Indiana DNR State Forest Properties
Report of Continuous Forest Inventory (CFI)
Summary of years 2015-2019

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FOREWORD

This report provides an overview of forest-resource attributes for State Forest land managed by the DNR Division of Forestry. The findings come from the continuous annual inventory conducted by the Forest Resource Information (FRI) Section of the Indiana DNR Division of Forestry (DoF). The CFI inventory of DoF State Forest property is based on a sample of 3,921 plots located randomly across those lands (a total area of 158,974 acres), a sampling rate of approximately one plot for every 40 acres. 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 the population (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) that are updated annually.

This report is a summary of the five years of plot installation and data collection for the years 2015-2019, a span that constitutes one entire cycle. With 20% of the plots measured annually, the 2019 plots were the same plots measured in 2014, thus the 2014 data were replaced with the 2019 data.

EXECUTIVE SUMMARY/HIGHLIGHTS

This is the seventh reported results of the established continuous forest inventory (CFI). The goal of the first five years (2008-2012) was to install all of the plots within the CFI sample frame and produce baseline resource

estimates. These baseline data/estimates are now being 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 state forest properties are:

- There are 158,974 total acres; 151,727 forested acres, with the balance in non-forest (i.e., campgrounds) and water.
- 94% of the forested acres are hardwoods.
- 79% of the forested acres are sawlog-sized stands.
- Forests contain 59.5 million live trees.
- American beech trees and seedlings are more abundant than any other species, with sugar maple a close second (12.2 and 12.0 million trees, respectively).
- There is 339.5 million cubic feet of total live tree volume.
- There is 986 million board feet (Doyle) of sawlog volume.
- White oaks, followed by red oaks, are the species groups with the most sawlog volume.
- 65.6% of the sawlog volume is considered grade 1 or 2.
- Oaks constituted nearly 5.5 million bdft Doyle or 51% of the total sawlog volume (10.7 million bdft Doyle) lost via mortality annually
- Japanese honeysuckle, multiflora rose and stiltgrass are the most common invasive species present.
- There are 10.28 million short tons of forest carbon stocks.

FOREST COMPOSITION

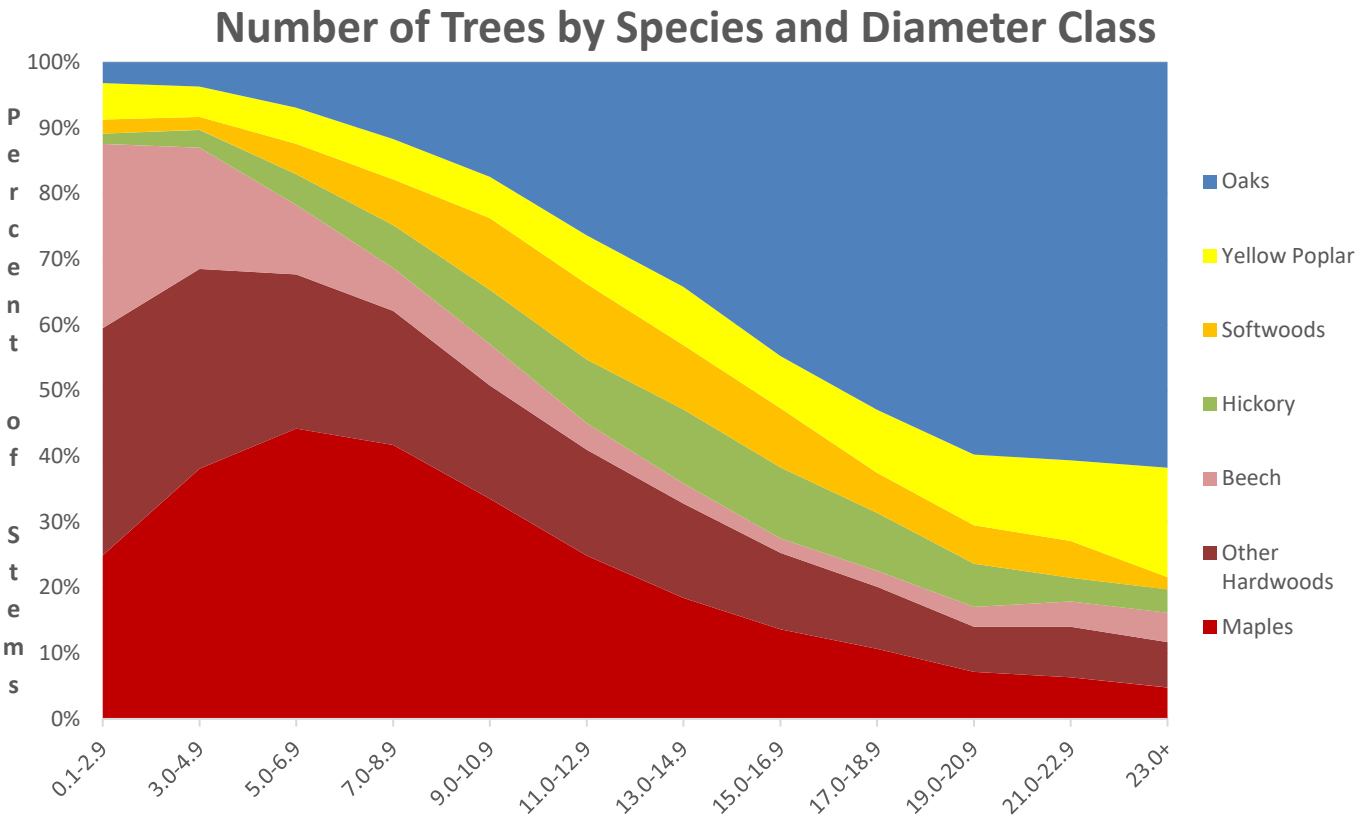
Area

State forest lands comprise approximately 158,974 acres located primarily in the southern third of Indiana. An estimated 151,727 of these acres is 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 ~7,000 acres being non-forest (open fields, campgrounds, 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, state forests are predominantly hardwoods, with 94% of the total forest area classified as hardwood forest types. The primary hardwood forest types were white oak/red oak/hickory (26,815 acres, 17%), white oak (22,349 acres, 14%), chestnut oak (15,361 acres, 10%), and yellow poplar (10,295 acres, 6%) (Table 1). Seventy-eight percent of the area was considered sawlog-sized stands [large diameter or 11.0-inches diameter breast height (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.) (Table 1).

Number of Live Trees

It is estimated that there are 59.5 million live trees 1 inch d.b.h. and larger on state forest lands. In terms of the total number of live trees, beech and sugar maple were the most abundant species, at 12.2 million and 12.0 million trees, respectively (Table 2). More than half of the number of trees were less than 3 inches d.b.h., with 43.7 million 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 about 3.2% of all saplings 1 inch to less than 5 inches d.b.h. Without significant management intervention, the lack of oak seedlings/saplings and over-abundance of maple 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 339.5 million cubic feet. Hardwoods constituted 318.0 million cubic feet (cuft) or 93%. Oaks made up 146.7 million cuft or 43%. Maples were 50.3 million cuft or 15%. Yellow poplar was 46.0 million cuft or 13%. Hickories were 25.3 million cuft or 7% of the total volume (Table 3). Approximately 41.9 million cuft or 12% 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.). 80.7 million cuft or 23% is 23 inches or greater d.b.h. (Table 3). It was estimated that 328.1 million 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 inches d.b.h. and greater, softwoods 9 inches d.b.h. and greater).

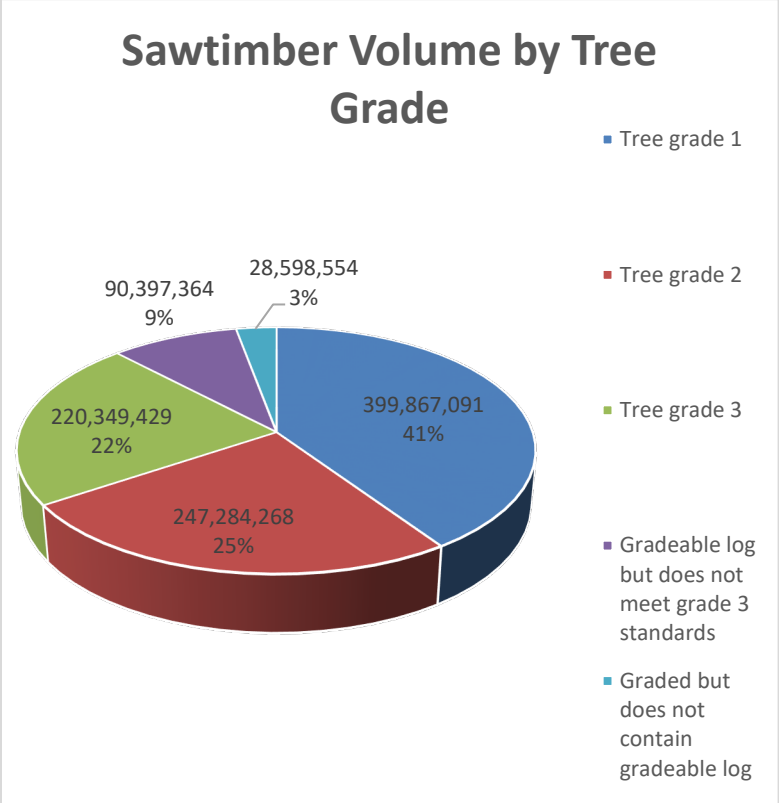
Volume of Sawtimber-sized Trees

The total net sawtimber volume was 986 million board feet Doyle scale (6,501 bdft/acre). White oak and yellow poplar were the most voluminous species, with 167.5 million board feet (MMBF) and 165.4 MMBF or 17% each, followed by chestnut oak and black oak, with 121.0 and 109.0 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 16 feet 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 399.8 MMBF of the total net sawtimber volume was grade 1 and 247.2 and 220.3 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



Standing Dead Trees

There were an estimated 1.8 million standing dead trees 5 inches d.b.h. and greater. The individual species with the largest number of standing dead trees was sassafras, with 278,000 stems. Chestnut oak was second, with 171,000 standing dead trees, with white oak, Virginia pine, and ashes following with 152,000, 138,000, and 135,000 standing dead trees, respectively (Table 11). As with the number of live trees, the number of standing dead trees decreased as the diameter increased. Of the 1.8 million standing dead trees, 934,000 had a diameter from 5-9 inches d.b.h., 605,000 were from 9-15 inches d.b.h., 181,000 were from 15-19 inches d.b.h., and the remaining 129,000 were 19 inches d.b.h. and greater (Table 11).

CHANGE ATTRIBUTES

Change attributes are determined by looking at the same data at two different points in time. We continued to re-measure plots, beginning in 2013, and completed the total sample re-measure in 2017. Except for an occasional new install plot (due to land acquisition), the majority of plots are now being re-measured.

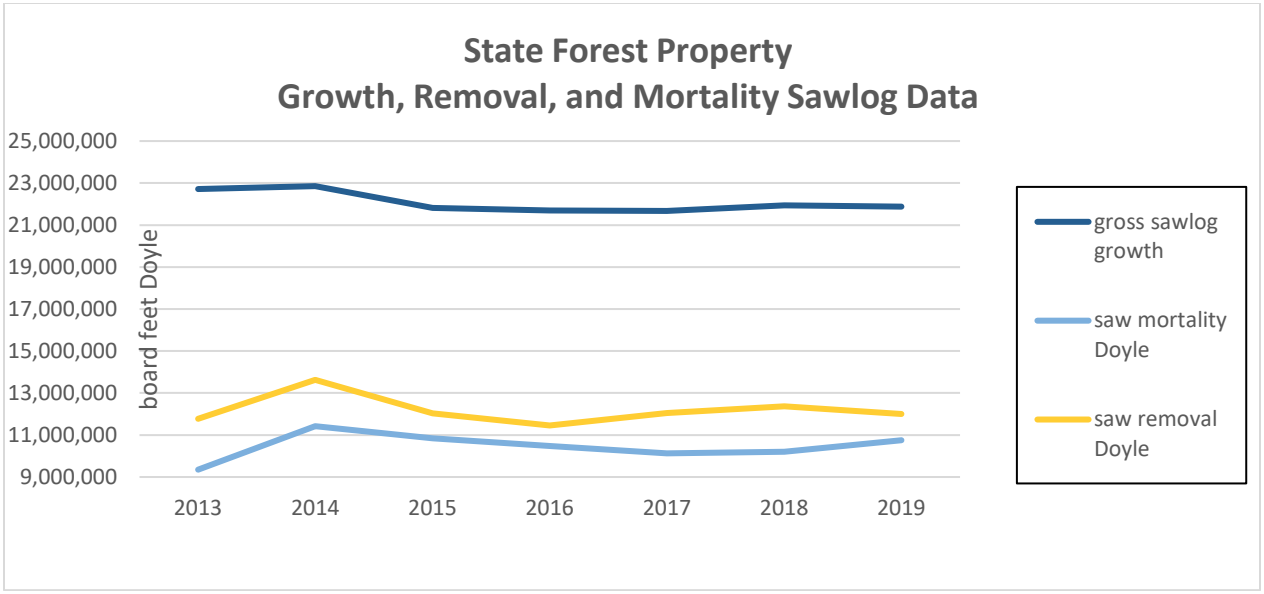
Growth

Net growth is defined as the gross or total growth, less 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, was 3.65 million cubic feet per year. Hardwoods grew 3.55 million cuft/year or 99% of the total growth, while cedar and pines merely netted 102,415 cuft/year. Oaks constituted 1.09 million cuft or 30%, maples were 1.03 million cuft or 28%, yellow poplar was 825,000 cuft or 22%, and hickories were 522,000 cuft or 14% of the total growth (Table 5). Species or species groups showing negative growth (a negative growth value would mean that mortality was larger than the gross growth) included ashes, elms, chestnut oak, sassafras, and other maples. Approximately 800,000 cuft or 22% 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.).

Looking at sawlog-size average annual total volume growth, trees collectively grew an average of 21.8 million board feet Doyle annually. Hardwoods grew 20.3 million bdft/year, while cedar and pines grew 1.5 million bdft/year. Oaks constituted 9.0 million bdft or 41%, yellow poplar was 4.0 million bdft or 18%, maples were 2.6 million bdft or 12%, and hickories were 1.8 million bdft or 8% of the total growth (Table 6). Ashes and elms had higher mortality than sawlog growth.

Historically sawlog growth was about 23 million bdft/year prior to the onset of EAB and the 2012 drought. Since then this increased mortality (discussed below) has diminished growth as depicted in Figure 3.

Figure 3



Mortality

The average annual volume mortality of all trees was 4.53 million cuft per year. Hardwoods accounted for 4.1 million cuft/year or 91% of the total mortality. Chestnut oak was 681,000 cuft or 15%, and white ash was 622,000 cuft or 13%. The next individual species with the most volume lost to mortality was yellow poplar losing 417,000 cuft, black oak losing 395,000 cuft, and white oak losing 379,000 cuft. Collectively, all oak species accounted for 1.85 million cuft or nearly 41% of all mortality (Table 7).

Looking at sawlog-sized volume mortality, forests lost an average of 10.7 million board feet Doyle annually. Hardwoods accounted for 9.8 million bdft/year or 91%. Oaks constituted 5.4 million bdft or 51%, ashes were 1.6 million bdft or 15%, yellow poplar was 814,000 bdft or 7%, and maples were 748,000 bdft or 7% of the total mortality (Table 8).

Mortality would actually be higher than reported; however, the DoF has made a concerted effort to salvage harvest recently deceased trees (especially ash, oak, and yellow poplar). These trees and their associated volume would be captured and reported as removals rather than mortality.

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 more than half of the mortality volume 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 removals of all trees was 3.7 million cuft per year. Hardwoods accounted for 3.2 million cuft/year or 87% of the total removals. Yellow poplar was 828,000 cuft or 22%, followed by black oak at 565,000 cuft, ashes at 275,000 cuft, and sugar maple at 242,000 cuft (Table 9).

Looking at sawlog-sized volume removals, 11.9 million board feet Doyle was removed annually. Hardwoods accounted for 10.5 million bdft/year. Oaks were 3.7 million bdft or 31% of the removals, yellow poplar 3.4 million bdft or 28%, maples and ashes followed at 870,000 bdft or 7% and 807,000 bdft or 6%, respectively (Table 10).

ANCILLARY DATA ITEMS

Invasive Species

If present, crews identify any invasive species found on plot and measure the area of the plot that those species occupy. These area estimates are then expanded to the entire 151,727 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 6,334 cumulative acres (about 4.1%) with invasive species present. Japanese (vine) honeysuckle, multiflora rose, and stiltgrass are the most prevalent invasive species, covering approximately 1,783, 1,730, and 1,546 acres, respectively.

Carbon

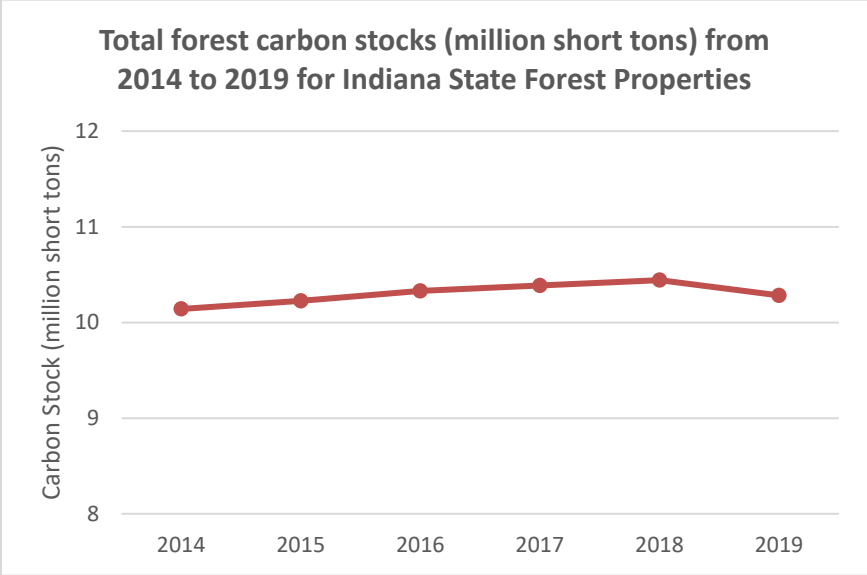
Carbon uptake and storage are a few of the many ecosystem services provided by forests. Carbon cycles through living organisms. Carbon dioxide (CO_2) is a gaseous component of the earth's atmosphere that plays several vital roles in the environment. Being a carbon source for plants is one of those roles. 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 a 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.

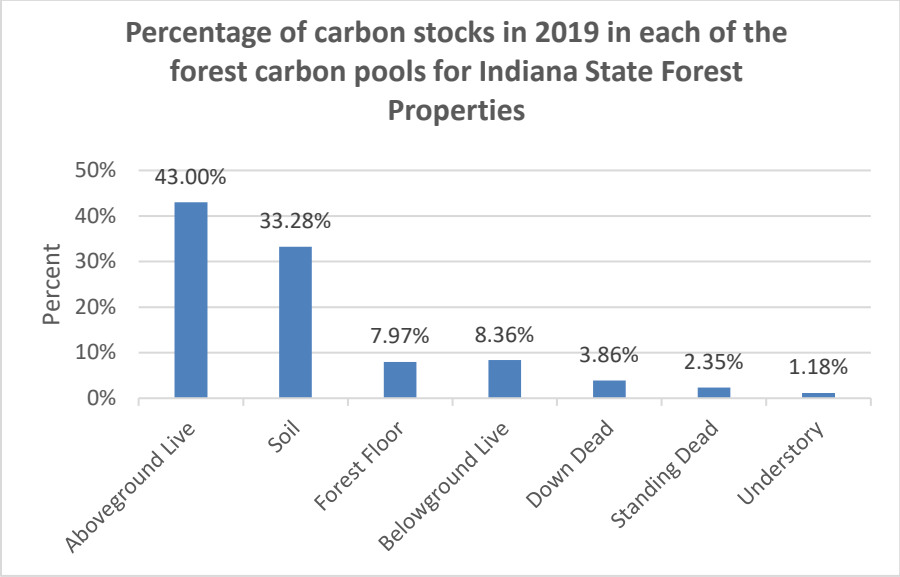
CFI data has begun to provide carbon estimates for the Indiana State Forest system lands. We will be able to use this as baseline data and monitor carbon estimate trends over time. Early data indicates that annual carbon stock estimates are fairly consistent since the inception of carbon measurements (2014) at just over 10 million short tons (Fig. 4). It is too soon to discuss trends because we don't have a historical baseline to compare with, but will as we annually add data.

Figure 4



In 2019 about 43.0% 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 (Fig. 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 33.3% 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.

Figure 5



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 State 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 state 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 Continuous Forest Inventory (CFI) system in 2007. The USDA Forest Service Forest Inventory and Analysis (FIA) program was chosen to mirror for several reasons. The Indiana 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 forest began in calendar year 2008. The plots were spaced such that approximately an equal number of plots per year per state forest property (an annual panel) would be completed. Annually, these panels can stand alone as an independent survey and therefore some results of significant value can be analyzed and reported on an annual basis. In 2013, we began to re-measure the plots that were established and measured in 2008. Therefore, now all annual panels of plots (100% of the total sample) have been updated with 2015-2019 data, and the 2009-2014 data has been dropped from the total estimate calculations. Subsequent years will follow the same protocol.

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 managed 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 are striving 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 of them, 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 2014 through 2018 (last year's report), 2015 through 2019 (this year's report) and so on.

Field plots of the inventory consist of installing and measuring of the annual sample of field plots (panel) on each state forest. It was determined for desired CFI precision standards that the sampling intensity would be one plot for approximately every 40 acres. For efficiency, it was also determined that an entire compartment of a state forest property would be established and measured within the same panel. INCFI 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 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 9.0) will suffice and is readily available online at https://www.fia.fs.fed.us/library/field-guides-methods-proc/docs/2019/core_ver9-0_10_2019_final.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 state forest property is based on a sample of 3,921 plots located randomly across those lands managed by the DoF (a total area of 158,974 acres), a sampling rate of approximately one plot for every 40 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 has been 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 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, which was described above.

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 those from 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. This is not applicable in the CFI system on state forest properties, but could apply to the CFI system on the classified forest program.

- 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 earlier.

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 create bias in the estimates, if the portion of the population not being sampled differs from the portion being sampled. Fortunately, in CFI, unlike 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 may be able to obtain permission to access these plots (for the Classified

Forest system), the hazardous conditions may have changed, or 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 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 of how to use EVALIDator has been attended.

APPENDIX

Table 1.—Area of forest land by forest type group and stand size class, State Forest properties, 2015-2019.

Table 2.—Number of all live trees by species and diameter class, State Forest properties, 2015-2019.

Table 3.—Net volume of all live trees by species and diameter class, State Forest properties, 2015-2019.

Table 4.—Sawtimber volume of all live trees by species and diameter class, State Forest properties, 2015-2019.

Table 5.—Net growth of all live trees by species and diameter class, State Forest properties, 2015-2019.

Table 6.—Total growth of sawtimber by species and diameter class, State Forest properties, 2015-2019.

Table 7.—Mortality of all live trees by species and diameter class, State Forest properties, 2015-2019.

Table 8.—Mortality of sawtimber by species and diameter class, State Forest properties, 2015-2019.

Table 9.—Removals of all live trees by species and diameter class, State Forest properties, 2015-2019.

Table 10.—Removals of sawtimber by species and diameter class, State Forest properties, 2015-2019.

Table 11.—Number of standing dead trees 5 inches d.b.h. and greater by species and diameter class, State Forest properties, 2015-2019.

Table 1.—Area of forest land by forest type group and stand size class, State Forest properties, 2015-2019.

Forest type	Stand-size	Large diameter	Medium diameter	Small diameter	Nonstocked
All	151,727	119,489	11,431	15,825	4,983
White oak / red oak / hickory	26,815	22,292	2,269	2,254	-
White oak	22,349	22,144	165	40	-
Chestnut oak	15,361	15,034	243	83	-
Yellow poplar	10,295	7,744	1,177	1,374	-
Hard maple / basswood	7,104	5,494	1,080	530	-
Sugar maple / beech / yellow birch	7,029	5,733	644	652	-
Chestnut oak / black oak / scarlet oak	6,293	5,581	302	411	-
Cherry / white ash / yellow poplar	6,146	2,526	591	3,030	-
Northern red oak	5,486	5,365	81	40	-
Mixed upland hardwoods	7,500	4,777	991	1,732	-
Pine/Hardwood	2,908	2,421	286	202	-
Other miscellaneous hardwood forest types	28,322	14,680	3,438	5,225	4,983
Miscellaneous softwood forest types	6,115	5,700	163	252	-

Table 2.—Number of all live trees by species and diameter class, State Forest properties, 2015-2019.

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	59,546,714	33,830,976	9,862,946	3,969,279	2,741,406	1,939,485	1,723,091	1,367,008	1,155,627	990,908	712,213	513,224	740,552
American beech	12,270,505	9,496,332	1,818,839	420,340	177,961	121,948	69,234	41,960	25,376	24,419	21,355	19,664	33,077
sugar maple	12,000,227	6,085,039	2,763,057	1,220,828	772,015	455,964	288,685	175,769	101,443	72,953	27,321	21,559	15,595
red maple	4,687,975	2,274,685	993,624	529,750	363,408	185,699	135,639	73,844	53,195	27,597	22,706	10,941	16,885
other hardwood species	4,636,532	2,916,170	910,655	221,613	149,969	95,299	89,484	73,413	56,818	44,884	23,591	22,931	31,713
yellow poplar	3,551,099	1,889,868	455,357	217,709	168,007	121,347	127,028	121,690	91,761	95,166	76,687	63,031	123,449
sassafras	2,489,601	1,570,791	463,789	164,996	109,063	76,431	57,624	26,441	10,756	7,796	969	-	946
other oaks	2,180,494	677,082	219,667	101,285	109,823	99,928	118,010	113,885	131,375	164,866	134,389	107,772	202,413
redcedar and pine species	2,089,344	726,316	195,830	183,027	191,681	211,727	198,565	133,344	104,339	60,507	41,555	28,700	13,753
eastern hophornbeam	1,969,528	1,762,131	183,045	18,510	4,858	984	-	-	-	-	-	-	-
white oak	1,838,481	283,698	61,131	95,655	116,138	130,835	163,378	164,415	196,751	183,408	158,084	113,065	171,922
blackgum	1,682,988	905,796	379,722	186,310	100,368	40,068	29,615	14,707	13,647	7,839	973	1,944	2,000
flowering dogwood	1,542,323	1,124,052	367,778	48,525	1,968	-	-	-	-	-	-	-	-
ash species	1,542,920	1,142,892	133,575	75,456	37,229	33,657	25,716	25,452	22,854	14,716	16,706	5,865	8,802
chestnut oak	1,511,624	109,910	85,840	78,972	94,946	108,059	173,303	189,343	188,702	176,110	133,085	90,393	82,960
pignut hickory	1,176,983	293,327	182,292	111,240	100,921	111,067	106,765	78,505	72,358	56,825	31,419	13,736	18,529
pawpaw	1,014,739	1,002,403	12,336	-	-	-	-	-	-	-	-	-	-
American elm	1,012,586	517,077	320,162	83,950	52,966	20,856	7,786	4,809	2,966	984	1,030	-	-
other hickories	768,445	232,060	85,871	74,440	78,202	50,091	60,557	75,673	52,895	30,314	15,646	4,866	7,832
black cherry	634,616	341,814	72,704	58,543	46,208	33,299	37,557	17,944	7,882	7,905	3,848	2,980	3,932
other elms	632,634	394,829	121,860	50,971	35,426	7,856	11,795	3,030	3,888	1,997	-	-	983
black walnut	313,072	84,707	35,814	27,163	30,252	34,368	22,350	32,786	18,622	12,620	2,848	5,780	5,762

Table 3.—Net volume of all live trees by species and diameter class, State Forest properties, 2015-2019.

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	339,534,571	9,332,868	14,141,336	18,427,710	26,710,655	31,574,000	37,644,215	43,535,676	40,564,996	36,853,908	80,749,208
white oak	53,595,193	226,116	599,665	1,194,803	2,392,410	3,545,400	5,974,743	7,526,218	8,333,318	7,531,349	16,271,170
yellow poplar	46,035,485	576,281	983,985	1,351,538	2,312,337	3,398,166	3,611,348	5,137,725	5,571,790	5,684,023	17,408,292
chestnut oak	38,851,129	177,732	442,673	937,859	2,379,410	3,843,357	5,354,189	6,655,655	6,509,924	5,527,204	7,023,127
sugar maple	33,332,093	3,150,655	4,260,707	4,577,077	4,823,317	4,408,572	3,580,821	3,486,356	1,722,081	1,667,294	1,655,213
black oak	30,331,312	77,735	177,152	301,926	803,257	982,014	2,031,253	3,635,381	4,405,115	4,596,576	13,320,902
redcedar and pine species	21,437,502	401,106	931,581	1,914,377	2,963,875	2,975,271	3,442,742	2,751,344	2,461,406	2,182,694	1,413,104
northern red oak	17,124,300	81,638	181,586	337,388	441,535	825,093	1,174,191	2,055,330	2,265,234	2,261,844	7,500,461
red maple	15,645,850	1,291,000	1,896,450	1,800,941	2,119,998	1,700,517	1,747,408	1,217,961	1,326,872	803,830	1,740,872
pignut hickory	15,932,225	259,477	534,573	1,081,885	1,754,771	1,932,454	2,627,055	2,758,803	1,978,594	1,095,970	1,908,644
American beech	13,188,187	945,664	888,566	1,138,548	1,080,311	924,142	809,765	1,080,969	1,287,891	1,397,083	3,635,249
other hardwood species	11,881,755	799,587	952,209	894,169	1,280,025	1,531,608	1,587,723	1,325,760	833,383	926,079	1,751,217
other hickories	9,374,447	173,847	421,489	497,678	1,012,947	1,864,546	1,833,525	1,481,134	972,351	384,893	732,038
ash species	5,367,517	167,105	173,979	318,317	381,770	606,107	773,292	673,184	944,423	428,812	900,528
American sycamore	7,112,210	88,542	107,676	173,942	374,218	462,221	714,290	952,419	505,544	985,153	2,748,205
other oaks	6,881,230	82,584	208,233	300,274	515,656	726,097	925,754	1,280,977	853,590	755,163	1,232,901
sassafras	3,522,262	324,431	494,744	630,471	799,202	528,877	319,734	326,975	55,638	-	42,190
black walnut	3,733,619	63,966	149,032	311,482	330,502	701,728	544,365	511,006	151,773	403,829	565,937
black cherry	2,963,458	116,145	208,151	281,933	511,254	363,459	261,789	323,780	224,576	222,111	450,259
elms	1,832,895	276,166	404,299	246,166	263,719	172,639	199,445	113,542	53,495	-	103,425
other maples	1,391,899	53,088	124,588	136,936	170,142	81,734	130,783	241,158	107,998	-	345,473

Table 4.—Sawtimber volume of all live trees by species and diameter class, State Forest properties, 2015-2019.

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	986,496,707	2,276,311	51,798,353	76,417,907	107,747,123	138,275,103	140,823,553	134,980,009	334,178,349
white oak	167,540,276	-	4,885,646	8,623,289	16,623,944	22,967,611	26,834,283	26,274,267	61,331,236
yellow poplar	165,433,783	-	4,737,500	8,810,636	10,971,130	17,329,776	20,901,159	22,153,653	80,529,929
chestnut oak	121,027,430	-	4,795,680	9,473,129	15,478,134	20,578,309	21,949,487	20,380,727	28,371,964
black oak	109,034,152	-	1,612,226	2,412,912	5,840,322	11,615,522	15,066,964	17,048,692	55,437,514
northern red oak	62,309,267	-	909,165	2,099,800	3,445,370	6,717,618	8,019,411	8,630,955	32,486,948
sugar maple	57,433,636	-	9,255,409	10,196,674	9,779,055	10,687,453	5,840,927	5,664,928	6,009,190
pignut hickory	44,622,913	-	3,575,752	4,856,276	7,709,409	9,026,070	7,072,583	4,261,739	8,121,085
other hardwood species	36,817,966	-	4,100,103	5,047,419	5,887,248	6,118,105	3,481,855	3,231,933	8,951,306
eastern white pine	32,849,832	276,121	1,032,257	1,946,196	4,610,995	5,781,911	5,661,796	8,518,898	5,021,657
American beech	31,928,083	-	2,127,079	2,197,223	2,203,053	3,194,792	4,391,469	3,983,261	13,831,205
red maple	26,056,730	-	3,620,612	3,437,710	4,192,995	3,287,204	4,071,928	2,521,512	4,924,768
American sycamore	23,663,922	-	711,150	1,104,342	1,961,870	2,882,641	1,445,596	3,396,521	12,161,802
Virginia pine	21,833,069	1,070,855	3,261,436	3,909,909	5,324,489	3,318,969	4,476,887	-	470,523
other oaks	20,067,908	-	974,291	1,621,846	2,546,247	4,083,718	2,937,728	2,806,649	5,097,429
shagbark hickory	16,576,344	-	1,424,738	3,155,694	3,557,797	3,035,240	2,511,416	907,555	1,983,905
ash species	14,879,727	-	627,573	1,389,714	2,142,386	2,103,163	3,235,596	1,599,429	3,781,866
other pines and redcedar	11,162,178	929,334	2,019,939	2,224,982	1,682,772	1,449,602	802,094	832,143	1,221,311
black walnut	9,618,558	-	668,141	1,695,361	1,542,737	1,602,729	512,345	1,443,947	2,153,299
other hickories	7,584,817	-	603,195	1,457,387	1,620,336	1,722,167	891,281	563,697	726,752
black cherry	6,056,117	-	856,462	757,408	626,833	772,506	718,745	759,505	1,564,659

Table 5.—Net growth of all live trees by species and diameter class, State Forest properties, 2015-2019.

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	3,652,714	330,523	237,297	194,222	325,997	361,061	359,696	390,884	366,691	357,052	729,569
yellow poplar	825,262	15,664	16,096	29,411	72,673	85,467	33,490	116,111	129,981	98,629	227,741
sugar maple	673,495	145,305	131,244	106,928	101,536	58,329	63,694	34,828	-16,174	29,233	18,572
white oak	565,175	2,745	-2,495	6,691	18,415	53,339	58,178	96,002	84,939	93,308	154,054
red maple	366,446	57,226	56,622	45,525	52,146	31,920	49,199	29,354	42,816	15,826	-14,187
pignut hickory	333,963	6,060	8,121	30,720	40,771	45,176	63,541	38,612	43,614	21,224	36,124
black oak	309,779	474	6,250	2,163	5,261	6,407	10,161	24,594	80,432	37,878	136,157
American beech	255,929	76,341	43,478	44,620	20,749	14,264	10,075	27,577	3,812	-23,754	38,766
American sycamore	176,010	3,321	3,412	5,814	13,516	12,067	21,615	27,111	15,238	21,495	52,421
northern red oak	173,816	240	2,106	-1,231	1,022	-12,257	6,514	20,375	12,046	12,516	132,484
shagbark hickory	119,862	2,887	6,733	5,991	16,119	35,461	31,042	20,299	-12,326	3,512	10,145
redcedar and pine species	102,415	2,018	-25,049	-38,686	-9,978	20,661	31,135	25,052	28,713	37,226	31,327
other hardwood species	75,615	15,545	7,354	1,522	2,777	21,292	39,571	6,865	-4,345	-23,529	8,572
black walnut	74,292	1,772	4,860	7,162	10,341	20,264	11,215	-5,967	4,058	9,715	10,872
other hickories	68,532	1,753	2,244	4,612	10,572	16,013	9,031	12,468	4,745	418	6,677
other oaks	58,088	4,404	6,195	1,545	7,039	2,823	6,698	12,583	5,804	6,927	4,071
black cherry	25,178	180	4,580	791	13,022	6,282	-1,629	-2,012	6,684	4,969	-7,688
scarlet oak	11,774	391	446	-534	1,668	-2,258	-9,206	-19,612	12,614	9,396	18,868
other maples	-1,264	2,737	3,264	-6,040	-584	-6,604	-10,772	8,983	2,012	-	5,739
sassafras	-21,931	-6,060	-18,849	-16,706	6,999	16,522	-6,870	7,466	1,929	823	-7,185
chestnut oak	-22,132	1,309	-2,093	-5,829	-16,329	-22,416	4,604	17,150	-36,585	25,081	12,974
elms	-30,500	3,839	4,021	-1,048	-6,630	-10,793	-3,944	-5,163	-12,208	-	1,704
ash species	-487,091	-7,629	-21,243	-29,197	-35,108	-30,894	-57,644	-101,786	-31,110	-23,842	-148,639

Table 6.—Total growth of sawtimber by species and diameter class, State Forest properties, 2015-2019.

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	21,877,521	114,980	3,603,023	1,986,330	2,448,604	2,894,082	2,797,588	2,551,365	5,481,550
yellow poplar	4,015,297	-	467,621	338,682	324,306	446,584	537,789	538,297	1,362,018
white oak	2,805,496	-	284,637	178,719	300,654	394,799	444,455	415,670	786,562
black oak	2,174,523	-	142,306	58,209	151,701	278,565	315,644	331,228	896,870
chestnut oak	2,055,807	-	260,308	145,174	253,739	298,192	310,647	305,523	482,224
sugar maple	1,624,051	-	742,948	245,235	207,390	186,323	90,694	77,127	74,335
northern red oak	1,567,306	-	94,531	65,265	105,925	168,246	195,684	190,934	746,721
pignut hickory	1,181,496	-	268,131	131,349	183,240	214,409	153,167	79,985	151,215
other hardwood species	954,465	-	296,879	142,545	144,388	121,118	60,349	70,685	118,502
red maple	907,595	-	339,321	128,802	117,269	74,017	122,327	44,256	81,603
eastern white pine	783,156	15,004	16,302	43,934	113,754	111,886	155,663	199,798	126,815
other pines and redcedar	780,643	99,975	121,895	135,624	156,936	127,655	95,563	23,508	19,487
American beech	678,906	-	167,720	66,966	52,271	96,127	63,907	61,784	170,131
American sycamore	589,672	-	72,834	29,672	60,530	86,476	41,944	78,463	219,753
shagbark hickory	412,663	-	81,072	86,654	87,049	63,407	40,542	12,974	40,965
ash species	327,432	-	47,571	40,822	51,945	54,310	60,852	17,792	54,140
scarlet oak	236,357	-	22,592	11,429	14,958	47,630	41,124	32,176	66,448
black walnut	222,204	-	36,058	48,584	33,141	30,025	12,357	30,095	31,945
other hickories	204,883	-	39,264	43,508	47,018	39,892	16,557	2,239	16,405
black cherry	187,996	-	83,673	18,203	11,493	17,172	19,966	15,482	22,007
other oaks	167,571	-	17,360	26,958	30,894	37,249	18,355	23,349	13,406

Table 7.—Mortality of all live trees by species and diameter class, State Forest properties, 2015-2019.

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	4,537,697	-	306	250,196	311,203	394,558	429,925	461,903	507,922	559,705	492,788
chestnut oak	681,357	-	-	6,282	12,453	25,815	61,646	82,329	93,260	86,201	138,424
white ash	621,920	-	-	16,685	27,029	42,289	40,018	46,069	81,010	116,840	51,990
yellow poplar	417,604	-	-	47,808	50,511	35,975	13,594	37,617	76,804	9,416	13,555
black oak	395,312	-	-	4,502	1,693	8,984	21,469	18,790	46,645	73,161	31,859
white oak	378,980	-	-	6,713	17,616	18,545	34,287	25,052	38,764	45,944	63,415
other hardwood species	342,059	-	-	38,055	38,275	42,868	43,088	19,981	7,695	45,206	22,313
northern red oak	303,344	-	-	2,986	4,866	13,410	14,159	40,963	32,270	35,125	48,835
sugar maple	259,458	-	-	30,145	22,580	38,844	34,555	49,740	8,740	29,342	45,512
Virginia pine	196,683	-	-	7,782	20,573	34,717	45,441	35,695	34,395	18,080	-
red maple	157,870	-	-	28,170	25,711	14,667	16,177	25,970	-	-	-
sassafras	134,900	-	-	23,340	39,340	38,917	15,374	2,484	15,446	-	-
elms	105,589	-	306	13,835	13,133	12,727	17,718	19,378	8,270	7,033	13,189
American beech	103,091	-	-	3,501	2,107	5,756	13,293	13,327	5,863	-	12,688
eastern white pine	96,401	-	-	2,666	5,074	16,199	12,057	8,186	-	9,730	26,460
hickories	86,033	-	-	3,764	5,430	1,609	7,177	6,438	8,141	28,924	24,550
scarlet oak	68,222	-	-	298	1,900	2,055	3,705	8,132	15,308	36,824	-
red pine	60,567	-	-	2,142	14,609	13,976	16,666	-	5,642	7,531	-
other maples	43,611	-	-	374	1,010	9,562	7,148	8,450	17,066	-	-
redcedar and pine species	34,918	-	-	8,638	4,520	12,039	2,884	-	6,838	-	-
other ashes	28,644	-	-	1,579	1,872	-	9,470	5,374	-	10,348	-
other oaks	21,132	-	-	932	902	5,604	-	7,930	5,765	-	-

Table 8.—Mortality of sawtimber by species and diameter class, State Forest properties, 2015-2019.

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	10,747,936	129,070	760,557	1,065,177	1,363,245	1,683,039	1,648,043	1,325,401	2,773,404
chestnut oak	1,963,191	-	116,436	178,732	262,988	271,549	437,259	229,484	466,745
black oak	1,277,936	-	43,890	46,777	133,767	231,465	109,252	216,516	496,269
yellow poplar	814,848	-	-	-	-	52,004	-	-	-
white oak	1,054,471	-	6,658	-	19,972	25,212	-	-	61,445
white ash	1,609,059	-	7,858	33,573	-	-	43,168	107,710	-
northern red oak	963,427	-	22,942	103,049	93,739	113,023	170,583	164,045	296,048
Virginia pine	482,365	59,708	110,755	111,147	127,096	73,659	-	-	-
other hardwoods	602,330	-	115,698	166,915	224,039	121,270	203,949	285,789	242,266
sugar maple	437,482	-	53,070	120,277	24,429	88,509	151,197	-	-
eastern white pine	294,021	25,344	28,029	23,662	-	35,660	113,463	67,861	-
scarlet oak	189,090	-	65,276	61,306	106,715	137,852	204,162	141,534	337,625
red maple	253,433	-	18,074	47,545	-	-	-	-	187,814
American beech	192,308	-	-	9,985	-	-	-	-	-
elms	120,987	-	12,811	26,076	22,001	20,517	39,582	-	-
pignut hickory	123,828	-	-	-	23,564	-	-	-	-
red pine	109,172	22,444	38,300	-	19,103	29,324	-	-	-
sassafras	38,352	-	19,833	-	18,519	-	-	-	-
shagbark hickory	84,017	-	14,761	16,186	-	92,881	-	-	-
other pines and redcedar	53,753	21,575	6,956	-	25,222	-	-	-	-
other oaks	26,299	-	7,548	30,759	59,790	117,292	-	-	-
other ashes	57,570	-	71,663	89,187	202,301	272,824	175,429	112,462	685,193

Table 9.—Removals of all live trees by species and diameter class, State Forest properties, 2015-2019.

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	3,712,882	77,800	94,352	104,631	208,831	324,405	446,866	378,419	430,400	390,229	1,256,949
yellow poplar	828,109	2,126	-	5,351	-	-	-	-	-	-	-
black oak	564,912	653	850	4,292	6,302	17,861	31,105	61,798	39,296	126,949	275,805
other hardwood species	321,016	48,064	52,461	45,561	75,636	119,776	100,286	102,932	194,777	113,866	764,271
sugar maple	242,371	408	-	-	-	-	4,924	-	13,339	-	-
white ash	241,346	-	-	-	-	-	12,873	-	-	-	21,123
chestnut oak	222,523	-	707	1,881	8,322	24,862	42,645	63,471	37,058	14,041	29,536
white oak	218,815	-	4,050	2,106	2,487	13,444	26,236	14,354	35,432	55,695	65,012
eastern white pine	212,911	492	-	8,593	7,592	38,602	46,850	27,855	35,151	28,270	19,506
American beech	161,374	1,150	3,118	5,838	22,380	32,602	37,791	50,771	24,340	11,586	51,771
red maple	150,063	14,658	11,406	3,755	6,129	23,748	37,689	10,939	11,814	-	29,924
Virginia pine	136,571	1,852	4,069	3,528	26,336	26,010	53,523	7,852	-	13,401	-
pignut hickory	135,652	-	1,068	-	-	-	9,679	-	-	-	-
redcedar and pine species	115,039	4,687	10,843	14,720	33,260	12,150	18,401	7,443	13,536	-	-
sassafras	91,725	3,711	5,780	6,716	10,476	15,352	14,095	9,773	13,920	11,903	-
northern red oak	70,457	-	-	2,292	9,913	-	10,768	21,230	11,736	14,518	-

Table 10.—Removals of sawtimber by species and diameter class, State Forest properties, 2015-2019.

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	11,996,378	42,410	417,891	775,876	1,276,856	1,130,482	1,454,789	1,414,151	5,483,923
yellow poplar	3,464,681	-	21,659	46,637	70,013	108,256	277,789	133,689	2,806,638
black oak	2,062,988	-	12,824	44,789	89,195	196,101	109,389	466,746	1,143,944
eastern white pine	765,593	11,637	17,248	111,538	158,698	105,646	149,932	123,014	87,880
other hardwood species	709,428	-	60,931	71,382	121,901	28,057	156,003	99,592	171,564
white oak	697,231	-	5,052	32,803	72,550	43,881	114,255	192,763	235,928
chestnut oak	688,288	-	16,793	62,539	119,793	199,063	122,632	53,185	114,283
white ash	665,042	-	36,525	76,773	103,225	130,717	82,109	-	235,693
sugar maple	514,723	-	50,095	102,208	100,584	63,626	74,176	-	124,035
Virginia pine	439,623	5,835	63,744	80,922	195,150	31,890	-	62,082	-
American beech	418,283	-	16,550	25,529	-	-	88,882	228,836	58,486
pignut hickory	380,757	-	15,649	24,130	21,311	95,223	140,753	-	83,691
red maple	356,188	-	10,929	52,095	94,967	30,588	35,632	-	131,978
redcedar and pine species	292,015	24,938	77,682	34,899	63,049	29,116	62,332	-	-
northern red oak	206,910	-	12,210	-	31,231	68,319	40,905	54,244	-
eastern cottonwood	192,509	-	-	9,633	-	-	-	-	182,876
green ash	142,117	-	-	-	35,189	-	-	-	106,928

Table 11.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, State Forest Properties, 2015-2019.

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	1,850,943	533,612	401,066	278,979	193,393	133,281	111,875	69,373	56,816	26,502	46,048
sassafras	278,739	132,974	72,573	39,931	14,675	9,783	6,837	983	983	-	-
chestnut oak	171,519	16,695	17,313	25,417	31,131	23,255	16,692	14,516	12,753	6,816	6,931
white oak	152,768	27,760	31,527	17,685	16,801	15,851	14,708	5,969	10,768	1,930	9,768
Virginia pine	138,697	23,767	30,720	27,762	25,747	16,830	9,908	2,972	991	-	-
ashes	135,263	31,454	21,678	16,729	17,715	11,794	9,768	13,620	4,764	1,982	5,760
yellow poplar	128,001	31,286	38,043	13,630	9,738	7,739	12,713	3,954	2,923	2,927	5,049
eastern redcedar	121,951	66,960	28,555	18,697	2,923	3,845	-	-	-	-	973
sugar maple	106,521	39,086	24,491	21,564	7,848	7,745	1,930	946	946	984	983
other hardwoods	96,109	31,873	24,681	16,916	12,791	4,935	983	1,967	-	983	984
black oak	87,019	9,805	5,874	7,801	9,794	5,805	13,714	12,718	9,760	3,951	7,797
red pine	79,765	10,788	33,835	19,632	11,654	1,939	984	932	-	-	-
eastern white pine	58,297	11,810	11,738	14,703	3,965	4,085	3,928	2,998	5,071	-	-
red maple	52,332	23,617	14,885	5,939	3,004	2,928	946	-	-	-	1,013
elms	51,081	22,409	10,824	4,915	5,882	4,039	1,030	1,013	971	-	-
northern red oak	46,046	4,893	4,895	4,964	3,921	3,914	6,871	3,866	3,930	3,972	4,822
black locust	35,855	19,016	7,960	3,979	3,917	984	-	-	-	-	-
black cherry	34,215	16,653	4,839	4,868	2,980	2,900	1,975	-	-	-	-
other oaks	33,439	6,862	9,879	7,851	1,975	2,937	1,967	983	984	-	-
American beech	25,638	2,948	2,923	4,986	4,957	991	2,926	-	983	2,958	1,967
hickories	14,680	2,960	3,834	-	991	984	2,985	1,936	991	-	-
other softwoods	3,009	-	-	1,013	983	-	1,013	-	-	-	-