b.h. and hardwood trees greater than 11 inches d.b.h. Some wood products are often measured in cords (a stack of wood 8 feet long by 4 feet wide and 4 feet high). A cord of wood consists of about 79 to 85 cubic feet of solid wood, with the remaining 43 to 49 cubic feet made up of bark and air.

How is forest biomass estimated?

The USDA Forest Service has developed estimates of specific gravity for many tree species (Miles and Smith 2009). These specific gravities are applied to tree volume estimates to approximate the merchantable biomass of trees (weight of the bole). Total aboveground tree biomass is calculated by adding top, limb, and stump biomass to bole biomass (Woodall et al. 2011). Currently, FIA does not report the biomass of foliage. FIA can report biomass as green or oven-dry weight. Green weight is the weight of a freshly cut tree. Oven-dry weight is the weight of a tree with no moisture content and is the unit used for biomass in this report. On average, 1.9 tons (2,000 pounds/ton) of green biomass equals 1 ton of oven-dry biomass.

How do we estimate all the forest carbon pools?

FIA does not directly measure the carbon in standing trees. Instead, forest carbon pools are estimated by assuming that half the biomass in standing live and dead trees consists of carbon. Additional carbon pools (e.g., soil, understory vegetation, belowground biomass) are modeled based on stand and site characteristics (e.g., stand age and forest type).

Regional analysis

Throughout this report, references are made to regions of New York (Fig. 1). These regions, which are synonymous with FIA survey or inventory units, reflect the diverse landscape of the State and facilitate meaningful analysis on a more local scale.

Forest inventory sample design

FIA established a set of permanent inventory plots across the United States that are periodically revisited. Each plot consists of four 24-foot radius subplots for a total area of about one-sixth of an acre. All plots (i.e., forested and nonforest) are randomly located within a hexagon that is about 6,000 acres in size. Therefore, each plot represents about 6,000 acres of land and can be used to generate unbiased estimates with associated sampling errors for attributes such as total forest land area. Full details of sample design and estimation procedures are available in Bechtold and Patterson (2005).

Understanding FIA data

Before 2000, FIA inventories were completed every 10 to 20 years. With these periodic inventories, it took decades to identify trends. With the new annual inventory, some trends are easier to identify because a subset of observations (about 14 percent) is made every year. It is still necessary to look over long time periods because many trends, such as forest succession, can be difficult to discern in short

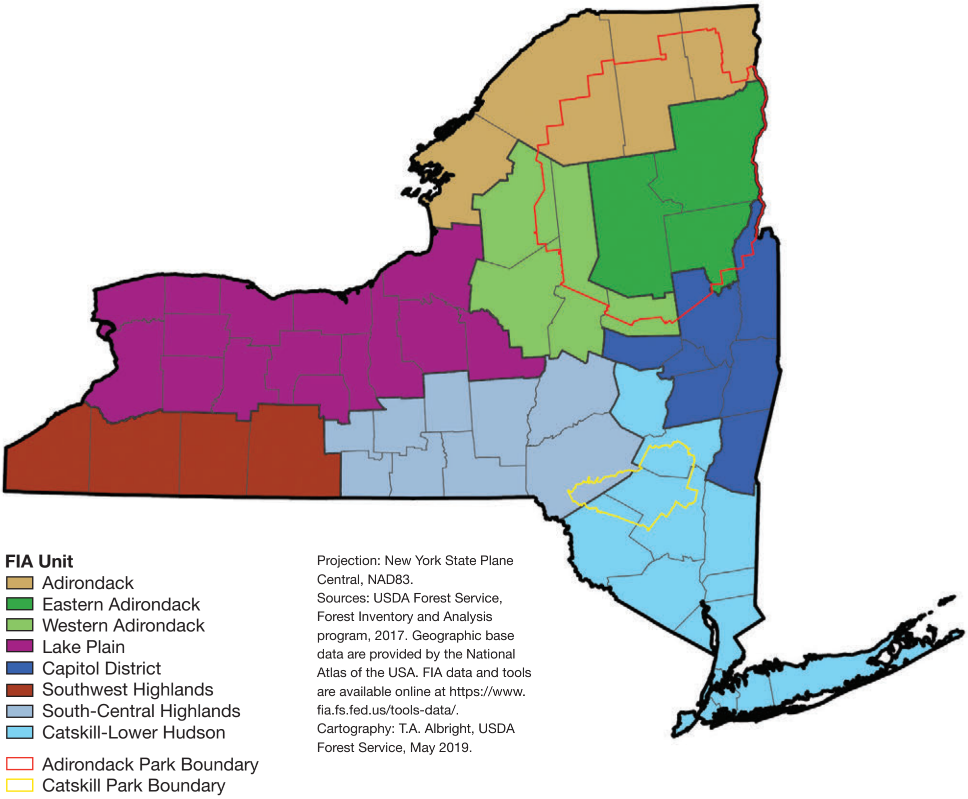


Figure 1.—Forest Inventory and Analysis inventory units (regions), New York, 2017. Note: The Adirondack unit was formerly referred to as "St. Lawrence/Northern Adirondack."

timespans. Definitions, methods, location, ownership, precision, scale, and temporal trends are important factors to consider when analyzing FIA data. Estimates are derived from sample plots throughout a state. Larger geographic areas will contain more plots and thus produce more reliable estimates. For example, there may not be a sufficient number of plots within a county or single forest type from which to derive reliable estimates. It is also important to consider the degree to which a variable can be measured precisely. For instance, a stand variable, such as age, is not as precise as forest type; and a tree variable, such as crown dieback, is not as precise as diameter. Because forest resources vary by geographic unit and ownership group, location and ownership should also be considered when analyzing the status and trends of forests. In addition, because some definitions and procedures have changed between inventories, some comparisons and estimates should be made with caution.

Since the beginning of the New York annual inventory in 2002, varying cycle lengths have been used for data collection. The first annual cycle took 6 years to complete, ending in inventory year 2007. In 2011, consistent 5-year cycle lengths began in the State, with 20 percent of all plots selected for measurement annually. The 5-year cycle length continued through 2013 with the second full cycle and first remeasurement of annual plots completed in 2012. In 2014, the third inventory returned to a 7-year cycle length that is scheduled for completion in 2019. Regardless of cycle length, FIA maintains a 5-year reporting period, with each report encompassing a full cycle of data. This creates a yearly moving window of 5-year cycles. The last year of each full cycle is used to identify the full set of plots. For example, the cycle of plots measured from 2011 through 2017 is collectively labeled the 2017 inventory, and this is the data used to produce this 2017 report. The 2007 inventory was the first annual inventory to include the complete cycle of annual inventory plots (Widmann et al. 2012), and the 2012 inventory was the first annual inventory to include a complete remeasurement of plots (Widmann et al. 2015).

For the 2017 inventory cycle, 5,300 locations in New York were selected for measurement. Of these plots, 3,186 contained forest land, 1,515 were nonforest, and 599 were not sampled due to access constraints. All estimates of current forest area, composition, volume, and other forest statistics are based on the 4,701 sampled plots. To get reliable estimates of change (e.g., forest area change, growth, mortality, and removals), FIA uses only those plots sampled during both the 2017 cycle and the previous cycle. Of the 4,701 measured in the 2017 inventory, 163 plots were not sampled during the previous cycle, so estimates of change in this 2017 report are based on 4,538 plots.

To improve the efficiency and reliability of the inventory, procedures and definitions have been updated over time. Major changes occurred in 1999 when the annual inventory began, and for the sake of consistency, a new, national plot design was implemented by FIA throughout the United States (Gormanson et al. 2018). Estimates for the 2017 inventory use the most recently updated protocols (USDA Forest Service 2015).

What is P2+?

In 2012, the Northern Research Station's Forest Inventory and Analysis program (NRS-FIA) began implementation of the Phase 2+ (P2+) protocol (USDA Forest Service 2016), which is applied to a 12.5 percent subset of all plots. P2+ plots are sampled during the leaf-on portion of the field season (May through September) and include a suite of additional measurements to document advanced tree seedling regeneration (ATSR), vegetation profile (Veg), invasive plant species (Invasives), down woody materials (DWM), and additional tree crown variables (Crowns). Half of P2+ plots (6.25 percent of all plots) are selected for soils measurements and subsequent laboratory analysis.

What is the National Woodland Owner Survey?

The National Woodland Owner survey is conducted periodically by the Forest Service (NWOS; https://www.fia.fs.fed.us/nwos). It is aimed at increasing our understanding of woodland owners, who are the critical link between forests and society (Butler et al. 2016). The most recent survey was conducted from 2011 through 2013 and included mailing questionnaires to individuals and private groups who own the woodlands where FIA has established inventory plots. Data presented in this report are based on responses from the 266 family forest owners from New York who participated in the survey (Butler et al. 2016).

Where can I find additional information?

Details about data collection, estimation procedures, and statistical reliability can be found in Gormanson et al. (2018). Most data used in this report can be downloaded from the FIA website (https://www.nrs.fs.fed.us/fia) and are also accessible by using the online web tools Design and Analysis Toolkit for Inventory and Monitoring (DATIM) and EVALIDator (USDA Forest Service 2019). These tools allow public access to all FIA databases, enabling anyone to generate tables and maps of forest statistics through a web browser without having to understand the underlying data structures. These programs are available at https://www.fia.fs.fed.us/tools-data/. Some graphs and tables in the printed portion of this report show only a sample of the prominent categories and values available for summarizing data. More categories may be found in online summary tables and custom tables created with DATIM and EVALIDator. Definitions of tables and fields are available in the FIA database user guide (Burrill et al. 2018). Other FIA resources for New York forest inventories are available at https://www.nrs.fs.fed.us/fia/data-tools/state-reports/NY/default.asp.

Forest Features

Vernal pool in Schuyler County. Photo by Thomas Albright, USDA Forest Service.

Area and Land Use

Background

Forests cover 62 percent of the land area in New York, providing a critical resource and offering a wide range of benefits. FIA characterizes land area by using several broad land use categories: forest, rangeland, agriculture, water, developed, and other land (wetlands, undeveloped beaches, nonvegetated lands, persisting snow and ice). The conversion of forest land to nonforest and water uses is referred to as gross forest loss (or diversion), and the conversion of nonforest land and water to forest is known as gross forest gain (or reversion). The magnitude of the difference between gross loss and gross gain is defined as net forest change. By comparing the land uses on New York inventory plots measured from 2011 through 2017 (hereafter referred to as the 2017 inventory) with the land uses recorded for the same plots measured during the previous inventory (from 2008 through 2012, and hereafter referred to as the 2012 inventory), we can characterize forest land-use change dynamics. To better understand New York forest land dynamics, it is important to explore underlying land-use changes in the State. Understanding land-use change dynamics is essential for monitoring the sustainability of New York's forest resources and helps land managers make informed policy decisions.

What we found

Decades of growth in the extent of forest land slowed in the 1990s and plateaued in the early part of the 21st century (Fig. 2). The 2017 estimate of forest land area was 18.7 million acres, a slight 1 percent decrease from the high of 19.0 million acres in 2012. Timberland accounted for 83 percent (15.6 million acres) of total forest land, with reserved forest land at an estimated 3.1 million acres, an anomaly in the eastern United States (See "Reserved Forest Land" on page 72). When calculated as a proportion of the total area of New York (including inland water bodies), 60 percent is forest land, 36 percent (11.4 million acres) is in nonforest land uses, and 4 percent (1.3 million acres) is water. Between 2012 and 2017, most of the land use in New York either remained forested (59.3 percent) or stayed in a nonforest land use (38.7 percent) (Fig. 3). Change plots—defined for mapping purposes as those remeasured plots having land use gain or loss of at least 25 percent—are distributed throughout the State, although a lower density of forest gain occurred within the already heavily forested Adirondack Park region of the State's northeast (Fig. 4).

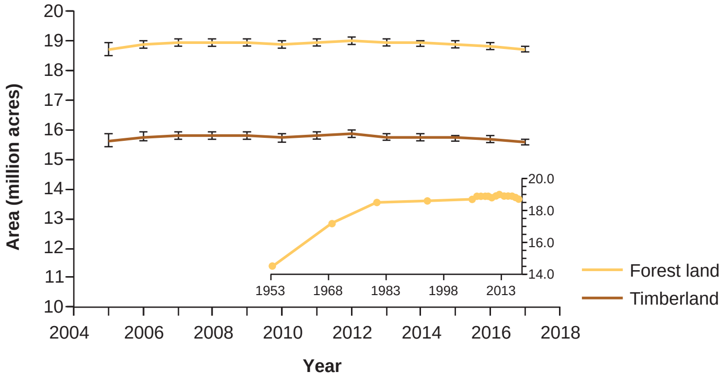


Figure 2.—Forest land area and timberland area by inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

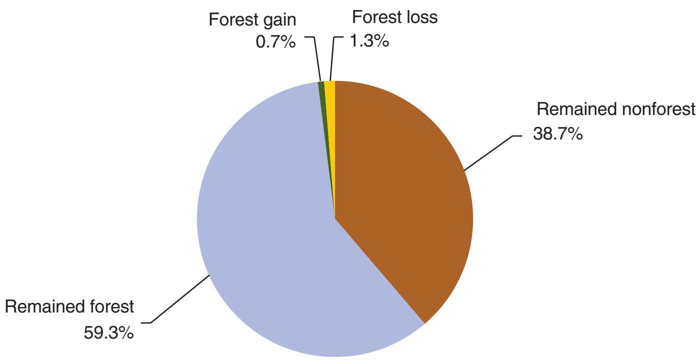


Figure 3.—Land use dynamics showing percentage of unchanged land, forest loss, and forest gain, New York, 2012 to 2017.

On the 2.0 percent of surface area where land use changed between inventories (Fig. 3), the amount of forest diverted to nonforest (390,000 acres) exceeded the amount of nonforest that reverted to new forest land (250,000 acres), leading to slight net loss in forest land area (Figs. 3, 5). Of the gross forest loss, 49 percent was due to diversion to agricultural land use (Fig. 5). Forest loss also resulted from forest land being converted to developed land (33 percent), other land uses (16 percent), and water (about 2 percent). Forty-nine percent of forest gain in New York was from agricultural land converting to forest. Developed land (35 percent), other land uses (14 percent), and water (2 percent) provided other sources of forest reversion (Fig. 5).

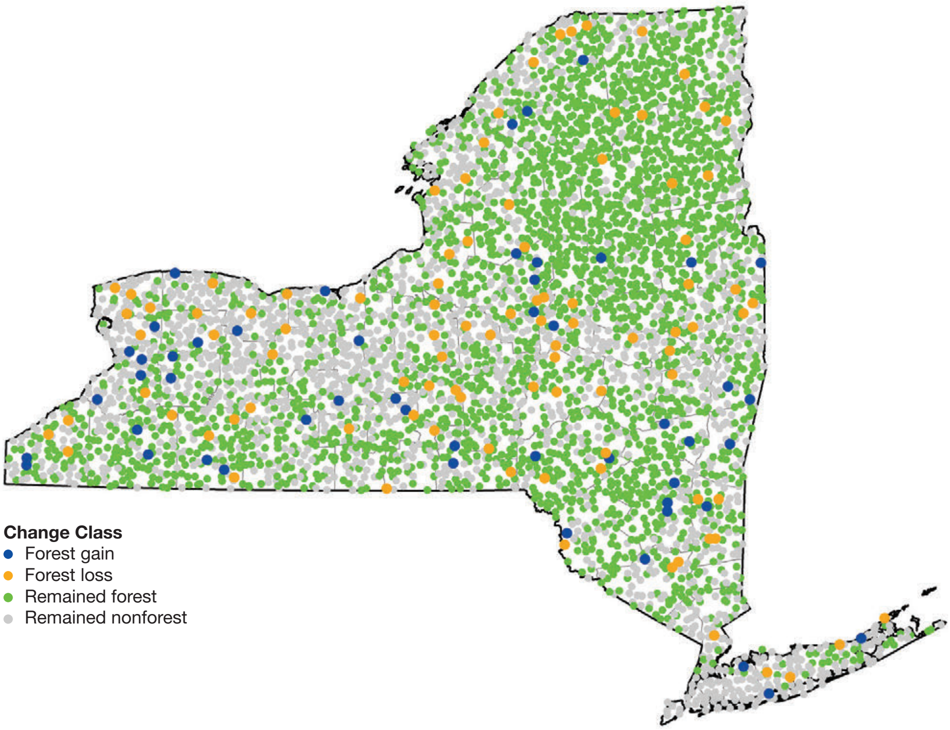


Figure 4.—Approximate locations of remeasured FIA plots showing forest gain, forest loss, persisting forest, and persisting nonforest, New York, 2012 to 2017.

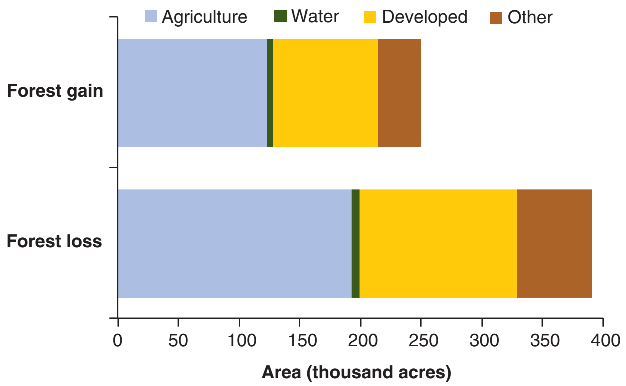


Figure 5.—Gross forest loss and forest gain by land use category, New York, 2012 to 2017.

What this means

The net loss of forest land reported in this inventory is small, with gross loss of forest partially offset by gross gain. Since the previous inventory, New York has seen a statistically significant loss of forest land, with a 0.3 percent average annual rate of decline and a statistically significant gain in nonforest, with a 0.4 percent average annual rate of increase. The decline in land classified as forest has more than offset the gains that culminated in the maximum extent of forest land seen in the 2012 inventory, resulting in a 1 percent net loss over the past decade. Gains and losses from multiple causes are driving land-use change dynamics in New York. Movement between forest and nonforest classifications may be a result of land meeting or not meeting FIA's definition of forest land due to small changes in understory disturbance, forest extent, or forest cover. Such changes are generally not permanent and may be more prevalent in stands of small diameter trees.

Additionally, the definition of forest land changed in 2013 from a minimum of 10 percent stocking to a minimum of 10 percent canopy cover. In the latest inventory, over half of the forest land acreage lost to agricultural land uses (112,000 acres) were classified as idle farmland, a land use defined as areas taken out of agricultural production but not yet reverted to forest land. It is likely that much of the change was due in part to procedural changes in forest land classifications rather than true on the ground land conversion. Watching this issue into the next inventory cycle should bring clarity to the question about the true trend in forest extent.

Urbanization and Fragmentation of Forest Land

Background

The wildland-urban interface (WUI) is the zone where human development meets or intermingles with undeveloped wildland vegetation. It is the fastest-growing land use type in the conterminous United States (Mockrin et al. 2019, Radeloff et al. 2018). Although originally defined to identify the area where wildfires pose the greatest risk to people, the WUI is associated with a variety of consequential human-environment conflicts. These include impacts such as the loss and fragmentation of native species, the introduction and spread of nonnative species (Gavier-Pizarro et al. 2010, Riitters et al. 2018), the loss of habitat area or critical connectivity (Bregman et al. 2014, Rogers et al. 2016), increased mortality of wildlife (Klem 2009, Loss and Marra 2013), reductions in regional complexity of plant and animal communities (Ferguson et al.

2017, Mack et al. 2000), increases in nonnative insect and disease invasions (Guo et al. 2018), and impacts on water quality and quantity from impervious surfaces and increased pollution (Bar-Massada et al. 2014, Gonzalez-Abraham et al. 2007). The 2018 report from the New England Climate Change Response Framework on New England and New York forest ecosystem vulnerability (Janowiak et al. 2018) identified fragmentation and land-use change as one of the top six current major stressors and threats to forest ecosystems. Two of the other major threats, invasion by nonnative species and forest diseases and insect pests, are themselves heavily influenced by forest fragmentation and urbanization.

In the 2012 report on New York forests (Widmann et al. 2015), forest spatial integrity was summarized by using a spatial integrity index that combined forest patch size, local forest density, and connectedness to core forest land; included maps of the pervasiveness of roads throughout forested areas; and introduced the additional and extensive effect that 2010 levels of housing density had on forest land. Although it is just one of the characteristics of fragmentation impacting forest ecosystems, examining the landscape using a spatial integrity index provides a scale-dependent but relatively robust way of looking at where forest remains the most spatially intact (core and high integrity forest) and where, either due to urban or agricultural development, the forest is more fragmented.[1] With the recent completion of a temporally consistent census block-level dataset capable of accurately comparing block-level change in housing densities from 1990 to 2010 (Mockrin et al. 2019, Radeloff et al. 2018), we are now able to analyze changes in housing density and forest land at a finer spatial resolution and with more accuracy than was previously possible. We use the data to identify FIA forest land and changes in WUI status via the following categories: forest land in census blocks that have had housing densities above established WUI thresholds for 30 years or more (from 1990 or before), forest that became WUI in the 1990s, forest that became WUI in the 2000s, forest that experienced change in WUI density in both decades, and forest land that remained in non-WUI census blocks in 2010 (Figs. 6 and 7). In Figures 6 and 7, forest land is depicted in the map using the 2011 National Land Cover Dataset (Homer et al. 2015) to mask out nonforest areas; however, all forest land statistics reported are summarized from the FIA plot data.

In this report, we examined how much forest land is already experiencing or is at risk of change because of its proximity to WUI levels of housing development, and what that rate of change has been in the last 20 years of available data (1990-2010). We also investigated the extent to which these WUI conditions occur in forest land that might otherwise be considered high integrity or core forest land. Finally, we analyzed

[1] Riemann, R. [N.d.]. Adaptation of a spatial integrity index to 30 m and 250 m scales, and its application across the northeastern United States. On file with author.

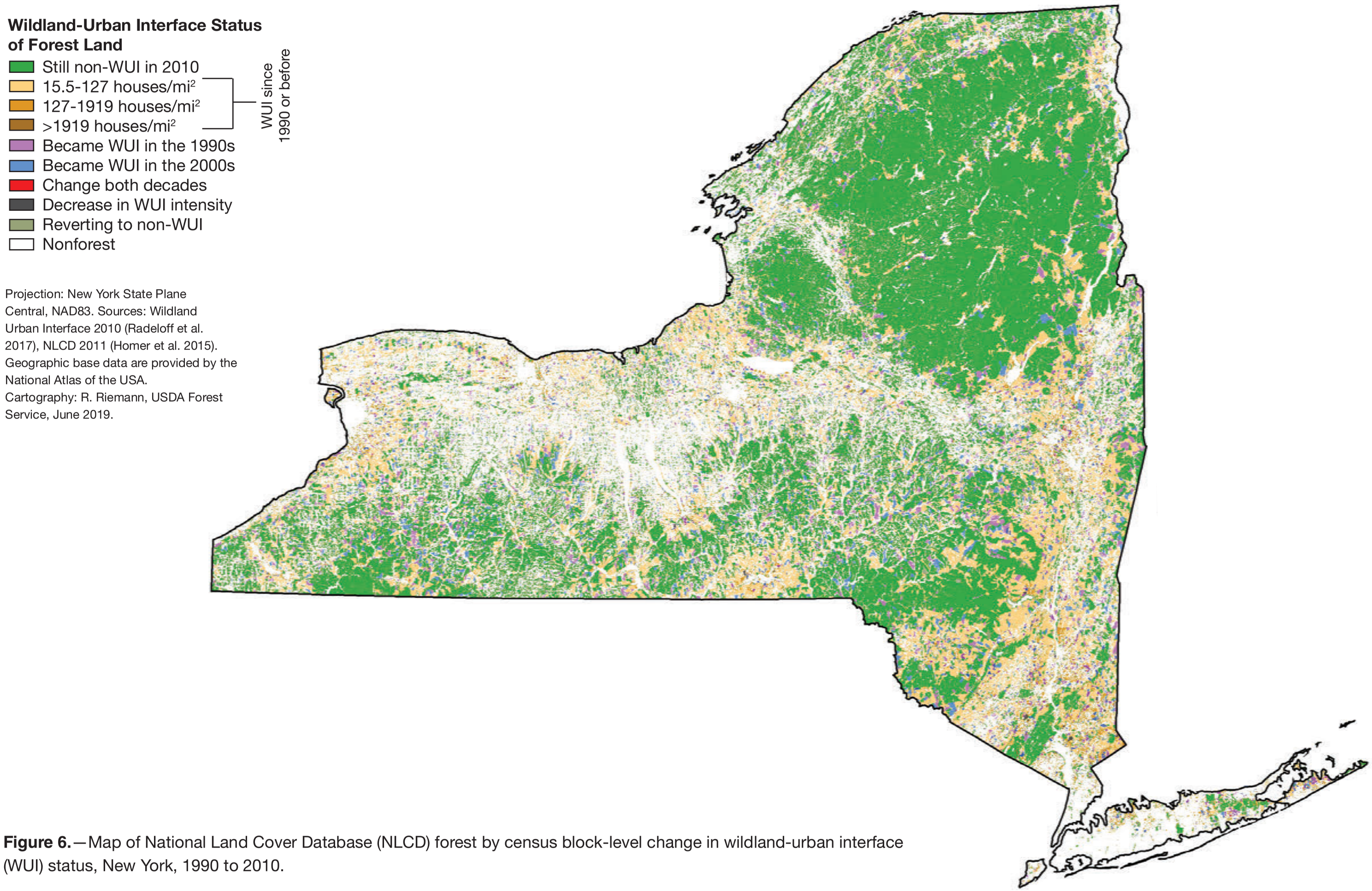


Figure 6.—Map of National Land Cover Database (NLCD) forest by census block-level change in wildland-urban interface (WUI) status, New York, 1990 to 2010.

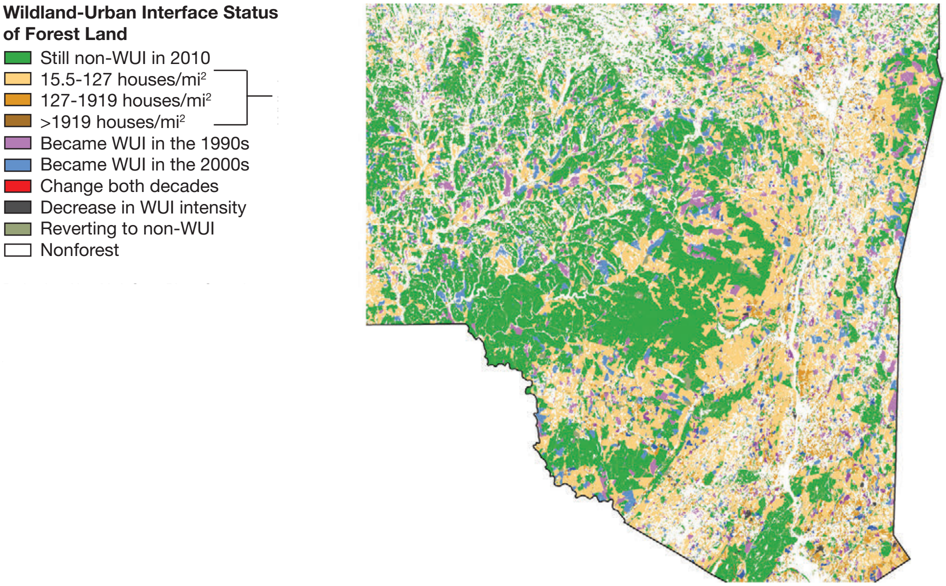


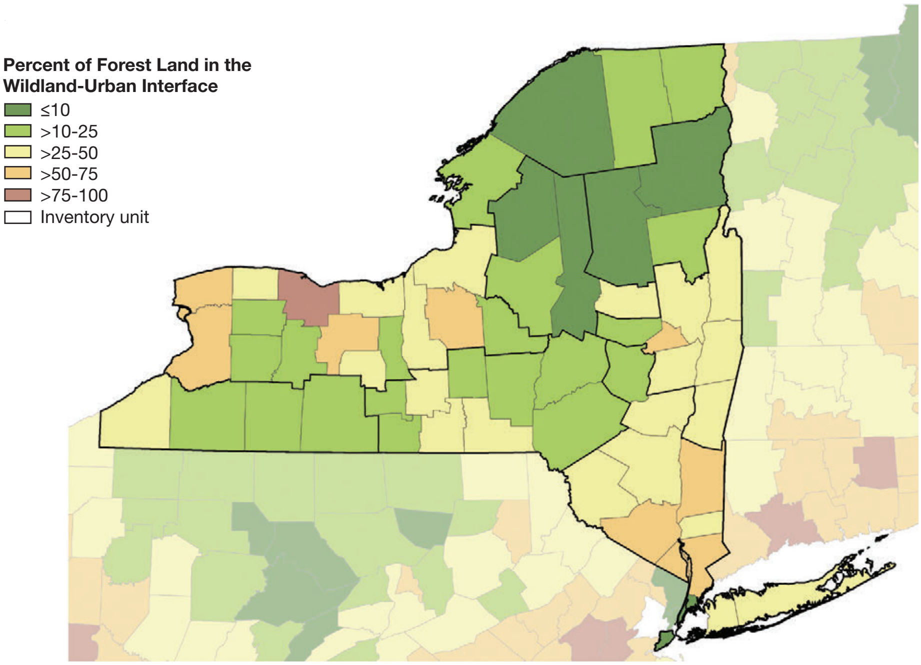
Figure 7.— Map of NLCD forest by census block-level change in wildland-urban interface (WUI) status, Catskills and Hudson Valley, New York, 1990 to 2010.

whether there were differences in how different forest types and ownership groups have been affected by urbanization levels above the low (15.5-127 houses per square mile), medium (127-1919), and high (>1919) WUI housing density thresholds.

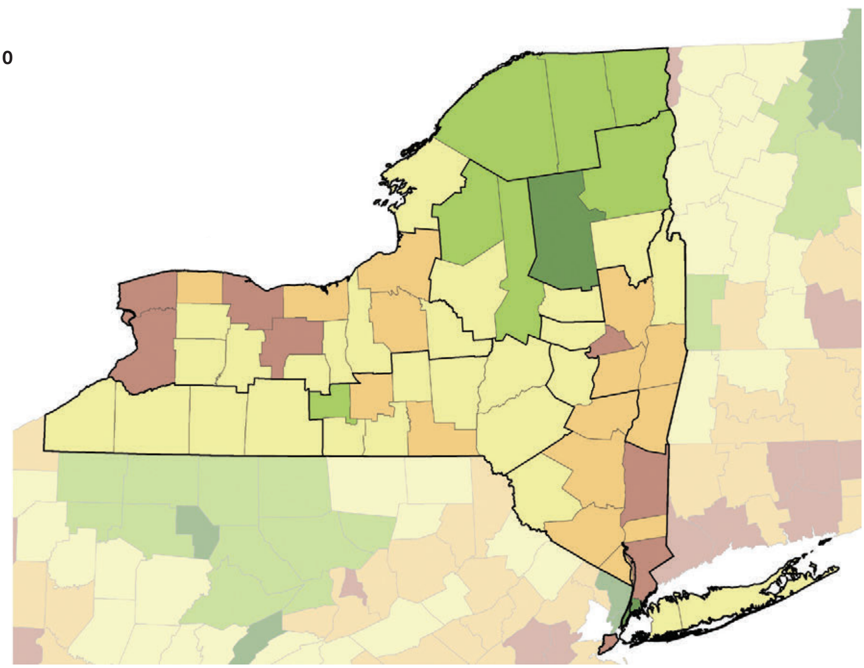
What we found

Both the area and proportion of forest that is non-WUI has continued to shrink in New York, from 14.3 to 12.5 million acres (76 to 66 percent of the total forest land) between 1990 and 2010 (Fig. 8). By 2020, 4.6 million acres of New York forest land will have been in WUI conditions for at least 30 years, with an additional 1.6 million acres of forest land crossing into the WUI category between 1990 and 2010. Some areas experienced more forest urbanization in the 1990s and some experienced more in the 2000s, with a portion of counties increasing urbanization at rates greater than 5 percentage points per decade (Fig. 9).

Forest types were affected to differing degrees in 2010, from 57 percent of their forest area for red maple/lowland and sugarberry/hackberry forest types to 21 percent of their forest area in sugar maple/beech/yellow birch (Table 1). Three additional forest types had at least 50 percent of their area in WUI as of 2010 (white oak/red oak/hickory, eastern white pine/northern red oak/white ash, and aspen). The aspen type

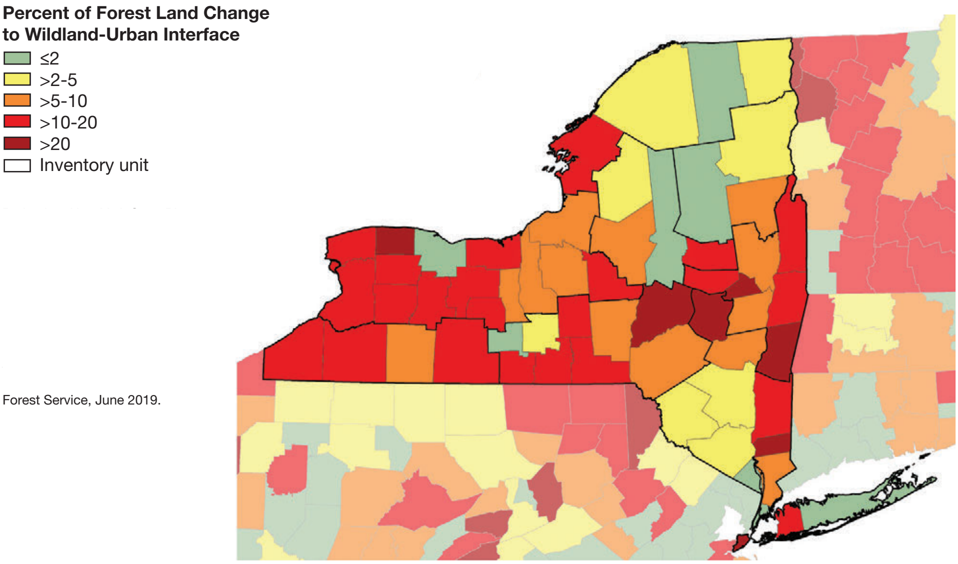


B. 2010



Projection: New York State Plane Central, NAD83. Sources: USDA Forest Service, Forest Inventory and Analysis program 2009-2013, Wildland-Urban Interface 2010 (Radeloff et al. 2017). Geographic base data are provided by the National Atlas of the USA. Cartography: R. Riemann, USDA Forest Service, June 2019.

Figure 8.—Proportion of forest in New York in the wildland-urban interface in (A) 1990 and (B) 2010.



Forest Service, June 2019.

Figure 9.—Proportion of forest land in each county that changed from non-wildland-urban interface (non-WUI) to WUI conditions, New York, 1990 to 2010.

Table 1.—Wildland-urban interface change class breakdown by forest type, New York

Forest type	Total acres	All classes	WUI change group: WUI from 1990 or earlier	WUI change group: New WUI 1990-2010	WUI change group: Still non-WUI as of 2010	WUI change group: Potential WUI decrease	Proportion of area in WUI in 2010
		percent	percent	percent	percent	percent	percent
Total	**18,950,318**	**100**	**24**	**9**	**66**	**1**	**33**
Sugarberry/hackberry/elm/green ash	293,585	2	51	6	43	0	57
Red maple/lowland	398,593	2	47	10	41	1	57
White oak/red oak/hickory	1,142,607	6	43	13	43	2	55
Elm/ash/black locust	479,237	3	40	9	50	2	49
Eastern white pine/northern red oak/white ash	516,020	3	38	13	47	3	51
Other hardwoods	292,460	2	33	11	51	4	44
Eastern white pine	574,695	3	33	12	53	2	45
Aspen	381,393	2	33	17	50	0	50
Northern red oak	459,784	2	32	12	54	2	44
Hard maple/basswood	2,077,800	11	28	9	62	1	37
Eastern hemlock	318,365	2	18	11	71	0	29
Red maple/upland	1,202,297	6	15	7	75	2	23
Sugar maple/beech/yellow birch	7,000,564	37	14	7	79	0	21
All other forest types[a]	3,812,920	20	14	0	86	0	14

[a] Those with at least 250,000 acres or 2 percent of total forest area.

had the greatest proportion of its area converted to WUI intermix between 1990 and 2010, at 17 percent, and eight forest types had 10 percent or more of their forest area converted to WUI intermix during that time. Eleven percent of the total forest area in WUI in New York in 1990 and 9 percent of the forest area in new WUI 1990-2010 was in the white oak/red oak/hickory forest type, which itself only represents 6 percent of the total forest area in New York (Table 2).

Table 2.—Forest type breakdown of wildland-urban interface change class, New York

	WUI change group			
Forest type	WUI from 1990 or earlier	New WUI 1990-2010	Still non-WUI as of 2010	Potential WUI decrease
Total area (acres)	**4,622,871**	**1,623,451**	**12,527,777**	**176,219**
Sugar maple / beech / yellow birch	22	29	44	8
Hard maple / basswood	13	12	10	8
Red maple / upland	4	5	7	13
White oak / red oak / hickory	11	9	4	13
Eastern white pine	4	4	2	5
Eastern white pine / northern red oak / white ash	4	4	2	8
Elm / ash / black locust	4	3	2	5
Northern red oak	3	3	2	5
Red maple / lowland	4	3	1	3
Aspen	3	4	2	0
Eastern hemlock	1	2	2	0
Sugarberry / hackberry / elm / green ash	3	1	1	0
Other hardwoods	2	2	1	7
All other forest types[a]	22	19	20	23

[a] Those with at least 250,000 acres or 2 percent of total forest area.

The ownerships with the greatest proportion of their forest land area remaining as non-WUI forest were State (99 percent) and Federal (94 percent) ownerships. The county and local government ownership group had the lowest proportion of its forest land remaining in non-WUI conditions in 2010 (53 percent), followed by the private ownership group (57 percent). However, the large amount of forest land in private ownership in New York meant that it had double the number of acres remaining in non-WUI conditions in 2010 as State land (Fig. 10). Almost all the forest land undergoing a change in WUI status between 1990 and 2010 was in private ownership (Fig. 11).

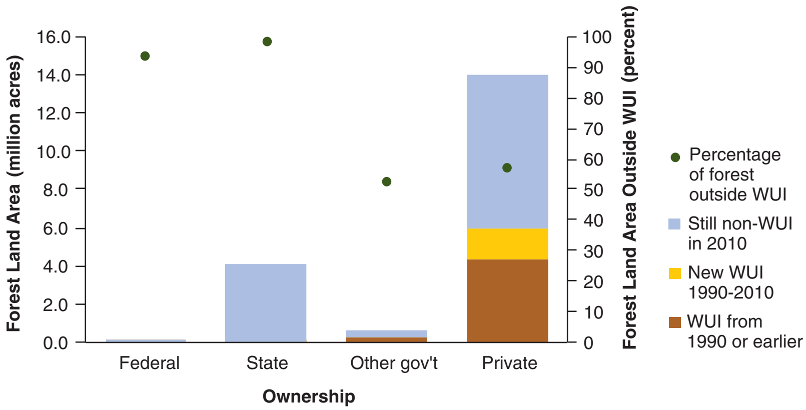


Figure 10.—Forest land area by ownership group and wildland-urban interface (WUI) change group, New York, 1990 to 2010.

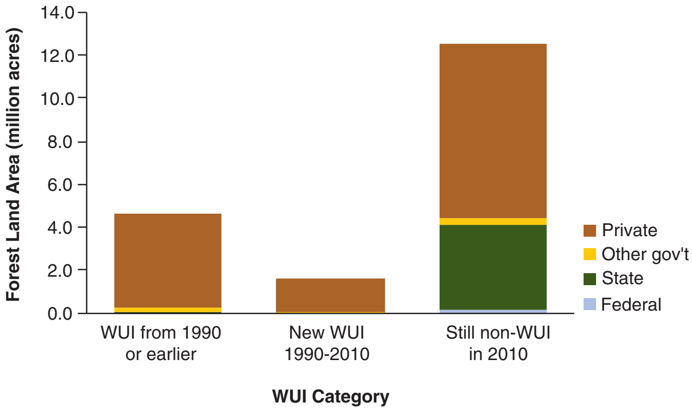


Figure 11.—Forest land area by wildland-urban interface (WUI) change group and ownership group, New York, 1990 to 2010.

When WUI areas are overlaid on the forest spatial integrity map, it is apparent that WUI occurs even in areas that would otherwise be considered core or high integrity forest. In New York, 67 percent of the forest land had a spatial integrity index value of "core" and/or "high integrity" at both the 30 m and 250 m scales (Fig. 12), as defined by patch size, local forest density, and connectedness (Widmann et al. 2015). However, of that core and/or high integrity forest land, 25 percent occurred in WUI conditions in 2010, the most recent census data available. Between 1990 and 2010, conversions of core and high spatial integrity forest to WUI conditions took place at an average rate of 3.5 percentage points per decade.

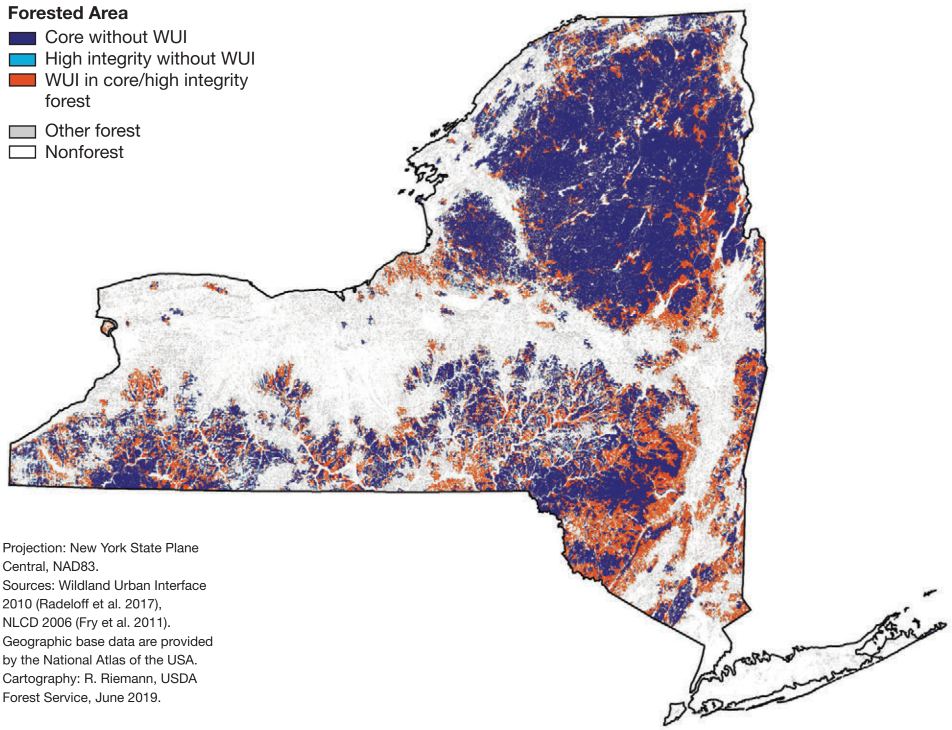


Figure 12.—Locations where wildland-urban interface (WUI) conditions occurred within forest land calculated to have core or high spatial integrity at both 30 m and 250 m scales, New York, 2010.

Excluding forest land classified as high integrity, 49 percent of the forest land in New York had a spatial integrity index value of "core" at both the 30 m and 250 m scales; however 18 percent of that core forest occurred in WUI conditions in 2010. From 1990 to 2010, this core forest was still being converted to WUI conditions at an average rate of 3 percentage points per decade.

What this means

Urbanization is affecting an increasing amount of forest area in New York, including unfragmented forest land in otherwise core or high spatial integrity situations. By 1990, a total of 4.6 million acres (24 percent of New York's forest land) was in WUI conditions, and between 1990 and 2010, forest land was still being converted to WUI conditions in some counties at rates greater than 5 percentage points per decade. These changes were not limited to already fragmented forest land in New York. Forest land in otherwise core and high spatial integrity conditions was being converted to WUI conditions at an average rate of 3.5 percentage points per decade between 1990 and 2010.

Increasing urbanization has the potential to change how forests of the Empire State function, affecting their vulnerability to threats such as insect pests and diseases, nonnative species proliferation, and loss of native species. All of these can hinder the overall resilience of the land in the face of both these threats and the additional changes and disturbances expected due to climate change. Such changes also affect the inherent ecosystem services forest land provides, such as water quantity and quality and forest products. Many of the above changes in forest ecosystems happen over time, so forest land that has only recently become WUI may not look different yet. Forest land that has been in WUI conditions for over 30 years is more likely to exhibit changes.

Given the well-documented negative effects of residential development on forest land and the amount of forest land occurring in WUI conditions, how we manage those residential areas matters and strategies to reduce the effects of those residential land uses on surrounding forest land should be pursued (Kramer et al. 2013). In addition, planning interventions are almost certainly required to maintain remaining forest connectivity.

Ownership

Background

How forest land is managed is primarily the decision of the owners. Therefore, the availability and quality of forest resources, including recreational opportunities, timber, and wildlife habitat, are largely determined by landowners. By understanding forest landowners, the forest conservation community can better help owners meet their needs, and in so doing, help conserve the State's forests for future generations. The National Woodland Owner Survey (NWOS; www.fia.fs.fed.us/nwos), a component of the FIA program, studies the attitudes, management objectives, and concerns of private forest landowners. The survey focuses on the diverse and dynamic group of owners that is the least understood—families, individuals, and other unincorporated groups, collectively referred to as "family forest owners." The NWOS data reported here are based on responses from 266 family forest ownerships from New York State that participated between 2011 and 2013 (Butler et al. 2016).[2] Where available, these results are compared to the previous iteration of the NWOS implemented between 2002 and 2006. For analysis of forest land by ownership category, data are also included for the most recent 2017 FIA inventory.

[2] Results from the 2017-2018 NWOS are expected to be released in 2020.

What we found

General Ownership Patterns

Three out of every four acres (73.8 percent) of forest land and 88.8 percent of timberland in New York are privately owned. The vast majority of these private lands, an estimated 10.4 million acres, are owned by family forest owners (Fig. 13). Details about this group are discussed below. Corporations own an estimated 2.9 million acres. Other private owners, including conservation organizations and unincorporated clubs and partnerships, own an estimated 0.6 million acres. An estimated 46,000 acres of forest land in New York is tribally owned and is distributed among a number of Native American tribes.

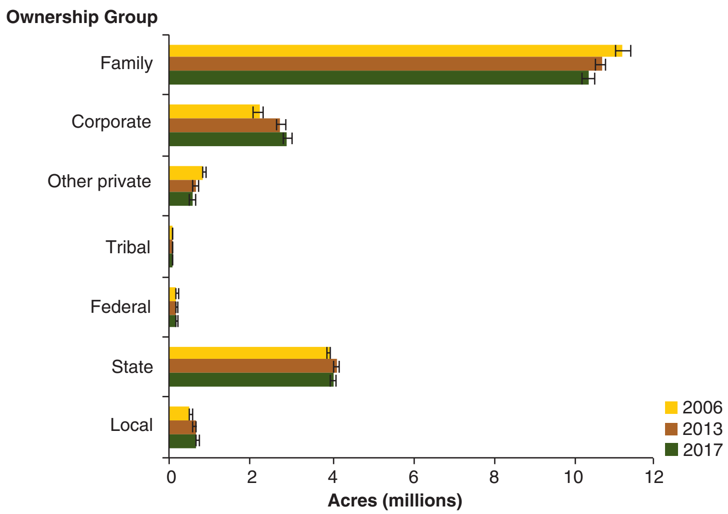


Figure 13.—Area of forest land by ownership group and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

Public owners control 26.0 percent of New York's forest land. State forest, park, and wildlife agencies are stewards of an estimated 4.0 million acres of forest land. Local governments control an estimated 670,000 acres of forest land in the State. The Federal government manages an estimated additional 160,000 acres of forest land.

Between 2006 and 2017, the largest changes in forest ownership area occurred in family and other private forest acreage, with decreases of an estimated 880,000 and 280,000 acres, respectively. The largest increase was in the area owned by corporate owners, which increased by an estimated 700,000 acres.

Family Forest Ownerships

As of 2013, the date of the latest available data, there was an estimated 197,000 family forest ownerships (standard error [SE] = 6.9 percent) across New York that each owned at least 10 acres of forest land. This group controls a collective 9.3 million acres, a decrease of 6.0 percent since 2006. The number of ownerships of at least 10 acres decreased by an estimated 11.9 percent. The average forest holding size for ownerships of at least 10 acres in 2013 was 46.8 acres per ownership (SE = 10.0 percent), which is not a substantial change from 2006. As of 2013, 68.7 percent of these family forest ownerships own less than 50 acres of forest land, but 67.7 percent of the family forest land is in holdings of at least 50 acres (Fig. 14).

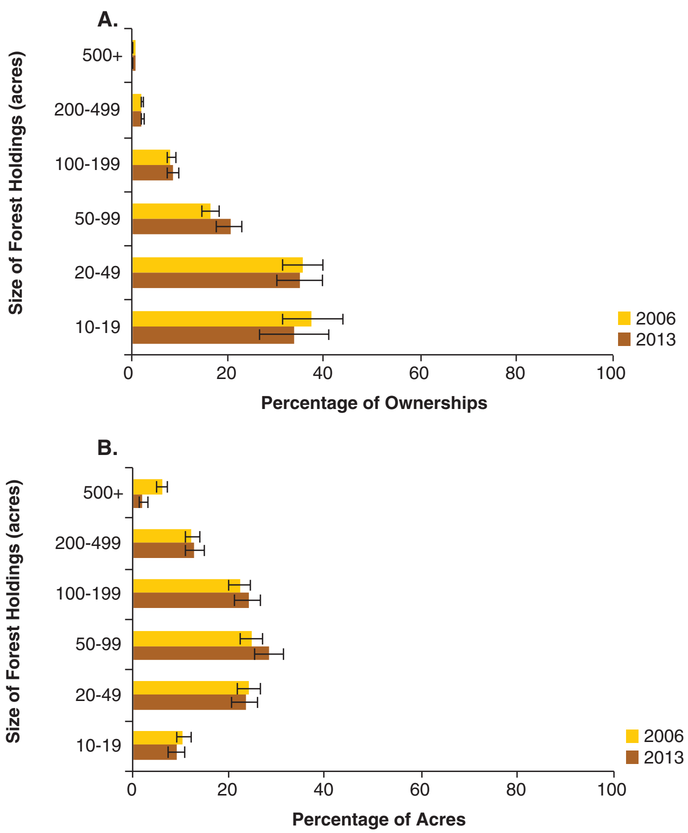
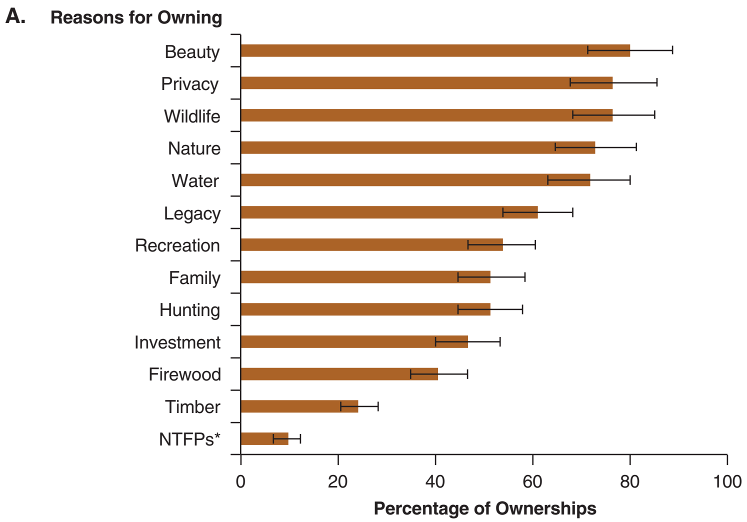


Figure 14.—Percentage of family forest ownerships (A) and acres of forest land (B) by size of forest land holdings and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

The primary reasons for owning forest land are related to aesthetics, privacy, wildlife habitat, and nature protection (Fig. 15). Objectives related to financial values, including timber production and land investment, are rated as dominant ownership reasons much less frequently. The most common activities on family forest land are personal recreation, such as hunting and hiking, and cutting trees for personal use, such as firewood (Fig. 16). Due to changes in question wording, it is not possible to directly compare the 2013 NWOS questions on ownership objectives to those in the 2006 NWOS.[3]

[3] More concerted efforts were made to keep the questions as consistent as possible between the 2013 and the forthcoming 2018 iterations of the NWOS to allow for more direct analyses of changes over time.



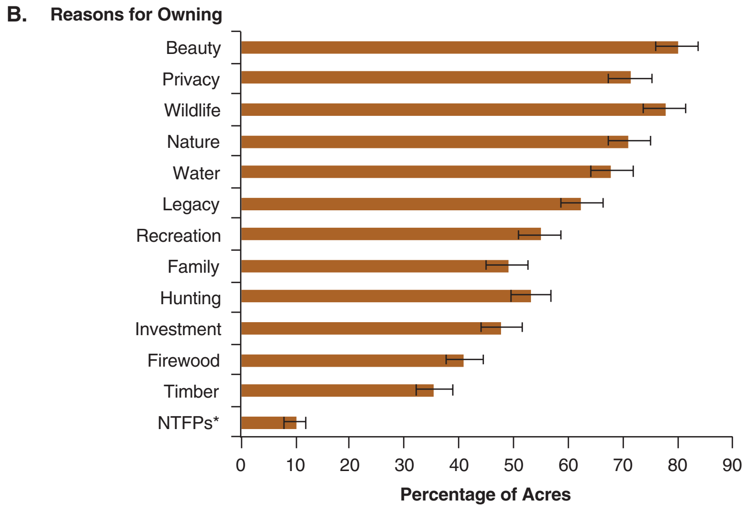


Figure 15.—Percentage of family forest ownerships (A) and acres of forest land (B) by reasons given for owning forest land (ranked as very important or important), New York, 2013. Categories are not exclusive. Error bars represent a 68 percent confidence interval around the mean. *Nontimber forest products (NTFPs).

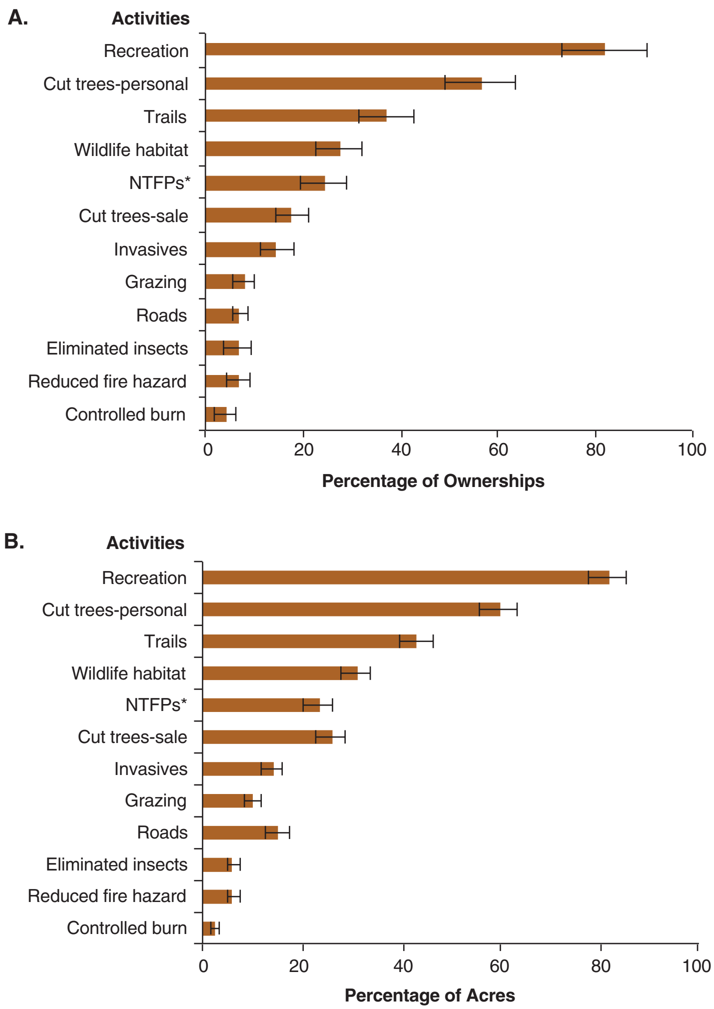
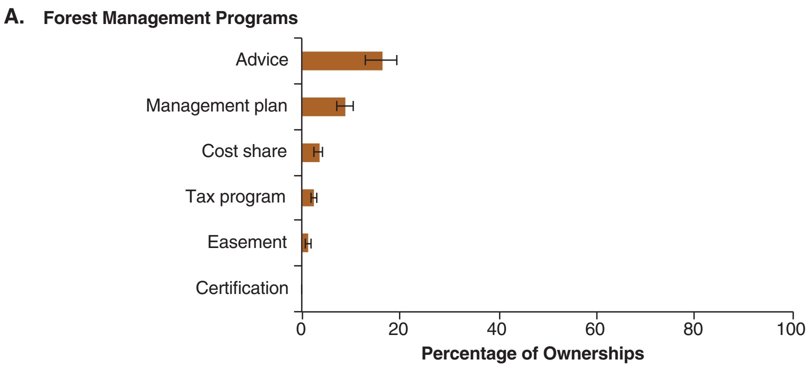


Figure 16.—Percentage of family forest ownerships (A) and acres of forest land (B) by activities in the past 5 years, New York, 2013. Categories are not exclusive. Error bars represent a 68 percent confidence interval around the mean. *Nontimber forest products (NTFPs).

The majority of family forest ownerships have not participated in traditional forestry management and assistance programs in the previous 5 years (Fig. 17). Sixteen percent of the ownerships, owning 27 percent of the family forest land, report receiving forest management advice in the previous 5 years. Nine percent of the ownerships, owning 18 percent of the family forest land, report having a written forest management plan. Less than 5 percent of the ownerships report participating in cost share, state property tax, easement, or certification programs. Again, comparisons between the 2006 and 2013 iterations of the NWOS are not feasible due to changes in question wording.



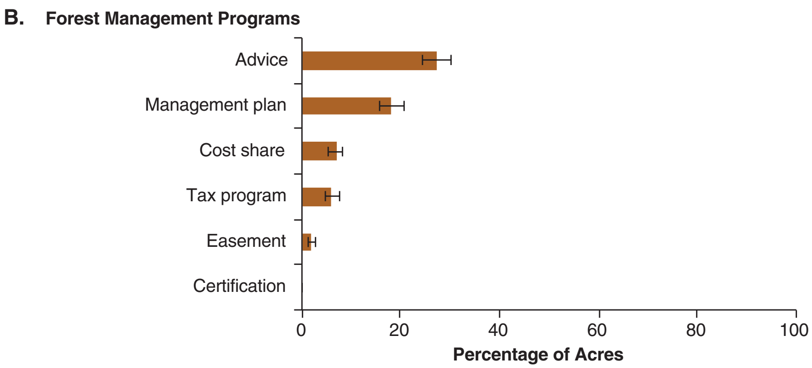


Figure 17.—Percentage of family forest ownerships (A) and acres of forest land (B) by participation in forest management programs, New York, 2013. Categories are not exclusive. Error bars represent a 68 percent confidence interval around the mean.

The average age of family forest owners in New York is 59.9 years (SE = 4.3 percent). Forty-one percent of the forest land is owned by people 65 or older (Fig. 18). Between 2006 and 2013, there was a decrease in the percentage of owners 75 or older and a marked increase in owners 55 to 64 years old.

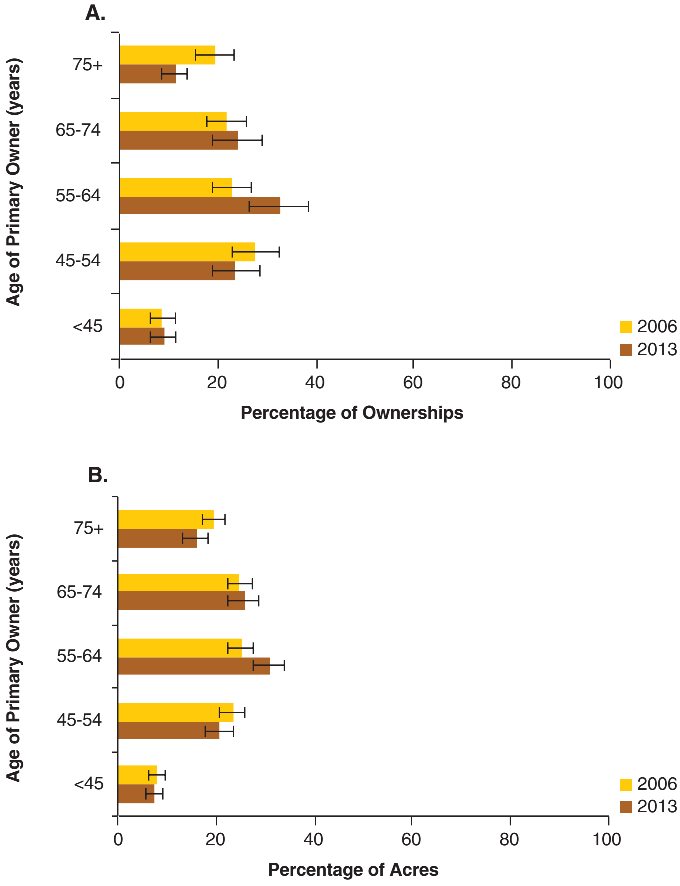


Figure 18.—Percentage of family forest ownerships (A) and acres of forest land (B) by age of primary owner and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

What this means

The fate of forests lies primarily in the hands of those who own and control the land. Therefore, it is critical to understand forest owners and what policies and programs can help them conserve the forests for current and future generations. One particular change that was observed is a decrease in the area of family forest land and nearly commensurate increase in area of corporate forest land. This may be due to family forest ownerships changing their legal form of ownership to some form of incorporation. Ideally, if these changes are due to address tax and intergenerational transfer issues and they still function as "family forest ownerships," then they would still be classified as such. This potential pattern is logistically challenging and will require additional research to verify or refute. Regardless, family forest ownerships are still the dominant form of forest ownership in New York State.

Family forest ownerships are the owner group that is the least understood and the fate whose land is arguably the most uncertain. They own their land primarily for amenity reasons, but many are actively using their land. The percentages of ownerships who have received advice and who have written forest management plans are relatively low, and there are significant opportunities to help owners increase their engagement and stewardship of their lands. Programs such as Tools for Engaging Landowners Effectively (http://www.engaginglandowners.org) can help the conservation community develop and implement programs more effectively and efficiently. Additional management resources are available from New York State Department of Environmental Conservation at https://www.dec.ny.gov/lands/4972.html.

Another important trend to watch is the aging of the family forest owners. With many of them being relatively advanced in age, this portends many acres of land passing on to new owners in the not too distant future. Programs such as Your Land Your Legacy (http://www.yourlegacyny.org/) and Ties to the Land (http://tiestotheland.org) are being implemented to help owners meet their bequest goals, but it is uncertain who the future forest owners will be and what they will do with their land.

Green frog in vernal pool. Photo by Thomas Albright, USDA Forest Service.

Forest Resource Attributes

Mature northern red oak in mixed upland forest. Photo by Thomas Albright, USDA Forest Service.

Forest Composition

Background

Multiple factors interact to influence the species that make up a forest. Soil attributes, climate, and competition between individuals have a great impact on which species ultimately occupy a forest. Timber harvesting, insect outbreaks, diseases, severe weather episodes, and fires, or the lack of such disturbances, also affect the characteristics of a given site. Substantial disturbances generally lead to a population of species with low shade tolerance. Conversely, mature forests lacking disturbance for a significant period of time tend to be favorable to shade-tolerant species. Forest management can alter species composition by disrupting these natural processes.

FIA characterizes the composition of a forest by forest-type groups, which can be further broken down into individual forest types. Tree species that generally coexist in a stand make up forest types, and similar forest types are collectively known as forest-type groups. Composition can be evaluated further by analyzing the number of trees by species and size.

What we found

The 2017 FIA inventory of New York identified stands that are categorized into 14 forest-type groups. The majority of the forests are dominated by hardwoods, with 88 percent of forest land area in hardwood forest-type groups (Fig. 19). Maple/beech/birch was the single largest group, occupying 10.3 million acres, or 55 percent of forest land (Fig. 20). An additional 3.3 million acres (17 percent) of forest land were in the oak/hickory group. No other forest-type group comprised more than 7 percent of total forest land. Of the 55 distinct forest types, only 3 had a total area exceeding 1 million acres. Sugar maple/beech/yellow birch was the single largest group, by far, with 7.0 million acres, or 37 percent of forest land. Hard maple/basswood, the next largest group, occupied 2.1 million acres (11 percent), and white oak/red oak/hickory covered 1.3 million acres (7 percent).

While the maple/beech/birch forest-type group is the most prevalent across the State, regional differences are apparent (Fig. 21). Maple/beech/birch is most prominent in the Eastern Adirondack unit, where it makes up 71 percent (1.9 million acres) of forest land. Three of the eight inventory units have less than half of their forest land in maple/beech/birch. The Lake Plain, Capitol District, and Catskill-Lower Hudson units have 41, 45, and 37 percent, respectively, of forested area in maple/beech/birch. Conversely, the oak/hickory group reached its highest concentrations of 23, 22, and 42 percent, respectively, in the same three regions. Only two forest-type groups other than oak/hickory and maple/beech/birch reached a concentration exceeding

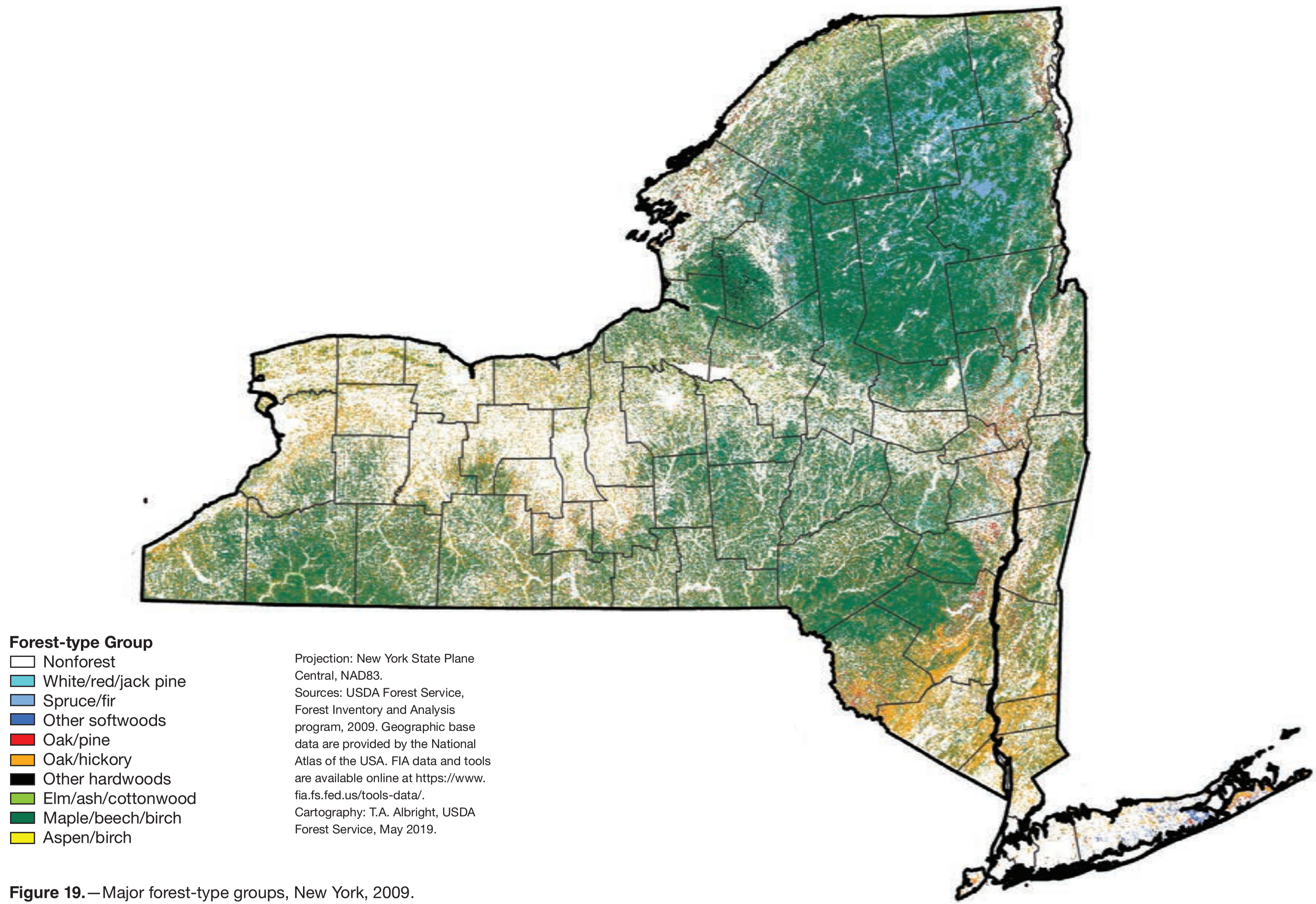


Figure 19.—Major forest-type groups, New York, 2009.

10 percent in any given region. Elm/ash/cottonwood covered 24 percent of the Lake Plain unit, and the white/red/jack pine made up 11 percent of the forested area in the Capitol District unit.

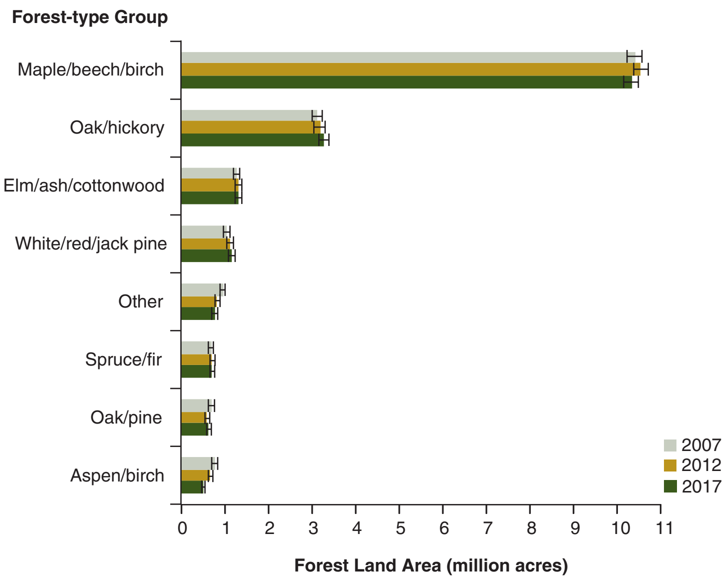


Figure 20.—Forest land area by forest-type group and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

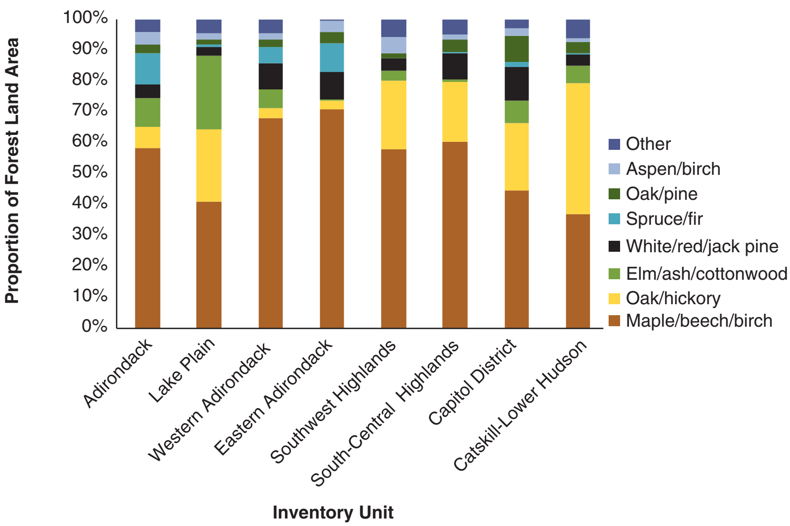


Figure 21.—Percentage of forest land area, by inventory unit and forest-type group, New York, 2017.

For 2017, FIA identified 94 tree species/undifferentiated genera having a diameter of at least 1 inch at breast height (see appendix) in the inventory. There were an estimated 3.2 billion trees with a diameter of 5 inches or greater, an increase of 2 percent over 2007. Twenty-one species had at least 1 percent of total tree abundance (Fig. 22) and together accounted for 88 percent of total species abundance. Red maple remained the most numerous at 573 million trees, or 18 percent of all trees at least 5 inches in diameter. Collectively, the top five species by number of trees (red maple, sugar maple, American beech, eastern hemlock, and white ash) accounted for over 50 percent of the total tree number. Notable increases in the number of trees since 2007 were observed in American beech (12 percent), sweet birch (13 percent), and green ash (32 percent). Decreases for six species having at least 1 percent of the total ranged from 1 percent in black cherry to 20 percent in paper birch.

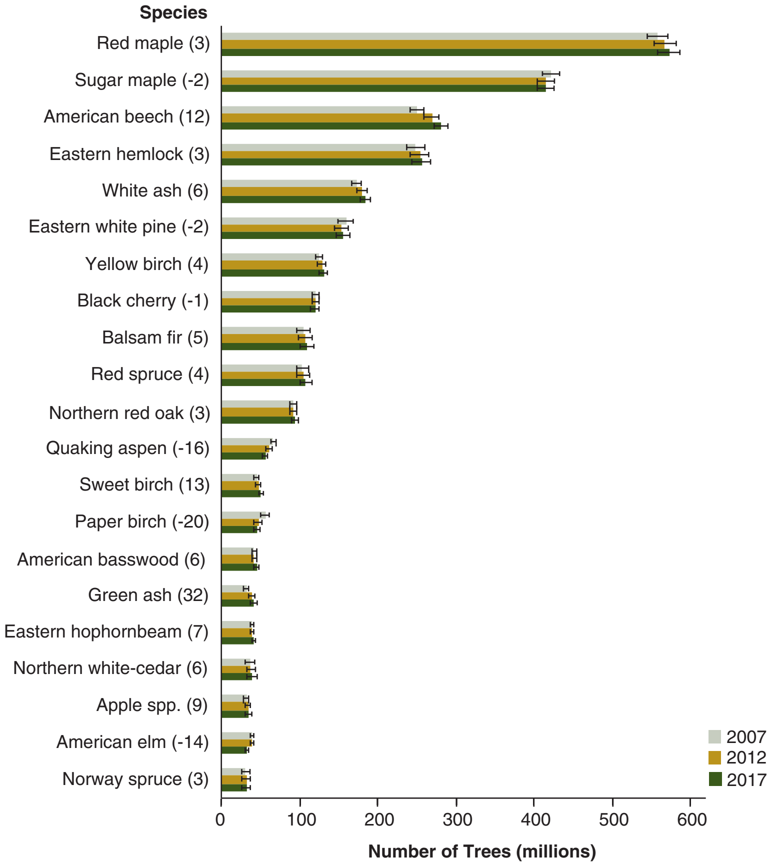


Figure 22.—Number of trees ≥5 inches in diameter on forest land for species composing at least 1 percent of total number of trees by species and inventory year, New York. Percent change from 2007 to 2017 is shown in parentheses. Error bars represent a 68 percent confidence interval around the mean.

Trees having a d.b.h. of at least 1 inch but less than 5 inches are referred to as saplings. Total sapling numbers in New York decreased 5 percent between 2007 and 2017 to an estimated 8.6 billion individuals. Eighteen species, each composing at least 1 percent of total sapling abundance (Fig. 23), collectively accounted for 89 percent of all saplings. A majority of these species (11 total) experienced a drop in sapling numbers since 2007. Major drops were seen in American elm (28 percent), black cherry (24 percent), and hawthorn (24 percent). The most numerous sapling species, American beech, increased 16 percent over the 2007 estimate to 1.6 billion, or 19 percent of total sapling abundance. Prominent increases in the number of saplings were also observed in red spruce (22 percent) and green ash (16 percent). Major decreases in the number of saplings for quaking aspen (-44 percent), gray birch (-40 percent), and apple (-36 percent) resulting in those species dropping below 1 percent of the total sapling estimate.

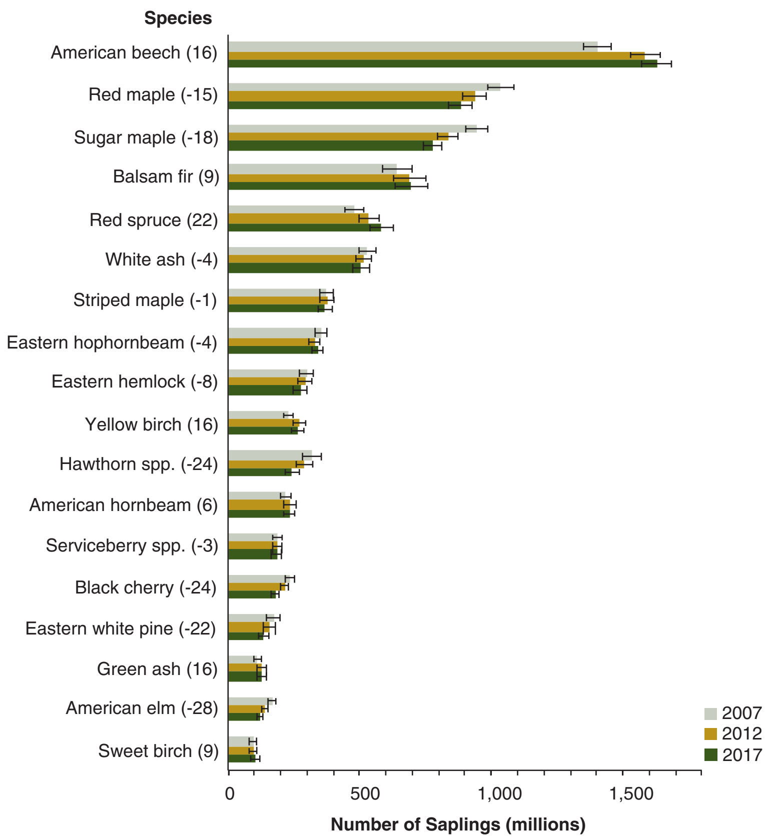


Figure 23.—Number of saplings (1.0 to 4.9 inch d.b.h.) for species composing at least 1 percent of total sapling numbers by species and inventory year, New York. Percent change from 2007 to 2017 is shown in parentheses. Error bars represent a 68 percent confidence interval around the mean.

Changes in the abundance of species groups are evident by comparing the 2007 inventory to the 2017 inventory, particularly when looking at various d.b.h. classes. In general, softwood species groups increased slightly in percentage of the total tree number estimate in diameters of 11 inches or greater to 25 percent of all trees. However, with the exception of the spruce and balsam fir species group, softwoods under 11 inches have decreased in prominence from 7 percent of all saplings to 6 percent and from 17 percent of all trees 5 to 10.9 inches to 16 percent. Spruce and balsam fir increased in those ranges, going from 13 percent of saplings in 2007 to 15 percent in 2017. A similar 1 percentage point increase in prominence was observed for spruce and balsam fir trees 5 to 10.9 inches.

Among hardwoods, oaks overall maintained similar proportions of saplings and trees under 11 inches relative to the 2007 inventory, accounting for 1 percent of all saplings and 4 percent of trees 5 to 10.9 inches in diameter. Representation of oaks among sawtimber-sized trees increased over 10 years, particularly among trees 17 inches or greater in diameter, where they compose 15 percent of all trees of that size, up from 13 percent in 2007. Conversely, hard maple lost ground across all tree sizes, dropping 1 to 2 percentage points to 9 percent for saplings, 12 percent for poletimber, and 15 percent for trees at least 17 inches in diameter. Soft maple also dropped as a proportion of all saplings, to 10 percent, but remained stable as a percentage of trees at least 5 inches in size. Species of ash increased in proportional abundance throughout every size category and were 8 percent of trees under 11 inches and 6 percent of trees 17 inches or greater in 2017. Beech was the largest gainer in saplings and poletimber trees between 2007 and 2017, growing to 19 percent of all saplings and 10 percent of trees 5 to 10.9 inches. Decreases were observed in abundance for beech trees at least 11 inches. Interestingly, the eastern noncommercial hardwoods group, those species with low or no commercial value, decreased as a proportion of saplings but remained relatively stable as a proportion of adult trees.

Seedlings are tree species with a d.b.h. less than 1 inch and having a length of at least 12 inches in hardwoods or 6 inches in conifers. The total seedling estimate increased 5 percent between 2007 and 2017 to 42.8 billion. Eighteen species composed at least 1 percent of the total estimate (Fig. 24) and collectively accounted for 92 percent of all seedlings. While the overall estimate of seedlings increased, a third of the top 18 species experienced a drop in seedling numbers. Most notably, the estimates for sugar maple and black cherry decreased by 37 and 35 percent, respectively. However, the most numerous seedling species remained American beech, which increased 37 percent over the 2007 estimate to 8.2 billion, or over 19 percent of all seedlings in New York.

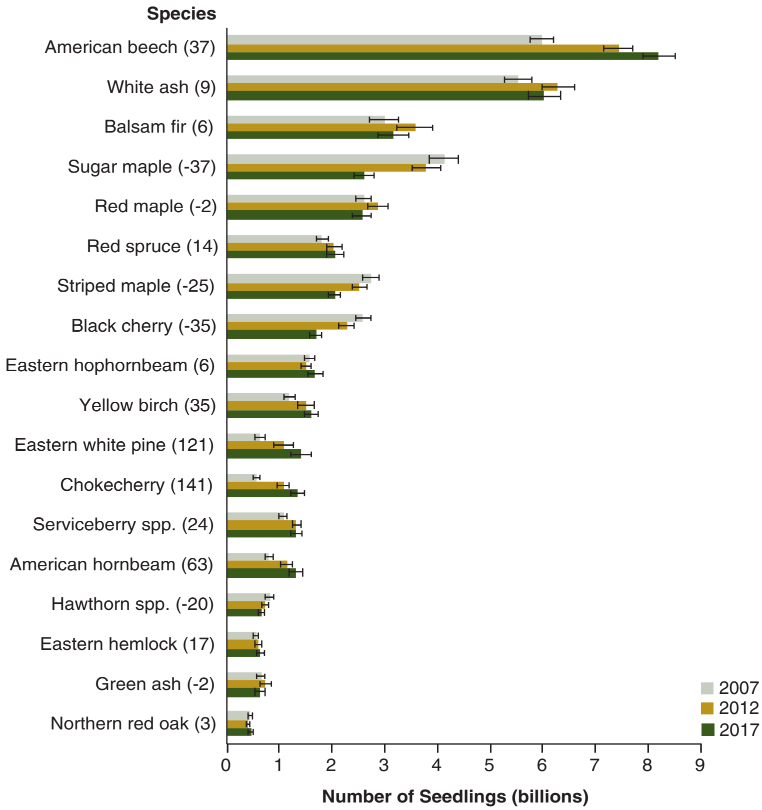


Figure 24.—Number of seedlings for species composing at least 1 percent of total seedling numbers, by species and inventory year, New York. Percent change from 2007 to 2017 shown in parentheses. Error bars represent a 68 percent confidence interval around the mean.

What this means

New York's diverse geography supports a similarly diverse population of tree species, providing a variety of goods and ecosystem services. The resilience to insects and diseases that disproportionally affect any one species or species group enjoyed by such a diverse forest resource should not be discounted. However, data indicates that a smaller number of species are occupying a greater proportion of the forests today versus 10 years ago. Whether considering seedlings, saplings, or adult trees, fewer species composed at least 1 percent of total individuals in 2017 than in 2007. The change was most pronounced in saplings, where 21 species had at least 1 percent of total sapling numbers in 2007 and only 18 had the same abundance in 2017. Given the fact that a consolidation of species has already occurred in the understory, it is likely that the diversity of the forest canopy will be further reduced in future inventories.

Further changes in the composition of New York forests may occur in the future as one considers those species growing in prominence across the State. Both ash and American beech have increased as a proportion of seedlings and saplings, but are experiencing challenges to tree health in the form of beech bark disease and emerald ash borer (see “Emerald Ash Borer” on page 103). This occupation of the understory by species less likely to survive into adulthood leaves increasingly fewer resources for the regeneration of more commercially viable species. Interestingly, New York does not suffer from an overall proliferation of species in the eastern noncommercial hardwoods species group that some nearby states have experienced, as those species have remained fairly stable or decreased in proportion of saplings and adult trees. This stability may not last going forward as noncommercial hardwoods are increasing as a percentage of seedlings. In fact, eastern noncommercial hardwoods accounted for 21 percent of all seedlings in 2017. Additionally, ash and beech seedlings were 35 percent of total seedlings, up 5 percentage points in just 10 years.

The forest-type groups that make up New York's forest land have been relatively stable over the past 10 years, but some changes are worth noting. Though a diverse population of 14 forest-type groups were found throughout the State, the top three by forested area increased as a percentage of the total from 78 percent in 2007 to 80 percent in 2017. Aspen/birch, a relatively small but important component of the resource, suffered the largest proportional loss over the 10 years, dropping over one-third of its area. The seven forest-type groups with the least amount of area have seen a decrease of 175,000 acres over the same time frame, going from 5 percent of total area to just 4 percent in 2017. Given the changes noted in species composition, it is very possible this consolidation of forest land into fewer forest-type groups will continue into the future.

Forest Structure

Background

Tree size, age, and density are used to describe forest structure within a stand. FIA defines stand size based on the diameter of trees occupying the majority of a forested condition and categorizes them in one of three classes: large diameter (minimum 11.0 inches d.b.h. for hardwoods and 9.0 inches d.b.h. for softwoods), medium diameter (5.0 to 10.9 inches d.b.h. for hardwoods and 5.0 to 8.9 inches d.b.h. for softwoods), and small diameter (less than 5.0 inches d.b.h.). These classes are generally indicative of the developmental stage of the resource and are also referred to as sawtimber, poletimber, and seedling/sapling, respectively.

A forest's stand age is analogous to its successional stage with early successional habitat exemplified by the youngest age classes. Tree cores collected from dominant and codominant trees that represent the plurality of trees within a stand are used to quantify stand age that is reported here in 20-year classes. A healthy distribution of age classes across the landscape is vital to ensure the long-term viability of a resource and the continual availability of forest products and services.

The density of trees within a given forested stand is referred to as relative stocking. This critical measure aids in understanding the dynamics at work in the forest, such as competition between individuals for light and nutrient availability that influences the growth rates of individual trees. Five classes of stocking are reported by FIA: overstocked (more than 100 percent), full (60-100 percent), moderate (35-59 percent), poor (10-34 percent), and nonstocked (0-9 percent). Crowded trees competing for limited resources are characteristic of overstocked stands and can result in reduced growth and increased mortality. A lack of regeneration, particularly of shade-intolerant species, is another typical challenge to overcome in overstocked stands. Fully-stocked stands are of sufficient density to effectively utilize the resources available on the site. Moderately-stocked stands have ample room for ingrowth and light can reach the forest floor through gaps in the canopy. Poorly stocked stands have sparse canopy cover and are especially susceptible to colonization by invasive and undesirable species. Nonstocked stands, typically found after a harvest or severe disturbance, are those with less than 10 percent stocking but that have not been converted to another use.

FIA evaluates stocking levels in two ways: based on all live trees and based on growing-stock trees only. Live-tree stocking includes all live trees within the stand, regardless of species or commercial merchantability. Even though a portion of the live trees will have little to no commercial value, the presence of such trees is vital in providing habitat and food sources for a diverse wildlife population. Growing-stock stocking uses only growing-stock trees, which are those trees of commercial species with less than two-thirds of their volume in rough or rotten cull. Each stocking type provides different information, with live-tree stocking describing the overall occupancy of available space within a stand and growing-stock stocking indicating the relative occupancy of a stand with trees of commercial value. Comparisons of growing-stock levels and live-tree levels at any given location allow for some insight into the proportions of merchantable trees and cull trees, which highlights areas where management interventions may be necessary to obtain desired outcomes.

Because growing-stock trees are a subset of all live trees, growing-stock stocking is a subset of live-tree stocking. Therefore, a forested stand with any given class of live-tree stocking can have a growing-stock stocking of the same or lower classes. Any given stand can be described in terms of both stocking types, and comparing growing-stock levels to live-tree levels at a given location is useful to evaluate the occupancy of a site relative to trees of merchantable species and quality. Likewise, trends in these evaluations can help to identify conditions of deteriorating commercial viability.

What we found

The timberland of New York continued the shift into larger size-classes that has been observed since the 1960s (Fig. 25). The increase in proportion of timberland classified as large diameter (i.e., sawtimber) resulted in an estimate of 10.1 million acres (65 percent of the total) in this class in 2017, up from 8.8 million acres (56 percent of the total) in 2007. Medium diameter (poletimber) and small diameter (seedling/sapling) size classes each experienced a 4 percentage point drop over the same time period with seedling/sapling stands decreasing to just 9 percent of timberland area, or 1.4 million acres. While the trends are similar on both public and private land, public timberland has a slightly smaller percentage (7 percent) of its area in small-diameter stands, but has maintained a relatively stable proportion of area in poletimber stands.

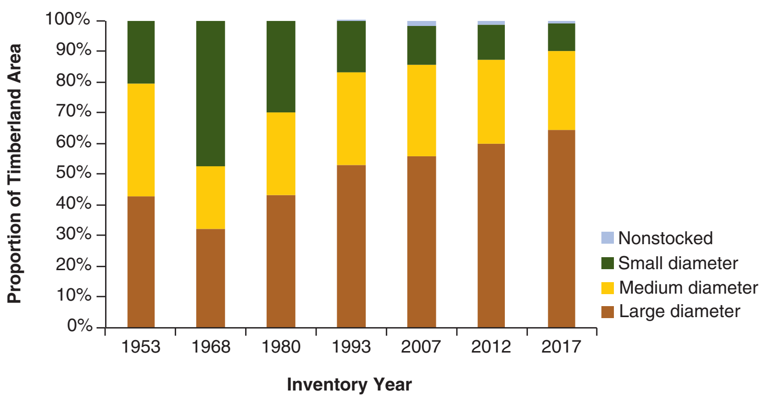


Figure 25.—Percentage of timberland area by inventory year and stand-size class, New York.

Distribution of timberland area by size class varies widely across the regions of the State. The Catskill-Lower Hudson unit contains a total of 2.1 million acres of timberland with 77 percent of that area (1.6 million acres) in sawtimber stands and only 3 percent in small diameter stands, the lowest proportion statewide (Fig. 26). On the other end of the spectrum, the Adirondack unit (formerly referred to as St. Lawrence/Northern Adirondack) has the largest amount of timberland at 2.6 million acres. This unit also has the highest proportion of timberland in seedling/sapling stands at 19 percent, or 503,000 acres. The 1.1 million acres of large diameter stands in the unit represents the lowest regional proportion of sawtimber in the State.

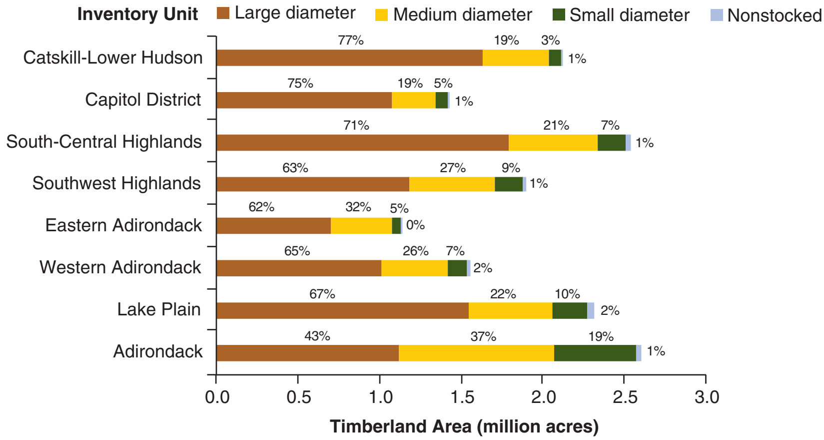


Figure 26.—Timberland area by inventory unit and stand-size class, New York, 2017.

Across all of New York, five classes of live-tree stocking describe the occupancy levels of timberland (Fig. 27). Overall, 5 percent of the timberland was overstocked in 2017, with values ranging from 5 percent of large-diameter stands to 1 percent of poletimber stands and 15 percent of small-diameter timberland. Fully-stocked timberland accounted for 51 percent of all diameter classes and 58 percent, 39 percent, and 44 percent of large, medium, and small diameter stands, respectively. Moderately-stocked stands composed 34 percent of all timberland and 31 percent of sawtimber stands. Poletimber had the highest proportion of moderately-stocked stands at 45 percent, compared to small diameter timberland with the lowest proportion at 28 percent. Poorly-stocked accounted for 6, 15, and 13 percent of sawtimber, poletimber, and seedling/sapling stands, respectively, averaging to a total of 9 percent of timberland overall. Only 1 percent of all timberland was in the nonstocked category (not shown in Fig. 27), and no single size class had more than 0.4 percent of its area in the nonstocked timberland. Live-tree stocking trended toward higher levels in the 10 years between the 2007 and 2017 inventories. Each of the three lower categories (nonstocked, poorly stocked, and moderately stocked) decreased by 1 percent of total timberland area (Fig 28). That 3 percent combined loss led to a 3 percent gain in the proportion of timberland in the fully-stocked class.

Stocking levels for growing-stock trees remained essentially stable with no class exhibiting a change in proportion of greater than 1 percent. Across the State, only 2 percent of all timberland was overstocked with growing-stock trees (Fig. 28). The fully-stocked class accounted for 38 percent of timberland in 2017, a slight increase over the 2007 estimate. Moderately stocked was the single largest class for growing-stock stocking levels at 40 percent in both 2007 and 2017. The poorly-stocked and nonstocked categories for growing-stock stocking combined for a total of 19 percent of timberland, down by nearly 80,000 acres from 2007.

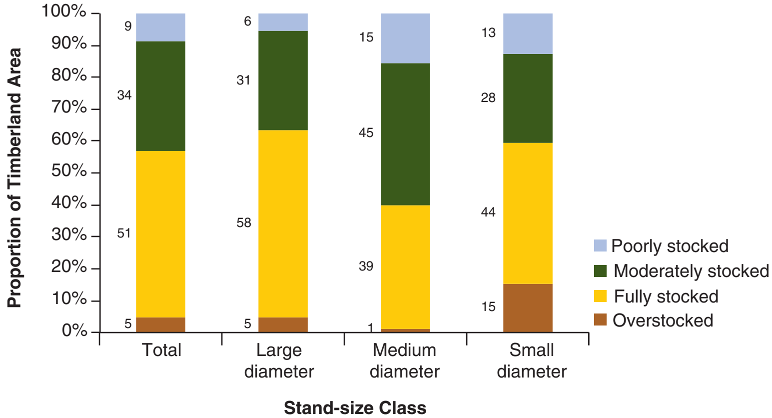


Figure 27.—Percentage of timberland area by stand-size class and live-tree stocking class, New York, 2017.

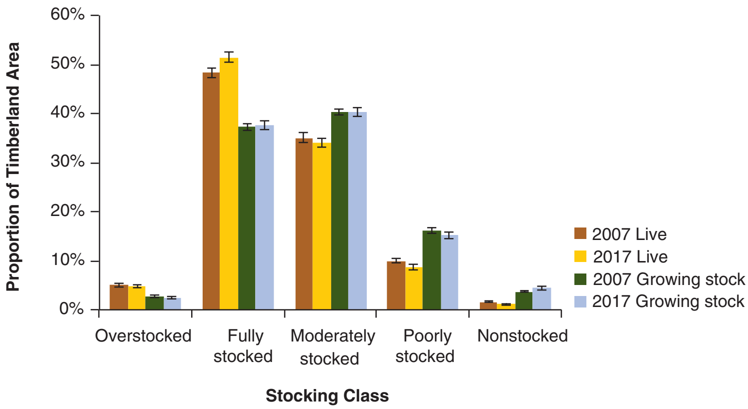


Figure 28.—Percentage of timberland area by stocking class and inventory year, for all live trees and growing-stock trees, New York. Error bars represent a 68 percent confidence interval around the mean.

Live-tree stocking varied to some degree across regions of the State from a combined 59 percent of timberland that was either overstocked or fully stocked in each of the Catskill-Lower Hudson, Capitol District, and South-Central Highlands units, to 52 percent of timberland in the two upper stocking classes in the Adirondack unit (Fig. 29). Greater variations were observed in growing-stock stocking, which ranged from a high of 46 percent of timberland overstocked or fully stocked in the Catskill-Lower Hudson unit to a low of 33 percent in the same two classes in the Western Adirondack region. The disparity between live-tree stocking and growing-stock stocking on timberland was also most pronounced in the Western Adirondack unit, where 50 percent of timberland was fully stocked with live trees, but only 31 percent was fully stocked with growing-stock trees.

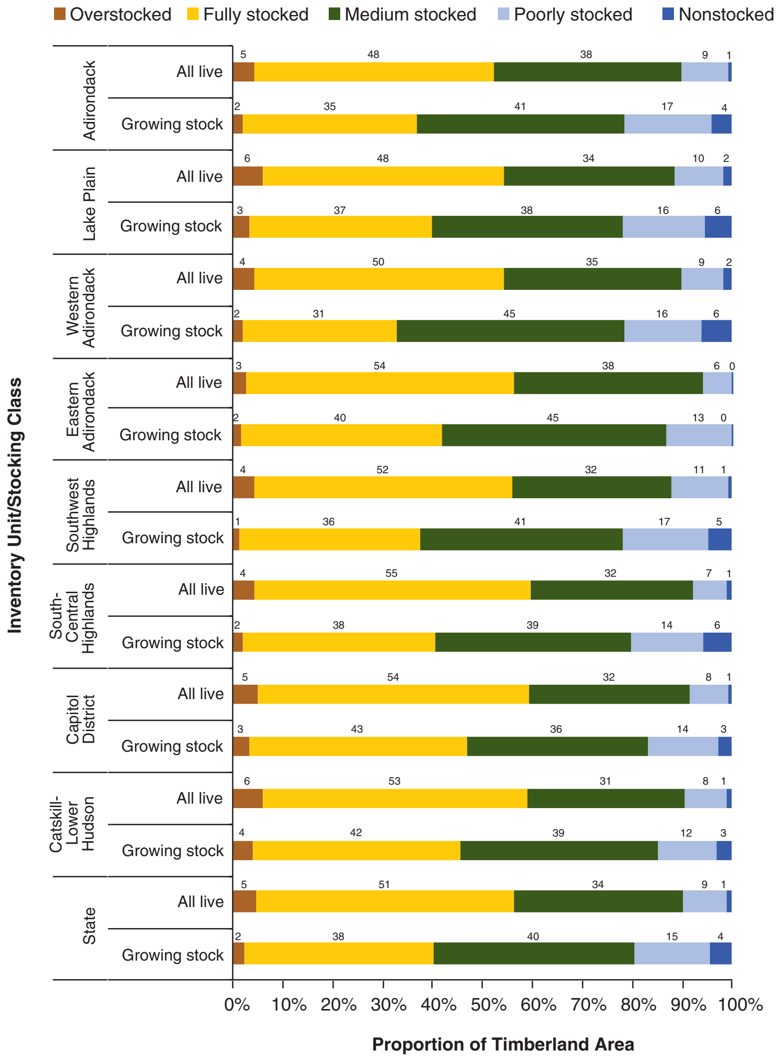


Figure 29.—Percentage of timberland area by inventory unit and stocking class for all live trees and growing-stock trees, New York, 2017.

Of the timberland acreage classified as overstocked with live trees in 2017, 52 percent was also overstocked with growing-stock trees and an additional 41 percent was fully stocked with growing-stock trees (Fig. 30). This represents a slight increase in the combined proportion of overstocked and fully-stocked classes since 2007. However, the proportion of land overstocked with live trees and either moderately, poorly, or nonstocked with growing-stock trees decreased from 10 percent to 8 percent. Similar results were found in the fully stocked with live trees category where 69 percent was fully stocked with growing stock and 27 percent was moderately stocked with growing stock, with a small decrease in the proportion that is poorly and nonstocked. The moderately-stocked class did not enjoy this same trend, but a decrease in the proportion that was also moderately stocked with growing-stock trees led to an increase in the proportion of each the poorly stocked and nonstocked growing-stock stocking classes.

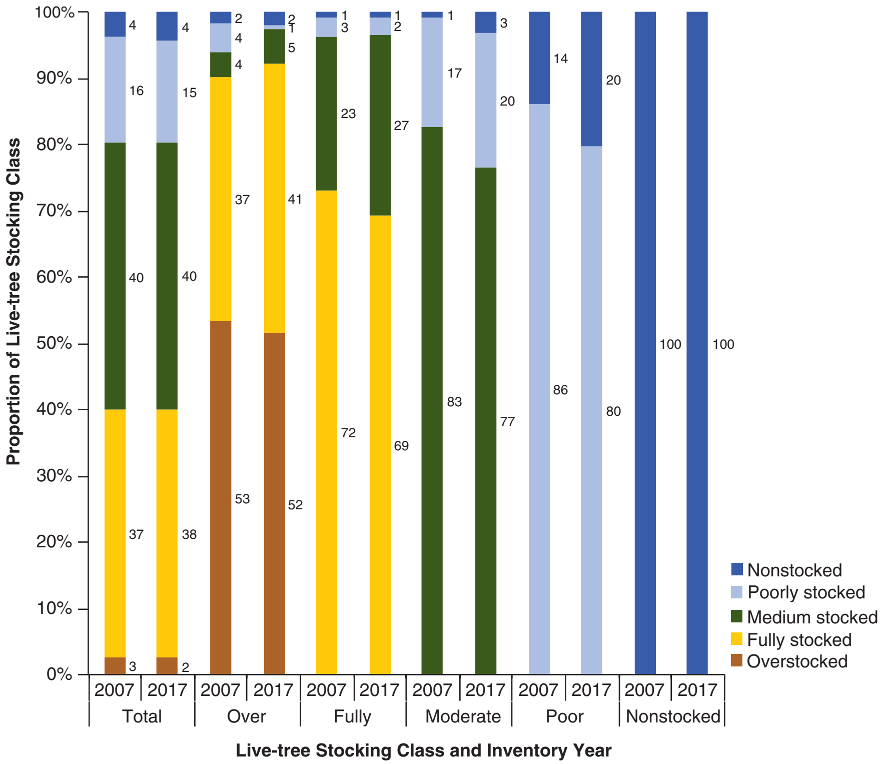


Figure 30.—Percentage of live-tree stocking class by growing-stock stocking class and inventory year, New York.

Like many of the forests of the Northeast, New York timberland continues to age. All age classes of 60 years or less decreased in area between 2007 and 2017, while the area of timberland aged 61 years or more increased (Fig. 31). The youngest class of forest, 0 to 20 years, lost half of its 2007 acreage by 2017, dropping from 1.3 million acres to just over 660,000 acres, or 4 percent of timberland. When combined, all stands aged 60 years or less accounted for 41 percent (6.4 million acres) of all timberland in 2017, down from 8.4 million acres, or 53 percent of timberland in 2007. Conversely, stands aged 61 years or more increased from 47 percent of timberland in 2007 to 59 percent in 2017. The 81-100 year age class exhibited the largest increase in acreage over 10 years, increasing 1.1 million acres to 2.9 million acres, or 19 percent of timberland.

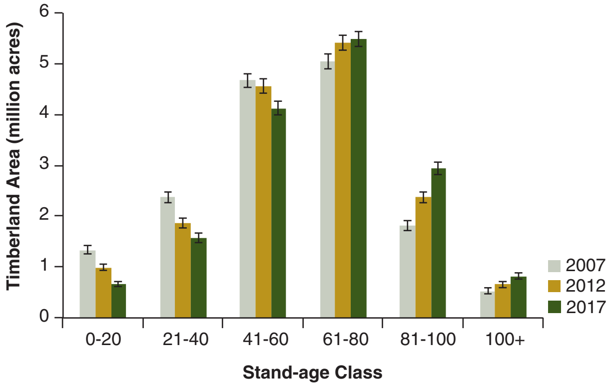


Figure 31.—Area of timberland by stand-age class and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

Public timberland saw the greatest change in age class distribution between the 2007 and 2017 inventories. All age classes 80 years or below exhibited a loss in proportion of total public timberland area, with the 0-20 year age and 21-40 year age classes dropping from 10 percent each to 6 and 8 percent of public timberland overall, respectively (Fig. 32). The area of public land in the two stand-age classes over 80 years increased in acreage by 2.5 times to 27 percent of publically-owned timberland. The total proportion of privately held timberland for age classes 41-60 years and below decreased, but did not skew as old. The proportional drop in young stands, however, was larger in private timberland, with the combined total for the two youngest age classes decreasing from 23 percent in 2007 to 14 percent in 2017.

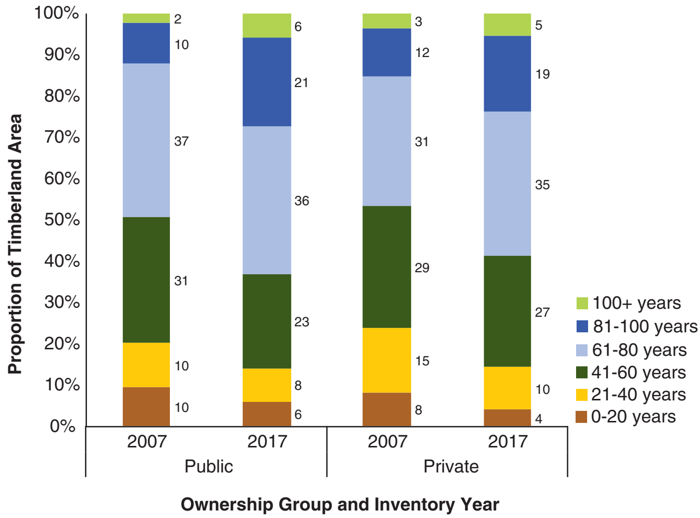


Figure 32.—Percentage of timberland area for major ownership groups, by inventory year, and stand-age class, New York.

What this means

The forests of New York are a largely mature resource as indicated by an increasing proportion of timberland being classified as large diameter stands and the continuing rise in stand ages. With a decreasing proportion of timberland in the youngest age class and smallest stand-size class, there is a lack of young stands to replace the aging resource and a shrinking proportion of young habitat available for wildlife that rely on such early successional stands. Increasing susceptibility to significant disturbances affecting mature stands is also a concern given the relative lack of diversity in age and size classes.

The results of an analysis of growing-stock stocking relative to live-tree stocking are encouraging. Growing stock remains a large proportion of overall stocking in denser stands, indicating that perhaps management activities have been effective at stemming the proliferation of cull trees and noncommercial species that can occur in some harvesting scenarios. A reduction in the amount of cull trees and noncommercial species in these dense stands is evidenced by the decreased proportion of poorly stocked and nonstocked classes for growing stock between 2007 and 2017. One reason for this may be that the value associated with larger diameter, higher stocked stands allows for stand improvement operations to be funded by harvest activities. Thus, the trend of lower proportions of cull trees does not continue into the lower live-tree stocking classes where timber values are lower and increases in the area of timberland that is poorly stocked or nonstocked with growing-stock trees occurs. Nevertheless, stocking trends remain a positive spot in the forests of New York.

Volume on Timberland

Background

Trends in tree volume estimates allow us to quantify changes in available timber resources. FIA evaluates several measures of volume: gross, sound, and net volume of both live trees and growing-stock trees in cubic feet, and sawtimber volume in board feet (International ¼-inch rule). The importance of the different classifications of volume become apparent when considering the various uses of wood resources.

Volume estimates here are based on trees that are at least 5 inches in diameter. Gross volume is the total wood volume in the merchantable portion of a tree, measured from stump height (1 foot above ground level) to a minimum top diameter (outside bark) of 4 inches. Sound volume is gross volume minus deductions for rotten and missing wood. Net sound volume, or net volume, is sound volume minus additional deductions for defects in form, such as sweep, crook, and forks. Restricting estimates of net volume to only growing-stock trees is useful to quantify the portion of the resource suitable for wood product use. Growing-stock trees are trees of a commercial species with less than two-thirds of their volume in any form of cull. Knowing the volume of cull trees, particularly as a proportion of the total, is useful to characterize what portion of available resources is not of sufficient quality to be used for products outside of fuel. Rough cull refers to trees of a noncommercial species or trees that have more than two-thirds of their volume in mostly sound cull. Rotten cull trees are those, regardless of species, with more than two-thirds cull, the majority of which is unsound. Sawtimber volume estimates are based on calculations of volume within the useable saw log portion of trees meeting minimum size requirements. In hardwoods, the minimum d.b.h. is 11 inches, and useable saw log portion of the tree is all merchantable wood between the stump height and a top diameter of 9 inches outside bark. The analogous minimums for softwoods are 9 inches in d.b.h. and top diameter of 7 inches outside bark. All sawtimber volume estimates are based on growing-stock trees only.

What we found

Gross volume on New York timberland totaled 40.5 billion cubic feet in 2017. Reserved forest land had 9.6 billion cubic feet of gross volume and other forest land and reserved other forest land had a combined total of 2.1 million cubic feet. Total combined gross volume on all forest land equaled an estimated 50.1 billion cubic feet in 2017, up 10 percent from the 2007 estimate. Sound volume on timberland was estimated at 39.3 billion cubic feet in 2017, an increase of 10 percent since 2007. Overall, sound volume totaled 48.5 billion cubic feet on forest land, again a 10 percent rise over 2007. Net volume across all forest land was an estimated 42.9 billion cubic feet, up 9 percent from 39.4 billion cubic feet 10 years previous. Timberland accounted for 34.7 billion cubic feet of net volume in 2017, representing a 10 percent increase in net merchantable volume over 10 years.

Growing-stock volume accounted for 89 percent of timberland net volume with an estimated 30.9 billion feet of net volume in growing-stock trees (Fig. 33). Rough cull accounted for 9 percent (3.3 billion cubic feet) of total net volume with the remaining 2 percent (529 million cubic feet) in rotten cull trees. Though total net volume increased 10 percent between 2007 and 2017, growing stock net volume went up only 6 percent in the same time period, and the proportion of overall net volume dropped from 92 percent in 2007. Collectively, rough and rotten cull increased 44 percent since 2007.

Twenty-one species throughout New York each contribute at least 1 percent of total net volume, with 19 of those species increasing in net volume from 2007 to 2017 (Fig. 34). The only exceptions were quaking aspen and red pine, which lost 7 percent and 8 percent, respectively, of their 2007 estimated net volume. Red maple remained the single species with the most volume at 5.7 billion cubic feet, a 9 percent rise from 2007. Sugar maple, eastern white pine, eastern hemlock, and northern red oak round out the top

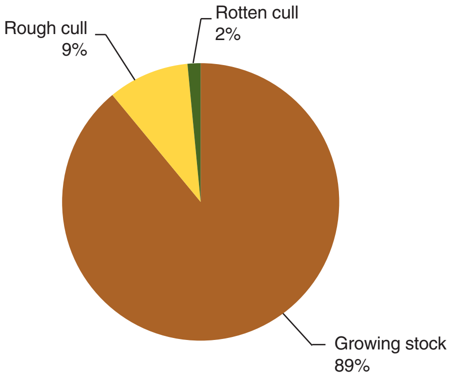


Figure 33.—Percentage of net volume on timberland by tree class, New York, 2017.

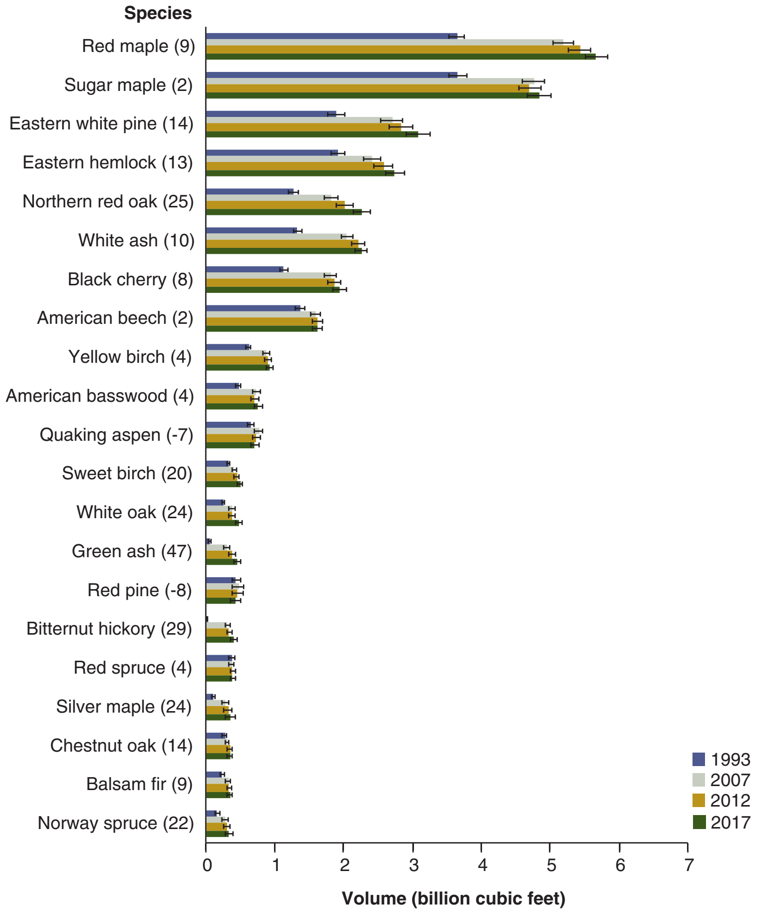


Figure 34.—Net volume on timberland for species composing at least 1 percent of total net volume, by species and inventory year, New York. Percent change from 2007 to 2017 is shown in parentheses. Error bars represent a 68 percent confidence interval around the mean.

five species by volume with respective 10 year gains of 2, 14, 13, and 25 percent. Other species with notable volume increases include white ash (10 percent), sweet birch (20 percent), and white oak (24 percent).

Of the eight inventory units within New York, red maple had the highest net volume in six of them with the only exceptions being the Eastern Adirondack and Capitol District units where sugar maple and eastern white pine, respectively, had the most volume (Table 3). Sugar maple was one of the top three most voluminous species in every unit. Though sugar maple had the most volume in the Eastern Adirondack region, it lost nearly 5 percent of its 2007 regional volume estimate but still represents 18 percent of all net volume in the unit. Each of the ten most voluminous species in the Lake Plain unit showed an increase in volume from 2007 to 2017. All other units had at least one species that experienced regional volume loss over the 10 year period. Total regional volume increase was highest in the Catskill-Lower Hudson inventory unit where net volume totaled 5.5 billion cubic feet, 15 percent higher than 2007. A substantial portion of the increase was driven by higher oak volumes with northern red oak, chestnut oak, and white oak gaining 45, 20, and 35 percent, respectively. Regional net volume on timberland was highest in the South-Central Highlands unit where the estimate increased 9 percent to 6.3 billion cubic feet.

Increases in net volume for all trees were concentrated in larger diameter classes. Each class composed of trees with a d.b.h. of 15 to 28.9 inches exhibited gains of at least 24 percent over the 2007 estimate (Fig. 35). Trees in the 6-inch, 8-inch, and 10-inch classes showed losses of 9 percent, 5 percent, and 4 percent, respectively. Net volume increased in all diameter classes of rough and rotten cull trees with increases ranging from just 2 percent for trees 29 inches or greater to 70 percent for trees in the 8-inch diameter class. Growing-stock trees, having 89 percent of total net volume, generally followed the trends of all trees.

Net volume per acre increased 11 percent overall between 2007 and 2017 to a statewide estimate of 2,229 cubic feet per acre of timberland (Fig. 36). Increases were the largest on federal land, with the national forest and other federal ownerships combined gaining 28 percent over the 2007 per acre estimates. State and locally-owned public land increased the least at 5 percent but showed nearly the highest per acre volume at 2,614 cubic feet, second only to national forest at 2,678 cubic feet per acre. Private timberland was estimated to have 2,186 cubic feet per acre, up from 1,962 in 2007. Stand-age classes showed varying results for per acre volume. Stands aged 21 to 60 years and over 100 years decreased in net volume per acre of timberland with those 21-40 years old exhibiting the largest loss (Fig. 37). Increases were most prominent in the 81 to 100 year class. Interestingly, stands in the youngest age class also increased in per acre volume.

Table 3.—Net volume on timberland for the 10 species with the most volume (ranked by 2017 volume) in each inventory unit, with percentage of regional volume, and percentage change in net volume, New York, 2007-2017

Region	Species	Volume in region, 2017 (million ft³)	Volume as a percentage of region, 2017	Percent change in volume, 2007-2017
Adirondack	Red maple	750	18	7.6
	Sugar maple	644	16	-0.1
	Eastern white pine	400	10	12.0
	Black cherry	240	6	6.4
	American beech	219	5	9.7
	Eastern hemlock	217	5	9.4
	Balsam fir	179	4	25.4
	Yellow birch	178	4	-5.1
	White ash	170	4	6.3
	Red spruce	156	4	7.4
	Regional total	**4,113**	**100**	**6.1**
Lake Plain	Red maple	795	15	13.9
	Sugar maple	770	14	4.9
	Black cherry	403	8	10.6
	White ash	401	8	16.8
	Green ash	339	6	55.0
	Silver maple	262	5	28.9
	Eastern hemlock	224	4	1.3
	American basswood	218	4	7.5
	Northern red oak	208	4	28.6
	American beech	194	4	10.1
	Regional total	**5,320**	**100**	**14.1**
Western Adirondack	Red maple	673	20	3.4
	Sugar maple	479	14	-4.7
	Eastern hemlock	350	10	15.2
	Eastern white pine	312	9	6.2
	Black cherry	263	8	1.3
	Yellow birch	229	7	15.4
	American beech	213	6	13.1
	White ash	171	5	4.6
	Balsam fir	91	3	5.3
	Red spruce	90	3	4.1
	Regional total	**3,340**	**100**	**4.2**
Eastern Adirondack	Sugar maple	426	18	-4.7
	Eastern hemlock	335	14	20.3
	Eastern white pine	332	14	-4.3
	American beech	226	9	-9.0
	Red maple	225	9	-3.0
	Yellow birch	163	7	-9.9
	Northern red oak	140	6	13.1
	Red spruce	96	4	-8.2
	White ash	75	3	2.9
	Paper birch	65	3	-27.2
	Regional total	**2,414**	**100**	**-2.7**

(Table continued on next page.)

(Table 3 continued)

Region	Species	Volume in region, 2017 (million ft^3)	Volume as a percentage of region, 2017	Percent change in volume, 2007-2017
Southwest Highlands	Red maple	745	18	22.0
	Sugar maple	633	15	2.0
	White ash	428	10	13.7
	Black cherry	311	7	20.8
	Eastern hemlock	300	7	10.3
	Northern red oak	280	7	8.2
	Eastern white pine	235	6	14.9
	Quaking aspen	185	4	1.0
	American beech	182	4	0.8
	American basswood	104	2	-5.1
	Regional total	**4,159**	**100**	**10.4**
South-Central Highlands	Red maple	1,312	21	14.0
	Sugar maple	946	15	3.2
	White ash	591	9	18.2
	Eastern hemlock	578	9	12.5
	Eastern white pine	563	9	13.9
	Northern red oak	446	7	24.9
	Black cherry	393	6	3.9
	American beech	286	5	-3.9
	American basswood	158	2	16.7
	Red pine	142	2	-13.3
	Regional total	**6,330**	**100**	**9.3**
Capitol District	Eastern white pine	630	17	24.7
	Sugar maple	425	12	12.9
	Red maple	420	12	5.2
	Northern red oak	386	11	10.3
	Eastern hemlock	352	10	12.5
	White ash	145	4	22.9
	Black cherry	136	4	33.7
	American beech	115	3	2.1
	White oak	81	2	36.7
	Quaking aspen	78	2	-2.4
	Regional total	**3,600**	**100**	**13.2**
Catskill-Lower Hudson	Red maple	752	14	-0.1
	Northern red oak	725	13	44.6
	Sugar maple	524	10	1.3
	Eastern white pine	474	9	21.3
	Eastern hemlock	390	7	21.3
	White ash	277	5	-11.6
	Sweet birch	267	5	27.3
	Chestnut oak	220	4	20.4
	White oak	210	4	34.5
	American beech	179	3	-2.6
	Regional total	**5,466**	**100**	**15.0**

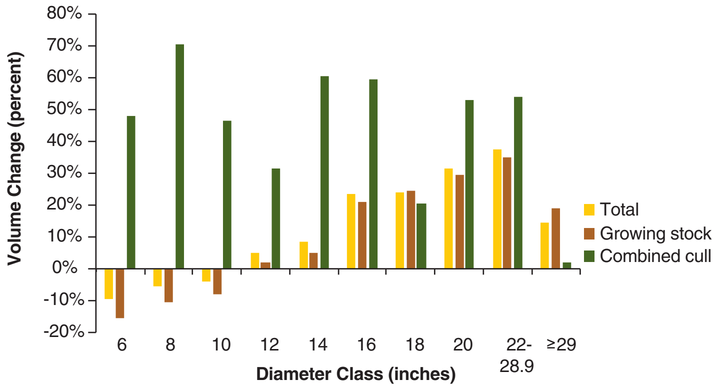


Figure 35.—Percent change in net volume of timberland, by diameter class and tree class, New York, 2007 to 2017.

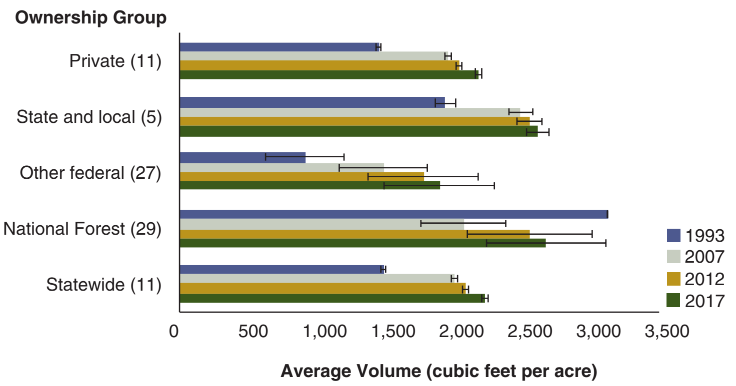


Figure 36.—Average net volume per acre of timberland by ownership group and inventory year, New York. Percent change between 2007 and 2017 shown in parentheses. Error bars represent a 68 percent confidence interval around the mean.

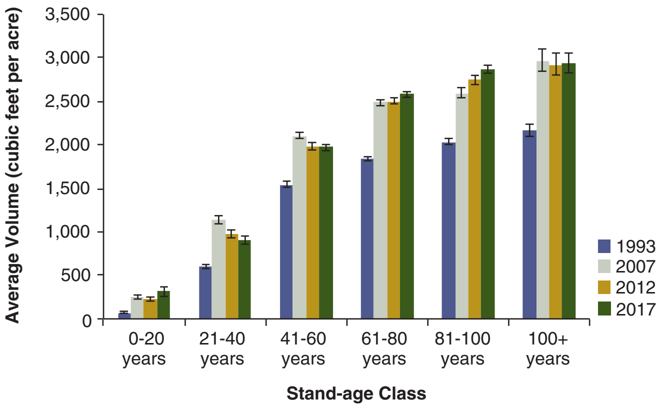


Figure 37.—Average net volume per acre of timberland by stand-age class and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

Changes in per acre net volume also varied substantially across regions of New York. The largest increase over the 10 year period between 2007 and 2017 was in the Lake Plain region, where the latest estimate of 2,299 cubic feet per acre is 17 percent higher than 2007 (Fig. 38). On the other end of the spectrum, volume per acre in the Eastern Adirondack inventory unit did not increase at all but remained essentially stable at 2,126 cubic feet per acre. The Catskill-Lower Hudson region showed the highest amount of net volume per acre of timberland at 2,571, a 14 percent rise over 2007.

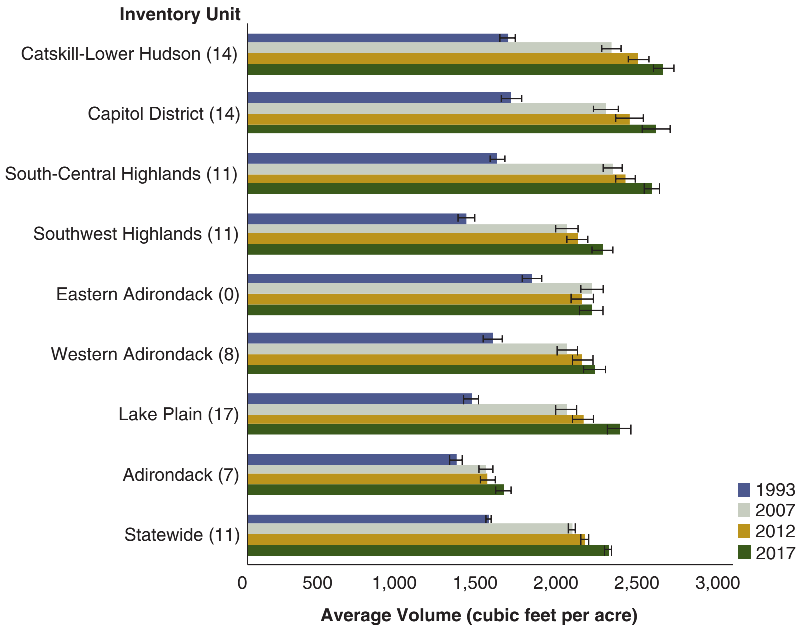


Figure 38.—Average net volume per acre of timberland, by inventory unit and year, New York. Percent change from 2007 to 2017 shown in parentheses. Error bars represent a 68 percent confidence interval around the mean.

The proportion of net volume composed of the three tree classes showed some changes not only by inventory year, but also by major ownership group. Growing-stock trees accounted for 95 percent of total public timberland volume in 2007 but only 91 percent in 2017 (Fig. 39). Rough cull trees increased by 3 percentage points over that time to 8 percent of volume. Rotten cull volume doubled to 56 million cubic feet, but remained only 1 percent of total volume. Private growing-stock volume, on the other hand, dropped slightly from 91 percent of total net volume in 2007 to 89 percent in 2017. Rough cull increased from 7 to 10 percent in 2017 and rotten cull was 2 percent, up from 1 percent in 2007.

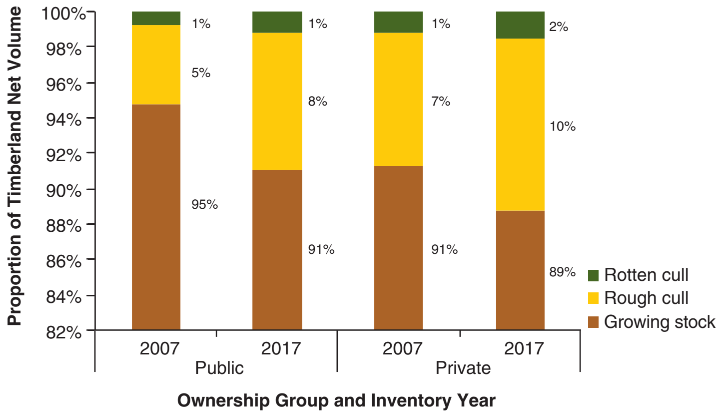


Figure 39.—Percentage of timberland net volume for major ownership groups by inventory year and tree class, New York.

There were 22 tree species that had at least 1 percent of total growing-stock volume on timberland in 2017 (Fig. 40), that when combined, accounted for 91 percent of all growing stock. Growing stock net volume increased 6 percent overall since 2007 to 30.9 billion cubic feet in 2017. Red maple remained the species with the highest growing-stock volume at 4.9 billion cubic feet, a 3 percent increase over 2007 and 500 million cubic feet more than sugar maple. Those two species of maple combined to account for 30 percent of all growing-stock volume in the State. Of the top 22 species by volume, all but 4 exhibited increases in the volume of growing-stock trees. American beech, yellow birch, quaking aspen, and red pine growing-stock volumes each decreased between 3 and 9 percent. Four species of oak having at least 1 percent of total growing-stock volume exhibited a collective 25 percent increase over 10 years. Northern red oak, the most voluminous oak species at 2.2 billion cubic feet, was ranked fifth in volume in the State overall.

Sawtimber volume totaled 101 billion board feet (International ¼-inch rule) in 2017, a 16 percent increase over the 2007 New York estimate. A total of 22 species each had volumes of at least 1 billion board feet, or 1 percent of the total sawtimber volume (Fig. 41). The three species with the most volume (sugar maple, red maple, and eastern white pine) when combined accounted for 39 percent of all sawtimber volume on timberland in New York. Again, the oaks exhibited major increases in volume, with northern red oak, white oak, black oak, and chestnut oak having a combined 13.5 billion board feet, a 38 percent rise over 2007. Those four oak species, plus sugar, red, and silver maples, composed 41 percent of total sawtimber volume in the State. Only two of the top 22 species experienced a loss of sawtimber volume over the 10 year period; both American beech and bigtooth aspen had 10 percent less board foot volume in 2017.

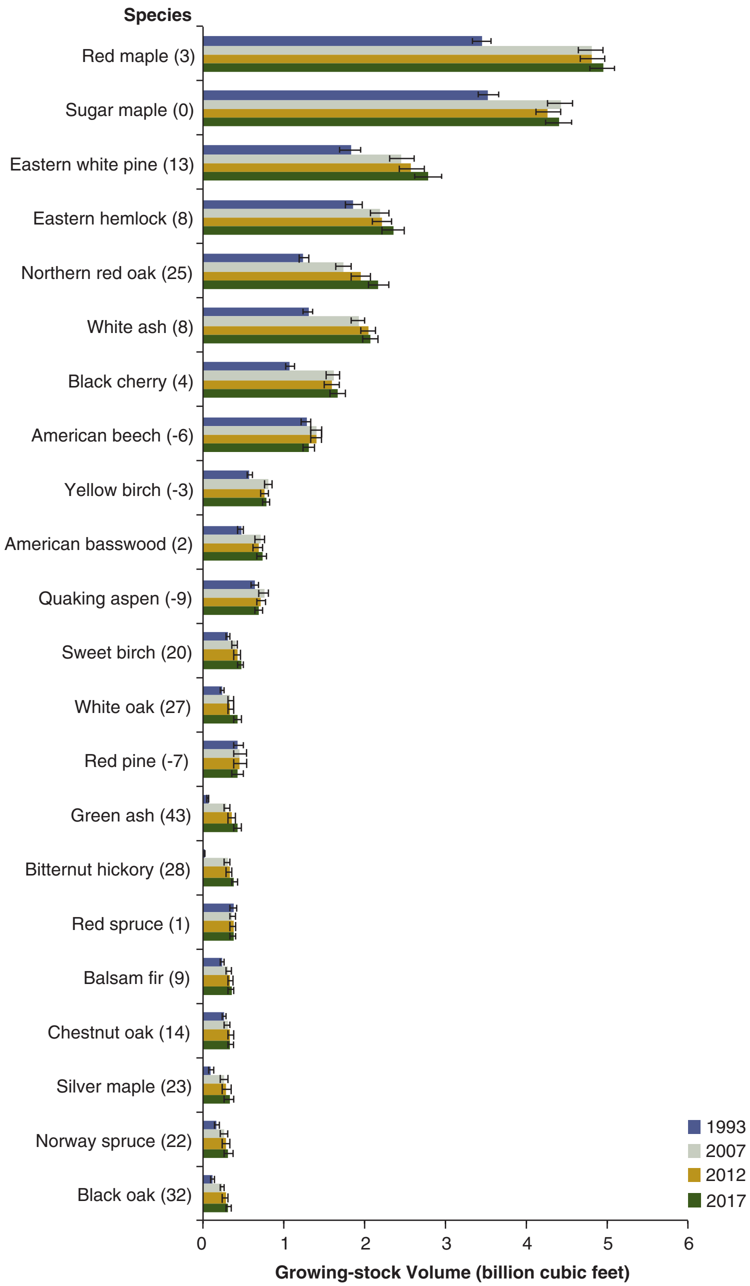


Figure 40.—Growing-stock volume on timberland for species composing at least 1 percent of total growing-stock volume by species and inventory year, New York. Percentage change from 2007 to 2017 shown in parentheses. Error bars represent a 68 percent confidence interval around the mean.

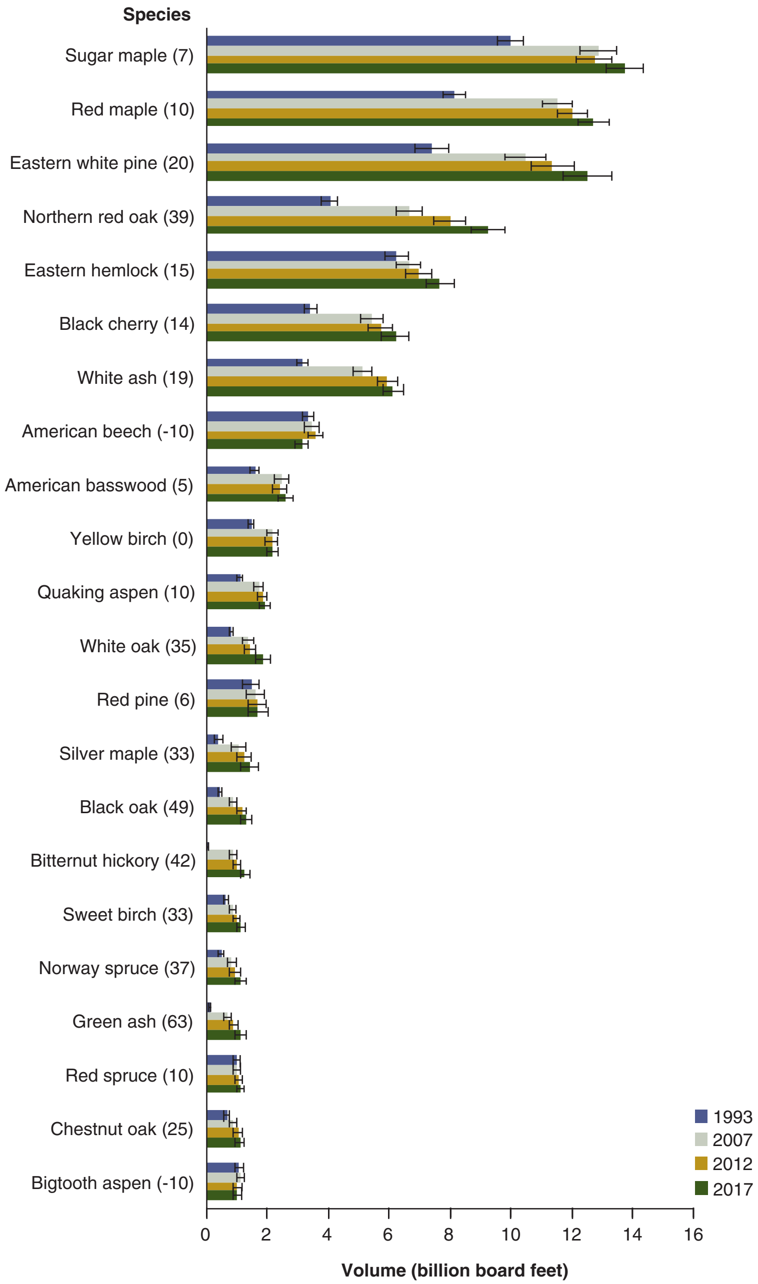


Figure 41.—Net volume of sawtimber trees (International ¼-inch rule) on timberland for species composing at least 1 percent of total sawtimber volume by species and inventory year, New York. Percentage change from 2007 to 2017 shown in parentheses. Error bars represent a 68 percent confidence interval around the mean.

Increases in hardwood sawtimber quality were apparent in this inventory across all timberland ownership groups. A higher percentage of hardwood sawtimber volume was in trees classified as grade 1, with decreases in the proportion of volume in grade 2 through grade 4 trees. Overall, grade 1 volume increased from 16 percent of hardwood sawtimber in 2007 to 20 percent in 2017. The proportion of volume in grade 2 trees decreased over the same time period from 19 to 15 percent, indicating that the increase in grade 1 is likely due to increases in diameter; grade 1 trees must be at least 16 inches in diameter for most hardwood species. The proportion of public sawtimber volume in grades 1 and 2 in 2007 was 44 percent but dropped slightly in 2017 to 43 percent. The proportion of volume in grades 1 and 2 still remained higher on public timberland compared to private timberland (34 percent) in both years (Fig. 42). Decreases in the percentage of sawtimber volume in grades 3 and grade 4 (referred to as "tie/local use") occurred across all timberland with each grade dropping 1 to 2 percentage points. Grade 5 trees (i.e., trees with a qualifying sawlog only outside of the butt section and here referred to as "uppers") increased as a proportion of sawtimber volume to 19 percent of public and 21 percent of private volume, or 20 percent overall.

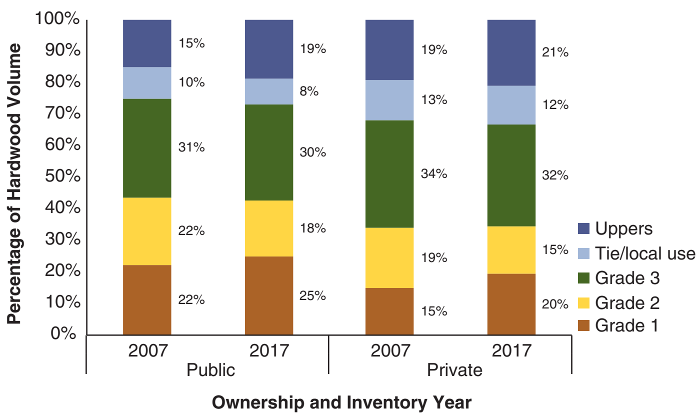


Figure 42.—Percentage of hardwood volume on timberland for major ownership groups by inventory year and tree grade, New York.

Among hardwoods in the top 22 species by sawtimber volume, northern red oak had the highest proportion of its volume in grades 1 and 2 at 59 percent; over a third of total volume (38 percent) was in grade 1 (Fig. 43). Black oak is the only oak species of the top 22 species by sawtimber value that had less than 50 percent of its volume in grade 1 or 2. In contrast, maples had a much lower proportion in the higher quality grades. Only 16 percent of sugar maple volume was in grade 1 trees with an additional 15 percent in grade 2. Red maple had a mere 20 percent of its sawtimber volume in grades 1 or 2, and nearly a third of sawtimber volume was in trees without a qualifying butt log.

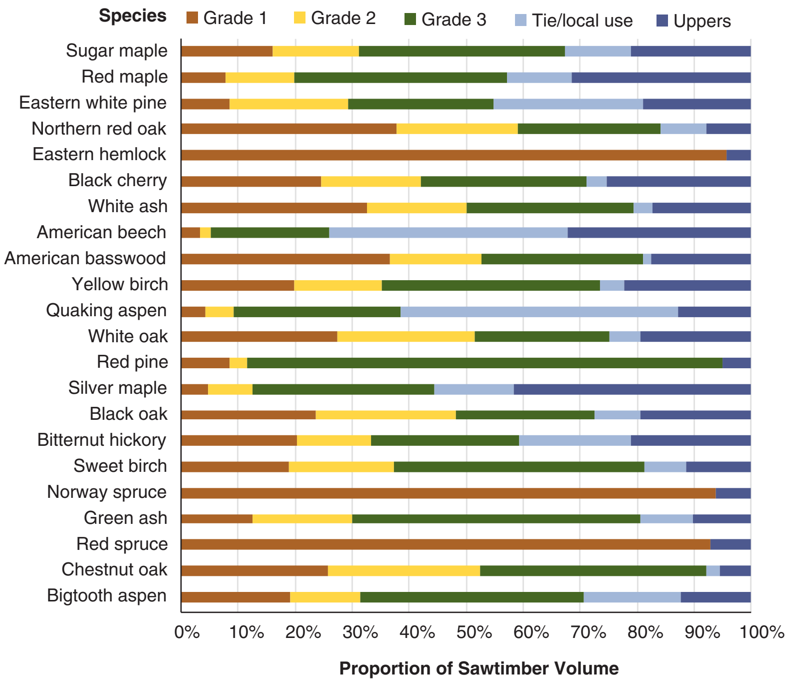


Figure 43.—Percentage of sawtimber volume on timberland for species composing at least 1 percent of total sawtimber volume by species and tree grade, New York, 2017. Uppers refers to trees containing a qualifying saw log outside the butt section.

What this means

Substantial increases in all measures of volume continue across New York, and current values are at levels higher than any previous FIA inventory the State has observed. Some of these trends, however, may be cause for concern, particularly if they continue into the future. While growing-stock volume is higher than previous estimates, rough and rotten cull tree volumes have outpaced growing-stock volume increases, resulting in cull trees growing as a proportion of overall net volume. Rotten cull in particular, while still a small percentage of total volume, increased 23 percent between 2012 and 2017 alone.

Most regions of the State saw increases in per acre volume, indicating rising volumes on a stable timberland base. The one exception was the Eastern Adirondack unit where net volume per acre remained nearly equal. More than volume trends are involved in this particular situation. Volume on all forest land increased by nearly 2 percent between 2007 and 2017, but the estimate of timberland area dropped by more than 30,000 acres over the same time period. A corresponding increase in reserved forest land occurred during that time due to changes in reserve status at individual locations. This resulted in the volume associated with those locations being pulled from the timberland classification. Still, overall net volume per acre of forest land only increased 2 percent over 10 years, representing the lowest amount of positive change of all units.

Volume increases were concentrated in sawtimber-sized diameter classes, a symptom of New York's continued consolidation of timberland stands into larger size classes and older age classes. The corresponding loss of volume in poletimber diameter classes is indicative of the smaller proportion of timberland occupied by young timber. Should this trend continue, it would be reasonable to expect a lack of young vigorous resources available to replace aging timber, particularly in large scale disturbances caused by insect or disease outbreaks.

Oaks as a species group have exhibited substantial volume growth over the past 10 years and represent a higher proportion of overall volume estimates for all volume categories in 2017 versus 2007. The total of the four major oak species (white, red, chestnut, and black) increased from 9 percent of growing stock and 11 percent of sawtimber volume to 11 and 13 percent, respectively. Additionally, more species compose at least one percent of all net volume, growing-stock volume, and sawtimber volume than in the 2007 inventory. This increasing diversity, coupled with the rise in oak, led to maples having a decreasing proportion of volume. Red, sugar, and silver maple have dropped from 33 percent of growing-stock volume to 31 percent, and experienced a similar drop to 28 percent of sawtimber.

Evaluations of volume by tree grade have also shown some encouraging trends, though they do not necessarily indicate rising quality or the result of deliberate management. The increases noted in the proportion of volume in grade 1 trees is likely a result of increasing tree diameters as hardwood trees must be at least 16 inches. Thus, as trees move into larger diameter classes, a portion are growing out of grade 2 and into grade 1. The decrease in proportion of public sawtimber volume in grades 1 and 2 combined was offset by a rise in proportion on private land. However, the rising proportion of volume in trees without a merchantable butt log is indicative of mixed results in quality trends.

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

Background

A forest's ability to provide continuous forest products and ecological services is determined by processes of change within the forest itself. These processes can be evaluated by analyzing growth, removals, and mortality across the resource. Growth is expressed on both a gross and net basis. Gross growth is all volume growth on trees already in the inventory (accretion) and growth due to trees coming into the sample for the first time (ingrowth). Estimates of mortality express the volume in trees that have died between plot visits. Removals fall into two general categories: harvest removals are trees removed due to harvest activities, and other removals refers to trees lost due to a change in land use. Changes in land use include conversions to nonforest land as well as changes in productivity or reserve status that removes a location from the timberland classification. Finally, net growth is calculated by subtracting mortality from gross growth, and net change is an expression of net growth minus removals. All change components are expressed on an average annual basis.

What we found

Gross growth on New York timberland was an estimated 1.1 billion cubic feet per year in 2017 (Fig. 44), representing a 1 percent increase in growth over the estimate in 2012. Mortality was estimated to be 358 million cubic feet per year, a decrease of 2 percent from 5 years previous. The resulting 716 million cubic feet per year of net growth represents a 2 percent increase from 2012. Both classifications of removals declined from 2012: 15 percent for harvest removals to 253 million cubic feet per year and 20 percent for other removals to 29 million cubic feet per year. Using these components of change, FIA estimated a surplus, or net change, of 433 million cubic feet per year, or 1 percent of net volume, up 18 percent over the statewide 2012 estimate.

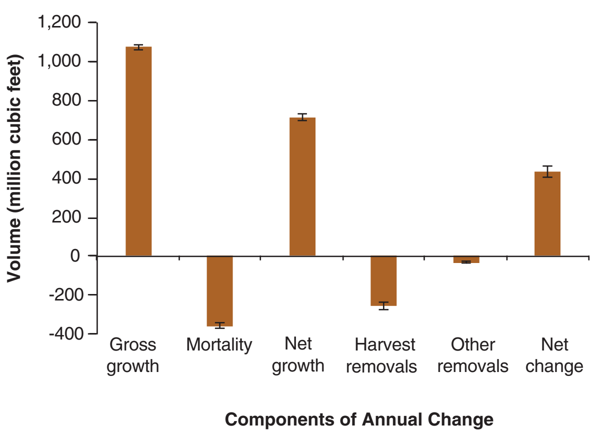


Figure 44.—Components of annual volume change on timberland, New York, 2017. Error bars represent a 68 percent confidence interval around the mean.

Net growth can be broken down into two broad categories describing the source of growth. Ingrowth volume is the net growth associated with trees not previously in the inventory. That includes previously measured saplings in the regeneration sample area that grew across the 5 inch diameter threshold and trees being measured for the first time due to previously not meeting the 5 inch minimum diameter. Ingrowth for 2017 totaled 129 million cubic feet per year or 18 percent of all net growth (Fig. 45). Accretion is the term used to describe growth on existing trees that were at least 5 inches in diameter at the time of previous measurement. Timberland accretion totaled 587 million cubic feet per year with over half of that (51 percent) having occurred on trees previously less than 11 inches d.b.h. The 12-inch diameter class had the single largest amount of net growth with 105 million cubic feet per year, or 18 percent of all accretion. Each successive step up in diameter class beyond 12 inches was associated with a lower rate of accretion. Only trees 29 inches or larger collectively exhibited negative net growth, which was estimated to be 8.7 million cubic feet per year and was generally the result of mortality in older, larger trees.

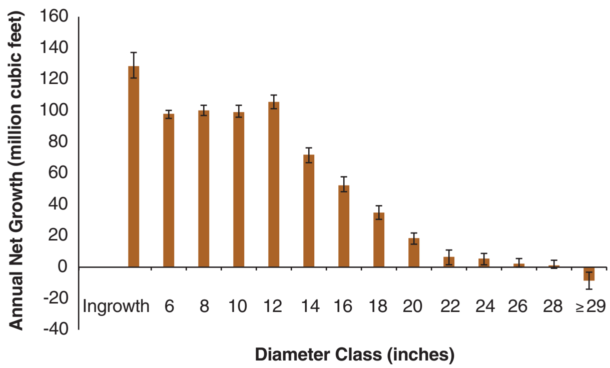


Figure 45.—Annual net growth volume on new trees (ingrowth) and existing trees (accretion) on timberland by diameter class at previous inventory, New York, 2017. Error bars represent a 68 percent confidence interval around the mean.

Sources of net growth varied widely by tree species. For instance, among the 11 tree species having at least 2 percent of total timberland net volume, ingrowth ranged from 7 percent of net growth in northern red oak to 38 percent for American basswood (Fig. 46). Many species had net growth concentrated in trees already of sawtimber size. Northern red oak, for example, had 75 percent of its total net growth volume from trees already 11 inches or greater in diameter. Eastern white pine, eastern hemlock, and black cherry all had at least half of net growth in trees of similar size. Conversely, some species appear to be in decline as net growth rates of larger trees was below zero, meaning that mortality in those diameters was greater than gross growth. American beech, American basswood, and quaking aspen all had negative net growth in trees of sawtimber size, with American beech having the lowest net growth at -11 million cubic feet per year. This negative net growth had a substantial impact on overall net growth.

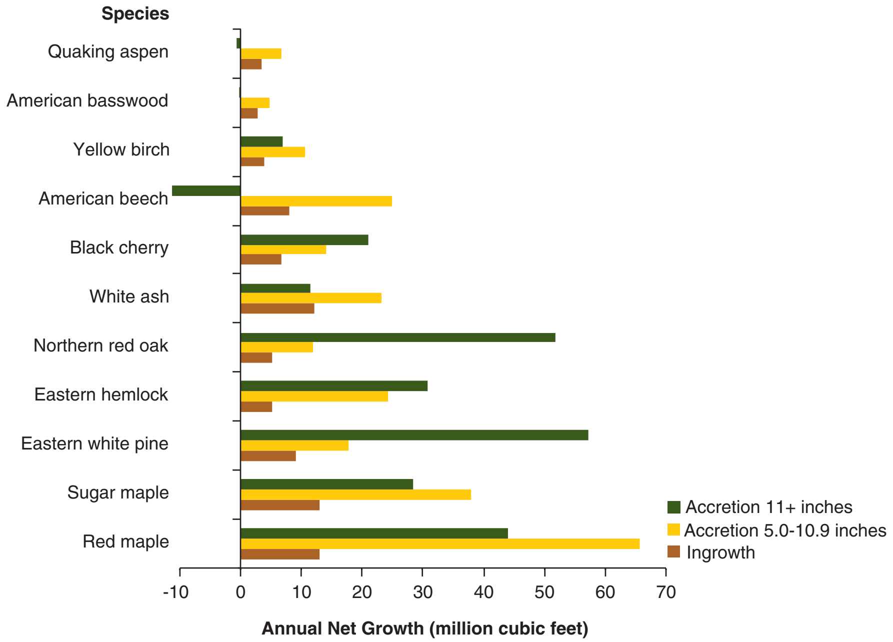


Figure 46.—Annual net growth volume for tree species composing at least 2 percent of total net volume by species and source, New York, 2017.

Harvest removals were down 15 percent from the 2012 estimate to 253 million cubic feet per year. Harvest removals were concentrated in trees of sawtimber size, with the 16-inch diameter class showing the highest annual volume harvested at 43 million cubic feet per year (Fig. 47), a 12 percent drop from the 2012 estimate. Removals by tree class closely resembled overall net volume by tree class with 89 percent of harvest removal volume coming from growing-stock trees. Rough cull removals were the only class that increased over 2012, going up 36 percent to 25 million cubic feet per year, or 10 percent of removed volume. The largest yearly harvested volume was of sugar maple at 43.3 million cubic feet, with red maple (36.5 million cubic feet), white ash (23.7 million cubic feet), eastern white pine (20.4 million cubic feet), and black cherry (18.8 million cubic feet) rounding out the five most harvested species. Trends in harvested volume by species indicate that while the majority of major species were harvested in 2017 at a rate lower than 2012, some species showed increases in harvesting. The annual harvested volume of eastern hemlock, white ash, American beech, white oak, and chestnut oak increased 29, 12, 9, 24, and 20 percent, respectively. Additionally, red pine harvests increased 155 percent over 2012.

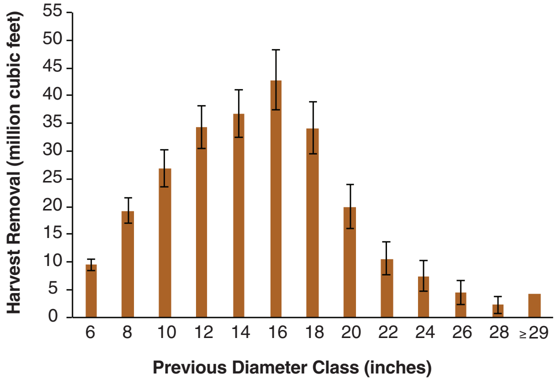


Figure 47.—Harvest removal volume by previous diameter class, New York, 2017. Error bars represent a 68 percent confidence interval around the mean.

Comparing harvested volume to net growth is a useful way to evaluate the sustainability of harvesting practices. Dividing annual net growth volume by annual harvest volume produces a ratio showing the rate of growth compared to the rate of harvest. A net growth to harvest removal volume (G:R) over 1.0 indicates that net growth is outpacing removals. Thus, a ratio under 1.0 indicates volume is harvested at a rate exceeding growth, a situation unsustainable in the long term. The 2017 statewide G:R was 2.8 (Table 4), meaning that net growth was 2.8 times harvest volume on an annual basis, an increase from the 2012 G:R of 2.3. Among the top ten species ranked by total net volume, G:R was highest in yellow birch with a net growth 5.6 times harvested volume (Fig. 48), followed by northern red oak (4.5), eastern white pine (4.1), eastern hemlock (4.1), and red maple (3.4). Red pine was the only species with at least 1 percent of total net volume that had harvests exceeding net growth as shown by a G:R of 0.5, though several other species (sugar maple, American beech, American basswood, quaking aspen, and chestnut oak) had ratios of 2.0 or less.

Harvest patterns by major ownership group remained consistent as compared to 2012 estimations, but strong differences were observed between the groups. Public timberland accounted for 13 percent of net volume in 2017 but was only 7 percent of annual harvest removals volume. This led to disparate G:R ratios in the two major ownership groups. Public timberland had a statewide G:R of 3.6 and privately held timberland was 2.8. While public timberland had the higher G:R, only 7 percent of volume harvested from public land was in cull trees, but 11 percent of private harvested volume was cull.

Table 4.—Timberland net volume, net growth to harvest removals ratio, and annual components of change, New York, 2017

Forest type	Net volume (million ft^3)	Ratio of net growth to harvest removals (G:R)	Annual change components as a percentage of net volume				
			Annual net growth	Annual harvest removals	Annual other removals	Annual mortality	Net change
Adirondack	4,113	1.9	2.3	1.2	0.0	1.5	1.1
Lake Plain	5,320	3.6	2.4	0.7	0.0	0.8	1.7
Western Adirondack	3,340	2.3	1.9	0.8	0.2	1.2	0.9
Eastern Adirondack	2,414	1.2	1.8	1.5	0.6	1.3	-0.3
Southwest Highlands	4,159	2.9	2.3	0.8	0.0	0.8	1.5
South-Central Highlands	6,330	3.2	2.1	0.6	0.0	0.8	1.4
Capitol District	3,600	4.2	2.3	0.6	0.0	0.9	1.8
Catskill-Lower Hudson	5,466	5.7	1.4	0.2	0.1	1.2	1.1
Statewide	34,743	2.8	2.1	0.7	0.1	1.0	1.2

Across the regions of New York, varying results were observed when analyzing the components of G:R change on timberland. Net growth to harvest removals ratios were lowest in the Adirondack (1.9) and Eastern Adirondack (1.2) units where annual harvested volumes were 1.2 percent and 1.5 percent of net volume, respectively (Table 4). Harvest rates were lowest in the Catskill-Lower Hudson unit, with annual harvest volume at only 0.2 percent of regional net volume and a G:R of 5.7. That same region had the lowest amount of net growth when expressed as a percentage of net volume at 1.4 percent. Annual net growth as a percentage of net volume was highest in the Lake Plain at 2.4. Net change, calculated as net growth minus removals, ranged from a surplus of 1.8 percent of net volume in the Capitol District to -0.3 percent in the Eastern Adirondack region, the only unit with negative net change.

The estimate of timberland acreage that showed evidence of harvesting treatments declined between 2007 and 2017. An estimated total of 1.9 million acres underwent harvest during the inventory cycle ending in 2007, but only 1.2 million acres showed evidence of harvest activities in the 2017 inventory cycle. Only 76,000 acres of public timberland were estimated to have been harvested, down from 106,000 acres in 2007. Private harvest activities dropped from 1.8 million acres to 1.1 million acres over the same period. Of the total estimated harvest removals volume of 253 million cubic feet annually, 23 million cubic feet were on land that was converted to nonforest and 1 million were on land converted from timberland to reserved forest land. Only 186 million cubic feet of the annual removals were associated with harvesting activities as indicated by treatment codes recorded with plot data. The majority of that harvested volume, 64 percent, came from stands with high basal area in excess of 120 square feet per acre, with an additional 30 percent from stands between 81 and 120 square feet per acre. Stands undergoing harvest activities generally remained in higher stocking classes after harvest, with 51 percent of treated acreage fully stocked and 35 percent moderately stocked post-harvest.

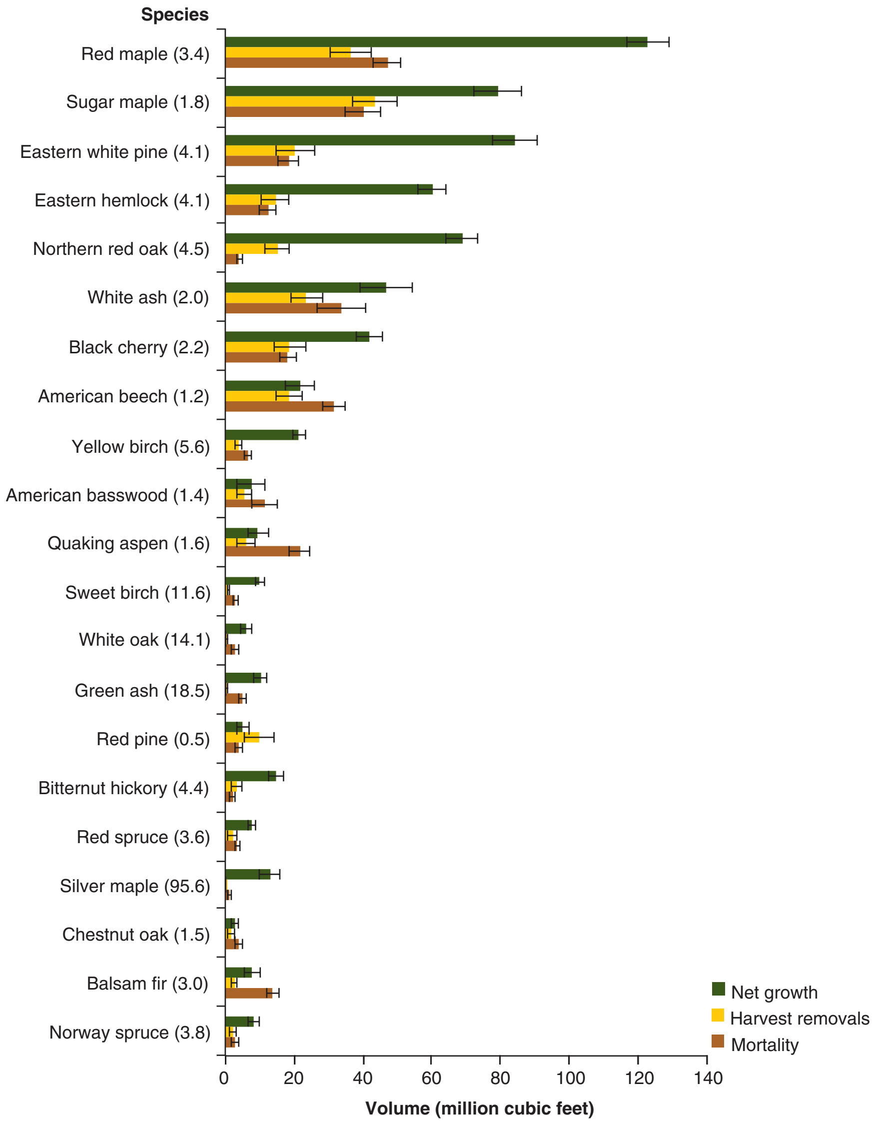


Figure 48.—Net growth, harvest removal, and mortality volume on timberland and net growth to harvest removal ratio (shown in parentheses) for all species that compose at least 1 percent of net volume on timberland, New York, 2017. Error bars represent a 68 percent confidence interval around the mean.

Annual mortality was estimated to be 358 million cubic feet in 2017, or 1 percent of net volume (Table 4), a slight 2 percent decrease when compared to the overall 2012 estimate. Drops in mortality estimates occurred for the majority of species having at least 1 percent of total net volume (Fig. 49), some of which were substantial. Northern red oak mortality decreased 39 percent to 4.1 million cubic feet per year, just 0.2 percent of total net volume for the species, the lowest rate when expressed as a proportion of net volume observed for the top 21 species by volume. Some species, however, saw increases in mortality since 2012. White ash and green ash annual mortality went up 65 percent and 73 percent, respectively, to 1.5 percent of white ash net volume and 1.2 percent of green ash volume. Two species have annual mortality rates of 3 percent or more of total net volume. Balsam fir mortality was 13.7 million

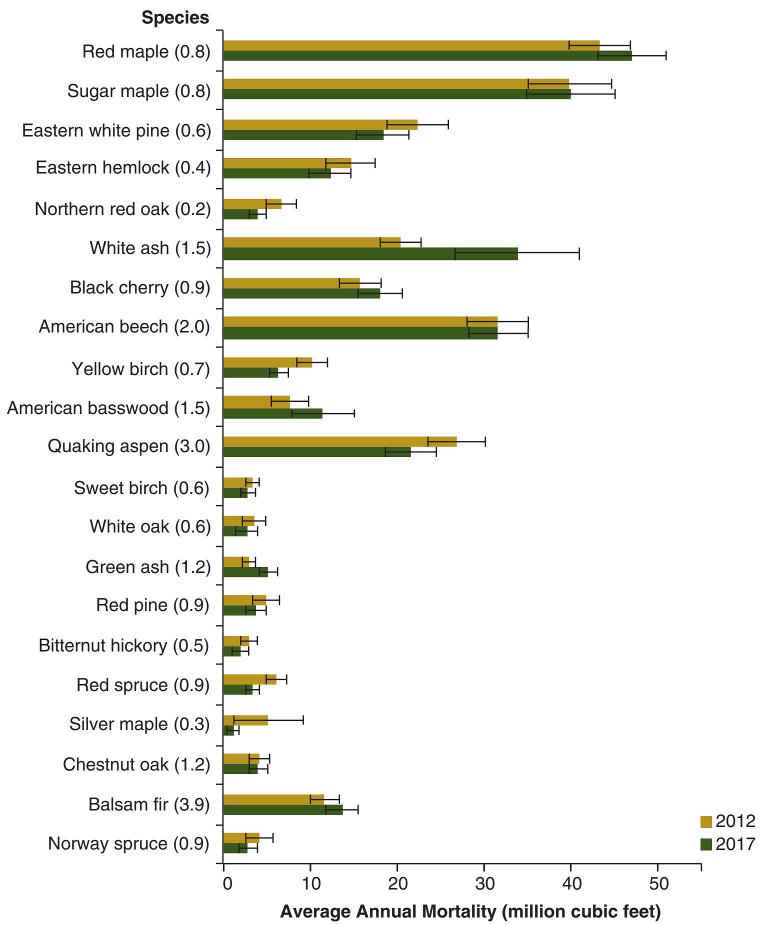


Figure 49.—Average annual mortality volume and mortality volume as a percentage of each species' net volume in 2017 (shown in parentheses) for all species that compose at least 1 percent of total net volume on timberland by species and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

cubic feet annually, or 3.9 percent of volume in 2017. Quaking aspen annual mortality actually decreased 20 percent to 21.6 million cubic feet, but this still represents 3.0 percent of net volume for the species.

Regional variations in mortality estimates were apparent. Absolute annual mortality volume was highest in the Catskill-Lower Hudson unit at 65 million cubic feet (Fig. 50). Mortality as a percentage of volume was highest in the Adirondack unit where annual mortality was estimated at 1.5 percent of regional net volume (Table 4). Mortality estimates decreased or remained stable in the majority of regions with the exception of both the Capitol District and the Catskill-Lower Hudson units, where increases of 24 percent and 35 percent, respectively, were found. Nearly 60 percent of the increased mortality in the Catskill-Lower Hudson unit can be attributed to the four-fold increase in ash mortality within the unit bringing mortality volume to 12.9 million cubic feet annually.

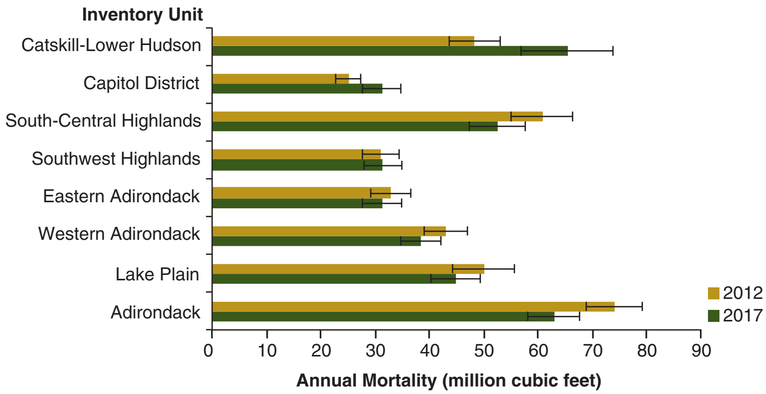


Figure 50.—Average annual mortality volume by inventory unit and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

Annual gross growth minus annual mortality results in the estimation of net growth. By comparing mortality to gross growth, insight into the interactivity of the two main drivers of volume change can be gained. When the ratio of mortality to gross growth is high, it can be a symptom of stand dynamics or health issues for individual species (Conkling et al. 2005). The statewide average of all species indicated that 34 percent of gross growth was lost to mortality (i.e., net growth was 66 percent of gross growth). Mortality for 4 of the top 21 species by net volume exceeded 60 percent of gross growth (Fig. 51). American basswood, quaking aspen, chestnut oak, and balsam fir had levels of mortality of 66, 70, 60, and 65 percent of gross growth, respectively. American beech mortality, notably, fell below the 60 percent threshold since 2012 to 57 percent of gross growth in 2017. Northern red oak mortality when calculated as a percentage of gross growth had the lowest value at 6 percent.

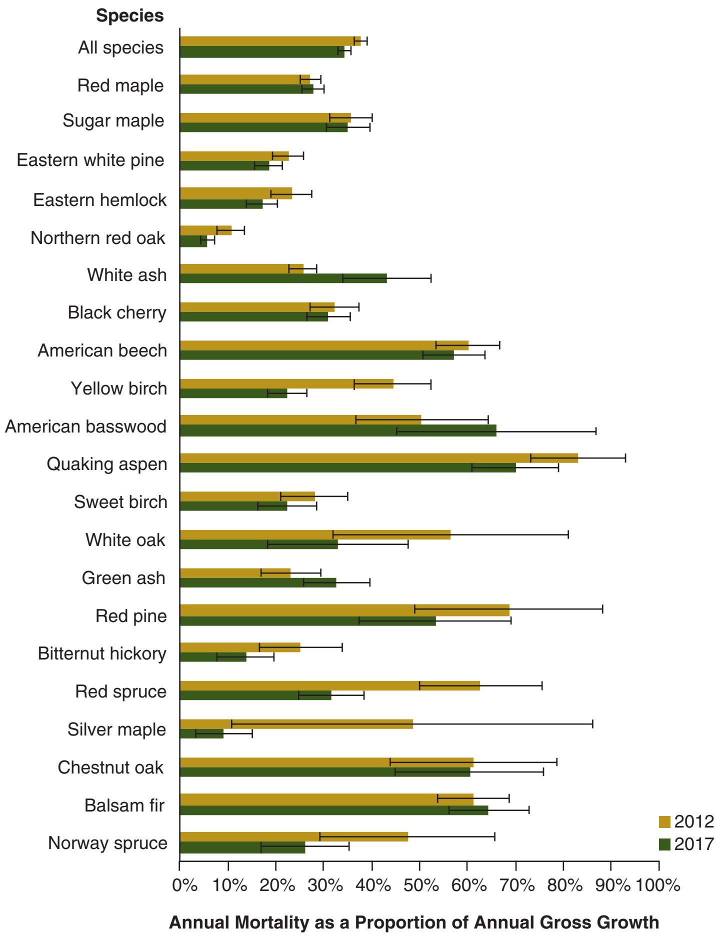


Figure 51.—Annual mortality volume as a proportion of annual gross growth volume for tree species that compose at least 1 percent of total timberland net volume, by inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

What this means

The volume of timberland in New York has continued to climb due to both an increase in gross growth and decreases in both mortality and removals. The removal of less material combined with the higher net growth seen in recent years has led to an average increase of 1.2 percent of total net volume annually, the highest rate since annual inventories of New York began. For many of the major species, the majority of growth has been in sawtimber size trees, a sign of the maturity of the resource as a whole.

Several forest health issues likely to challenge future change components are either coming or already present in New York. Increases in ash mortality observed this last inventory are likely the result of emerald ash borer (*Agrilus planipennis*) infestations in the southern counties. The continuing effects of beech bark disease are evident in the high mortality-to-gross-growth ratio for the species. Hemlock woolly adelgid (*Adelges tsugae*) already has an entrenched presence in the southern units of the State and has the potential to become a major statewide problem as it has elsewhere, although hemlock mortality is currently decreasing. Oak wilt also already exists in New York but is not widespread at this time and is not reflected in the oak mortality for this inventory.

Some major gains by individual species may be an indicator of future changes in the forest resource. Decreased mortality and removals coupled with increased gross growth in northern red oak have led to its 25 percent increase in net volume over 2007 and positioned the species to become an even more prominent volume component in the future forests of New York. Similar factors led to big increases in white oak and chestnut oak as well. Because the majority of volume increases in oaks were seen on trees already of sawtimber size, regeneration and poletimber management will be of major importance for the long-term sustainability of these species. Conversely, American beech, American basswood, and quaking aspen seem to be in decline as indicated by high mortality estimates and negative net growth in trees 11 inches or greater in diameter.

Decreasing harvest rates, while generally affected by market conditions, are one indication that New York's forests may be underutilized relative to growth for the production of forest products. The resulting increases in net growth to harvest removals ratios and annual volume increases in the range of 1.4 to 1.8 percent of net volume, particularly in the areas outside the Adirondacks, show that there is great opportunity for increased resource utilization in the State. Future market trends, especially in the area of low value trees, will have an impact on the decisions landowners make and the future of New York timberlands.

Reserved Forest Land of New York

Background

The majority of this report focuses on the resources of timberland, but there is another important component of New York forest land. Reserved forest land is publically-owned land where forest management is prohibited by statute. This land can include, but is not limited to, parks, wilderness areas, and natural areas. While such areas cannot be sources of timber products, the ecosystem services provided by reserved forest lands are myriad. Wildlife habitat, recreational opportunities, carbon sequestration, and sources of clean water are just some of the benefits offered by these types of protected land. New York is unique in that it is one of only eight states in the United States, that has more than 15 percent of the total forest land area classified as reserved, and the only one in the eastern United States. In fact, New York's reserved forest area accounts for nearly one third (31 percent) of all such land in the entirety of the 24-state area covered by the Northern Research Station FIA program (Fig. 52).

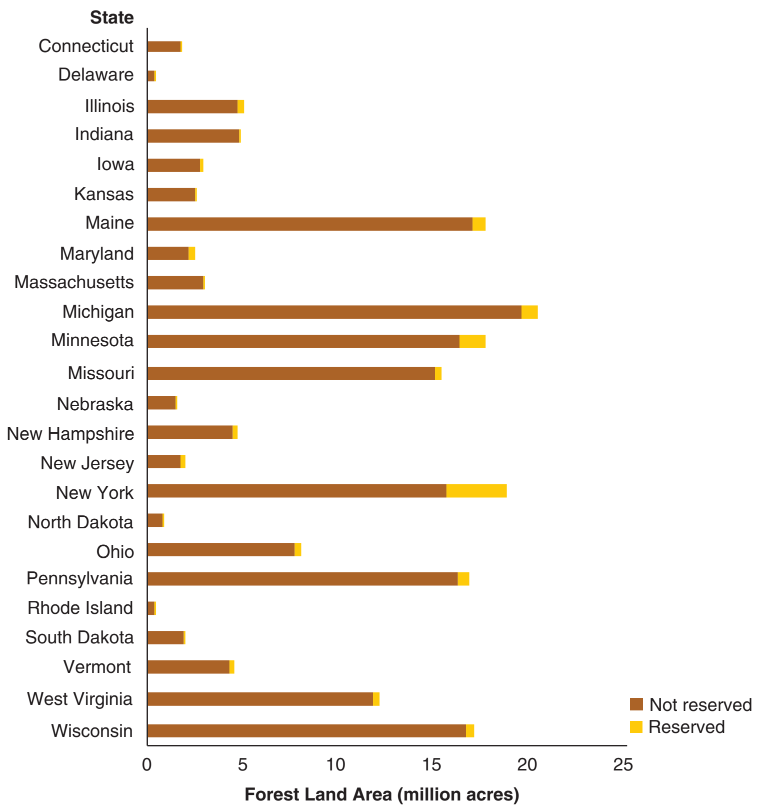


Figure 52.—Forest land area by state and reserved status, Northern Research Station, 2017, 2018.

What we found

The FIA estimate of New York's reserved forest land is 3.1 million acres, a number that increased slightly since 2007. This amount represents nearly 17 percent of the total forest land estimate of 18.7 million acres. Most of this reserved land falls within the Adirondack Park, where 2.6 million acres of the overall 6 million acre area is classified as the Adirondack Forest Preserve (http://www.dec.ny.gov/lands/4960.html). The largest amount of reserved forest, both proportionally and in absolute acreage, is in the Eastern Adirondack unit, where 56 percent of all forest land is classified as reserved, a total of 1.5 million acres (Fig. 53). Proportionally, the Western Adirondack region has the next highest amount at 24 percent (480,000 acres) of total forest land. The Adirondack unit has 462,000 acres of reserved land, which represents only 15 percent of the total forest land in the region. An additional 510,000 acres of reserved forest land is located in the Catskill-Lower Hudson unit. This accounts for 19 percent of forest land in the region and is primarily located in the Catskill Forest Preserve. No other region had more than 5 percent of forest land classified as reserved.

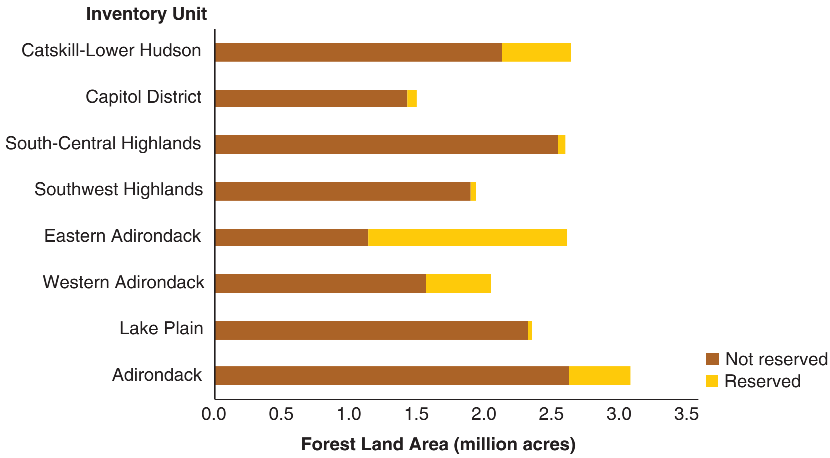


Figure 53.—Forest land area by inventory unit and reserve status, New York, 2017.

Because much of the reserved land in New York has been excluded from commercial forest management activities for a century or more, the resources occupying this land differ from the 83 percent of forest land classified as timberland. The proportion of all live trees that exists on reserved land closely follows the proportion of forest land that is reserved, with an estimated 569 million live trees 5 inches or greater on reserved land, or 18 percent of the total 3.2 billion trees on forest land. However, 25 percent of all standing dead trees, totaling 105 million individuals, were estimated to be on reserved forest land. Differences in composition between forest land overall and reserved forest land are also clearly apparent. Maple/beech/birch is the largest forest-type group by far (Fig. 54), representing 71 percent of all reserved forest land area, in contrast to only 55 percent on forest land overall. Spruce/fir stands occupy 9 percent of reserved land, but only 4 percent of all forest land.

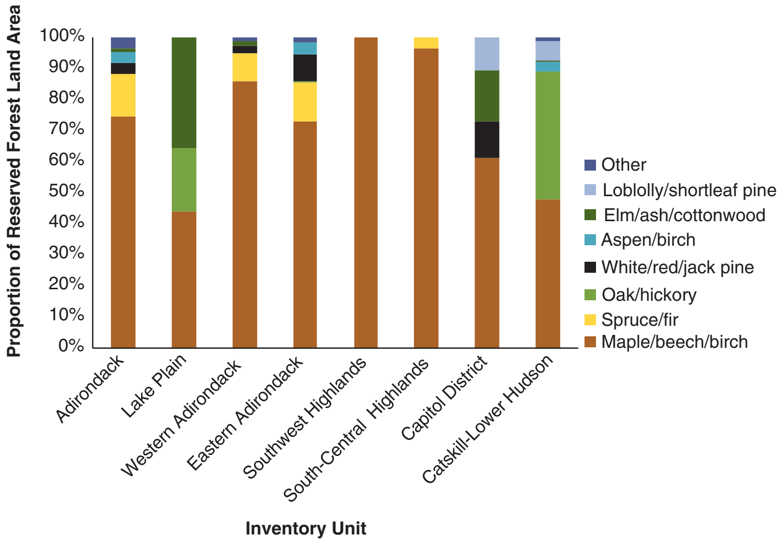


Figure 54.—Percentage of reserved forest land area by inventory unit and forest-type group, New York, 2017.

Stands on reserved forest land tend to fall in the larger diameter classes and older stand ages. Large diameter stands accounted for 76 percent of forest land area classified as reserved (Fig. 55), in contrast to the 65 percent of timberland in the same diameter class. Only 3 percent of reserved forest area was classified as small diameter stands. Less than 10 percent of reserved forest land area was in stands 60 years of age or younger. The largest single age class was 81-100 years and accounted for 39 percent of reserved area (Fig. 56). Over a quarter (28 percent) of reserved land was classified as being in stands over 100 years old.

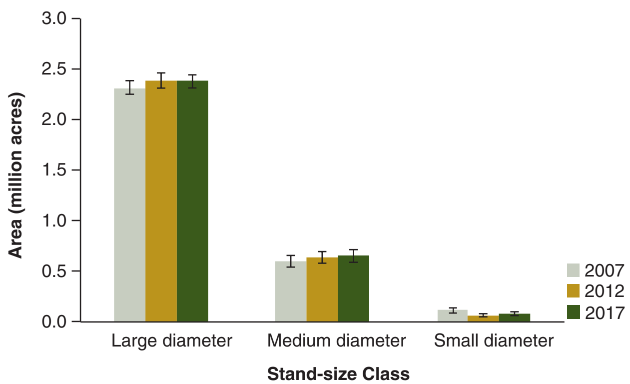


Figure 55.—Reserved forest land area by stand-size class and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

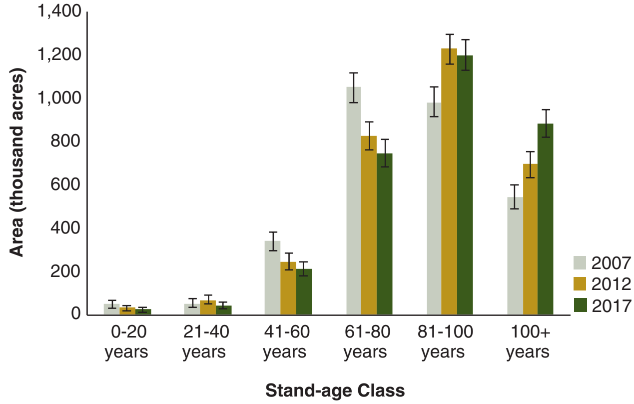


Figure 56.—Reserved forest land area by stand-age class and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

With reserved land being excluded from management activities, estimates of volume are not used to describe resources available for timber products; however, having these values can be useful as a method of comparing reserved land to timberland resources. Per acre volumes in 2017 were substantially higher on the reserved forest land of New York at 2,625 cubic feet per reserved acre in comparison to timberland at 2,229 cubic feet per acre (Fig. 57). Volume increases on a per acre basis were considerably lower in reserved land, with the 2017 estimate being only 4 percent higher than 10 years previous, whereas timberland per acre volume increased 11 percent over that same period. Changes in land bases affected this particular estimate of change. Absolute net volume increased 7 percent in reserved areas between 2007 and 2017, but the estimate of reserved forest land also increased about 2 percent, keeping per acre volume growth somewhat suppressed. Nevertheless, 19 percent of all net volume on forest land existed on reserved land.

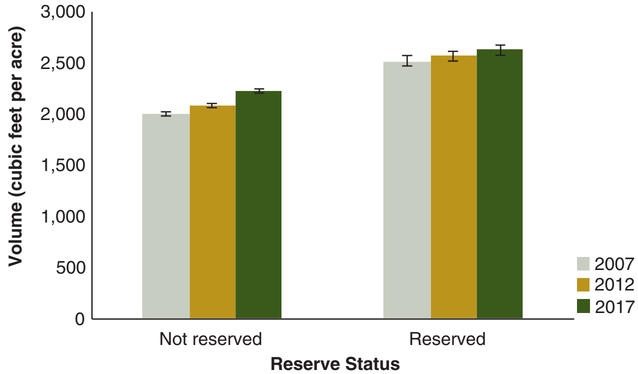


Figure 57.—Net volume by reserve status and inventory year, New York. Error bars represent a 68 percent confidence interval around the mean.

Given the prevalence of older age classes on reserved land and the prohibition of forest management, components of volume change differ from timberland. Even though reserved forest land net volume represents 19 percent of volume statewide, reserved gross growth was only 15 percent of total gross growth. Mortality rates on reserved forest land were substantially higher with annual mortality volume estimated to be 75 percent of annual gross growth volume. On timberland, the mortality rate was less than half that at 34 percent of gross growth. This was true for the majority of species groups, though not all (Fig. 58). Several groups, such as hard maple, yellow birch, beech, other eastern soft hardwoods, and ash, had annual mortality nearly equal to or exceeding annual gross growth. These factors (i.e., lower gross growth and increase mortality) kept net growth on reserved forest land relatively low at 0.6 percent of total net volume, in contrast to 2.1 percent on timberland.

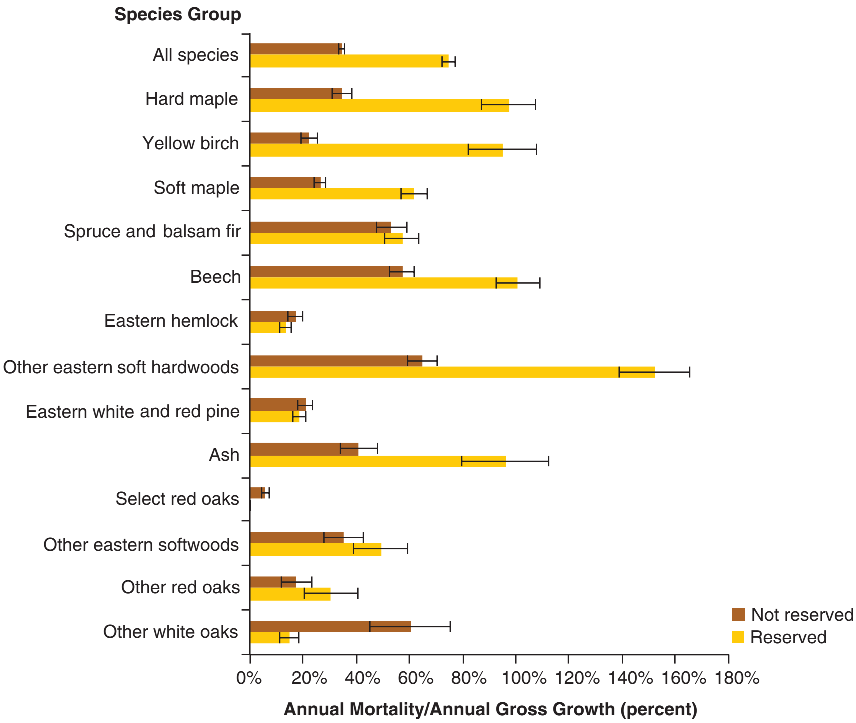


Figure 58.—Annual mortality volume as a proportion of annual gross growth volume on forest land for species groups composing at least 1 percent of total reserved land net volume, by reserve status, New York, 2017. Error bars represent a 68 percent confidence interval around the mean.

One of the major benefits inherent in all forests is their ability to serve as carbon sinks. An estimated 296 million tons of carbon were contained in reserved forests, representing 18 percent of forest carbon in New York. Because of the relationship between tree volume and carbon stores, total carbon per acre, estimated to be 94 tons per acre in reserved forests, was higher than the 84 tons per acre estimate on timberland (Fig. 59). Increases in carbon per acre occurred at higher rates on timberland, however, rising 5.2 percent between 2007 and 2017. Reserved forest carbon per acre increased at just over half that rate, or 2.7 percent, over 10 years. Down woody materials existed in much higher proportions on reserved land as well. Estimates of carbon stored in this dead wood lying on the forest floor of reserved land were more than double that of timberland. Total down woody carbon was 12 tons per acre in reserved forests versus 5 tons per acre on timberland with substantial variation among age classes (Fig. 60).

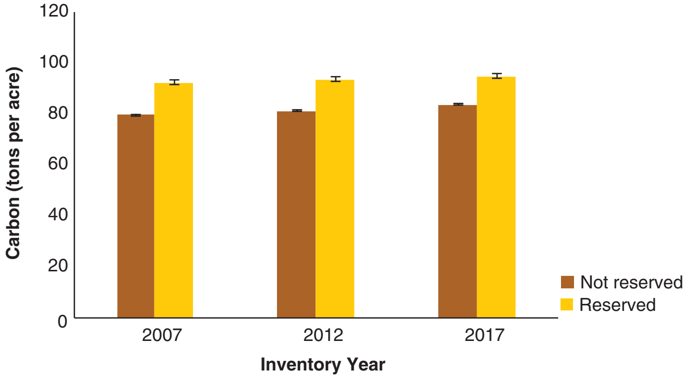


Figure 59.—Forest carbon by inventory year and reserve status, New York. Error bars represent a 68 percent confidence interval around the mean.

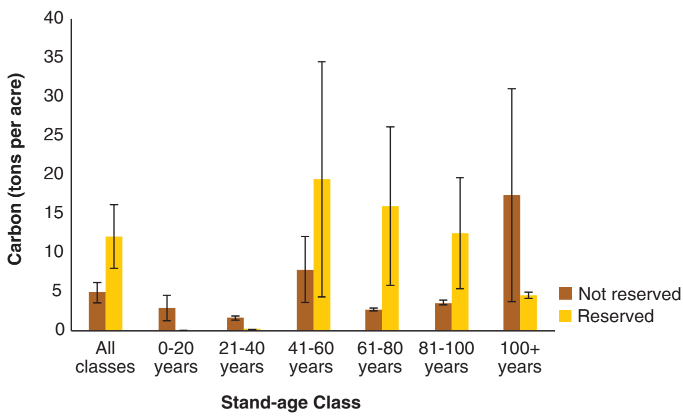


Figure 60.—Carbon, in down woody materials by stand-age class and reserve status, New York, 2017. Error bars represent a 68 percent confidence interval around the mean.

What this means

The benefits reserved forest land provides to all New Yorkers, from clean water to opportunities for solitude, should not be underestimated. It also offers the ability to study the effects of widespread prohibitions of forest management on a large scale. Some of the differences between the reserved forest and timberland are striking.

Differences in composition can be explained partially by geography, as the majority of reserved forest land is in the northern regions of New York, areas already dominated by maple/beech/birch and spruce/fir stands. Other reasons for such compositional differences are due directly to the lack of management. Without human intervention in the form of harvests and/or regeneration treatments, stands will move toward later successional stages populated by species of high shade tolerance.

Because of the absence of management, forested stands in reserved areas tended toward older age classes and larger diameter classes. Higher numbers of standing dead trees also result from a lack of management as stands age within the reserved structure. Lower growth rates associated with increased age, coupled with highly elevated rates of mortality, suppressed volume increases over the last decade.

It is clear that the lack of management that defines reserved forest land has some profound impacts on the resource overall. Nevertheless, the reserved forest land of New York remains an outstanding asset that provides numerous benefits for all to enjoy.

Forest Carbon

Background

Among terrestrial ecosystems, forests contain the largest reserves of sequestered carbon. The accumulation of carbon in forests helps to mitigate emissions of carbon dioxide to the atmosphere from sources such as wild fires or the burning of fossil fuels. Carbon accumulates in growing trees via the photosynthetically driven production of structural and energy-containing organic (carbon) compounds that primarily accumulate in trees as wood. About 50 percent of tree biomass is carbon (based on dry weight). Over time, this stored carbon also accumulates in standing dead trees, down woody materials, litter, and forest soils. For most forests, the understory grasses, forbs, and nonvascular plants, as well as animals, represent minor pools of carbon stocks. The FIA program uses a combination of field measurements and models to estimate forest carbon stocks. Procedures for estimating forest carbon are detailed in U.S. Environmental Protection Agency (2018).

What we found

Total forest ecosystem carbon stocks in New York are estimated at 2.2 billion tons. This represents an increase of one-half percent in total forest carbon stocks since 2012, despite a small decrease in forest land area. Soil organic carbon and live trees are the largest pools and combined account for 91 percent of forest carbon (Fig. 61). Total carbon distribution across stand-age classes generally follows the distribution of forest land. As such, most of New York's forest carbon stocks are in stands between 61 and 100 years old (59 percent of total forest carbon). Thirty-one percent of total forest carbon is found in stands younger than 61 years old, and 10 percent is in stands that are older than 100 years. As a per acre estimate, average carbon density (short tons per acre) in the live biomass pools (live trees and understory) increases with stand age, and net accumulation is greater within live biomass than in the dead wood, litter, and soil pools (Fig. 62). The maple/beech/birch forest-type group contains the majority of the total forest carbon (58 percent), as it covers a large amount of the forest land (Fig. 63A). Carbon density was also highest in the maple/beech/birch forest-type group (122.5 short tons per acre), followed by the oak/pine group with 118.0 short tons per acre (Fig. 63B).

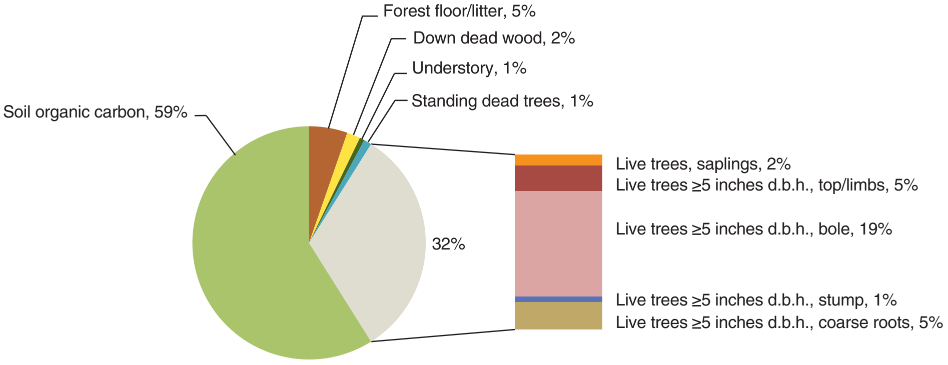


Figure 61.—Carbon stocks on forest land by forest ecosystem component, New York, 2017.

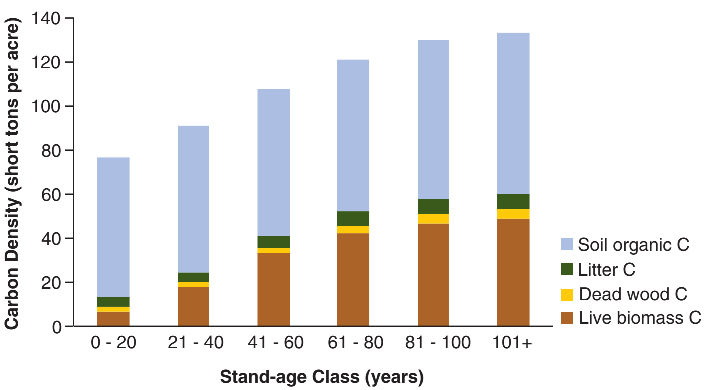


Figure 62.—Carbon density of live biomass and dead wood and litter components on forest land by stand-age class, New York, 2017.

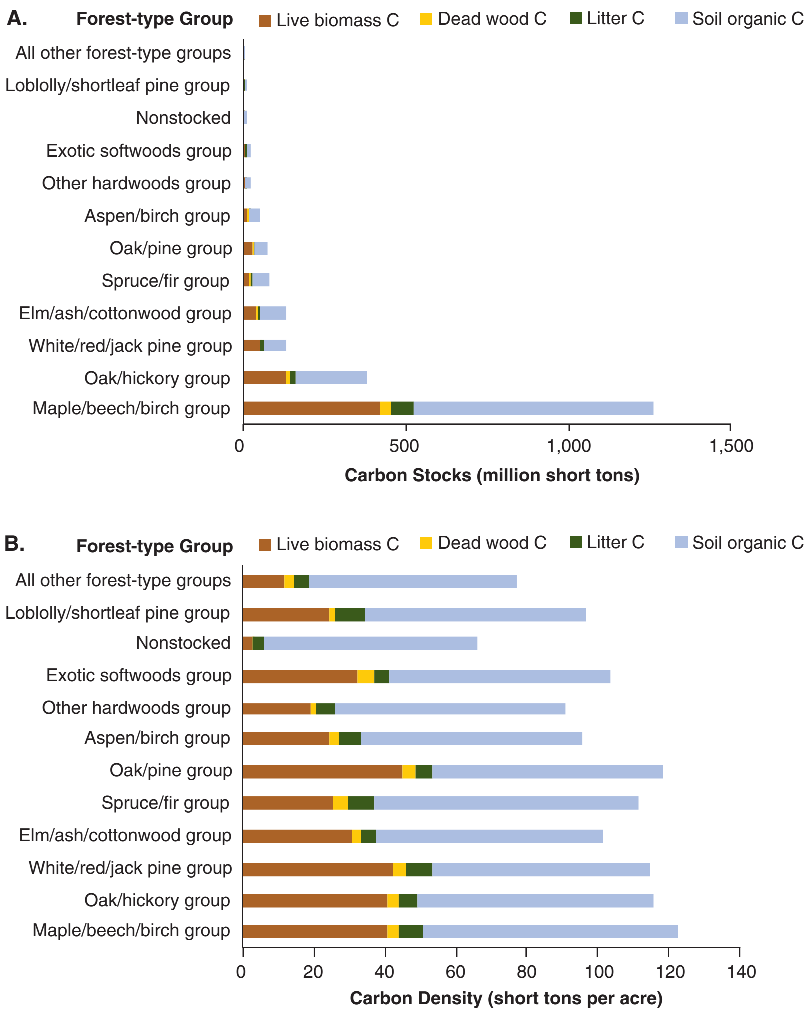


Figure 63.—Carbon stocks (A), and carbon density (B) by forest-type group, New York, 2017.

What this means

Forest carbon stocks continue to rise in New York, despite the loss of forest land, as maturing stands accumulate carbon, particularly in aboveground live biomass components. Soil organic carbon, the largest pool, is important to long-term carbon sequestration. However, because changes in soil carbon are slow, there are few opportunities to manage this carbon stock in the near term. The live tree carbon pool has the best opportunity to increase carbon stocks in the shorter term, as this carbon pool is the one most affected by forest management. As mitigating U.S. greenhouse gas emissions becomes increasingly important, an understanding of trends in carbon sequestration and storage will be an essential tool for forest managers.

Down Woody Materials

Background

Down woody materials, in the various forms of fallen trees and shed branches, play a critical role in the forests of New York. Down woody materials provide valuable wildlife habitat, seedling browse protection, stand structural diversity, a store of carbon/biomass, and contribute towards forest fire hazards via surface woody fuels.

What we found

The total carbon stored in down woody materials (fine and coarse woody debris and residue piles) on New York's forest land exceeded 109 million tons in 2017, which is much greater than in 2010 (Fig. 64). Downed woody debris carbon was positively related to the amount of live tree basal area, with forests having more than 80 square feet per acre of basal area having the highest amounts of downed dead wood carbon (~100 million tons). The downed dead wood biomass within New York forests is dominated by coarse woody debris (Fig. 65) at approximately 118 million tons, with fine woody debris representing only 16 percent of statewide totals. Piles of coarse woody debris (i.e., harvest residue) represented 31 percent of downed dead wood biomass. The total volume of coarse woody debris in 2017 was highest in the state/local ownership category (which includes state forest preserve lands within the Adirondack State Park) at approximately 8.2 billion cubic feet (Fig. 66). The private ownership category had the second largest total of coarse woody debris volume with 5.6 billion cubic feet, while Federal ownership only had a total of 5 million cubic feet. Totals for the state/local ownership group, such as the Adirondacks, increased markedly from 2010 to 2017.

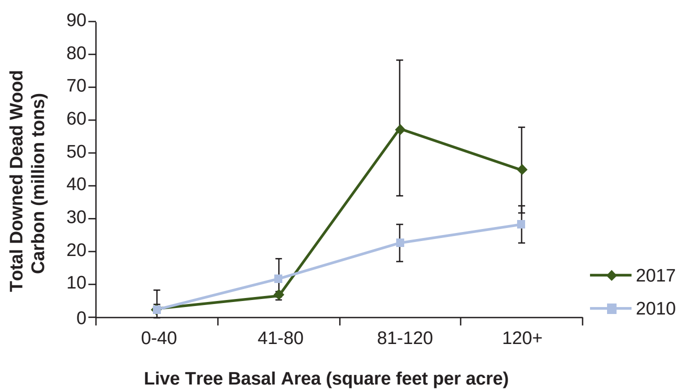


Figure 64.—Total carbon (short tons) in down woody materials (fine and coarse woody debris and piles) by live-tree basal area class on forest land, New York, 2006-2010 and 2012-2017. Error bars represent a 68 percent confidence interval around the mean.

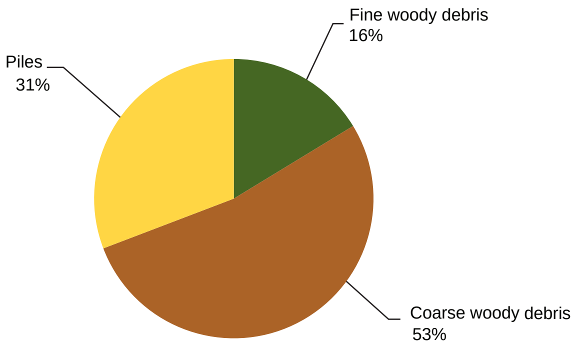


Figure 65.—Proportion of down woody material biomass on forest land by dead wood component, New York, 2012-2017.

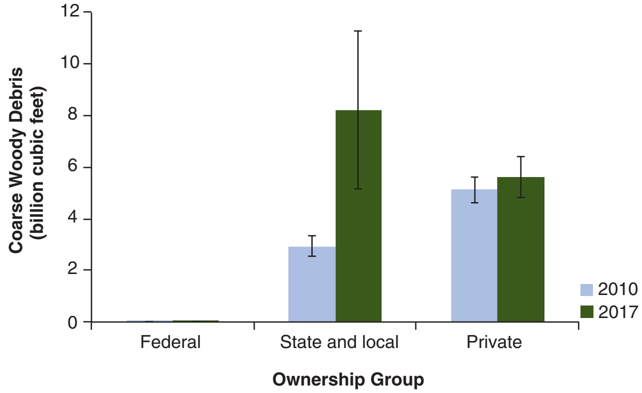


Figure 66.—Total volume of coarse woody debris and deadwood piles on forest land by ownership group, New York, 2006-2010 and 2012-2017. Error bars represent a 68 percent confidence interval around the mean.

What this means

Given the relatively moist temperate forests across New York, only in times of dry spring conditions and extended drought would the biomass of down woody materials be considered a fire hazard, especially since the proportion of fine woody debris is relatively low. This stands in contrast to forests in other areas of the nation (Woodall et al. 2013), where greater amounts of fine woody debris in arid forests increases the risk of wildfires. Although the carbon stocks associated with New York's down woody materials are relatively small compared to those of soils and standing live biomass, it is still a critical component of the carbon cycle and acts as a transitory stage between live biomass and other detrital pools such as the litter (Russell et al. 2015). While the vast majority of coarse woody debris volume is estimated to be in private and state/

local ownership, nearly 90 percent of the volume on public lands is in forests that are reserved from management activities. Therefore, it is the management of New York's private forests that will have the greatest effect on the future of down woody material contributions to statewide forest carbon stocks and wildlife habitat (i.e., stand structure). Overall, because estimated fuel loadings are not exceedingly high across the state, possible fire dangers may be outweighed by the numerous ecosystem services provided by down woody materials.

Forest Indicators of Health and Sustainability

Canopy gap caused by emerald ash borer induced mortality. Photo by Thomas Albright, USDA Forest Service.

Regeneration and Browse Status

Background

Trajectories for long-term sustainability of forest values are set in the forest understory during the stand-initiation stage of development. This makes regeneration management a key factor for sustaining healthy, productive forests (Smith et al. 1997). The Wildlife Society recently issued a policy statement for managing forest biodiversity in the northeastern United States that addresses two tenets of sustainable restoration management (Ronis 2018):

- Sustainable forest management strategies can promote a mosaic of forest structure and age-classes across a landscape and create various habitat types, which contribute to the maintenance of biological diversity.
- Land-use changes, such as natural succession and development, have created an under-representation of both early- and late-successional habitat, and a predominance of secondary growth (40-100 year-old forests) across the region.

Forest restoration management and policy aimed at establishing healthy young forest habitat (YFH) are critically important, but are complicated by multiple stressors and their interactions (e.g., climate variability, invasive plants, herbivory, and wildfire exclusion). Landowner preferences and perceptions surrounding large-scale treatments necessary to create YFH are also major obstacles to the creation and maintenance of such habitat. In 2012, NRS-FIA implemented a set of regeneration indicator (RI) measurement protocols on a subset of NRS-FIA core sample plots (P2) measured during the growing season (P2+) to fill information gaps for managers and policymakers (McWilliams et al. 2015). The findings in this report are based on data collected from 377 sample plots measured from 2012 to 2017 and represent a near complete baseline RI dataset. The procedures count all established tree seedlings at least 2 inches tall by height class and include a browse impact assessment for the area surrounding the plot. The inclusion of small tree seedlings supplements FIA's core P2 seedling tally of hardwood seedlings at least 1 foot in length and softwood seedlings at least 6 inches in length. The new RI findings, regeneration study results, and core P2 results for YFH can help to clarify how current tree reproduction may influence future forests in the Empire State.

What we found

Young forest habitat as described by Swanson et al. (2011) defines early succession plant communities as occupying potential forest land between the stand-initiation and canopy closure stages. FIA's primary indicator of YFH extent, condition, and health is stand-age class in 10- or 20-year classes. The broader 0 to 20 year class is more inclusive and has the requisite flexibility for analyzing the region's many forest biomes that regenerate on different schedules. Age class is a useful indicator of early succession brushy seedling-shrub habitat that supports early-succession forest obligate and facultative wildlife species, such as American Woodcock (*Scolopax minor*), or golden-winged warbler (*Vermivora chrysoptera*), and codependent species such as bobcat (*Lynx rufus*) and snowshoe hare (*Lepus americanus*).

Currently, only 4 percent (or 693,206 acres) of New York forest land is YFH based on forest land 20 years or younger. (This includes 2 percent [279,899 acres] in the 0- to 10-year class; however, the low number of samples in this class precludes more detailed estimates.) The acreage of YFH today is about half of what was recorded in 2005. The top five forest-type groups by volume that account for 89 percent of the total forest land in New York, all have low amounts of YFH (Table 5), ranging from 2 percent for maple/beech/birch to 5 percent for elm/ash/cottonwood.

Table 5.—Summary of young forest habitat[a] resource for the top five forest-type groups by volume, New York, 2012-2017

Forest-type group	Forest land (percent)	Young forest (percent)	Young forest (acres)	Young forest confidence interval (acres)[b]
Maple/beech/birch	55	2	192,825	32,587
Oak/hickory	17	3	114,105	25,126
Elm/ash/cottonwood	7	5	69,089	18,861
White/red/jack pine	6	2	21,101	10,097
Spruce/fir	4	4	25,100	11,426

[a] Young forest habitat is defined here as the area of forest land in the 0-20 year age class.

[b] Confidence intervals based on 68 percent sampling errors.

The impacts of large ungulate browsing of young tree seedlings are a paramount impediment to establishing viable forest regeneration (Russell et al. 2001). Areas where forest lands have had at least moderate browse impacts require consideration of whether or not ameliorative treatments need to be included in regeneration management prescriptions (Brose et al. 2008). In New York, the primary browse agent is the white-tailed deer (*Odocoileus virginianus*). Forty-nine percent of the samples had moderate impacts that generally follow the location of forest land (Fig. 67). Fifteen percent were classified as having high impacts and were associated with three notable areas: southern Adirondack Mountains, Catskill Mountains, and the State's southeastern corner. High impacts were also observed, but to a lesser extent, in the Allegheny Plateaus to the west. These results correspond to a probability map of browse impacts (Fig. 68) developed for the 24 NRS-FIA states (McWilliams et al. 2018). These areas indicate an expansion of regeneration problem areas identified by Shirer and Zimmerman (2010) using core FIA seedlings (Fig. 69).

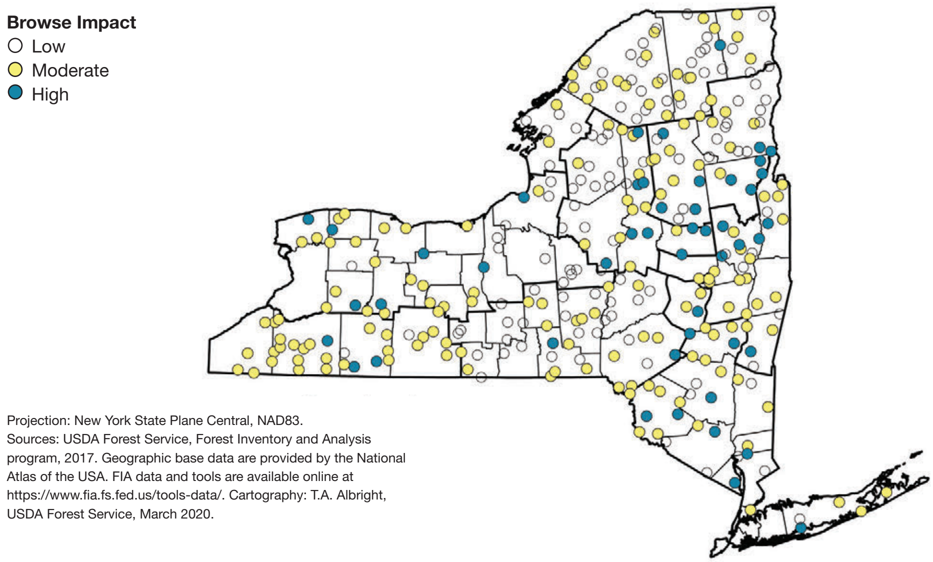


Figure 67.—Browse impact level on forested P2+ sample plots, New York, 2017. Depicted plot locations are approximate.

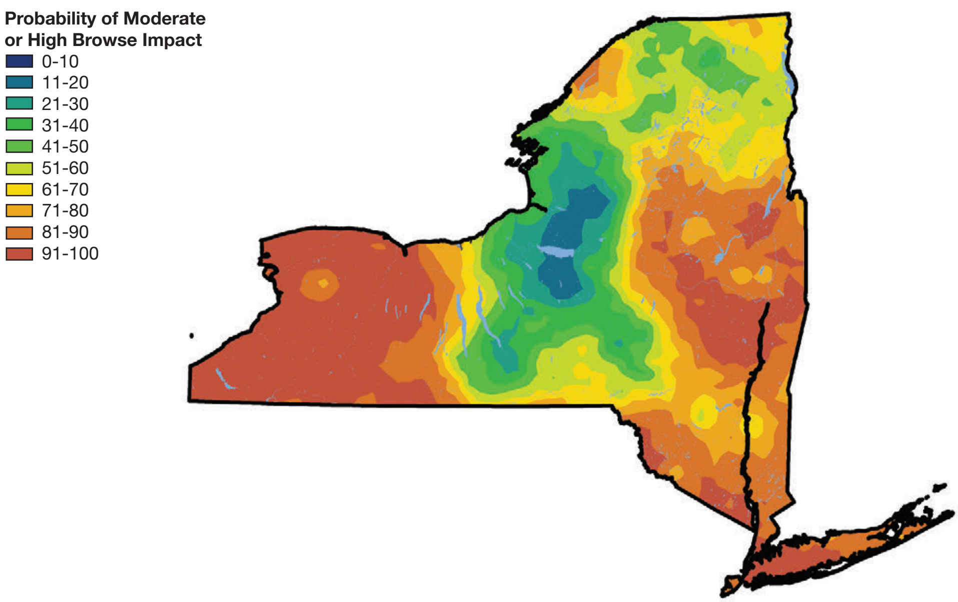


Figure 68.—Probability of moderate or high browse impact New York, 2017.

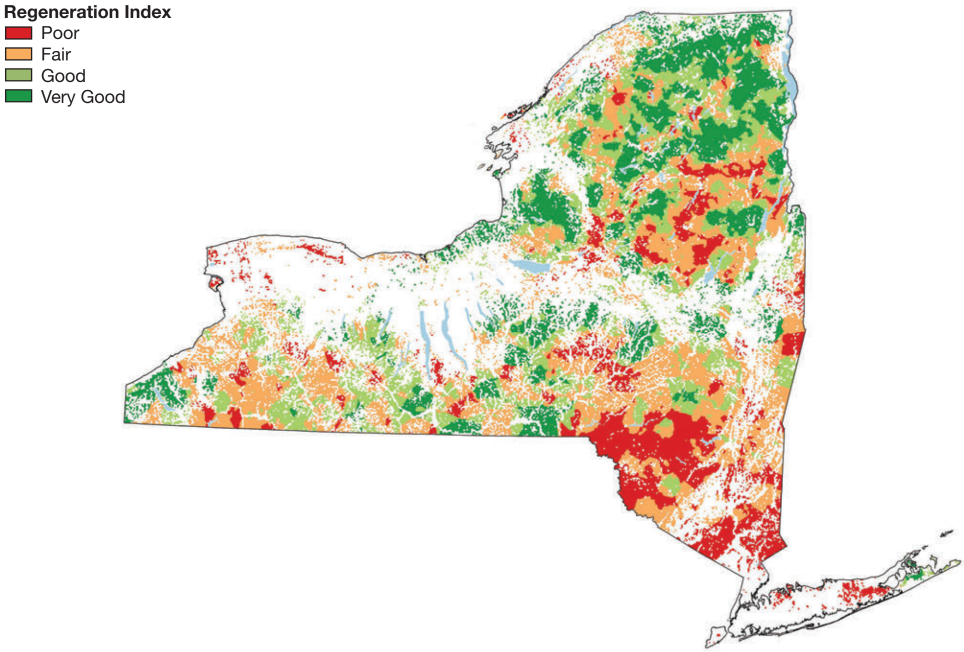


Figure 69.—Predicted values for regeneration index of native canopy species, New York, 2010 (Source: Shirer and Zimmerman 2010).

The RI estimate of the number of established seedlings at least 2 inches tall is 143.3 billion, or 7,280 per acre. Comparing tree-seedling composition (taxa) and abundance (numbers of stems) by size class with total aboveground biomass for dominant and codominant adult trees sheds light on trends in recruitment (Fig. 70). Prospective "gainers" are taxa with comparatively high percentages of stems in the reproduction pool. American beech and balsam fir are showing higher percentages across all seedling size classes. Red maple, yellow birch, and white ash have seeding abundances in balance with the adult population. Sugar maple was less abundant in seedling classes than in dominant and codominant adult classes. Understory species (e.g., striped maple, chokecherry, serviceberry spp., eastern hophornbeam, American hornbeam, hawthorn spp.) represent 16 percent of the seedling component.

A new technique was developed to use the RI seedling tally to approximate highly complex early-stand dynamics that determine composition and structure of the future forest (Vickers et al. 2018). The three-step approach evaluates the security of regeneration by taxonomic group and ecological province. In New York, the maple/beech/birch and oak/hickory type groups were evaluated because they account for the majority of the forest land and have enough samples for making inferences. American beech was excluded for the evaluation of maple/beech/birch because of its poor viability of sprouts and impacts of beech bark disease.

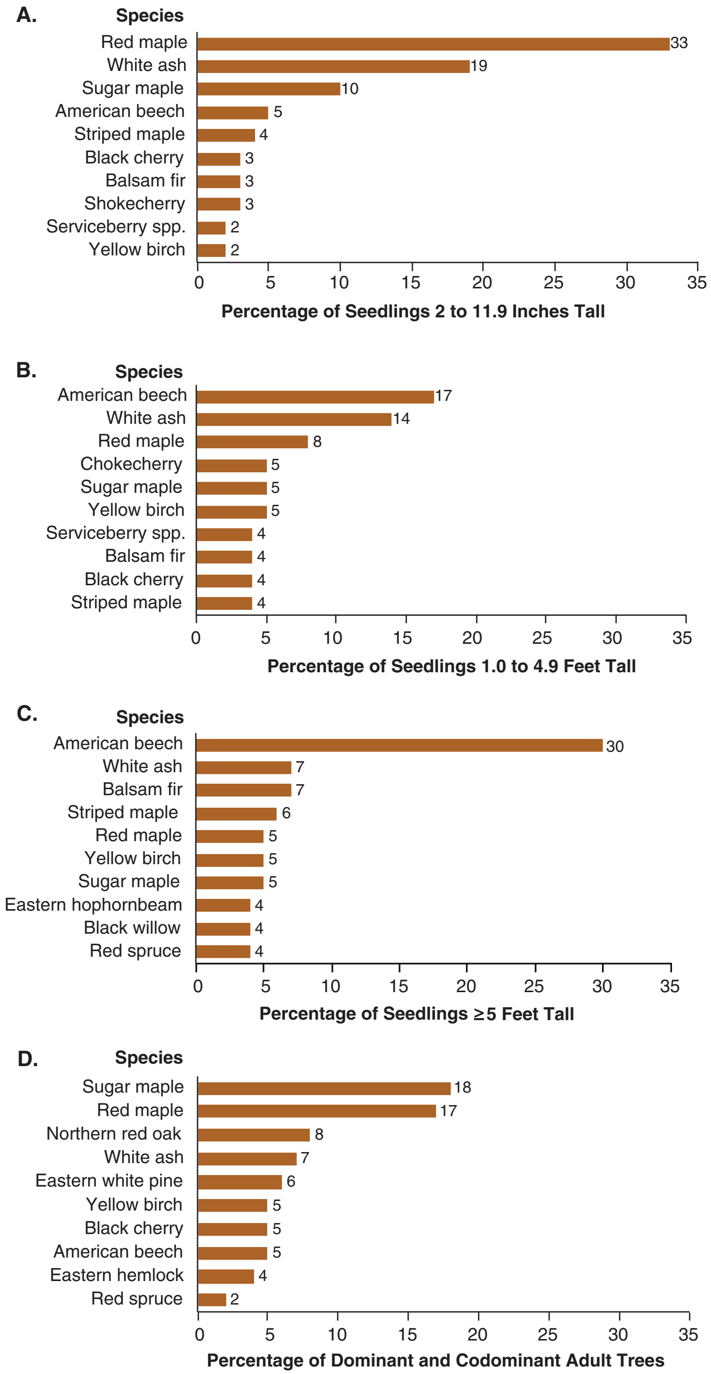


Figure 70.—Percentage of seedlings based on forested P2+ sample plots by height class for the ten most common species in each class: (A) seedlings 2 to 11.9 inches, (B) seedlings 1.0 to 4.9 feet, (C) seedlings ≥5 feet, and (D) percentage of aboveground biomass in dominant and codominant adult trees. New York, 2017.

The first step in this process is to establish meaningful regeneration objectives for desired future forest conditions. Two contrasting objectives help to evaluate whether there are enough surviving seedlings per acre (target) for regeneration success following a stand-initiating disturbance. The first objective is stand replacement, which evaluates regeneration security of any species capable of reaching the canopy of YFH at a future date (endpoint). The goal is to attain a fully-stocked stand based on attributes from published silvicultural guides. The second objective is species maintenance, which focuses on retaining the dominant taxa for the type group. For maple/beech/birch, the goal is to maintain a cohort of maple and associate species in the canopy 30 years following disturbance (based on Leak et al. 2014). For oak/hickory, the goal is to maintain a cohort of oak, hickory, and associates in the canopy 20 years following disturbance (based on Gingrich 1967).

The next step is to calculate the maximum annual rate of seedling mortality, or allowable mortality, that can be afforded and still meet the regeneration objective. This is accomplished by estimating the annual survival rate required for the inventoried reproduction to meet the target condition by the assumed endpoint. Allowable mortality is equal to 1 minus the survival rate.

The last step is to compare allowable mortality to expected mortality from published reports. A forested condition is considered to have secure regeneration if allowable mortality exceeds expected mortality for the objective and type group of interest. This approach has flexibility to adjust taxa-specific objectives, targets, endpoints, and expected mortality to reflect different scenarios.

The results of the regeneration security assessment were used to estimate the marginal proportion of secure regeneration across samples. Proportions for stand replacement and species maintenance for maple/beech/birch and oak/hickory forest-type groups were calculated for the State (Table 6). Sixty-seven and 51 percent of the maple/beech/birch samples were secure for stand replacement and species maintenance, respectively, compared to 59 and 27 percent for oak/hickory samples. The maple/beech/birch group had favorable proportions of secure regeneration across the State for both objectives. Proportions were highest in the Adirondack region. The oak/hickory group is typified by favorable proportions for stand replacement and less favorable for species maintenance.

The effects of browsing are reflected in the proportions of secure samples for each regeneration objective and browse impact level (Table 7). For the maple/beech/birch group, 67 and 49 percent of the total samples with moderate browse impacts were secure for the stand replacement and species maintenance objectives respectively, compared to 53 and 37 percent for samples with high impact. For oak/hickory, moderate-impact samples were 62 and 27 percent for the two objectives. Comparison of proportions for the species maintenance objective for samples under moderate conditions show marked differences for the two type groups: maple/beech/birch at 49 percent versus oak/hickory at 27 percent. The error rates for samples classified as high impact were too large for reliable comparisons.

Table 6.—Sample size for forest land classified as maple/beech/birch and oak/hickory and proportion of samples by regeneration objective and regeneration security status, New York, 2012-2017

		Stand replacement			Species maintenance		
Forest-type group	**Sample size**	**Fail**	**Insecure**	**Secure**	**Fail**	**Insecure**	**Secure**
	# of samples	-------*percent of samples*------			------*percent of samples*------		
Maple/beech/birch[a]	157	16	17	67	38	11	51
Oak/hickory	41	34	7	59	71	2	27

[a] Evaluation of regeneration security for maple/beech/birch excluded American beech because of poor viability of sprouts and beech bark disease impacts.

Table 7.—Sample size for forest land classified as maple/beech/birch and oak/hickory and proportion of samples with secure regeneration by browse impact, and regeneration objective, New York, 2012-2017

	Sample size			Stand replacement			Species maintenance		
Forest-type group	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
	----*number of samples*----			---*percent of samples secure*---			---*percent of samples secure*---		
Maple/beech/birch[a]	45	93	19	73	67	53	60	49	37
Oak/hickory	8	26	7	87	62	14	25	27	29

[a] Evaluation of regeneration security for maple/beech/birch excluded American beech because of poor viability of sprouts and beech bark disease impacts.

What this means

As forests continue to mature, the rich array of goods, services, and wildlife habitat available from YFH is missing across most of New York. The trend towards larger, older stands will likely continue as today's young and middle-age forest land advances to older age classes. The issue for YFH revolves around the lack of new young stands to replace those that are advancing to older age classes. Restoring older stands following disturbances will be pivotal for securing future canopy trees to provide the many values New Yorkers have come to expect while also providing healthy new YFH. Because of the importance of YFH to future forest composition and health, managers and policymakers should consider the dearth of YFH when making plans to enhance forest biodiversity.

The ecological implications of browsing have acute long-term impacts on forest composition, structure, and function (Côté et al. 2004, Russell et al. 2001) and are becoming more prominent in the minds of managers and landowners. The New York Forest Owners Association (2018) has concluded that deer browsing is the number one problem threatening the future of woodlands in New York. The results of the browse evaluation confirm that forest regeneration management will need to consider local browse conditions during the stand-initiation stage across much of the State.

The RI seedling inventory revealed prospective shifts in composition of canopy adults. Positive indications for American beech, balsam fir, and red spruce seedling signal a future as canopy dominants. American beech has the potential to expand its dominance, but beech bark disease and the questionable ability of root sprouts to survive to sawtimber size leave this issue unresolved and something to watch in future inventories. The findings for seedlings support the need for control of nonviable beech brush, and along with the presence of an abundance of saplings, suggest red maple and yellow birch reproduction are set to maintain dominance in the future. A future for white ash appears plausible, but impacts of the emerald ash borer need to be considered.

The regeneration security assessment showed that maple/beech/birch regeneration is generally secure as maple and birch seedlings and saplings are abundant. Still, about half of sampled maple/beech/birch locations were not secure for species maintenance. Unfavorable proportions for the oak/hickory stand replacement objective suggest a shift toward more mesophytic associates of the group, (e.g., maple). This adds to the evidence that maintaining an oak component in the future forest will be difficult.

New York forests face a variety of health risks. Establishing desired tree seedlings is an opportunity for addressing many of them during the early stages of forest development. Yet the interactions of factors such as browsing and invasive species, in combination with unfavorable harvesting practices, make it more difficult to establish desired taxa. The RI results indicate that sugar maple, red maple, yellow birch, white ash, balsam fir, and red spruce should continue their canopy dominance. Although a preponderance of American beech seedlings (10 percent of total number of seedlings) and saplings (19 percent of total) were evident, the future of beech is questionable due to the impacts of beech bark disease. The findings strongly suggest the role of eastern white pine, eastern hemlock, and northern red oak will shrink. The future of YFH and related resources will depend on the amount of stand-initiation disturbances (e.g., catastrophic mortality or wind throw) and the relative mix of planned harvests and restoration versus unplanned major disturbances and poorly executed forest management that make establishing advance regeneration more difficult.

Tree Crown Health and Damage

Background

The overall health and crown condition of trees can be impacted by various types of stressors. Biotic stressors include native or introduced insects, diseases, invasive plant species, and animals. Abiotic stressors include storm damage, drought, flooding, cold temperatures, nutrient deficiencies, the physical properties of soils that affect moisture and aeration, and toxic pollutants. 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). New York's forests have suffered from the impacts of well-known exotic and invasive agents such as European gypsy moth (*Lymantria dispar*), hemlock woolly adelgid (*Adelges tsugae*), and the beech bark disease complex for many decades. A more recent invasion includes emerald ash borer (*Agrilus planipennis*).

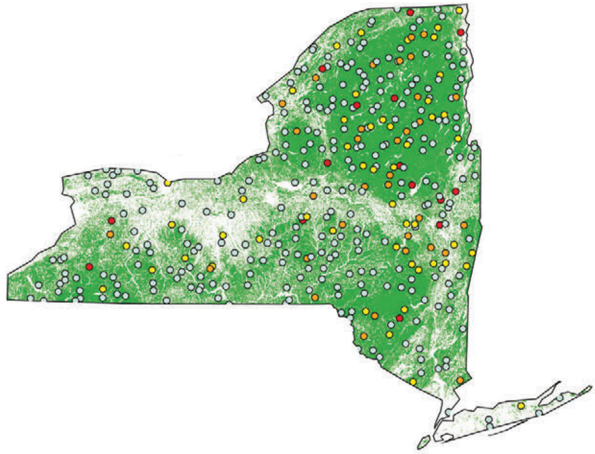
Tree-level crown dieback data is collected on P2+ plots. Crown dieback, defined as recent mortality of branches with fine twigs, reflects the severity of recent stresses on a tree. A crown is labeled as "poor" if crown dieback is greater than 20 percent. This threshold is based on findings by Steinman (2000) that associated crown ratings with tree mortality. Additionally, crown dieback has been shown to be the best crown variable for predicting tree survival (Morin et al. 2015).

Tree damage is assessed for all trees with a d.b.h. of 5.0 inches or greater. Up to three of the following types of damage can be recorded: insect damage, cankers, decay, fire, animal damage, weather, and logging damage. If more than three types of damage are observed, decisions about which three are recorded are based on the relative abundance of the damaging agents.

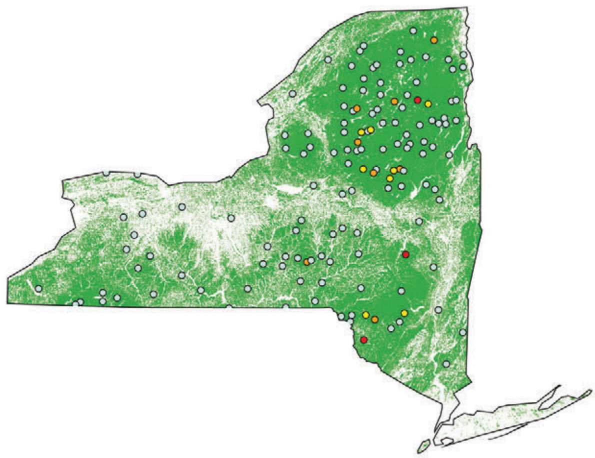
What we found

The incidence of poor crown condition for all species combined is relatively low across New York (Fig. 71a). Additionally, the proportion of basal area with poor crowns was below five percent for all individual species, and there were no notable increases in unhealthy basal area when compared with 2012 (Table 8). However, the occurrence of unhealthy crowns for American beech and ash species (Figs. 71b, c) do appear to be spatially congruent with the statewide distribution of beech bark disease and the recent spread of emerald ash borer.

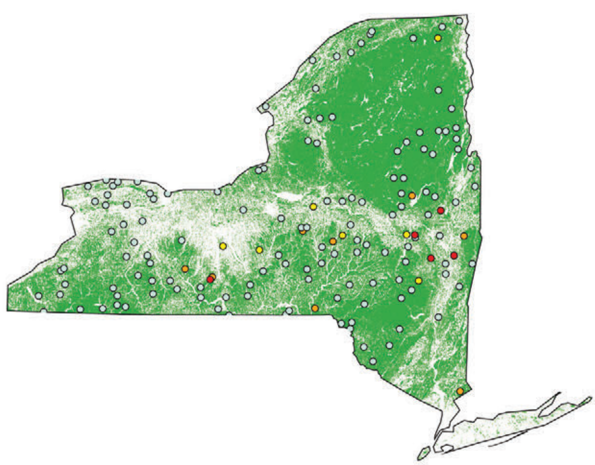
A.



B.



C.



Projection: New York State Plane Central, NAD83. Sources: USDA Forest Service, Forest Inventory and Analysis program, 2009, 2017. Geographic base data are provided by the National Atlas of the USA. FIA data and tools are available online at https://www.fia.fs.fed.us/tools-data/. Cartography: R.S. Morin, USDA Forest Service. November 2018.

Figure 71.—Percentage of live basal area with poor crowns for (A) all species, (B) American beech, and (C) ash species, New York, 2017. Depicted plot locations are approximate.

Table 8.—Percentage of live basal area with poor crowns, by inventory year, New York

	Percent of basal area with poor crowns	
Species	**2012**	**2017**
American beech	4.9	4.7
White ash	4.5	3.3
Red maple	2.1	2.2
Black cherry	2.6	1.5
Sugar maple	2.6	1.5
Yellow birch	2.0	1.1
Eastern white pine	0.0	0.9
Eastern hemlock	0.3	0.5
Northern red oak	0.0	0.2
Red spruce	0.0	0.1

Average crown dieback ranged from less than 1 percent for the major softwood species to 3 percent for black cherry (Table 9). An analysis of the trees from the 2012 inventory that were remeasured in the 2017 inventory revealed that the proportion of the trees that die increases with increasing crown dieback. Over 15 percent of trees with crown dieback greater than 20 percent during the 2012 inventory were dead when visited again during the 2017 inventory (Fig. 72).

Table 9.—Mean crown dieback and other statistics for live trees (>5 inches d.b.h.) on forest land by species, New York, 2017

Species	Trees	Mean	SE	Minimum	Median	Maximum
	-number-	*---------------------------------*		*percent*		*----------------------------*
Black cherry	254	3.2	0.58	0	0	90
White ash	510	3.1	0.47	0	0	99
American beech	797	2.9	0.30	0	0	90
Sugar maple	1,009	1.7	0.17	0	0	99
Red maple	1,759	1.6	0.12	0	0	95
Northern red oak	243	1.4	0.18	0	0	25
Yellow birch	350	1.1	0.22	0	0	50
Red spruce	350	0.8	0.14	0	0	20
Eastern hemlock	755	0.6	0.14	0	0	70
Eastern white pine	545	0.4	0.10	0	0	40

Damage was recorded on approximately 36 percent of the trees in New York, and the most frequent types of damage overall were decay (24 percent) and cankers (7 percent) (Fig. 73). The incidence of decay ranged from 7 percent of red spruce to 44 percent of American beech trees, and cankers ranged from nearly zero on the softwood species and northern red oak to 67 percent of American beech. Notably, insect damage was present on 53 percent of eastern white pine trees. The occurrence of all other injury types was very low.

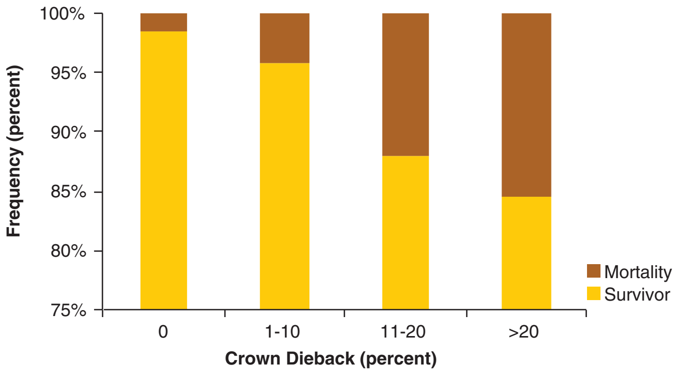


Figure 72.—Crown dieback distribution by tree survivorship for remeasured trees, New York, 2012 to 2017.

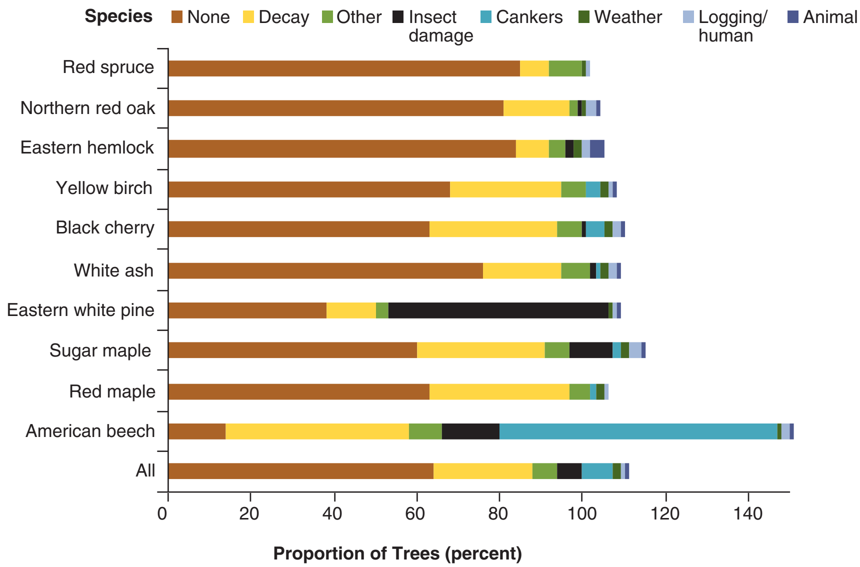


Figure 73.—Percentage of trees with damage, by species, New York, 2017. Categories sum to greater than 100 percent due to up to three damage types recorded per tree.

What this means

The trees of most important species in the forests of New York generally have healthy crowns. However, the incidence of poor crown health in American beech and ash species does appear to be correlated with the impacts of invasive forest pests. Crown health of ash species should be monitored closely in the coming years given the recent introduction of emerald ash borer (see "Emerald Ash Borer" on page 103).

Decay was the most commonly observed damage. This is not unusual given that over 65 percent of New York's forests are large diameter stands composed of mature trees. The high incidence of insect damage on eastern white pine is due to the accumulation of deformed stems caused by the native white pine weevil, *Pissodes strobi* (Peck). Although the weevil damage does not typically kill trees, the form and quality of saw logs is impacted. The high frequency of cankers on American beech is due to the long history of beech bark disease in the region.

Invasive Plant Species

Background

Invasive plant species (IPS) are a concern throughout the world. Some invasive plants are alternate hosts for insects and diseases and can cause severe agricultural impacts. The presence of IPS also affects forest structure, health, and diversity. These invaders often form dense understory layers that limit light, nutrient, and water availability. While some invasive plants have beneficial qualities, such as for medicinal purposes (e.g., common barberry) (Kurtz 2013) or culinary use (e.g., garlic mustard), the negative impacts to ecosystems are problematic and typically outweigh the benefits. The monitoring and removal of IPS cost billions of dollars annually. Because of the vast implications caused by IPS, it is important to increase awareness through informing and educating private landowners and the general public.

What we found

During the 2017 inventory, 430 P2 invasive plots in New York were monitored for the presence of 39 IPS and one undifferentiated genus (nonnative bush honeysuckle) (Table 10) as a part of the invasive plant monitoring protocol. Twenty-seven different IPS were observed (Table 11). In comparison to the 2012 data, one new species, English ivy, was observed. Three species observed in 2012 (European cranberrybush, leafy spurge, and chinaberry) were not found in 2017. Nonnative bush honeysuckle was the most commonly observed IPS, occurring on 165 plots (38.4 percent). Multiflora rose was the second most commonly observed invasive plant, occurring on 139 plots (32.3 percent). Both of these species are found throughout New York (Figs. 74, 75) with the exception of much of the northeast part of the State where there are fewer major roads, a lower human population density, and higher elevation.

Table 10.—List of invasive plant species monitored by the Northern Research Station on Forest Inventory and Analysis P2 invasive plots, 2007 to present

Tree Species	Vine Species
Black locust (*Robinia pseudoacacia*)	English ivy (*Hedera helix*)
Chinaberry (*Melia azedarach*)	Japanese honeysuckle (*Lonicera japonica*)
Norway maple (*Acer platanoides*)	Oriental bittersweet (*Celastrus orbiculatus*)
Princesstree (*Paulownia tomentosa*)	
Punktree (*Melaleuca quinquenervia*)	**Herbaceous Species**
Russian olive (*Elaeagnus angustifolia*)	Black swallow-wort (*Cynanchum louiseae*)
Saltcedar (*Tamarix ramosissima*)	Bohemian knotweed (*Polygonum xbohemicum*)
Siberian elm (*Ulmus pumila*)	Bull thistle (*Cirsium vulgare*)
Silktree (*Albizia julibrissin*)	Canada thistle (*Cirsium arvense*)
Tallow tree (*Triadica sebifera*)	Creeping jenny (*Lysimachia nummularia*)
Tree of heaven (*Ailanthus altissima*)	Dames rocket (*Hesperis matronalis*)
	European swallow-wort (*Cynanchum rossicum*)
Woody Species	Garlic mustard (*Alliaria petiolata*)
Autumn olive (*Elaeagnus umbellata*)	Giant knotweed (*Polygonum sachalinense*)
Common barberry (*Berberis vulgaris*)	Japanese knotweed (*Polygonum cuspidatum*)
Common buckthorn (*Rhamnus cathartica*)	Leafy spurge (*Euphorbia esula*)
European cranberrybush (*Viburnum opulus*)	Purple loosestrife (*Lythrum salicaria*)
European privet (*Ligustrum vulgare*)	Spotted knapweed (*Centaurea stoebe* ssp. *micranthos*)
Glossy buckthorn (*Frangula alnus*)	
Japanese barberry (*Berberis thunbergii*)	**Grass Species**
Japanese meadowsweet (*Spiraea japonica*)	Common reed (*Phragmites australis*)
Multiflora rose (*Rosa multiflora*)	Nepalese browntop (Japanese stiltgrass; *Microstegium vimineum*)
Nonnative bush honeysuckles (*Lonicera* spp.)	
	Reed canarygrass (*Phalaris arundinacea*)

Table 11.—Invasive plant species recorded on Forest Inventory and Analysis P2+ invasive plots, New York, 2017

Species	Number of plots	Percentage of plots
Nonnative bush honeysuckle	165	38.4
Multiflora rose	139	32.3
Common buckthorn	90	20.9
Garlic mustard	60	14.0
Japanese barberry	29	6.7
Creeping jenny	23	5.3
Oriental bittersweet	19	4.4
Autumn olive	19	4.4
Black locust	18	4.2
Glossy buckthorn	16	3.7
Reed canarygrass	12	2.8
Dames rocket	11	2.6
European privet	10	2.3
Norway maple	6	1.4
Tree of heaven	5	1.2
Nepalese browntop/Japanese stiltgrass	5	1.2
Bull thistle	4	0.9
Japanese honeysuckle	3	0.7
Canada thistle	3	0.7
Spotted knapweed	2	0.5
Common reed	2	0.5
English ivy	1	0.2
Louise's swallow-wort	1	0.2
European swallow-wort	1	0.2
Common barberry	1	0.2
Purple loosestrife	1	0.2
Japanese knotweed	1	0.2

Nonnative Bush Honeysuckle

○ Absent

● Present

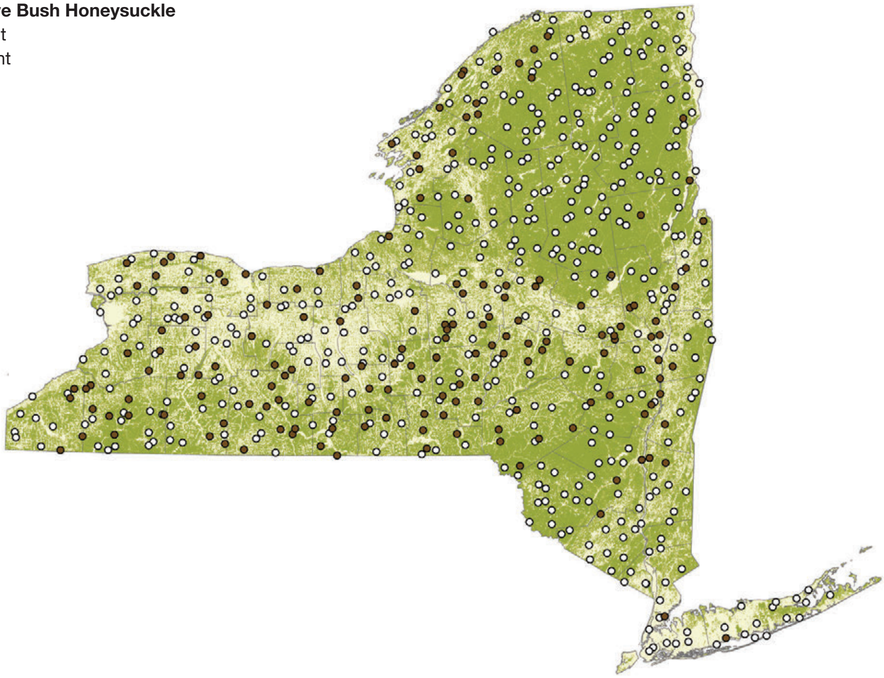


Figure 74.—Presence of nonnative bush honeysuckle on P2 invasive plots, New York, 2017. Plot locations are approximate.

Multiflora Rose

○ Absent

● Present

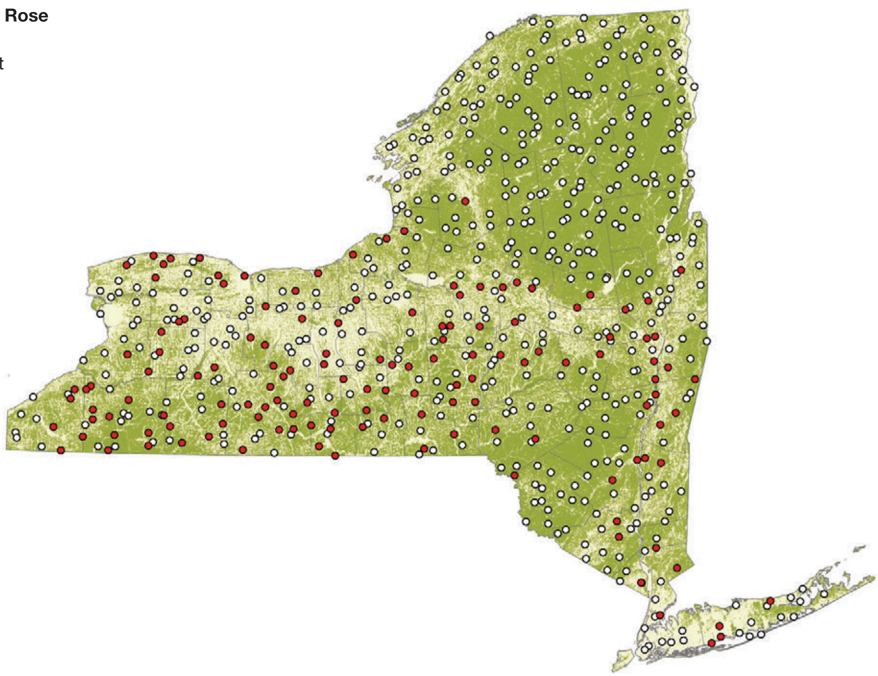


Figure 75.—Presence of multiflora rose on P2 invasive plots, New York, 2017. Plot locations are approximate.

Invasive plant species were found on 54.9 percent of the plots. This is similar to what was found in 2012 when nearly 51 percent of plots had one or more IPS (Widmann et. al 2015). Plots had between zero and eight invasive plants per plot (Fig. 76). The percentage of plots invaded in New York is more than double that of neighboring Vermont at 23.8 percent (Morin et al. 2020) and nearly equal to Southern New England[4] at 54.1 percent.

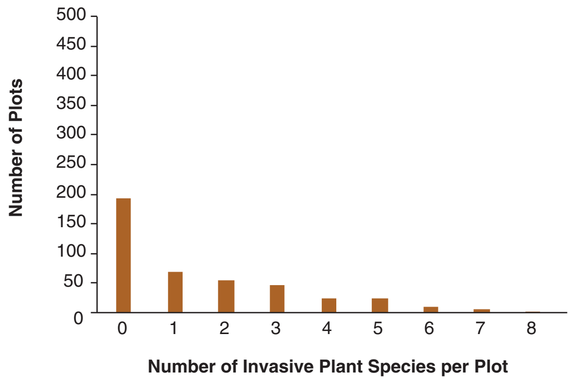


Figure 76.—Number of monitored invasive plant species per plot, by number of P2 invasive plots on which they were found, New York, 2017.

What this means

Invasive plants species impact a number of ecological functions, and the relatively high number of IPS in New York is concerning. Invasive plants are troublesome because they can cause detrimental forest changes. These plants can change hydrology, displace native species, and reduce the aesthetics of an area. Heavily infested areas may result in a change in wildlife habitat. Once established, IPS can rapidly increase in cover and impact co-occurring native plant species. Through continual monitoring of invasive species, managers can remain aware of the presence of these aggressive species, including any newly observed IPS, and be more informed to make better management decisions.

[4] Butler et al. [N.d.] The forests of Southern New England, 2017. Manuscript in preparation. On file with author.

Forest Insects and Diseases of Special Concern

Emerald Ash Borer

Background

Emerald ash borer (*Agrilus planipennis*; EAB), a wood-boring beetle native to Asia, was first detected in North America in 2002, where it was found near Detroit, MI (Herms and McCullough 2014). Because EAB is difficult to detect at low-levels, natural spread is enhanced by human-mediated transportation of infested materials. Therefore, the spread of EAB has outpaced detection with population establishment averaging 3 to 8 years prior to identification (Herms and McCullough 2014). In New York, EAB was initially detected in the western part of the State in 2009 and along the Hudson River Valley in 2010. Continued spread has resulted in the detection of EAB across the majority of the State. All North American ash species (*Fraxinus* spp.) are hosts of EAB, and although EAB shows some preference for stressed trees, all trees 1 inch in diameter or greater are susceptible, regardless of vigor (Herms and McCullough 2014). While mortality due to EAB varies by infestation level, a mortality-to-gross-growth ratio above 0.6 is indicative of an acute forest health issue (Conkling et al. 2005).

What we found

New York forest land contains an estimated 921.7 million ash trees (greater than or equal to 1 inch in diameter), or 8 percent of total species abundance on forest land. White ash is the most prevalent ash species (75 percent), followed by green ash (18 percent), and black ash (7 percent). Found across the State, ash is most densely concentrated in western New York and the Catskills region (Fig. 77). Even though ash is present on 8.7 million acres, or 47 percent of forest land, it generally makes up less than 25 percent of total live-tree basal area (Fig. 78). Average annual mortality of ash on forest land increased from 28.7 million cubic feet in 2012 to 44.6 million cubic feet in 2017; ash mortality represented 9 percent of total mortality in 2017. Between 2012 and 2017, the mortality-to-gross-growth ratio for ash increased from 0.29 to 0.44 (Fig. 79).

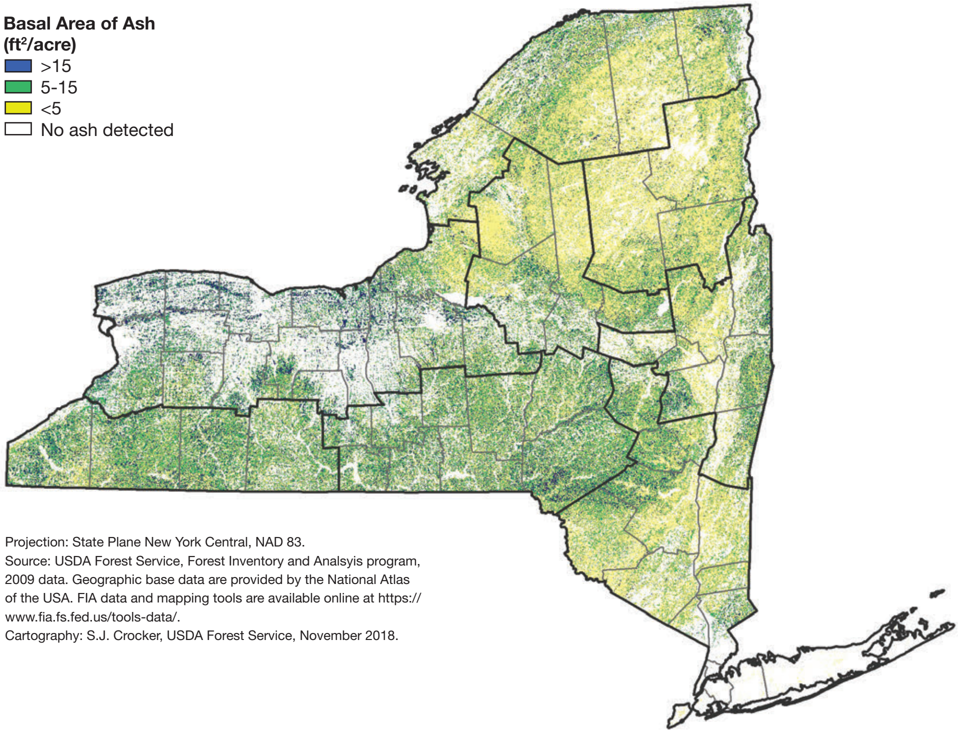


Figure 77.—Ash density on forest land, New York, 2009.

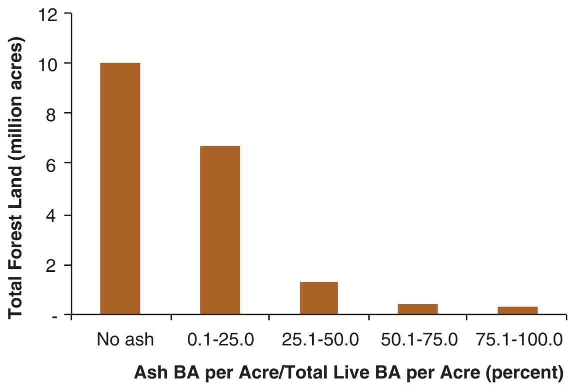


Figure 78.—Presence of ash on forest land, as a percentage of total live-tree basal area (BA), New York, 2017.

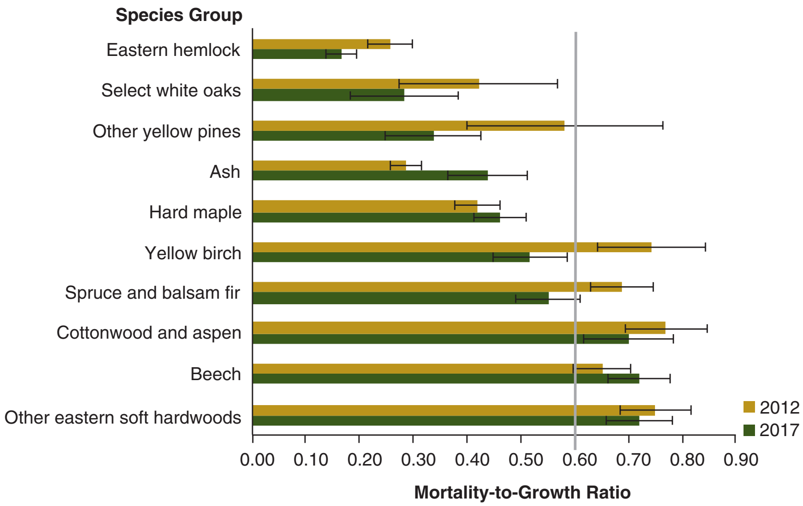


Figure 79.—Ratio of average annual mortality volume to gross growth volume for selected species groups on forest land by inventory year, New York. Error bars represent a 68 percent confidence interval around the mean. Vertical line indicates 0.6 threshold for potential acute forest health issue (Conkling et al. 2005).

What this means

Ash makes up an important component of New York's woodland, riparian, and urban forest resource. Given the statewide abundance of forest land, the predominance of ash in low density stands, and the relatively recent emergence of EAB in the State, changes in ash abundance and mortality (mortality-to-gross-growth ratio < 0.6) related to the presence of EAB are fairly low. However, EAB has caused extensive ash mortality throughout the eastern United States and represents a significant threat to the ash resource in New York. Mortality of ash is expected to increase as EAB persists and populations grow. The loss of ash in forested ecosystems will affect species composition and alter community dynamics. Continued monitoring will help to identify the long-term impacts of EAB in forested settings.

Hemlock Woolly Adelgid

Background

White "wool" on the branches of eastern hemlock is a tell-tale sign of a hemlock woolly adelgid (*Adelges tsugae*; HWA) infestation (USFS 2010b). A tiny, sap-feeding insect from Asia, HWA was first reported in the eastern United States in Virginia in 1951. By 1985, the adelgid had spread to Long Island and the lower Hudson Valley in New York (NYSDEC 2016). In the northern range of hemlock, tree decline and mortality generally occurs within 4 to 10 years of infestation (USFS 2010b). The rate of tree mortality increases if infested trees also experience drought, attack by secondary insects and diseases, or other stresses.

What we found

There are an estimated 530.5 million eastern hemlock trees (greater than 1 inch in diameter) on New York forest land, a 3 percent decrease since 2007. While hemlock is distributed across much of the State, it is concentrated in northern New York (Fig. 80). Approximately 77 percent of the hemlock trees occur on rolling upland sites (i.e., sites with gently rolling hills and small streams), while 5 percent are found on wetland or floodplain sites. From 2012 to 2017, average annual mortality of hemlock on forest land decreased slightly from 18.6 million cubic feet to 13.9 million cubic feet. Sixty-four percent of hemlock mortality occurred in the Catskill-Lower Hudson and South-Central Highlands units, where HWA has been present the longest.

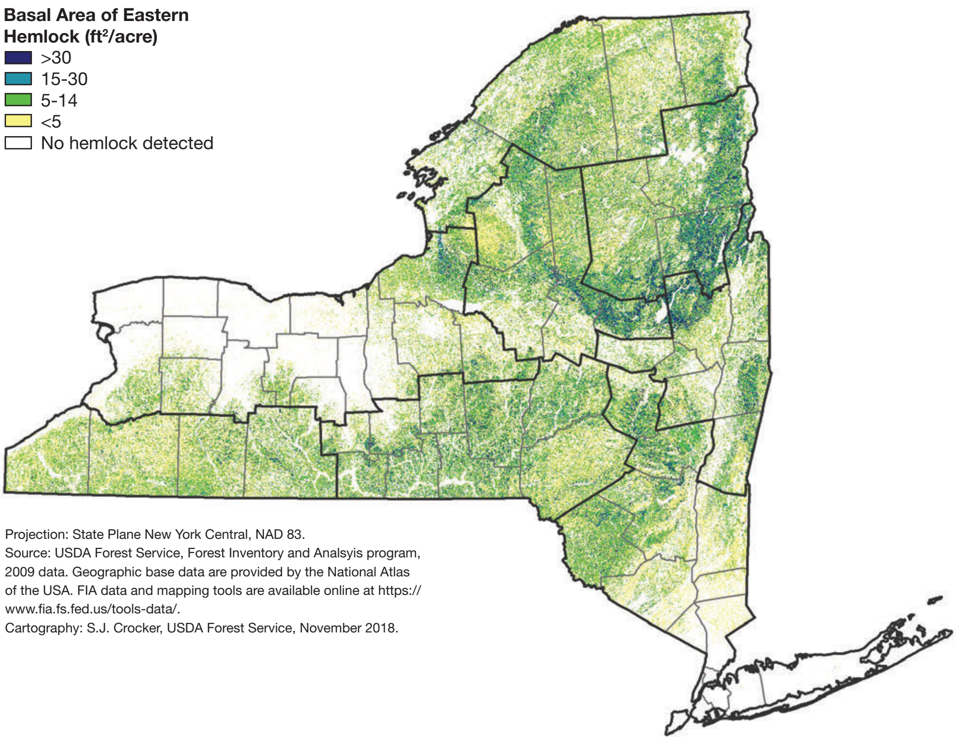


Figure 80.—Eastern hemlock density on forest land, New York, 2009.

What this means

Eastern hemlock is a unique and important component of New York's forests. As a foundation species, hemlock plays a key role in defining the ecosystem of which it is a part and creating conditions necessary for the survival of other species (Ellison 2014, Ellison et al. 2005). Loss or removal of hemlock has been shown to cause pronounced changes in the composition of associated flora and fauna (Ellison 2014). Therefore, the loss of hemlock due to the activity of HWA could have a significant impact on the future structure and composition of New York's forests. Currently, hemlock mortality is highest in areas where HWA has been active the longest, suggesting this mortality is likely due to HWA. Continued monitoring of the hemlock resource will help to quantify the effects of HWA in New York.

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Appendix

Tree species (>1 inch in diameter) found on Forest Inventory and Analysis inventory plots, New York, 2017

Common name	Genus	Species	Species group
balsam fir	*Abies*	*balsamea*	Spruce and balsam fir
Fraser fir	*Abies*	*fraseri*	Other eastern softwoods
eastern redcedar	*Juniperus*	*virginiana*	Other eastern softwoods
tamarack (native)	*Larix*	*laricina*	Other eastern softwoods
larch spp.	*Larix*	spp.	Other eastern softwoods
Norway spruce	*Picea*	*abies*	Other eastern softwoods
white spruce	*Picea*	*glauca*	Spruce and balsam fir
black spruce	*Picea*	*mariana*	Spruce and balsam fir
blue spruce	*Picea*	*pungens*	Other eastern softwoods
red spruce	*Picea*	*rubens*	Spruce and balsam fir
jack pine	*Pinus*	*banksiana*	Jack pine
Table Mountain pine	*Pinus*	*pungens*	Other yellow pines
red pine	*Pinus*	*resinosa*	Eastern white and red pines
pitch pine	*Pinus*	*rigida*	Other yellow pines
eastern white pine	*Pinus*	*strobus*	Eastern white and red pines
Scotch pine	*Pinus*	*sylvestris*	Other yellow pines
Douglas-fir	*Pseudotsuga*	*menziesii*	Other eastern softwoods
northern white-cedar	*Thuja*	*occidentalis*	Other eastern softwoods
eastern hemlock	*Tsuga*	*canadensis*	Eastern hemlock
boxelder	*Acer*	*negundo*	Other eastern soft hardwoods
striped maple	*Acer*	*pensylvanicum*	Eastern noncommercial hardwoods
Norway maple	*Acer*	*platanoides*	Hard maple
red maple	*Acer*	*rubrum*	Soft maple
silver maple	*Acer*	*saccharinum*	Soft maple
sugar maple	*Acer*	*saccharum*	Hard maple
mountain maple	*Acer*	*spicatum*	Eastern noncommercial hardwoods
ailanthus	*Ailanthus*	*altissima*	Eastern noncommercial hardwoods
European alder	*Alnus*	*glutinosa*	Eastern noncommercial hardwoods
serviceberry spp.	*Amelanchier*	spp.	Eastern noncommercial hardwoods
yellow birch	*Betula*	*alleghaniensis*	Yellow birch
sweet birch	*Betula*	*lenta*	Other eastern hard hardwoods
river birch	*Betula*	*nigra*	Other eastern soft hardwoods
paper birch	*Betula*	*papyrifera*	Other eastern soft hardwoods
gray birch	*Betula*	*populifolia*	Other eastern soft hardwoods
American hornbeam, musclewood	*Carpinus*	*caroliniana*	Eastern noncommercial hardwoods
mockernut hickory	*Carya*	*alba*	Hickory

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(Appendix continued)

Common name	Genus	Species	Species group
bitternut hickory	*Carya*	*cordiformis*	Hickory
pignut hickory	*Carya*	*glabra*	Hickory
shellbark hickory	*Carya*	*laciniosa*	Hickory
shagbark hickory	*Carya*	*ovata*	Hickory
American chestnut	*Castanea*	*dentata*	Eastern noncommercial hardwoods
northern catalpa	*Catalpa*	*speciosa*	Other eastern soft hardwoods
hackberry	*Celtis*	*occidentalis*	Other eastern soft hardwoods
flowering dogwood	*Cornus*	*florida*	Other eastern hard hardwoods
hawthorn spp.	*Crataegus*	spp.	Eastern noncommercial hardwoods
American beech	*Fagus*	*grandifolia*	Beech
white ash	*Fraxinus*	*americana*	Ash
black ash	*Fraxinus*	*nigra*	Ash
green ash	*Fraxinus*	*pennsylvanica*	Ash
butternut	*Juglans*	*cinerea*	Other eastern soft hardwoods
black walnut	*Juglans*	*nigra*	Black walnut
sweetgum	*Liquidambar*	*styraciflua*	Sweetgum
yellow-poplar	*Liriodendron*	*tulipifera*	Yellow-poplar
cucumbertree	*Magnolia*	*acuminata*	Other eastern soft hardwoods
sweet crab apple	*Malus*	*coronaria*	Eastern noncommercial hardwoods
apple spp.	*Malus*	spp.	Eastern noncommercial hardwoods
white mulberry	*Morus*	*alba*	Other eastern hard hardwoods
red mulberry	*Morus*	*rubra*	Other eastern hard hardwoods
blackgum	*Nyssa*	*sylvatica*	Tupelo and blackgum
eastern hophornbeam	*Ostrya*	*virginiana*	Eastern noncommercial hardwoods
American sycamore	*Platanus*	*occidentalis*	Other eastern soft hardwoods
balsam poplar	*Populus*	*balsamifera*	Cottonwood and aspen
eastern cottonwood	*Populus*	*deltoides*	Cottonwood and aspen
bigtooth aspen	*Populus*	*grandidentata*	Cottonwood and aspen
quaking aspen	*Populus*	*tremuloides*	Cottonwood and aspen
American plum	*Prunus*	*americana*	Eastern noncommercial hardwoods
sweet cherry, domesticated	*Prunus*	*avium*	Eastern noncommercial hardwoods
pin cherry	*Prunus*	*pensylvanica*	Eastern noncommercial hardwoods
black cherry	*Prunus*	*serotina*	Other eastern soft hardwoods
chokecherry	*Prunus*	*virginiana*	Eastern noncommercial hardwoods
white oak	*Quercus*	*alba*	Select white oaks
swamp white oak	*Quercus*	*bicolor*	Select white oaks
scarlet oak	*Quercus*	*coccinea*	Other red oaks
northern pin oak	*Quercus*	*ellipsoidalis*	Other red oaks
scrub oak	*Quercus*	*ilicifolia*	Eastern noncommercial hardwoods
bur oak	*Quercus*	*macrocarpa*	Select white oaks

(Appendix continued on next page.)

(Appendix continued)

Common name	Genus	Species	Species group
chinkapin oak	*Quercus*	*muehlenbergii*	Select white oaks
pin oak	*Quercus*	*palustris*	Other red oaks
chestnut oak	*Quercus*	*prinus*	Other white oaks
northern red oak	*Quercus*	*rubra*	Select red oaks
post oak	*Quercus*	*stellata*	Other white oaks
black oak	*Quercus*	*velutina*	Other red oaks
black locust	*Robinia*	*pseudoacacia*	Other eastern hard hardwoods
Bebb willow	*Salix*	*bebbiana*	Eastern noncommercial hardwoods
black willow	*Salix*	*nigra*	Other eastern soft hardwoods
weeping willow	*Salix*	*sepulcralis*	Other eastern soft hardwoods
sassafras	*Sassafras*	*albidum*	Other eastern soft hardwoods
American mountain-ash	*Sorbus*	*americana*	Eastern noncommercial hardwoods
European mountain-ash	*Sorbus*	*aucuparia*	Eastern noncommercial hardwoods
northern mountain-ash	*Sorbus*	*decora*	Eastern noncommercial hardwoods
American basswood	*Tilia*	*americana*	Basswood
American elm	*Ulmus*	*americana*	Other eastern soft hardwoods
slippery elm	*Ulmus*	*rubra*	Other eastern soft hardwoods
rock elm	*Ulmus*	*thomasii*	Other eastern hard hardwoods

White pine in young red maple stand. Photo by Thomas Albright, USDA Forest Service.

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This report constitutes the third full report of annualized inventory on New York forest land and summarizes field data collected from 2011 through 2017. New York has 18.7 million acres of forest land on which 94 tree species and 55 forest types were identified. Net cubic-foot, growing-stock, and sawtimber volumes continued to increase, as did the area occupied by large diameter stands. The net growth-to-harvest removals ratio increased from 2.3:1 in 2012 to 2.8:1 in 2017. Substantial forest health challenges, including invasive insect pests and invasive plant species, continue to impact the forest resources of the State. Additional information on land-use change, fragmentation, ownership, forest composition, structure, age, carbon stocks, reserved land, and regeneration of New York forests is also presented. Supplemental resources are available online at https://doi.org/10.2737/NRS-RB-121 and include: (1) tables that summarize quality assurance and (2) a core set of tabular estimates for a variety of forest resources.

KEY WORDS: inventory, land use, fragmentation, forest statistics, forest land, timberland, forest ownership, forest regeneration, volume, carbon, growth, removals, mortality, forest health, forest pest, invasive plants, New York

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