USDA United States Department of Agriculture

RESOURCE UPDATE FS-88

Forests of Indiana, 2015

This resource update provides an overview of forest resources in Indiana based on an inventory conducted by the U.S. 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. The estimates are for the measurement years 2010-2015 with comparisons to estimates reported in 2010. The current 2010-2015 sample set consists of 6,272 plots with 1,592 plots forested or partially forested. About 14.3 percent of the plots were measured each year with observations collected over 6 years. Data used in this publication were accessed from the FIA database in April 2016. See Bechtold and Patterson (2005) and O'Connell et al. (2014) for definitions and technical details. FIA estimates, tabular data, and maps may be generated at: http://www.fia.fs.fed.us/tools-data/.

Overview

Indiana has nearly 4.9 million acres of forest land. Forested area has increased by about 2.1 percent (101,000 acres) since 2010 (Table 1). Timberland accounts for nearly 97 percent forest land, while the remaining 3 percent is reserved or unproductive. There are an estimated 2.2 billion live trees in 2015, a decrease of 0.7 percent from 2010. The density of trees (≥1 inch) averages 460 trees/acre. Net volume of live trees is 10.6 billion ft^3, a 6.3 percent increase since 2010. Statewide average volume is 2,200 ft^3/acre, or a little over 27 cords/acre. Net volume of sawtimber trees is 26.5 billion bd ft, an increase of 13.5 percent since 2010. Average annual net growth decreased 21.8 percent because the forests are maturing with increasing mortality and tree/stand size. Statewide, average annual net growth is 44.5 ft^3/acre/yr, while annual harvest removals decreased by 16.4 percent. Annual mortality of live trees increased nearly 26 percent between 2010 and 2015; however, as a percentage of net volume, mortality was 1.3 percent, up from 1.1 percent in 2010. Similar trends were observed on Indiana's timberlands (Table 1).

Table 1.—Indiana forest statistics, change between 2010 and 2015

	2010 Estimate	Sampling error (percent)	2015 Estimate	Sampling error (percent)	Percent change since 2010
Forest Land					
Area (1,000 acres)	4,775.2	1.1	4,876.0	1.1	2.1
Number of all live trees ≥1 in diameter (million trees)	2,198.9	1.9	2,183.1	2.0	-0.7
Net volume of all live trees ≥5 in diameter (million ft^3)	9,964.9	1.6	10,596.3	1.7	6.3
Net volume of sawtimber trees (million bd ft; Doyle rule)	23,200.8	2.0	26,327.6	2.1	13.5
All live tree aboveground biomass (1,000 oven-dry tons)	260,621.8	1.5	273,825.4	1.6	5.1
Net growth of all live trees ≥5 inches (thousand ft^3/yr)	279,357.7	5.0	218,399.8	5.0	-21.8
Annual mortality of all live trees ≥5 inches (thousand ft^3/yr)	109,628.2	7.2	137,991.8	6.1	25.9
Harvest removals of all live trees ≥5 inches (thousand ft^3/yr)	88,180.2	14.6	73,746.4	13.6	-16.4
Other removals of all live on forest land (thousand ft^3/yr)	5,659.6	52.5	14,178.3	29.7	150.5
Timberland					
Area (1,000 acres)	4,630.4	1.1	4,713.3	1.2	1.8
Number of all live trees ≥1 inch diameter (million trees)	2,110.7	2.0	2,092.6	2.1	-0.9
Net volume of all live trees ≥5 inch diameter (million ft^3/yr)	9,661.8	1.7	10,235.9	1.8	5.9
Net volume of sawtimber trees (million bd ft; Doyle rule)	23,354.1	2.0	25,448.3	2.2	9.0
All live tree aboveground biomass (1,000 oven-dry tons)	252,530.5	1.6	264,302.5	1.6	4.7
Net growth of growing stock trees ≥5 inches (thousand ft^3/yr)	251,917.1	4.9	207,287.3	4.4	-17.7
Annual mortality of growing stock trees ≥5 inches (thousand ft^3/yr)	79,373.6	8.6	96,385.8	7.2	21.4
Harvest removals of growing stock trees ≥5 inches (thousand ft^3/yr)	82,745.7	15.1	65,178.1	13.9	-21.2
Other removals of growing-stock on timberland (thousand ft^3/yr)	3,021.5	45.5	12,936.0	34.0	328.1

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 (976,000 acres), Upland Flats (673,000 acres), and Knobs (1.83 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; the Knobs survey unit containing about 40 percent of the forest.

Eighty-four percent or over 4.1 million acres of forest land is privately owned. The state and local government owns 8.0 percent or 392,000 acres of forest land while the Federal government owns roughly 7.5 percent, or 365,000 acres. A little over 3 percent or 161,200 acres of forest land is considered reserved.

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

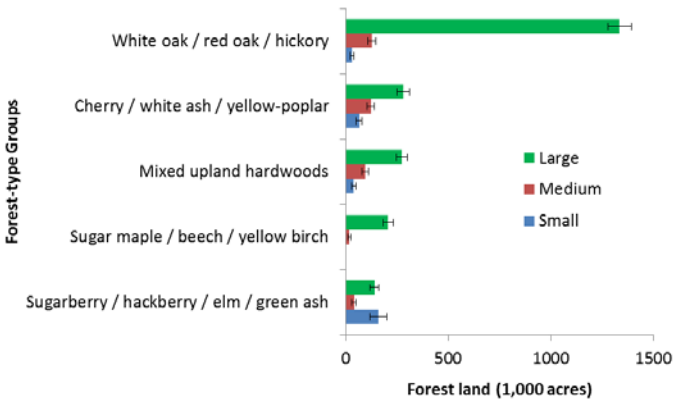

Figure 3.—Area of forest land by five most common forest-type groups and stand-size classes, Indiana, 2015. Error bars represent one standard error or a 68 percent confidence interval.

A male bobcat kitten views the world from a safe perch. Photo by Indiana Department of Natural Resources, used with permission.

Indiana's forest land area (4.9 million acres) and timberland area (4.7 million acres) increased modestly over the past several decades following a trend since 1967 (Fig. 2); however, it appears that this trend is stabilizing.

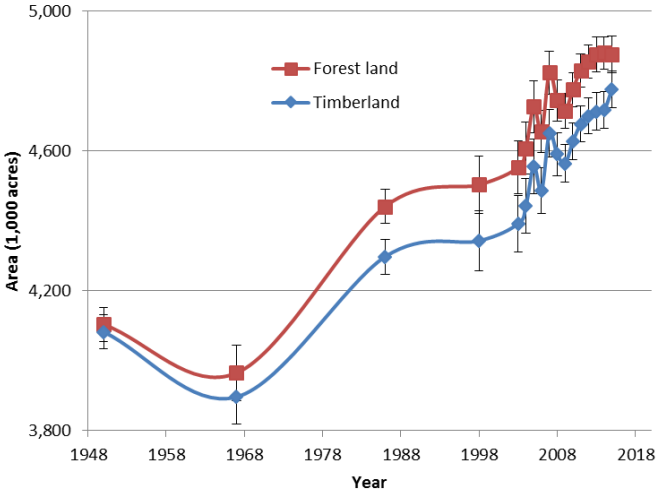

Figure 2.—Area of forest land and timberland in Indiana by inventory year. Error bars represent one standard error or a 68 percent confidence interval.

Hardwood species are dominant 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 (1.5 million acres). Softwoods alone occupy 106,500 acres. The oak/pine group occupies almost 144,238 acres which represents 3 percent of the forest land.

Forest land consists mainly of sawtimber stands (78 percent); 14 percent of forest land is made up of poletimber stands, 7 percent contain seedling-sapling stands and less than 1 percent is considered nonstocked.

Indicative of a maturing (aging) forest, white and red oak/hickory is found primarily in the large stand-size class (Fig. 3). The cherry/white ash/yellow-poplar group is less common (468,000 acres) as are the mixed upland hardwoods (406,000 acres). Both show similar distributions across stand-size classes with a large proportion in the medium and large diameter classes. The sugar maple/beech/yellow birch forest-type group is relatively abundant (224,000 acres) and occurs mostly in large stand-size classes (Fig. 3).

Currently, about 49 percent of the stands are over 61 years of age.

Volume, Biomass, and Trends

The net volume of trees on forest land increased by 6.3 percent to nearly 10.6 billion ft^3 since 2010 (Table 1). Yellow-poplar continues to be the most voluminous species followed by sugar maple, white oak, and black oak (Table 2). Black cherry, American sycamore, and black walnut showed the highest percent increases since 2010. Of the 95 tree species tallied over the 2015 inventory period, the 15 species shown in Table 2 make up nearly 75 percent of Indiana's live tree volume.

Since 2010, sawtimber volume on forest land increased by 13.5 percent to 26.3 billion bd ft. Yellow-poplar was the leading sawtimber species, followed by sugar maple and white oak. Sawtimber volume estimates for black cherry, silver maple, red maple, and black walnut showed the greatest increases. The 15 species in Table 2 also comprise 80 percent of Indiana's sawtimber volume.

Live tree biomass (aboveground) is estimated at 273.8 million oven-dry tons, or about 56.2 tons/acre. The 15 species shown comprise nearly 73 percent of Indiana's above ground biomass.

Today's well-stocked forests are a product of growth consistently outpacing removals during the last half century and the surplus accumulating in the forest. In terms of average annual growth and removals on forest land, yellow-poplar had the highest growth rate and also the greatest estimated removals of all tree species (Fig. 4). The 2012 drought and tulip tree scale in southern Indiana may have decreased the of growth for yellow-poplar; thus without the drought and scale, yellow-poplar growth may have been greater. In addition, removals increased in the Indiana Knobs and Upland Flat Units (Fig. 1) where foresters realized that large yellow-poplar may not survive because of drought intolerance and other site conditions.

Total annual growth outpaced removals by a ratio (G:R) of 2.5:1 in 2015, although ratios varied considerably among species (Fig. 4). Among the 10 most voluminous species, red maple had the largest growth to removals ratio (10.5:1) and white ash had the smallest (1.0:1).

White ash and black oak have high mortalities relative to growth due to emerald ash borers and oak decline complexes respectively (see next section).

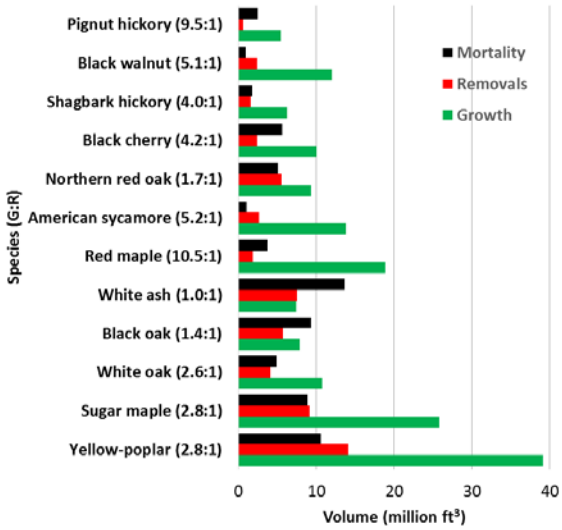

Figure 4.—Average annual net growth, removals, and mortality of net volume on forest land, and growth to removals ratio (G:R) for select species, Indiana, 2015.

Table 2.—Top 15 species by net volume and percentage change since 2010 on forest land; sawtimber volume and associated change since 2010 on forest land; and biomass on forest land, Indiana, 2015

	Volume of live trees on forest land (million ft³)[a]	Sampling error (percent)	Percent change since 2010	Volume of sawtimber trees on forest land (million bd ft; Doyle)	Sampling error (percent)	Percent change since 2010	Aboveground biomass on forest land (thousand tons)	Sampling error (percent)
Yellow-poplar	1,243.1	6.3	7.1%	4,052.5	6.8	10.8%	23,546	6.2
Sugar maple	1,128.3	4.8	7.3%	2,233.1	5.8	14.8%	33,397	4.5
White oak	740.8	6.3	1.6%	2,107.7	6.5	4.5%	20,456	6.3
Black oak	568.6	8.0	4.6%	1,740.5	8.3	9.8%	15,609	7.9
White ash	555.2	6.7	1.4%	1,632.8	8.1	8.0%	9,936	6.4
Red maple	490.0	8.8	12.8%	1,489.5	10.6	23.2%	12,682	8.3
American sycamore	487.0	9.4	16.5%	1,333.6	10.0	15.0%	15,133	9.2
Northern red oak	452.3	7.9	-3.9%	980.8	8.2	3.6%	11,886	7.8
Black cherry	365.1	7.7	16.9%	861.8	10.0	35.4%	11,370	7.1
Shagbark hickory	359.6	7.3	1.3%	1,108.7	8.1	1.3%	4,639	7.1
Black walnut	333.6	7.0	14.6%	748.9	8.6	18.3%	9,461	6.7
Pignut hickory	302.4	7.5	4.1%	657.2	8.4	9.6%	8,281	7.3
Silver maple	296.0	16.6	12.6%	765.6	17.8	26.1%	6,053	16.3
American beech	287.2	9.2	5.7%	727.7	11.1	9.2%	7,812	8.3
Eastern cottonwood	262.9	18.1	4.5%	588.2	18.3	6.6%	9,009	17.9
Total of all species	10,596.3	1.7	6.3	26,327.6	2.1	13.5%	273,825.4	1.6

[a] *Trees ≥ 5 inches in diameter*

Factors Affecting Species Composition in Indiana's Forests

Indiana's forests today are a legacy of past land use and bear the imprint of land use practices over prior centuries. Comparing species' composition by diameter class shows that oak/hickory species and yellow-poplar are better represented in diameters ≥11 inches than they are in smaller diameter classes (Fig. 5). Oak/hickory species comprise over 30 percent of trees ≥11 inches in diameter and 6 percent of trees 1 to 4.9 inches (saplings). Yellow-poplar comprises 10 percent of trees ≥11 inches in diameter and 2 percent of saplings. These contrast with the maple/beech species comprising 30 percent of saplings and 18 percent of trees ≥11 inches. Yellow-poplar and oak/hickory species are intolerant of shade. American beech, sugar, and red maple are very tolerant of shade. In addition, they are numerous across all diameter classes and seemingly will continue to dominate in the larger size classes, which indicates that these species may play a larger role in Indiana's future forest.

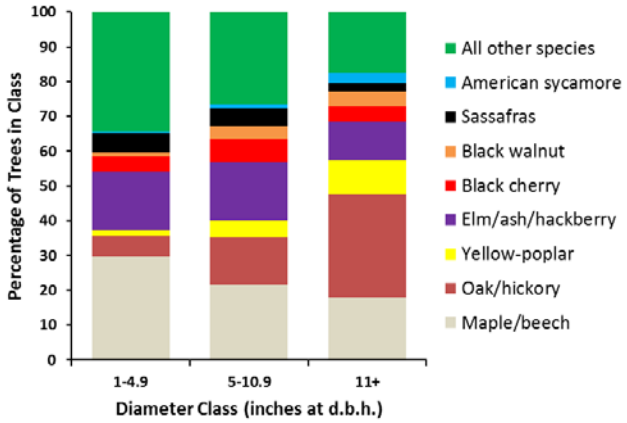

Figure 5.—Species composition as a percent of all trees by diameter class on forest land, Indiana, 2015.

Expectations for ash and elm species should be tempered with knowledge of the impacts of the emerald ash borer (EAB), *Agrilus planipennis* Fairmaire and Dutch elm disease (DED).

Current driving trends for species composition include successional stage (age and shade tolerance), invasive species presence, site condition, land-use, soil moisture, markets, forest fragmentation, parcelization, and browse by herbivores. Further, as Indiana's forest matures, trees become older, denser, show less annual growth (Table 1), become less vigorous and more susceptible to declines related to disease and insects infestations, as well as weather-related events. The high mortality of Indiana black oak is one such example (Fig. 4). Black oak mortality is attributed to oak wilt, old age, drought, poor site conditions, and oak decline. Black oak is a stress sensitive species, especially as it ages, and they readily succumb under stress (particularly drought/defoliation) from secondary agents like two lined chestnut borer (*Agrilus bilineatus*), hypoxylon canker (*Hypoxylon mammatum*), and shoestring root rot (*Armillaria mellea*), which are referred to as oak decline. Thus, as black oak ages, managers should expect an increase in sawtimber mortality and decreases in sawtimber volume. As it ages, red oak (and to a lesser extent, white oak) is also very susceptible to the oak decline disease/insect complex. Hickories are also susceptible.

Other factors affecting species composition include the removal of fire (both natural and man made) from the landscape, and a shift away from aggressive harvesting and regeneration systems that previously provided clearings and competition control necessary for oaks and hickories to thrive. These have resulted in a shift in the forest composition toward shade-tolerant species such as maple. Absent intervention, oak decline and its associated tree killers will accelerate that shift, which appears to already have started (Burbeck 2015). If perpetuation of the oak/hickory forest type is desired, then forest land owners and natural resource managers will need new management strategies to change the current trends and it will take decades to alter.

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.

Burbeck, Tony. 2015. **Oak decline: The slow march toward altered forests.** Hardwood Review Express. 15(15). 3 p.

O'Connell, B.M.; LaPoint, E.B.; Turner, J.A.; Ridley, T.; Pugh, S.A.. [et al.]. 2014. **The Forest Inventory and Analysis database: database description and users manual version 6.0.1 for Phase 2.** Washington, DC: U.S. Department of Agriculture, Forest Service. (http://www.fia.fs.fed.us/library/database-documentation/)

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