# Indiana DNR Classified Forests
# Report of Continuous Forest Inventory (CFI)
# Summary of years 2018-2022

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## ACKNOWLEDGMENTS

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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 and Wildland 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 3,243 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 years of plot installation and data collection for the years 2018-2022, a span that constitutes one entire cycle. With 20% of the plots measured annually, the 2022 plots were the same plots measured in 2017, thus the 2017 data were replaced with the 2022 data.

## EXECUTIVE SUMMARY/HIGHLIGHTS

These are the annual reported results of the classified forest continuous forest inventory (CFI). The goal of the first five years (2012-2016) was to install all 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 Appendix. Baseline resource estimates of Classified Forest properties are:

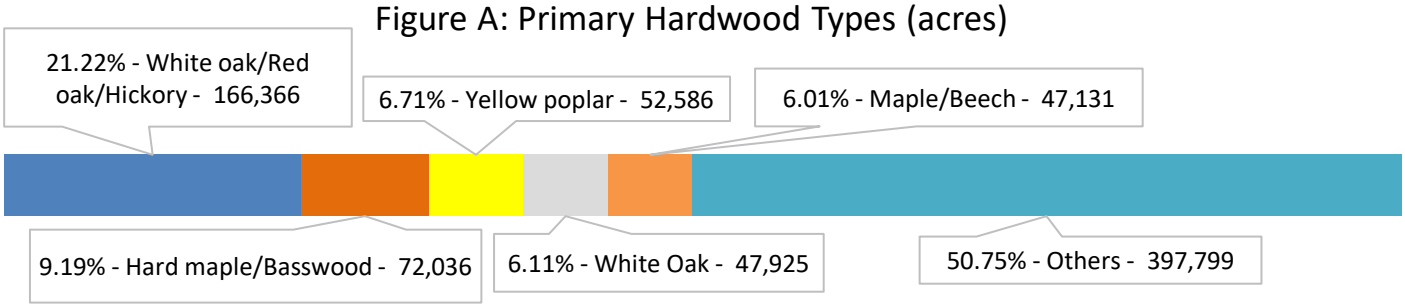
- 783,843 forested acres with the balance in non-forest (i.e., open areas) and water.
- 97% of the forested acres are hardwoods.
- 74% of the forested acres are sawlog-sized stands.
- Forests contain 310 million live trees.
- Sugar-maple trees and seedlings are more abundant than trees of any other species.
- The total live-tree volume is 1.677 billion cubic feet.
- There is 4.369 billion board feet (Doyle) of sawlog volume.
- Yellow poplar, sugar maple and white oak, in order, are the species with the most sawlog volume.
- 63% of the sawlog volume is considered grade 1 or 2.
- Japanese honeysuckle, Creeping jenny, Glossy buckthorn, and European privet are the most common invasive species.

## FOREST COMPOSITION

### Area

Classified Forest lands comprise approximately 783,843 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 >4.5 acres and permanent rivers/streams), and non-census water (bodies of water <4.5 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 are illustrated below (Figure A) (Table 1).

Figure A: Primary Hardwood Types (acres)

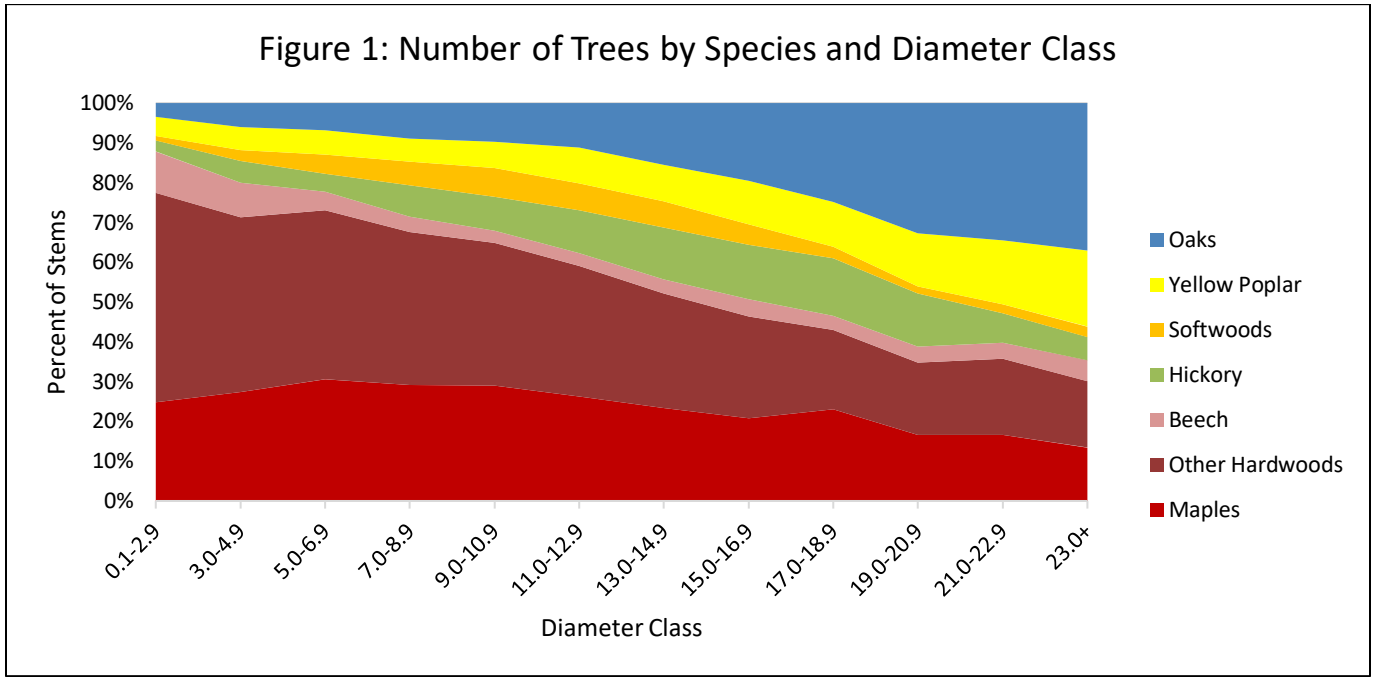



Many forest types are similar, therefore, difficult to discern. For example, mixed upland hardwoods, hard maple/basswood, sugar maple/beech/birch and some in the miscellaneous hardwood forest types each would include a heavy component of maple. Seventy-four percent of the area was considered sawlog-sized 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

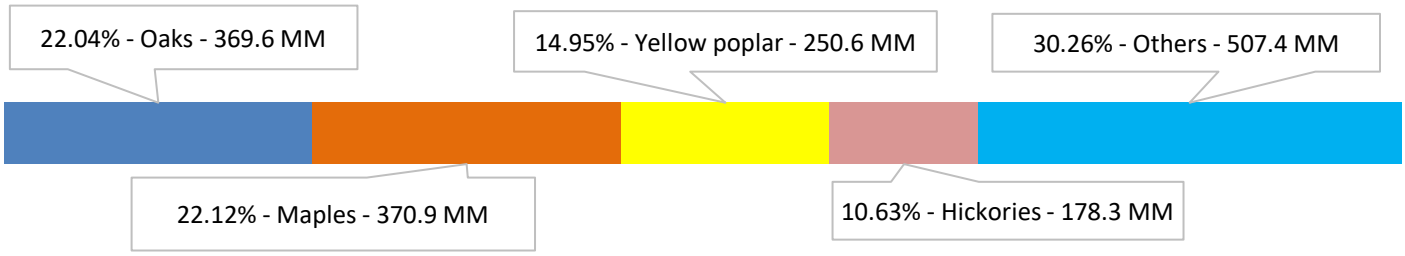
It is estimated that there are 310 million live trees on Classified Forest lands. In terms of the total number of live trees, Sugar maple was by far the most abundant species at 63.3 million trees, followed by American beech, yellow-poplar, and red maple with 25.3 million, 18.6 million and 15.2 million trees, respectively (Table 2). More than half of the number of trees were less than 3 inches d.b.h. with 218.0 million (70%) being less than 5 inches d.b.h. An item of concern is the lack of oak stems in the smaller diameter classes (Figure 1). In this sample, all oak species combined represent only 4.7% which has grown higher since last year (4.1%) of all saplings 1 inch to less than 5 inches d.b.h. Although it isn't a significant growth, it suggests that it is going in the right direction for their preservation, but it is not enough to maintain the older population of oak stems.




## 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, is 1.677 billion cubic feet (cuft). Hardwoods constituted 1.610 billion cuft (96%) and its distribution with respect to the total volume is illustrated below (Figure B) (Table 3).

Figure B: Hardwood Volume distribution (cubic feet - cuft)

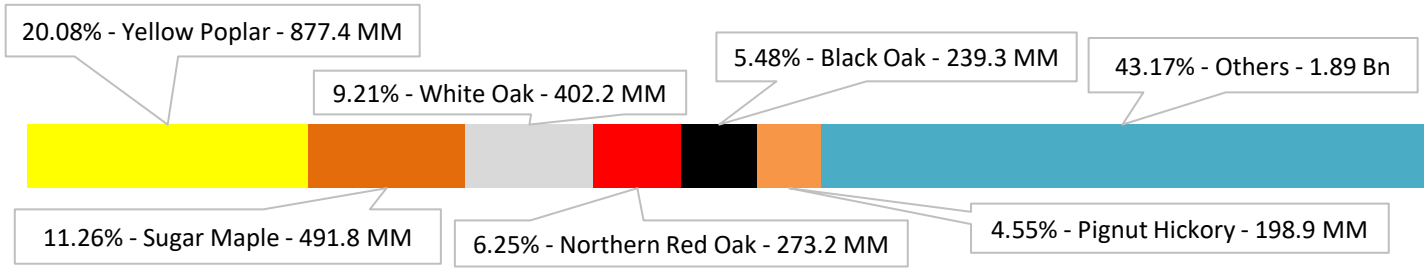



Approximately 267.4 million cuft (16%) of the volume is in pole-sized trees (trees <11 inches d.b.h.) with the remainder being sawlog-sized (11 inches and greater d.b.h.). A total of 352.9 million cuft (21%) is 23 inches or greater d.b.h. (Table 3). It was estimated that 1.550 billion cuft of the total 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

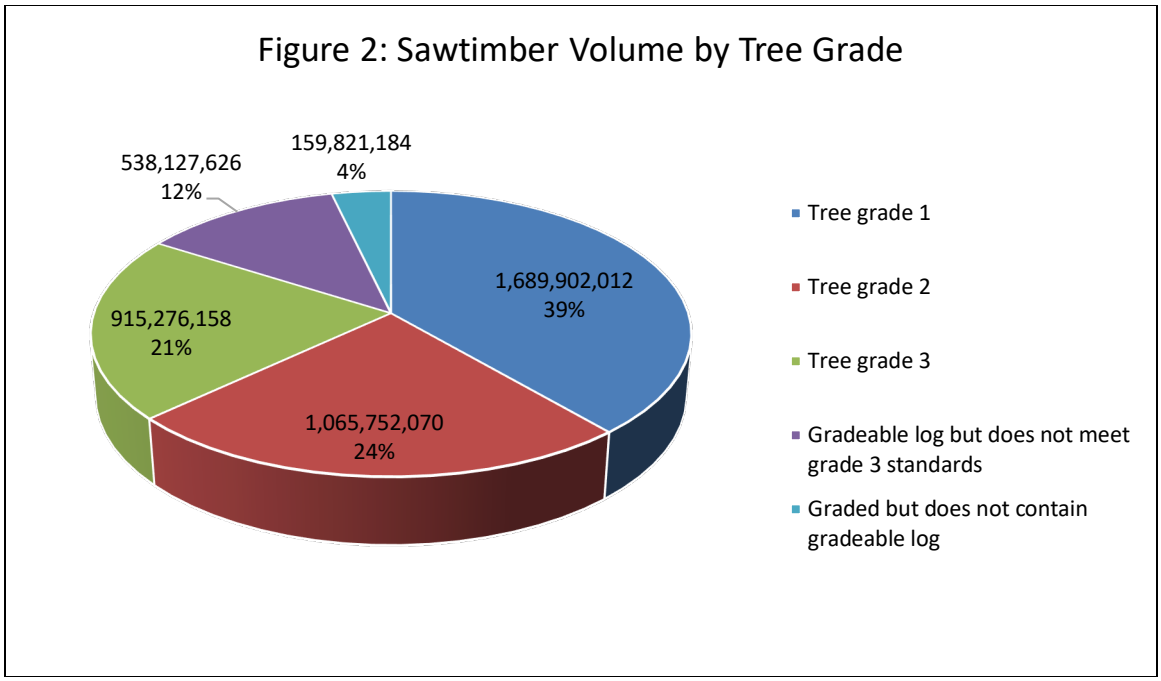
The total net sawtimber volume is 4.369 billion board feet Doyle scale and the distribution is illustrated below (Table 4).

Figure C: Sawtimber Volume distribution (broad feet - bdft)




## 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 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 is estimated that 1.690 billion BF of the total net sawtimber volume was grade 1 and 1.066 and 0.915 billion BF in grades 2 and 3, respectively (Figure 2). Ninety-nine percent of the sawtimber volume of trees had 0-10% cull deductions.



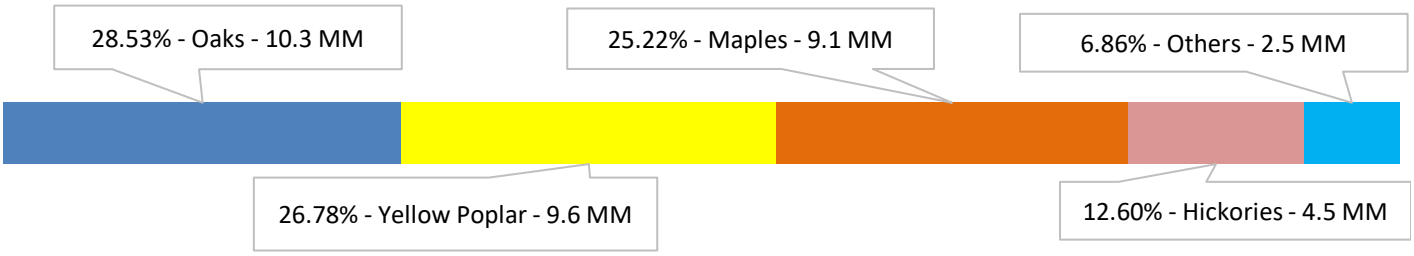

## CHANGE ATTRIBUTES

As stated earlier, the "goal of the first five years of the Classified Forest Inventory system was to install all 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 2018, with a portion of the sample measured annually and completed the first set of remeasurements in 2022. In addition to plot remeasurements, new plot establishment still occurs as we add acreage to the classified forest program to ensure our statistical reliability of expansion factors used.

### Growth

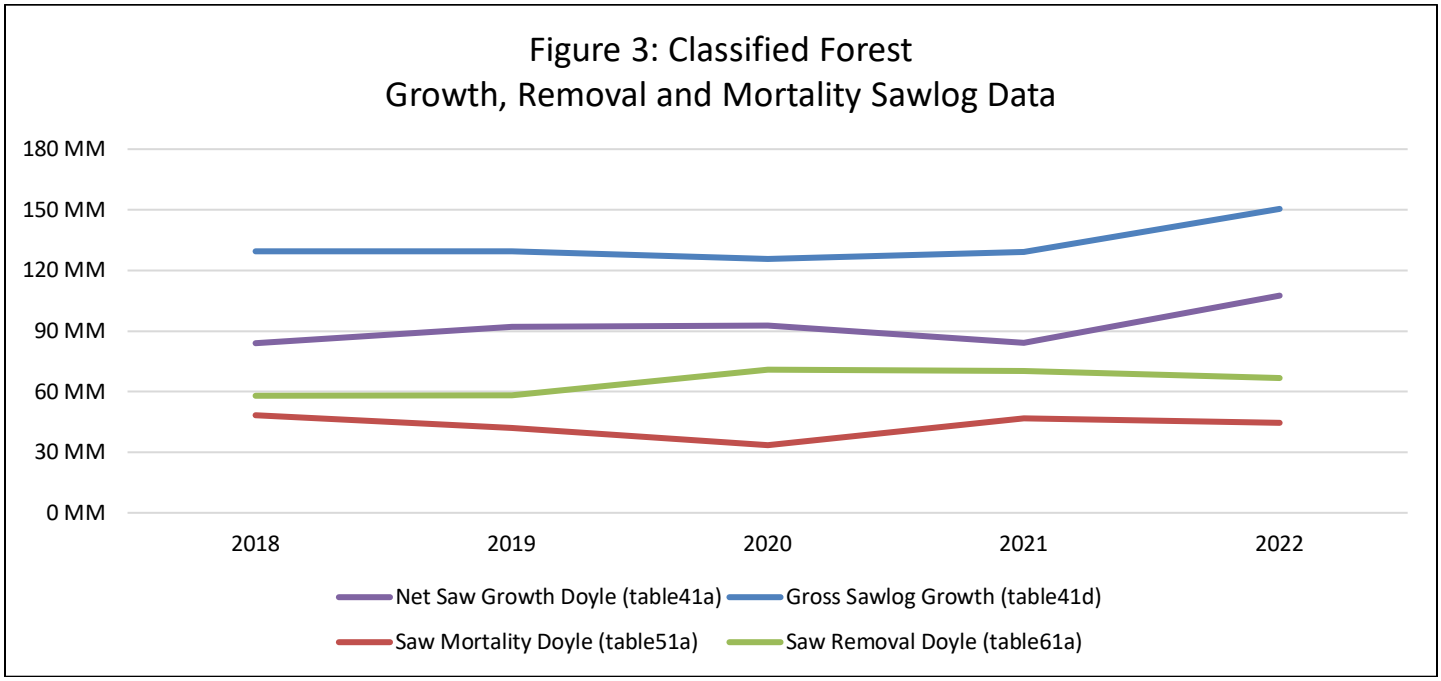
*Net* growth is defined as the gross or total growth minus the mortality. The average annual net volume growth of all live trees, which includes growing stock, rough, and rotten trees, 5 inches d.b.h. and more, is 35.971 million cubic feet per year. Approximately 9.092 million cuft (25%) of the growth is in pole-size trees (trees <11 inches d.b.h.), with the remainder being sawlog-size (11 inches and greater d.b.h.). Ashes showed a negative growth (a negative growth value would mean that mortality was larger than the gross growth). Hardwoods grew 28.410 million cuft/year (96%) of the total growth, while cedar and pines merely netted 1.037 million cuft/year. The hardwood growth distribution with respect to total growth is illustrated below (Figure D) (Table 5).

Figure D: Hardwood Growth distribution (cubic feet - cuft)




Looking at sawlog-size average annual *total* volume growth, trees collectively grew an average of 150.4 million board feet Doyle annually. Hardwoods grew 143.57 million bdft/year, while cedar and pines grew 6.86 million bdft/year. Oaks are 35.6 million bdft (24%), Yellow poplar constitutes 34.2 million bdft (23%), Maples are 25.8 million bdft (17%), and Hickories are 15.1 million bdft (10%) of the total growth (Table 6).

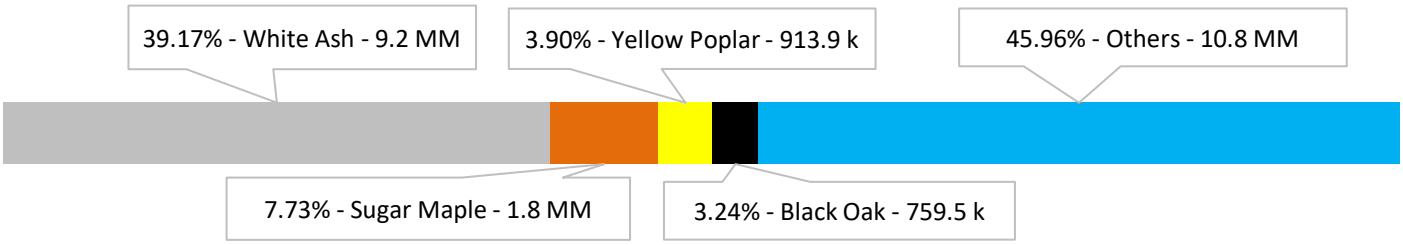
It can be observed that historically the sawlog growth was about 130 million bdft/year since 2018 and it has been consistent till 2021 as the net saw growth, saw mortality and saw removal have not changed with respect to each other significantly. In 2022, there is a significant increase in the net growth resulting in higher gross sawlog growth. The same is illustrated below (Figure 3).




## Mortality

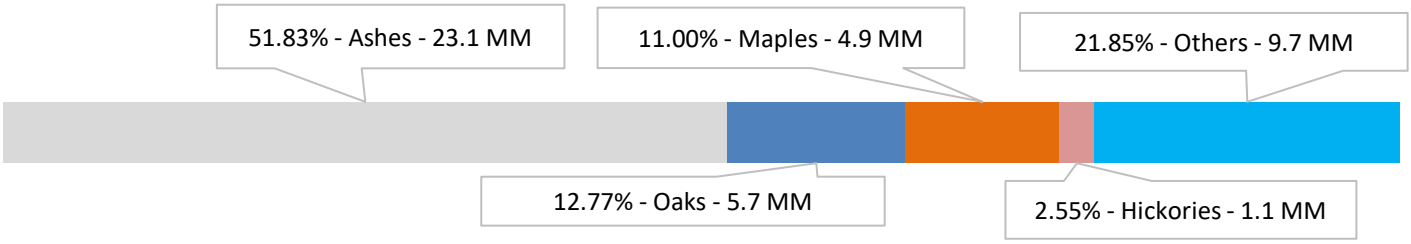
The average annual volume mortality of all trees is 23.41 million cuft per year. Hardwoods accounts for 22.5 million cuft/year (96%) of the total mortality with oak species accounting for 2.0 million cuft (11%) of all mortality. The hardwood mortality distribution with respect to total mortality is illustrated below (Figure E.1) (Table 7).

Figure E.1: Hardwood Mortality distribution (cubic feet - cuft)




Similarly, looking at sawlog-sized volume mortality, forests lost an average of 44.5 million board feet Doyle annually. Hardwoods accounted for 42.8 million bdft/year (96%) and its distribution is illustrated below (Figure E.2) (Table 8).

Figure E.2: Sawlog Volume Mortality distribution (board feet - bdft)




Some of the high mortality is easily explained. The ash decline can be contributed to emerald ash borer. Ash will continue to increase in mortality loss as this invasive pest continues to spread. Other high mortalities, however, are more complex.

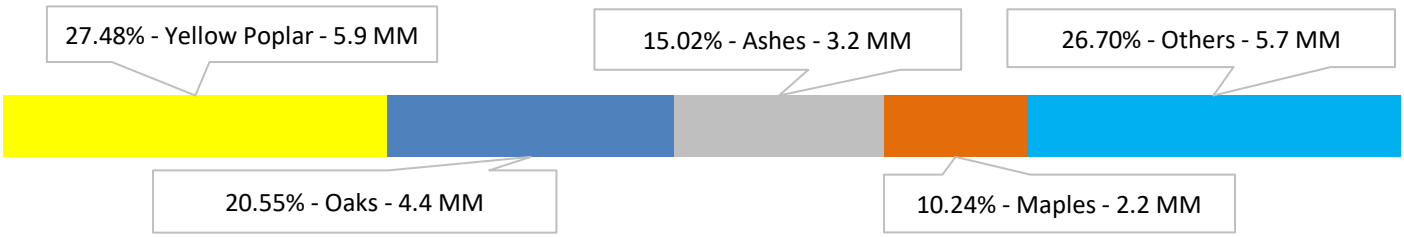
Several possible factors such as intermittent droughts over the last 20 years (with the latest severe drought in 2012), an outbreak of tulip scale attacking yellow poplar a few years ago, other possible insects and diseases, and natural age progression of many individual tree species, could be contributing to the volume lost to mortality.

Softwoods, planted in the past for quick soil stability of eroded and abandoned farm fields, are at or past their age of maturity and will continue to decline. Yellow poplar will always be susceptible to extreme drought conditions on certain sites. Many of our oaks are nearing their maturity age. Trees show less vigorous growth attributes with age and therefore are potentially more likely to succumb to issues brought about by insects, diseases, drought, etc. In a younger, more vigorous growth stage these oak trees would normally overcome such attacks. With much of the mortality volume (except for ash) occurring in the oak species, this will continue to be an issue without serious management efforts to promote younger oak trees to replace the aging stands of oak we now enjoy.

## Removals

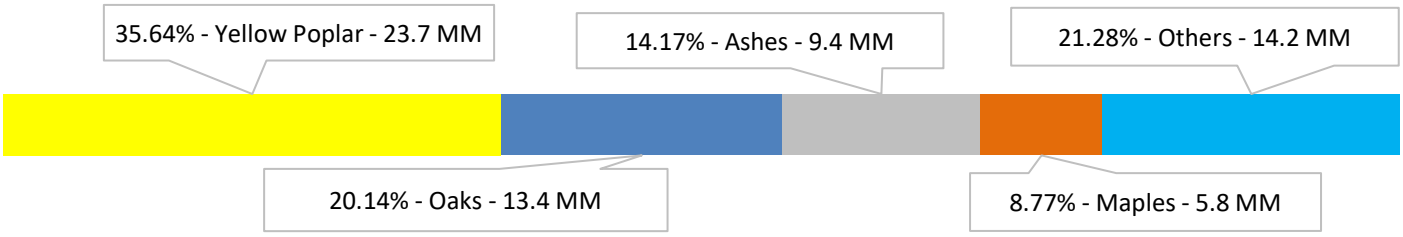
The average annual volume removal of all trees is 21.37 million cuft per year. Hardwoods accounts for 21.18 million cuft/year or 99.1% of the total removals and the removal distribution is illustrated below (Figure F.1) (Table 9).

Figure F.1: Removal distribution (cubic feet - cuft)




Similarly, looking at average sawlog-sized volume removals over the 5-year period, 66.6 million board feet Doyle is removed annually. Hardwoods accounted for 66.3 million bdft/year and its distribution is illustrated below (Figure F.2) of which Yellow poplar is 23.7 million bdft (36%) of the removals followed by Oaks, Ashes, Maples accounting for 13.4 million bdft (20%), 9.4 million bdft (14%), and 5.8 million bdft (9%) respectively (Table 10).

Figure F.2: Sawlog Volume Removal distribution (board feet - bdft)

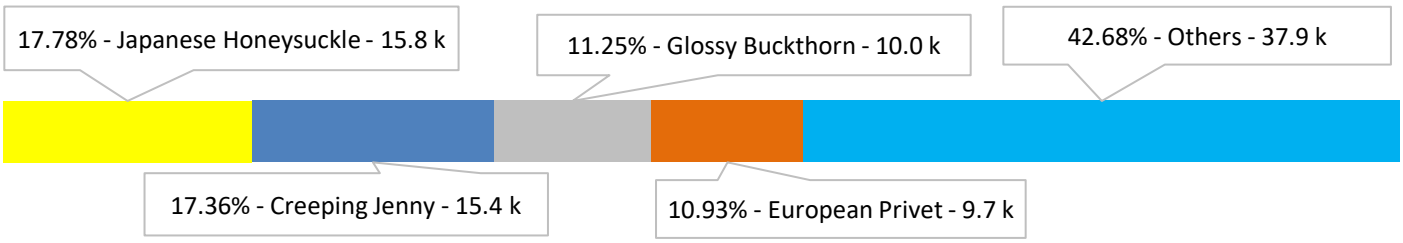



## ANCILLARY DATA ITEMS

### Invasive Species

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 783,843 forested acres to estimate a total area that each invasive species occupies. Some plots may have multiple species present, while most plots are free from invasive species. There were an estimated 88,711 cumulative acres with invasive species present and their distribution is illustrated below (Figure G) (Table 11).

Figure G: Invasive Species distribution (acres)



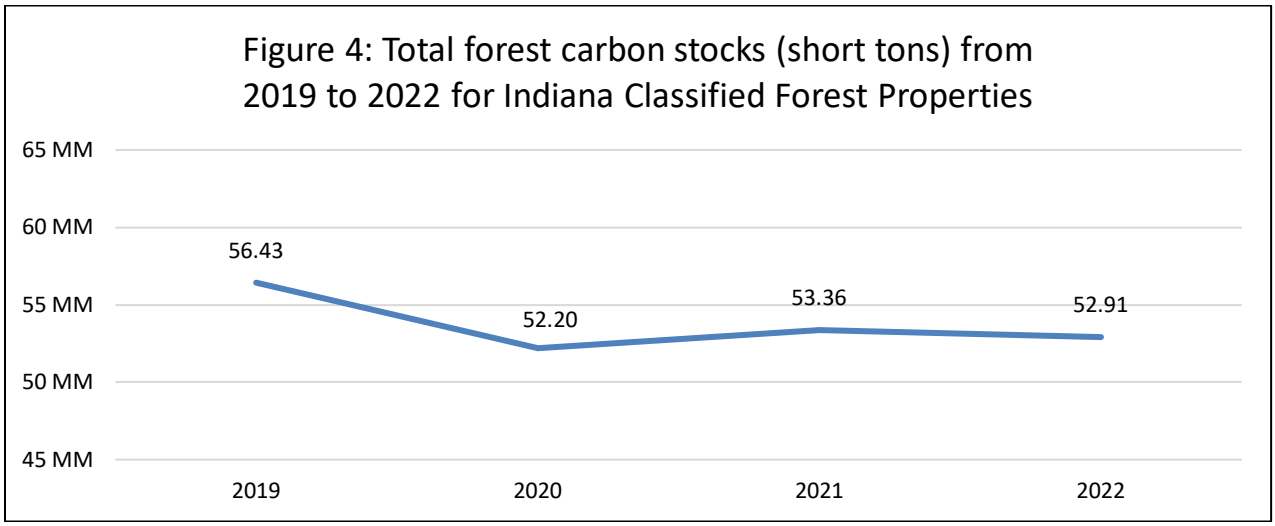
## Carbon

Carbon uptake and storage are a few of the many ecosystem services provided by forests. Carbon cycles through living organisms. Carbon dioxide ($CO_2$) is a gaseous component of the earth's atmosphere that plays several vital roles in the environment. Being a carbon source for plants is one of those roles. Through a process called photosynthesis, plants and photosynthetic algae and bacteria use energy from sunlight to combine $CO_2$ from the atmosphere with water to form carbohydrates. These carbohydrates are carbon-based sugars necessary for tree functioning and to make wood for growth. Every part of a tree stores carbon, including the trunks, branches, leaves, and roots. While the chemical composition of trees varies from species to species, by weight, trees are about 50% carbon.

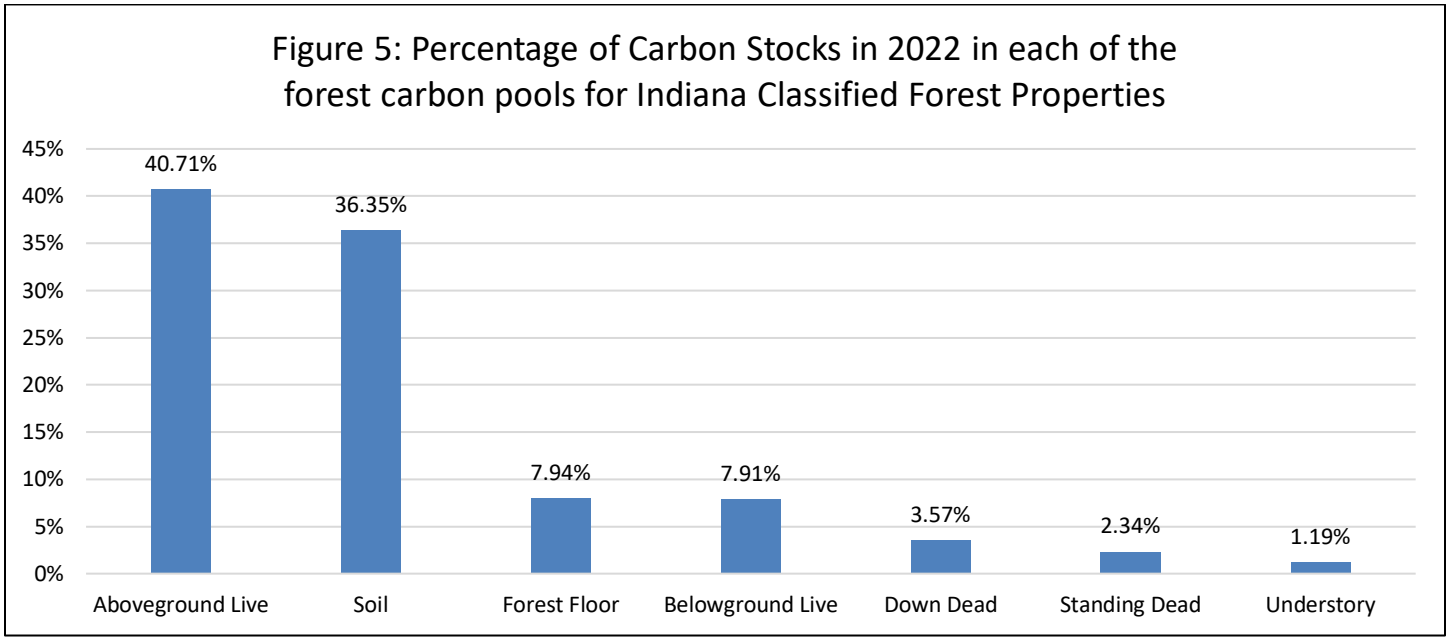
Carbon is also found in soils. Carbon in soils come from the organic matter from trees and other vegetation in varying degrees of decomposition. In fact, soil carbon represents about 50% of the total carbon stored in forest systems in the United States. Soils release carbon dioxide when soil microbes break down organic matter. Some soil carbon can decompose in hours or days, but most resides in soils for decades or centuries. In some conditions, carbon resides in soils for thousands of years before fully decomposing. Soil carbon is generally considered very stable, meaning it does not change much or quickly in response to vegetation dynamics.

Because forests are naturally dynamic systems, the carbon contained within forests is always changing. On the scale of minutes, forests can simultaneously take up and store carbon through photosynthesis and release carbon as cells in trees respire, and soils release carbon through decomposition by soil microbes. Over months and years, the balance uptake and loss of carbon in a forest determines whether the forest is gaining or losing carbon stocks. The amount of carbon uptake and storage depends on the growing conditions and species of the trees in the given system. For example, in some temperate forests, a warm and wet climate can support forests that grow quickly and store a great deal of carbon. The opposite might be true of forests with a cold and dry climate. Younger forests generally take up and store carbon at greater rates than older forests.

CFI data has begun to provide carbon estimates for the Indiana Classified Forest system lands. We will be able to use this as baseline data and monitor carbon estimate trends over time. The data initially shows a dip from 2019 to 2022 in the annual carbon stock estimates but is consistent over the years ending at just over 52.9 million short tons in 2022. (Figure 4).



In 2022 about 40.71% of the forest carbon stocks on the Indiana State Forests are stored in the aboveground portion of live trees, which includes all live woody vegetation at least 1 inch in diameter (Figure 5). The soil carbon pool, which consists of organic material in the mineral soil to a depth of 1 meter (excluding roots), is the second largest carbon pool, storing another 36.35% of the forest carbon stocks. The remaining forest carbon stocks can be found in the forest floor (litter), belowground portion of live trees, down dead material, standing dead trees, and the understory.




For further discussion of carbon stocks on Indiana State Forests, explore the report titled Forest Carbon Assessment for Indiana State Forest Properties at https://www.in.gov/dnr/forestry/files/fw-carbon_assessment.pdf

## 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 to prior estimates available from the FIA program and previous inventories conducted on state forest properties. As estimates of state forest land resource attributes were either sampled at a lower plot intensity (FIA) or using inconsistent methodologies (stand-exams), estimates from Indiana's classified forest land CFI program may be considered as a superior baseline. Change estimates (growth, mortality, and removals) have become statistically stronger as all plots have now been remeasured to provide reliable estimates.

# 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% of the initial 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 percentage 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 ($1/24^{th}$ acre) circular subplot with the offset 6.8-foot-radius ($1/300^{th}$ 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 9.1) will suffice and is readily available online at https://www.fia.fs.usda.gov/library/field-guides-methods-proc/docs/2022/core_ver9-2_9_2022_SW_HW%20table_rev_12_13_2022.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 3,243 plots located randomly across those lands enrolled in the Classified Forest Program, a sampling rate of approximately one plot for every 200 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% 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



**Disclaimer:**

All the above tables have estimates which are rounded to the nearest value due to which the values may not add up to the total value as shown in the tables.

## Table 1 - Area of forest land (acres) by forest type group and stand size class, IN Classified Forests, 2018-2022

| Forest type | Stand-size | Large diameter | Medium diameter | Small diameter | Nonstocked |
|---|---|---|---|---|---|
| **All** | 783,843 | 580,819 | 112,044 | 60,483 | 30,498 |
| **Other miscellaneous hardwood forest types** | 271,028 | 165,873 | 47,375 | 27,281 | 30,498 |
| **White oak / red oak / hickory** | 166,366 | 139,758 | 20,098 | 6,511 | - |
| **Hard maple / basswood** | 72,036 | 59,757 | 9,113 | 3,166 | - |
| **Yellow-poplar** | 52,586 | 40,210 | 7,386 | 4,990 | - |
| **White oak** | 47,925 | 46,263 | 1,115 | 547 | - |
| **Sugar maple / beech / yellow birch** | 47,131 | 40,759 | 4,005 | 2,368 | - |
| **Mixed upland hardwoods** | 38,672 | 30,754 | 5,387 | 2,530 | - |
| **Cherry / white ash / yellow-poplar** | 38,189 | 14,741 | 11,240 | 12,208 | - |
| **Northern red oak** | 25,311 | 23,826 | 1,183 | 302 | - |
| **Miscellaneous softwood forest types** | 14,335 | 13,151 | 1,185 | - | - |
| **Pine/Hardwood** | 10,266 | 5,731 | 3,955 | 580 | - |

# Table 2 - Number of all live trees (trees) by species and diameter class, IN Classified Forests, 2018-2022

| 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** | 310,453,346 | 162,282,829 | 55,688,753 | 26,004,151 | 18,168,852 | 12,489,284 | 9,774,199 | 7,869,946 | 5,513,764 | 4,304,085 | 3,393,484 | 1,897,752 | 3,066,248 |
| **sugar maple** | 63,320,264 | 33,212,787 | 11,841,210 | 6,189,432 | 3,989,506 | 2,615,205 | 1,908,134 | 1,312,851 | 871,843 | 707,270 | 328,902 | 158,023 | 185,100 |
| **other hardwood species** | 52,476,009 | 29,259,593 | 8,611,825 | 4,591,377 | 2,845,024 | 2,066,872 | 1,543,770 | 1,209,397 | 810,410 | 531,822 | 448,348 | 238,123 | 319,446 |
| **American beech** | 25,268,905 | 16,810,328 | 4,798,311 | 1,236,437 | 700,036 | 364,956 | 318,269 | 274,000 | 239,565 | 148,623 | 140,316 | 76,490 | 161,574 |
| **oaks** | 20,863,266 | 5,545,088 | 3,342,076 | 1,792,758 | 1,621,808 | 1,210,785 | 1,087,173 | 1,218,336 | 1,074,455 | 1,069,340 | 1,110,552 | 654,608 | 1,136,290 |
| **yellow-poplar** | 18,570,512 | 7,853,966 | 3,245,859 | 1,554,396 | 1,041,467 | 832,194 | 880,979 | 728,770 | 605,379 | 482,097 | 454,097 | 305,907 | 585,400 |
| **hickories** | 15,516,515 | 4,568,434 | 3,038,238 | 1,161,959 | 1,430,365 | 1,077,607 | 1,061,407 | 1,025,172 | 759,019 | 623,300 | 450,687 | 141,659 | 178,661 |
| **red maple** | 15,175,559 | 6,642,097 | 3,257,966 | 1,602,264 | 1,141,214 | 830,650 | 524,456 | 384,974 | 204,205 | 186,526 | 196,613 | 99,540 | 105,054 |
| **sassafras** | 15,095,732 | 9,179,471 | 2,806,089 | 1,102,851 | 727,093 | 540,732 | 340,131 | 214,867 | 96,942 | 19,604 | 39,684 | 7,276 | 20,993 |
| **American elm** | 13,017,830 | 6,516,338 | 3,335,598 | 1,421,859 | 896,526 | 460,448 | 212,594 | 62,018 | 56,689 | 27,586 | 7,228 | 7,228 | 13,718 |
| **pawpaw** | 11,151,954 | 10,977,621 | 174,334 | - | - | - | - | - | - | - | - | - | - |
| **white ash** | 9,819,114 | 7,400,588 | 923,545 | 461,749 | 298,390 | 178,319 | 156,738 | 135,777 | 104,452 | 49,074 | 28,499 | 33,599 | 48,382 |
| **flowering dogwood** | 9,151,960 | 6,470,315 | 2,384,723 | 257,259 | 39,664 | - | - | - | - | - | - | - | - |
| **hackberry** | 8,390,172 | 3,934,609 | 1,798,397 | 895,022 | 717,657 | 311,190 | 255,056 | 202,596 | 92,911 | 50,279 | 34,630 | 34,154 | 63,671 |
| **black cherry** | 7,776,842 | 2,698,478 | 1,295,156 | 1,094,396 | 736,904 | 660,882 | 493,298 | 320,689 | 203,744 | 151,422 | 57,616 | 35,201 | 29,055 |
| **American hornbeam** | 6,283,184 | 4,632,269 | 1,461,150 | 156,213 | 27,110 | 6,442 | - | - | - | - | - | - | - |
| **eastern redcedar** | 5,250,321 | 1,229,496 | 1,481,581 | 978,185 | 727,576 | 466,794 | 187,398 | 132,040 | 40,530 | 6,719 | - | - | - |
| **other maples** | 5,277,072 | 2,416,049 | 608,863 | 621,323 | 433,286 | 319,137 | 264,703 | 185,972 | 91,027 | 112,943 | 36,237 | 57,922 | 129,610 |
| **other elms** | 4,865,730 | 2,338,093 | 1,203,635 | 593,807 | 416,013 | 118,089 | 69,294 | 76,504 | 21,238 | 14,551 | - | 7,276 | 7,228 |
| **other softwood species** | 3,182,406 | 597,212 | 80,196 | 292,859 | 379,211 | 428,982 | 470,798 | 385,982 | 241,357 | 122,924 | 60,074 | 40,747 | 82,064 |

# Table 3 - Net volume of all live trees (cuft) by species and diameter class, IN Classified Forests, 2018-2022

| 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** | 1,676,830,632 | 59,745,333 | 91,143,063 | 116,527,886 | 151,130,988 | 184,126,354 | 184,470,873 | 195,671,977 | 200,267,868 | 140,844,914 | 352,901,378 |
| **yellow-poplar** | 250,615,717 | 4,177,294 | 6,082,441 | 9,126,795 | 15,974,105 | 20,130,008 | 24,379,904 | 25,932,041 | 32,539,960 | 27,323,526 | 84,949,642 |
| **sugar maple** | 247,642,174 | 16,041,855 | 22,006,288 | 26,907,139 | 32,230,227 | 32,939,486 | 31,084,389 | 33,428,892 | 20,060,524 | 11,760,213 | 21,183,161 |
| **other hardwood species** | 173,430,926 | 11,783,977 | 15,616,956 | 16,849,783 | 19,976,929 | 21,983,622 | 19,822,494 | 14,862,098 | 19,100,672 | 10,586,429 | 22,847,979 |
| **white oak** | 129,119,137 | 913,593 | 2,210,276 | 3,142,472 | 4,475,676 | 8,853,224 | 12,659,769 | 16,863,225 | 22,552,170 | 15,106,943 | 42,341,790 |
| **other oaks** | 87,410,947 | 1,805,479 | 3,693,566 | 3,877,989 | 5,503,238 | 7,144,751 | 7,802,166 | 12,628,237 | 13,719,293 | 8,409,179 | 22,827,049 |
| **northern red oak** | 80,131,335 | 861,876 | 1,118,750 | 2,038,626 | 2,675,110 | 4,533,250 | 5,994,195 | 8,099,014 | 14,880,453 | 10,849,536 | 29,080,527 |
| **red maple** | 79,738,031 | 3,901,452 | 6,012,882 | 7,783,326 | 8,040,436 | 8,989,589 | 6,645,780 | 8,467,128 | 11,084,196 | 7,281,002 | 11,532,239 |
| **black oak** | 72,898,055 | 730,791 | 1,304,870 | 2,089,074 | 3,389,665 | 6,068,401 | 6,940,790 | 7,439,193 | 9,461,458 | 10,516,246 | 24,957,567 |
| **redcedar and pine species** | 66,966,749 | 2,595,184 | 5,205,405 | 7,650,075 | 9,392,806 | 11,793,622 | 8,528,118 | 5,994,181 | 3,410,077 | 3,171,869 | 9,225,408 |
| **American beech** | 66,883,293 | 2,839,156 | 3,607,580 | 3,414,857 | 5,066,661 | 6,459,878 | 7,740,341 | 6,347,181 | 7,958,677 | 5,761,296 | 17,687,667 |
| **pignut hickory** | 66,863,163 | 865,826 | 2,228,504 | 2,964,322 | 6,029,509 | 8,358,294 | 7,604,783 | 10,094,729 | 9,865,410 | 7,148,272 | 11,703,513 |
| **shagbark hickory** | 63,962,856 | 1,204,373 | 2,955,336 | 4,250,218 | 7,124,585 | 10,554,747 | 12,212,861 | 11,077,365 | 8,726,788 | 2,561,925 | 3,294,659 |
| **black walnut** | 51,680,721 | 1,102,880 | 2,689,086 | 5,130,183 | 7,017,939 | 8,425,817 | 7,415,937 | 5,616,139 | 6,431,205 | 2,981,432 | 4,870,102 |
| **other hickories** | 47,493,223 | 740,521 | 2,262,228 | 3,602,651 | 4,272,280 | 6,260,872 | 6,679,158 | 8,144,775 | 9,145,175 | 1,147,622 | 5,237,941 |
| **black cherry** | 45,626,189 | 2,207,605 | 3,342,974 | 5,472,062 | 6,851,291 | 6,852,982 | 6,337,970 | 6,502,529 | 3,207,783 | 2,533,027 | 2,317,966 |
| **other maples** | 43,506,483 | 1,358,241 | 1,931,765 | 2,797,620 | 3,523,513 | 4,221,017 | 2,790,208 | 5,006,574 | 2,159,213 | 4,120,833 | 15,597,501 |
| **American sycamore** | 38,746,215 | 830,392 | 879,253 | 1,903,531 | 1,805,596 | 3,310,057 | 2,511,475 | 5,017,171 | 2,729,528 | 5,122,363 | 14,636,849 |
| **elms** | 27,918,902 | 4,052,907 | 5,581,455 | 4,664,509 | 3,746,771 | 2,684,133 | 2,352,452 | 1,790,718 | 389,714 | 1,002,373 | 1,653,871 |
| **white ash** | 24,462,196 | 1,034,655 | 1,530,904 | 1,723,697 | 2,293,763 | 3,210,673 | 3,372,424 | 2,025,837 | 1,671,736 | 2,440,468 | 5,158,040 |
| **other ashes** | 11,734,319 | 697,282 | 882,545 | 1,138,956 | 1,740,887 | 1,351,930 | 1,595,661 | 334,951 | 1,173,836 | 1,020,361 | 1,797,907 |

## Table 4 - Sawtimber volume (bdft – FIA Doyle) of all live trees by species and diameter class, IN Classified Forests, 2018-2022

| 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 | 4,368,879,050 | 8,269,972 | 275,122,652 | 420,852,801 | 501,284,193 | 596,587,697 | 672,156,774 | 502,577,903 | 1,392,027,059 |
| yellow-poplar | 877,402,339 | - | 31,563,347 | 50,707,758 | 73,564,587 | 86,595,042 | 122,037,990 | 107,727,736 | 405,205,878 |
| sugar maple | 491,826,515 | - | 60,471,078 | 75,626,698 | 82,455,971 | 99,788,096 | 63,540,683 | 36,911,560 | 73,032,430 |
| white oak | 402,212,219 | - | 8,873,545 | 21,360,364 | 33,690,216 | 51,321,551 | 73,739,213 | 52,682,427 | 160,544,902 |
| other hardwood species | 369,686,317 | - | 37,657,155 | 47,849,148 | 55,876,518 | 46,339,804 | 61,547,884 | 38,471,978 | 81,943,830 |
| northern red oak | 273,164,544 | - | 5,131,899 | 11,469,995 | 17,495,666 | 26,382,220 | 52,606,464 | 40,176,559 | 119,901,741 |
| other oaks | 243,693,199 | - | 10,925,696 | 16,857,553 | 21,575,257 | 39,991,407 | 47,047,991 | 28,935,694 | 78,359,601 |
| black oak | 239,268,296 | - | 6,705,168 | 14,987,316 | 19,603,770 | 23,867,283 | 32,868,542 | 39,183,549 | 102,052,668 |
| pignut hickory | 198,916,405 | - | 12,057,658 | 21,134,403 | 22,133,072 | 32,906,983 | 34,071,528 | 25,854,398 | 50,758,362 |
| other softwoods and redcedar | 181,022,202 | 8,269,972 | 19,414,496 | 31,103,346 | 27,292,706 | 22,938,371 | 13,943,068 | 13,998,367 | 44,061,877 |
| red maple | 164,777,511 | - | 12,669,724 | 15,436,841 | 15,469,677 | 22,129,012 | 32,029,385 | 24,697,505 | 42,345,367 |
| shagbark hickory | 160,633,851 | - | 13,867,558 | 25,944,657 | 34,639,389 | 35,138,393 | 28,009,505 | 9,728,697 | 13,305,652 |
| American beech | 159,914,226 | - | 10,054,629 | 16,201,900 | 20,368,640 | 19,233,374 | 25,063,239 | 20,063,380 | 48,929,066 |
| black walnut | 112,589,719 | - | 13,404,013 | 19,334,948 | 18,828,434 | 16,094,847 | 20,568,377 | 9,282,285 | 15,076,816 |
| bitternut hickory | 111,922,709 | - | 7,658,825 | 13,241,272 | 17,382,974 | 18,919,100 | 27,978,621 | 4,474,371 | 22,267,546 |
| American sycamore | 111,815,851 | - | 3,391,527 | 7,874,341 | 6,364,330 | 14,006,422 | 9,174,144 | 17,833,157 | 53,171,930 |
| other maples | 83,476,579 | - | 2,461,267 | 5,951,080 | 5,622,871 | 11,576,884 | 5,503,454 | 10,968,725 | 41,392,298 |
| black cherry | 81,581,230 | - | 11,116,521 | 13,336,080 | 13,579,541 | 18,551,742 | 9,379,902 | 8,712,862 | 6,904,582 |
| white ash | 60,079,582 | - | 3,596,318 | 7,279,573 | 8,880,035 | 3,813,252 | 5,709,490 | 9,067,301 | 21,733,613 |
| other ashes | 27,488,196 | - | 3,227,094 | 2,877,473 | 4,380,861 | 1,040,901 | 4,007,004 | 3,807,355 | 8,147,508 |
| other hickories | 17,407,562 | - | 875,130 | 2,278,057 | 2,079,679 | 5,953,013 | 3,330,291 | - | 2,891,392 |

# Table 5 - Net growth of all live trees (cuft) by species and diameter class, IN Classified Forests, 2018-2022

| 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** | 35,971,260 | 3,573,725 | 2,793,148 | 2,735,918 | 3,589,086 | 4,378,694 | 3,458,968 | 3,507,173 | 3,756,360 | 3,412,141 | 5,488,959 |
| **yellow-poplar** | 9,633,408 | 450,284 | 360,041 | 450,661 | 937,484 | 781,321 | 1,510,753 | 916,541 | 1,159,049 | 1,189,546 | 1,864,525 |
| **sugar maple** | 6,408,283 | 1,252,184 | 924,369 | 973,776 | 980,442 | 656,448 | 607,233 | 591,082 | 425,711 | 428,265 | -291,637 |
| **other hardwood species** | 3,247,164 | 426,624 | 260,001 | 443,711 | 445,503 | 400,578 | 290,352 | 139,239 | 191,410 | 246,091 | 452,497 |
| **white oak** | 3,110,666 | 26,546 | 1,526 | 83,093 | 152,971 | 259,959 | 261,726 | 725,199 | 423,470 | 279,581 | 883,506 |
| **northern red oak** | 2,928,634 | 43,174 | 50,523 | 92,189 | 158,247 | 158,358 | 206,194 | 163,712 | 498,379 | 324,706 | 1,220,636 |
| **red maple** | 2,527,426 | 258,447 | 224,394 | 339,997 | 137,242 | 413,194 | 210,019 | 304,271 | 360,889 | 181,998 | 310,881 |
| **other oaks** | 2,398,805 | 101,143 | 152,991 | 187,890 | 130,596 | 208,088 | 111,486 | 146,153 | 547,551 | 313,986 | 565,058 |
| **black oak** | 1,825,503 | 14,554 | 71,020 | 94,084 | 88,094 | 288,112 | 220,697 | 193,348 | 212,702 | 142,591 | 500,301 |
| **pignut hickory** | 1,780,627 | 11,418 | 60,037 | 88,512 | 200,466 | 352,856 | 220,354 | 275,182 | 179,269 | 141,581 | 247,053 |
| **American beech** | 1,500,922 | 295,281 | 205,225 | 135,425 | 286,671 | 218,825 | 205,600 | 133,312 | 160,778 | 106,177 | -246,374 |
| **shagbark hickory** | 1,478,398 | 30,163 | 76,453 | 52,946 | 262,618 | 298,434 | 297,154 | 288,185 | 113,667 | 54,314 | 84,348 |
| **black walnut** | 1,452,245 | 45,477 | 143,334 | 178,403 | 251,796 | 232,292 | 25,293 | 220,473 | 173,082 | 32,780 | 155,203 |
| **black cherry** | 1,046,238 | 98,392 | 22,565 | 295,218 | 153,420 | 199,293 | -30,456 | 217,254 | 26,827 | 135,129 | - |
| **bitternut hickory** | 1,002,113 | 51,224 | 71,060 | 172,933 | 70,318 | 99,099 | 194,403 | 56,563 | 181,507 | 17,881 | 87,123 |
| **other maples** | 135,672 | 102,279 | -7,145 | -50,598 | 112,690 | 220,233 | -16,318 | 204,939 | -49,022 | 102,013 | -482,374 |
| **eastern white pine** | 947,895 | 4,609 | -4,057 | 27,397 | 146,904 | 80,151 | 193,328 | 84,599 | 62,617 | 154,818 | 192,849 |
| **American sycamore** | 938,293 | 80,146 | 48,036 | 45,879 | 113,636 | 140,881 | 95,671 | 136,306 | 33,650 | 124,129 | 169,881 |
| **hackberry** | 738,337 | 192,658 | 186,373 | 85,809 | -1,228 | 140,145 | 95,130 | -47,066 | 93,781 | 41,068 | -43,062 |
| **elms** | 480,089 | 196,407 | 122,257 | -85,251 | -52,897 | 144,118 | 21,852 | 64,390 | 18,600 | 0 | 65,340 |
| **other hickories** | 272,838 | 12,614 | 11,190 | 5,662 | 23,337 | 62,349 | 11,892 | 81,457 | 28,060 | 0 | 36,278 |
| **redcedar and pine species** | 246,464 | -3,167 | -39,062 | -46,168 | 48,832 | 31,446 | -54,172 | 94,903 | 120,232 | 72,785 | 59,667 |
| **ash species** | -8,128,761 | -116,736 | -147,985 | -835,648 | -1,058,059 | -1,007,488 | -1,219,222 | -1,482,868 | -1,205,852 | -677,298 | -342,741 |

## Table 6 - Total growth of sawtimber (bdft – Doyle) by species and diameter class, IN Classified Forests, 2018-2022

| 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** | 150,435,035 | 599,783 | 29,558,740 | 15,700,270 | 18,114,882 | 18,541,658 | 20,630,528 | 15,948,078 | 31,341,096 |
| **yellow-poplar** | 34,182,107 | - | 5,126,572 | 2,602,526 | 4,668,438 | 3,674,094 | 5,105,187 | 4,603,694 | 8,401,596 |
| **sugar maple** | 16,253,411 | - | 6,098,161 | 1,893,397 | 2,026,711 | 1,962,970 | 1,960,153 | 1,239,833 | 1,072,186 |
| **other hardwood species** | 13,882,928 | - | 3,327,183 | 1,776,970 | 1,645,774 | 1,231,966 | 1,765,078 | 945,440 | 3,190,515 |
| **white oak** | 10,044,835 | - | 588,977 | 613,163 | 881,722 | 2,163,606 | 1,570,176 | 1,496,764 | 2,730,427 |
| **northern red oak** | 9,646,567 | - | 808,718 | 493,086 | 597,822 | 518,841 | 1,683,636 | 1,155,944 | 4,388,520 |
| **other oaks** | 8,183,413 | - | 937,976 | 554,683 | 555,673 | 1,131,378 | 1,735,164 | 997,038 | 2,271,506 |
| **black oak** | 7,749,517 | - | 667,558 | 718,017 | 813,750 | 858,370 | 1,085,108 | 1,082,347 | 2,524,366 |
| **red maple** | 6,467,295 | - | 1,245,415 | 851,831 | 637,947 | 804,407 | 1,057,021 | 570,266 | 1,300,408 |
| **pignut hickory** | 5,658,940 | - | 750,384 | 890,188 | 635,371 | 884,376 | 972,799 | 499,694 | 1,026,127 |
| **shagbark hickory** | 5,102,295 | - | 1,714,303 | 730,671 | 833,715 | 901,093 | 388,001 | 202,150 | 332,361 |
| **black walnut** | 4,760,207 | - | 1,725,475 | 633,291 | 744,077 | 589,419 | 501,777 | 117,766 | 448,402 |
| **American beech** | 4,514,605 | - | 1,202,699 | 670,661 | 729,983 | 377,250 | 596,876 | 365,421 | 571,715 |
| **other hickories** | 4,342,240 | - | 745,624 | 712,586 | 597,043 | 954,297 | 724,275 | 67,960 | 540,455 |
| **eastern white pine** | 3,875,914 | 143,103 | 341,183 | 559,441 | 682,385 | 322,928 | 256,230 | 651,438 | 919,207 |
| **ash species** | 3,303,906 | - | 1,174,662 | 335,185 | 486,484 | 148,756 | 178,941 | 513,163 | 466,716 |
| **American sycamore** | 3,088,535 | - | 702,172 | 350,060 | 241,155 | 586,702 | 111,234 | 440,192 | 657,019 |
| **other pines and redcedar** | 2,984,412 | 456,681 | 195,299 | 390,290 | 356,473 | 370,824 | 549,428 | 332,603 | 332,816 |
| **black cherry** | 2,974,632 | - | 1,235,296 | 429,145 | 255,239 | 551,442 | 78,467 | 425,043 | - |
| **sweetgum** | 2,075,202 | - | 368,910 | 169,562 | 581,159 | 332,998 | 254,466 | 241,323 | 126,783 |
| **elm species** | 1,344,073 | - | 602,170 | 325,518 | 143,961 | 175,941 | 56,511 | - | 39,971 |

# Table 7 - Mortality of all live trees (cuft) by species and diameter class, IN Classified Forests, 2018-2022

| 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** | 23,406,804 | 1,470,247 | 1,684,720 | 2,346,057 | 3,056,883 | 2,272,195 | 3,227,636 | 2,731,161 | 2,529,955 | 1,256,124 | 1,885,407 |
| **white ash** | 9,167,472 | 306,281 | 284,164 | 986,978 | 1,074,011 | 1,080,405 | 1,395,755 | 1,503,326 | 1,334,620 | 866,823 | 274,706 |
| **other hardwood species** | 2,048,375 | 220,625 | 117,067 | 187,235 | 275,386 | 129,443 | 298,956 | 284,542 | 363,207 | 0 | 0 |
| **sugar maple** | 1,808,485 | 72,622 | 166,359 | 59,218 | 235,092 | 132,984 | 65,200 | 90,679 | 143,971 | - | 686,042 |
| **other oaks** | 1,212,354 | 26,476 | 88,230 | 20,562 | 76,695 | 0 | 174,395 | 257,284 | 109,787 | 204,733 | 179,613 |
| **elms** | 1,098,707 | 163,486 | 201,499 | 280,009 | 347,600 | 0 | 87,801 | 0 | 0 | 0 | 0 |
| **redcedar and pine species** | 945,562 | 114,464 | 163,299 | 166,600 | 39,673 | 247,513 | 170,084 | 0 | 0 | 0 | 0 |
| **yellow-poplar** | 913,866 | 67,809 | 86,726 | 136,882 | 135,562 | 150,245 | - | 147,870 | 188,773 | - | - |
| **other maples** | 903,348 | 104,401 | 157,123 | 184,613 | 82,812 | 87,070 | 126,553 | 0 | 148,200 | 0 | 0 |
| **other ashes** | 893,241 | 18,065 | 30,292 | 61,366 | 226,866 | 117,784 | 98,312 | 127,975 | 0 | 0 | 212,581 |
| **black cherry** | 783,500 | 109,147 | 140,794 | 79,642 | 170,133 | - | 204,052 | - | - | - | - |
| **black oak** | 759,486 | 24,602 | - | - | 39,281 | - | 82,373 | 91,861 | 127,384 | 184,568 | 209,416 |
| **sassafras** | 741,388 | 74,338 | 112,204 | 77,439 | 83,534 | 111,910 | 160,336 | 107,132 | - | - | - |
| **red maple** | 680,662 | 87,322 | 55,006 | 48,119 | 204,567 | - | 60,402 | - | - | - | - |
| **hickories** | 622,651 | 37,598 | 67,961 | 57,396 | 34,885 | 107,734 | 0 | 120,493 | 114,015 | 0 | 0 |
| **American beech** | 459,429 | 7,111 | - | - | - | 56,862 | 72,407 | - | - | - | 323,049 |
| **black walnut** | 349,348 | 30,963 | - | - | 30,787 | 50,244 | 231,010 | - | - | - | - |
| **northern red oak** | 18,930 | 4,937 | 13,993 | - | - | - | - | - | - | - | - |

## Table 8 - Mortality of sawtimber (bdft – Doyle) by species and diameter class, IN Classified Forests, 2018-2022

| 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** | 44,529,868 | 237,100 | 4,781,093 | 4,785,290 | 7,485,434 | 8,135,792 | 7,260,789 | 4,532,958 | 7,311,413 |
| **white ash** | 20,893,294 | - | 1,775,720 | 2,429,357 | 3,817,141 | 4,631,077 | 3,995,924 | 3,180,929 | 1,063,147 |
| **other hardwoods** | 4,405,643 | - | 1,012,573 | 247,266 | 1,112,889 | 1,120,141 | 912,775 | - | - |
| **sugar maple** | 3,747,726 | - | 388,899 | 320,849 | - | - | 477,109 | - | 2,560,868 |
| **black oak** | 2,521,433 | - | 79,895 | - | 234,408 | 292,711 | 436,779 | 679,899 | 797,740 |
| **other ashes** | 2,185,512 | - | 421,548 | 274,865 | 268,094 | 394,640 | - | - | 826,366 |
| **yellow-poplar** | 1,785,133 | - | 226,185 | 382,371 | - | 499,302 | 677,276 | - | - |
| **pines** | 1,690,001 | 237,100 | 84,760 | 738,764 | 629,377 | - | - | - | - |
| **American beech** | 1,578,523 | - | - | - | 207,496 | - | - | - | 1,371,027 |
| **other oaks** | 1,240,371 | - | 156,737 | - | 275,715 | 807,919 | - | - | - |
| **white oak** | 1,231,027 | - | - | - | 200,878 | - | 358,019 | 672,130 | - |
| **hickories** | 1,135,721 | - | 71,340 | 271,471 | - | 390,003 | 402,907 | - | - |
| **elms** | 791,931 | - | 563,435 | - | 228,496 | - | - | - | - |
| **pin oak** | 692,265 | - | - | - | - | - | - | - | 692,265 |
| **black walnut** | 631,288 | - | - | 120,348 | 510,940 | - | - | - | - |

## Table 9 - Removals of all live trees (cuft) by species and diameter class, IN Classified Forests, 2018-2022

| 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** | 21,369,345 | 321,241 | 441,836 | 537,603 | 493,580 | 467,920 | 1,650,558 | 2,165,547 | 3,246,215 | 3,588,834 | 7,069,704 |
| **yellow-poplar** | 5,873,181 | 4,937 | 43,110 | 41,842 | 98,189 | - | 89,945 | 589,477 | 1,134,918 | 674,446 | 3,102,694 |
| **ashes** | 3,209,608 | 3,815 | 84,044 | 81,825 | - | 62,786 | 423,817 | 110,413 | 636,113 | 1,091,259 | 385,259 |
| **white oak** | 2,357,428 | - | - | - | - | 50,907 | - | 429,956 | 304,098 | 374,511 | 954,932 |
| **sugar maple** | 1,980,962 | 58,725 | 68,491 | 54,292 | - | 122,645 | 274,260 | 125,280 | 128,284 | 315,950 | 768,710 |
| **other hardwood species** | 1,698,406 | 134,532 | 140,767 | 165,784 | 211,886 | - | - | 297,665 | - | 151,884 | 298,656 |
| **American beech** | 1,306,568 | 19,420 | 23,651 | 45,167 | 31,430 | 51,854 | 103,911 | - | 486,465 | - | 544,668 |
| **black walnut** | 928,758 | 15,280 | - | - | - | - | 299,799 | 106,112 | - | - | 507,567 |
| **black oak** | 874,036 | 8,750 | - | - | - | - | 189,589 | 111,992 | 115,316 | 161,068 | 287,322 |
| **other oaks** | 867,691 | 9,848 | 25,426 | 50,741 | - | 61,700 | - | - | 124,096 | 191,420 | 219,897 |
| **shagbark hickory** | 740,761 | - | - | 51,013 | - | - | 76,796 | 211,437 | 207,114 | 194,402 | - |
| **pignut hickory** | 601,695 | 6,717 | 41,676 | - | 35,392 | - | - | - | - | 433,894 | - |
| **sassafras** | 448,273 | 59,214 | 14,671 | 25,625 | 92,480 | 49,257 | 192,441 | - | - | - | - |
| **chestnut oak** | 293,025 | - | - | - | - | - | - | 183,213 | 109,812 | - | - |
| **redcedar and pine species** | 188,950 | - | - | 21,314 | 24,202 | 68,772 | - | - | - | - | - |

## Table 10 - Removals of sawtimber (bdft – Doyle) by species and diameter class, IN Classified Forests, 2018-2022

| 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 | 66,604,075 | 33,578 | 987,418 | 1,052,967 | 3,993,297 | 6,781,202 | 10,802,730 | 13,452,661 | 29,500,222 |
| yellow-poplar | 23,740,897 | - | 205,808 | - | 270,981 | 1,988,460 | 3,708,698 | 2,810,124 | 14,756,825 |
| ashes | 9,435,806 | - | - | 147,185 | 1,157,119 | 339,840 | 2,146,322 | 4,004,869 | 1,640,470 |
| white oak | 7,777,038 | - | - | 125,309 | - | 1,294,951 | 988,955 | 1,310,503 | 4,057,321 |
| sugar maple | 5,840,760 | - | - | 294,289 | 760,851 | 374,159 | 418,453 | 1,135,007 | 2,858,001 |
| American beech | 3,452,596 | - | 65,147 | 131,269 | 297,162 | - | 1,659,081 | - | 1,299,937 |
| black walnut | 2,979,729 | - | - | - | 829,521 | 322,991 | - | - | 1,827,218 |
| other hardwood species | 2,973,135 | - | 411,027 | - | - | 861,560 | - | 517,741 | 1,182,807 |
| black oak | 2,646,445 | - | - | - | 216,774 | 352,172 | 399,201 | 584,819 | 1,093,480 |
| shagbark hickory | 2,315,347 | - | - | - | 216,482 | 665,191 | 707,192 | 726,483 | - |
| other oaks | 2,032,326 | - | - | 156,025 | - | - | 396,886 | 695,253 | 784,162 |
| pignut hickory | 1,740,199 | - | 72,336 | - | - | - | - | 1,667,863 | - |
| chestnut oak | 959,822 | - | - | - | - | 581,880 | 377,942 | - | - |
| sassafras | 417,487 | - | 173,080 | - | 244,408 | - | - | - | - |
| redcedar and pine species | 292,489 | 33,578 | 60,021 | 198,890 | - | - | - | - | - |

## Table 11 - Number of standing dead trees (trees) 5 inches d.b.h. and greater by species and diameter class, IN Classified Forests, 2018-2022

| 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 | 9,576,149 | 3,253,246 | 2,043,405 | 1,434,736 | 927,158 | 589,179 | 551,710 | 330,282 | 214,273 | 91,215 | 140,944 |
| white ash | 2,491,216 | 577,990 | 337,465 | 425,097 | 318,821 | 257,999 | 232,772 | 144,563 | 111,459 | 49,817 | 35,233 |
| sassafras | 1,453,596 | 746,766 | 354,477 | 176,384 | 74,002 | 34,108 | 40,470 | 20,160 | - | - | 7,228 |
| other hardwoods | 906,546 | 318,998 | 222,874 | 138,667 | 83,091 | 27,713 | 36,236 | 36,237 | 35,450 | - | 7,276 |
| yellow-poplar | 283,436 | 81,359 | 47,237 | 68,720 | 32,488 | 20,899 | 13,162 | 6,442 | 13,129 | - | - |
| black locust | 323,428 | 96,402 | 82,487 | 54,545 | 20,437 | 34,663 | 20,437 | 14,457 | - | - | - |
| eastern redcedar | 396,957 | 227,064 | 98,541 | 38,653 | 26,013 | - | 6,687 | - | - | - | - |
| American elm | 535,831 | 197,033 | 175,848 | 84,387 | 35,498 | 29,103 | 13,963 | - | - | - | - |
| black cherry | 469,186 | 222,098 | 120,685 | 55,069 | 28,514 | 7,276 | 29,103 | 6,442 | - | - | - |
| sugar maple | 397,284 | 124,180 | 89,864 | 39,929 | 47,873 | 47,449 | 20,357 | 6,442 | 7,276 | - | 13,915 |
| slippery elm | 265,873 | 68,539 | 70,453 | 77,945 | 35,775 | 13,162 | - | - | - | - | - |
| eastern white pine | 443,463 | 176,187 | 147,721 | 41,643 | 28,467 | 14,504 | 21,271 | 13,671 | - | - | - |
| other oaks | 215,489 | 36,378 | 41,613 | 21,239 | 34,549 | 6,687 | 41,777 | 26,554 | - | - | 6,687 |
| white oak | 196,020 | 40,795 | 46,695 | 41,087 | 7,276 | 13,162 | 27,436 | - | 6,442 | 13,129 | - |
| Virginia pine | 102,819 | 34,570 | 13,374 | 21,144 | - | 13,915 | 6,442 | 13,374 | - | - | - |
| red maple | 179,500 | 53,170 | 35,681 | 19,816 | 27,863 | - | 6,687 | 7,276 | 7,228 | 7,276 | 14,504 |
| other softwoods | 151,187 | 54,282 | 48,330 | 13,374 | 20,650 | 7,276 | 7,276 | - | - | - | - |
| other ashes | 226,461 | 49,074 | 41,798 | 43,465 | 43,051 | 27,388 | 7,228 | 7,228 | - | - | 7,228 |
| hickories | 143,341 | 25,768 | 41,431 | 20,160 | 6,719 | 13,718 | 7,276 | 14,551 | 13,718 | - | - |
| American beech | 140,679 | 20,437 | 6,442 | 33,289 | 27,110 | 6,442 | - | 6,442 | 12,884 | - | 27,633 |
| black walnut | 107,173 | 60,168 | 13,162 | 13,439 | - | 13,718 | 6,687 | - | - | - | - |
| black oak | 146,666 | 41,987 | 7,228 | 6,687 | 28,961 | - | 6,442 | 6,442 | 6,687 | 20,993 | 21,238 |

## Table 12 - Invasive Cover (acres) by invasive species and site productivity, IN Classified Forests, 2018-2022

| | Site productivity | 225+ | 165-224 | 120-164 | 85-119 | 50-84 | 20-49 | 0-19 |
|---|---|---|---|---|---|---|---|---|
| **Invasive species** | 88,711 | 415 | 2,139 | 9,245 | 33,786 | 29,884 | 12,458 | 103 |
| **Japanese honeysuckle** | 15,773 | 16 | 217 | 1,292 | 4,725 | 6,798 | 2,639 | - |
| **creeping jenny** | 15,396 | 74 | 597 | 2,385 | 6,322 | 4,170 | 1,672 | 36 |
| **glossy buckthorn** | 9,979 | 6 | 254 | 1,055 | 3,160 | 3,904 | 1,469 | - |
| **European privet** | 9,698 | 21 | 386 | 526 | 4,524 | 2,697 | 1,410 | 48 |
| **multiflora rose** | 8,910 | 15 | 302 | 1,501 | 3,749 | 2,586 | 688 | - |
| **Nepalese browntop** | 7,364 | - | 13 | 494 | 2,801 | 2,438 | 1,597 | - |
| **honeysuckle** | 4,762 | 18 | 3 | 798 | 1,940 | 1,553 | 447 | - |
| **English ivy** | 3,065 | - | 3 | 299 | 1,379 | 537 | 847 | - |
| **bull thistle** | 2,365 | 54 | 54 | 96 | 1,383 | 558 | 193 | 6 |
| **autumn olive** | 2,055 | 39 | 57 | 184 | 1,116 | 403 | 249 | - |
| **silktree** | 1,628 | 106 | 12 | 63 | 678 | 319 | 436 | - |
| **black locust** | 1,560 | - | - | 65 | 358 | 980 | 157 | - |
| **common barberry** | 1,391 | 54 | 6 | 221 | 304 | 585 | 208 | 12 |
| **common reed** | 767 | - | - | 98 | 254 | 415 | - | - |
| **tree of heaven** | 730 | - | - | 8 | 416 | 219 | 78 | - |
| **Norway maple** | 569 | - | 143 | 17 | 96 | 208 | 106 | - |
| **garlic mustard** | 418 | - | - | 24 | 31 | 322 | 36 | - |
| **forest sandmat** | 300 | - | - | - | 11 | 288 | - | - |
| **oriental bittersweet** | 289 | - | 9 | 11 | 70 | 160 | 39 | - |
| **Amur honeysuckle** | 285 | - | - | - | 8 | 34 | 154 | - |
| **Bell's honeysuckle** | 277 | - | 82 | - | 147 | 48 | - | - |
| **reed canarygrass** | 221 | - | - | 60 | 11 | 144 | 6 | - |
| **Texas greeneyes** | 202 | 12 | - | 19 | 111 | 60 | - | - |
| **lespedeza** | 201 | - | - | - | - | 201 | - | - |
| **Japanese barberry** | 176 | - | - | 15 | 70 | 80 | 8 | - |
| **Canada thistle** | 119 | - | - | 3 | 11 | 102 | 3 | - |
| **Tatarian honeysuckle** | 79 | - | - | 8 | 31 | 36 | 3 | - |
| **common buckthorn** | 56 | - | - | - | 44 | 6 | 6 | - |
| **white mulberry** | 16 | - | - | - | - | 13 | 3 | - |
| **winter creeper** | 15 | - | - | - | 15 | - | - | - |
| **Russian olive** | 9 | - | - | - | 6 | 3 | - | - |
| **Siberian elm** | 9 | - | - | - | - | 9 | - | - |
| **periwinkle** | 9 | - | - | - | - | - | 9 | - |
| **burning bush** | 6 | - | - | - | 6 | - | - | - |
| **Sierra mint** | 6 | - | - | 3 | 3 | - | - | - |
| **Japanese wisteria** | 6 | - | - | - | - | 6 | - | - |
| **Winter creeper** | 3 | - | - | - | 3 | - | - | - |