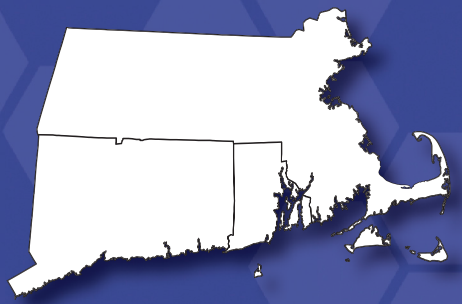
The Forests of Southern New England, 2007



A Report on the Forest Resources of Connecticut, Massachusetts, and Rhode Island

Resource Bulletin
NRS-55

USDA United States Department of Agriculture
Forest Service
Northern Research Station

Abstract

This report summarizes the results of the fifth forest inventory of the forests of Southern New England, defined as Connecticut, Massachusetts, and Rhode Island, conducted by the U.S. Forest Service, Forest Inventory and Analysis program. Previous inventories were conducted in 1998, 1985, 1972, and 1953. Information in this report includes forest attributes, ownership, land-use change, carbon, timber products, forest health, and statistics and quality assurance of data collection. There are 5.1 million acres of forest land across the region: 3.0 million acres of forest land is in Massachusetts, 1.7 million acres in Connecticut, and 0.4 million acres in Rhode Island. This amount has decreased by 5 percent since the last inventory was completed in 1998. There are 2.6 billion trees on this forest land that have a total volume of 12.6 billion cubic feet. Red maple and eastern white pine are the most common species in terms of both numbers of trees and volume. Fifty percent of the forest land is classified as the oak-hickory forest type.

Acknowledgments

There are a great many people who made this report possible. We would like to thank the following individuals for their hard work and dedication: Carol Alerich, Todd Bixby, Aarron Clark, Ted Goodnight, Mark Hansen, John Higham, Bob Ilgenfritz, Erika Mattson, Jason Morrison, Dennis May, Will McWilliams, Dacia Meneguzzo, Anne Quinion, Joyce Quinn, Brian Rudd, Bryan Tirrell, Jim Westfall, John Vissage, and Ashley Zickefoose. Reviews of earlier drafts of this report from Gordon Boyce, Doug Emmerthal, Chris Modisette, Jeff Ward, and Rich Widmann provided useful improvements.

Cover: Fall colors in Southern New England. Photo by Brett J. Butler, U.S. Forest Service.

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Contents

Highlights

On the Plus Side

The landscape is dominated by forest land. Fifty-nine percent, 5.1 million acres, of Southern New England is forested.

There are approximately 2.6 billion trees (≥1 inch d.b.h.) across the forests of Southern New England.

Eighty-eight species of trees were observed on the inventory plots. Red maple and eastern white pine were the most common.

Half of the forest land was classified as oak/hickory forests. Other common forest-type groups included maple/beech/birch, oak/pine, white/red pine, and elm/ash/cottonwood.

The total weight or biomass of the forest trees is 340 million over-dry tons. These trees account for 50 percent of the 418 million tons of carbon that are stored in the forests. Thirty-six percent of the forest carbon is in the soil.

For most species of trees, the trees are gaining more volume from growth than they are losing due to mortality and removals.

The understory vegetation contains a diversity of forbs, herbs, trees, shrubs, graminoids, and vines. Ninety percent of the understory plants identified on the plots are native to the region.

The tree crown health, a general indicator of total tree health, was found to be good for most species in the region.

Down woody fuel loads are low to moderate for most forests in the region and, except in times of extreme drought, do not pose a significant fire risk.

Annually, 15 million cubic feet of industrial roundwood are harvested. Eastern white pine and northern red oak are the most commonly harvested species.

There are 69 sawmills in the region that employ approximately 23,500 people and have an annual payroll of $1.1 billion.

Problem Areas

The area of forest land has been steadily decreasing. Between 1998 and 2007, the region has lost 285,000 acres of forest land; this is equal to 87 acres of forest land lost per day. Most forest land is being lost to development.

Although there is a lot of forest land, much of it is fragmented by, or in close proximity to, roads and other anthropogenic uses. Forty-nine percent of the forest land is within 300 feet of development or agriculture.

Forest holdings are decreasing in size due to parcellation. The average size of family forest holdings is now 7 acres.

For a small subset of tree species, including American beech, butternut, paper birch, and red pine, mortality is exceeding net growth.

Native and nonnative insects and diseases are impacting the forest. In particular, Asian longhorned beetle and hemlock woolly adelgid are relatively new arrivals that are predominately threatening maples and hemlocks, respectively.

Eight percent of the plants identified in the understory are nonnative or introduced species.

Multiflora rose, Japanese barberry, and oriental bittersweet are the most common invasive plants in the region and were found on 19 percent of the plots where they were searched for.

Issues to Watch

Twenty-one percent of the forest land is within what the U.S. Census defines as urban areas or clusters. These lands are more likely to be impacted by human activities.

The fate of the forest lies primarily in the hands of the 428,000 families who control 52 percent of the forest land. Other private owners control an additional 20 percent and public agencies, primarily state, control the rest.

Stand size has been steadily increasing. Large stands now account for 75 percent of the forest land. Only 4 percent of the forest land is occupied by small, predominately young, stands.

Over half (55 percent) of the removals are due to conversions to other land uses.

While not yet in the region, emerald ash borer has been found in nearby states.

Background

Waterfall in Southern New England. Photo by Brett J. Butler, U.S. Forest Service.

Introduction & Background

Introduction

Forests are the green backdrop that largely define the landscape of Southern New England. From water protection to timber to aesthetics, forests provide countless benefits to the people of the region. To help ensure that forests are being used wisely, it is important to have up-to-date information on the status and trends of this critical resource.

What is FIA?

The 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 inventory and analysis of the present and prospective conditions of and requirements 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 over 80 years with the first FIA inventories in Southern New England completed in the 1950s. Information is collected on the status and trends of the extent, composition, structure, health, and ownership of the forests. This information is used by policy makers, resource managers, researchers, and the general public to better understand forest resources and to make more informed decisions about its fate.

What is this report?

This report is a summary of the findings from the fifth survey of the forest resources of Connecticut, Massachusetts, and Rhode Island conducted by FIA. Data for this survey were collected between 2003 and 2007, but throughout this report, we refer to 2007 as the inventory year. Previous inventories were conducted in 1998, 1985, 1972, and 1953 (Table 1).

Information for these three states is being combined into a single report to allow for examination of broader and more reliable trends, and reduce publication and analysis costs. Many issues, while not identical, are similar across the states. Combining the data creates more robust sample sizes and more reliable trends. This is particularly important for the rarer events and the least intensive samples. State-specific data tables are included on the accompanying DVD.

After providing a primer on the FIA inventory procedures, the results of the survey are divided into chapters that focus on forest features, forest health, and forest economics. Details about the data procedures and a basic glossary are also included. The detailed set of tables for each state along with information on statistical reliability are included in the section "Statistics, Methods, and Quality Assurance" which is on the accompanying DVD.

More information

Data access tools, previous reports, and additional information are available at: www.nrs.fs.fed.us/fia.

Table 1.—References for the 1998, 1985, 1972, and 1953 FIA reports for Connecticut, Massachusetts, and Rhode Island.

	State		
Year	Connecticut	Massachusetts	Rhode Island
1998	Alerich 2000a	Alerich 2000b	Alerich 2000c
1985	Dickson and McAfee 1998a	Dickson and McAfee 1998b	Dickson and McAfee 1998c
1972	Dickson and Bowers 1976	Peters and Bowers 1977a	Peters and Bowers 1977b
1953	Griswold and Ferguson 1957	Ferguson and Howard 1956	Ferguson and McGuire 1957

A Beginners Guide to Forest Inventory

What is a tree?

It is usually obvious what is a tree and what is not, but there is some gray area when it comes to differentiating between trees and other woody plants, such as large shrubs. FIA defines a tree as a woody, perennial plant that has a dominant, central stem, a well defined crown, and reaches a height of at least 15 feet at maturity. Trees identified on FIA inventory plots in Southern New England between 2003 and 2007 are listed in Appendix I. For a complete list of plants classified as trees by FIA, refer to the FIA Field Manual (U.S. For Ser. 2007).

What is a forest?

A forest is a collection of trees and like trees, most people would agree on what is a forest and what is not. But in order for statistics to be reliable and comparable, a definition must be created to avoid ambiguity. For FIA, a forest is land that is at least one acre in size, 120 feet wide, and is at least 10 percent stocked by trees of any size or formerly had such tree cover and is not currently developed for a nonforest use. For a complete list of rules used to classify forest land, refer to the FIA Field Manual (U.S. For. Ser. 2007).

FIA divides forest land into three subcategories: timberland, reserved forest land, and other forest land. Timberland is forest land that is not reserved and is capable of producing at least 20 cubic feet of commercial wood per acre per year. Reserved forest land is forest land that is withdrawn from timber production by legislative or administrative decree. Forest land that has low productivity and is not reserved is classified as other forest land. Ninety-six percent of the forest land in Southern New England is classified as timberland—productive and not reserved. Unless noted otherwise, this report presents data for the most inclusive category, forest land.

How is forest land area estimated?

FIA has established a set of permanent inventory plots across the United States that are periodically revisited. Each plot consists of four, 24-foot subplots for a total area of approximately 1/6 of an acre (Fig. 1).

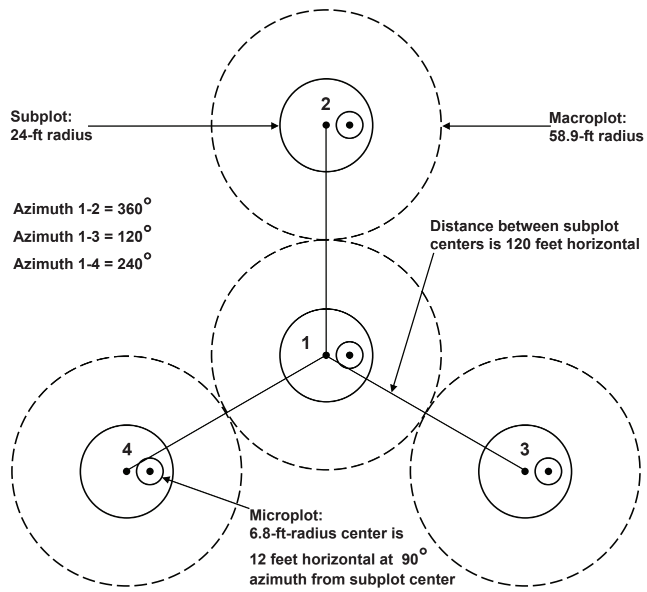

Figure 1.—FIA plot design.

Each plot is randomly located within a hexagon that is approximately 6,000 acres in size. Therefore, each plot represents about 6,000 acres of land and can be used to generate unbiased estimates and associated sampling errors for attributes such as total forest land area. Full details of estimation procedures are available in Bechtold and Patterson (2005).

How are numbers of trees estimated?

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

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

How are tree volumes estimated?

The volume of a tree, or any other object, is equal to the amount of liquid displaced by it. In this report, it is expressed in terms of cubic feet, unless noted otherwise. Other commonly reported units of tree volume include cords and board feet.

By using measurements of the diameter and height of a tree, equations are used to estimated tree volume for specific species groups and site indices (the productivity of a given stand).

How is forest biomass estimated?

By combining information on tree volume and specific gravity, the biomass or weight of a tree can be estimated. Estimates of the biomass in the stumps, limbs, and barks are modeled. Biomass in the report is expressed in terms of oven dry tons. One dry ton is roughly equivalent to 1.9 green tons.

How are forest carbon pools estimated?

The FIA program does not directly measure forest carbon stocks. Instead, a combination of empirically derived carbon estimates (e.g., standing live trees) and models (e.g., soil carbon models based on forest-type group, latitude, and longitude) are used to estimate forest carbon stocks (Smith et al. 2006).

How can results from different inventories be compared?

Comparisons between the current data and data collected before 1998 are hampered by changes in sampling methods and data collection procedures. The inventories conducted in 1998 used the same sampling frame and, in general, the same data collections procedures and are therefore, generally comparable.

Resource Availability

FIA does not attempt to identify which lands are suitable or available for timber harvesting. For example, Butler et al. (2010) estimated that biophysical and social constraints, primarily social constraints, reduced the availability of wood from family forest lands across the northern United States by 62 percent. Availability is dependent upon a complex set of factors including economic/market constraints, accessibility, and ownership objectives and all need to be considered when estimating availability.

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

FIA field crew measuring tree diameter.
Photo by Brett J. Butler, U.S. Forest Service.

Forest Features

Forest following a harvest in Southern New England. Photo by William N. Hill, Massachusetts Department of Conservation and Recreation.

Forest Area

Background

The most basic forest statistic is the total area of forest land. In addition to totals, it is important to know about the distribution, configuration, composition, and structure of the forests; these topics are discussed later in this report.

FIA defines forest land based on how land is actually used and not solely on the presence of tree cover. The estimates for the two different approaches, land use versus land cover, can be very different. This is especially true in urban and suburban areas where there may be a lot of tree cover, but the dominant use is commercial or residential and natural forest processes are inhibited.

What we found

There are 5.1 million acres of forest land across Southern New England; 3.0 million of these acres are in Massachusetts, 1.7 million acres are in Connecticut, and 0.4 million acres are in Rhode Island. This represents between 54 and 61 percent of the land in each State (Fig. 2). Forest land distribution is far from uniform across the region (Fig. 3). In general, the areas with highest numbers of people, such as the greater Boston, Hartford, and Providence areas, have lower relative amounts of forest land.

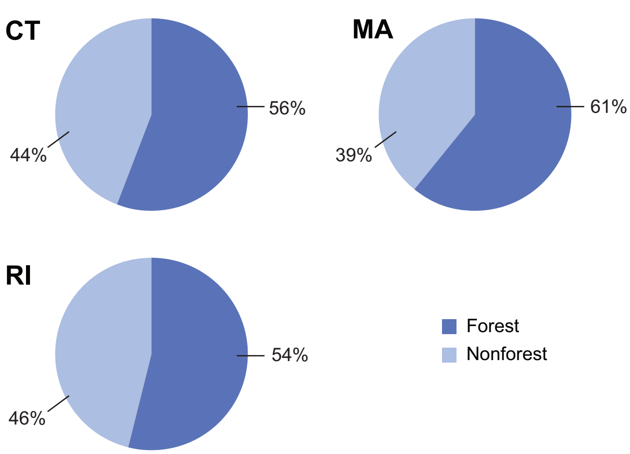

Figure 2.—Percentage of land that is forested and nonforested, Connecticut, Massachusetts, and Rhode Island, 2007.

The area of forest land has been decreasing across the region for at least the past decade (Fig. 4). Rhode Island had a 9 percent reduction in forest land area between 1998 and 2007, Connecticut an 8 percent loss, and Massachusetts a 3 percent loss.

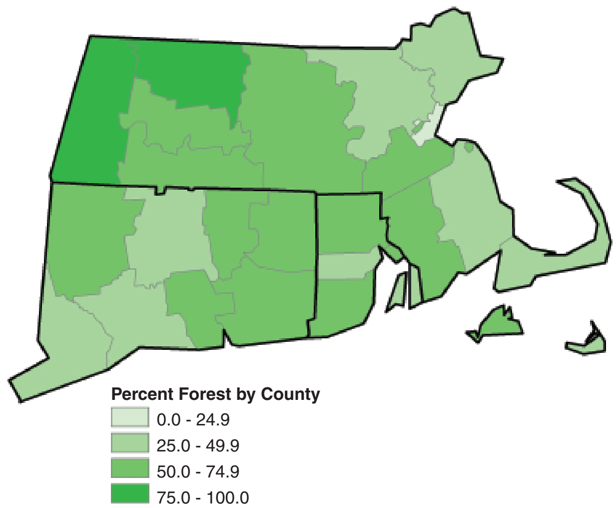

Figure 3.—Percentage forest area by county, Southern New England, 2007.

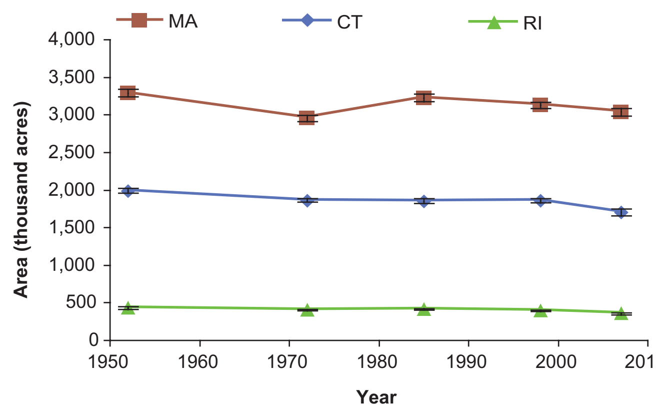

Figure 4.—Forest area, Connecticut, Massachusetts, and Rhode Island, 1953-2007. Error bars represent a 68 percent confidence interval around the mean.

What this means

When European settlers arrived in the region, they found a landscape that was dominated by forests. This tree cover was largely removed to provide land to cultivate crops and graze livestock. Following the large-scale abandonment of agriculture through the twentieth century, forest land area increased. Forest land area stabilized once there was little more agriculture land to revert, currently development is causing a net loss of forest land.

Land Use Change

Background

Forests are under pressure from residential and commercial development. The area of urban land in the United States is predicted to nearly triple between 2000 and 2050 (Nowak et al. 2005).

FIA broadly characterizes land as forest, agriculture, or developed. By comparing the current land uses on inventory plots with the previous land uses on the plots, land-use change dynamics can be quantified. Only remeasured plots can be used in this analysis and therefore forest land percentages may not exactly match other estimates given in this report.

What we found

Approximately 95 percent of the land that was forest in 1998 remained forest in 2007. The net loss of forest land across Southern New England was 3 percent. Rhode Island had the greatest net forest loss and Massachusetts the least (Fig. 5). This loss was most likely to occur near nonforest (e.g., developed) areas (Fig. 6).

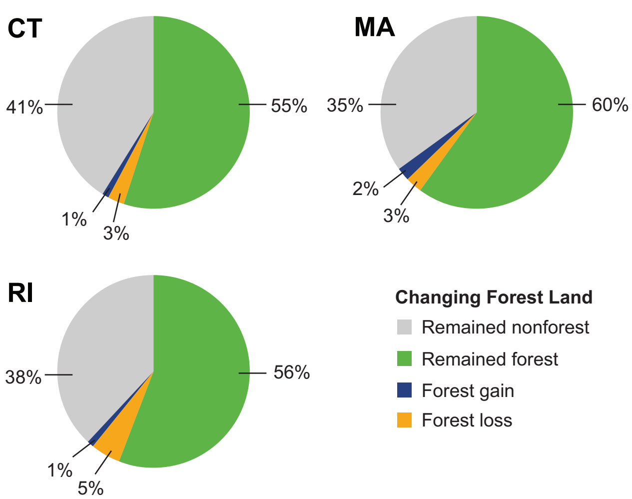

Figure 5.—Forest land-use dynamics, Connecticut, Massachusetts, and Rhode Island, 2007.

Most of the lost forest land was converted to developed land uses (Fig. 7). Generally speaking, this new development is unlikely to revert back to forest because of the roads, buildings, and other long-term human structures built. Most of the forest gained was from developed land uses, with the majority from parks or other recreation areas where maintenance patterns or management strategies had changed. It is unknown if this regrowth will be persistent.

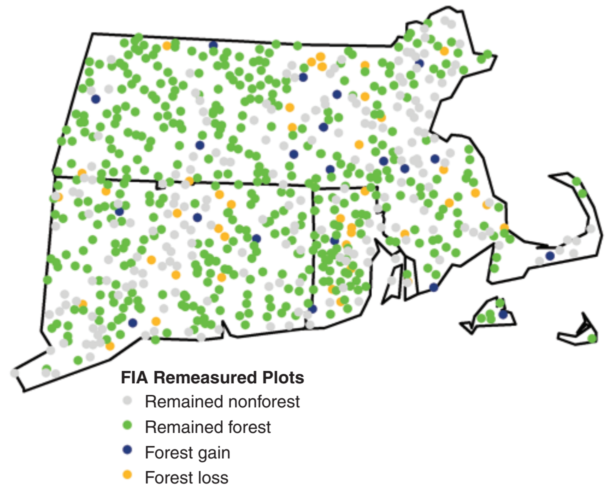

Figure 6.—Approximate locations of remeasured inventory plots showing forest gains and losses, Southern New England, 2007.

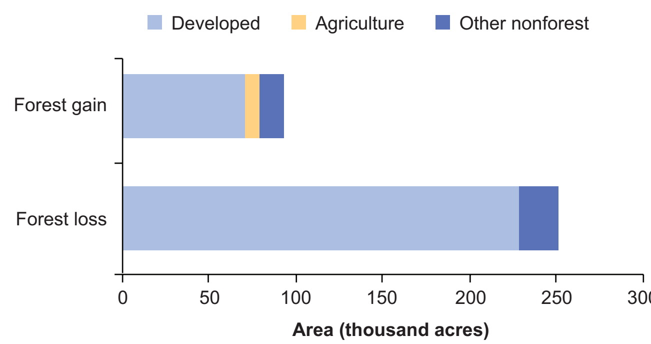

Figure 7.—Sources and sinks of forest gains and losses, Southern New England, 2007.

What this means

Examination of the pattern of forest loss across Southern New England reveals that it generally occurs near urban areas and near major roads. This correlation between existing development and forest loss, coupled with the fact that urbanization is expected to continue its increase over the coming decades, suggests that forest loss will continue to increase until urbanization slows. It is difficult to predict what will happen with rates of reversion of developed land to forest, but it can be assumed that as populations increase, more pressure will be put on parks and recreation areas, necessitating more intensive management and less likelihood of these lands reverting to forest.

Forest Fragmentation and Urbanization

Background

The expansion of developed land often results in the breaking up, or fragmentation, of natural habitats. Wildlife habitat, forest health, ecosystem services, and management opportunities are affected by changes in forest fragmentation.

What we found

While most of Southern New England is forested, most of this forest land exists in close proximity to buildings (Fig. 8) and roads (Fig. 9). Thirty-nine percent of the forest land is located in areas with at least 150 houses per square mile. This varies considerably across the region, from 13 percent in western Massachusetts to 72 percent in eastern Massachusetts.

In Southern New England, 49 percent of the forest land is within 300 feet from developed or agricultural land. Thirty-four percent of the forest land is within 330 feet of a road and 72 percent is within 980 feet.

Habitat requirements vary by species, but 100 acres, depending on configuration, provides sufficient habitat for many species. Eighty-eight percent of the forests in the region are in patches of at least 100 acres (Fig. 10).

What this means

Roads and other human structures impact the ecological processes of the forests they abut. The extent of the impact is influenced by the type and level of impact which can be managed to minimize negative effects. The areas of higher population density tend to have the smallest average patch sizes. But given the pervasiveness of houses and roads within the forested landscape of Southern New England, patch size alone is not a good indicator of wildlife habitat quality. It is, however, another indicator of the extent to which the people of Southern New England live within a forest-dominated landscape.

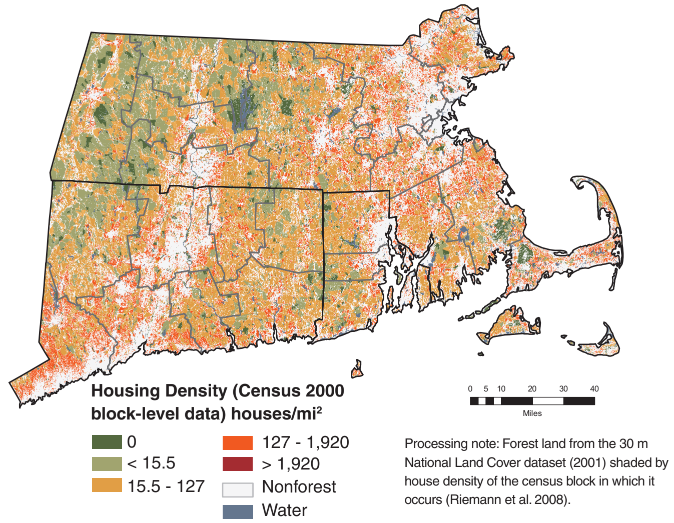

Figure 8.—Housing density in forested areas of Southern New England, 2006.

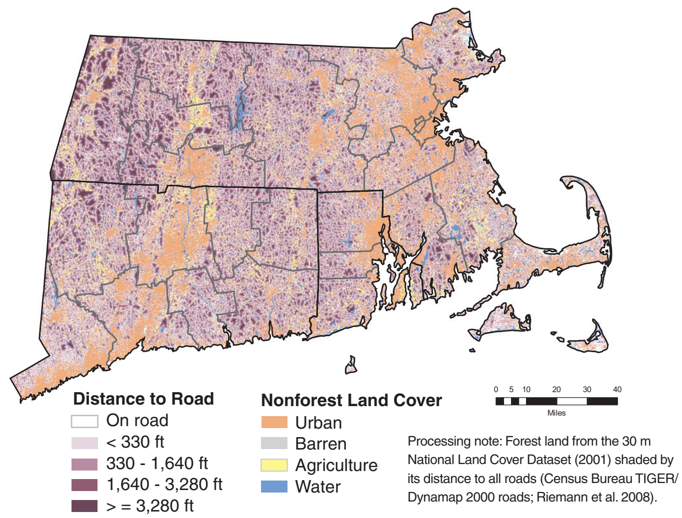

Figure 9.—Distance of forest land to roads, Southern New England, 2006.

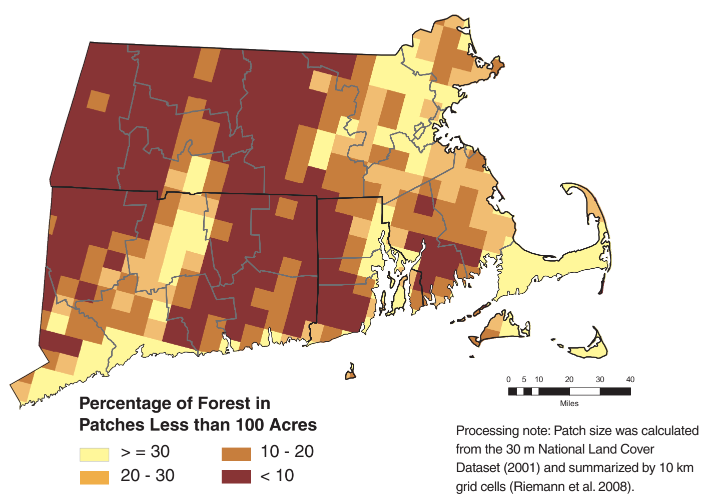

Figure 10.—Percentage of forest area in patches less than 100 acres, Southern New England, 2006.

Urban Forests

Background

Urban forest land is defined here as land that meets the FIA forest land criteria and is located in U.S. Census-defined urbanized areas/clusters—areas with population densities of at least 1,000 people per square mile and adjoining areas with at least 500 people per square mile. More than 80 percent of the U.S. population lives in these urban areas. Forest land in close proximity to developed land or in areas of high population density may be directly and indirectly influenced by the activities that occur there.

What we found

Twenty-one percent of the forest land in Southern New England lies within urban areas and urban clusters. In Massachusetts, 22 percent of the forest land is urban, in Connecticut 20 percent is urban, and in Rhode Island 19 percent is urban. Most forest land in both urban and non-urban areas is privately owned, however there is a higher proportion of forest land that is owned by local governments in urban areas and a higher proportion of state owned lands in non-urban areas (Fig. 11).

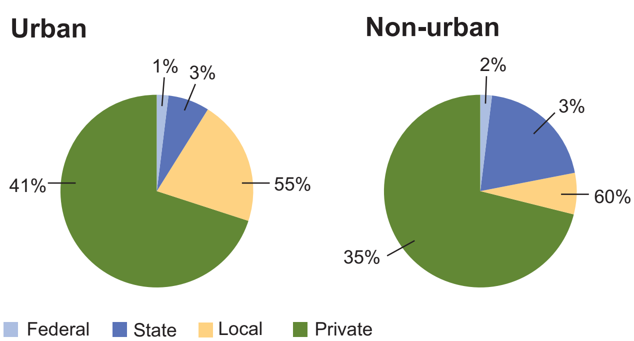

Figure 11.—Urban and non-urban forest land by ownership category, Southern New England, 2007.

The oak/hickory forest-type group predominates across the region and does so in urban and non-urban areas as well, but the distribution of other forest-type groups differ (Fig. 12). For example, the oak/pine forest-type group is relatively more common in urban areas and the maple/beech/birch forest-type group is relatively more common in non-urban areas.

Urban forest lands show more evidence of disturbance than non-urban forest land (Fig. 13). In urban areas, competing vegetation, including native and nonnative invasives, is the largest disturbance.

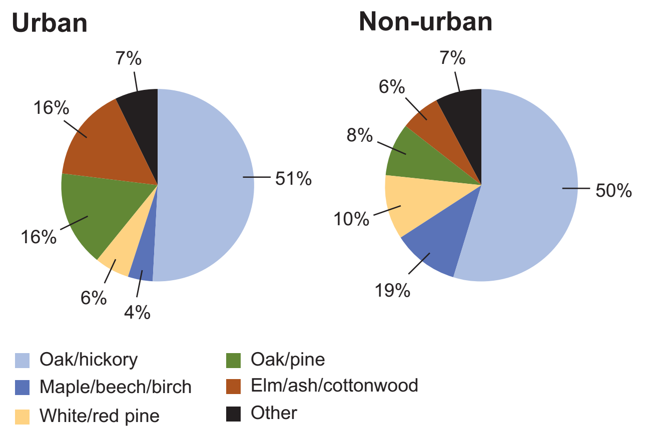

Figure 12.—Distribution of forest-type groups within urban and non-urban forest land, Southern New England, 2007.

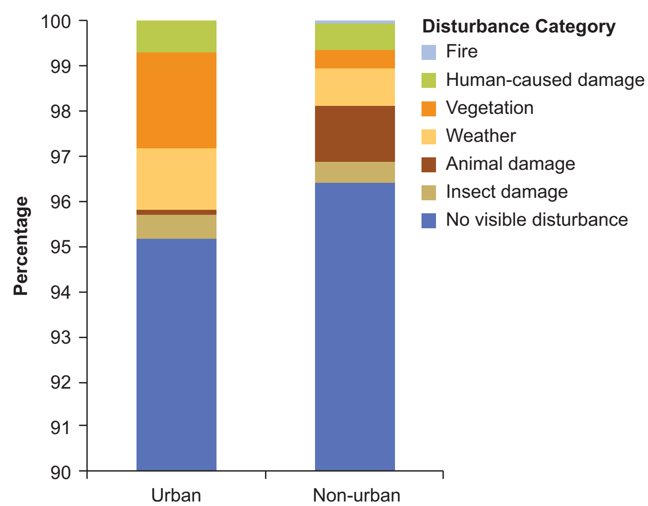

Figure 13.—Proportion of forest land in urban and non-urban areas by disturbance category, Southern New England, 2007.

What this means

Urban area is projected to increase (Nowak et al. 2005) and thus the impact of these areas on the forests will increase as well. While the distribution of forest-type groups may not be directly attributable to human causes, i.e., forest-type group is largely controlled by biophysical factors, the types of forests influenced will change. Likewise, the magnitude and types of influences people place on the forest will change as the urban areas expand.

Forest Ownership

Background

It is the owners of the forest land who ultimately control its fate and decide if and how it will be managed. By understanding forest owners, the forestry and conservation communities can better help the owners meet their needs, and in so doing, help conserve the region's forests for future generations. FIA conducts the National Woodland Owner Survey (NWOS) to better understand who owns the forests, why they own it, and how they use it (Butler 2008).

What we found

Most forests of Southern New England are privately owned, ranging from 85 percent of the forest area in Rhode Island to 69 percent in Massachusetts (Fig. 14). Of these private acres, most (72 percent) are owned by families, individuals, and other unincorporated groups, collectively referred to as family forest owners.

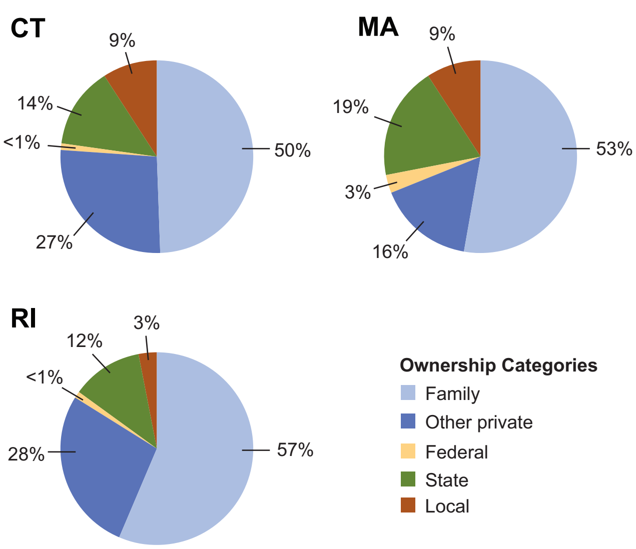

Figure 14.—Forest ownership, Connecticut, Massachusetts, and Rhode Island, 2006.

A total of 428,000 family forest owners control 2.8 million forested acres across the region. Ninety percent of these owners have between 1 and 9 acres of forest land (Fig. 15). The average holding size is 9 acres in Connecticut and 6 acres in Massachusetts and Rhode Island. The primary reasons for owning forest land are related to aesthetics, privacy, and forest land being part of their home (Fig. 16).

Although timber production is not a major ownership objective, 42 percent of the family forest land is owned by people who have commercially harvested trees. Twenty percent of the land is owned by people who have a written management plan, and 31 percent of the land is owned by people who have received management advice.

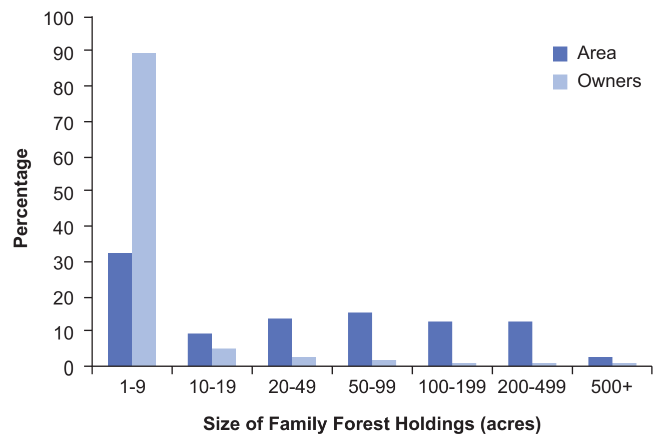

Figure 15.—Size of family forest holdings, Southern New England, 2006.

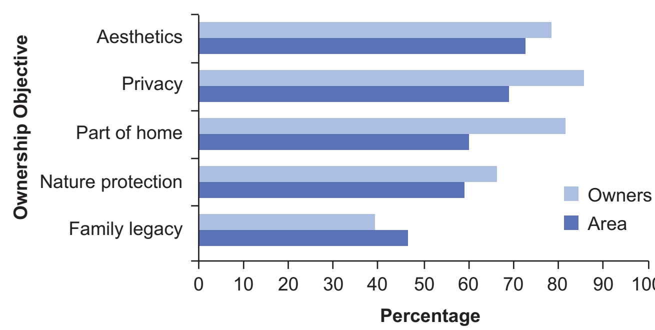

Figure 16.—Primary ownership objectives of family forest owners, Southern New England, 2006.

What this means

The average parcel size is decreasing and much land will soon be changing hands. One in four acres is owned by someone who plans to pass the land onto heirs or sell it in the near future. Family legacy is a major ownership objective and it is also a major concern. What can be done to help the forest owners and the land? It is clear that timber production is not on the forefront of forest owners' minds, but it is also clear that many owners are not adverse to harvesting and other activities in the woods. It is important to provide programs that meet the owners' needs.

Tree Species Composition

Background

The composition of the forest helps determine what the forest looks like and what resources it provides to both people and wildlife. Tree composition is a function of regeneration/seed sources, regional climate, microclimate, soils, and competition.

What we found

There are approximately 2.6 billion trees (≥ 1 inch diameter at breast height [d.b.h.]) across Southern New England. There were 88 species of trees observed on FIA inventory plots (Appendix I). The 10 most common species represent 74 percent of these trees (Fig. 17). In terms of volume, the 10 most common species represent 83 percent (Fig. 18). Red maple is the most common tree in terms of numbers of trees and volume; eastern white pine is the second most common species. Other common species include northern red oak, eastern hemlock, sweet birch, American beech, black oak, and sugar maple.

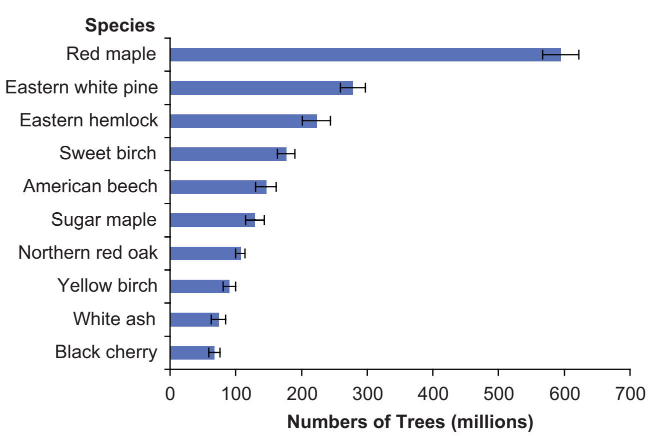

Figure 17.—Numbers of the 10 most common trees (>1 inch d.b.h.) by species, Southern New England, 2007. Error bars represent a 68 percent confidence interval around the mean.

Forest types and forest-type groups are classified based on the mix of tree species that are present on a given site. Half of the forest land in the region is classified as oak/hickory (Fig. 19). Maple/beech/birch, oak/pine, white/red pine, and elm/ash/cottonwood each represent between 8 and 16 percent of the forest land.

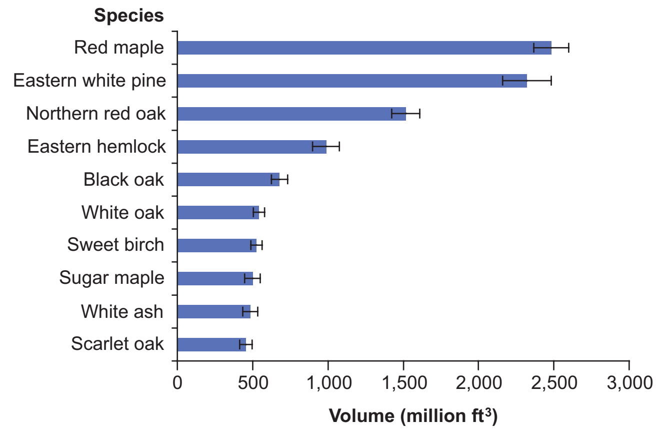

Figure 18.—Volumes (million ft^3) of the 10 most common trees (≥1 in d.b.h.) by species, Southern New England, 2007. Error bars represent a 68 percent confidence interval around the mean.

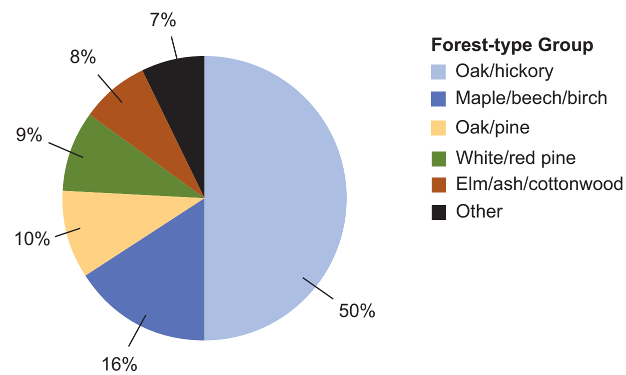

Figure 19.—Distribution of forest land area by forest-type group, Southern New England, 2007.

What this means

There are a wide diversity of trees across the region, each uniquely adapted to specific circumstances. Red maple is a highly adaptable tree that tends to be replaced by other species as stands mature. At that point, assuming no major disturbances, shade tolerant species, such as sugar maple and American beech, would increase in dominance. Insects and diseases, such as hemlock woolly adelgid (discussed later in this report), and other stand dynamics will influence the ultimate successors in the forest.

Forest Structure

Background

Forest structure refers to the physical attributes and arrangement of the trees that make up a stand. It is the result of the historical events, the physical environment, and the competition amongst the species. Distribution of tree size and the predominance of trees of certain sizes, i.e., stand size, are two metrics used to quantify stand structure on FIA plots.

What we found

Sixty-five percent of the trees across Southern New England are small, i.e., less than 5.0 inches in diameter (Fig. 20). This distribution varies significantly across species. Shade tolerant trees, such as American beech, and understory trees, such as flowering dogwood, tend to have higher percentages of trees in the smaller size classes.

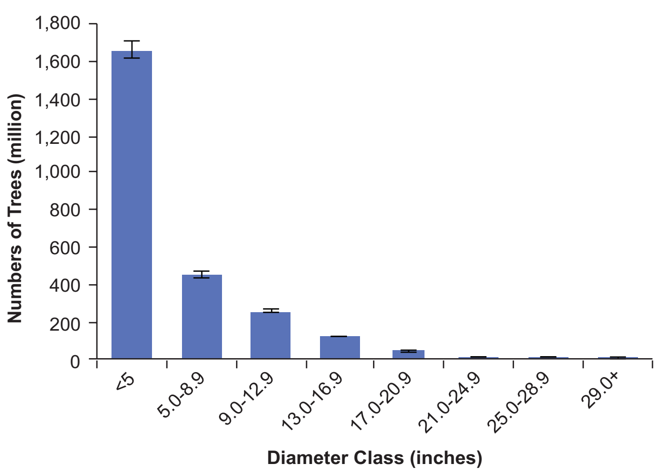

Figure 20.—Numbers of trees by diameter class, Southern New England, 2007. Error bars represent a 68 percent confidence interval around the mean.

The distribution is much different when examined by volume (Fig. 21). Fifty-six percent of the volume is in trees with diameters between 9 and 17 inches. Volumes are not calculated for trees with diameters less than 5 inches.

Stand size has been steadily increasing over time and currently stands dominated by larger trees account for 75 percent of the forest area in the region (Fig. 22). Definitions of stand size classes are included in the glossary of this report.

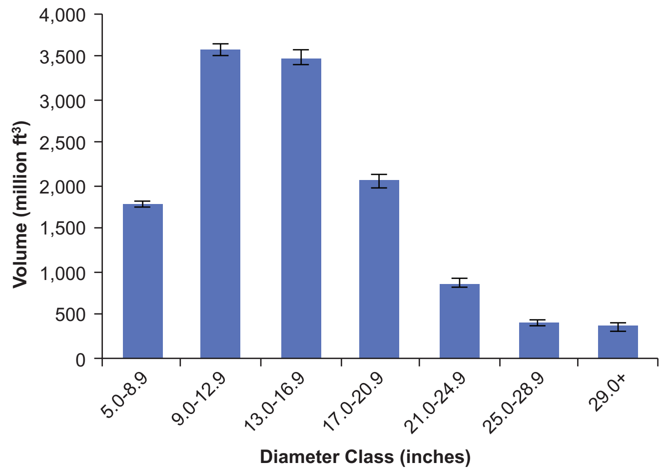

Figure 21.—Volume (million ft^3) of trees by diameter class, Southern New England, 2007. Error bars represent a 68 percent confidence interval around the mean.

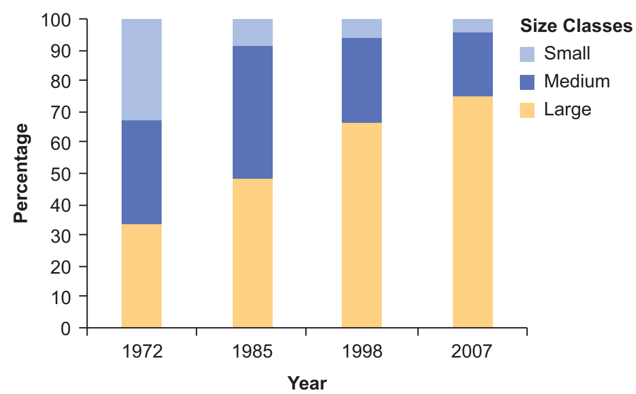

Figure 22.—Forest stand size, Southern New England, 1972-2007.

What this means

There are more small trees and fewer large trees due to competition. Although there are fewer large trees, each of the larger trees has a proportionally higher volume and hence, the difference between numbers of trees and volumes.

The forests of Southern New England have been steadily maturing and this is causing the increase in stands with large trees. The low levels of major disturbances, such as hurricanes or timber harvesting, and the relatively small amount of land that is reverting from other land uses is minimizing the proportion of stands dominated by smaller trees. This has repercussions for wildlife species that rely on these forests with small trees.

Forest Biomass

Background

In addition to looking at the number or volume of trees, another forest metric one could look at is the mass or weight of the trees in the forest. This could be interesting as simply another way of examining forest statistics, but it is also useful in discussions related to the contributions of woody biomass as a renewable energy source. And, as is discussed in the next section, biomass estimates are a means for quantifying carbon storage.

What we found

There is a total of 340 million oven-dry tons of biomass across the forests of Southern New England. Fifty-nine percent of this biomass is in Massachusetts, 34 percent is in Connecticut, and 6 percent is in Rhode Island.

Nearly three-fourths of the aboveground tree biomass is in the boles, or central stems, of the trees (Fig. 23). An additional 17 percent of the biomass is in tops and limbs. The remaining biomass is in stumps and saplings. Biomass in foliage, shrubs, or herbaceous plants or any belowground biomass are not included in these estimates.

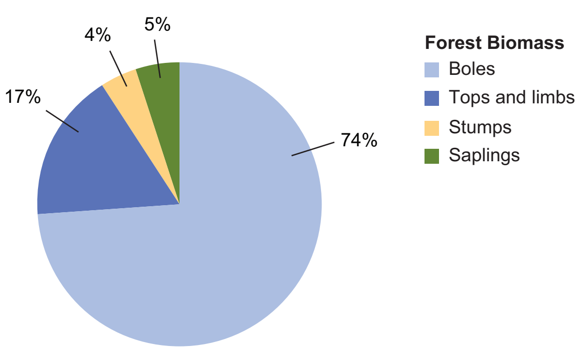

Figure 23.—Forest biomass by tree component, Southern New England, 2007.

Forest biomass is not evenly distributed across the landscape (Fig. 24). The amount of biomass per acre increases substantially from east to west and is highest in the northwest part of the region.

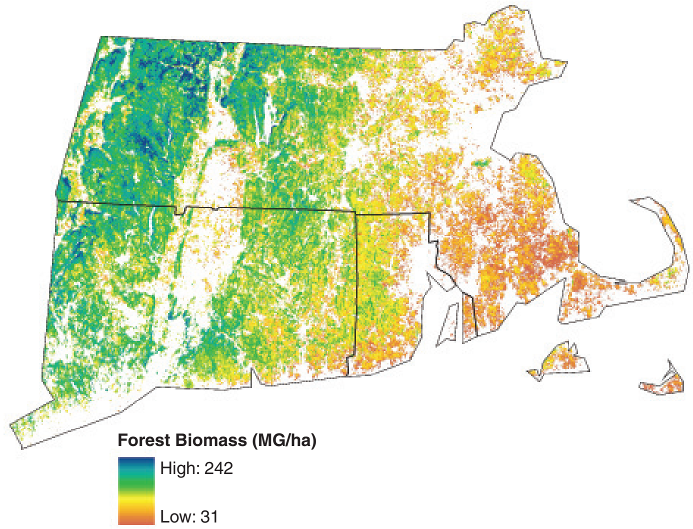

Figure 24.—Distribution of forest biomass, Southern New England, 2007. (Adapted from Blackard et al. 2008.)

What this means

There is a substantial amount of woody biomass in the woods of Southern New England. This biomass is likely to continue to increase due to harvesting rates that are significantly lower than growth rates (discussed later in this report).

Forest Carbon

Background

Collectively, forest ecosystems represent the largest terrestrial carbon sink on earth. The accumulation of carbon in forests through sequestration helps to mitigate emissions of carbon dioxide to the atmosphere from sources such as the burning of fossil fuels and forest fires.

What we found

Southern New England's forests currently contain more than 418 million tons of carbon; 61 percent of this forest carbon is in Massachusetts, 32 percent is in Connecticut, and 6 percent is in Rhode Island. Live trees and saplings represent the largest forest ecosystem carbon pool, followed by soil organic matter (SOM) (Fig. 25). Within the live tree and sapling pool, boles contain the bulk of the carbon.

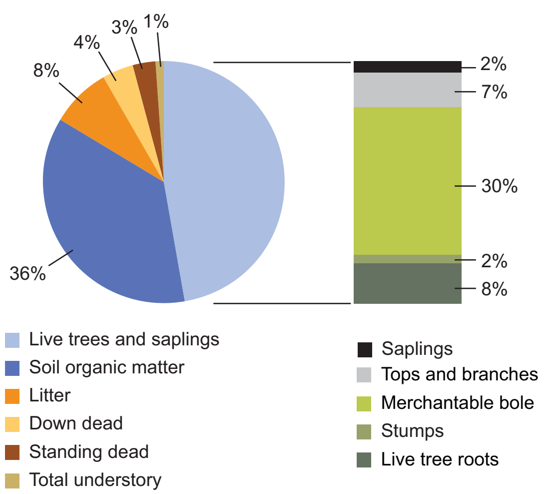

Figure 25.—Estimated total carbon stocks on forest land by forest ecosystem component, Southern New England, 2007.

The majority of forest carbon stocks in the region are in stands that are 61-100 years old (Fig. 26). Early in stand development, most of the forest ecosystem carbon is in SOM and belowground tree components. As forests mature, the ratio of above- to belowground carbon shifts and by age 41-60 years the aboveground components represent the majority of forest carbon. This trend continues well into stand development as carbon accumulates in live and dead aboveground components.

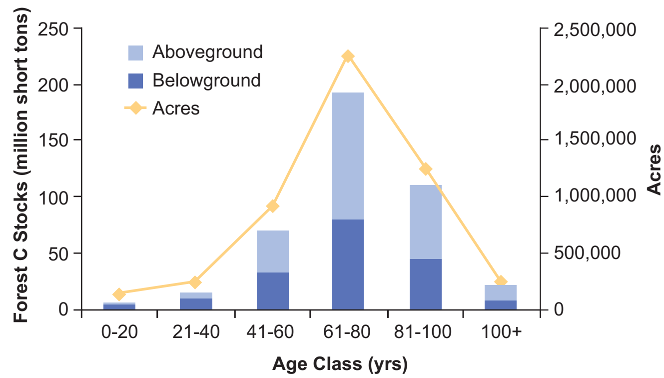

Figure 26.—Estimated above and belowground carbon stocks on forest land by stand age class, Southern New England, 2007.

Despite the similarity in per-acre estimates, the distribution of forest carbon stocks by forest-type group is quite variable (Fig. 27). For example, SOM varies from 61 percent in the aspen/birch forest-type group to 32 percent in the oak/hickory forest-type group.

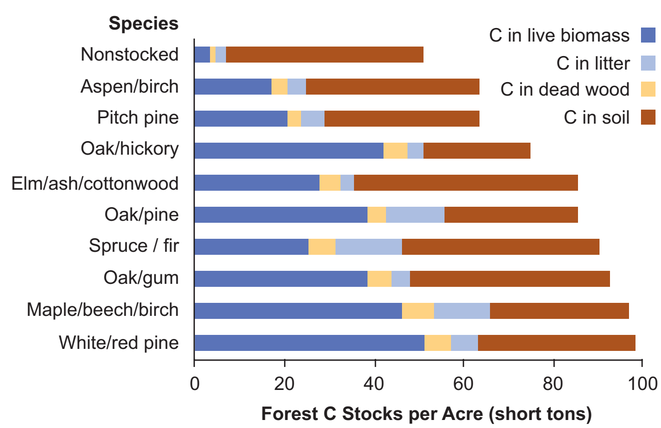

Figure 27.—Estimated carbon stocks on forest land by forest type group and carbon pool per acre, Southern New England, 2007.

What this means

Most forest carbon in Southern New England is found in 40 to 100 year-old stands dominated by relatively long-lived species. This suggests that forest carbon stocks will continue to increase as stands mature and accumulate carbon in above- and belowground components. Given the age-class structure and species composition of forests in the region, there are opportunities to increase forest carbon stocks. That said, managing for carbon in combination with other land management objectives will require careful planning and creative silvicultural practices beyond simply managing to maximize growth and yield.

Tree Growth & Mortality

Background

The composition and structure of a forest are heavily influenced by the growth, mortality, and removals of the trees. Growth is due to trees getting larger and new trees being established. Mortality is tree death due to natural causes, such as senescence, insects, and diseases. Removals are due to land clearing and/or timber harvesting and are discussed elsewhere in this report.

Growth is reported in net terms, meaning the average annual amount trees grew since the previous inventory in 1998, plus in-growth of new trees, minus mortality due to natural causes. Harvesting and other human removals are not included in these estimates. Due to data processing issues, growth and mortality (and removals) do not include data for 2007.

What we found

The forests of Southern New England are growing by approximately 270 million cubic feet per year; 58 percent of this growth is in Massachusetts, 33 percent in Connecticut, and 8 percent in Rhode Island. Although growth is not equal across all acres, the mean growth is 53 cubic feet per acre per year. The three most common species, red maple, eastern white pine, and northern red oak, account for 55 percent of the growth (Fig. 28).

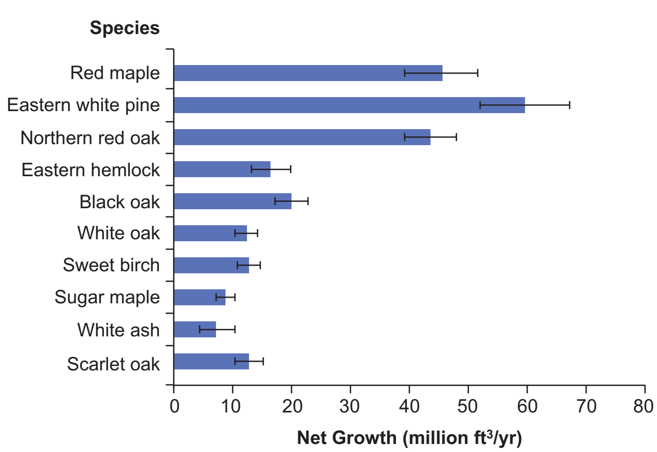

Figure 28.—Net growth of selected tree species, Southern New England, 2006. Error bars represent a 68 percent confidence interval around the mean.

The forests are losing approximately 84 million cubic feet per year due to insects, diseases, senescence (dying due to plants reaching old age), and other natural mortality. While on an absolute basis, red maple accounts for most of the mortality (Fig. 29), on a relative basis, the greatest losses are for American beech, butternut, paper birch, and red pine—all of which have net negative growths.

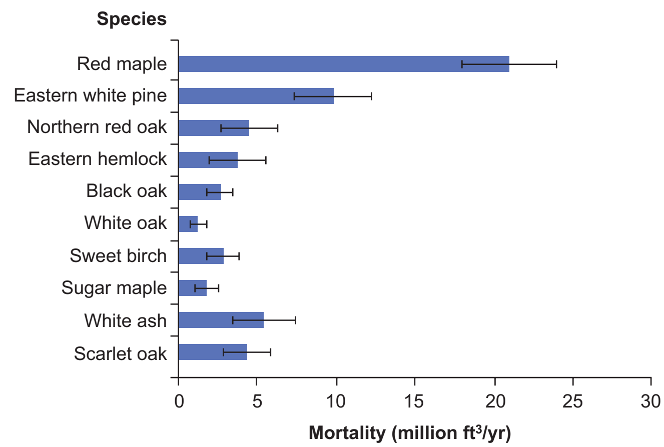

Figure 29.—Mortality of selected tree species, Southern New England, 2006. Error bars represent a 68 percent confidence interval around the mean.

What this means

Overall, the forests of the region have a positive net growth, but this varies substantially by species. Diseases and insects are the primary reasons for the species that are showing net decreases in volume.

Tree Removals

Background

People impact the forests many different ways, but the most direct is by removing trees. Timber harvesting is done to remove or enhance selected trees and following this disturbance, trees are allowed to grow again. This is in contrast to other removals that are caused by land-use conversions.

The ratio of net growth to removals is useful to help assess the sustainability of the forest resource by answering this basic question: is the growth of trees less than, equal to, or greater than the mortality/removals. A growth to removals ratio of 1.0 means that growth is equal to removals, a ratio less than 1.0 means that removals exceed growth, and a value greater than 1.0 means growth exceeds removals.

What we found

There is an estimated 50 million cubic feet of trees harvested across the region each year and an additional 60 million cubic feet lost due to conversion to other land uses. Sixty-six percent of the removals is in Massachusetts; 37 percent is in Connecticut; and 6 percent is in Rhode Island.

Eastern white pine is by far the most common tree harvested, accounting for a third of the removals (Fig. 30). Ninety percent of eastern white pine removals were due to timber harvesting. The next most commonly removed species were red maple, black oak, and northern red oak.

The over-all growth-to-removals ratio in Southern New England is 2.5. This means that for every 1.0 cubic foot harvested or otherwise removed, 2.5 cubic feet are grown—growth is far exceeding removals. The growth-to-removals ratio varies dramatically by species. While it exceeds 1.0 for all of the most common species, it is 1.7 for eastern white pine versus 11.4 for sugar maple (Fig. 31).

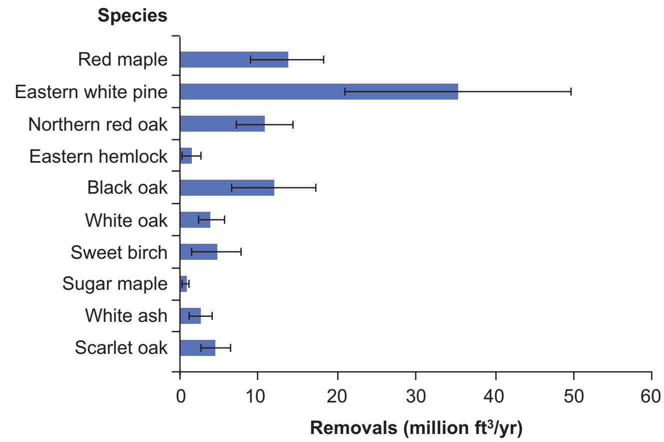

Figure 30.—Harvesting and other removals of selected tree species, Southern New England, 2006. Error bars represent a 68 percent confidence interval around the mean.

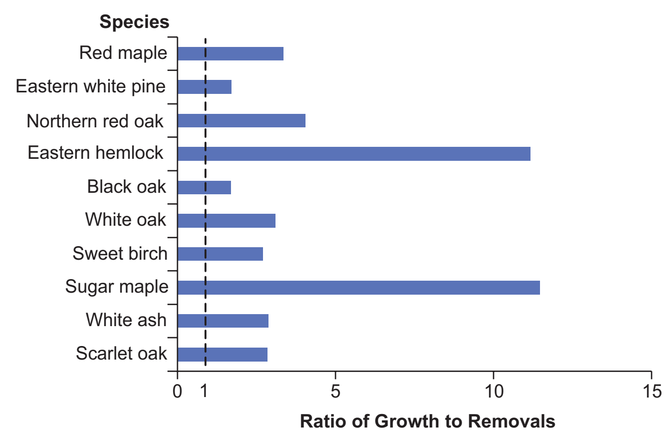

Figure 31.—Growth-to-removals ratios of selected tree species, Southern New England, 2006.

What this means

Growth to removals is, in general, greater than 1.0 for Southern New England. This is one metric that helps identify sustainable forest management, but other factors, such as the quality of the trees that are left behind, also need to be considered.

Forest Indicators

Tree defoliation in Southern New England. Photo by Bruce Payton, Rhode Island Division of Forest Environment.

Insect and Plant Diseases

Background

The health of forests are influenced by various biotic and abiotic stressors. Biotic stressors include native or introduced damaging insects, diseases, invasive plants, and animals. Abiotic stressors include drought, flooding, cold temperatures or freeze injury, nutrient deficiencies, soil physical properties affecting soil moisture and aeration, or toxic pollutants.

The presence of insects and diseases, both native and introduced, helps shape the structure and composition of forest ecosystems. Monitoring the status of these organisms provides a measure of forest health and is crucial in assessing the current state and changing trends in Southern New England's forests. Some specific insects and diseases are discussed below and three issues, Asian longhorned beetles, emerald ash borer, and hemlock woolly adelgid, are discussed in more detail separately.

What we found

While the overall health of the forests of Southern New England is good, a number of insects and diseases were active during the survey period.

Native Insects

Forest tent caterpillar is a major defoliator of hardwoods, particularly oaks, throughout the region. Massachusetts was the hardest hit, experiencing heavy and widespread defoliation in 2005 and 2006. In addition to defoliation, Rhode Island experienced associated oak mortality. Fall cankerworm, eastern tent caterpillar, and orange-striped oakworm were also active defoliators.

Nonnative Insects

European gypsy moth has been a concern since its accidental introduction near Boston in the 1860s and it subsequently spread across the region (Tobin et al. 2007). Gypsy moth affects a multitude of species, but its greatest impact is on oaks and aspens. Following a collapse in population density, gypsy moth activity began to build again in 2005. Peak defoliation occurred in 2006, when totals reached approximately 252,000 acres of forest land in Connecticut, 121,000 acres in Massachusetts, and 3,000 acres in Rhode Island.

After being discovered in Massachusetts in 2003 and in Rhode Island and southeastern Connecticut in 2005, winter moth became established along the coast of Southern New England. Severe defoliation was recorded in Massachusetts between 2005 and 2007; Rhode Island and Connecticut experienced patchy defoliation over the same period.

Diseases

Beech bark disease is endemic throughout the region. Beech decline and mortality were recorded in northwestern Massachusetts. Dutch elm disease decimated the elm of the region in the early to mid 1900s and is still prevalent across the region. In conjunction with drought stress, Dutch elm disease-related decline of elms was high in Connecticut.

Emerging Threats

In addition to existing forest health issues, the forests of Southern New England are also at risk for future, exotic introductions of sirex woodwasp, emerald ash borer, and sudden oak death (SOD). Sirex woodwasp, a pest of pine trees, was found in upstate New York in 2005 (Haugen and Hoebeke 2005). Species in the region susceptible to SOD include a variety of oaks and rhododendron species (O'Brien et al. 2002). SOD-infected nursery stock was identified in Connecticut in 2004, however, the disease has so far not been found in forested settings.

What this means

During the survey period, Southern New England's forests were host to a variety of insects and diseases. The extent of damage caused by these stressors ranged from moderate to heavy, and often impacted tree growth and mortality. Several pest and disease agents were consistently damaging each year, while others caused a varying amount of damage from year to year. The activity of insects and diseases can affect the composition and structure of forests and impact forest-related industries and recreation. In addition to currently introduced exotic species, Southern New England's forests face serious risk from the potential introduction of insects and diseases, especially those on the following pages.

The Asian Longhorned Beetle

Asian longhorned beetle. Photo by Kenneth R. Law, USDA APHIS PPQ, Bugwood.org

Background

The Asian longhorned beetle is a nonnative wood-boring beetle that attacks a variety of hardwood species found in the region (USDA APHIS 2010). Maple (most favored), birch, willow, and elm are the preferred hosts; poplar and ash are occasional hosts. It was first identified in New York City in 1996 and was first identified in Southern New England in Worchester, MA, in 2008.

What we found

Forty-seven percent of all trees in Southern New England's forests are susceptible to Asian longhorned beetle. Of this group, maples are the most dominant species across the region, followed by birches and ashes (Fig. 32). Susceptible host species account for 4.6 billion cubic feet of live-tree volume, or 37 percent of all live-tree volume in the region. Present throughout the region, these species are most abundant in Northern Rhode Island and north-central Connecticut (Fig. 33).

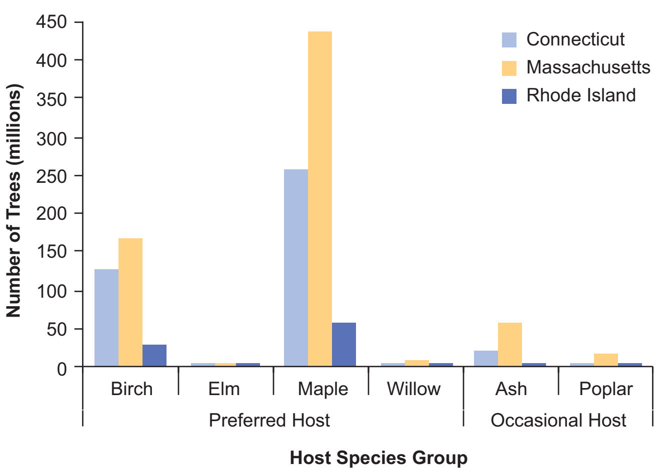

Figure 32.—Number of forest trees susceptible to Asian longhorned beetles by level of host preference, species group and state, Southern New England, 2007.

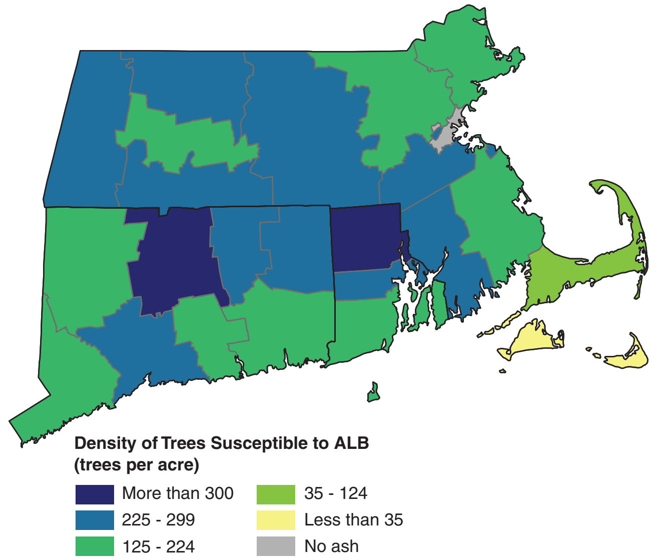

Figure 33.—Number of Asian longhorned beetle susceptible trees on forest land by county, Southern New England, 2007.

What this means

Asian longhorned beetle has caused major economic losses in China, where it is a pest of trees in urban areas, windbreaks, and plantations (MacLeod et al. 2002, Haack et al. 2010). Since its introduction to the United States, it has been a significant source of urban tree mortality. However, with a wide range of susceptible host species, this insect could have a substantial impact on hardwood forests across Southern New England. Quarantine establishment and management efforts have been initiated in Massachusetts with the hope to follow the successful eradication of Asian longhorned beetle in Chicago, IL, and Jersey City, NJ.

Emerald Ash Borer

Emerald ash borer. Photo by Howard Russell, Michigan State University, Bugwood.org

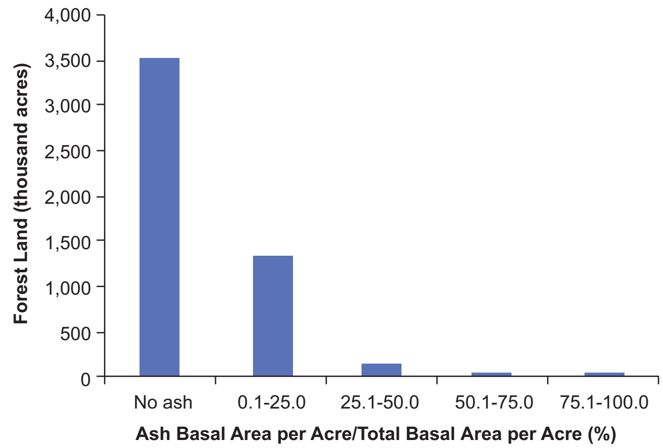

Figure 34.—Presence of ash species on forest land, Southern New England, 2007.

Background

The emerald ash borer is a wood-boring beetle native to Asia. In North America, it has been identified only as a pest of ash trees; all native species of ash appear to be susceptible (Poland and McCullough 2006). Trees and branches as small as 1-inch in diameter have been attacked. While stressed trees may be preferred, healthy trees are also susceptible (Cappaert et al. 2005). In areas with a high density of emerald ash borer, tree mortality generally occurs 1 to 4 years after infestation depending on tree size and vigor (Poland and McCullough 2006). Spread of emerald ash borer has been facilitated by human transportation of infested material. It was not found in Southern New England during the 2003-2007 inventory period, however, the threat of emerald ash borer introduction to the region has increased with the 2010 discovery of this pest in New York.

What we found

Southern New England's forests contain an estimated 79.5 million ash trees (≥ 1.0 inch d.b.h.) that account for 495 million cubic feet of volume or 4 percent. White ash is the most prevalent ash species in the region, making up 93 percent of total ash abundance. Ash is present on approximately 1.6 million acres or 30 percent of forest land (Fig. 34). Rarely the most abundant species in a stand, ash generally makes up less than 25 percent of a stand's basal area. Distributed throughout most of the region, the highest concentrations of ash are found in the western parts of the region (Fig. 35).

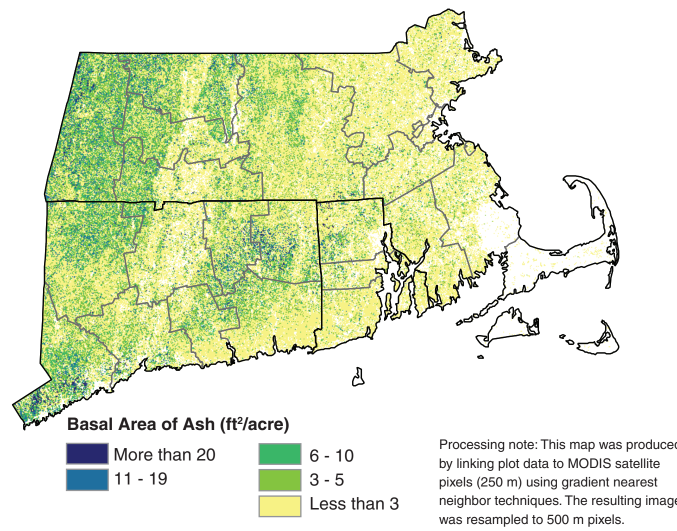

Figure 35.—Distribution of ash species on forest land, Southern New England, 2007.

What this means

Ash is an important component of Southern New England's forests. As emerald ash borer has caused extensive decline and mortality of ash throughout the north-central United States, it similarly represents a significant threat to the forested and urban ash tree resource in the region. Continued monitoring of ash resources will help to identify the long-term impacts of emerald ash borer in forested settings. Efforts to slow the spread of emerald ash borer will be enhanced by discontinuing the transportation of firewood.

Hemlock Woolly Adelgid

Hemlock woolly adelgid. Photo by John A. Weidhass, Virginia Polytechnic Institute and State University, Bugwood.org

Background

White 'wool' on the underside of branches of eastern hemlock is a telltale sign of a hemlock woolly adelgid infestation. A tiny, sap-feeding insect from Asia, hemlock woolly adelgid was first reported in the U.S. in Virginia in 1951 (U.S. For. Ser. 2010). By 1985, it had spread to Southern New England where it was found in Connecticut. Hemlock woolly adelgid was present in all three states by 1989. Hemlock decline generally occurs within 3 to 6 years of infestation with mortality rates being highest when infested trees also experience other stressors, such as drought.

What we found

Hemlock is found throughout much of Southern New England with the highest densities in the northwestern part of the region (Fig. 36). Regionally, there were an estimated 222 million hemlock trees (≥ 1.0 inch d.b.h.) on forest land that accounted for 987 million cubic feet of volume. Average annual mortality of hemlock was 1.6 million cubic feet per year in Connecticut and 858,000 cubic feet per year in Massachusetts; hemlock mortality was not detected in Rhode Island. When mortality was expressed as a fraction of total volume, Connecticut had the highest rate of hemlock mortality at approximately 0.9 percent (Fig. 37).

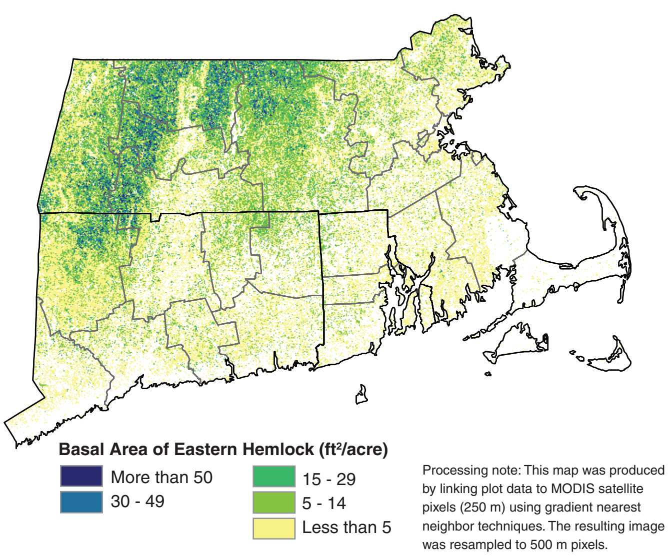

Figure 36.—Distribution of hemlock on forest land, Southern New England, 2007.

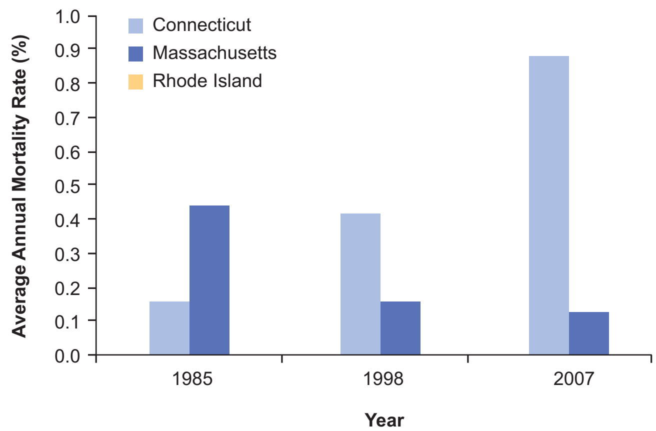

Figure 37.—Average annual mortality of hemlock growing stock per unit volume of growing stock on timberland (in percent) by state and inventory year, Southern New England, 2007.

What this means

Hemlock has a unique niche within the forests of Southern New England. The loss of this species could affect soil stability, water temperature, and water quality where hemlocks are found. Hemlock occurs in both pure and mixed stands, therefore, hemlock mortality impacts a variety of species. Based on trends in mortality, hemlock woolly adelgid has been especially damaging in Connecticut, where it has been active the longest. Slower spread of hemlock woolly adelgid to western Massachusetts, where hemlock is most abundant, may help explain the relatively lower amount of hemlock mortality in that state. Continued monitoring of the hemlock resource throughout the region will help to quantify the effects of hemlock woolly adelgid in Southern New England.

Understory Vegetation

Background

Understory vegetation is an important forest component, it helps curtail erosion, regulate soil temperature, sequester carbon, and provides food and cover for wildlife. In 2007 and 2008, understory vegetation was inventoried on 21 plots across Southern New England. Due to the small sample size, these results need to be interpreted cautiously.

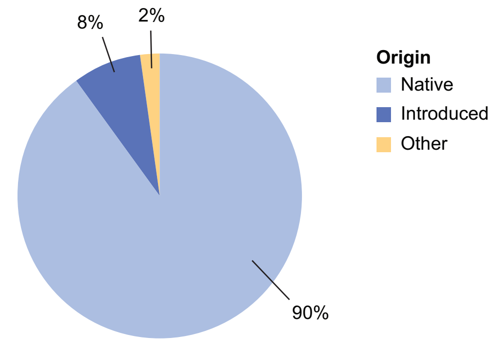

Figure 39.—Origin of understory plants found on understory vegetation plots, Southern New England, 2007-2008.

What we found

One hundred and ninety-four species of plants were found on the understory vegetation plots. The most common species were red maple, northern red oak, Canada mayflower, and starflower (Fig. 38). Each of these species was found on at least half of the understory vegetation plots inventoried.

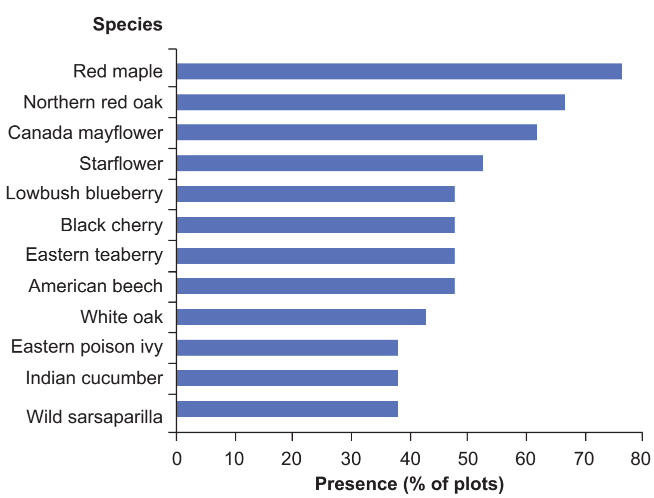

Figure 38.—Top 12 understory plants found on understory vegetation plots, Southern New England, 2007-2008.

Ninety percent of the species were classified as native to the region, 8 percent were introduced, and the rest were either cultivated or classified as both native and introduced (Fig. 39). Forbs and herbs were the most common growth forms, followed closely by tree species (Fig. 40).

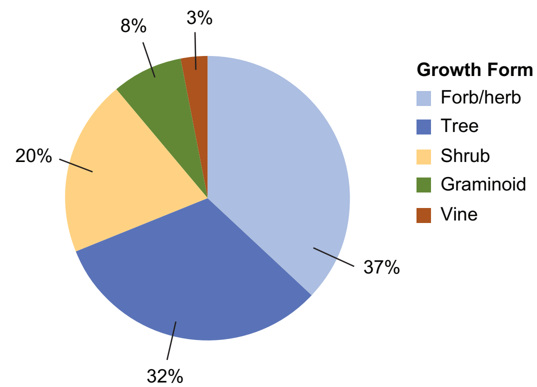

Figure 40.—Growth forms of understory plants found on understory vegetation plots, Southern New England, 2007-2008.

What this means

The forests of Southern New England host a large number of plant species that comprise many different growth forms. This greatly contributes to the diversity of the forests in terms of habitat, nutrient cycling, and many other ecosystem processes. While the majority of the plants are native to the region, a significant number are introduced. Invasive plants are discussed in the next section of this report.

Invasive Plants

Background

Invasive plants, both native and nonnative, can change the structure and function of forests by limiting regeneration and altering nutrient levels. Additionally, as these species infest forested areas, they can alter the habitat quality and species suitability for wildlife and other plant species. FIA assessed the presence and abundance of 43 species of invasive plants (Appendix II) on 116 plots during the 2007, 2008, and 2009 growing seasons.

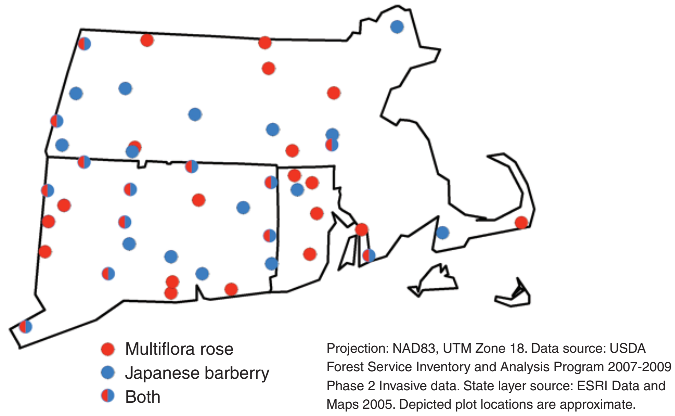

Figure 42.—Approximate location of invasives monitoring plots with multiflora rose or Japanese barberry, Southern New England, 2007-2009.

What we found

Nineteen invasive plant species were identified on one or more of the invasives monitoring plots in Southern New England. Multiflora rose, found on 19 percent of the plots, was the most commonly occurring invasive plant species (Fig. 41). Japanese barberry, found on 18 percent of the plots, was the second most common invasive plant identified. These plants were well distributed throughout the region (Fig. 42).

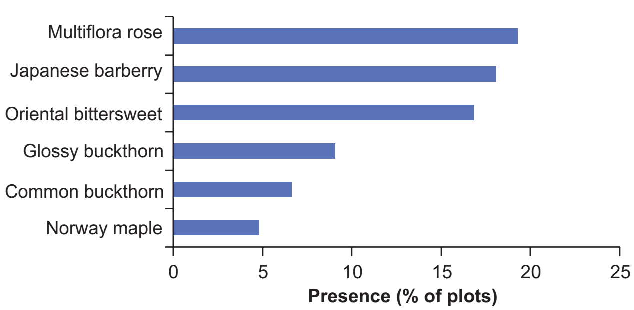

Figure 41.—Presence of the six most common invasive plant species on invasives monitoring plots, Southern New England, 2007-2009.

What this means

It is important that forest landowners and resource managers continue to monitor invasive plants to further understand the distribution, spread, and impact these species are causing. As more plots are measured, and subsequently remeasured, the new data will facilitate analyses and improve estimates. Determining the factors that make a site susceptible to invasion will help managers identify at-risk areas.

Tree Crown Health

Background

The relative health and vigor of a tree may be reflected in the health of its crown. Tree crown health was assessed on 52 forest health monitoring plots in Southern New England between 2003 and 2007. The factors used here to determine the condition of tree crowns were crown dieback, crown density, and foliage transparency (Steinman 2000). Additional crown health variables monitored include vigor class, crown ratio, light exposure, and crown position.

What we found

Tree crowns are generally healthy across the region. The incidence of poor crown condition was highest for eastern hemlock with nearly 31 percent of the live basal area having poor crowns (Fig. 43). Sugar maple and white ash had just over 20 percent of their basal areas with poor crowns. Conversely, the occurrence of poor crowns in northern red oak was very low.

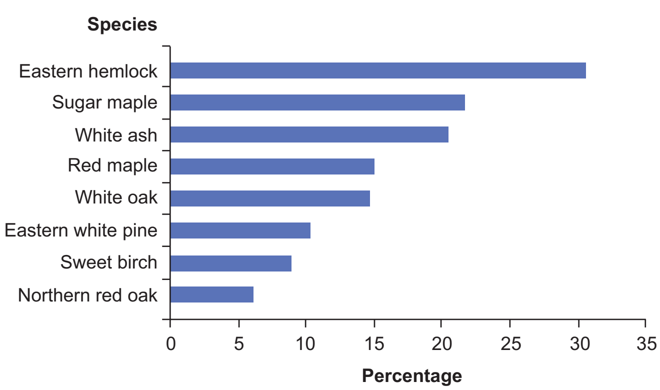

Figure 43.—Percentage of live basal area with poor crowns for selected tree species, Southern New England, 2007.

There are an estimated 91 million standing dead trees (≥ 5 inches in diameter), also referred to as "snags," across Southern New England. This equates to an average of 18 snags per acre. White oak had the highest percentage of standing dead trees, followed by white ash and northern red oak (Fig. 44). The highest occurrences of standing dead tree was in the western part of the region (Fig. 45).

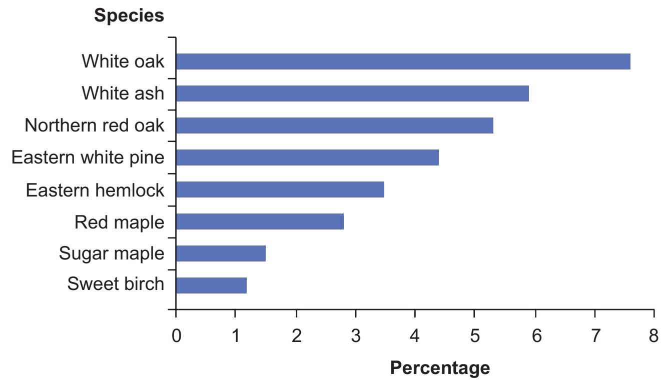

Figure 44.—Percentage of standing trees that are dead for selected tree species, Southern New England, 2007.

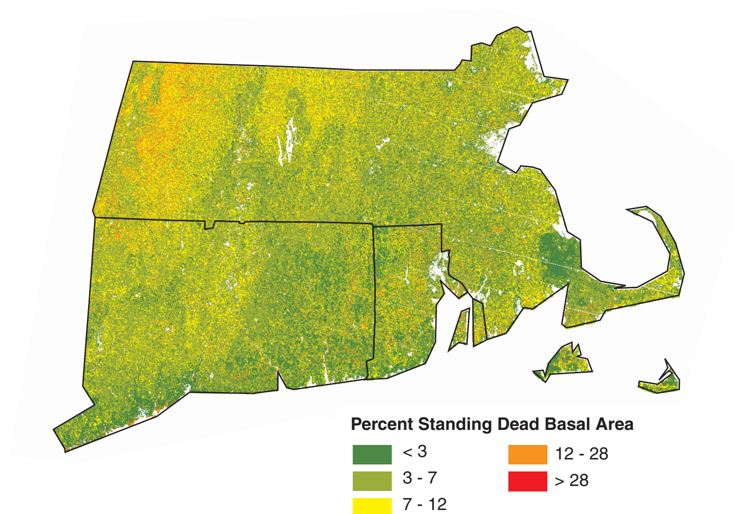

Figure 45.—Percentage of basal area comprised of standing dead trees, Southern New England, 2006.

What this means

Oaks are an important component of the forests of Southern New England. Although the crowns of living oak trees are generally healthy across the region, a high proportion (relative to other species) of standing dead oak trees likely reflects past damage events, such as gypsy moth defoliation.

Eastern hemlock is another important species in the region. The poor crown condition of many hemlock trees is likely related to the hemlock woolly adelgid that is discussed earlier in this report.

Wildlife Habitat

Background

Southern New England forests provide habitat for numerous species of mammals, birds, reptiles, and amphibians, as well as for fish, invertebrates, and plants. Several indicators of wildlife habitat abundance can be derived from FIA data. Forest composition and structure affect the suitability of habitat for each species. Abundance and trends in forest structure and successional stages serve as indicators of population carrying capacity for wildlife species (Hunter et al. 2001).

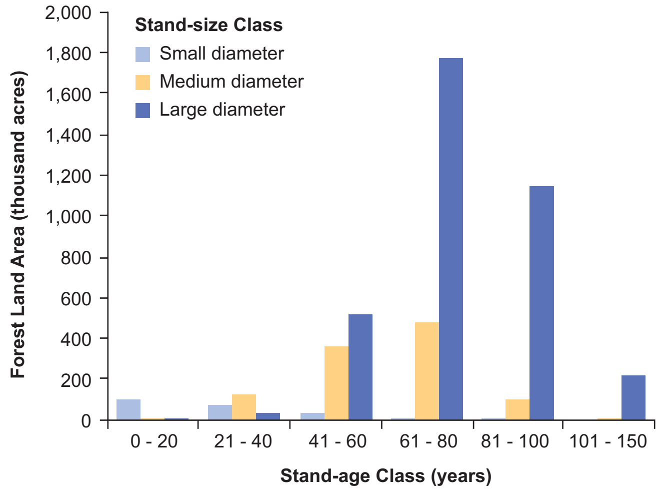

Figure 47.—Area of forest land by stand-age class and stand-size class, Southern New England, 2007.

What we found

Area of forest land in the small stand-size class in Southern New England decreased from 10 percent in 1985 to 4 percent in 2007 (Fig. 46). Concurrently, distribution of large size forest increased steadily from less than 53 percent to 75 percent.

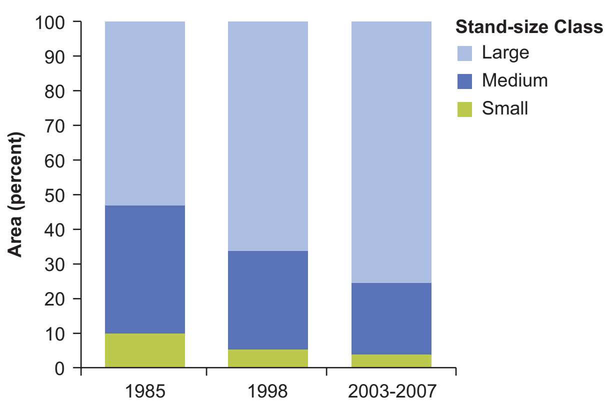

Figure 46.—Area (percent) of forest land by stand-size class, Southern New England, 1985-2007.

A large majority of New England forest land (87 percent) is in stand-age classes between 40 and 100 years. Less than 5 percent is over 100 years of age and only 0.3 percent is older than 150 years. Small diameter stand-size classes predominate in forests of 0-20 years, medium diameter predominates in the 21-40 year class, and large diameter predominates in forests over 40 years of age (Fig. 47).

What this means

Decreasing abundance of both small- and medium-diameter stand-size classes is offset by increasing abundance in large-diameter class. Ninety-four percent of the large-diameter class is less than 100 years of age. Although both stand-size class and stand-age class provide indicators of forest successional and structural stage, the two attributes are not exactly interchangeable and are best viewed in combination. There is a need to monitor and maintain forest conditions in multiple stand-size and stand-age classes, including both early (young) and late (old) successional stages to provide habitats for all forest-associated species, as is indicated in States' Wildlife Action Plans.

Snags: Standing Dead Trees

Background

Snags provide areas for foraging, nesting, roosting, hunting perches, and cavity excavation for wildlife, from primary colonizers such as insects, bacteria, and fungi to birds, mammals, and reptiles. The number and density of standing dead trees, together with decay classes, species, and sizes, define the snag resource across Southern New England forests.

What we found

There are more than 90 million standing dead trees in the forests of Southern New England, with 24.3, 60.4, and 5.8 million in Connecticut, Massachusetts, and Rhode Island, respectively. This represents an overall density of 17.8 standing dead trees per acre of forest land. Soft maple species group, composed primarily of red maple, contained the largest number of standing dead trees (Fig. 48). The eastern white/red pine group has the next largest number.

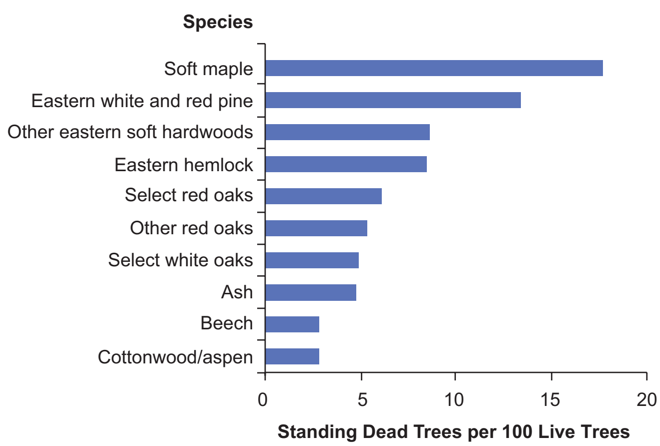

Figure 48.—Number of standing dead trees per 100 live trees by species group, Southern New England, 2007.

Across Southern New England, more than 80 percent of standing dead trees were smaller than 11 inches d.b.h. (Fig. 49). The greatest number of standing dead trees was estimated for the three intermediate decay classes, with the least number in the class of most decay (Fig. 49).

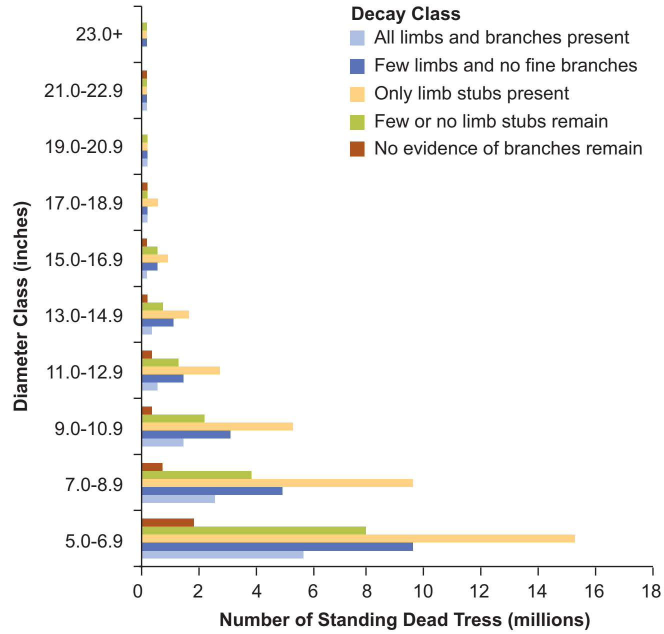

Figure 49.—Distribution of standing dead trees by decay and diameter classes for all dead trees in Southern New England, 2007.

What this means

Snags result from a variety of causes, including diseases and insects, weather damage, fire, flooding, drought, competition, and other factors. Although the soft maple species group contained the greatest number of snags, the composition varied when assessing the density of standing dead trees per 100 live trees of the same species group. Providing a variety of forest structural stages and retaining specific features like snags on both private and public lands are ways to maintain the abundance and quality of habitat for forest-associated wildlife species in Southern New England.

Down Woody Material

Background

Down woody material, in the form of fallen trees and branches, fulfill a critical ecological niche in the forests of Southern New England. These materials contribute to both wildlife habitat in the form of coarse woody debris, and forest fire hazards via surface woody fuels.

What we found

The fuel loadings of down woody materials are not exceedingly high in Southern New England (Fig. 50). Fuel loadings are reported in terms of time-lag classes defined as the time it take for moisture to fluctuate in a piece of wood—the larger the piece, the longer the time-lag.

The size-class distribution of coarse woody debris is heavily skewed (95 percent) toward pieces less than 8 inches in diameter at the point of intersection with the sampling transects (Fig. 51). With regard to decay class distribution of coarse woody debris, there appears to be moderate stages of coarse woody decay across the state (86 percent is in decay classes 2, 3, and 4) (Fig. 52). Decay class 3 and 4 coarse woody pieces are typified by moderate to heavily decayed logs that are sometimes structurally sound but missing most or all of their bark and have extensive sapwood decay.

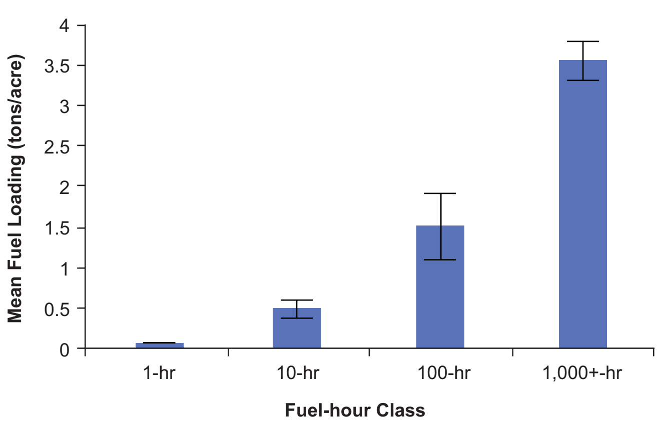

Figure 50.—Mean fuel loadings on forest land, Southern New England, 2004-2008. Error bars represent a 68 percent confidence interval around the mean.

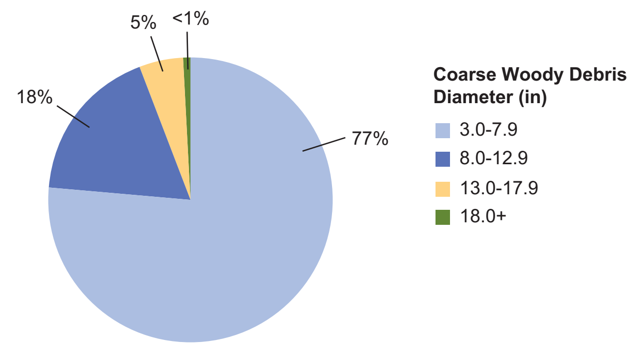

Figure 51.—Proportion of coarse woody debris by diameter on forest land, Southern New England, 2004-2008.

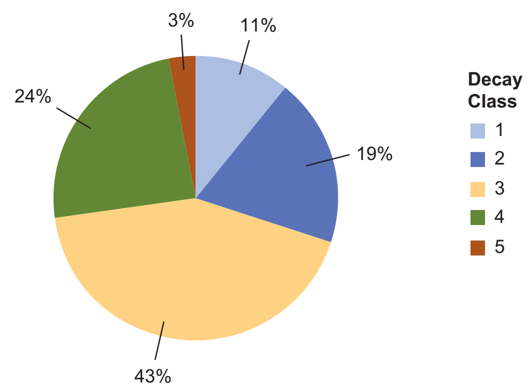

Figure 52.—Proportion of coarse woody debris by decay classes on forest land, Southern New England, 2004-2008.

What this means

The down woody fuel loadings in Southern New England are not exceedingly high and therefore, only in times of extreme drought would these low amounts of fuels pose a hazard across the region. Of all down woody components, coarse woody debris (i.e., 1,000+ hr fuels) comprised the largest volume. Coarse woody debris volumes were still relatively low and were predominantly represented by small, moderately decayed pieces. The scarcity of large coarse woody debris resources may also indicate a lack of high quality wildlife habitat and a relatively small carbon stock.

Soils

Background

The soils that sustain forests are influenced by a number of factors, including: climate; the trees, shrubs, herbs, and animals living there; landscape position; elevation; and the passage of time. Carbon stocks in soils are important long-term stores of carbon accumulated in woody biomass, foliage, and other organic matter. Climate-soil interactions, e.g., acid deposition from industrial emissions, are one way that humans influence the character of the soil and consequently the trees and the rest of the forest.

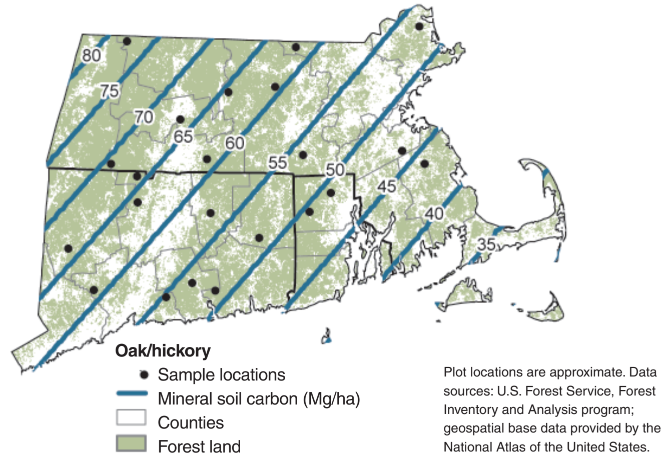

Figure 54.—Gradient of shallow mineral soil (0-20 cm) carbon storage (Mg/ha) for the oak/hickory forest-type group, Southern New England, 2007.

What we found

Forest soil characteristics in the region were found to be correlated with forest-type group, latitude, and longitude. Carbon stocks in the forest floor of oak/hickory forest-type group tend to be highest in the east and lowest in the west (Fig. 53). Conversely, carbon stocks in the mineral soil of this forest-type group have the opposite pattern (Fig. 54).

The ratios of aluminum to calcium and aluminum to magnesium can be used to measure the impact of acid deposition on forest soils. Crown vigor was correlated with aluminum:calcium and aluminum:magnesium ratios (Fig. 55). The ratios of live crown length to tree height, the uncompacted live crown ratio, of red maple and white oak increase with aluminum relative to calcium and magnesium. By contrast, the uncompacted live crown ratio of white ash declines with increases in aluminum content.

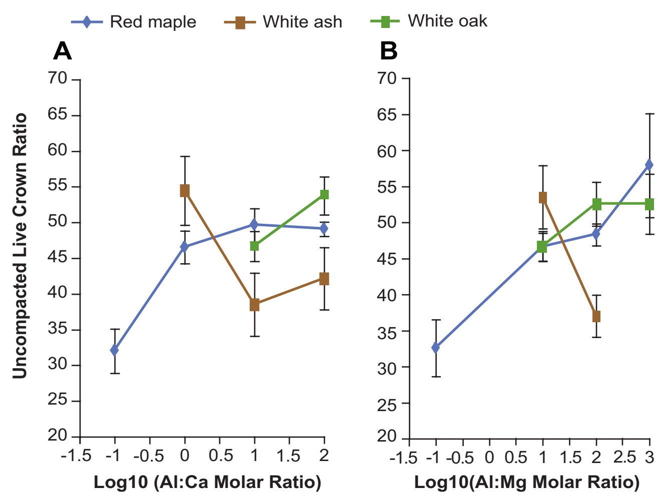

Figure 55.—Relationships between (A) Al:Ca and (B) Al:Mg and selected tree species, Southern New England, 2007. Error bars represent a 68 percent confidence interval around the mean.

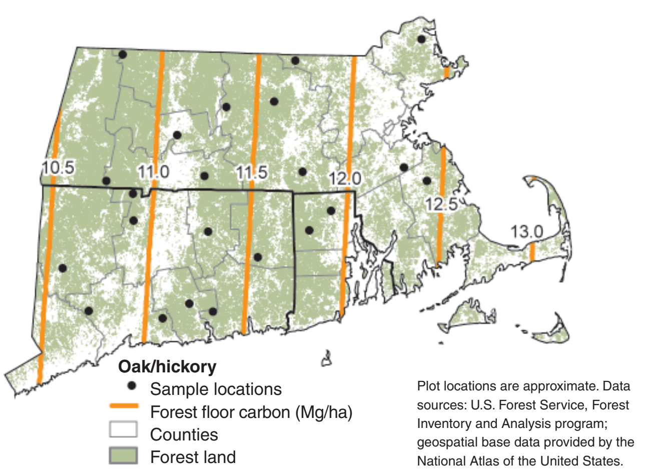

Figure 53.—Gradient of forest floor carbon storage (Mg/ha) for the oak/hickory forest-type group, Southern New England, 2007.

What this means

Atmospheric deposition of different chemical compounds changes the soil substrate through additions and/or removals of nutrients and pollutants. These changes in the soil influence the ability of existing trees to thrive and reproduce in their current locations, as well as the ability of other trees to colonize new landscapes. For example, our observations suggest that red maple and white oak have a competitive advantage in landscapes of Southern New England altered by acid deposition. It is important to document and understand natural and anthropogenic processes in the soil since they profoundly influence the current forest and success of future forest management plans. In turn, these changes in tree species composition across the landscape influence carbon sequestration rates by forests.

Lichens

Background

Lichens are symbiotic, composite organisms made up from members of as many as three kingdoms—fungi, algae, and cyanobacteria. The fungi provide the basic structure and the other species manufacture food via photosynthesis.

Lichen abundance and diversity are monitored on a subset of the FIA plots in order to address issues such as biodiversity trends and the impact of air pollution on forest resources. A close relationship exists between lichen communities and air pollution, especially acidifying or fertilizing nitrogen- and sulfur-based pollutants. A major reason lichens are so sensitive to air quality is their total reliance on atmospheric sources of nutrition. By contrast, it is difficult to separate tree-growth responses specific to air pollution (McCune 2000).

What we found

Fifty-eight lichen species were sampled on the lichen plots in Southern New England between 1994 and 2003 (Table 2). The most common lichen genera, *Parmelia* and *Physcia*, were present on 14 percent of the plots. *Cladonia* was the genus with the highest number of species sampled (13 species).

Simply counting the number of species does not provide a complete picture of ecosystem diversity because abundance is excluded. Species diversity values account for both numbers of species and abundance. Species richness values were in the low and medium ranges across Southern New England (Table 2). The spatial distribution of lichen species richness scores (Fig. 56) show the highest scores in the northeastern and southwestern parts of the broader Northeast region.

Table 2.—Lichen communities summary, Southern New England, 1994-2003.

Parameter	Value
Number of plots surveyed	34
Number of plots by species richness category	
0-6 species (low)	8
7-15 species (medium)	26
16-25 species (high)	0
Median	9
Range of species richness score per plot (low-high)	2-15
Average species richness score per plot (alpha diversity)	9.1
Standard deviation of species richness score per plot	3.2
Species turnover rate (beta diversity)[a]	6.4
Total number of species per area (gamma diversity)	58

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

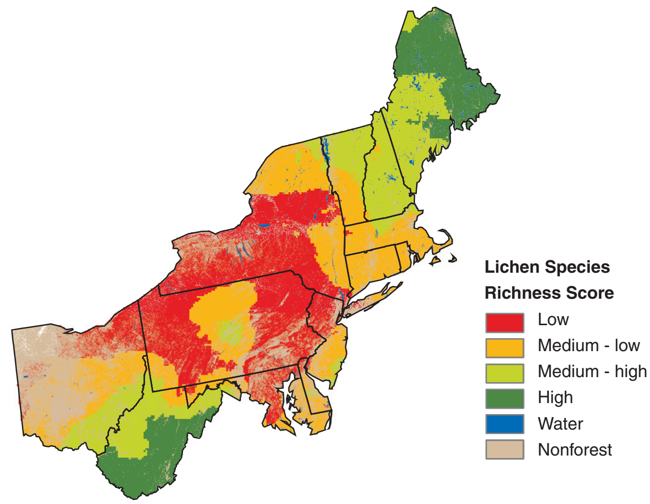

Figure 56.—Estimated lichen species richness, northeastern United States, 2000-2003.

What this means

Sulfate deposition levels have been relatively homogenous across Southern New England and are relatively low compared to other areas in the northeastern United States. A general pattern of lower lichen species richness scores in high deposition areas, and vice versa, is evident (Fig. 57), but there are also other factors that affect the distribution of lichen species, including intrinsic forest characteristics and long-term climate changes.

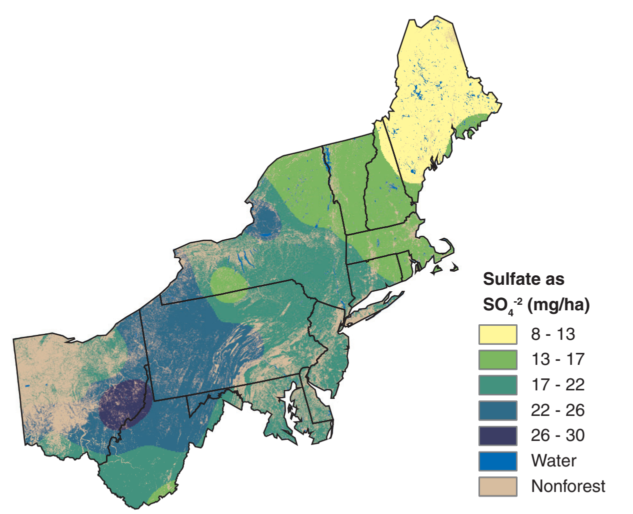

Figure 57.—Mean sulfate ion wet deposition, northeastern United States, 1994-2002 (Data source: National Atmospheric Deposition Program).

Ozone Bioindicator Plants

Background

Ozone (O_3) is naturally found in the lower atmosphere and is a byproduct of industrial development. Ground-level ozone is known to have detrimental effects upon forest ecosystems.

Certain plant species exhibit visible, easily diagnosed foliar symptoms of ozone exposure. Ozone-induced foliar injury on indicator plants is used to describe the risk of impact within the forest environment. A national system of sites, not co-located with FIA forest inventory plots, is used to assess ozone damage. Ozone plots were monitored in Southern New England between 1994 and 2007.

What we found

Most of the ozone indicator plants sampled in Southern New England were black cherry, milkweed, and blackberry (Table 3). The findings for the region indicate that risk of foliar injury due to ozone has been trending downward since the mid-1990s (Fig. 58) as have ozone exposure levels. A biosite index is calculated based on amount and severity ratings where the average score (amount × severity) for each species is averaged across all species at each site and multiplied by 1,000 to allow risk to be defined by integers (Smith et al. 2007).

Table 3.—Plant species sampled for ozone injury, Southern New England, 1994-2007.

Species	Number Sampled	Percent of Total Sampled
Black cherry	5,808	26.7
Milkweed	5,246	24.2
Blackberry	4,116	19.0
White ash	3,128	14.4
Spreading dogbane	1,515	7.0
Sassafras	1,469	6.8
Pin cherry	208	1.0
Yellow-poplar	204	0.9
Sweetgum	26	0.1

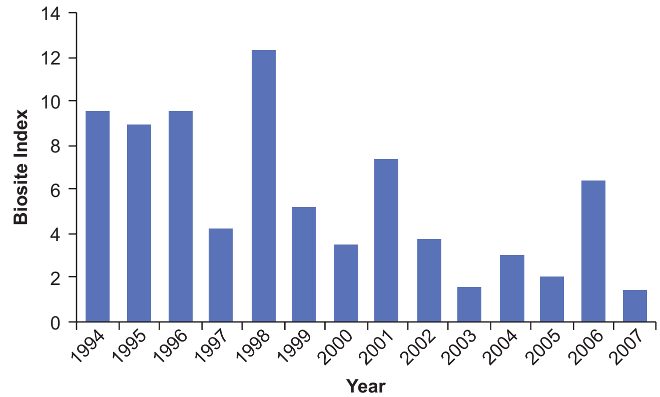

Figure 58.—Biosite index, Southern New England, 1994-2007.

What this means

Ozone exposure rates have been decreasing with corresponding decreases in foliar injury. This is in contrast to evidence of medium and high risk ozone exposure in portions of the mid-Atlantic region (Coulston et al. 2003).

A typical summer ozone exposure pattern for the Northeast is shown in Figure 59. SUM06 is defined as the sum of all valid hourly ozone concentrations that equal or exceed 0.06 parts per million. Controlled studies have found that high ozone levels (shown in orange and red in Fig. 59) can lead to measurable growth suppression in sensitive tree species (Chappelka and Samuelson 1998). Smith et al. (2003) reported that even when ambient ozone exposures are high, the percentage of injured plants can be reduced sharply in dry years.

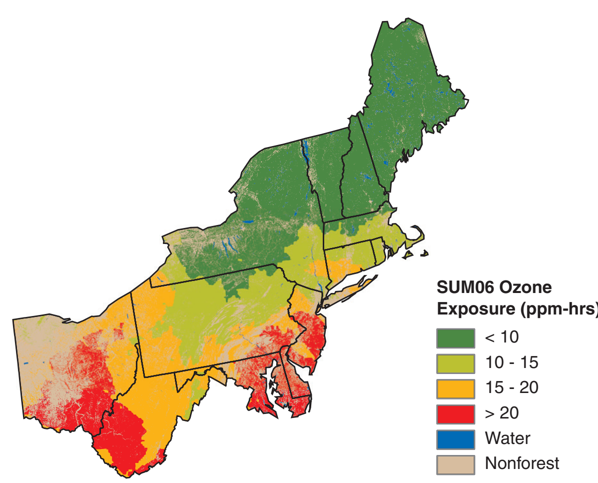

Figure 59.—Typical ozone exposure rates, northeastern United States (Data Source: NLCD 1992, EPA 2006).

Forest Economics

Forest products harvested in Southern New England. Photo by William N. Hill, Massachusetts Department of Conservation and Recreation.

Timber Products

Background

The harvesting and processing of timber products produces a stream of income shared by forest owners, foresters, loggers, truckers, and processors. The wood products industry of Southern New England employs approximately 23,500 people, with an average annual payroll of $1.1 billion (U.S. Census Bureau 2007). Surveys of wood-processing mills in the region are periodically conducted to estimate the amount of wood processed and the products produced. The last timber product output surveys conducted in Massachusetts was in 2004 and Connecticut and Rhode Island in 2005. Data reported in this report are from those surveys.

What we found

There were 69 sawmills in the region: 22 in Connecticut, 41 in Massachusetts, and 6 in Rhode Island. These sawmills processed over 85 million board feet of logs. Ninety-four percent of the sawlogs processed originated in the region.

A total of 15 million cubic feet of industrial roundwood were harvested from the region and the vast majority of this was sawlogs (Fig. 60). White pine and red oaks accounted for most of this wood (Fig. 61). Other important species groups harvested were hemlock, white oaks, and soft maples.

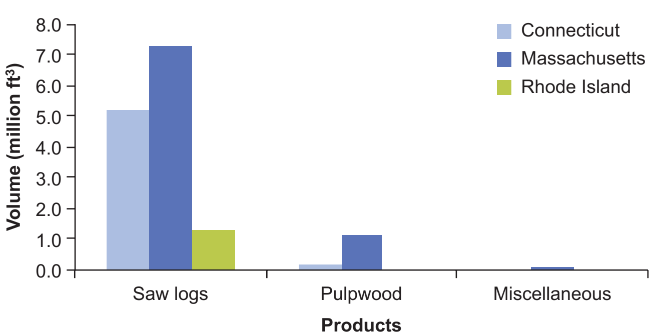

Figure 60.—Industrial roundwood production by state and product, Southern New England, 2004 and 2005.

In the process of harvesting industrial roundwood, 9.6 million cubic feet of harvest residues were left on the ground (Fig. 62). The processing of industrial roundwood in the region generated another 12.5 million cubic feet of wood and bark residues. Ninety-eight percent of the mill residues were utilized as mulch, animal bedding, fuelwood, or other uses.

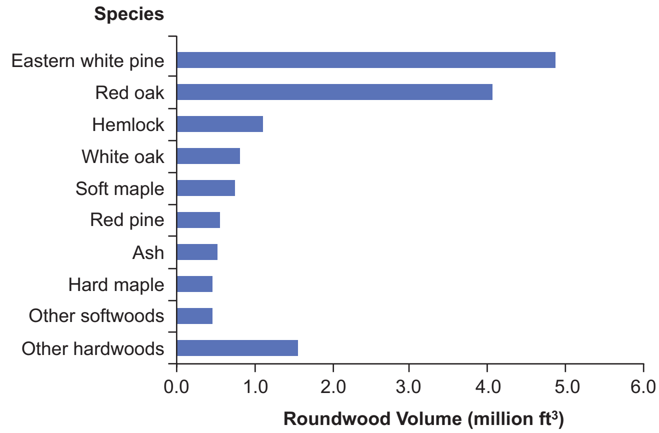

Figure 61.—Industrial roundwood harvested by species group, Southern New England, 2004 and 2005.

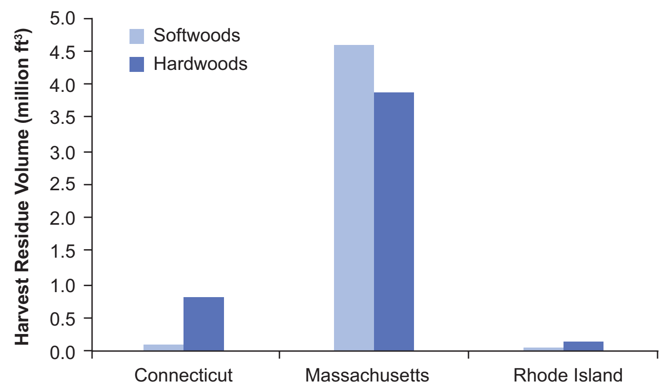

Figure 62.—Harvest residue generated by industrial roundwood harvesting by state and softwoods/hardwoods, Southern New England, 2004 and 2005.

What this means

All of the wood-processing facilities in Southern New England are sawmills processing primarily logs grown in the region. The number of wood-processing mills has been steadily declining. The loss of processing facilities makes it harder for forest owners to find markets for the timber harvested.

There is a substantial volume of harvest residues that are currently going unused. Better utilization of the resource and the use of logging slash and mill residues for industrial fuelwood at co-generation facilities are possible solutions for this problem.

Growing-stock Volume

Background

Most tree volume statistics in this report have included all trees regardless of quality. Growing-stock trees meet specific standards for quality and excludes rough and rotten trees. As with other volume estimates, these estimates include living trees that are at least 5.0 inches in diameter. In addition, only trees on timberland, the 96 percent of the forest land that meets specific productivity levels (i.e., capable of producing at least 20 cubic feet of commercial wood per acre per year), are included.

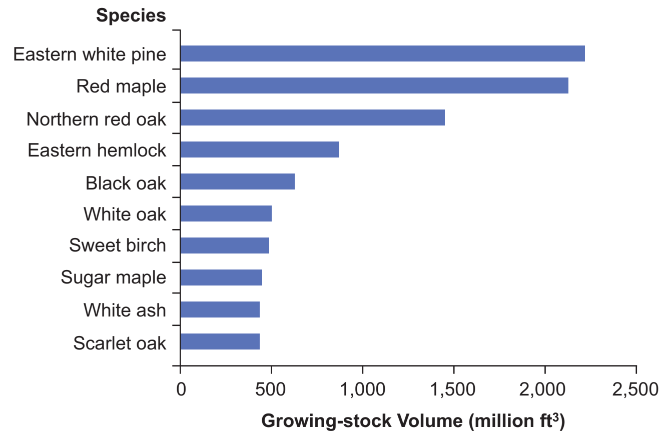

Figure 64.—Growing-stock volume by selected tree species, Southern New England, 2007.

What we found

There are 11.4 billion cubic feet of volume in growing-stock trees across Southern New England (Fig. 63). On average, there are 2,400 cubic feet of volume of growing-stock trees per acre of timberland in Massachusetts, 2,200 cubic feet per acre in Connecticut, and 2,000 cubic feet per acre in Rhode Island. This volume has been steadily increasing and has nearly doubled since 1953.

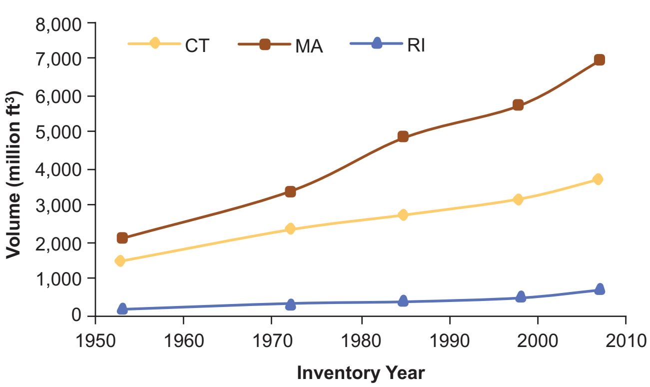

Figure 63.—Growing-stock volume on timberland, Southern New England, 1953-2007.

Eastern white pine and red maple are the dominant species in terms of growing-stock volume (Fig. 64). These two species, along with northern red oak, account for 51 percent of the region's growing-stock volume.

What this means

As the forests of the region have matured and growth has exceeded harvesting and other removals, the growing-stock volume has been increasing. This trend is likely to continue unless harvesting or other practices shift dramatically, or major disturbances occur across the region.

The dominance of specific species is a function of the biophysical environment, the age and history of the stand, and the characteristics of the species present. The species that will be dominant in the future depends on a number of factors including successional pathways. If the current stands are left undisturbed, shade tolerant species will eventually dominate. If major stand-replacing events occur, other species, such as pines or oaks, will be favored.

Sawtimber Quantity and Quality

Background

A further subset of growing-stock volume is sawtimber, the trees that are currently large enough to produce commercial lumber products. Sawtimber trees must be alive, have at least one 12-foot sawlog or two noncontiguous 8-foot sawlogs and meet minimum diameter thresholds. For softwoods the minimum diameter is 9.0 inches and for hardwoods it is 11.0 inches.

These statistics are reported in terms of board feet, a unit of measure that represents the amount of final wood products that could be produced. A board foot is equal to a piece of wood 1 foot by 1 foot by 1 inch. The International 1/4-inch rule is the specific conversion used.

A system of standards, called tree grades, are used to rate the quality of a tree for producing forest products. The meanings differ by species group, but grade 1 is the highest quality and the quality decreases with higher grade numbers. Many factors affect grading including defects, curvature, and length of usable sections (U.S. For. Ser. 2007).

What we found

There are 38 billion board feet of sawtimber across Southern New England. Sixty-one percent of this volume is in Massachusetts, 33 percent is in Connecticut, and 6 percent is in Rhode Island. Eastern white pine accounts for 26 percent of this volume (Fig. 65). The top three species, by volume, account for 55 percent of the volume across the region.

There is a relatively even split between higher-grade, 1 and 2, and lower grade logs (Fig. 66). Eighteen percent of the volume are in Grade 1 logs, 23 percent in Grade 2 logs, and the other 59 percent are in logs that are Grade 3 or lower.

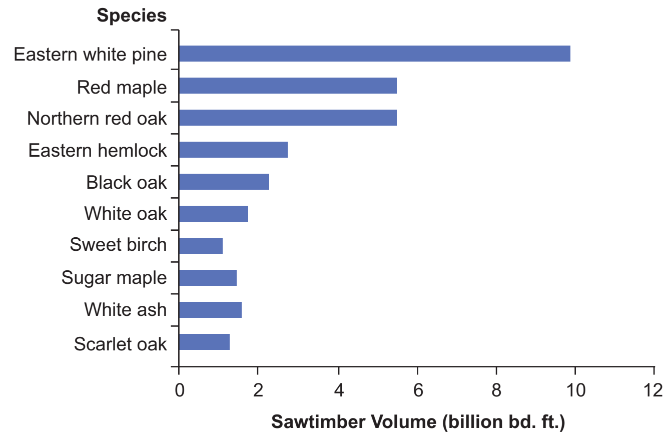

Figure 65.—Sawtimber volume on timberland for selected tree species, Southern New England, 2003- 2007.

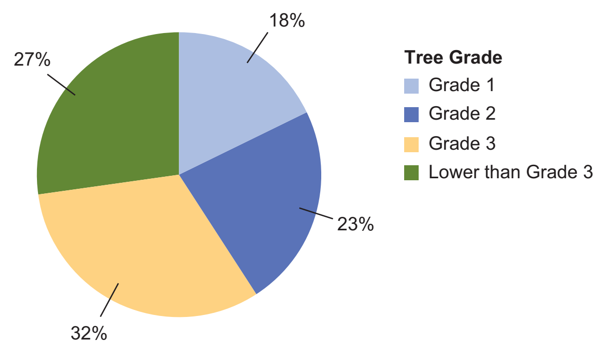

Figure 66.—Sawtimber volume on timberland by tree grade, Southern New England, 2007.

What this means

There is a wide diversity of the quality of the saw logs in Southern New England. Over half of the volume is of relatively low quality, Grade 3 or less. While these lower quality logs may not be suitable for high-end final products such as wood furniture, they are suitable for railroad ties, pallets, and other uses.

Data Sources and Techniques

Forest Inventory

Information on the condition and status of forests in Connecticut, Massachusetts, and Rhode Island was obtained from the Northern Research Station's Forest Inventory and Analysis (NRS-FIA) program. Previous inventories of the region's forest resources were completed in 1953, 1972, 1985, and 1998.

Since the 1998 inventory, several changes in FIA methods have improved the quality of the inventory. The most significant change between inventories has been the shift from a periodic to an annual inventory. Historically, FIA inventoried each state on a cycle that averaged about 12 years. The need for timely and consistent data across large geographical regions along with national legislative mandates resulted in FIA implementing an annual inventory program. Annual inventory was initiated in Southern New England in 2003.

With the NRS-FIA annual inventory system, approximately one-fifth of all field plots are measured each year. The entire inventory is completed within 5 years. After this initial 5-year period, NRS-FIA will report and analyze results using a moving 5-year average. For example, NRS-FIA will be able to generate inventory results for 2003 through 2007 or for 2004 through 2008.

Other significant changes between inventories include implementing new remote-sensing technology, a new field-plot configuration and sample design, and gathering additional remotely sensed and field data. The use of new remote-sensing technology allows NRS-FIA to use classifications of Multi-Resolution Land Characterization (MRLC) data and other remote-sensing products to stratify the total area of a state and to improve estimates.

New algorithms were used for the 2003-2007 inventory to assign forest type and stand-size class to each condition observed on a plot. These algorithms are being used nationwide by FIA to provide consistency from state to state. As a result, changes in forest type and stand-size class will reflect actual changes in the forest and not changes due to differences between algorithms. The list of recognized forest types, groupings of these forest types for reporting purposes, models used to assign stocking values to individual trees, definition of nonstocked (stands with a stocking value of less than 10 percent for live trees), and names given to the forest types changed with the new algorithms. As a result, comparisons between the published 2003-2007 results and those published for the 1998 inventory may be invalid. Contact NRS-FIA for additional information on the algorithms used in both inventories.

Detailed information about the forest inventory sample design, estimation procedures, and data quality are included on the DVD that accompanies this report.

National Woodland Owner Survey

Information about family forest owners is collected through the U.S. Forest Service's National Woodland Owner Survey (NWOS). The NWOS was designed to increase our understanding of owner demographics and motivations (Butler et al. 2005). Individuals and private groups identified as forest owners by FIA are invited to participate in the NWOS. Data presented here are based on survey responses from 172 randomly selected families and individuals who own forest land in Connecticut, Massachusetts, or Rhode Island. For additional information about the NWOS, visit: www.fia.fs.fed.us/nwos.

Timber Products Output Survey

This study was a cooperative effort among NRS-FIA and the state forestry agencies. Using a questionnaire designed to determine the size and composition of the region's forest products industry, its use of roundwood (round sections cut from trees), and its generation and disposition of wood residues, agency personnel contacted via mail and telephone all primary wood-using mills in the states. Completed questionnaires were sent to NRS-FIA for analyzing and processing. As part of data analyzing and processing, all industrial roundwood volumes reported on the questionnaires were converted to standard units of measure using regional conversion factors.

Insects and Disease

Information about the insects and diseases affecting Southern New England's forests was gathered from the U.S. Forest Service, Northeastern Area State and Private Forestry (www.na.fs.fed.us), the national Forest Health Monitoring program (fhm.fs.fed.us/), and state forestry agencies.

National Land Cover Data Imagery

Derived from Landsat Thematic Mapper satellite data (30-meter pixel), the National Land Cover Dataset (NLCD) is a land cover classification scheme (21 classes) applied across the United States by the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (EPA). The NLCD was developed from data acquired by the MRLC Consortium, a partnership of Federal agencies that produce or use land-cover data. Partners include the USGS, EPA, U.S. Forest Service, and National Oceanic and Atmospheric Administration.

Mapping Procedures

Maps in this report were constructed using (1) categorical coloring of state counties according to forest attributes (such as forest land area); (2) a variation of the k-nearest-neighbor (KNN) technique to apply information from forest inventory plots to remotely sensed MODIS imagery (250 m pixel size) based on the spectral characterization of pixels and additional geospatial information; or (3) colored dots to represent plot attributes at approximate plot locations.

Ozone Monitoring

Ozone plots are chosen for ease of access and optimal size, species, and plant counts. As such, the ozone plots do not have set boundaries and vary in size. At each plot, between 10 and 30 individual plants of three or more indicator species are evaluated for ozone injury. Each plant is rated for the proportion of leaves with ozone injury and the mean severity of symptoms using break points that correspond to the human eye's ability to distinguish differences.

Lichen Monitoring

This long-term lichen monitoring program in the United States dates back to 1994. The objectives of the lichen indicator are to determine the presence and abundance of lichen species on woody plants and to collect samples. Lichens occur on many different substrates (e.g., rocks) but all sampling is restricted to standing trees or branches/twigs that have recently fallen to the ground. Samples are sent to lichen experts for species identification.

Glossary

Below are definitions of selected terms used in this report. A more comprehensive glossary is available on the DVD that accompanies this report.

Annual mortality of growing stock: The average cubic-foot volume of wood in growing-stock trees that died in one year.

Annual net growth of growing stock: The annual change in cubic-foot volume of wood in live growing-stock trees, and the total volume of trees entering all of the diameter classes at least 5.0 inches d.b.h., through ingrowth. All volume losses through natural causes must be deducted. Natural causes include mortality except that which is due to logging damage, timber stand improvement activities, or conversion to nonforest land use.

Annual removals from growing stock: The average cubic-foot volume of wood in live growing-stock trees removed annually for roundwood forest products, in addition to the volume in logging residues or mortality due to logging damage (harvest removals). This component of change also includes the volumes of growing-stock trees removed due to land use changes (other removals).

Basal area: The cross-sectional area of a tree stem at breast height, expressed in square feet.

Board foot: A unit of lumber measuring 1-foot long, 1-foot wide, and 1-inch thick, or its equivalent. International ¼-inch rule is used as the U.S. Forest Service standard log rule in the eastern United States.

Diameter at breast-height (d.b.h.): The diameter outside bark of a standing tree measured at 4.5 feet above the ground.

Forest land: Accessible land that is at least 10 percent stocked with trees of any size, or that formerly had such tree cover and is not currently developed for a nonforest use. The minimum area for classification as forest land is 1 acre and 120 feet wide measured stem-to-stem from the outer-most edge. The components that make up forest land are timberland and all noncommercial forest land.

Gross growth: The sum of accretion and ingrowth.

Growing stock: A classification of timber inventory that includes live trees of commercial species meeting specified standards of quality or vigor. Rough and rotten trees are excluded. When concerning volume estimates, includes only trees 5 inches d.b.h. and larger.

Growing-stock trees: Live trees of commercial species classified as poletimber or sawtimber, and are not rough or rotten trees.

Growing-stock volume: Net or gross volume in cubic feet of growing-stock trees 5.0 inches and larger d.b.h. measured from the 1-foot stump to a minimum 4.0-inch top diameter outside bark on the central stem, or to the point where the central stem splits into limbs. Net volume equals gross volume minus deduction for cull defects.

Hardwood trees: Trees belonging to the botanical subdivision Angiospermae, class Dicotyledonous, usually broad-leaved and deciduous.

Industrial wood: All commercial roundwood products except fuelwood.

Live aboveground biomass: The aboveground weight of live trees (including bark but excluding foliage) reported in dry tons (dry weight).

Net cubic-foot volume: The gross volume in cubic feet less the deductions for rot, roughness, and poor form. Volume is computed from the 1-foot stump to a minimum 4.0-inch top diameter outside bark on the central stem, or to the point where the central stem splits into limbs.

Saplings: Live trees with a d.b.h. between 1.0 inch and 4.9 inches.

Seedling: Live tree smaller than 1.0 inch d.b.h. and at least 6.0 inches in height for softwoods and 12.0 inches in height for hardwoods.

Softwood tree: A coniferous tree, usually evergreen, having needles or scale-like leaves.

Stand-size class: A condition classification of accessible forest land based upon the size class of stocking; that is, small-diameter stands (less than 5.0 inches d.b.h.), medium-diameter stands (5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods), or large-diameter stands (≥ 9.0 inches for softwoods and 11.0 d.b.h. for hardwoods), of live trees in the selected area.

Timberland: Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative rule. (Note: Areas qualifying as timberland are capable of producing in excess of 20 cubic feet of wood per acre, per year in natural stands. Currently inaccessible and inoperable areas are included).

Total live tree biomass: The total mass of live trees and associated saplings expressed in pounds or tons (dry weight) per unit area.

Tree: A woody plant usually having one or more erect perennial stems, a stem d.b.h. of at least 3.0 inches, a more or less definitely formed crown of foliage, and a height of at least 15 feet at maturity.

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Appendix I. Tree Species in Southern New England

The followings is a list of tree species found on FIA sample plots in Connecticut, Massachusetts, and Rhode Island between 2003 and 2007. This is not a complete list of all tree species in the states.

Common name	Scientific name	CT	MA	RI
Ailanthus				
Tree-of-heaven	*Ailanthus altissima*	X	X	X
Alder				
European alder	*Alnus glutinosa*		X	
Apple				
Apple	*Malus* spp.	X	X	X
Ash				
Black ash	*Fraxinus nigra*	X	X	X
Green ash	*Fraxinus pennsylvanica*	X	X	X
White ash	*Fraxinus americana*	X	X	X
Basswood				
American basswood	*Tilia americana*	X	X	
Beech				
American beech	*Fagus grandifolia*	X	X	X
Birch				
Gray birch	*Betula populifolia*	X	X	X
Paper birch	*Betula papyrifera*	X	X	X
Sweet birch	*Betula lenta*	X	X	X
Yellow birch	*Betula alleghaniensis*	X	X	X
Blackgum				
Blackgum	*Nyssa sylvatica*	X	X	X
Cherry				
Black cherry	*Prunus serotina*	X	X	X
Chokecherry	*Prunus virginiana*		X	
Pin cherry	*Prunus pensylvanica*	X	X	X
Chestnut				
American chestnut	*Castanea dentata*	X	X	X
Dogwood				
Flowering dogwood	*Cornus florida*	X	X	X
Elm				
American elm	*Ulmus americana*	X	X	X
Rock elm	*Ulmus thomasii*	X		
Slippery elm	*Ulmus rubra*	X	X	X
Fir				
Balsam fir	*Abies balsamea*		X	
Hackberry				
Hackberry	*Celtis occidentalis*			X
Hawthorn				
Hawthorn	*Crataegus* spp.	X		
Hemlock				
Eastern hemlock	*Tsuga canadensis*	X	X	X
Hickory				
Bitternut hickory	*Carya cordiformis*	X	X	
Mockernut hickory	*Carya alba*	X	X	X

(Appendix I. continued on next page.)

(Appendix I. Continued)

Common name	Scientific name	CT	MA	RI
Pecan	*Carya illinoinensis*		X	
Pignut hickory	*Carya glabra*	X	X	X
Shagbark hickory	*Carya ovata*	X	X	X
Honeylocust				
Honeylocust	*Gleditsia triacanthos*		X	
Holly				
American holly	*Ilex opaca*		X	X
Hophornbeam				
Eastern hophornbeam	*Ostrya virginiana*	X	X	X
Hornbeam				
American hornbeam	*Carpinus caroliniana*	X	X	X
Locust				
Black locust	*Robinia pseudoacacia*	X	X	X
Maple				
Boxelder	*Acer negundo*			X
Mountain maple	*Acer spicatum*		X	
Norway maple	*Acer platanoides*	X	X	
Red maple	*Acer rubrum*	X	X	X
Silver maple	*Acer saccharinum*	X	X	
Striped maple	*Acer pensylvanicum*	X	X	
Sugar maple	*Acer saccharum*	X	X	X
Mountain-ash				
American mountain-ash	*Sorbus americana*	X		
Mulberry				
Red mulberry	*Morus rubra*			X
Pine				
Eastern white pine	*Pinus strobus*	X	X	X
Pitch pine	*Pinus rigida*	X	X	X
Red pine	*Pinus resinosa*	X	X	
Scotch pine	*Pinus sylvestris*	X	X	
Poplar				
Balsam poplar	*Populus balsamifera*		X	X
Bigtooth aspen	*Populus grandidentata*	X	X	X
Eastern cottonwood	*Populus deltoides*	X	X	X
Quaking aspen	*Populus tremuloides*	X	X	X
Oak				
Black oak	*Quercus velutina*	X	X	X
Bur oak	*Quercus macrocarpa*		X	
Chestnut oak	*Quercus prinus*	X	X	X
Northern pin oak	*Quercus ellipsoidalis*	X	X	X
Northern red oak	*Quercus rubra*	X	X	X
Pin oak	*Quercus palustris*	X	X	
Post oak	*Quercus stellata*		X	
Scarlet oak	*Quercus coccinea*	X	X	X
Scrub oak	*Quercus ilicifolia*		X	
Swamp chestnut oak	*Quercus michauxii*		X	

(Appendix I. continued on next page.)

(Appendix I. Continued)

Common name	Scientific name	CT	MA	RI
Swamp white oak	*Quercus bicolor*	X	X	X
White oak	*Quercus alba*	X	X	X
Redcedar/juniper				
Eastern redcedar	*Juniperus virginiana*	X	X	X
Sassafras				
Sassafras	*Sassafras albidum*	X	X	X
Serviceberry				
Common serviceberry	*Amelanchier arborea*	X		
Spruce				
Black spruce	*Picea mariana*		X	
Norway spruce	*Picea abies*	X	X	
Red spruce	*Picea rubens*	X	X	
White spruce	*Picea glauca*		X	
Sycamore				
American sycamore	*Platanus occidentalis*	X		X
Tamarack				
Tamarack (native)	*Larix laricina*		X	
Walnut				
Black walnut	*Juglans nigra*	X	X	X
Butternut	*Juglans cinerea*	X	X	
White-cedar				
Atlantic white-cedar	*Chamaecyparis thyoides*		X	X
Willow				
Bebb willow	*Salix bebbiana*		X	
Black willow	*Salix nigra*		X	
White willow	*Salix alba*	X		
Yellow-poplar				
Yellow-poplar	*Liriodendron tulipifera*	X	X	X

Appendix II. Invasive Plants in Southern New England

Plants (scientific and common names) monitored on FIA invasive plots, Southern New England, 2007-2008.

Common name	Scientific name
Barberry, common	*Berberis vulgaris*
Barberry, Japanese	*Berberis thunbergii*
Browntop, Nepalese	*Microstegium vimineum*
Buckthorn, common	*Rhamnus cathartica*
Buckthorn, glossy	*Frangula alnus*
Canarygrass, reed	*Phalaris arundinaceae*
Chinaberry	*Melia azedarach*
Cranberrybush, European	*Viburnum opulus*
Elm, Siberian	*Ulmus pumila*
Honeysuckle, Amur	*Lonicera maackii*
Honeysuckle, Japanese	*Lonicera japonica*
Honeysuckle, Morrow’s	*Lonicera morrowii*
Honeysuckle, showy fly	*Lonicera x.bella*
Honeysuckle, Tatarian bush	*Lonicera tatarica*
Ivy, English	*Hedera helix*
Jenny, creeping	*Lysimachia nummularia*
Knapweed, spotted	*Centaurea biebersteinii*
Knotweed, Bohemian	*Polygonum x.bohemicum*
Knotweed, giant	*Polygonum sachalinense*
Knotweed, Japanese	*Polygonum cuspidatum*
Locust, black	*Robinia pseudoacacia*
Loosestrife, purple	*Lythrum salicaria*
Maple, Norway	*Acer platanoides*
Meadowsweet, Japanese	*Spiraea japonica*
Mustard, garlic	*Alliaria petiolata*
Olive, autumn	*Elaeagnus umbellata*
Olive, Russian	*Elaeagnus angustifolia*
Princesstree	*Paulownia tomentosa*
Privet, European	*Ligustrum vulgare*
Punktree	*Melaleuca quinquenervia*
Reed, common	*Phragmites australis*
Rocket, dames	*Hesperis matronalis*
Rose, multiflora	*Rosa multiflora*
Saltcedar	*Tamarix ramosissima*
Silktree	*Albizia julibrissin*
Spurge, leafy	*Euphorbia esula*
Swallow-wort, Louise’s	*Cynanchum louiseae*
Swallow-wort, European	*Cynanchum rossicum*
Tallow tree	*Triadica sebifera*
Thistle, bull	*Cirsium vulgare*
Thistle, Canada	*Cirsium arvense*
Tree-of-heaven	*Ailanthus altissima*

Butler, Brett J.; Barnett, Charles J.; Crocker, Susan J.; Domke, Grant M.; Gormanson, Dale; Hill, William N.; Kurtz, Cassandra M.; Lister, Tonya; Martin, Christopher; Miles, Patrick D.; Morin, Randall; Moser, W. Keith; Nelson, Mark D.; O'Connell, Barbara; Payton, Bruce; Perry, Charles H.; Piva, Ron J.; Riemann, Rachel; Woodall, Christopher W. 2011. **The Forests of Southern New England, 2007: A report on the forest resources of Connecticut, Massachusetts, and Rhode Island.** Resour. Bull. NRS-55. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 48 p. [DVD included].

This report summarizes the results of the fifth forest inventory of the forests of Southern New England, defined as Connecticut, Massachusetts, and Rhode Island, conducted by the U.S. Forest Service, Forest Inventory and analysis program. Information on forest attributes, ownership, land use change, carbon, timber products, forest health, and statistics and quality assurance of data collection are included. There are 5.1 million acres of forest land across the region; 60 percent of this forest land is in Massachusetts, 33 percent in Connecticut, and 7 percent in Rhode Island. This amount has decreased by 5 percent since the last inventory was completed in 1998. There are 2.6 billion trees on this forest land that have total volume of 12.6 billion cubic feet. Red maple and eastern white pine are the most common species in terms of both numbers of trees and volume. Fifty percent of the forest land is classified as the oak-hickory forest type.

KEY WORDS: inventory, forest statistics, forest land, land use, ownership, volume, biomass, carbon, growth, removals, mortality, and forest health

DVD Contents

The Forests of Southern New England 2007 (PDF)

The Forests of Southern New England: Statistics, Methods, and Quality Assurance (PDF)

The Forests of Southern New England Inventory Database (CSV file folder)

The Forests of Southern New England Inventory Database (Access file)

Field guides that describe inventory procedures (PDF)

Database User's Guide (PDF)

The Forests of Southern New England 2007: Statistics, Methods, and Quality Assurance

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