



Forests of Pennsylvania, 2016

This resource update provides an overview of the forest resources in Pennsylvania based on inventories conducted by the U.S. Forest Service, Forest Inventory and Analysis (FIA) program of the Northern Research Station. Estimates are based on field data collected using the FIA annualized sample design and are updated yearly.¹ Information about the national and regional FIA program is available online at <http://fia.fs.fed.us>. Since 2000, FIA has implemented an annual inventory in Pennsylvania. The 2016 estimates of current resource attributes, such as area, volume, and biomass, are based on 4,539 (3,030 forested) plot samples collected from 2011–2016. Estimates of components of change, such as net growth, removals, and mortality, are based on 4,146 (2,663 forested) samples collected from 2006 to 2011 and remeasured from 2011–2016. Estimates from earlier inventories are shown for comparison. See Bechtold and Patterson (2005), Gormanson et al (2017), and O’Connell et al. (2017) for definitions and technical details. A complete set of inventory tables is available at <https://doi.org/10.2737/FS-RU-132>.

Overview

Pennsylvania’s forest land area totals 16.8 million acres, covering 58 percent of the area in the Commonwealth (Table 1). Ninety-six percent of Pennsylvania’s forest land, 16.2 million acres, is classified as timberland. Four percent (593,000 acres) is reserved forest land, publically-owned land where the commercial harvesting of trees is restricted by law or public policy.

One-tenth of a percent (20,000 acres) is other forest land where minimum productivity standards are not met. The net volume of trees continues to increase. Annual net growth on timberland still outpaces annual removals by a factor of 2.2:1. Annual mortality on forest land also increased nearly 10 percent since 2011 to 368,000 cubic feet per year.

¹One-fifth of the plots was measured annually from 2000 thru 2013 resulting in a full cycle every 5 years. In 2014, this changed to 7 years, wherein 1/7th (14.3 percent) of the plots are measured annually.

Table 1.—Pennsylvania forest statistics, 2016 and 2011. Volume estimates are for trees 5 inches and larger in diameter. Numbers of trees and biomass estimates are for trees 1 inch and larger in diameter. Sampling errors in tables and error bars in figures represent 68 percent confidence intervals.

	2016 Estimate	Sampling error (percent)	2011 Estimate	Sampling error (percent)	Change since 2011 (percent)
Forest Land					
Area (thousand acres)	16,846.9	0.6	16,781.2	0.7	0.4
Number of live trees ≥ 1 in diameter (million trees)	8,121.9	1.7	8,165.7	1.7	-0.5
Aboveground biomass of live trees ≥ 1 in (thousand oven-dry tons)	1,103,347.6	1.0	1,044,805.3	1.0	5.6
Net volume of live trees ≥ 5 in diameter (million ft ³)	38,784.7	1.0	36,582.9	1.1	6.0
Annual net growth live trees ≥ 5 in (thousand ft ³ /yr)	779,201.0	2.8	871,640.5	3.0	-10.6
Annual mortality of live trees ≥ 5 in (thousand ft ³ /yr)	367,511.6	3.8	35,357.3	4.1	9.6
Annual harvest removals of live trees ≥5 in (thousand ft ³ /yr)	342,005.8	7.8	398,855.3	7.2	-14.3
Annual other removals of live trees ≥5 in (thousand ft ³ /yr)	8,675.4	26.1	11,564.5	28.7	-25.0
Timberland					
Area (thousand acres)	16,233.4	0.7	16,144.5	0.8	0.6
Number of live trees ≥ 1 in diameter (million trees)	7,863.4	1.8	7,909.0	1.7	-0.6
Aboveground biomass of live trees ≥ 1 in (thousand oven-dry tons)	1,056,152.4	1.1	1,000,579.3	1.1	5.6
Net volume of live trees ≥ 5 in diameter (million ft ³)	37,123.8	1.1	35,033.5	1.2	6.0
Net volume of growing stock trees (million ft ³)	33,895.4	1.2	32,160.5	1.3	5.4
Annual net growth of growing stock trees (thousand ft ³ /yr)	647,109.8	2.7	713,215.0	2.8	-9.3
Annual mortality of growing stock trees (thousand ft ³ /yr)	260,726.6	4.3	243,979.9	4.5	6.9
Annual harvest removals of growing stock trees (thousand ft ³ /yr)	287,586.8	8.0	340,253.0	7.2	-15.5
Annual other removals of growing stock trees (thousand ft ³ /yr)	9,399.9	45.4	15,751.8	28.9	-40.3



Forest Area

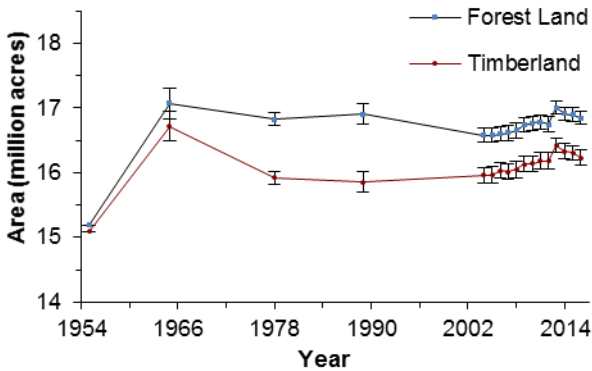


Figure 1.—Area of forest land and timberland by year, Pennsylvania, 1955 to 2016.

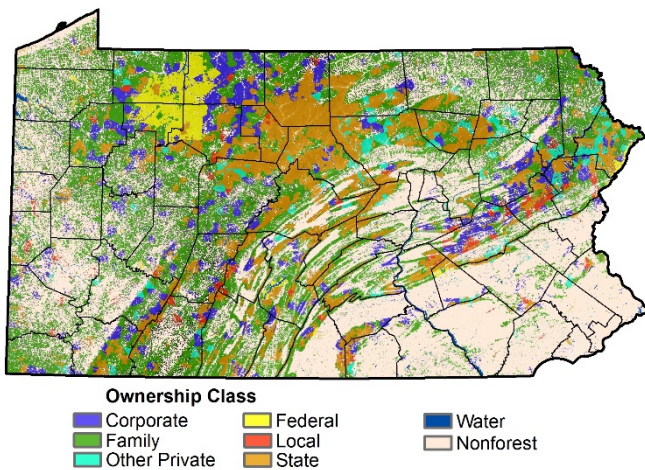


Figure 2.—Distribution of forest land by ownership class, Pennsylvania, 2009.

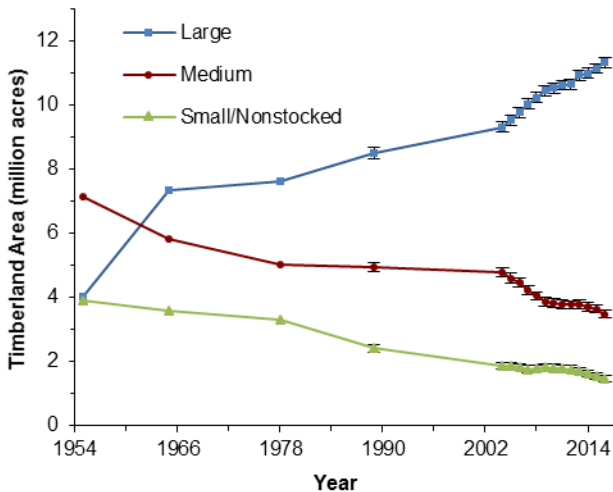


Figure 3.—Area of timberland by stand-size class and inventory year, Pennsylvania, 1955 to 2016.

Pennsylvania’s forest land area has been very stable since 1965, with small fluctuations in the last 5 decades (Fig. 1). Over this period, losses of forest land to development and other nonforest uses have been about equal to that of agricultural and other nonforest land reverting to forest. Since 1989, total forest land ranged from a low of 16.6 million acres in 2004 to 17.0 million acres in 2013. It is too early to say whether the 150,000 acre decrease in forest land since 2013 is the start of a larger downward trend or a continuation of the fluctuations seen in the past. Public ownerships hold 30 percent of the forest land in the Commonwealth, mostly in the north-central region (Fig. 2).

The area of timberland in large diameter stands² has steadily increased since the 1950s (Fig. 3). Currently, 70 percent of the Commonwealth’s timberland is in large diameter stands and only 9 percent is in small diameter stands. Forest types dominated by oak species have even lower percentages in small diameter stands (Fig. 4). The northern red oak, chestnut oak/black oak/scarlet oak and chestnut oak types each have less than 1 percent of their area in small diameter stands. The cherry/white ash/yellow-poplar forest type has 12 percent of its area in small diameter stands. The lack of small diameter oak stands is in sharp contrast to the other hardwoods forest type. The other hardwoods forest type (composed of 51 percent sweet birch biomass) has 195,000 acres in small diameter stands, 15 percent of the total small diameter timberland area.

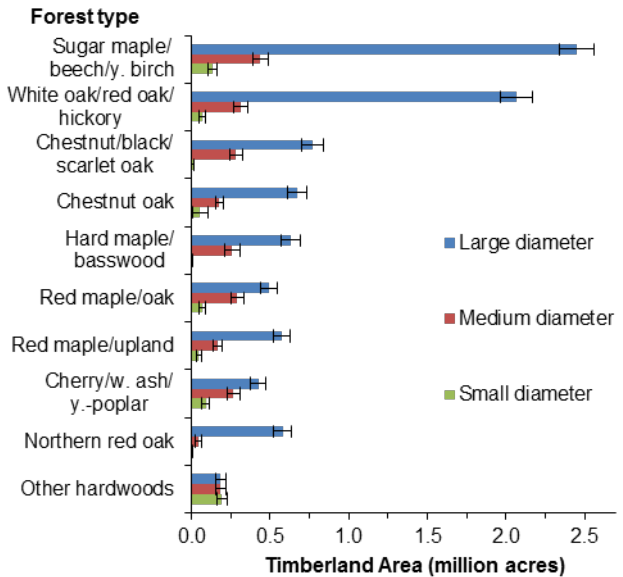


Figure 4.— Area of timberland by stand-size class² for the top ten forest types ranked by total acres, Pennsylvania, 2016.

² Small diameter stands: dominated by trees less than 5.0 inches d.b.h.; Medium: 5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods; Large: ≥ 9.0 inches for softwoods and ≥ 11.0 d.b.h. for hardwoods.

Volume, Biomass, and Trends

The net volume of trees on forest land increased by 6 percent since 2011 and now totals 38.8 billion cubic feet. Red maple remained the number one species in terms of net volume (Table 2) with more volume than the two highest ranked oak species (red and chestnut) combined. Changes in net volume since 2011 varied among the 10 most voluminous species. The majority had increases in net volume ranging from 3.7 percent (white oak) to 13.3 percent (yellow-poplar). The notable exception is white ash, which decreased in net volume by 1.1 percent.

Sawtimber volume on timberland increased by 10.6 percent to 119.0 billion board feet. Red maple is the leading sawtimber species by volume, followed by northern red oak, black cherry, and sugar maple. Percent increase in sawtimber volume since 2011 was greatest in sweet birch (14.1 percent) with yellow-poplar (13.4), red maple (11.7), northern red oak (11.6), hemlock (10.4), and white oak (10.4) rounding out the top six gainers. Interestingly, white ash sawtimber volume on timberland still gained 5.9 percent despite its loss of net volume on forest land.

Aboveground biomass on forest land increased 5.6 percent since 2011, now totaling 1.1 billion dry tons. On timberland, aboveground biomass averaged 65.1 dry tons per acre for all live trees 1 inch and larger in diameter, up 5.0 percent from 62.0 tons per acre in 2011.

In terms of average annual growth and removals of net volume on timberland, red maple had the largest annual volume of both net growth and removals expressed as cubic-foot volume (Fig. 5).

Among the 12 most voluminous species, sweet birch has the highest growth to removals ratio (G:R) at 5.9:1. White ash for the first time had a G:R under 1:1 indicating removals are outpacing net growth. Notably, three of these top 12 species (hemlock, white ash, American beech) had higher rates of annual mortality than annual net growth.

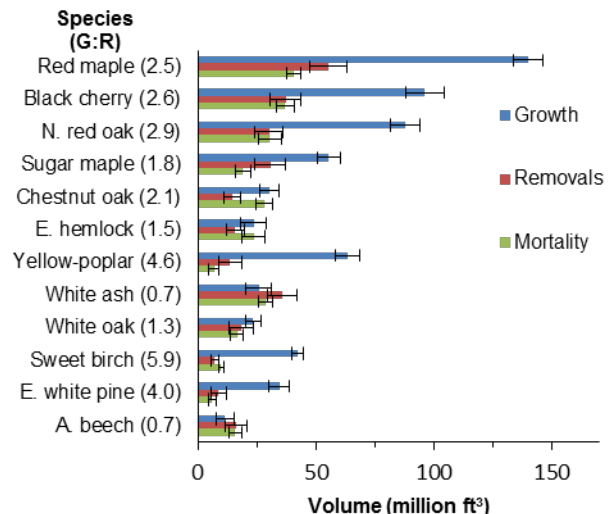


Figure 5.—Average annual net growth, removals, and mortality volume on timberland, with growth to removals ratios (G:R) in parentheses, for the top 12 species ranked by total net volume, Pennsylvania, 2016.

Table 2.—Net volume, and percent change in net volume on forest land; sawtimber volume and percent change on timberland, and biomass on forest land, Pennsylvania, 2016, (top 10 species by net volume). Volume estimates are for trees 5 inches and larger. Biomass estimates are for trees 1 inch and larger.

Species	Volume of live trees on forest land (million ft³)	Sampling error (percent)	Percent change since 2011	Volume of sawtimber trees on timberland (million bd.ft.)	Sampling error (percent)	Percent change since 2011	Aboveground biomass on forest land (million tons)	Sampling error (percent)
Red maple	7,147	2.5	6.7	18,095	3.7	11.7	194	2.4
Black cherry	4,145	3.9	4.1	13,563	5.1	7.5	106	3.7
Northern red oak	3,825	3.8	7.7	15,273	4.4	11.6	122	3.7
Sugar maple	2,854	4.7	7.2	8,697	5.9	10.3	90	4.6
Chestnut oak	2,657	4.4	4.6	7,422	5.2	9.2	86	4.3
Eastern hemlock	1,961	5.8	6.3	5,830	6.6	10.4	37	5.7
Yellow-poplar	1,937	7.4	13.3	8,321	8.5	13.4	40	7.3
Sweet birch	1,728	4.4	12.1	3,221	6.3	14.1	62	4.0
White ash	1,709	5.2	-1.1	5,540	6.9	5.9	51	5.1
White oak	1,685	5.2	3.7	5,893	6.5	10.4	55	5.2
Other softwoods	1,807	6.6	9.6	6,251	7.6	18.6	34	6.4
Other hardwoods	7,330	2.3	3.9	20,877	3.3	9.2	225	2.1
Total	38,785	1.0	6.0	118,982	1.6	10.6	1,103	1.0

The Decline of Ash in the Commonwealth

The FIA inventory identified three species of ash in Pennsylvania: white, green, and black ash. White ash is by far the most prominent with 98 percent of the combined ash net volume. Green ash comprises 2 percent of volume and black ash is less than 1 percent. Of the 101 species identified in the 2016 inventory, white ash ranks 9th by net volume. While an important species group for both ecologic and timber values, ash is usually found in relatively low concentrations in stands. As a proportion of biomass in the 16 forest-type groups identified in Pennsylvania, ash ranges from less than 1 percent of the exotic hardwoods group to 14 percent of the elm/ash/cottonwood group.

Emerald ash borer (EAB, *Agrilus planipennis*) is a beetle native to Asia. It was first found in the Commonwealth in 2007, 5 years after first being discovered in the United States. Currently in Pennsylvania, it is known to exist in all counties except five in the eastern portion of the State (Pennsylvania State University 2017). Female beetles lay eggs in and on ash bark, and the larvae that hatch feed on the inner bark of the tree. EAB attacks cause the eventual death of the host, though an infestation can exist for up to 3 years before symptoms become evident.

The effects of EAB, as well as other insects and diseases, on the ash resource have become more and more apparent. All relevant measures of volume show the decline of ash throughout the Commonwealth. Total net volume dropped from 1.83 billion cubic feet in 2013 to an estimated 1.75 billion cubic feet in 2016 (Fig. 6). Average annual net growth decreased over 50 percent since 2012 to 24.9 million cubic feet per year. Average annual mortality increased by over 90 percent since EAB was first discovered in the State to 29.7 million cubic feet or 1.7 percent of net volume. Removals average 35.7 million cubic feet per year. For the first time, annual net growth has been surpassed by both annual mortality and annual removals in 2016. Given the increased mortality and reduction in volume, ash in the Commonwealth deserves to be closely monitored into the future.

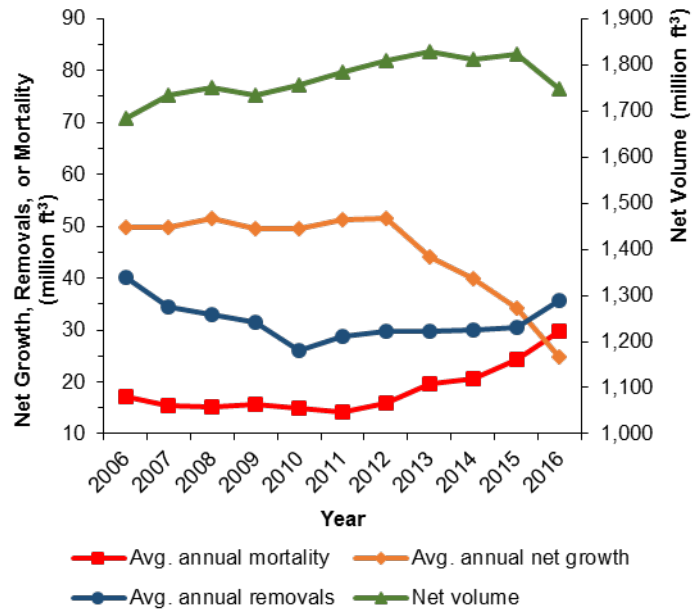


Figure 6.—Ash average annual mortality, net growth, and removals along with net volume of ash (right axis), Pennsylvania 2016.

Literature Cited

- Bechtold, W.A.; Patterson, P.L., eds. 2005. **The enhanced Forest Inventory and Analysis Program: national sampling design and estimation procedures**. Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Dept. of Agriculture, Forest Service, Southern Research Station. 85 p. <https://doi.org/10.2737/SRS-GTR-80>.
- Gormanson, D.D.; Pugh, S.A.; Barnett, C.J. [et al.] 2017. Statistics and quality assurance for the Northern Research Station Forest Inventory and Analysis Program, 2016. Gen. Tech. Rep. NRS-166. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 23 p. <https://doi.org/10.2737/NRS-GTR-166>.
- O'Connell, B.M.; Conkling, B.L.; Wilson, A.M. [et al.]. 2017. **The Forest Inventory and Analysis Database: Database description and user guide version 7.0 for Phase 2**. U.S. Dept. of Agriculture, Forest Service. 830 p. <http://www.fia.fs.fed.us/library/database-documentation/>.
- Pennsylvania State University. 2017. **Timeline of EAB detection in PA**. University Park, PA: Pennsylvania State University, College of Agricultural Sciences. <http://ento.psu.edu/extension/trees-shrubs/emerald-ash-borer/timeline-of-eab-detection-in-pa> (accessed June 29, 2017).

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Contact Information

Thomas A. Albright, Forester
 USDA Forest Service, Northern Research Station
 Ph: 412-523-0103
talbright@fs.fed.us
 Northern FIA: <http://nrs.fs.fed.us/fia/>
 National FIA: <http://fia.fs.fed.us>

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