Indiana DNR Classified Forests
Report of Continuous Forest Inventory (CFI)
Summary of years 2014-2018

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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 of DoF Classified Forest lands is based on a sample of 2,779 plots located randomly across those lands enrolled in the program at a sampling rate of approximately one plot for every 200 forested acres. It should be noted that there are also acres enrolled in the program that originated as Classified Wildlife acres under the DNR Division of Fish & Wildlife but are now managed with the Classified Forest program. These acres are not included in this sample.

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

This report is a summary of the five panels of plot installation and data collection for the years 2014-2018, which constitutes an entire cycle or total sample population. All initial plots have been installed and measured. Change attributes such as growth, removals, and mortality will not be reported until a later date after plot re-measurement on a sufficient number of sample plots.

EXECUTIVE SUMMARY/HIGHLIGHTS

This is the fourth annual report of results of the classified forest continuous forest inventory (CFI). The goal of the first five years was to install all of the plots within the CFI sample frame and produce baseline resource estimates. These baseline data/estimates will then be used as a monitoring baseline to compare to future re-measurement data in compilation of statistical change estimates (e.g., tree growth/mortality). Details of the results are discussed below, and tabular results can be found in the additional "Part B" report. Baseline resource estimates of Classified Forest properties are:
- 770,123 forested acres comprise the balance in non-forest (i.e., open areas) and water.
- 97% of the forested acres are hardwoods.
- 75% of the forested acres are sawlog-sized stands.
- Forests contain 307 million live trees.
- Sugar-maple trees and seedlings are more abundant than trees of any other species.
- The total live-tree volume is 1.610 billion cubic feet.
- There is 4.177 billion board feet (Doyle) of sawlog volume.
- Yellow poplar, sugar maple, and white oak, in order, are the species with the most sawlog volume.
- 61% of the sawlog volume is considered grade 1 or 2.
- Multiflora rose, Japanese honeysuckle, bush honeysuckle, and stiltgrass are the most common invasive species.

## FOREST COMPOSITION

Area

Classified Forest lands comprise approximately 770,123 acres considered forest land (land considered stocked with trees or seedlings that is at minimum 1 acre in size and 120 feet in width), with the remaining acres being non-forest (open fields, rights-of-way, etc.), census water (bodies of water >5 acres and permanent rivers/streams), and non-census water (bodies of water <5 acres and small streams). Like most of Indiana's forests, Classified Forests are predominantly hardwoods, with 97% of the total forest area classified as hardwood forest types. The primary hardwood forest types were white oak/red oak/hickory (165,462 acres, 21%), hard maple/basswood (66,648 acres, 9%), white oak (52,785 acres, 7%), yellow poplar (48,893 acres, 6%), and cherry/ash/poplar (48,559 acres, 6%) as shown in Table 1. Many forest types are similar and therefore difficult to discern. For example, mixed upland hardwoods, hard maple/basswood, sugar maple/beech/birch and some in the miscellaneous hardwood forest types each would include a heavy component of maple. Seventy-five percent of the area was considered sawlog-sized stands (large diameter or 11.0 inches d.b.h. and greater), with the remainder classified as poles (medium diameter or 5.0-10.9 inches d.b.h.) and seedling/saplings (small diameter or 1.0-4.9 inches d.b.h.), as shown in Table 1.

Number of Live Trees

It is estimated there are 307 million live trees on Classified Forest lands. In terms of the total number of live trees, sugar maple was by far the most abundant species at 63.1 million trees, followed by beech, yellow poplar, and red maple with 22.1 million, 17.7 million and 17.5 million trees, respectively (Table 2). More than half of the number of trees were less than 3 inches d.b.h. with 216.0 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 3.3% of all saplings 1 inch to less than 5 inches d.b.h., while all oaks represent 19.1% of all stems 15 inches d.b.h. and greater. The lack of oak seedlings/saplings and abundance of other shade-tolerant seedlings/saplings suggests a future decline of oak/hickory forest types as mature stands senesce.

Figure 1
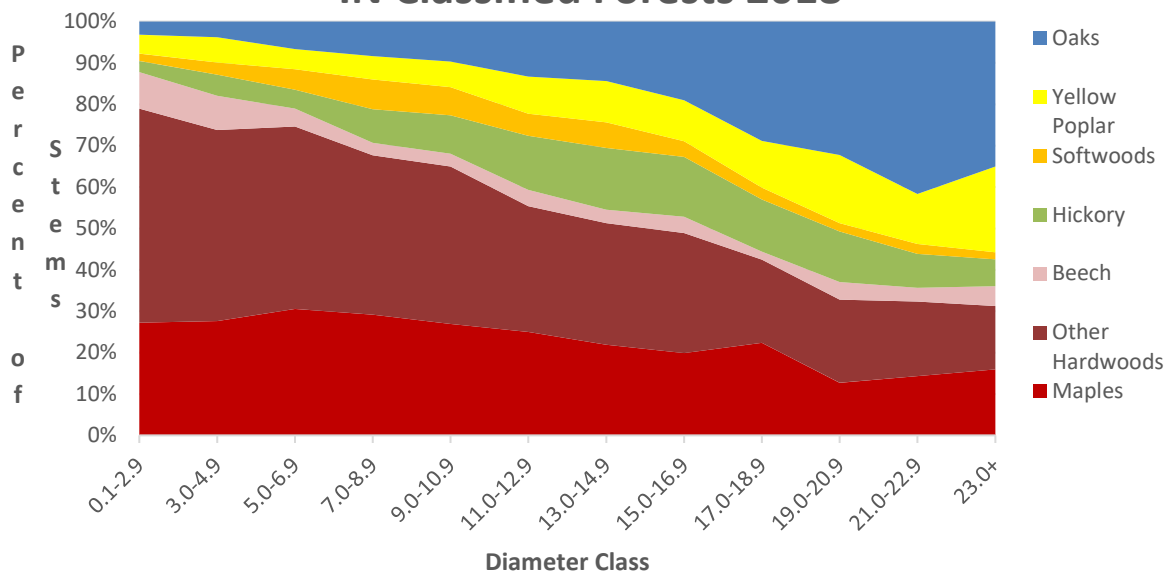
Volume of All Live Trees

The net volume of all live trees, which includes growing stock, rough, and rotten trees, 5 inches d.b.h. and over, was 1.610 billion cubic feet (cuft). Hardwoods constituted 1.552 billion cuft or 96%. Oaks made up 360.8 million cuft or 22%, maples were 344.8 million cuft or 21%, yellow poplar was 239.3 million cuft or 15%, and hickories were 179.4 million cuft or 11% of the total volume (Table 3). Approximately 260.1 million cuft or 16% of the volume is in pole-sized trees (trees <11 inches d.b.h.) with the remainder being sawlog-sized (11 inches and greater d.b.h.). A total of 313.3 million cuft or 19% is 23 inches or greater d.b.h. (Table 3). It was estimated that 1.502 billion cuft of the total volume was in growing stock trees, with the remainder in rough cull and rotten cull trees. These volumes are presented in cubic feet because board foot volume estimates are only calculated on sawtimber-sized trees (hardwoods 11" d.b.h. and greater, softwoods 9" d.b.h. and greater).
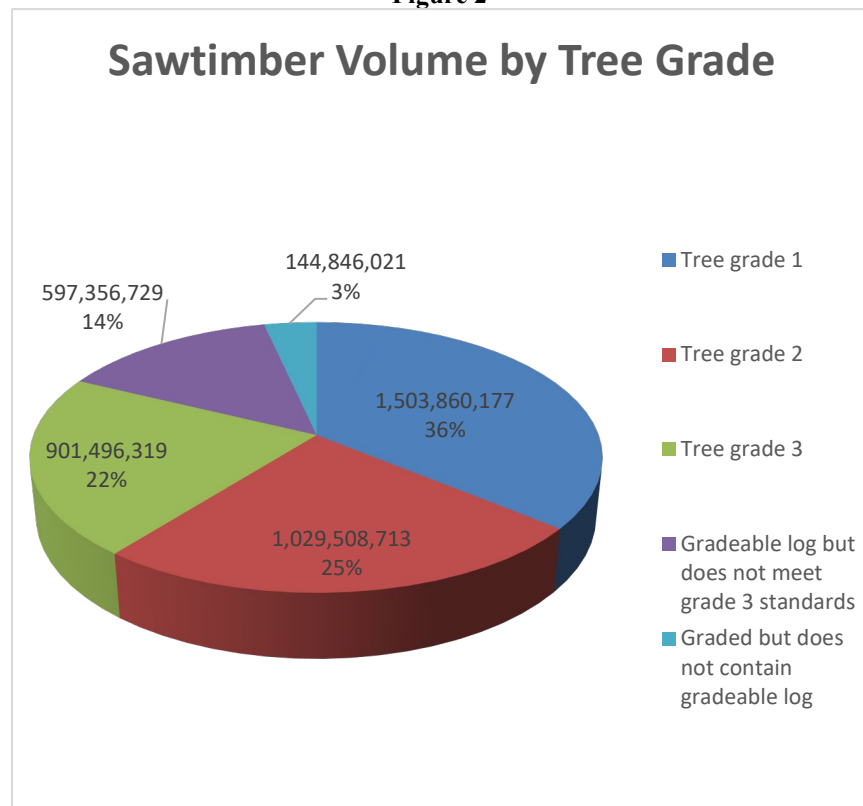
Volume of Sawtimber-sized Trees

The total net sawtimber volume was 4.177 billion board feet Doyle scale. Yellow poplar was the most voluminous species, with 827.5 million board feet (MMBF) or 19.8%, followed by sugar maple (423.1 MMBF) and white oak (408.3 MMBF). Northern red oak, black oak, and red maple were the other major hardwood species ranked by sawlog volume, with 260.7, 235.6, and 180.0 MMBF, respectively (Table 4).

Grade of Sawtimber-sized Trees

Trees are graded using the Forest Service tree-grading system. The system grades the best 12-foot section in the butt, the best 16-foot section for hardwoods. Grade 1 must yield 10 feet clear of defects, grade 2 must yield 8 feet clear, grade 3 must yield 6 feet clear, grade 4 must only be sound (tie grade) and grade 5 has a non-gradable butt log (due to form or rot) but has a gradable upper log (above the butt 16-foot log). It was estimated that 1.504 billion BF of the total net sawtimber volume was grade 1 and 1.029 billion BF and 901 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

Sawtimber Volume by Tree Grade

- Tree grade 1 — 1,503,860,177 — 36%
- Tree grade 2 — 1,029,508,713 — 25%
- Tree grade 3 — 901,496,319 — 22%
- Gradeable log but does not meet grade 3 standards — 597,356,729 — 14%
- Graded but does not contain gradeable log — 144,846,021 — 3%

CHANGE ATTRIBUTES AND ANCILLARY DATA ITEMS

Growth, Removals, and Mortality

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

Standing Dead Trees

There were an estimated 9.4 million standing dead trees with 5 inches d.b.h. and greater. The individual species with the largest number of standing dead trees were white ash and sassafras, with 1.7 and 1.5 million stems. Yellow poplar and American elm followed, with 722,000 and 630,000 standing dead trees, respectively (Table 5). As with the number of live trees, the number of standing dead trees decreased as the diameter increased. Of the 9.4 million standing dead trees, 5.5 million had a diameter from 5-9 inches d.b.h., 2.7 million were from 9-15 inches d.b.h., 795,000 were from 15-19 inches d.b.h., and the remaining 417,000 were 19 inches d.b.h. and greater (Table 5).

Invasive Species

Crews identify any invasive species found on the plot and measure the area of the plot that species occupy. These area estimates are then expanded to the entire 770,123 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 67,531 cumulative acres with invasive species present. Multiflora rose, Japanese (vine) honeysuckle, bush honeysuckle, and stiltgrass are the most prevalent, covering 20,199 acres, 13,627 acres, 13,058 acres, and 7,096 acres, respectively, with autumn olive, black locust, garlic mustard, and others also present.

SUMMARY

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

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

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

INVENTORY METHODS AND TECHNIQUES

In order to better understand Indiana's public forests, to assist in providing public disclosure for forest management, and with third-party certification from SFI and FSC in mind, DoF began designing a CFI system in 2007 on State Forest lands. We then expanded this CFI system to include private lands enrolled in the Classified Forest system in 2011.

We chose to mirror the USDA FIA program for several reasons. The DNR began to negotiate with FIA to build the CFI system to meet the certification audit requirements and yet coincide with the existing FIA standards. A unique system was designed and implementation of plot establishment on the State Forests began in calendar year 2008. The expansion to include the Classified Forest lands began in 2011. The plots on classified lands were spaced such that an approximately equal number of plots per year per natural region, chosen as the reporting unit (an annual panel), would be completed. Annually, these panels can stand alone as an independent survey; therefore, some results of significant value can be analyzed and reported on an annual basis. It took two years to complete the first panel, so 2016 marked our fifth completed panel, or 100 percent of the total sample.

Quality Assurance/Quality Control

The CFI program is the key program that provides the information needed to assess the status and trends of the DoF's Classified Forest lands. The goal of the CFI is to assure the production of complete, accurate, and unbiased forest information of known quality. Specific measurement quality objectives (MQO) for precision are designed to provide a window of performance that we strive to achieve in 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 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 inches of diameter for all trees measured by both production field staff and QA staff.

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

Field Production Protocols

With the annual inventory system, about one-fifth of all field plots are measured each year. After five years, an entire inventory cycle is completed. After the first five years, results can be analyzed and reports created as a moving five-year average. For example, Indiana CFI will be able to generate a report based on inventory results for 2011-2012 through 2016 (the first report with all plots completed), 2013-2017, and so on.

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

Field crews measure vegetation on plots based on FIA standards and protocols with few exceptions. Instead of the four subplot design that FIA uses, Indiana CFI only uses one 24-foot-radius (1/24th acre) circular subplot with the offset 6.8-foot-radius (1/300th acre) microplot. Trees with a d.b.h. of 5 inches and larger are measured on the 24-foot-radius circular subplot. All trees 1 inch d.b.h. and larger are measured on the 6.8-foot-radius circular microplot located 12 feet east of the center of the subplot. Both tree and forest measurements are collected. Some measurements include:
- General stand characteristics such as forest type, stand size and age, slope and aspect, and any recent disturbances
- Tree species, diameter, several different heights, damage, amount of rotten or missing wood, crown measurements, and tree quality
- Counts of tree regeneration
- Presence of identified invasive plants

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

Estimation Errors or Quality of the Estimates

The four primary sources of error common to all sample-based estimates are sampling, measurement, prediction, and non-response error. For each of these sources of error, a definition within the context of the CFI 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 of DoF Classified Forest property is based on a sample of 2,608 plots located randomly across those lands enrolled in the Classified Forest Program (a total area of 759,005 acres), a sampling rate of approximately one plot for every 204 acres. Along with every estimate is an associated sampling error that is typically expressed as a percentage of the estimated value but that can also be expressed in the same units as the estimate or as a confidence interval (the estimated value plus or minus the sampling error). This sampling error is the primary measure of the reliability of an estimate. A sampling error can be interpreted to mean that the chances are two-out-of-three that, if a 100-percent inventory were taken using these methods, the results would have been within the limits indicated (i.e., 67% confidence interval).

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

Measurement Error

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

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

Prediction Error

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

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

Non-response Error

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

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

- Hazardous/inaccessible – Entire plots or portions of plots where the conditions 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 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.

<u>**Data Management**</u>

This collected data is then imported, housed, and processed using a sophisticated Oracle database system. This Oracle system consists of three different but linked databases: MIDAS, NIMS and FIADB. MIDAS is the pre-field database and historical data-housing unit. NIMS is the post-field housing and processing database. FIADB is the database housing the presentation tables. So this Oracle system not only houses the data but also

processes and readies the data for distribution. "Processing" the data combines certain measurements to determine some calculated estimates (e.g., using tree diameter, tree height, site index measurements, tree species, etc. to estimate tree volume using a volume equation).

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

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

APPENDIX

Table 1.—Area of forest land by forest type group and stand size class, IN Classified Forests, 2014-2018.

Table 2.—Number of all live trees by species and diameter class, IN Classified Forests, 2014-2018.

Table 3.—Net volume of all live trees by species and diameter class, IN Classified Forests, 2014-2018.

Table 4.—Sawtimber volume of all live trees by species and diameter class, IN Classified Forests, 2014-2018.

Table 5.—Number of standing dead trees 5" d.b.h. and greater by species and diameter class, IN Classified Forests, 2014-2018.

Table 1.—Area of forest land by forest type group and stand-size class, Indiana Classified Forests, 2014-2018.

Estimate: Total-Area of forestland(acres)

Forest type	Stand-size	Large diameter	Medium diameter	Small diameter	Nonstocked
All	770,123	573,500	115,651	52,855	28,117
White oak / red oak / hickory	165,462	137,323	20,552	7,587	-
Hard maple / basswood	66,648	53,913	9,091	3,645	-
White oak	52,785	51,454	1,331	-	-
Yellow-poplar	48,893	37,490	8,145	3,258	-
Cherry / white ash / yellow-poplar	48,559	25,036	14,957	8,566	-
Sugar maple / beech / yellow birch	38,906	34,638	3,899	369	-
Mixed upland hardwoods	38,805	28,320	7,385	3,100	-
Northern red oak	27,448	26,399	311	738	-
Sugarberry / hackberry / elm / green ash	26,823	17,608	7,577	1,638	-
Other miscellaneous hardwood forest types	231,549	142,407	38,292	22,735	28,117
Miscellaneous softwood forest types	12,722	11,063	1,659	-	-
Pine/Hardwood	11,523	7,851	2,453	1,220	-

Table 2.—Number of all live trees by species and diameter class, Indiana Classified Forests, 2014-2018.

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

Species	Diameter class	0.1-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0+
All	307,150,454	160,723,707	55,272,044	26,139,375	17,703,056	12,025,791	10,019,827	7,669,851	5,588,945	4,287,017	3,110,592	1,886,148	2,724,102
sugar maple	63,084,707	34,645,668	11,723,050	6,027,406	3,672,463	2,295,258	1,702,278	1,083,375	757,175	598,594	247,963	144,949	186,527
other hardwood species	56,617,992	28,330,033	9,583,094	5,931,407	3,771,580	2,796,919	1,946,691	1,509,989	1,059,972	668,216	452,250	225,673	342,185
American beech	22,062,857	14,181,890	4,564,104	1,131,913	529,622	373,474	395,842	253,126	221,891	83,491	133,575	62,705	131,224
yellow-poplar	17,735,178	7,328,751	3,396,657	1,272,232	991,016	745,248	896,230	766,786	551,853	482,770	511,404	227,248	564,985
red maple	17,517,712	8,127,814	3,563,740	1,768,549	1,284,556	773,966	710,012	458,862	260,854	212,024	121,435	72,554	163,346
sassafras	14,445,660	8,655,291	2,792,553	1,067,090	710,540	516,302	317,479	241,080	86,162	21,597	30,367	-	7,199
other oaks	13,536,064	4,121,925	1,488,799	1,358,449	1,059,964	835,255	906,530	696,827	624,273	698,773	655,628	507,597	582,053
American elm	11,025,874	4,902,390	3,266,487	1,433,391	704,950	327,763	193,543	106,554	41,211	31,938	8,877	8,770	-
flowering dogwood	10,812,507	7,410,759	3,029,000	286,615	77,363	8,770	-	-	-	-	-	-	-
white ash	10,609,444	6,589,746	1,210,287	752,332	488,168	401,458	309,766	205,741	335,787	107,742	80,040	78,578	49,799
pawpaw	10,150,131	9,834,909	308,126	7,096	-	-	-	-	-	-	-	-	-
other hickories	9,723,718	2,733,743	1,914,789	704,936	893,629	677,694	859,978	672,410	424,430	339,143	258,596	84,876	159,497
eastern hophornbeam	6,801,035	5,578,931	801,833	318,884	74,756	26,631	-	-	-	-	-	-	-
American hornbeam	6,732,810	5,249,977	1,281,336	162,670	22,962	15,866	-	-	-	-	-	-	-
other maples	6,368,301	2,969,429	888,667	792,244	611,769	305,708	169,950	203,990	108,339	154,184	26,417	52,726	84,879
other elms	5,807,775	3,275,083	1,003,891	747,485	418,070	195,577	86,347	48,699	14,976	8,877	0	0	8,770
white oak	5,789,678	1,119,477	703,254	407,053	422,136	328,858	428,069	404,002	440,711	538,051	347,760	278,219	372,087
eastern redcedar	5,723,362	1,886,306	1,433,523	904,892	768,644	438,627	115,722	137,896	30,264	7,488	-	-	-
shagbark hickory	5,675,259	1,575,094	927,131	470,483	554,141	436,649	449,568	471,011	384,990	200,162	119,678	69,986	16,365
other softwood species	3,648,423	980,225	179,173	397,898	502,706	379,822	420,950	336,566	178,825	116,430	63,773	45,636	46,419
other ashes	3,281,967	1,226,266	1,212,550	196,355	144,021	145,954	110,874	72,938	67,235	17,540	52,833	26,631	8,770

Table 3.—Net volume of all live trees by species and diameter class, Indiana Classified Forests, 2014-2018.

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

Species	Diameter class	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0+
All	1,610,464,671	59,128,093	88,166,844	112,807,959	154,670,924	180,604,568	186,245,205	193,268,247	184,619,395	137,660,513	313,292,923
yellow-poplar	239,327,071	3,347,006	5,599,662	8,181,696	15,937,291	21,678,973	21,914,326	26,053,155	36,822,212	20,106,600	79,686,149
sugar maple	215,823,999	15,504,330	20,227,955	23,630,684	28,678,019	26,912,107	26,899,175	28,005,902	15,179,235	10,686,346	20,100,247
other hardwood species	160,132,061	11,272,565	13,925,106	16,993,030	18,549,662	21,088,640	18,407,551	16,857,758	16,411,789	7,514,749	19,111,211
white oak	132,199,062	954,317	2,164,407	2,964,454	6,410,628	8,912,426	13,185,383	21,871,713	18,374,002	18,382,177	38,979,556
red maple	88,572,233	4,357,216	6,881,490	7,410,553	11,070,619	10,899,974	8,624,652	9,701,609	6,697,339	5,282,727	17,646,052
other oaks	80,492,157	1,825,666	3,222,066	4,000,342	5,994,344	4,473,401	8,696,067	11,854,987	13,424,947	10,330,971	16,669,361
northern red oak	77,856,071	538,083	982,482	1,944,943	3,657,766	4,973,650	5,352,297	8,779,591	13,041,136	17,151,160	21,434,963
black oak	70,291,943	839,167	1,234,827	1,776,115	3,720,436	6,177,269	5,261,583	8,787,840	9,759,878	8,765,164	23,969,664
shagbark hickory	63,499,873	1,151,346	2,844,340	4,472,688	7,163,886	11,192,059	13,239,508	9,178,303	7,370,344	5,278,539	1,608,860
pignut hickory	61,900,462	922,677	2,132,416	3,397,707	8,379,974	8,962,768	6,425,600	9,380,918	7,838,325	3,951,831	10,508,245
redcedar and pine species	58,946,798	2,778,500	6,014,687	7,129,917	7,856,374	10,453,545	6,544,945	5,603,243	3,666,781	3,303,100	5,595,702
American beech	58,012,715	2,687,631	2,648,392	3,611,950	5,994,822	5,914,892	7,375,946	3,684,165	7,259,707	4,420,238	14,414,971
white ash	48,667,699	1,584,656	2,357,502	3,870,751	4,684,516	4,798,486	10,953,326	4,579,051	4,787,052	5,489,515	5,562,844
black walnut	46,528,063	1,261,826	2,140,106	4,770,711	5,918,379	6,317,931	9,252,380	3,717,909	5,185,659	2,505,900	5,457,262
other maples	40,403,825	1,603,531	2,765,569	2,784,070	2,248,650	4,547,593	3,779,387	6,867,822	1,605,457	3,913,364	10,288,382
black cherry	40,135,785	2,478,501	3,889,309	5,108,086	5,725,664	6,850,498	5,261,131	5,050,611	3,479,715	1,611,663	680,607
bitternut hickory	40,080,660	657,723	2,073,890	2,611,395	4,558,068	5,517,760	6,033,487	5,254,065	5,744,671	2,555,896	5,073,705
American sycamore	34,175,949	518,494	1,214,370	1,989,891	1,520,963	3,888,563	2,581,600	4,060,154	2,110,861	3,918,647	12,372,405
elms	24,811,845	4,289,493	4,816,933	4,123,243	3,718,449	3,031,541	1,585,660	1,634,534	327,590	640,626	643,776
other ashes	14,663,712	424,612	735,898	1,385,250	1,685,703	1,785,340	2,261,717	873,056	2,930,159	1,851,300	730,678
other hickories	13,942,692	130,753	295,434	650,483	1,196,709	2,227,153	2,609,484	1,471,862	2,602,533	-	2,758,281

Table 4.—Sawtimber volume of all live trees by species and diameter class, Indiana Classified Forests, 2014-2018.

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

Species	Diameter class	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0 +
All	4,177,067,959	8,524,458	289,587,812	422,551,493	510,097,522	591,548,155	621,936,801	490,446,270	1,242,375,448
yellow-poplar	827,526,418	-	31,645,756	56,079,876	66,004,205	87,942,168	138,782,087	75,976,845	371,095,480
sugar maple	423,117,148	-	54,566,581	63,695,307	72,291,053	83,471,737	47,116,600	36,226,969	65,748,901
white oak	408,328,895	-	12,722,405	21,586,164	35,746,836	65,841,287	58,914,882	64,325,955	149,191,367
other hardwood species	262,014,717	-	31,485,578	39,924,699	38,469,905	36,053,243	47,024,020	15,439,443	53,617,829
northern red oak	260,710,843	-	7,376,592	12,183,784	15,727,234	28,698,072	46,234,096	65,422,113	85,068,953
black oak	235,584,990	-	7,673,423	15,645,865	15,271,404	28,327,523	33,978,339	32,736,697	101,951,739
red maple	180,001,900	-	17,801,858	21,604,363	20,999,616	26,378,603	18,102,770	17,964,456	57,150,234
pignut hickory	174,968,350	-	17,233,000	22,058,094	18,819,162	29,649,698	27,997,602	13,387,438	45,823,355
shagbark hickory	158,490,339	-	14,267,281	27,494,409	37,001,558	29,247,017	23,900,113	20,091,257	6,488,703
other softwoods and redcedar	156,361,845	8,524,458	17,324,240	27,588,155	22,024,108	20,974,970	16,127,511	14,889,289	28,909,113
American beech	153,114,156	-	11,750,158	14,210,132	20,576,810	11,010,624	22,533,856	15,491,639	57,540,937
other oaks	146,657,653	-	10,602,584	7,896,221	19,457,953	29,233,333	27,637,451	19,711,771	32,118,341
white ash	120,452,274	-	8,397,050	10,774,511	28,509,577	13,419,199	16,402,694	19,162,182	23,787,061
bitternut hickory	111,265,845	-	9,468,847	13,563,309	17,688,700	16,161,753	20,549,662	9,922,075	23,911,498
black walnut	100,297,263	-	11,302,131	15,704,938	25,635,097	10,823,360	16,177,692	5,795,873	14,858,173
American sycamore	96,408,803	-	2,587,145	9,160,020	7,004,542	12,501,504	7,070,268	14,566,291	43,519,033
other maples	80,449,233	-	2,264,847	7,272,587	8,257,877	18,254,117	5,028,024	11,534,199	27,837,580
pin oak	78,779,182	-	925,691	2,987,400	4,330,387	8,425,579	16,058,006	17,889,644	28,162,475
black cherry	65,213,237	-	9,967,351	14,521,387	10,729,586	14,193,376	10,226,149	5,575,388	-
sweetgum	63,239,746	-	4,855,366	9,173,933	11,835,848	14,513,357	4,045,098	7,428,598	11,387,546
other hickories	38,173,743	-	2,190,253	5,531,509	7,446,660	3,695,332	7,991,677	-	11,318,311
other ashes	35,911,381	-	3,179,675	3,894,827	6,269,405	2,732,302	10,038,203	6,908,151	2,888,819

Table 5.—Number of standing dead trees 5" d.b.h. and greater by species and diameter class, Indiana Classified Forests, 2014-2018.

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

Species	Diameter class	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-22.9	23.0+
All	9,428,234	3,286,664	2,186,836	1,306,145	853,028	584,277	402,342	392,367	187,520	115,971	113,086
white ash	1,757,033	390,922	356,226	250,131	167,448	156,373	117,823	118,322	92,696	74,756	32,338
sassafras	1,522,659	787,670	363,949	216,570	98,680	23,746	32,045	-	-	-	-
other hardwoods	952,657	379,299	198,438	182,561	97,718	14,398	7,199	51,263	14,687	-	7,096
yellow-poplar	722,481	300,737	151,791	78,180	84,191	62,915	-	28,590	7,199	8,877	-
American elm	629,877	204,570	186,591	92,977	86,878	33,620	16,365	8,877	-	-	-
sugar maple	383,092	128,481	111,297	51,054	7,199	37,859	24,739	22,464	-	-	-
slippery elm	375,335	140,289	91,010	54,907	33,620	30,268	16,365	8,877	-	-	-
black locust	360,579	80,537	83,501	83,597	15,866	37,257	15,973	26,310	17,540	-	-
eastern redcedar	353,917	180,973	100,767	43,091	29,085	-	-	-	-	-	-
black cherry	341,823	130,447	102,422	26,631	39,719	17,754	24,850	-	-	-	-
white oak	260,460	41,000	59,642	61,423	7,199	24,850	23,457	17,754	17,647	7,488	-
eastern white pine	257,849	102,345	46,344	32,441	32,441	17,754	17,754	8,770	-	-	-
other oaks	239,624	71,194	39,430	14,976	14,976	32,730	22,464	29,271	7,096	-	7,488
red maple	195,656	62,779	49,877	14,976	16,365	-	7,488	8,877	8,770	8,877	17,647
American beech	172,637	30,656	14,295	30,763	7,199	37,467	-	7,199	7,199	7,096	30,763
black oak	151,926	30,474	24,846	7,199	33,797	15,969	7,199	7,199	7,488	-	17,754
other hickories	139,915	21,886	30,371	15,969	23,461	16,076	23,275	-	-	8,877	-
Virginia pine	135,985	31,835	59,511	14,976	-	7,488	14,687	7,488	-	-	-
other softwoods	133,607	59,848	21,886	17,754	16,365	8,877	8,877	-	-	-	-
other ashes	131,326	48,014	42,386	7,199	26,631	-	7,096	-	-	-	-
black walnut	116,252	40,926	37,570	-	14,192	8,877	14,687	-	-	-	-
pignut hickory	93,546	21,783	14,687	8,770	-	-	-	41,108	7,199	-	-