Indiana DNR Classified Forests
Report of Continuous Forest Inventory (CFI)
Summary of Years 2013-2017

Joey Gallion
Forest Resource Information/Forest Inventory Program Coordinator

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FOREWORD

This report provides an overview of forest-resource attributes for privately owned land enrolled in the Indiana DNR Division of Forestry's Classified Forest Program, based on findings from a continuous annual inventory conducted by the Forest Resource Information (FRI) Section of the Indiana DNR Division of Forestry (DoF). The CFI inventory of DoF Classified Forest lands is based on a sample of 2,608 plots located randomly across those lands enrolled in the program at a sampling rate of approximately one plot for every 200 forested acres. It should be noted that there are also acres enrolled in the program that originated as Classified Wildlife acres under the DNR Division of Fish & Wildlife but are now managed with the Classified Forest program. These acres are not included in this sample.

Information in this report is gathered from quantitative and qualitative measurements that describe forest-site attributes; stand characteristics; tree measurements on live and dead stems such as species, diameter, height, damage, tree quality; counts of regeneration; and estimates of growth, mortality, and removals. All estimates in this assessment are estimates of a population based on a statistical sample derived from the expansion of plot data and therefore may differ slightly from complete censuses of some populations (e.g., total acres). Given the multitude of estimates of forest-resource attributes, they are organized in "core tables" (e.g., forest-land area vs. live tree volumes), which are updated annually.

This report is a summary of the five panels of plot installation and data collection for the years 2013-2017, which constitutes an entire cycle or total sample population. All initial plots have been installed and measured. Change attributes such as growth, removals, and mortality will not be reported until a later date, after plot re-measurement on a sufficient number of sample plots.

EXECUTIVE SUMMARY/HIGHLIGHTS

This is the third-annual report of results of the classified forest continuous forest inventory (CFI). The goal of the first five years was to install all of the plots within the CFI sample frame and produce baseline resource estimates. These baseline data/estimates will then be used as a monitoring baseline to compare to future re-measurement data in compilation of statistical change estimates (e.g., tree growth/mortality). Details of the results are discussed below, and tabular results can be found in the additional "Part B" report. Baseline resource estimates of Classified Forest properties are:

- 759,005 forested acres comprise the balance in non-forest (i.e., open areas) and water.
- 97% of the forested acres are hardwoods.
- 75% of the forested acres are sawlog-sized stands.
- Forests contain 307 million live trees.
- Sugar-maple trees and seedlings are more abundant than trees of any other species.
- The total live-tree volume is 1.592 billion cubic feet.
- There is 4.079 billion board feet (Doyle) of sawlog volume.
- Yellow poplar, white oak and sugar maple, in order, are the species with the most sawlog volume.
- 59% of the sawlog volume is considered grade 1 or 2.
- Multiflora rose, Japanese honeysuckle and bush honeysuckle are the most common invasive species.

FOREST COMPOSITION

Area

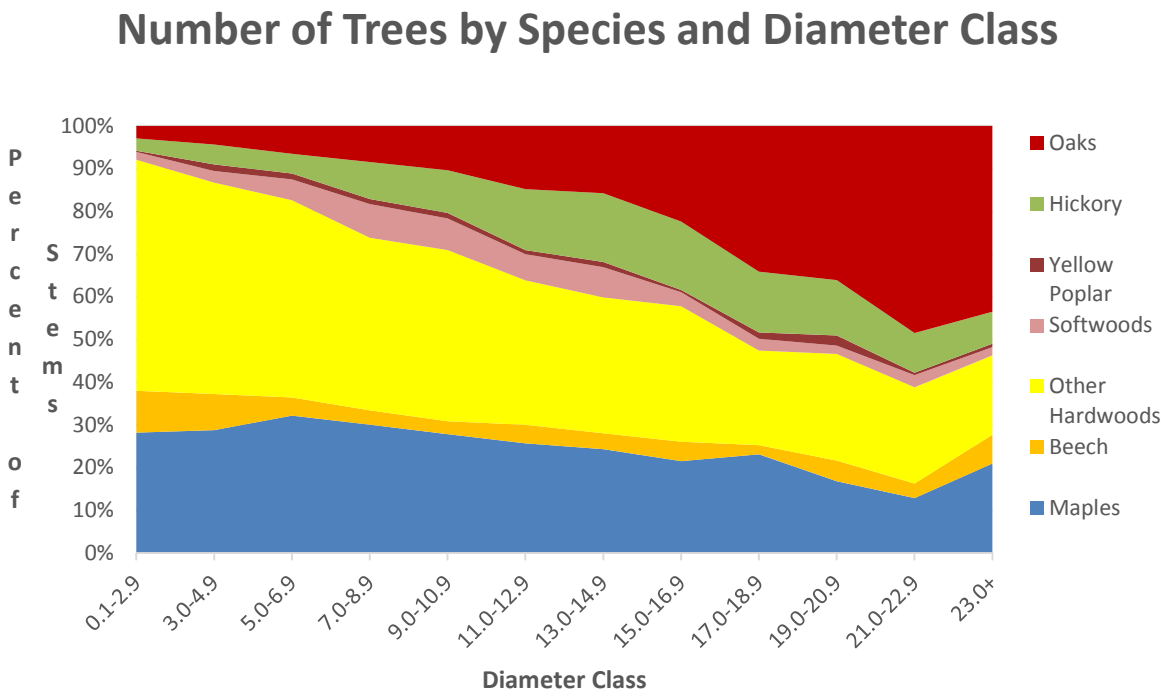
Classified Forest lands comprise approximately 759,005 acres considered forest land (land considered stocked with trees or seedlings that is at minimum 1 acre in size and 120 feet in width), with the remaining acres being non-forest (open fields, rights-of-way, etc.), census water (bodies of water >5 acres and permanent rivers/streams), and non-census water (bodies of water <5 acres and small streams). Like most of Indiana's forests, Classified Forests are predominantly hardwoods, with 97% of the total forest area classified as hardwood forest types. The primary hardwood forest types were white oak/red oak/hickory (166,762 acres, 22%), hard maple/basswood (63,225 acres, 8%), white oak (51,799 acres, 7%), cherry/ash/poplar (49,671 acres, 7%) and yellow poplar (49,473 acres, 7%), as shown in Table 1. Many forest types are similar and therefore difficult to discern For example, mixed upland hardwoods, hard maple/basswood, sugar maple/beech/birch and some in the miscellaneous hardwood forest types each would include a heavy component of maple. Seventy-five percent of the area was considered sawlog-sized stands (large diameter or 11.0 inches d.b.h. and greater), with the remainder classified as poles (medium diameter or 5.0-10.9 inches d.b.h.) and seedling/saplings (small diameter or 1.0-4.9 inches d.b.h.), as shown in Table 1.

Number of Live Trees

It is estimated that there are 307 million live trees on Classified Forest lands. In terms of the total number of live trees, sugar maple was by far the most abundant species at 62.4 million trees, followed by beech, red maple, and

yellow poplar with 22.9 million, 17.5 million and 17.1 million trees, respectively (Table 2). More than half of the number of trees were less than 3 inches d.b.h. with 216.1 million (70%) being less than 5 inches d.b.h. An item of concern is the non-uniform distribution of the number of stems by diameter class for different species (Figure 1). In this sample, all oak species combined represented only 3.1% of all saplings 1 inch to less than 5 inches d.b.h. The lack of oak seedlings/saplings and abundance of maple and other shade-tolerant seedlings/saplings suggests a future decline of oak/hickory forest types as mature stands senesce.

Figure 1



Volume of All Live Trees

The net volume of all live trees, which includes growing stock, rough, and rotten trees, 5 inches d.b.h. and more, was 1.592 billion cubic feet (cuft). Hardwoods constituted 1.535 billion cuft or 96%. Oaks made up 361.8 million cuft or 23%, maples were 336.8 million cuft or 21%, yellow poplar was 232.9 million cuft or 14%, and hickories were 174.7 million cuft or 11% of the total volume (Table 3). Approximately 255.0 million cuft or 16% of the volume is in pole-sized trees (trees <11 inches d.b.h.) with the remainder being sawlog-sized (11 inches and greater d.b.h.). A total of 299.4 million cuft or 19% is 23 inches or greater d.b.h. (Table 3). It was estimated that 1.481 billion cuft of the total volume was in growing stock trees, with the remainder in rough cull and rotten cull trees. These volumes are presented in cubic feet because board foot volume estimates are only calculated on sawtimber-sized trees (hardwoods 11” d.b.h. and greater, softwoods 9” d.b.h. and greater).

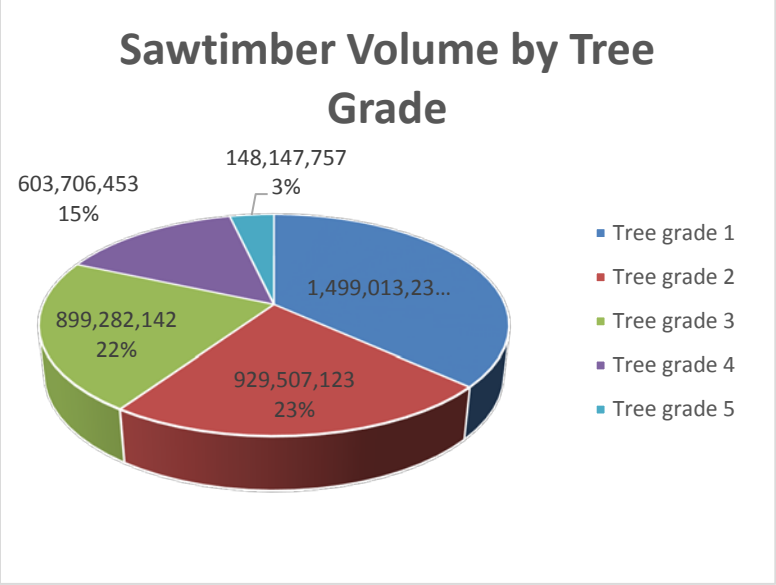
Volume of Sawtimber-sized Trees

The total net sawtimber volume was 4.079 billion board feet Doyle scale. Yellow poplar was the most voluminous species, with 795.9 million board feet (MMBF) or 19%, followed by white oak (401.2 MMBF) and sugar maple (397.3 MMBF). Northern red oak, black oak, and red maple were the other major hardwood species groups ranked by sawlog volume, with 256.5, 227.2, and 177.3 MMBF, respectively (Table 4).

Grade of Sawtimber-sized Trees

Trees are graded using the Forest Service tree-grading system. It grades the best 12-foot section in the butt and 16 foot for hardwoods. Grade 1 must yield 10 feet clear of defects, grade 2 must yield 8 feet clear, grade 3 must yield 6 feet clear, grade 4 must only be sound (tie grade) and grade 5 has a non-gradable butt log (due to form or rot) but has a gradable upper log (above the butt 16-foot log). It was estimated that 1.499 MMBF of the total net sawtimber volume was grade 1 and 929 and 899 MMBF in grades 2 and 3, respectively (Figure 2). Ninety-eight percent of the sawtimber volume of trees had 0-10% cull deductions.

Figure 2



CHANGE ATTRIBUTES AND ANCILLARY DATA ITEMS

Growth, Removals, and Mortality

As stated earlier, the "goal of the first five years of the Classified Forest Inventory system was to install all of the plots within the CFI sample frame and produce baseline resource estimates. These baseline data/estimates will then be used as a monitoring baseline to compare to future re-measurement data in compilation of statistical change estimates (e.g., tree growth/mortality)." To get estimates of change such as growth, removals, and mortality, one must compare results to those established at an earlier time. Therefore, we must establish this baseline first in order to compare future data for estimating change attributes. Re-measurement of plots began in 2017, with 20% of the sample measured annually. Until we are able to estimate change attributes from our plot data with statistical confidence, we will not report any change attributes.

Standing Dead Trees

There were an estimated 8.9 million standing dead trees 5 inches d.b.h. and greater. The individual species with the largest number of standing dead trees were sassafras and white ash, each with 1.5 million stems. Yellow poplar and American elm followed, with 735,000 and 613,000 standing dead trees, respectively (Table 5). As with the number of live trees, the number of standing dead trees decreased as the diameter increased. Of the 8.9

million standing dead trees, 5.2 million had a diameter from 5-9 inches d.b.h., 2.6 million were from 9-15 inches d.b.h., 680,000 were from 15-19 inches d.b.h., and the remaining 371,000 were 19 inches d.b.h. and greater (Table 5).

Invasive Species

If present, crews identify any invasive species found on plot and measure the area of the plot that species occupy. These area estimates are then expanded to the entire 759,005 forested acres to estimate a total area that each invasive species occupies. Some plots may have multiple species present, while the majority of plots are free from invasive species. There were an estimated 64,745 cumulative acres with invasive species present. Multiflora rose, Japanese (vine) honeysuckle and bush honeysuckle are the most prevalent, covering 20,318 acres, 13,480 acres, and 12,502 acres, respectively, with stiltgrass, autumn olive, black locust, garlic mustard, and others also present.

SUMMARY

The establishment of a statistically rigorous forest-resource monitoring program modeled after many aspects of the nation's forest inventory program (FIA) on Indiana's Classified Forests is already yielding a baseline of resource information. Estimates from this baseline compare favorably with prior estimates available from the FIA program.

Change estimates will become available in the future as a sufficient number of plots are re-measured to provide reliable estimates. The CFI system was not designed to produce change estimates until plots are re-measured (beginning in 2017 with 20% measured annually). Until a sufficient number of CFI plots are re-measured, we will not report change estimates.

Even if all CFI plots are re-measured for change estimates, it is expected that the uncertainty associated with estimates of harvest will be relatively high as harvest is often only observed on a minority of plots compared to growth. We will strive to augment this removal data with other potential data sources in the future.

INVENTORY METHODS AND TECHNIQUES

In order to better understand Indiana's public forests, to assist in providing public disclosure for forest management, and with third-party certification from SFI and FSC in mind, DoF began designing a CFI system in 2007 on State Forest lands. We then expanded this CFI system to include private lands enrolled in the Classified Forest system in 2011. We chose to mirror the USDA FIA program for several reasons. The DNR began to negotiate with FIA to build the CFI system to meet the certification audit requirements and yet coincide with the existing FIA standards. A unique system was designed and implementation of plot establishment on the State Forests began in calendar year 2008. The expansion to include the Classified Forest lands began in 2011. The plots on Classified lands were spaced such that an approximately equal number of plots per year per natural region, chosen as the reporting unit (an annual panel), would be completed. Annually, these panels can stand alone as an independent survey; therefore, some results of significant value can be analyzed and reported on an annual basis. It took two years to complete the first panel, so 2016 marked our fifth completed panel, or 100 percent of the total sample.

Quality Assurance/Quality Control

The CFI program is the key program that provides the information needed to assess the status and trends of the DoF's Classified Forest lands. The goal of the CFI is to assure the production of complete, accurate and unbiased forest information of known quality. Specific measurement quality objectives (MQO) for precision are designed to provide a window of performance that we strive to achieve for every field measurement (quality assurance or QA). Quality control (QC) procedures include direct feedback to field staff to provide continual real-time assessment and improvements or refinements of field-staff performance. These data-quality goals were adapted from the USFS FIA program goals, which were developed from knowledge of measurement processes in forestry and forest ecology.

At the heart of CFI quality is extensive staff training and expertise. Field staff meets minimum forest-inventory requirements of a forestry education and background. In addition, each field-staff member begins with an extensive on-the-job training program. Once field-staff members have a comfort level for what is expected, they begin production-data collection on their own.

To quantify and evaluate how the field staff is performing, a second measurement (quality check), taken on a sample of completed field plots, is performed by a trained and certified QA staff. This technique is done blindly, or without the production-crew data on hand, and then the two sets of data are compared, analyzed, and scored to the given MQO standards. Three percent of the plots are pre-selected and considered mandatory quality-check plots. The field staff does not have knowledge of which plots are mandatory checks. Field staff turn in completed data at given time intervals, and if no mandatory check plots are in that batch of production plots, then a random plot (non-mandatory) is picked to perform a quality check so that timely feedback can continuously be provided to the production field staff.

Each datum measured in the field has an associated MQO for precision. This is an assigned tolerance or acceptable level of measurement error, and measures the ability of field staff to make repeatable measurements or observations within the assigned tolerances. In the analysis of QA data, an observation is within tolerance when the difference between the production field-staff data and the quality-check data do not exceed the assigned tolerance or MQO for that data element. For some data elements, the tolerance is "no error," thus only observations that are identical are within tolerance. For example, the tolerance for measurement of tree d.b.h. is +/- 0.1 inch for each 20.0 inches of diameter of a live tree with the MQO for d.b.h. set at 95%. The quality of the data is evaluated by comparing the desired rate of differences within tolerance (as a percent of observations) to the MQO. In the example above, the objective for d.b.h. would be that 95% or more of the d.b.h. observations are within +/- 0.1 inch for each 20.0 inches of diameter for all trees measured by both production field staff and QA staff.

Analysis of this QA dataset assures two things for the program: 1) a measurement of the accuracy of the data being collected and 2) an indicator of future training needs and refinement of the production field staff. With continuous program monitoring and productive feedback to field staff, the QAQC portion of the CFI program should continually improve the quality of the data over time.

Field Production Protocols

With the annual inventory system, about one-fifth of all field plots are measured each year. After five years, an entire inventory cycle is completed. After the first five years, results can be analyzed and reports created as a

moving five-year average. For example, Indiana CFI will be able to generate a report based on inventory results for 2011-2012 through 2016 (the first report with all plots completed), 2013-2017, and so on.

Field plots of the inventory consist of installing and measuring of the annual sample of field plots (panel) in each natural region. It was determined for desired CFI precision standards that the sampling intensity would be one plot for approximately every 200 acres. Indiana CFI used the FIA non-overlapping hexagonal method to assist with establishing plot locations using Arc Map.

Field crews measure vegetation on plots based on FIA standards and protocols with few exceptions. Instead of the four subplot design that FIA uses, Indiana CFI only uses one 24-foot-radius (1/24th acre) circular subplot with the offset 6.8-foot-radius (1/300th acre) microplot. Trees with a d.b.h. of 5 inches and larger are measured on the 24-foot-radius circular subplot. All trees 1 inch d.b.h. and larger are measured on the 6.8-foot-radius circular microplot located 12 feet east of the center of the subplot. Both tree and forest measurements are collected. Some measurements include:

- General stand characteristics such as forest type, stand size and age, slope and aspect, and any recent disturbances
- Tree species, diameter, several different heights, damage, amount of rotten or missing wood, crown measurements, and tree quality
- Counts of tree regeneration
- Presence of identified invasive plants

Specific field protocols can be found in the Indiana CFI Field Data Collection Procedures for Plots Field Manual (internal document). With few exceptions, the FIA field manual (version 4.0) will suffice and is readily available online at http://www.fia.fs.fed.us/library/field-guides-methods-proc/docs/core_ver_4-0_10_2007_p2.pdf.

Estimation Errors or Quality of the Estimates

The four primary sources of error common to all sample-based estimates are sampling, measurement, prediction, and non-response error. For each of these sources of error, a definition within the context of the CFI inventory is provided, along with a discussion of methods used to quantify and reduce this error.

Sampling Error

The process of sampling (selecting a random subset of a population and calculating estimates from this subset) causes estimates to contain error they would not have if every member of the population had been observed and included in the estimate. The CFI inventory of DoF Classified Forest property is based on a sample of 2,608 plots located randomly across those lands enrolled in the Classified Forest Program (a total area of 759,005 acres), a sampling rate of approximately one plot for every 204 acres. Along with every estimate is an associated sampling error that is typically expressed as a percentage of the estimated value but that can also be expressed in the same units as the estimate or as a confidence interval (the estimated value plus or minus the sampling error). This sampling error is the primary measure of the reliability of an estimate. A sampling error can be interpreted to mean that the chances are two-out-of-three that, if a 100-percent inventory were taken using these methods, the results would have been within the limits indicated (i.e., 67% confidence interval).

The sampling errors for State-level estimates of the major attributes presented in this report are shown in the Part B tabular data report. The estimators used by CFI are unbiased under the assumptions that the sample plots are a random sample of the total population and the observed value for any plot is the true value for that plot. Deviations from these basic assumptions are not reflected in the computation of sampling errors. The following sections on measurement, prediction, and nonresponsive error address possible departures from these basic assumptions.

Measurement Error

Errors associated with the methods and instruments used to observe and record the sample attributes are called measurement errors. On CFI plots, attributes such as the diameter and height of a tree are measured with different instruments, and other attributes such as species and crown class are observed without the aid of an instrument. On a typical CFI plot, six to 12 trees are observed, with 15 to 20 attributes recorded on each tree. In addition, many attributes that describe the plot and conditions on the plot are observed. Errors in any of these observations affect the quality of the estimates. If a measurement is biased (such as tree diameter consistently being taken at an incorrect place on the tree), then the estimates that use this observation (such as volume) will reflect this bias. Even if measurements are unbiased, high levels of random error in the measurements will add to the total random error of the estimation process.

To ensure that all CFI observations are made to the highest standards possible, a regular program of quality assurance and quality control is an integral part of all CFI data-collection efforts, as described earlier.

Prediction Error

Errors associated with using mathematical models (such as volume models) to provide observations of the attributes of interest based on sample attributes are referred to as prediction errors. Area, number of trees, volume, biomass, growth, removals, and mortality are the primary attributes of interest presented in this report. Area and number-of-trees estimates are based on direct observation and do not involve the use of prediction models; however, CFI estimates of volume, biomass, growth, removals, and mortality use model-based predictions in the estimation process. Models are used to predict volume and biomass estimates of individual tree volumes. In the future, change estimates such as growth, mortality and removals will be based on these model-based predictions of volume from both the future plot re-measurements and the measurements taken in this first inventory.

Users of CFI estimates should be aware of the possible prediction errors in CFI estimates. In comparing CFI estimates to other data sources, users need to be aware of the prediction models used in both estimates. If both estimates are based on the same prediction models with matching fitted parameter values, then the prediction bias of one estimate should cancel out that of the other estimate. If the estimates are based on different prediction models, then the user should be aware of the prediction error of both models.

Non-response Error

Non-response error refers to the error caused by not being able to observe some of the elements in the sample. In CFI, non-response occurs when crews are unable to measure a plot (or a portion of a plot) at a selected location. Non-response falls into the following three classes:

- Denied access – Entire plots or portions of plots where the field crew is unable to obtain permission from the landowner and is therefore unable to measure the trees on the plot.

- Hazardous/inaccessible – Entire plots or portions of plots where the conditions present prevent a crew from safely getting to the plot or measuring the trees on the plot.

- Other – Plots where the field crew is unable to obtain a valid measurement for a variety of reasons other than those stated above.

Non-response has two effects on the sample. First, it reduces the sample size. The reduced sample size is reflected in the sampling errors discussed in that section. Second, non-response can cause bias in the estimates if the portion of the population not being sampled differs from the portion being sampled. Fortunately, in CFI, unlike in many survey samples, non-response rates are relatively low. The non-response plots in this inventory were not permanently removed from the CFI system of plots. In future inventories, we will again attempt to measure these plots. At that time, we (1) may be able to obtain permission to access these plots (for the Classified Forest system), (2) the hazardous conditions may have changed, or (3) other circumstances that caused us to not measure plots could be different.

Data Management

This collected data is then imported, housed, and processed using a sophisticated Oracle database system. This Oracle system consists of three different but linked databases: MIDAS, NIMS and FIADB. Midas is the pre-field database and historical data-housing unit. NIMS is the post-field housing and processing database. FIADB is the database housing the presentation tables. So this Oracle system not only houses the data but also processes and readies the data for distribution. “Processing” the data combines certain measurements to determine some calculated estimates (e.g., using tree diameter, tree height, site index measurements, tree species, etc. to estimate tree volume using a volume equation).

Distribution is accomplished by eventually loading the post-processed data (FIADB tables) into a customized access database that is very similar in functionality to the USFS FIA EVALIDator online tool. This access database is used to assist with the analysis and interpretation of data. One can create customized tables with error estimates using this EVALIDator access database.

Oracle processing protocols are documented as well (several internal documents). Most protocols are scripts written in sequel programming code or are instructions for the processing of the data and are intended for the database manager or advanced user only. An access EVALIDator user guide was created (beta version – work in progress) with the intent of being used as a reference guide after a training session on how to use EVALIDator has been attended.

APPENDIX

Table 1.—Area of forest land by forest type group and stand size class, IN Classified Forests, 2013-2017.

Table 2.—Number of all live trees by species and diameter class, IN Classified Forests, 2013-2017.

Table 3.—Net volume of all live trees by species and diameter class, IN Classified Forests, 2013-2017.

Table 4.—Sawtimber volume of all live trees by species and diameter class, IN Classified Forests, 2013-2017.

Table 5.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, IN Classified Forests, 2013-2017.

Table 1.—Area of forest land by forest type group and stand-size class, Indiana Classified Forests, 2013-2017.

Estimate: Total-Area of forest land(acres)

Forest type	Stand-size	Large diameter	Medium diameter	Small diameter	Nonstocked
All	759,005	569,527	118,189	45,930	25,359
White oak / red oak / hickory	166,762	136,059	22,648	8,055	-
Hard maple / basswood	63,225	50,857	9,244	3,125	-
White oak	51,799	50,390	1,409	-	-
Cherry / white ash / yellow-poplar	49,671	27,700	14,936	7,035	-
Yellow-poplar	49,473	39,081	7,965	2,427	-
Sugar maple / beech / yellow birch	39,501	33,813	5,092	595	-
Mixed upland hardwoods	38,181	29,091	6,844	2,246	-
Sugarberry / hackberry / elm / green ash	28,015	17,994	8,308	1,712	-
Northern red oak	26,632	25,537	320	775	-
Other miscellaneous hardwood forest types	220,673	139,846	36,475	18,992	25,359
Miscellaneous softwood forest types	12,963	10,574	2,389	0	0
Pine/Hardwood	12,109	8,586	2,556	968	0

Table 2.—Number of all live trees by species and diameter class, Indiana Classified Forests, 2013-2017.

Estimate: Total-Number of all live trees on forest land(trees)

Species	Diameter class	0.1-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0+
All	307,189,488	161,328,086	54,807,542	26,161,344	17,454,319	12,416,855	9,981,687	7,597,931	5,649,236	4,226,851	3,013,331	1,922,944	2,629,360
sugar maple	62,439,529	34,079,030	11,640,503	6,221,016	3,620,979	2,381,170	1,608,768	1,032,063	754,760	542,094	262,642	118,693	177,811
other hardwood species	56,249,230	27,875,450	10,063,493	5,722,333	3,721,182	2,766,686	1,941,158	1,503,300	1,007,808	632,942	440,327	256,847	317,704
American beech	22,893,130	15,153,816	4,444,475	1,079,936	559,812	354,792	401,543	256,635	234,620	80,793	125,202	57,003	144,502
red maple	17,526,924	8,399,084	3,467,236	1,756,723	1,183,517	717,886	680,342	499,131	238,557	219,223	143,835	49,746	171,642
yellow-poplar	17,094,387	7,170,754	3,076,164	1,136,973	982,592	825,608	824,877	787,955	517,502	516,557	487,399	262,055	505,950
sassafras	15,065,900	9,142,181	2,879,559	1,143,973	688,792	527,331	326,167	228,547	83,071	15,426	23,139	-	7,713
other oaks	13,125,448	3,537,023	1,661,670	1,269,293	970,064	895,723	946,089	700,812	689,516	722,258	604,238	564,533	564,221
flowering dogwood	11,695,609	8,411,792	2,883,433	309,957	81,249	9,177	-	-	-	-	-	-	-
American elm	11,560,190	5,552,991	3,145,465	1,499,715	675,482	326,412	184,840	96,495	44,863	24,604	9,324	-	-
white ash	10,889,548	6,597,419	1,125,523	861,841	504,405	458,078	365,259	217,505	360,181	135,506	118,026	91,617	54,187
pawpaw	8,939,850	8,610,538	321,956	7,356	-	-	-	-	-	-	-	-	-
American hornbeam	6,937,178	5,459,788	1,256,177	180,790	23,889	16,533	-	-	-	-	-	-	-
other maples	6,691,589	3,036,693	1,049,796	874,554	596,226	338,632	187,117	188,126	132,327	115,941	27,679	46,034	98,463
eastern hophornbeam	6,469,655	5,227,357	841,420	301,892	71,014	27,973	-	-	-	-	-	-	-
shagbark hickory	5,990,416	1,979,187	851,618	469,858	520,940	503,642	409,764	470,867	376,943	200,804	116,431	73,179	17,184
other elms	5,938,644	3,098,506	1,264,438	753,735	422,114	205,002	99,898	51,405	34,368	-	-	-	9,177
white oak	5,773,927	1,082,448	737,981	413,534	439,017	322,539	422,489	385,223	465,202	563,067	329,847	245,536	367,045
eastern redcedar	5,443,397	1,907,633	1,238,327	790,516	791,428	431,319	129,565	129,859	16,891	7,860	-	-	-
other softwood species	3,722,175	930,110	191,913	449,138	526,159	439,244	437,994	358,354	153,581	96,108	50,671	47,615	41,284
other ashes	3,571,428	1,577,629	1,068,650	216,129	152,993	198,700	105,462	51,925	89,075	18,355	55,358	27,972	9,177
other hickories	9,171,333	2,498,662	1,597,750	702,077	922,460	670,402	910,354	639,725	449,968	335,311	219,208	82,111	143,296

Table 3.—Net volume of all live trees by species and diameter class, Indiana Classified Forests, 2013-2017.

Estimate: Total-Volume of all live on forest land(cuft)

Species	Diameter class	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0+
All	1,592,639,350	58,839,716	86,830,527	116,986,184	154,390,144	178,604,136	187,889,144	191,374,260	177,938,751	140,405,459	299,381,029
yellow-poplar	232,924,178	3,062,439	5,592,784	9,065,162	14,747,611	22,198,544	20,579,760	28,060,728	34,437,657	23,254,636	71,924,857
sugar maple	209,071,285	15,982,105	19,878,266	24,515,195	27,218,629	25,817,330	26,929,795	25,435,133	16,100,530	8,761,431	18,432,870
other hardwood species	157,666,564	11,147,112	13,796,406	17,239,938	18,402,106	21,932,802	16,342,616	15,948,454	15,865,087	8,632,588	18,359,455
white oak	130,029,594	965,047	2,265,453	2,905,262	6,321,042	8,398,131	13,874,460	22,907,692	17,504,175	16,248,762	38,639,571
red maple	87,330,847	4,258,133	6,203,211	6,842,092	10,575,633	11,804,571	8,009,981	9,870,720	8,112,577	3,369,504	18,284,424
other oaks	85,379,686	1,633,526	2,812,384	4,419,504	6,288,704	4,293,268	9,999,379	12,653,398	11,964,990	11,474,211	19,840,322
northern red oak	77,153,032	565,108	1,043,895	2,008,679	3,391,184	5,607,189	5,424,906	9,485,353	10,480,253	19,448,363	19,698,102
black oak	69,243,764	833,894	1,099,206	1,803,257	4,385,292	5,723,284	5,942,673	8,752,670	10,784,573	9,196,918	20,721,997
shagbark hickory	62,709,754	1,151,242	2,563,200	5,125,329	6,582,685	11,091,529	12,940,681	9,055,744	7,138,345	5,411,383	1,649,617
American beech	58,633,508	2,497,327	2,796,319	3,417,208	5,997,783	5,973,104	7,699,960	3,604,099	7,023,099	3,957,506	15,667,102
pignut hickory	57,686,812	907,869	1,976,605	3,868,947	8,489,060	8,488,441	7,053,461	9,036,824	6,542,008	3,626,832	7,696,766
redcedar and pine species	57,090,137	2,673,204	6,250,827	7,603,975	8,400,822	10,758,849	5,401,195	4,686,346	2,933,151	3,511,267	4,870,503
white ash	56,047,976	1,781,701	2,391,811	4,402,413	5,465,804	4,962,384	11,707,674	5,851,693	7,095,509	6,473,413	5,915,575
black walnut	44,371,737	1,174,800	1,913,302	4,897,036	5,983,519	6,066,867	8,153,295	3,982,702	4,545,786	3,048,842	4,605,589
other maples	40,430,510	1,731,267	2,715,421	3,093,306	2,546,140	4,155,656	4,543,911	5,174,043	1,598,934	3,233,149	11,638,683
bitternut hickory	39,563,092	660,737	2,307,988	2,339,757	4,957,442	5,429,461	6,334,753	5,099,664	4,439,816	2,706,451	5,287,024
black cherry	39,233,839	2,459,756	4,218,500	4,840,104	5,945,527	6,281,541	6,081,388	3,720,121	3,530,511	1,441,495	714,895
American sycamore	33,567,442	373,033	1,023,305	1,930,291	1,688,363	3,580,726	3,055,095	4,251,788	1,767,836	4,664,142	11,232,864
elms	23,977,592	4,402,273	4,791,850	4,176,175	3,797,095	2,854,610	2,126,420	935,364	344,094	0	549,710
other ashes	15,726,726	458,530	756,464	1,946,843	1,619,427	1,313,117	2,939,352	913,630	3,070,163	1,944,566	764,635
other hickories	14,801,271	120,613	433,330	545,710	1,586,277	1,872,734	2,748,390	1,948,093	2,659,656	0	2,886,468

Table 4.—Sawtimber volume of all live trees by species and diameter class, Indiana Classified Forests, 2013-2017.

Estimate: Total-All live net sawtimber volume on forest land(bdft - FIA Doyle)

Species	Diameter class	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0 +
All	4,079,656,711	9,394,568	289,161,752	419,452,045	510,729,842	584,431,841	598,653,060	498,940,125	1,168,893,477
yellow-poplar	795,930,333	-	29,668,507	57,848,932	61,844,617	94,565,642	129,672,468	88,779,937	333,550,230
white oak	401,199,349	-	12,514,585	20,763,341	37,626,974	68,925,107	55,933,879	56,897,997	148,537,466
sugar maple	397,283,501	-	52,153,125	61,454,081	71,972,719	76,241,668	49,970,619	29,091,452	56,399,838
northern red oak	256,505,008	-	6,988,907	13,776,153	15,943,943	30,998,370	37,174,244	72,160,312	79,463,078
other hardwood species	251,324,488	-	31,452,708	38,242,058	34,835,468	32,534,328	45,351,990	14,068,089	54,839,846
black oak	227,255,404	-	9,039,082	14,500,473	16,474,886	28,192,396	37,543,241	34,424,842	87,080,485
red maple	177,354,964	-	17,255,801	23,628,766	20,049,708	27,154,927	22,412,604	10,186,567	56,666,592
other oaks	159,802,525	-	11,397,287	7,472,561	22,915,216	30,234,107	23,835,552	23,201,661	40,746,141
American beech	158,250,659	-	11,458,250	13,825,460	22,095,771	10,675,149	22,520,357	13,648,279	64,027,391
shagbark hickory	157,438,472	-	13,095,944	27,236,827	36,111,487	28,860,285	24,872,960	20,609,158	6,651,810
pignut hickory	154,166,178	-	17,450,684	20,817,010	20,645,031	28,514,343	23,353,902	12,027,062	31,358,146
other softwoods and redcedar	145,421,535	9,394,569	18,405,582	28,410,213	18,012,203	17,376,197	13,015,820	15,640,657	25,166,291
white ash	140,833,838	-	9,446,433	11,163,485	30,505,757	17,356,486	24,314,304	22,769,570	25,277,803
bitternut hickory	109,088,782	-	10,296,603	13,308,489	18,583,845	15,584,184	15,867,934	10,506,091	24,941,636
American sycamore	94,214,508	-	2,718,344	8,457,974	8,293,060	13,091,438	5,961,371	16,941,534	38,750,787
black walnut	92,793,848	-	11,720,459	14,832,283	23,027,341	10,874,762	14,040,590	9,222,092	9,076,322
pin oak	82,784,819	-	686,487	2,626,408	4,548,547	8,805,317	14,805,931	18,431,660	32,880,468
other maples	78,828,617	-	2,680,476	7,063,053	9,344,141	13,279,193	5,015,213	9,162,908	32,283,633
black cherry	60,657,710	-	10,034,420	13,704,707	12,760,407	10,201,141	10,394,156	3,562,879	-
sweetgum	60,158,169	-	4,898,817	12,549,808	9,152,268	12,950,815	3,927,130	10,351,203	6,328,128
other hickories	40,604,140	-	2,967,168	4,641,668	7,843,324	5,156,706	8,150,961	-	11,844,312
other ashes	37,759,867	-	2,832,079	3,128,294	8,143,129	2,859,281	10,517,834	7,256,177	3,023,073

Table 5.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, Indiana Classified Forests, 2013-2017.

Estimate: Total-Number of standing dead trees 5""+ dbh on forest land (trees)

Species	Diameter class	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0+
All	8,939,080	3,149,220	2,110,455	1,287,009	787,807	553,584	326,300	353,654	165,981	112,591	92,478
sassafras	1,468,288	738,897	324,982	266,010	80,892	32,757	24,751	-	-	-	-
white ash	1,450,118	275,321	301,143	200,676	138,449	161,980	90,216	119,197	78,516	60,079	24,540
yellow-poplar	735,552	320,325	168,144	65,514	73,958	66,685	-	22,425	9,177	9,324	-
American elm	613,369	213,742	175,388	80,682	91,191	35,182	7,860	9,324	-	-	-
slippery elm	386,772	139,606	96,122	66,930	25,857	31,749	17,184	9,324	-	-	-
sugar maple	366,559	115,407	100,109	53,717	7,713	39,966	26,068	23,579	-	-	-
eastern redcedar	366,142	174,450	114,772	45,922	30,999	-	-	-	-	-	-
black locust	348,293	91,814	79,820	86,133	16,533	29,780	16,680	9,177	18,355	-	-
black cherry	322,931	136,984	98,400	18,502	33,717	18,648	7,356	9,324	-	-	-
eastern white pine	289,182	146,910	53,717	17,037	34,221	18,648	18,648	-	-	-	-
white oak	263,341	41,430	45,857	64,863	7,713	26,004	32,463	18,648	18,502	7,860	-
other oaks	228,031	56,142	52,073	15,720	15,720	26,508	23,579	23,075	7,356	0	7,860
red maple	200,412	50,461	60,078	7,860	26,361	-	-	9,324	9,177	18,648	18,502
black oak	185,359	30,853	35,539	33,928	35,539	16,891	7,713	15,573	-	-	9,324
American beech	144,144	24,750	24,393	15,573	7,713	31,749	-	7,713	-	7,356	24,897
Virginia pine	144,127	33,424	62,374	15,719	9,177	-	15,573	7,860	-	-	-
black walnut	123,430	51,862	39,819	-	14,712	9,324	7,713	-	-	-	-
pignut hickory	108,051	23,075	25,044	9,177	-	-	-	33,717	17,037	-	-
other hickories	106,504	15,573	22,782	18,502	24,897	-	15,426	-	-	9,324	-
other ashes	104,648	52,576	27,679	7,713	9,324	-	7,356	-	-	-	-
other hardwoods	867,201	367,435	178,934	178,184	76,611	7,713	7,713	35,391	7,860	-	7,356
other softwoods	116,625	48,183	23,286	18,648	26,508	-	-	-	-	-	-