IN DNR Classified Forests
Report of Continuous Forest Inventory (CFI)
Summary of years 2012-2016

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FOREWARD

This report provides an overview of forest resource attributes for privately-owned land enrolled in the IN DNR Division of Forestry's Classified Forest Program based on findings from a continuous annual inventory conducted by the Forest Resource Information (FRI) Section of the IN DNR-Division of Forestry. The CFI inventory of Indiana DNR Division of Forestry Classified Forest lands is based on a sample of 2,404 plots located randomly across those lands enrolled in the program (a total area of 491,653 acres), a sampling rate of approximately one plot for every 204 acres. It should be noted that there are also acres enrolled in the program that originated as Classified Wildlife acres under the Division of Fish and Wildlife but are now managed with the Classified Forest program…these acres are not included in this sample. Information in this report are 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 first five panels of plot installation and data collection for the years 2012-2016, which constitutes an entire cycle or total sample population. All initial plots have been installed and measured now. Change attributes such as growth, removals, and mortality will not be reported until a later date as plot re-measurement must occur.

EXECUTIVE SUMMARY/HIGHLIGHTS

This is the second annual reported results of the classified forest continuous forest inventory (CFI), the first with all panels of annual plots (100% of the total sample) being measured. 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:

- 491,653 total acres; 485,976 forested acres with the balance in non-forest (i.e. open areas) and water
- 98% of the forested acres are hardwoods
- 75% of the forested acres are sawlog-sized stands
- Forests contain 202 million live trees
- Sugar maple trees and seedlings are more abundant than any other species
- 1.040 billion cubic feet of total live tree volume
- 2.523 billion board feet (Doyle) of sawlog volume
- Yellow poplar followed by sugar maple are the species with the most sawlog volume
- 58% of the sawlog volume is considered grade 1 or 2
- Growth exceeds harvest
- Japanese honeysuckle and multiflora rose are the most common invasive species

FOREST COMPOSITION

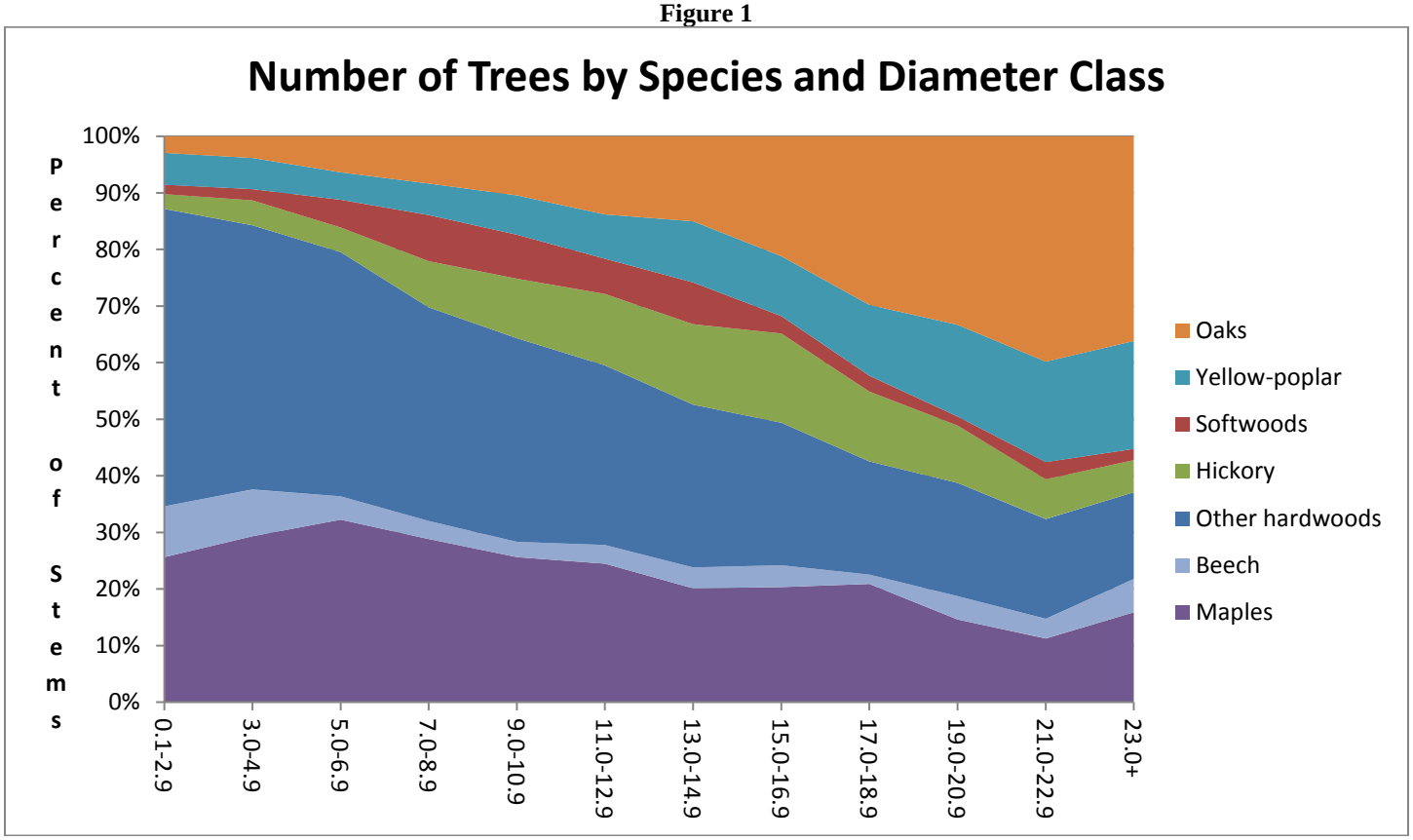
Area

Classified Forest lands are comprised of approximately 491,653 acres located primarily in the southern 1/3 of Indiana. An estimated 485,976 of these acres are considered forestland (land considered stocked with trees or seedlings that is at minimum 1 acre in size and 120 feet in width), with the remaining ~5,000 acres being non-forest (open fields, right-of-ways, 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 98% of the total forest area classified as hardwood forest types. The primary hardwood forest types were white oak/red oak/hickory (110,902 acres, 23%), mixed upland hardwoods (42,356 acres, 9%), hard maple/basswood (36,472 acres, 7%), yellow poplar (32,521 acres, 6%) and cherry/ash/poplar (29,122 acres, 6%) (Table 1). Many forest types are very similar and difficult to discern…as an example mixed upland hardwoods, hard maple/basswood, sugar maple/beech/birch and some in the miscellaneous hardwood forest types would all include a heavy component of maple. Seventy-five percent of the area was considered sawlog-sized stands (large diameter or 11.0" d.b.h. and greater), with the remainder classified as poles (medium diameter or 5.0-10.9" d.b.h.) and seedling/saplings (small diameter or 1.0-4.9" d.b.h.) (Table 1).

Number of Live Trees

It is estimated that there are 202 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 40.7 million trees followed by beech, yellow poplar, and red maple with 14.6 million, 12.6 million and 11.3 million trees respectively (Table 2). Over ½ of the number of trees were less than 3 inches d.b.h. with 142.6 million (70%) being less than 5 inches d.b.h. An item of concern is the non-uniform distribution of the number of stems by diameter class for different species (Figure 1). In this sample, all oak species combined represented only 3.1% of all saplings 1 inch to less than 5 inches d.b.h. The lack of oak seedlings/saplings and abundance of maple 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" d.b.h. and above was 1.040 billion cubic feet (cuft) or 2,142 cuft per forested acre on average. Hardwoods constituted 999.7 million cuft or 96%. Oaks made up 238.7 million cuft or 23%, maples were 215.7 million cuft or 21%, yellow poplar was 160.0 million cuft or 15%, and hickories were 112.2 million cuft or 11% of the total volume (Table 3). Approximately 173.8 million cuft or 16% of the volume is in pole-sized trees (trees <11" d.b.h.) with the remainder being sawlog-sized (11" and greater d.b.h.). 185.8 million cuft or 17% is 23" or greater d.b.h. (Table 3). It was estimated that 971.7 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" d.b.h. and greater, softwoods 9" d.b.h. and greater).

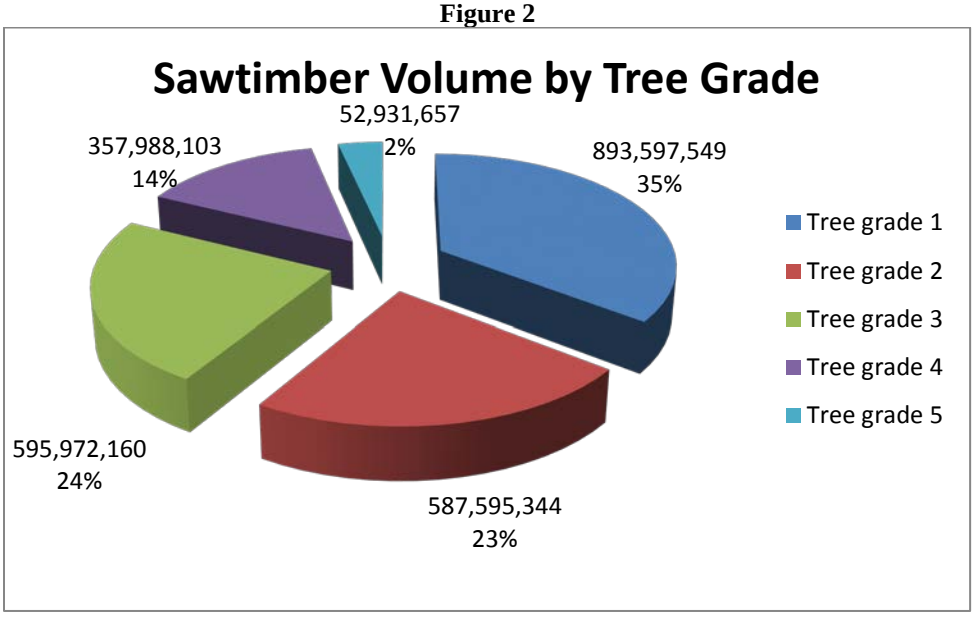
Volume of Sawtimber-sized Trees

The total net sawtimber volume was 2.523 billion board feet Doyle scale (5,192 Bdft/acre). Yellow poplar was the most voluminous species with 511.9 million board feet (MMBF) or 20%, with sugar maple second with 252.8 MMBF or 10%. White oak, northern red oak, other oaks, and black oak were the other major hardwood species groups ranked by sawlog volume with 251.7, 164.2, 148.9, and 132.8 MMBF respectively (Table 4).

Grade of Sawtimber-sized Trees

Trees are graded using the Forest Service tree grading system. It grades the best 12' section in the butt 16' for hardwoods. Grade 1 must yield 10' clear of defects, grade 2 must yield 8' clear, grade 3 must yield 6' 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' log). It was estimated that 893 MMBF of the total net sawtimber volume was grade 1 and 587 and 595 MMBF in grades 2 and 3 respectively (Figure 2). Ninety-seven percent of the sawtimber volume of trees had 0-10% cull deductions.

Figure 2



CHANGE ATTRIBUTES AND ANCILLARY DATA ITEMS

Growth, Removals, and Mortality

As stated earlier, the "goal of the first five years of the classified forest inventory system is 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 will begin 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 5.4 million standing dead trees 5" d.b.h. and greater. The individual species with the largest number of standing dead trees was sassafras with 899 thousand stems. The ash group was second with

621 thousand standing dead trees with yellow poplar, American elm, and sugar maple following with 478, 402 and 293 thousand 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 5.4 million standing dead trees, 3.3 million had a diameter from 5-9" d.b.h., 1.6 million were from 9-15" d.b.h., 362 thousand were from 15-19" d.b.h., and the remaining 198 thousand were 19" d.b.h. and greater (Table 5).

Invasive Species

If present, crews identify any invasive species found on plot and measure the area of the plot that species occupy. These area estimates are then expanded to the entire 485,976 forested acres to estimate a total area that each invasive species occupy. Some plots may have multiple species present, while the majority of plots are free from invasive species. There were an estimated 1,057 cumulative acres with invasive species present. Japanese (vine) honeysuckle and multiflora rose are the most prevalent covering 385 acres and 287 acres respectively, with oriental bittersweet, autumn olive, garlic mustard, bush honeysuckle, 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 favorable to prior estimates available from the FIA program.

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

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

INVENTORY METHODS AND TECHNIQUES

In order to have a better understanding of Indiana's public forests, to assist in providing public disclosure for forest management, and with third party certification from FSC® and the SFI® program* (www.sfiprogram.org) in mind, Indiana DNR Division of Forestry began designing a Continuous Forest Inventory (CFI) system in 2007 on state forest lands (FSC-C012858). We then expanded this CFI system to include private lands enrolled in the classified forest system in 2011 (FSC-C071226). The USDA Forest Service Forest Inventory and Analysis (FIA) program was chosen to mirror for several reasons. The IN 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 approximately an equal number of plots per year per natural regions, chosen as the reporting unit, (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. It took 2 years to get the first panel completed, so 2016 was our fifth completed panel or 100 percent of the total sample.

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Quality Assurance/Quality Control

The CFI program is the key program that provides the information needed to assess the status and trends of the IN DNR-Division of Forestry'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 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 the field staff member has 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 data measured in the field has an associated MQO for precision. This is an assigned tolerance or acceptable level of measurement error, and measure 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 DBH is +/- 0.1 inch for each 20.0 inches of diameter of a live tree with the MQO for DBH 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 DBH would be that 95% or more of the DBH 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 5 years, an entire inventory cycle is completed. After the first 5 years, results can be analyzed and reports created as a moving 5-year average. For example, Indiana CFI will be able to generate a report based on inventory results for 2011/12 through 2016 (the first report with all plots completed), 2013 through 2017 and so on. Until then, we will provide limited data if statistically significant (this report).

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. 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 ($1/300^{th}$ acre) microplot. Trees with a d.b.h. 5 inches and larger are measured on the 24-foot-radius circular subplot. All trees 1 inch d.b.h. and larger are measured on the 6.8-foot-radius circular microplot located 12 feet east of the center of the subplot. Both tree and forest measurements are collected. Some measurements include:

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

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

Estimation Errors or Quality of the Estimates

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

Sampling Error

The process of sampling (selecting a random subset of a population and calculating estimates from this subset) causes estimates to contain error they would not have if every member of the population had been observed and included in the estimate. The CFI inventory of Indiana DNR Division of Forestry classified forest property is

based on a sample of 2,405 plots located randomly across those lands enrolled in the Classified Forest Program (a total area of 491,653 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 had a 100-percent inventory been taken using these methods, the results would have been within the limits indicated (i.e., 67-percent 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, 6 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 other data sources, users need to be aware of the prediction models used in both estimates. If both estimates are based on the same prediction models with matching fitted parameter values, then the prediction bias of one estimate should cancel out that of the other estimate. If the estimates are based on different prediction models, then the user should be aware of the prediction error of both models.

Non-response Error

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

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

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

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

Non-response has two effects on the sample. First, it reduces the sample size. The reduced sample size is reflected in the sampling errors discussed in that section. Second, non-response can bias 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 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 of how to use EVALIDator has been attended.

APPENDIX

Table 1.—Area of forestland by forest type group and stand size class, IN Classified Forests, 2012-2016.

Table 2.—Number of all live trees by species and diameter class, IN Classified Forests, 2012-2016.

Table 3.—Net volume of all live trees by species and diameter class, IN Classified Forests, 2012-2016.

Table 4.—Sawtimber volume of all live trees by species and diameter class, IN Classified Forests, 2012-2016.

Table 5.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, IN Classified Forests, 2012-2016.

Table 1.—Area of forestland by forest type group and stand size class, IN Classified Forests, 2012-2016.

Estimate: Total-Area of forestland (acres)

Forest type	Stand-size	Large diameter	Medium diameter	Small diameter	Nonstocked
All	485,876	365,070	81,246	27,472	12,089
White oak / red oak / hickory	110,902	90,400	15,149	5,353	-
Mixed upland hardwoods	42,356	32,536	8,206	1,615	-
Hard maple / basswood	36,472	530	-	-	-
Yellow-poplar	32,521	24,929	5,654	1,938	-
Cherry / white ash / yellow-poplar	29,122	1,859	1,783	-	-
White oak	27,413	26,616	798	-	-
Sugar maple / beech / yellow birch	23,158	286	265	-	-
Pine/Hardwood	9,630	6,718	2,912	-	-
Other miscellaneous hardwood forest types	161,481	172,578	45,110	15,962	12,089
Miscellaneous softwood forest types	12,820	8,068	1,370	532	-

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Table 2.—Number of all live trees by species and diameter class, IN Classified Forests, 2012-2016.

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	202,250,780	106,874,357	35,735,458	17,138,298	11,429,306	8,307,309	6,558,133	4,775,668	3,707,352	2,779,251	2,019,638	1,305,959	1,620,053
sugar maple	40,736,877	21,320,401	8,193,314	4,235,230	2,370,433	1,536,095	1,144,168	567,947	581,548	388,669	179,470	96,560	123,042
American beech	14,642,285	9,589,154	2,953,222	707,104	362,187	226,574	214,778	176,358	142,184	45,717	83,680	45,173	96,152
yellow-poplar	12,643,782	6,000,304	1,956,857	832,652	640,057	575,639	514,963	514,712	391,967	347,981	327,648	231,746	309,255
red maple	11,286,913	5,345,839	2,275,882	1,183,009	797,816	501,995	417,230	316,790	115,951	134,603	89,553	18,958	89,287
sassafras	10,583,187	7,006,772	1,519,906	733,464	444,676	400,219	265,141	134,930	45,540	19,235	6,412	6,892	-
ash species	9,246,407	5,277,797	1,028,712	706,928	487,751	467,888	331,453	228,871	291,980	173,688	123,982	76,593	50,765
other oaks	8,992,596	2,648,722	1,040,365	818,771	639,672	626,646	586,615	510,013	478,312	489,418	434,797	352,699	366,567
flowering dogwood	8,706,281	6,706,935	1,744,752	209,080	45,514	-	-	-	-	-	-	-	-
American elm	7,292,945	3,518,653	2,067,717	915,296	388,981	211,087	114,976	44,339	12,750	19,146	-	-	-
black cherry	6,615,811	2,647,947	1,600,850	737,897	646,463	365,888	276,193	148,505	102,130	44,911	25,384	13,267	6,375
redcedar and pine species	5,966,145	1,775,941	714,310	841,501	929,065	648,438	408,689	352,055	115,441	77,132	31,792	39,571	32,210
other hickories	5,756,823	1,447,397	952,963	455,859	599,053	531,883	543,568	386,897	347,100	226,537	134,622	46,197	84,747
hackberry	5,358,154	2,704,267	1,105,643	572,377	342,022	228,092	157,972	94,940	39,284	25,384	31,363	6,260	50,551
other elms	4,274,443	2,250,529	961,744	504,865	318,560	82,532	91,043	39,206	19,642	-	-	-	6,323
shagbark hickory	4,000,985	1,356,470	629,388	288,849	332,468	340,672	281,784	294,282	237,607	117,096	70,151	45,325	6,892
sweetgum	3,609,564	2,365,649	234,661	260,615	138,439	126,514	120,557	158,104	70,149	64,054	31,718	25,950	13,152
white oak	3,440,257	482,355	336,872	271,342	312,809	240,003	318,606	208,100	306,805	338,610	237,630	167,579	219,546
blackgum	3,029,550	1,470,022	649,854	353,861	238,059	115,399	63,928	58,844	39,431	6,892	27,000	6,260	-
black walnut	2,813,040	716,216	400,910	361,855	279,299	336,904	235,252	177,950	127,160	63,159	44,431	31,823	38,082
common small hardwood species	19,419,879	16,107,134	2,664,568	527,007	83,016	31,745	6,412	-	-	-	-	-	-
other hardwood species	13,834,858	6,135,854	2,702,965	1,620,739	1,032,966	713,098	464,810	362,827	242,371	197,016	140,004	95,105	127,104

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Table 3.—Net volume of all live trees by species and diameter class, IN Classified Forests, 2012-2016.

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	1,040,714,753	38,389,124	57,136,139	78,157,923	101,567,615	111,981,632	125,073,997	125,988,920	119,321,564	97,278,578	185,819,261
yellow-poplar	159,998,081	2,155,126	3,705,799	6,385,638	9,176,313	14,470,612	15,609,783	19,180,812	22,954,784	21,140,541	45,218,673
sugar maple	143,257,900	10,690,506	13,066,991	15,728,624	19,381,267	14,154,309	21,007,880	18,109,225	11,109,948	7,119,958	12,889,192
white oak	84,416,883	663,705	1,602,234	2,125,086	4,863,421	4,587,541	9,212,612	13,754,125	12,599,196	10,990,716	24,018,248
ash species	54,106,541	1,495,344	2,346,662	4,460,027	4,939,893	5,317,220	9,323,291	7,556,928	7,276,662	5,434,981	5,955,532
other oaks	56,494,497	1,004,909	1,938,909	2,721,414	4,122,211	3,061,410	6,415,581	9,452,014	7,265,546	7,112,094	13,400,406
northern red oak	51,635,176	337,150	728,070	1,390,429	2,342,229	3,633,718	3,977,074	5,213,142	8,699,779	11,945,827	13,367,759
black oak	46,171,665	638,900	663,821	1,669,906	2,181,720	4,643,794	4,586,847	5,972,398	7,989,017	5,836,378	11,988,883
red maple	51,704,838	2,859,938	4,240,041	4,795,158	6,486,274	7,302,707	3,988,717	6,165,042	5,008,299	1,426,013	9,432,650
redcedar and pine species	41,182,112	1,863,488	4,531,749	5,585,019	6,161,093	7,297,463	3,509,366	3,519,097	1,862,646	2,905,576	3,706,141
shagbark hickory	39,338,746	737,623	1,577,458	3,439,155	4,591,933	7,077,581	8,327,688	5,252,675	4,362,871	3,303,450	668,312
other hardwood species	46,843,071	3,931,372	4,157,198	4,866,501	5,125,840	5,426,802	5,260,292	3,982,648	6,991,615	2,243,476	4,857,319
pignut hickory	38,152,901	577,484	1,509,777	3,165,208	5,430,494	4,794,943	5,278,816	5,792,261	4,448,426	2,593,186	4,562,307
American beech	37,727,259	1,628,089	1,801,711	2,177,422	3,123,493	4,128,601	4,572,814	1,996,974	4,749,101	3,381,395	10,167,659
other hickories	34,747,839	504,767	1,595,466	2,173,102	3,644,506	4,631,609	7,190,427	5,080,676	3,908,855	997,880	5,020,550
black walnut	25,408,225	774,570	1,373,740	2,973,416	3,384,808	3,828,713	3,872,901	2,384,237	2,184,997	2,064,092	2,566,753
black cherry	22,261,446	1,464,092	2,970,853	2,966,037	3,717,528	3,307,526	3,229,941	1,950,136	1,492,339	742,117	420,877
American sycamore	20,320,128	212,816	633,785	1,266,874	1,249,329	2,081,998	1,933,748	2,584,896	1,378,991	3,174,591	5,803,101
sweetgum	17,599,104	529,135	616,314	1,178,635	1,708,390	3,593,377	2,251,692	2,751,068	1,676,224	1,834,385	1,459,885
other maples	20,698,135	1,082,221	1,681,638	1,685,688	1,536,208	2,061,904	2,145,431	2,497,310	1,456,758	2,224,282	4,326,696
hackberry	18,200,985	1,143,865	1,478,953	1,898,798	2,160,507	1,925,598	1,104,145	1,118,344	1,547,212	213,994	5,609,570
sassafras	16,074,983	1,430,475	1,973,376	3,077,772	3,591,919	2,764,812	1,337,372	947,313	358,295	593,648	-
elms	14,374,240	2,732,388	3,051,563	2,361,853	2,692,694	1,605,811	823,582	727,601	-	-	378,748

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Table 4.—Sawtimber volume of all live trees by species and diameter class, IN Classified Forests, 2012-2016.

Estimate: Total-All live net sawtimber volume on forestland (bdft - 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	2,522,947,194	6,763,363	177,264,156	246,702,265	320,495,792	359,566,923	382,290,299	330,210,406	699,653,990
yellow-poplar	511,919,032	-	16,790,594	35,617,501	41,359,589	59,255,968	82,110,912	77,545,031	199,239,435
sugar maple	252,790,580	-	33,254,980	29,903,107	53,044,951	48,170,215	33,670,696	17,988,070	36,758,561
white oak	251,712,810	-	9,752,580	11,337,925	24,244,768	40,433,778	40,146,494	35,620,153	90,177,113
northern red oak	164,240,011	-	4,585,463	8,114,847	10,975,542	16,131,195	28,302,655	42,430,287	53,700,022
other oaks	148,884,769	-	7,662,540	6,031,488	17,400,090	28,155,647	18,878,598	24,097,068	46,659,344
black oak	132,848,028	-	4,296,387	11,343,401	11,526,668	18,365,098	23,028,885	20,330,836	43,956,753
ash species	130,281,657	-	7,968,147	10,693,612	24,514,876	19,453,079	22,604,257	19,331,604	25,716,080
pignut hickory	98,363,855	-	10,135,432	11,512,954	13,952,635	18,030,844	15,883,648	8,289,967	20,558,374
red maple	96,688,697	-	9,595,912	14,080,759	6,967,050	17,333,313	14,046,713	3,347,536	31,317,415
American beech	94,680,773	-	5,943,838	8,478,445	13,100,328	6,504,568	15,740,898	10,679,798	34,232,898
shagbark hickory	94,667,801	-	8,522,680	16,588,278	22,351,275	16,736,553	15,200,626	12,580,960	2,687,428
other hickories	87,684,720	-	6,639,049	10,654,098	19,024,998	13,773,591	11,311,761	3,861,006	22,420,218
American sycamore	53,257,476	-	2,160,855	4,574,116	4,485,726	6,959,919	4,674,875	11,451,797	18,950,190
eastern white pine	51,402,989	1,739,336	6,214,391	7,975,166	2,147,872	6,630,139	4,825,891	12,956,623	8,913,571
black walnut	48,359,283	-	6,580,210	9,317,252	10,433,942	5,380,105	6,501,587	6,317,429	3,828,757
sweetgum	38,964,492	-	2,947,588	7,785,525	5,555,028	7,580,631	3,315,270	6,328,031	5,452,418
black cherry	31,792,526	-	5,469,220	6,879,941	7,288,265	5,771,194	4,786,526	1,597,380	-
other hardwood species	183,763,490	-	22,414,264	26,241,575	22,211,046	18,694,276	33,790,466	15,456,833	44,955,032
other pines and redcedar	50,644,199	5,024,027	6,330,022	9,572,275	9,911,139	6,206,814	3,469,540	-	10,130,382

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Table 5.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, IN Classified Forests, 2012-2016.

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	5,469,784	1,960,990	1,347,216	841,856	476,108	282,801	220,246	141,952	108,338	51,590	38,688
sassafras	899,241	6,323	-	-	-	-	-	-	-	-	-
ashes	621,770	108,145	114,953	104,324	64,251	63,843	38,688	44,734	44,509	31,948	6,375
yellow-poplar	478,846	226,638	123,390	46,250	31,793	25,610	6,323	12,520	6,323	-	-
American elm	402,338	-	6,375	6,375	-	-	-	-	-	-	-
sugar maple	292,935	110,192	71,619	46,171	12,583	25,939	12,646	13,784	-	-	-
eastern redcedar	280,936	120,140	102,611	32,058	26,127	-	-	-	-	-	-
eastern white pine	228,112	111,342	46,020	12,786	26,053	12,750	19,161	-	-	-	-
slippery elm	222,767	419,630	201,031	167,390	77,727	20,677	12,786	-	-	-	-
black locust	215,270	6,892	-	-	-	-	-	-	-	-	-
black cherry	191,887	27,569	-	27,569	-	-	-	-	-	-	-
white oak	168,518	6,412	-	-	-	-	-	-	-	-	-
other oaks	138,504	121,871	115,869	85,403	19,627	45,544	39,305	6,375	6,375	6,892	6,412
black oak	122,621	6,260	6,260	-	-	-	6,892	6,260	6,260	-	-
red maple	116,971	38,622	32,794	6,892	6,892	6,323	-	6,375	6,323	6,375	6,375
other hickories	90,388	19,716	25,458	6,375	26,054	-	6,412	-	-	6,375	-
American beech	83,695	13,304	12,671	6,412	6,412	18,895	6,323	6,412	-	-	13,267
red pine	76,436	38,014	12,520	12,635	13,267	-	-	-	-	-	-
pignut hickory	65,510	13,152	20,159	6,412	-	-	-	13,152	12,635	-	-
bigtooth aspen	55,138	6,375	6,323	-	12,750	-	-	-	-	-	-
other hardwoods	571,088	298,111	203,212	152,077	76,270	31,629	38,246	25,965	12,646	-	6,260
other softwoods	146,813	32,842	60,917	33,426	6,323	-	13,304	-	-	-	-

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