INDIANA DNR Classified Forests
Report of Continuous Forest Inventory (CFI)
Summary of years 2011-2015

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FOREWORD

This report provides an overview of forest-resource attributes for privately owned land enrolled in the Indiana DNR Division of Forestry's Classified Forest Program based on findings from a continuous annual inventory conducted by the Forest Resource Information (FRI) Section of the division. The CFI inventory of Indiana DNR Division of Forestry Classified Forest lands is based on a sample of 2,405 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 & Wildlife but are now managed with the Classified Forest program. Those 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 and 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 four panels of plot installation and data collection for the years 2011-2015, which constitutes 80% of an entire cycle or total sample population. 1,924 plots have been installed and measured thus far. Change attributes such as growth, removals, and mortality will not be reported until a later date because plot re-measurement must occur.

EXECUTIVE SUMMARY/HIGHLIGHTS

This is the first report of results of the classified forest continuous forest inventory (CFI), with the first four panels of annual plots (80% of the total sample) being measured. The goal of the first five years 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). 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:

- 487,192 total acres; 484,732 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 204 million live trees
- Sugar maple trees and seedlings are more abundant than any other species
- 1.022 billion cubic feet (cf) of total live tree volume
- 2.614 billion board feet (bf) (Doyle) of sawlog volume
- Yellow poplar followed by white oak are the species with the most sawlog volume
- Nearly 60% 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

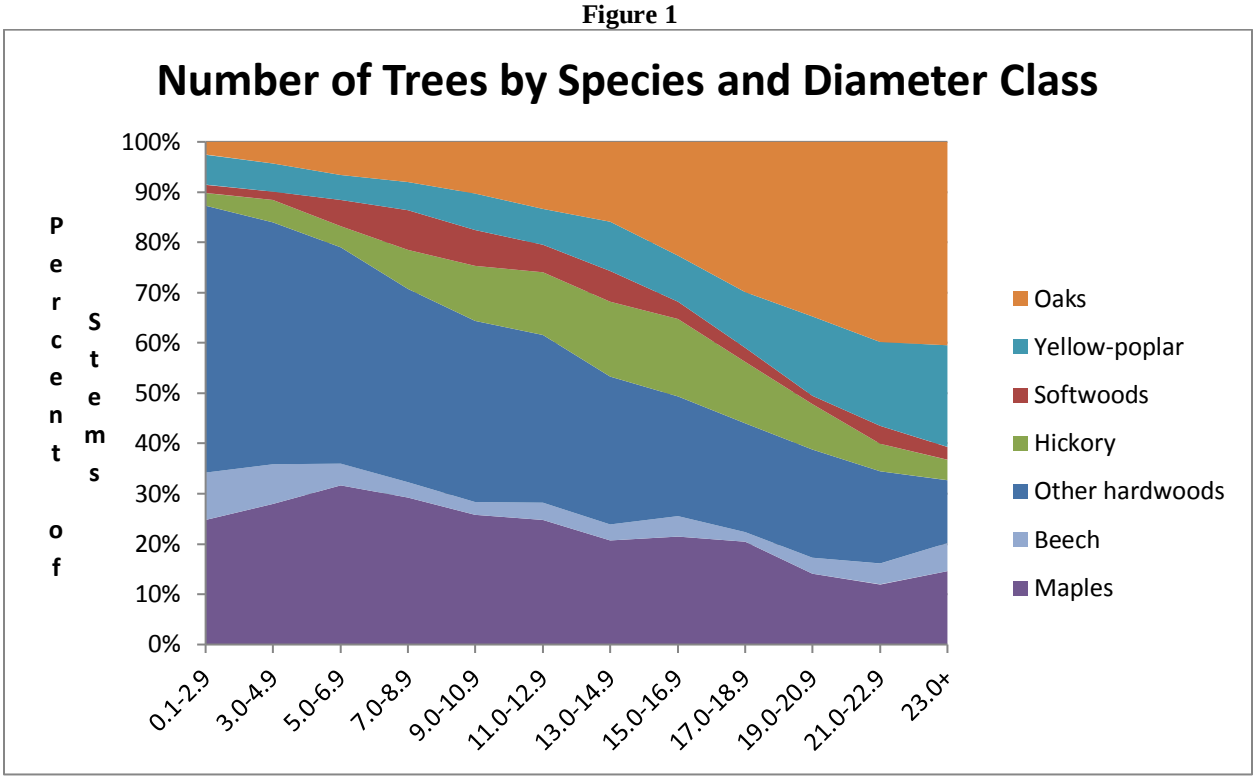
Area

Classified Forest lands comprise approximately 487,192 acres located primarily in the southern third of Indiana. An estimated 484,732 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 ~2,500 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 98% of the total forest area classified as hardwood forest types. The primary hardwood forest types were White Oak/Red Oak/Hickory (110,827 acres, 23%), Mixed Upland Hardwoods (46,432 acres, 10%), Hard Maple/Basswood (36,112 acres, 7%), Yellow Poplar (30,650 acres, 6%) and Cherry/Ash/Poplar (28,098 acres, 6%) (Table 1). Many forest types are very similar and difficult to discern. For 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" diameter breast height or 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 204 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 42.0 million trees followed by Beech, Yellow Poplar, and Sassafras with 15.0 million, 13.0 million and 10.7 million trees, respectively (Table 2). More than half of the number of trees were less than 3 inches d.b.h. with 144.8 million (71%) 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 3.0% 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 1.022 billion cubic feet (cuft) or 2,110 cuft per forested acre on average. Hardwoods constituted 982.8 million cuft or 96%. Oaks made up 245.9 million cuft or 24%, Maples were 213.7 million cuft or 21%, Yellow Poplar was 149.8 million cuft or 14%, and Hickories were 104.9 million cuft or 10% of the total volume (Table 3). Approximately 171.8 million cuft or 17% 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.). 177.1 million cuft or 17% is 23" or greater d.b.h. (Table 3). It was estimated that 952.1 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" d.b.h. and greater, softwoods 9" d.b.h. and greater).

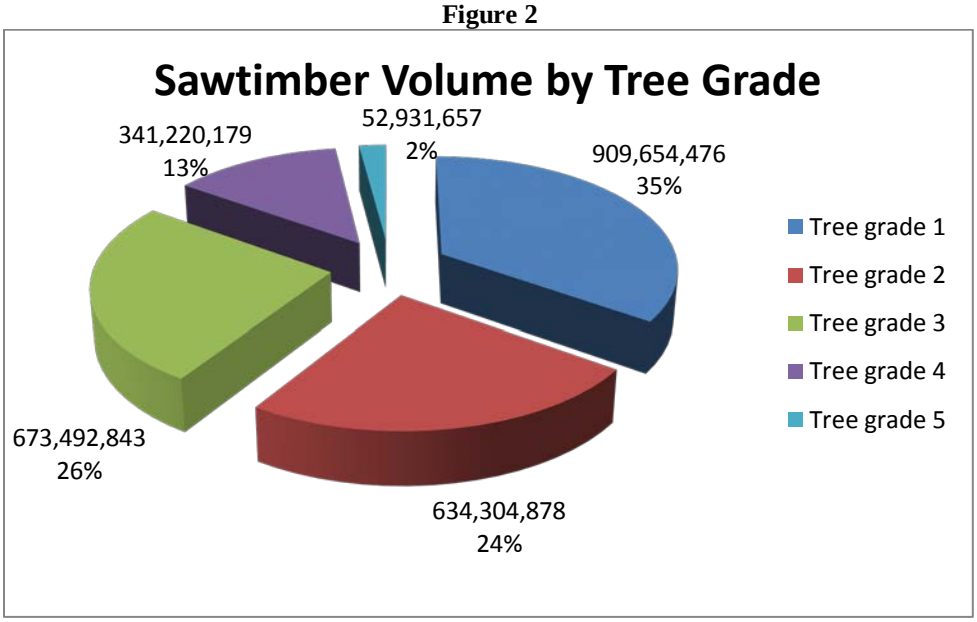
Volume of Sawtimber-sized Trees

The total net sawtimber volume was 2.614 billion board feet (MMBF) Doyle scale (5,392 Bdft/acre). Yellow Poplar was the most voluminous species with 408.4 million board feet (MMBF) or 16%, with White Oak second with 339.8 MMBF or 13%. Sugar Maple, Northern Red Oak, Other Oaks, and the Ash species group were the other major hardwood species groups ranked by sawlog volume with 261.9, 230.5, 199.3, and 167.9 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 909.7 MMBF of the total net sawtimber volume was grade 1 and 634.3 and 673.5 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 apply averages based from FIA data for Indiana where appropriate.

According to IN FIA data, the following averages occur. These estimates are based on all FIA plots measured on forestland (statewide and all ownerships) and are total cubic foot volumes. Total volume is estimated at 2,137 cubic feet (cuft) per forested acre. Compared to the total volume, annual growth is nearly 3.3%, annual mortality is 1.0%, and annual removals are 0.7%. Applying these same estimates to the 1.022 billion cuft of

volume on classified forestlands would produce an average annual growth of 33.4 million cuft, average annual mortality of 10.2 million cuft, and annual removals of 7.1 million cuft.

Standing Dead Trees

There were an estimated 5.2 million standing dead trees 5" d.b.h. and greater. The individual species with the largest number of standing dead trees was Sassafras with 966 thousand stems. Yellow Poplar was second with 442 thousand standing dead trees with the ash group, American Elm, and Sugar Maple following with 410,370 and 323,000 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 5.2 million standing dead trees, 3.2 million had a diameter from 5-9" d.b.h., 1.5 million were from 9-15" d.b.h., 352,000 were from 15-19" d.b.h., and the remaining 185,000 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 484,732 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 4,812 cumulative acres (about 1%) with invasive species present. Japanese (vine) honeysuckle and multiflora rose are the most prevalent covering 2,152 acres and 1,713 acres respectively, with oriental bittersweet, autumn olive, garlic mustard, and bush honeysuckle covering 200+ acres each.

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 primarily rely on FIA data for 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 SFI and FSC in mind, the Indiana DNR Division of Forestry began designing a Continuous Forest Inventory (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 Forest Service Forest Inventory and Analysis (FIA) program 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 state forests began in 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 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 two years to get the first panel completed, so 2015 was our fourth completed panel.

Quality Assurance/Quality Control

The CFI program is the key program that provides the information needed to assess the status and trends of the 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 strive to achieve for every field measurement (quality assurance or QA). Quality control (QC) procedures include direct feedback to field staff to provide continual real-time assessment and improvements or refinements of field staff performance. These data-quality goals were adapted from the USFS FIA program goals, which were developed from knowledge of measurement processes in forestry and forest ecology.

At the heart of CFI quality lies 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 extensive on-the-job training. 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 members 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 on which to perform a quality check so that timely feedback can continuously be provided to the production field staff.

Each piece of data measured in the field has an associated MQO for precision. This is an assigned tolerance or acceptable level of measurement error, and a measure of 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 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 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 (1/24th acre) circular subplot with the offset 6.8-foot-radius (1/300th 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, 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 earlier.

Prediction Error

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

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

Non-response Error

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

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

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

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

Non-response has two effects on the sample. First, it reduces the sample size. The reduced sample size is reflected in the sampling errors discussed in that section. Second, non-response can 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 are 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) to be used as a reference guide after attending 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, 2011-2015.

Table 2.—Number of all live trees by species and diameter class, IN Classified Forests, 2011-2015.

Table 3.—Net volume of all live trees by species and diameter class, IN Classified Forests, 2011-2015.

Table 4.—Sawtimber volume of all live trees by species and diameter class, IN Classified Forests, 2011-2015.

Table 5.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, IN Classified Forests, 2011-2015.

Table 1.—Area of forestland by forest type group and stand size class, IN Classified Forests, 2011-2015.

Estimate: Total-Area of forestland(acres)

Forest type	Stand-size	Large diameter	Medium diameter	Small diameter	Nonstocked
All	484,732	363,413	84,593	25,475	11,251
White oak / red oak / hickory	110,827	89,927	15,101	5,799	-
Mixed upland hardwoods	46,432	35,847	9,611	974	-
Hard maple / basswood	36,112	29,298	5,801	1,013	-
Yellow poplar	30,650	22,106	6,555	1,989	-
Cherry / white ash / yellow poplar	28,098	17,388	8,095	2,615	-
White oak	27,030	26,068	962	-	-
Sugar maple / beech / yellow birch	23,224	19,015	3,989	221	-
Pine/Hardwood	9,333	6,480	2,854	-	-
Other miscellaneous hardwood forest types	161,081	108,787	28,495	12,543	11,251
Miscellaneous softwood forest types	11,946	8,496	3,129	321	-

Table 2.—Number of all live trees by species and diameter class, IN Classified Forests, 2011-2015.

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	204,123,204	108,214,944	36,618,936	17,162,288	11,436,500	8,140,432	6,531,910	4,727,678	3,651,262	2,804,330	1,979,622	1,308,232	1,547,071
sugar maple	42,038,256	21,773,948	8,569,924	4,327,655	2,492,602	1,626,074	1,232,999	632,146	617,669	391,319	162,441	93,855	117,625
American beech	15,079,497	10,101,647	2,883,983	745,157	352,301	211,200	227,245	151,582	148,577	55,560	62,371	54,356	85,517
yellow poplar	13,042,407	6,473,811	2,067,817	855,657	642,938	587,034	461,881	464,852	334,696	311,604	312,462	217,120	312,535
sassafras	10,736,073	7,171,444	1,452,682	716,221	458,729	428,606	281,223	148,161	39,798	23,151	7,717	8,341	-
ash species	9,579,041	5,329,877	1,159,921	723,335	537,901	499,186	370,321	244,731	277,047	195,817	134,010	76,018	30,874
red maple	9,433,256	4,498,152	1,676,114	1,034,195	726,772	411,761	342,787	291,180	117,628	133,045	92,967	23,160	85,494
other oaks	8,931,590	2,403,724	1,165,018	886,293	585,824	604,541	543,835	538,540	478,551	506,393	446,997	365,537	406,333
flowering dogwood	8,488,868	6,515,124	1,762,231	180,633	30,879	-	-	-	-	-	-	-	-
American elm	7,584,533	3,663,669	2,220,537	924,842	371,163	184,375	126,153	54,916	15,429	23,447	-	-	-
black cherry	6,022,997	2,221,179	1,648,339	644,093	604,833	334,404	249,116	141,970	86,083	46,348	22,861	16,055	7,714
redcedar and pine species	5,670,210	1,760,343	575,886	875,644	903,977	583,318	358,590	290,982	125,322	77,569	31,460	47,601	39,516
other hickories	5,546,413	1,264,238	1,054,060	451,877	574,061	526,257	541,541	375,482	336,211	211,513	124,740	31,785	54,647
hackberry	5,379,960	2,815,110	1,071,153	539,162	324,823	233,031	178,147	86,966	47,539	30,576	22,877	7,432	23,143
shagbark hickory	4,053,495	1,460,435	580,137	278,927	307,025	363,525	278,562	323,985	224,926	134,320	54,082	39,231	8,341
other elms	4,585,116	2,454,988	1,068,218	498,446	311,523	77,782	102,833	39,542	23,770	-	-	-	8,013
sweetgum	3,952,885	2,738,836	192,299	260,472	154,157	124,118	123,583	156,227	79,582	54,096	38,013	15,730	15,773
white oak	3,444,818	384,101	407,674	251,548	331,634	234,995	327,674	211,870	348,335	330,427	240,887	155,891	219,781
blackgum	3,348,344	1,679,118	783,701	343,925	241,161	109,884	53,458	56,184	47,550	8,341	25,022	-	-
black walnut	3,199,865	864,065	481,060	404,131	312,720	352,736	262,112	207,788	108,616	76,035	53,439	38,871	38,290
common small hardwood species	19,759,767	16,157,319	2,933,611	545,318	85,224	30,578	7,717	-	-	-	-	-	-
other hardwood species	14,245,813	6,483,817	2,864,571	1,674,761	1,086,246	617,023	462,126	310,572	193,931	194,768	147,273	117,248	93,472

Table 3.—Net volume of all live trees by species and diameter class, IN Classified Forests, 2011-2015.

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	1,022,730,383	38,295,697	57,094,436	76,400,611	101,179,815	110,403,863	122,508,580	125,979,662	116,562,123	97,230,891	177,074,705
yellow poplar	149,820,267	2,226,084	3,757,180	6,512,976	8,516,168	13,008,046	13,405,081	17,108,393	21,697,743	19,966,087	43,622,510
sugar maple	147,617,958	10,887,960	13,700,340	16,666,124	20,978,131	15,727,765	22,411,162	18,096,506	10,040,916	6,805,434	12,303,619
white oak	85,628,168	618,166	1,680,335	2,032,178	5,045,543	4,663,311	10,550,067	13,278,974	12,872,478	10,249,307	24,637,808
ash species	54,816,723	1,531,784	2,589,558	4,714,581	5,481,736	5,631,523	8,710,775	8,445,062	7,853,889	5,517,384	4,340,429
other oaks	60,339,830	1,070,199	1,657,913	2,775,121	4,026,049	3,116,488	6,849,408	10,188,176	7,559,571	7,587,582	15,509,323
northern red oak	54,789,933	348,064	575,652	1,288,303	2,084,686	4,198,267	3,546,249	5,367,655	9,551,380	12,608,304	15,221,372
black oak	45,166,223	726,220	726,485	1,533,747	1,837,905	4,660,944	4,605,087	5,905,309	7,529,435	5,368,583	12,272,510
red maple	48,689,994	2,464,172	3,885,208	3,974,626	5,336,684	6,641,326	4,101,230	6,127,889	5,370,210	1,743,187	9,045,460
Red cedar and pine species	39,904,973	1,856,561	4,252,572	4,971,316	5,218,171	6,231,024	3,966,876	3,478,117	1,864,616	3,494,608	4,571,112
shagbark hickory	39,102,252	717,801	1,471,922	3,665,750	4,497,764	7,889,810	7,793,380	6,040,162	3,320,295	2,896,606	808,762
other hardwood species	42,879,390	3,921,536	4,204,468	3,866,822	5,035,597	5,248,309	4,951,335	4,076,235	7,100,667	2,234,449	2,239,970
pignut hickory	35,544,388	664,480	1,533,735	3,115,356	5,656,551	5,626,916	5,847,879	5,106,066	4,423,310	1,918,482	1,651,613
American beech	36,101,213	1,684,610	1,759,434	1,991,641	3,296,998	3,475,211	4,689,651	2,426,556	3,643,092	4,068,214	9,065,806
other hickories	30,233,670	410,692	1,481,473	2,170,499	3,300,759	3,498,193	6,124,782	5,018,443	3,275,129	598,803	4,354,895
black walnut	27,515,517	881,038	1,534,996	3,077,918	3,780,010	4,440,927	3,323,992	2,869,666	2,626,582	2,523,986	2,456,402
black cherry	20,839,348	1,269,077	2,827,523	2,695,761	3,407,819	3,160,300	2,677,695	2,053,536	1,340,240	898,075	509,323
American sycamore	21,791,245	186,380	548,769	1,337,302	1,344,731	1,491,218	1,459,087	2,737,039	1,685,242	3,868,016	7,133,461
sweetgum	17,382,070	520,970	670,373	1,143,389	1,742,328	3,596,294	2,556,706	2,279,375	2,007,632	1,117,183	1,747,819
other maples	17,390,150	1,136,759	1,844,111	1,602,494	1,375,628	1,458,068	1,474,420	1,999,146	1,349,770	2,794,126	2,355,628
hackberry	15,348,391	1,063,657	1,391,529	1,932,105	2,451,971	1,806,107	1,336,180	1,347,187	1,018,675	254,068	2,746,913
sassafras	16,941,927	1,390,066	2,061,639	3,252,452	3,762,768	3,054,263	1,130,880	1,140,201	431,250	718,407	-
elms	14,886,753	2,719,421	2,939,219	2,080,147	3,001,817	1,779,551	996,656	889,969	-	-	479,970

Table 4.—Sawtimber volume of all live trees by species and diameter class, IN Classified Forests, 2011-2015.

Estimate: Total-All live net sawtimber volume on forestland(bdft - IN 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	2,613,548,459	3,717,565	153,037,732	245,018,493	351,885,381	415,942,259	396,766,213	390,880,512	656,300,306
yellow poplar	408,408,859	-	12,828,729	27,533,609	33,020,638	47,520,245	76,583,882	66,045,947	144,875,809
white oak	339,819,561	-	11,551,755	14,372,734	35,444,085	48,494,629	38,353,447	50,951,152	140,651,760
sugar maple	261,938,960	-	30,516,565	34,113,546	69,169,369	48,646,772	28,547,094	16,372,210	34,573,403
northern red oak	230,487,932	-	4,986,405	11,090,305	14,691,121	19,303,009	48,966,718	64,820,081	66,630,293
other oaks	199,317,552	-	8,037,451	7,336,085	26,252,480	43,388,062	23,480,081	32,695,763	58,127,631
ash species	167,938,387	-	7,858,950	12,815,230	32,357,000	30,235,236	28,218,907	25,685,007	30,768,057
black oak	127,802,847	-	2,767,814	11,987,816	13,018,376	24,844,227	20,858,802	12,006,991	42,318,822
shagbark hickory	105,990,685	-	6,240,493	20,357,150	22,595,145	21,215,285	17,575,135	13,769,038	4,238,439
red maple	103,049,864	-	6,503,781	11,717,004	7,672,810	20,095,079	15,029,811	6,090,224	35,941,154
American beech	89,563,103	-	5,551,765	7,265,912	11,265,657	9,903,557	13,241,136	16,006,946	26,328,131
other hickories	82,679,807	-	5,051,809	8,840,783	16,192,219	18,821,643	7,990,166	3,736,194	22,046,993
pignut hickory	78,725,092	-	9,562,941	14,957,057	14,656,775	15,035,489	8,258,581	11,705,561	4,548,688
eastern white pine	59,745,322	893,239	2,881,796	4,437,211	4,035,669	6,884,802	5,945,561	22,839,007	11,828,039
American sycamore	48,885,059	-	3,143,275	3,809,873	1,666,402	10,798,847	8,604,497	12,355,852	8,506,313
black walnut	46,938,838	-	6,326,911	11,127,606	4,399,488	6,569,598	8,371,943	6,867,698	3,275,595
black cherry	35,733,377	-	4,539,085	7,352,037	9,399,813	8,600,819	2,768,946	3,072,678	-
sweetgum	34,817,450	-	1,524,458	5,093,255	7,577,269	9,897,790	2,435,545	2,619,555	5,669,578
other hardwood species	164,965,489	-	19,987,842	25,126,292	21,272,046	21,019,534	38,347,565	23,240,608	15,971,601
other pines and red cedar	26,740,276	2,824,326	3,175,906	5,684,990	7,199,018	4,667,637	3,188,398	-	-

Table 5.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, IN Classified Forests, 2011-2015.

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	5,176,817	1,873,347	1,287,772	811,582	406,860	257,268	221,324	132,823	116,065	23,143	46,633
sassafras	965,924	434,079	226,974	186,280	86,477	16,681	15,432	-	-	-	-
yellow-poplar	442,426	220,477	104,635	47,544	15,730	23,149	8,013	14,864	8,013	-	-
ashes	410,022	77,225	70,075	46,306	38,575	61,780	23,770	23,143	46,005	15,429	7,714
American elm	370,551	115,833	115,473	38,013	54,303	30,874	8,341	7,714	-	-	-
sugar maple	323,631	117,964	79,045	47,265	15,445	31,204	16,026	16,681	-	-	-
eastern red cedar	282,788	120,960	99,467	30,868	31,492	-	-	-	-	-	-
slippery elm	238,482	75,750	70,360	38,010	23,160	7,432	16,055	-	7,714	-	-
black locust	221,897	60,648	60,307	46,026	8,013	7,717	15,147	8,013	16,026	-	-
eastern white pine	198,008	103,486	47,603	15,432	16,055	7,714	7,717	-	-	-	-
white oak	156,027	15,773	31,546	54,979	7,717	7,432	23,149	-	7,714	-	7,717
other oaks	151,683	38,921	31,799	25,022	-	16,055	25,023	7,432	7,432	-	-
black cherry	148,124	69,452	46,591	8,013	8,013	8,341	-	7,714	-	-	-
black oak	142,251	30,868	39,500	23,743	24,068	8,013	7,717	8,341	-	-	-
red maple	110,500	39,220	32,110	-	-	8,013	-	7,714	8,013	7,714	7,714
other softwoods	95,728	24,399	23,490	23,770	8,013	-	16,058	-	-	-	-
American beech	93,573	16,058	15,149	7,717	7,717	15,147	8,013	7,717	-	-	16,055
red pine	83,797	37,731	14,864	15,147	16,055	-	-	-	-	-	-
pignut hickory	78,805	15,773	24,396	7,717	-	-	-	15,773	15,147	-	-
bigtooth aspen	66,725	33,363	-	33,363	-	-	-	-	-	-	-
other hickories	61,729	7,717	23,148	7,714	15,432	-	7,717	-	-	-	-
other hardwoods	534,142	217,646	131,236	108,651	30,594	7,714	23,148	7,714	-	-	7,432