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Maine Forests 2018: Summary Report



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Abstract

Results of the fourth annual inventory estimate that 89 percent, or 17.5 million acres, of Maine's land base (exclusive of water) is forested, making Maine the most forested state in the Nation. Over 75 percent of Maine's forest land is dominated by the maple/beech/birch and spruce/fir forest-type groups. The volume of sawtimber on timberland has risen 75 percent since 1959 while average annual net growth (merchantable bole volume) of growing stock on timberland averaged 713 million cubic feet per year from 2013 to 2018. The density of carbon in Maine's forest land was estimated at 88 tons per acre with soil organic carbon and live trees accounting for 87 percent of total forest carbon stocks. This summary includes additional information on forest attributes, land-use change, timber products, ownership, and forest health, among other critical forest ecosystem services. A detailed interactive report is available at <https://doi.org/10.2737/NRS-RB-126-INT>, and supplemental information, including (1) tables summarizing quality assurance, (2) a core set of tabular estimates for forest resources, and (3) user and database guides for P2 and P2+ protocols, can be accessed at <https://doi.org/10.2737/NRS-RB-126>.

Key Words: inventory, forest statistics, forest land, volume, biomass, carbon, growth, removals, mortality, forest health

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Cover photo: Overlooking Shirley Pond, Piscataquis County, Maine. Courtesy photo by Phil Hofmeyer, used with permission.

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Foreword

It is with great pleasure that I welcome you to the fourth 5-year report from the USDA Forest Service statewide forest inventory, “Maine Forests 2018”. Maine is 89 percent forested, which puts us as the Number 1 forested state in the country. Our forests are iconic, and our trees give our state our unique identity. With such an identity, it is imperative that we understand and have the data to allow us to make decisions for the forests’ welfare. Enter the 2018 forest inventory report. This inventory is conducted as a cooperative program between the Maine Forest Service and the Forest Inventory and Analysis program of the USDA Forest Service. Results of the inventory show that Maine’s forests are composed of over 23 billion trees (greater than 1 inch diameter at breast height) representing a little over 50 different tree species. There are over 373 million standing dead trees across Maine’s forests that provide important habitat to wildlife species in addition to increasing the structural diversity of forest stands. Other interesting points in the report include that over 75 percent of Maine’s 17.5 million acres of forest land fall into just two forest-type groups: maple/beech/birch with 7.2 million acres (41 percent), and spruce/fir with 6.0 million acres (34 percent). In terms of individual forest types, 37 were identified but nearly 50 percent of forested area was in either the balsam fir type (2.3 million acres) or sugar maple/beech/yellow birch (6.2 million acres). Sound tree volume in Maine increased by over 1 billion cubic feet from 2013 to 2018.

Maine’s forests are stable and in good health, but they also face a variety of concerns. For example, the average age of family forest owners is 66.9 years with sizeable acreage owned by people substantially older. Given that 9 out of every 10 acres of forest land in Maine are privately owned with 29.9 percent owned by family forest owners, we can expect a large turnover in forest ownership in the not-to-distant future. Although well less than 1 percent of Maine’s forests have been converted to nonforest land uses over the past decade, the rate of forests being converted to nonforest versus nonforest being converted to forest is approximately 2 to 1. Invasive species were observed on 12.7 percent of monitored plots, which represents an increase of 2.3 percent since 2013. Nonnative bush honeysuckle (*Lonicera* spp.) was the most common invasive plant detected in Maine’s forests. Another troubling find is that the few forest types that cover most of Maine may limit the ability for communities to respond to global change events (droughts, disease, or both) which may suggest a lack of adaptive capacity in Maine’s forests.

Maine Forests 2018 gives those who are interested a common set of scientifically gathered, statistically accurate numbers that we can use to make responsible management decisions. Our forests certainly face some challenges, but with the information in this report, we are better positioned to face these challenges. I trust this document will be informative and inspire you to join us in our pursuit to sustain Maine’s treasured trees and forests.

Patty Cormier

State Forester

Maine Forest Service

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Pitch pine tree near a river bank at the Holt Research Forest in Arrowsic, Maine. USDA Forest Service photo by Laura Kenefic.

Highlights

Many of the issues listed here are not addressed in this summary report of Maine forests, but can be found in the Interactive report, available at <https://doi.org/10.2737/NRS-RB-126-INT>.

On the plus side

- Maine is the most forested state in the Nation with forests covering 89 percent of the State exclusive of inland water bodies.
- Over 75 percent of Maine's 17.5 million acres of forest land fall into just two forest-type groups: maple/beech/birch with 7.2 million acres (41 percent), and spruce/fir with 6.0 million acres (34 percent). In terms of individual forest types, 37 were identified but nearly 50 percent of forested area was in either the balsam fir type (2.3 million acres) or sugar maple/beech/yellow birch (6.2 million acres).
- Sound tree volume in Maine increased by over 1 billion cubic feet from 2013 to 2018. Ninety-four percent of sound volume in Maine was on timberland but most of the increase (640 million cubic feet) was on public land withdrawn from harvesting.
- The downed dead wood biomass within Maine's forests has remained fairly stable since the previous inventory and is dominated by coarse woody debris at approximately 117 million tons with fine woody debris representing 24 percent of statewide totals. Piles of coarse woody debris (i.e., harvest residue piles) were estimated at 7 percent of statewide downed wood biomass totals.
- From 2012 to 2018, over 62 percent of Maine's forest land was assessed as having very low to low ungulate browse impact on seedlings. Less than 2 percent of Maine's forest land was identified as suffering from high to very high impact of seedling browse.
- Total forest ecosystem carbon stocks in Maine are an estimated 1.5 billion tons which represents an increase of less than 1 percent over 2013, despite a decrease in the area of forest land. Carbon density is an estimated 88 tons per acre of forest land with soil organic carbon and live trees are the largest components; combined, these account for 87 percent of forest carbon stocks.
- Since 2008, average annual net growth has increased in Maine while average annual mortality and removals have decreased slightly. Net growth (merchantable bole volume) of growing-stock trees on timberland averaged 713 million cubic feet annually as of 2018, and the ratio of net growth to removals (1.4:1.0) increased from what was reported for 2008 (1.0:1.0) and 2013 (1.3:1.0).
- There are over 373 million standing dead trees across Maine's forests that provide important habitat to wildlife species in addition to increasing the structural diversity of forest stands.

- The incidence of poor tree crown conditions (such as density and dieback) is relatively low across Maine with no discernable spatial pattern for all species combined.
- Since 1959, net sawtimber volume in Maine's timberlands has increased over 75 percent.
- Approximately 69 percent of Maine's softwoods on timberland are grade 1, the highest or best quality.
- Maine's forest land contains over 23 billion trees (greater than 1 inch d.b.h.) representing a little over 50 different tree species.
- Maine's forests are estimated to contain over 11 million apple (*Malus* spp.) trees that are perhaps relics from abandoned farms and/or homesteads but currently serve as a source of food for wildlife.

Issue to Watch

- The average age of family forest owners is 66.9 years with sizeable acreage owned by people substantially older. Given that 9 out of every 10 acres of forest land in Maine are privately owned, with 29.9 percent owned by family forest owners, we can expect a large turnover in forest ownership in the not-to-distant future.
- Less than 1 percent of Maine's forests have been converted to nonforest land uses over the past decade, the rate of forests being converted to nonforest (forest loss) versus nonforest being converted to forest (forest gain) is approximately 2 to 1.
- The few forest types that cover most of Maine may limit the ability for communities to respond to global change events (droughts and/or disease) meaning there is a lack of adaptive capacity in Maine's forests.
- Sawtimber volume on timberland decreased for the first time since 2003, in part due to a loss of timberland area from 2013 to 2018 resulting from the addition of reserved areas (i.e., new National Monument). Per-acre estimates of volume offer one way to quantify this difference as total sawtimber volume decreased by 2 percent while per acre estimates had a 1 percent increase.
- The invasive plant, nonnative bush honeysuckle (*Lonicera* spp.) was the most common invasive plant detected in Maine's forests being observed on 4.4 percent of monitored plots which represents an increase of 2.2 percent since 2013.
- A 2018 survey of Maine's wood processing mills indicates that total harvests have decreased 15 percent since 2015, but sawlog harvest levels increased 11 percent while pulpwood harvests decreased 29 percent.

- Since the first inventory in 1959, the amount of forest land continues to decrease in or near population centers while counties with reduced agricultural abandonment may be seeing less new forests created.
- Most of Maine's standing dead trees are less than 9 inches in diameter and are composed of four species: balsam fir, northern white-cedar, paper birch, and eastern white pine.
- Urban land covers only 1.2 percent of Maine's area and is projected to increase 3 percent by the year 2060. However, urban tree cover slightly decreased over the past decade. A newly established urban forest inventory will provide detailed assessments in future reports.
- Both the acres and proportion of forest that is non-wildland urban interface (WUI) continues to shrink, from 15.2 to 14.2 million acres in Maine (86 to 81 percent of the total forest land) between 1990 and 2010. By 2020, 2.4 million acres of Maine forest land will have been in WUI conditions for at least 30 years with an additional 0.97 million acres of forest land crossing the WUI threshold between 1990 and 2010.
- Over 6 percent of northern white-cedar exhibited poor crown health while the vast majority of American beech trees demonstrated the negative effects of beech bark disease.
- Nearly half of Maine's trees are preferred hosts of spruce budworm (*Choristoneura fumiferana*). As it has been a few decades since the last major outbreak of spruce budworm in Maine's forests one could expect another outbreak in the not-to-distant future.
- Hemlock wooly adelgid (*Adelges tsugae*) and emerald ash borer (*Agrilus planipennis*) continue to affect related tree species in Maine with expected future rates of increasing tree mortality.
- Despite its iconic status and importance to a number of specialty industries, stands highly dominated by northern white-cedar have decreased by over half since 1995 while stands where the northern white-cedar is a minor component have increased 13 percent.
- Trends in sawtimber volumes by diameter class since 1959 suggest a maturing resource whereas the percentage of the largest diameter trees has increased over 150 percent while the volume of the smallest sawtimber trees have increased almost 60 percent.

An Overview of Forest Inventory

What is FIA?

The USDA Forest Service's Forest Inventory and Analysis (FIA) program, is often referred to as the Nation's continuous forest inventory (<http://www.nrs.fs.usda.gov/fia>). FIA is a national program that conducts and maintains a comprehensive inventory of forest resources in the United States and its territories. For more detailed information see Gormanson et al. 2018.

What is this report?

This summary report provides brief findings of the eighth forest inventory for Maine. FIA has been conducting inventories of Maine's forest resources since 1959. Prior to 1999, inventories were conducted periodically, or approximately once every 10 to 20 years. Periodic inventories were completed in 1959 (Ferguson and Longwood 1960), 1971 (Ferguson and Kingsley 1972), 1982 (Powell and Dickson 1984), and 1995 (Griffith and Alerich 1996). In 1999, an annual inventory system was implemented, wherein a percentage of plots were measured each year and an entire inventory cycle completed every 5 to 7 years. Previous annual inventories were completed in 2003 (McWilliams et al. 2005), 2008 (McCaskill et al. 2011), and 2013 (McCaskill et al. 2016). Maine's plot remeasurement time period (5 years) aligns with FIA's 5-year reporting period such that each report covers a full data cycle. Such an analytical approach creates a yearly moving window of 5-year cycles, composed of plots measured from 2014 through 2018 which are collectively referred to as the 2018 inventory.

More detailed results of Maine's 2018 inventory are available in an interactive digital collection available at <https://doi.org/10.2737/NRS-RB-126-INT>. The results presented in the interactive report are divided into sections that focus on forest features, forest health and sustainability, ecosystem indicators and services, and resource attributes (Fig. 1). Graphics, including interactive maps and charts, summarize data and illustrate trends that make it easier for readers to make comparisons between inventory periods, geographic locations, and ecological divisions. This document offers a summary of those results.

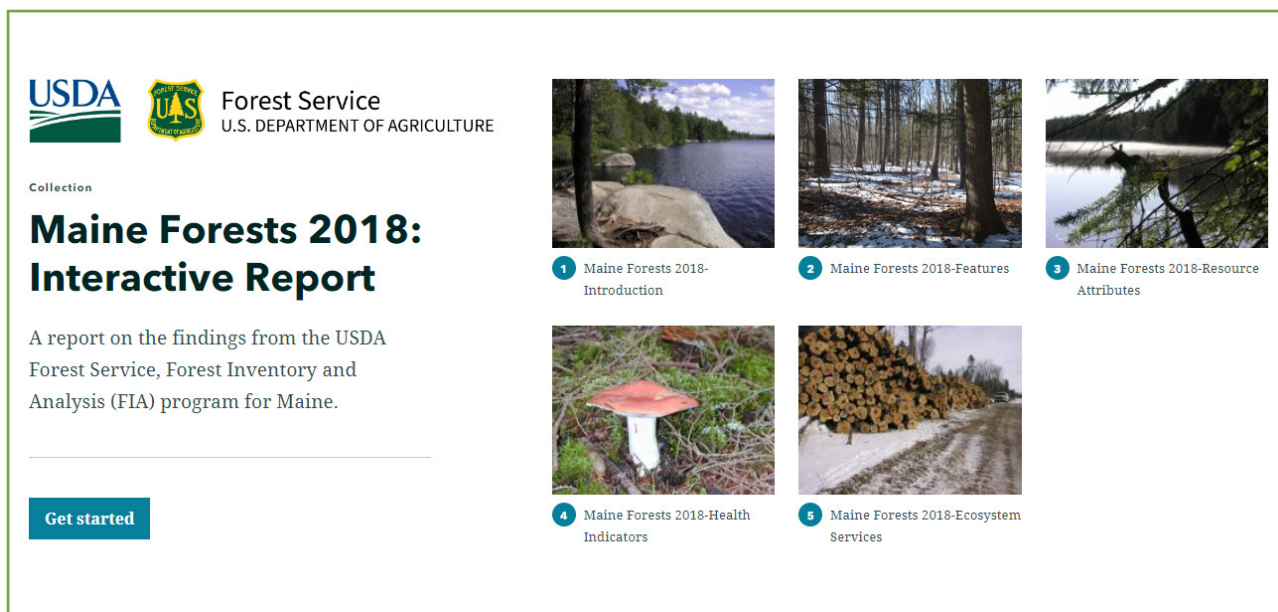


Figure 1.—Maine Forests 2018: Interactive Report is a digital collection that focuses on different forest aspects.

For the 2018 inventory, 3,522 plots in Maine were selected for measurement. Of those, 3,150 plots contained forest land and 372 were nonforest. Current estimates of forest area, composition, volume, and other statistics are based on these 3,522 sampled plots. Estimates of change (e.g., forest area change, growth, mortality, and removals) are based on 3,496 plots that were measured both during the 2018 cycle and the previous cycle, which ended in 2013 (2000 to 2013).

See the [appendix](#) for a complete list of forest tree species found in Maine during the 2018 inventory.

Forest Features

Forest Area and Land Use

Nearly 89 percent of Maine (exclusive of census and noncensus water bodies) is covered by forests, an estimated 17.5 million acres in 2018, making Maine proportionally the most forested state in the Nation. This area of forest in Maine is nearly the same area that was estimated when forest inventories first began in 1959. It is estimated that Maine forest land area peaked in 2003 at 17.7 million acres.

FIA delineates land use by several categories including, but not limited to forest land, pasture, cropland, idle farmland, developed, and water. Tracking changes in land use is important for analyzing factors affecting forest loss (diversion) and forest gain (reversion). To accomplish this, land use is compared on plots visited on two separate occasions, for this report plots visited between 2009 and 2013 and revisited between 2012 and 2018, hereafter referred to as 2013 and 2018, were evaluated. Maintaining accurate estimates of forest land acreage is critical to monitoring trends in the health, quantity, and quality of Maine's forests. Overall, less than 1 percent of Maine's forest was converted to nonforest over the inventory period (Fig. 2). Developments were the dominant land use to which forests were converted. In terms of long-term changes in forest area, since 1959 trajectories in changes in forest area have varied from increasing forests across Downeast and central Maine from 1959 to 2000 while more recent changes, since 2000, have seen decreases in forest area in the southeast of Maine closer to population centers (e.g., Cumberland County) (Fig. 3).

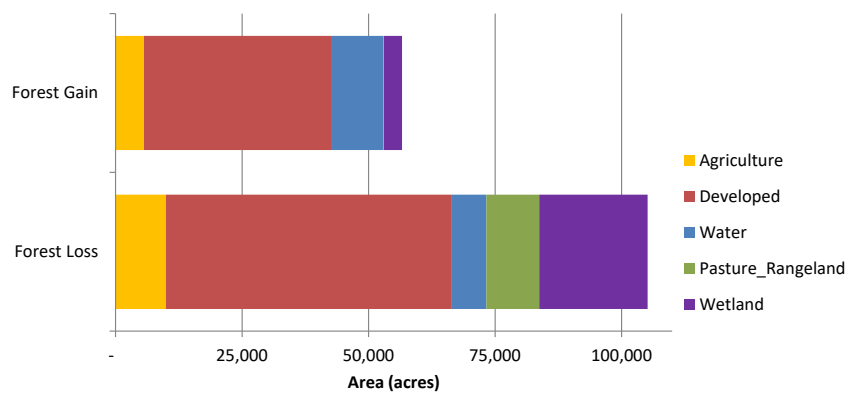


Figure 2.—Gross area of forest loss and forest gain by land use category, Maine, 2013 to 2018.

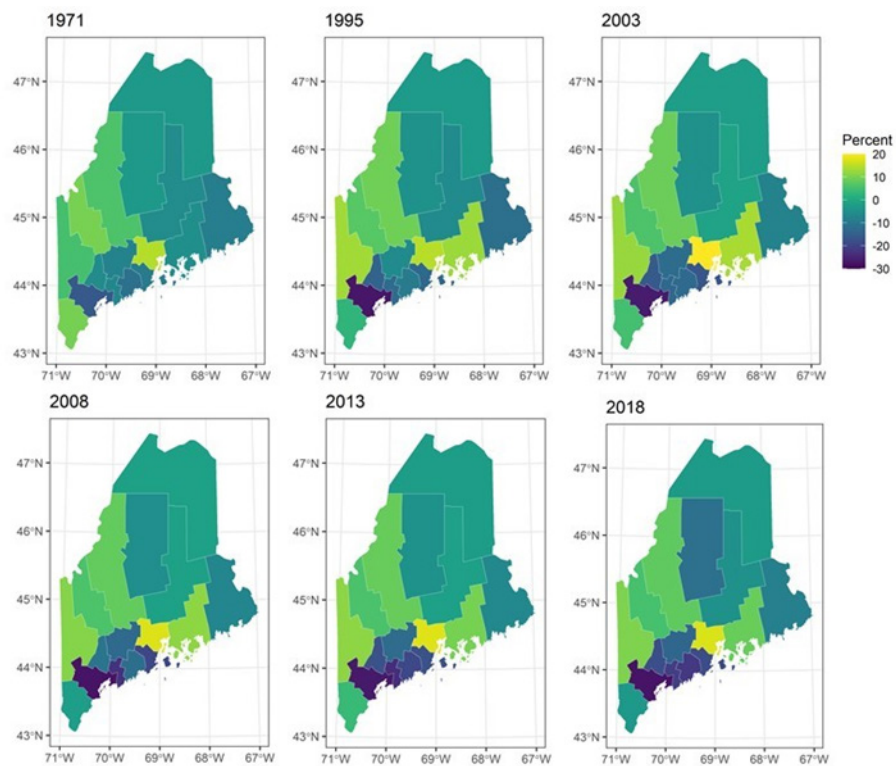


Figure 3.—Percent change in forest land area since 1959 by county, Maine.

Forest Ownership

To a large extent, the availability and quality of forest resources are determined by landowners, including recreational opportunities, timber availability, and wildlife habitat. By understanding the priorities of forest land owners, the forest conservation community can better help owners meet their needs, and in so doing, help manage forests sustainably for future generations.

Nearly 9 out of every 10 acres of forest land in Maine are privately owned. Most of these private acres, an estimated 10.0 million acres (56.9 percent of all forest land), are owned by corporations. Family forest ownerships control the next highest percentage (5.2 million acres; 29.9 percent). There are an estimated 75,000 family forest ownerships with 10 or more acres of forest land across Maine. An estimated 64.8 percent of these family forest ownerships own less than 50 acres of forest land (Fig. 4A), but 74.0 percent of the family forest land is in holdings of at least 50 acres (Fig. 4B). The average size of a family forest holding in Maine is 62.5 acres.

Federal, State, and local governments are responsible for 10 percent of Maine's forest land with most of this area controlled by State forestry, parks, and wildlife agencies.

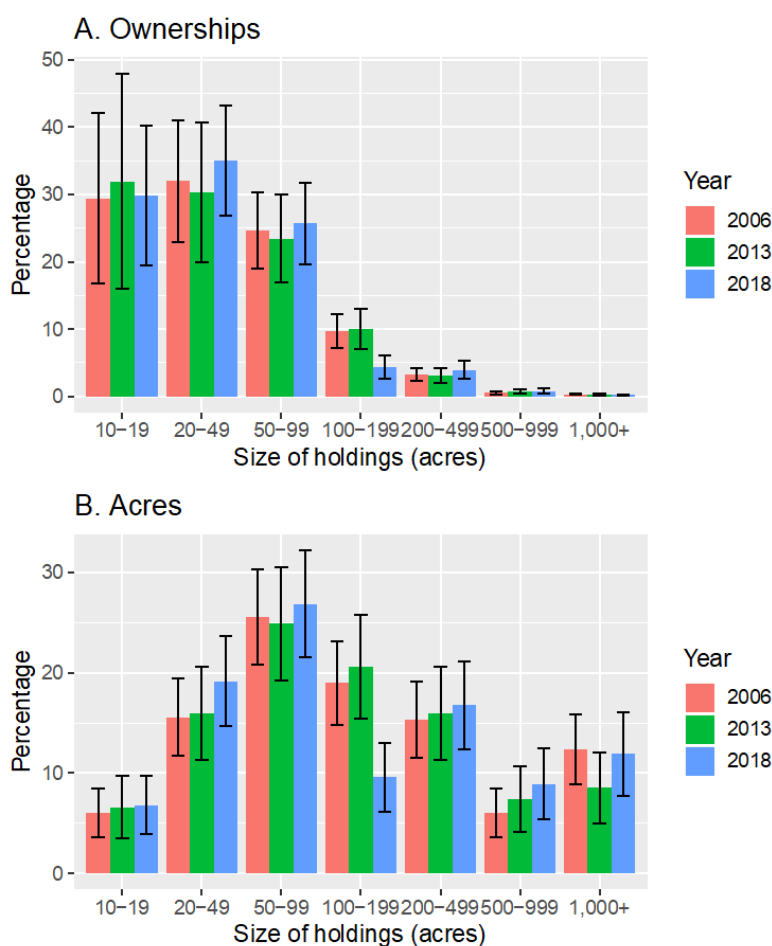


Figure 4.—Percentage of (A) family forest ownerships, and (B) family forest acreage by size of forest holdings, Maine, 2006, 2013, and 2018. Error bars represent 95 percent confidence intervals.

Resource Attributes

Forest Type

Species composition, stand size, stocking, and stand age are the attributes most commonly used to describe a forest. Several factors contribute to the species composition of a forest. Site characteristics like slope, aspect, soil type, and water availability determine what species grow where. Management practices such as timber stand improvement and harvesting as well as disturbances like fire, weather events (e.g., flooding, drought, high winds), insects, and disease all play a role in shaping forest composition. The frequency and severity of these events, over time, created the forests that we see today. FIA describes the overall composition of a forest by assigning forest types and forest-type groups. A forest type is a collection of species that commonly grow together, and similar forest types are aggregated to make up forest-type groups. Forest types are delineated by determining the most common species present in the overstory. Some forest types, such as sugar maple/beech/yellow birch, have remained the most prevalent type across Maine with little change since 2003 (-0.2 percent) (Fig. 5). Other forest types have greatly increased since 2003, such as red maple/upland (37.6 percent) and eastern white pine (26.9 percent). In contrast, early successional forest types such as paper birch (-35.5 percent) and aspen (-23.0 percent) have decreased in prevalence.

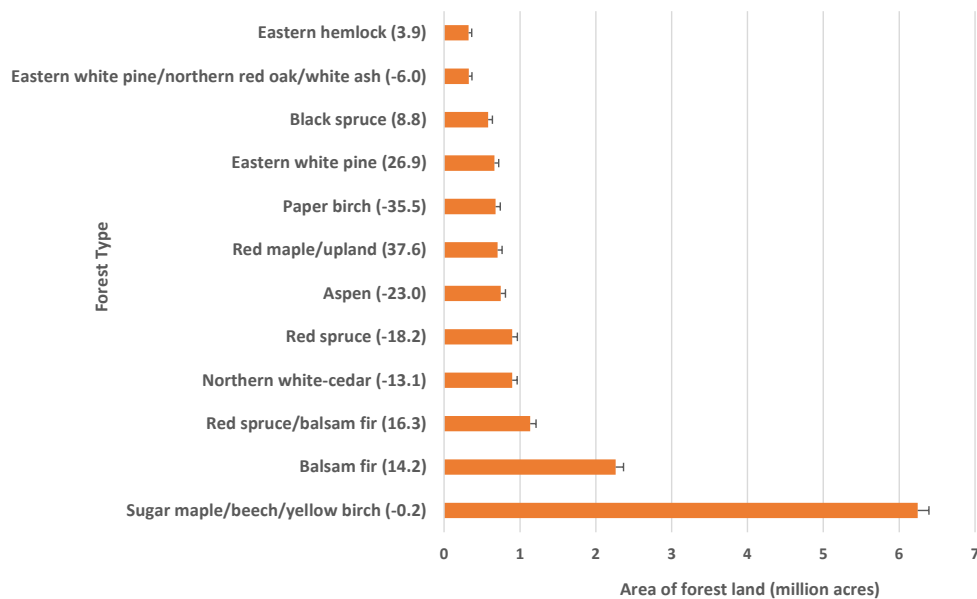


Figure 5.— Top 12 forest types by area, Maine, 2018. Numbers in parentheses indicate the percentage change since the first annual inventory in 2003. Error bars represent a 68 percent confidence interval around the estimated mean.

Standing Dead Trees

Although there are over 370 million standing dead trees across Maine's forests that serve as important wildlife habitat and increase stand structural diversity, the majority of these vital attributes are below 9 inches in diameter and of advanced decay resulting from past disturbance events decades ago (e.g., spruce budworm with resulting mortality and stand recovery). As can be seen, the largest sized standing dead trees in Maine are dominated by advanced stages of decay (decay class 3 or greater) (Fig. 6).

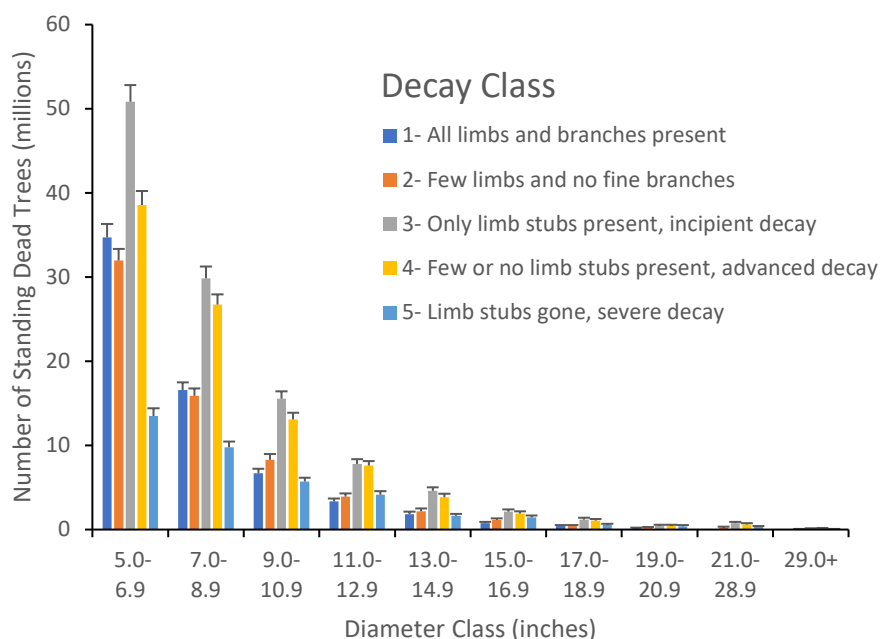


Figure 6.—Standing dead trees by diameter class and decay class, on forest land, Maine, 2018.

Volume on Timberland

The assessment of the volume of live trees provides information on trends in the resource, the potential uses of that wood, and its economic value. Current volumes and changes in volume over time can characterize forests and reveal important resource trends.

There were 29.5 billion cubic feet of sound volume on forest land in Maine in 2018, a 3.6 percent increase from 2013. Ninety-four percent of that volume was on timberland (27.7 billion cubic feet), a 1.4 percent increase over the previous time period. Sound volume on reserved productive forest land increased 56 percent and accounted for 6 percent of the total increase, leaving less than 1 percent of volume on land that does not meet minimum productivity standards. Fourteen species had at least 2 percent of all growing-stock volume in 2018, and nine of these saw a decrease in that volume from the 2013 estimate (Fig. 7). All prominent softwood species saw an increase in growing-stock volume except eastern hemlock and northern white-cedar. Red spruce and balsam fir volume increased 4 percent and 16 percent, respectively, to 2.9 billion cubic feet and 2.8 billion cubic feet, respectively. Northern white-cedar, sugar maple, and American beech all experienced double digit percentage volume losses from 2013 to 2018. American beech growing-stock volume decreased 113 million cubic feet over that time period, in part due to an average annual mortality volume of 10 million cubic feet per year.

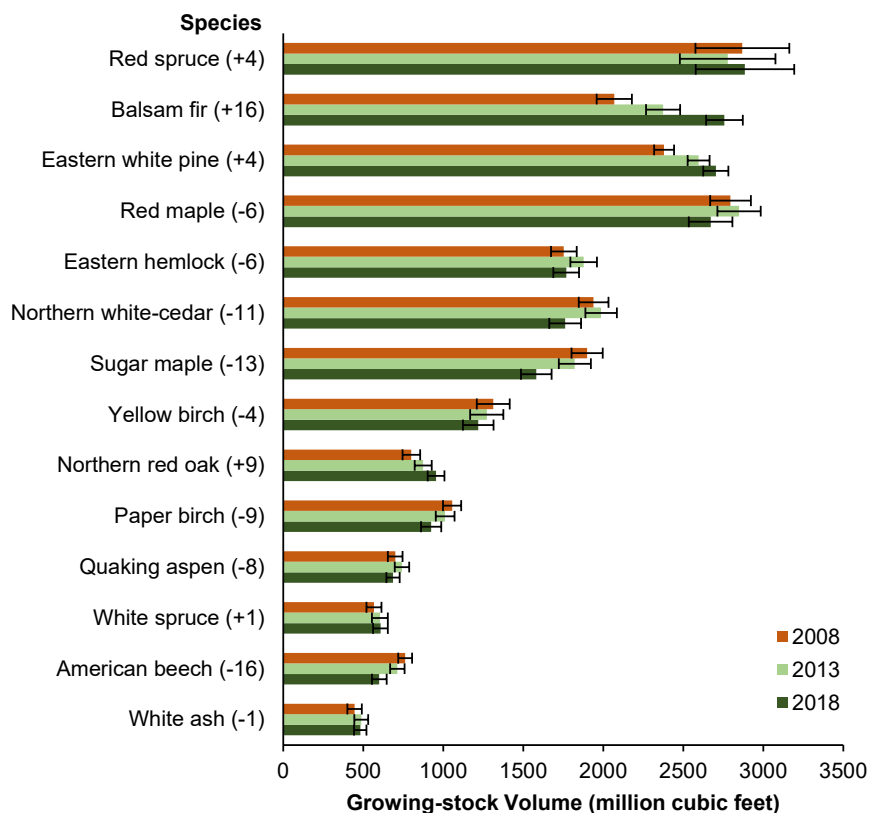


Figure 7.—Growing-stock volume on timberland of species having at least 2 percent of volume, by species and inventory year, with percentage change between 2013 and 2018 in parentheses, Maine.

Timberland Growth, Removals, and Mortality

Sustainably managed forests provide a continuous supply of goods and services without compromising long-term productivity. One way to judge the sustainability of a forest is to examine the components of annual change in inventory volume: growth, removals, and mortality. Gross growth includes growth (accretion) on trees measured previously as well as the volume of ingrowth¹ trees on existing samples and newly forested plots. Net growth is the volume of gross growth less deductions for mortality. Mortality includes trees that died from natural causes, insect and disease infestations, fire and animal damage, and damage from weather. Removals include trees cut during harvests, silvicultural treatments, and land clearing (harvest removals) as well as previously measured trees now on nonforest land (other removals). Analysis of these individual components can help us better understand changes in volume.

Although there was an increase in removals and mortality (and subsequent reduction in net growth) across Maine's timberland from the 1980s through the 1990s due to a regional spruce budworm outbreak and onset of beech bark disease, for over a decade the net growth, removals (majority being harvests), and mortality of growing-stock volume has been somewhat stable (Fig. 8).



Figure 8.—Average annual net growth, mortality, and removals (both harvest and other) of growing-stock volume on timberland, Maine, 1959 to 2018.

¹ Ingrowth refers to any tree that grew into a merchantable size (e.g., 5-inch diameter) since the previous inventory. For instance, a tree that was not of minimum size during one inventory, but by the next inventory, it had grown into the minimum size.

Health Indicators

Forest Regeneration

Unlike many forests in the eastern United States, Maine does not suffer from widespread browsing of tree seedlings, which can impede effective tree regeneration. Balsam fir, sugar maple, and red spruce appear to have abundant populations of the smallest seedlings with recruitment into the larger height classes while American beech, which suffers from beech bark disease, has greater abundance of the largest-sized seedlings than smaller ones (Fig. 9). Overall, the lack of young forest and scarcity of tree regeneration will remain a problem for select forest types dependent on relatively open conditions for regeneration, such as eastern white pine. In contrast, reasonable levels of regeneration may enable continued active management of the commercially important species of red spruce and balsam fir. The prevalence of red maple in the understory coupled with health concerns of other major species, such as American beech (beech bark disease) and red spruce (spruce budworm), should be monitored.

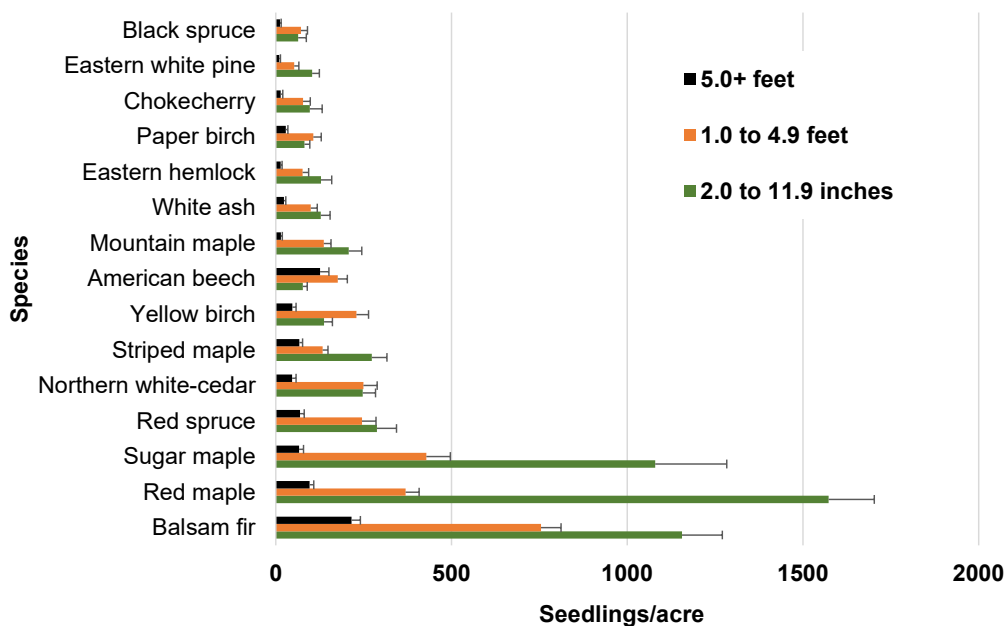


Figure 9.—The 15 most abundant tree seedling species by height classes on forest land, Maine, 2018. Error bars represent a 68 percent confidence interval around the estimated mean.

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Appendix

List of tree species, greater than or equal to 5 inches d.b.h, found on FIA inventory plots, Maine, 2018.

Common name	Genus	Species
Balsam fir	<i>Abies</i>	<i>balsamea</i>
Larch	<i>Larix</i>	spp.
Tamarack	<i>Larix</i>	<i>laricina</i>
Norway spruce	<i>Picea</i>	<i>abies</i>
White spruce	<i>Picea</i>	<i>glauca</i>
Black spruce	<i>Picea</i>	<i>mariana</i>
Red spruce	<i>Picea</i>	<i>rubens</i>
Jack pine	<i>Pinus</i>	<i>banksiana</i>
Red pine	<i>Pinus</i>	<i>resinosa</i>
Pitch pine	<i>Pinus</i>	<i>rigida</i>
Eastern white pine	<i>Pinus</i>	<i>strobus</i>
Scotch pine	<i>Pinus</i>	<i>sylvestris</i>
Northern white-cedar	<i>Thuja</i>	<i>occidentalis</i>
Eastern hemlock	<i>Tsuga</i>	<i>canadensis</i>
Boxelder	<i>Acer</i>	<i>negundo</i>
Striped maple	<i>Acer</i>	<i>pensylvanicum</i>
Red maple	<i>Acer</i>	<i>rubrum</i>
Silver maple	<i>Acer</i>	<i>saccharinum</i>
Sugar maple	<i>Acer</i>	<i>saccharum</i>
Mountain maple	<i>Acer</i>	<i>spicatum</i>
Norway maple	<i>Acer</i>	<i>platanoides</i>
Serviceberry spp.	<i>Amelanchier</i>	spp.
Yellow birch	<i>Betula</i>	<i>alleghaniensis</i>
Sweet birch	<i>Betula</i>	<i>lenta</i>
Paper birch	<i>Betula</i>	<i>papyrifera</i>
Gray birch	<i>Betula</i>	<i>populifolia</i>
American hornbeam, musclewood	<i>Carpinus</i>	<i>caroliniana</i>
Shagbark hickory	<i>Carya</i>	<i>ovata</i>
American chestnut	<i>Castanea</i>	<i>dentata</i>
Hawthorn	<i>Crataegus</i>	spp.
American beech	<i>Fagus</i>	<i>grandifolia</i>
White ash	<i>Fraxinus</i>	<i>americana</i>
Black ash	<i>Fraxinus</i>	<i>nigra</i>
Green ash	<i>Fraxinus</i>	<i>pennsylvanica</i>
Butternut	<i>Juglans</i>	<i>cinerea</i>
Apple	<i>Malus</i>	spp.
Eastern hophornbeam	<i>Ostrya</i>	<i>virginiana</i>

Appendix (continued).

Common name	Genus	Species
Balsam poplar	<i>Populus</i>	<i>balsamifera</i>
Bigtooth aspen	<i>Populus</i>	<i>grandidentata</i>
Quaking aspen	<i>Populus</i>	<i>tremuloides</i>
Pin cherry	<i>Prunus</i>	<i>pensylvanica</i>
Black cherry	<i>Prunus</i>	<i>serotina</i>
Chokecherry	<i>Prunus</i>	<i>virginiana</i>
White oak	<i>Quercus</i>	<i>alba</i>
Swamp white oak	<i>Quercus</i>	<i>bicolor</i>
Scrub oak	<i>Quercus</i>	<i>ilicifolia</i>
Bur oak	<i>Quercus</i>	<i>macrocarpa</i>
Northern red oak	<i>Quercus</i>	<i>rubra</i>
Black oak	<i>Quercus</i>	<i>velutina</i>
Black locust	<i>Robinia</i>	<i>pseudoacacia</i>
Willow spp.	<i>Salix</i>	spp.
Mountain-ash spp.	<i>Sorbus</i>	spp.
American mountain-ash	<i>Sorbus</i>	<i>americana</i>
Northern mountain-ash	<i>Sorbus</i>	<i>decora</i>
Basswood spp.	<i>Tilia</i>	spp.
American basswood	<i>Tilia</i>	<i>americana</i>
American elm	<i>Ulmus</i>	<i>americana</i>

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