USDA
United States Department of Agriculture

RESOURCE UPDATE FS-165

Forests of Indiana, 2017

Overview

This resource update provides an overview of forest resources in Indiana based on an inventory conducted by the USDA Forest Service, Forest Inventory and Analysis (FIA) program at the Northern Research Station in cooperation with the Indiana Department of Natural Resources. Estimates are based on field data collected using the FIA annualized strategic sample design and are updated yearly. In 2014, NRS-FIA changed to a 7-year inventory cycle, wherein 1/7th (14.3 percent) of the plots will be measured annually. For the 2017 inventory, estimates for current variables such as area, volume, and biomass are based on 4,683 plot samples (1,248 forested) collected from 2011–2017. Change variables such as net growth, removals, and mortality are based on 4,533 plots (1,182 forested) collected in 2006–2011 and remeasured in 2011–2016. Estimates from earlier inventories are shown for comparison. Data used in this publication were accessed from the FIA database in May 2018. See Bechtold and Patterson (2005), Burrill et al. (2017), and Gormanson et al. (2018) for definitions and technical details. A complete set of inventory tables is available at https://doi.org/10.2737/FS-RU-165.

Indiana has over 4.9 million acres of forest land. Forested area has increased by about 1.2 percent (58,000 acres) since 2012 (Table 1). Timberland accounts for nearly 97 percent of the forest land, while the remaining 3 percent of forest is reserved or unproductive. There were an estimated 2.16 billion live trees on forest land in 2017, a decrease of 1.3 percent from 2012. The density of trees (≥1 inch) averages 440 trees per acre. Net volume of live trees is about 10.9 billion ft^3, a 5.3 percent increase since 2012. Statewide average volume is 2,210 ft^3/acre, or about 28 cords/acre. Net volume of sawtimber trees is 27.2 billion board feet (bd ft), an increase of 8.3 percent since 2012. Statewide average sawtimber volume is 5,527 bd ft/acre. Average annual net growth decreased 19.6 percent because the forests are maturing with increasing mortality and increasing tree/stand size. Statewide, average annual net growth is 40 ft^3/acre/year, while annual harvest removals showed a 13.2 percent increase. Annual mortality increased 37.2 percent between 2012 and 2017; however, as a percentage of net volume, mortality was 1.4 percent, up from 1.1 percent in 2012. Similar trends were observed on Indiana's timberlands (Table 1).

Table 1.—Indiana forest statistics, change between 2012 and 2017

	2017 Estimate	Sampling error (percent)	2012 Estimate	Sampling error (percent)	Percent change since 2012
Forest Land					
Area (1,000 acres)	4,913.3	1.1	4,855.3	1.0	1.2
Number of all live trees ≥1 inch diameter (million trees)	2,162.8	2.3	2,191.1	1.8	-1.3
Net volume of all live trees ≥5 inches diameter (million ft^3)	10,860.8	1.9	10,316.0	1.5	5.3
Net volume of sawtimber trees (million bd ft--Doyle rule)	27,155.2	2.7	25,051.7	2.1	8.3
All live tree aboveground biomass (1,000 oven-dry tons)	279,836.0	1.7	268,141.2	1.4	4.4
Annual net growth of all live trees ≥5 inches (thousand ft^3/yr)	198,065.7	5.4	246,428.7	4.1	-19.6
Annual mortality of all live trees ≥5 inches (thousand ft^3/yr)	154,127.2	5.7	112,371.8	5.7	37.2
Annual harvest removals of all live trees ≥5 inches (thousand ft^3/yr)	87,428.5	12.8	77,249.8	14.5	13.2
Annual other removals of all live on forest land (thousand ft^3/yr)	14,337.2	30.4	9,028.1	36.3	58.8
Timberland					
Area (1,000 acres)	4,747.6	1.2	4,702.2	1.1	1.0
Number of all live trees ≥1 inch diameter (million trees)	2,079.6	2.4	2,107.0	1.9	-1.3
Net volume of all live trees ≥5 inches diameter (million ft^3/yr)	10,482.4	2.0	9,970.9	1.6	5.1
Net volume of sawtimber trees (million bd ft--Doyle rule)	26,229.4	2.8	24,199.0	2.2	8.4
All live tree aboveground biomass (1,000 oven-dry tons)	270,163.4	1.8	259,012.5	1.5	4.3
Annual net growth of growing stock trees ≥5 inches (thousand ft^3/yr)	189,379.8	4.8	224,267.7	4.0	-15.6
Annual mortality of growing stock trees ≥5 inches (thousand ft^3/yr)	110,822.5	6.6	82,037.4	6.7	35.1
Annual harvest removals of growing stock trees ≥5 inches (thousand ft^3/yr)	77,513.0	13.2	73,075.2	14.9	6.1
Annual other removals of growing-stock on timberland (thousand ft^3/yr)	10,285.6	33.6	8,142.7	42.6	26.3

Forest Area

Indiana is divided into four survey units, with forest land (4.9 million acres) unevenly distributed among units: Northern (1.4 million acres), Lower Wabash (961,849 acres), Upland Flats (660,573 acres), and Knobs (1.87 million acres) (Fig. 1). The three southern survey units comprise about 40 percent of the land and water area but contain over 70 percent of the forest. Of the southern survey units, Knobs is the most forested, representing about 40 percent of the forest land.

Eighty-four percent or over 4.1 million acres of forest land is privately owned. The state and local government owns nearly 8.0 percent or 394,000 acres of forest land while the Federal government owns roughly 7.5 percent or 388,493 acres. A little over 3 percent or 165,781 acres of forest land is considered reserved.

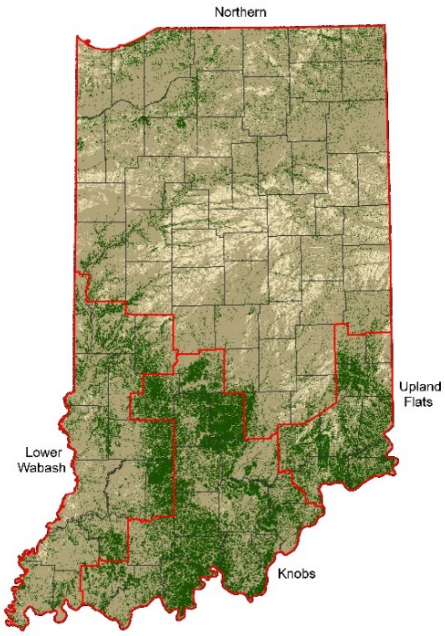

Figure 1.—Forest land (dark green) by survey unit, Indiana.

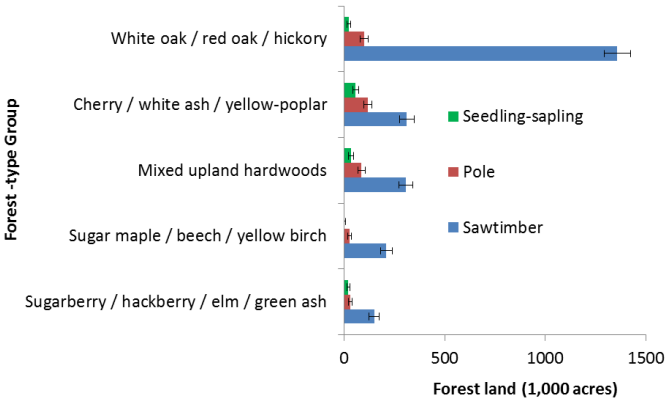

Figure 3.—Area of forest land by five common forest-type groups and stand-size classes, Indiana, 2017. Error bars represent 1 standard error or a 68-percent confidence interval.

The painted hills of Green's Bluff in Owen County ablaze with autumn colors. Photo by Indiana Department of Natural Resources, used with permission.

Indiana's forest land (4.9 million acres) and timberland (4.7 million acres) has modest increases over the past several decades following a trend since 1967 (Fig. 2), however, it appears that this trend may be stabilizing.

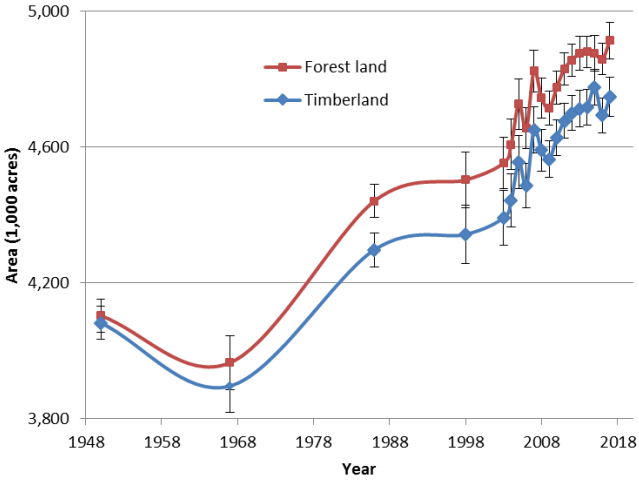

Figure 2.—Area of forest land and timberland in Indiana by inventory year. Error bars represent 1 standard error or a 68-percent confidence interval.

Hardwoods are the dominant tree species in Indiana. Some forest-type groups are much more common than others. The oak/hickory group alone occupies 71 percent of forest land, the bulk of which resides in the white oak/red oak/hickory forest type (nearly 1.5 million acres). Softwoods occupy 98,221 acres. The oak/pine group occupies 150,017 acres which represents 3 percent of the forest land.

Forest land consists mainly of sawtimber stands (nearly 80 percent); 13 percent of forest land is made up of poletimber stands, 6 percent contain seedling-sapling stands, and less than 1 percent is considered nonstocked.

Indicative of a maturing (aging) forest, white and red oak/hickory forest-type group is found primarily in the sawtimber stand-size class (Fig. 3). The cherry/white ash/yellow-poplar forest-type group is less common (487,112 acres) as are the mixed upland hardwoods (430,064 acres). Both show similar distributions across stand-size classes with a large proportion in the pole and sawtimber stand-size classes. The sugar maple/beech/yellow birch forest-type group is relatively abundant (240,904 acres) and occurs mostly in the sawtimber stand-size class (Fig. 3). Currently, nearly 55 percent of the stands are over 61 years of age.

Volume, Biomass, and Trends

The net volume of trees on forest land increased by 5.3 percent to nearly 10.9 billion ft³ since 2012 (Table 1). Yellow-poplar (*Liriodendron tulipifera*) continues to be the most voluminous species followed by sugar maple (*Acer saccharum*), white oak (*Quercus alba*), and black oak (*Quercus velutina*) (Table 2). Black cherry (*Prunus serotina*), red maple (*Acer rubrum*), American sycamore (*Platanus occidentalis*), and black walnut (*Juglans nigra*) showed the greatest percentage increases in volume since 2012. Of the 93 tree species tallied over the 2017 inventory period, the 11 species shown in Table 2 make up over 63 percent of Indiana's total net live tree volume.

Live tree biomass (aboveground) is estimated at 279.8 million oven-dry tons or about 56.9 tons per acre. The 11 species shown in Table 2 comprise over 62 percent of Indiana's aboveground biomass.

In terms of average annual growth and removals on forest land, yellow-poplar has the greatest growth rate and also the greatest estimated removals of all tree species (Fig. 4). The 2012 drought and tulip-tree scale (*Toumeyella liriodendri*) epidemic in southern Indiana may have lessened the total amount of growth for yellow-poplar; thus without the drought and scale, yellow-poplar growth may have been greater. In addition, removals increased in the southern Indiana Knobs and Upland Flat Survey Units (Fig. 1), where foresters realized that large yellow-poplar may not survive because of drought intolerance and other site conditions. In addition, white ash (*Fraxinus americana*) and black oak have high mortality rates relative to growth due to emerald ash borer (*Agrilus planipennis*) and oak decline, respectively (Gormanson et al. 2016).

As Indiana's forests mature, trees become older, denser, show less annual net growth (Table 1), become less vigorous, and are more susceptible to declines related to disease and insect infestations, as well as weather related events.

Tulip-tree scale dripping honeydew. Photo by Indiana Department of Natural Resources, used with permission.

Currently, successional stage (age and shade tolerance), invasive species presence, site condition, land-use, soil moisture, markets, harvest regimes, fire occurrence, weather events, and browse by herbivores are all driving trends in Indiana's species composition. Total net annual growth outpaced removals by a ratio (G:R) of 2.3:1 in 2017, although ratios varied considerably among species (Fig. 4). Among the 11 most voluminous species, red maple had the largest growth to removals ratio (7.0:1) and white ash had the smallest (-0.6:1).

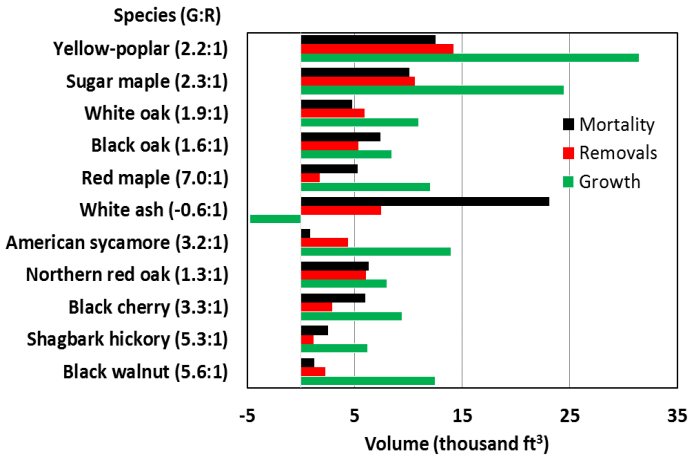

Figure 4.—Average annual net growth, removals, and mortality of net volume on forest land, and growth to removals ratio (G:R) for select species, Indiana, 2017.

Table 2.—Number, volume, biomass, growth, mortality, and removals of live trees on forest land by species of the top 11 tree species by net volume, Indiana, 2017.

Common name	Latin name	Million trees[a]	Net volume[b] (million ft³)	Aboveground biomass[a] (thousand dry tons)	Average annual net growth[b] (thousand ft³)	Average annual mortality[b] (thousand ft³)	Average annual removals[b] (thousand ft³)
Yellow-poplar	*Liriodendron tulipifera*	69.8	1,293.3	24,480.4	31,425.0	12,520.7	14,189.8
Sugar maple	*Acer saccharum*	351.4	1,179.1	34,718.4	24,483.9	10,057.5	10,619.4
White oak	*Quercus alba*	33.5	782.1	21,527.2	10,940.6	4,761.7	5,890.2
Black oak	*Quercus velutina*	33.8	574.3	15,813.0	8,455.1	7,357.3	5,363.3
Red maple	*Acer rubrum*	107.2	511.7	12,313.8	12,025.4	5,251.4	1,725.9
White ash	*Fraxinus americana*	93.4	494.0	13,573.4	-4,749.5	23,110.2	7,457.1
American sycamore	*Platanus occidentalis*	18.1	493.0	10,081.3	13,959.7	838.8	4,349.4
Northern red oak	*Quercus rubra*	25.3	442.4	12,414.6	7,993.0	6,286.0	6,055.1
Black cherry	*Prunus serotina*	99.6	381.5	9,318.6	9,414.5	5,949.7	2,894.1
Shagbark hickory	*Carya ovata*	43.8	361.4	11,422.8	6,207.9	2,537.3	1,169.9
Black walnut	*Juglans nigra*	44.0	354.0	8,705.0	12,467.4	1,233.4	2,232.7
	Total all species	2,162.8	10,860.8	279,836.0	198,065.7	154,127.2	87,428.5

[a] *Trees ≥ 1 inches in diameter*
[b] *Trees ≥ 5 inches in diameter*

Are Indiana's Forests Being Managed Sustainably?

Changes in net volume on timberland can be explained by examining growth, removals, and mortality of trees. Comparing net growth to removals addresses one aspect of forest sustainability; when net growth exceeds removals, total volume increases. Timberland removals include trees harvested on land that remain in timberland, trees on timberland that has been reclassified to reserved forest land, and trees lost because the forest was developed for a nonforest land use. The volume of trees that die from natural causes, such as insects, diseases, wind, and suppression from other trees, is reported as mortality. The data presented in Figure 5 are estimates of annual change in net volume on private land and public timberland in Indiana. These data are based on the changes that occurred over the most recent remeasurement period. Analysis of these individual components can help us better understand what is influencing net change in volume.

The growth of trees has greatly outpaced their mortality and removals. The most recent inventory revealed that as a percentage of the current total inventory, gross growth was 3.6 percent; mortality: 1.6 percent, net growth: 2.0 percent; and removals: 0.9 percent.

These result in an overall net change of 1.0 percent annually. This implies that the current level of removals is sustainable and that increases in volume will continue, although the 8.8 percent of annual removals due to land-use change (nonforest) is a concern and may impact growth in the future.

Of the 8.8 percent of annual removals going from timberland to nonforest, agricultural land makes up 5 percent, cropland 36.9 percent, pasture (improved through cultural practices) 24.9 percent, developed 4.1 percent, cultural (business, residential, other intense human activity) 22.6 percent, and rights-of-way (improved road, railway, power line) 6.5 percent.

As the total volume of trees continues to increase, some species are faring better than others, indicating a shift in the species composition of the forest resource (Table 2, Fig. 4). Illustrating this shift, sugar maple and yellow-poplar had large increases in volume and higher ratios of growth to removals. These species may play a bigger role in Indiana's future forest, while the oaks and white ash had smaller increases in volume and lower ratios of growth to removals, and may play a smaller part of the future forest.

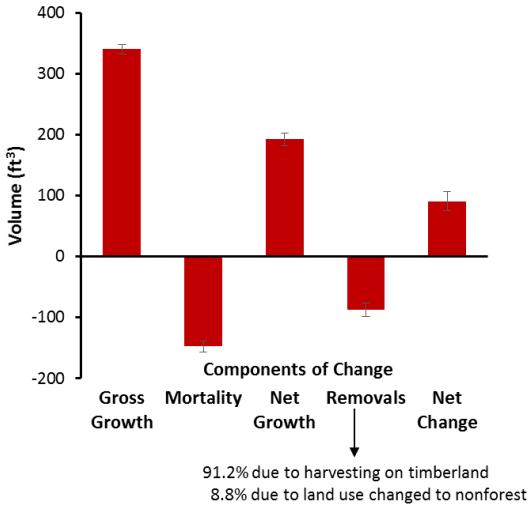

Figure 5.—Average annual components of change in net volume on timberland, Indiana, 2017. Error bars represent 1 standard error or a 68-percent confidence interval

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. Department of Agriculture, Forest Service, Southern Research Station. 85 p. https://doi.org/10.2737/SRS-GTR-80.

Burrill, E.A.; Wilson, A.M.; Turner, J.A. [et al.]. 2017. **The Forest Inventory and Analysis Database: Database description and user guide version 7.2 for phase 2.** Washington, DC: U.S. Department of Agriculture, Forest Service. 946 p. http://www.fia.fs.fed.us/library/database-documentation/ (accessed Aug. 10, 2018).

Gormanson, D.D.; Gallion, J.; Barnett, C.J. [et al.]. 2016. **Indiana Forests 2013.** Resour. Bull. NRS-107. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 156 p.

Gormanson, D.D.; Pugh, S.A.; Barnett, C.J. [et al.]. 2018. Statistics and quality assurance for the Northern Research Station Forest Inventory and Analysis Program. Gen. Tech. Rep. NRS-178. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 25 p. https://doi.org/10.2737/NRS-GTR-178.

How to Cite This Publication
Gormanson, Dale D. 2018.
Forest of Indiana, 2017.
Resource Update FS-165. Newtown Square, PA:
U.S. Department of Agriculture, Forest Service,
Northern Research Station. 4 p.
https://doi.org/10.2737/FS-RU-165.

Northern FIA: http://nrs.fs.fed.us/fia/
National FIA: http://fia.fs.fed.us

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The published report is available online at https://doi.org/10.2737/FS-RU-165