IN DNR Classified Forests
Report of Continuous Forest Inventory (CFI)
Summary of years 2011-2014

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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 2,405 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 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 three panels of plot installation and data collection for the years 2011-2014, which constitutes 60% of an entire cycle or total sample population. 1,443 plots have been installed and measured thus far. 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 first reported results of the classified forest continuous forest inventory (CFI), with the first three panels of annual plots (60% 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:

- 491,653 total acres; 472,237 forested acres with the balance in non-forest (i.e. open areas) and water
- 98% of the forested acres are hardwoods
- 76% of the forested acres are sawlog-sized stands
- Forests contain 206 million live trees
- Sugar Maple trees and seedlings are more abundant than any other species
- 1.020 billion cubic feet of total live tree volume
- 2.250 billion board feet (Doyle) of sawlog volume
- Yellow Poplar followed by White Oak are the species with the most sawlog volume
- Over half 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

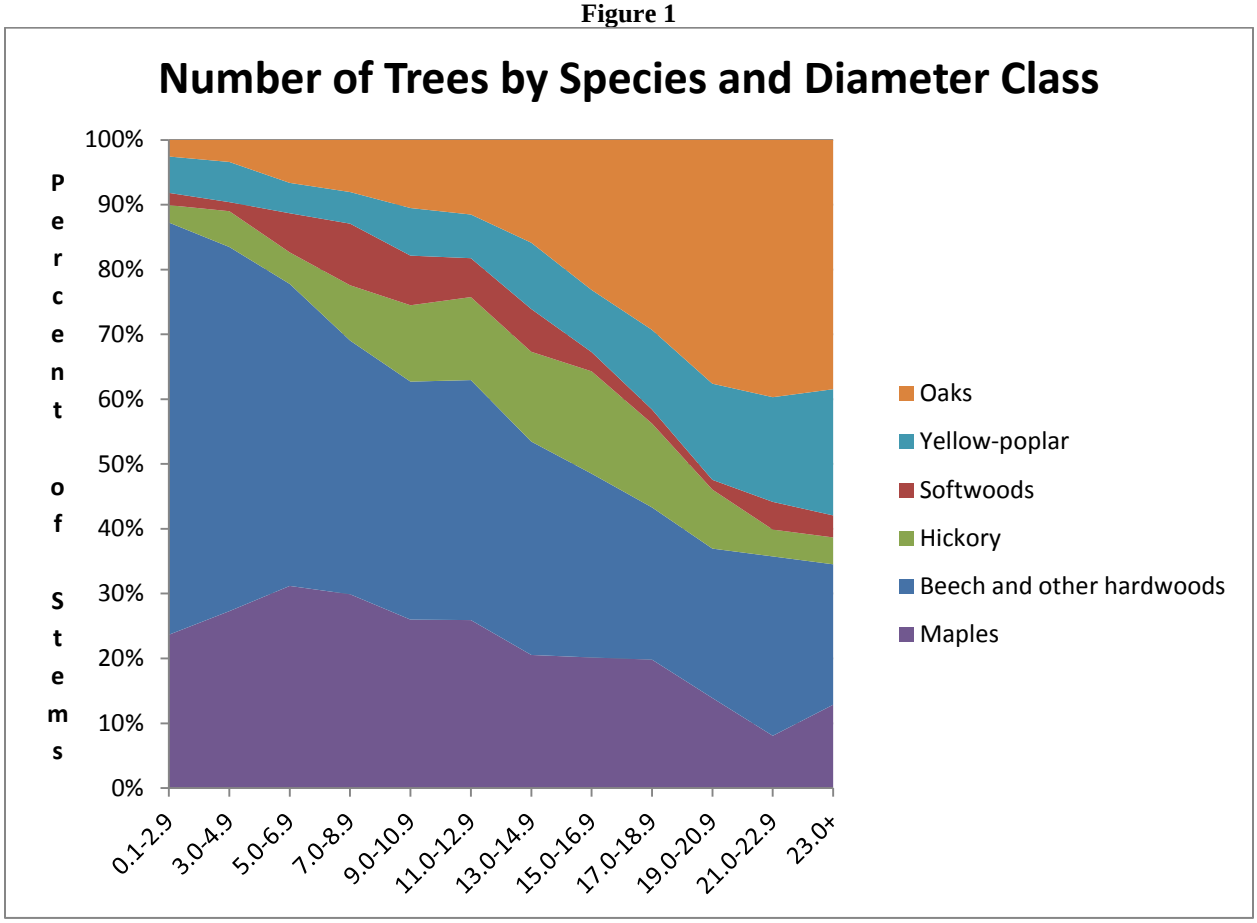
Area

Classified Forest lands are comprised of approximately 491,653 acres located primarily in the southern 1/3 of Indiana. An estimated 472,237 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 ~19,400 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 (110,138 acres, 23%), mixed upland hardwoods (52,223 acres, 11%), Hard Maple/Basswood (34,063 acres, 7%), Yellow Poplar (29,953 acres, 6%) and Cherry/Ash/Poplar (28,184 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-six 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 206 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 40.4 million trees followed by Beech, Yellow Poplar, and Sassafras with 14.5 million, 12.8 million and 10.8 million trees respectively (Table 2). Over ½ of the number of trees were less than 3 inches d.b.h. with 146.7 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 about 3.3% 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 1.020 billion cubic feet (cuft) or 2,160 cuft per forested acre on average. Hardwoods constituted 977.6 million cuft or 96%. Oaks made up 244.3 million cuft or 23%, Maples were 206.6 million cuft or 20%, Yellow Poplar was 146.8 million cuft or 14%, and Hickories were 107 million cuft or 10% of the total volume (Table 3). Approximately 343 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.). 344.7 million cuft or 17% is 23" or greater d.b.h. (Table 3). It was estimated that 949.6 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).

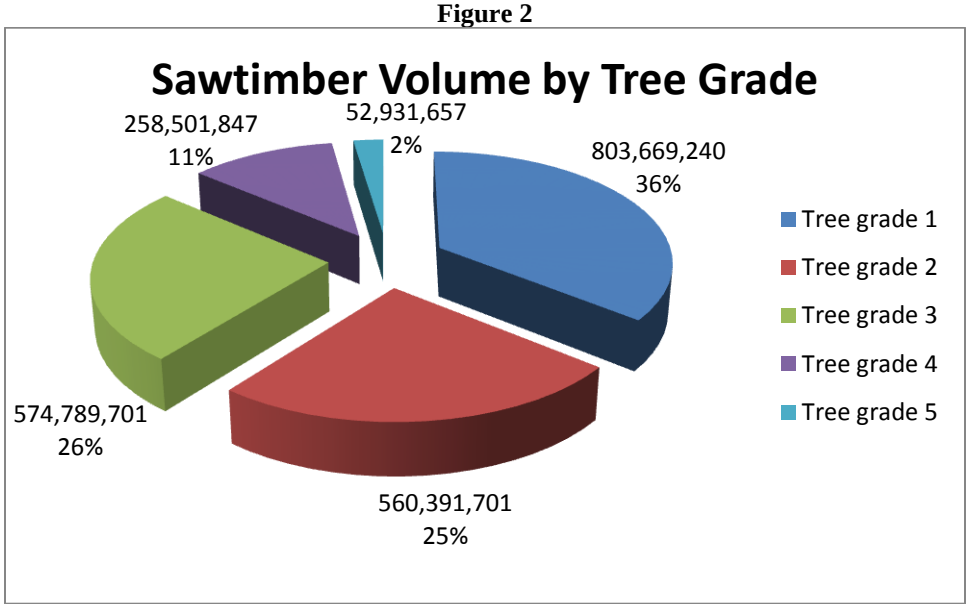
Volume of Sawtimber-sized Trees

The total net sawtimber volume was 2.250 billion board feet Doyle scale (4,765 Bdft/acre). Yellow Poplar was the most voluminous species with 322.9 million board feet (MMBF) or 14%, with White Oak second with 300.2 MMBF or 13%. Sugar Maple, Northern Red Oak, and the Ash species group were the other major hardwood species groups ranked by sawlog volume with 222.1, 201.0, and 188.3 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 803.7 MMBF of the total net sawtimber volume was grade 1 and 560.4 and 574.8 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 1.020 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 4.8 million standing dead trees 5" d.b.h. and greater. The individual species with the largest number of standing dead trees was Sassafras with 793 thousand stems. Yellow Poplar was second with 384 thousand standing dead trees with American Elm, Sugar Maple, and Eastern Redcedar following with 373, 338 and 314 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 4.8 million standing dead trees, 3.3 million had a diameter from 5-9" d.b.h., 1.3 million were from 9-15" d.b.h., 306 thousand were from 15-19" d.b.h., and the remaining 163 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 472,237 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 5,959 cumulative acres (about 1%) with invasive species present. Japanese (vine) honeysuckle and multiflora rose are the most prevalent covering 2,625 acres and 2,142 acres respectively, with autumn olive, oriental bittersweet, garlic mustard, and bush honeysuckle covering 200-300 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, 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. 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 2014 was our third 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 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) on each state forest. 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, 2011-2014.

Table 2.—Number of all live trees by species and diameter class, IN Classified Forests, 2011-2014.

Table 3.—Net volume of all live trees by species and diameter class, IN Classified Forests, 2011-2014.

Table 4.—Sawtimber volume of all live trees by species and diameter class, IN Classified Forests, 2011-2014.

Table 5.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, IN Classified Forests, 2011-2014.

Table 1.—Area of forestland by forest type group and stand size class, IN Classified Forests, 2011-2014.

Estimate: Total-Area of forestland(acres)

Forest type	Stand-size	Large diameter	Medium diameter	Small diameter	Nonstocked
All	484,982	368,208	82,504	23,758	10,512
White oak / red oak / hickory	110,138	91,107	13,238	5,793	-
Mixed upland hardwoods	52,223	41,729	9,651	844	-
Hard maple / basswood	34,063	28,148	5,460	454	-
Yellow-poplar	29,953	22,371	5,873	1,709	-
Cherry / white ash / yellow-poplar	28,184	17,626	8,034	2,524	-
White oak	25,162	23,936	1,226	-	-
Sugar maple / beech / yellow birch	23,560	18,597	4,673	289	-
Pine/Hardwood	9,610	6,287	3,323	-	-
Other miscellaneous hardwood forest types	159,052	109,479	27,313	11,745	10,512
Miscellaneous softwood forest types	13,037	8,929	3,708	400	-

Table 2.—Number of all live trees by species and diameter class, IN Classified Forests, 2011-2014.

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	205,997,677	112,421,123	34,269,798	17,271,882	11,050,785	8,328,137	6,390,717	4,978,651	3,764,201	2,838,004	1,950,874	1,239,990	1,493,515
sugar maple	40,420,509	21,027,881	7,701,249	4,305,632	2,460,715	1,696,698	1,270,171	665,013	605,012	387,791	150,210	59,447	90,690
American beech	14,518,247	10,326,342	2,171,017	724,080	298,877	209,852	241,431	164,377	143,178	30,809	29,337	69,685	109,260
yellow-poplar	12,821,613	6,307,769	2,123,945	809,198	539,100	611,458	430,677	509,377	360,899	348,591	289,433	200,287	290,880
sassafras	10,758,838	7,056,001	1,627,301	864,449	410,688	330,455	228,853	161,242	40,008	28,904	-	10,937	-
ash species	9,761,722	5,538,699	979,131	746,115	495,549	525,826	372,051	280,902	322,405	213,268	156,527	90,736	40,514
red maple	9,711,934	4,931,510	1,652,507	989,167	691,601	396,867	335,344	297,291	92,570	133,179	100,972	20,305	70,621
flowering dogwood	9,355,201	7,654,855	1,503,072	167,599	29,674	-	-	-	-	-	-	-	-
other oaks	8,686,663	2,505,417	901,986	877,969	543,992	644,367	435,544	565,540	503,138	499,297	482,340	363,547	363,528
American elm	7,427,897	3,627,152	2,155,351	920,615	343,846	190,168	110,918	40,271	10,237	29,337	-	-	-
black cherry	6,700,926	2,537,727	2,011,620	651,930	581,114	345,850	244,005	153,681	61,784	51,355	30,446	21,174	10,237
redcedar and pine species	6,357,134	2,127,335	479,147	1,043,367	1,051,181	637,746	383,669	328,637	111,596	61,423	29,337	53,020	50,680
other hickories	6,201,445	1,509,569	1,387,802	519,468	572,634	571,135	497,439	350,327	351,192	232,832	137,729	20,305	51,018
hackberry	4,866,674	2,647,701	883,289	434,989	231,567	242,768	171,616	110,989	52,586	30,446	20,040	9,972	30,712
sweetgum	4,709,245	3,499,903	125,256	242,165	159,692	139,340	149,915	180,985	80,979	50,920	49,450	19,703	10,937
shagbark hickory	4,243,765	1,517,414	505,355	321,396	369,928	410,062	320,768	339,100	243,214	134,607	39,912	31,073	10,937
other elms	3,841,014	1,862,530	983,560	436,701	302,313	68,984	103,363	42,083	31,412	-	-	-	10,068
blackgum	3,824,885	2,142,531	742,775	378,290	258,938	109,260	59,422	51,381	60,413	-	21,874	-	-
black walnut	3,348,825	981,197	512,062	387,944	279,842	360,560	250,479	221,505	132,310	90,639	50,655	40,949	40,684
white oak	3,296,525	374,630	263,629	267,149	344,458	230,928	299,986	223,970	368,403	332,484	251,376	128,626	210,886
common small hardwood species	20,810,091	17,453,568	2,819,248	455,642	61,423	20,209	-	-	-	-	-	-	-
other hardwood species	14,334,526	6,791,393	2,740,498	1,728,016	1,023,655	585,603	485,067	291,981	192,866	182,123	111,235	100,224	101,864

Table 3.—Net volume of all live trees by species and diameter class, IN Classified Forests, 2011-2014.

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	1,020,340,785	38,662,769	54,950,663	78,138,356	98,952,239	116,263,517	126,245,619	128,168,180	114,264,940	92,369,266	172,325,237
yellow-poplar	146,832,196	2,126,211	3,189,495	6,706,617	7,936,571	14,177,534	14,599,530	19,122,881	20,050,879	18,467,018	40,455,460
sugar maple	143,407,930	10,941,290	13,273,226	17,317,249	21,499,411	16,564,124	21,937,832	18,429,083	9,324,691	4,649,687	9,471,337
white oak	85,086,006	660,254	1,708,027	1,953,626	4,617,820	4,894,189	11,133,337	13,334,079	13,288,456	8,576,882	24,919,337
ash species	61,724,429	1,589,862	2,386,752	5,024,709	5,418,043	6,430,189	10,167,779	9,272,837	9,127,581	6,652,024	5,654,656
other oaks	57,897,494	1,068,643	1,471,553	3,248,721	3,033,340	3,514,673	6,977,747	10,640,318	8,908,381	5,775,670	13,258,447
northern red oak	53,137,742	355,724	746,921	1,244,798	1,638,105	3,991,575	3,525,923	5,221,278	9,721,012	12,883,948	13,808,457
black oak	48,160,284	731,136	656,318	1,505,472	1,856,881	5,154,039	5,345,927	5,316,681	8,155,307	6,858,818	12,579,704
red maple	45,885,189	2,298,439	3,656,461	3,686,728	5,212,333	6,922,304	3,179,786	6,054,679	5,866,693	1,501,568	7,506,197
redcedar and pine species	42,701,072	2,225,694	4,938,699	5,377,178	5,550,732	6,897,402	3,552,146	2,773,219	1,656,696	3,880,448	5,848,858
shagbark hickory	40,648,254	846,728	1,770,528	4,199,603	5,157,238	8,256,961	8,422,139	6,146,969	2,530,382	2,257,176	1,060,531
other hardwood species	40,113,670	3,903,576	3,986,367	4,073,153	4,762,830	4,733,183	5,149,387	4,353,647	5,198,892	2,049,467	1,903,168
pignut hickory	37,048,545	713,976	1,522,462	3,626,905	5,181,605	5,590,136	6,493,723	6,165,386	4,866,387	762,094	2,125,871
American beech	36,756,274	1,631,010	1,531,712	1,980,064	3,507,627	3,770,280	4,462,618	1,459,667	1,618,132	5,210,025	11,585,138
other hickories	29,271,881	508,904	1,489,158	2,109,269	3,131,266	2,947,382	6,169,489	5,093,706	3,625,135	794,621	3,402,951
black walnut	28,803,196	815,972	1,409,382	3,201,590	3,696,338	4,695,926	4,004,324	3,350,894	2,491,266	2,579,834	2,557,670
black cherry	21,219,763	1,314,293	2,724,086	2,760,282	3,197,682	3,453,913	1,880,541	2,244,674	1,785,418	1,182,994	675,879
American sycamore	19,792,954	165,541	470,708	851,804	1,389,578	1,400,854	1,180,839	1,507,214	1,527,818	4,169,727	7,128,869
sweetgum	18,355,887	491,645	692,810	1,284,508	2,109,776	4,174,977	2,582,596	2,011,639	2,599,559	1,399,858	1,008,518
other maples	17,325,041	1,198,143	1,796,316	1,483,834	1,793,994	1,638,414	1,901,494	1,824,011	1,128,410	1,434,472	3,125,954
hackberry	15,955,656	788,183	981,899	1,992,133	2,326,961	2,305,570	1,472,578	1,308,405	793,848	340,885	3,645,194
sassafras	15,567,495	1,683,767	1,744,353	2,433,008	3,031,355	3,243,984	1,065,435	1,423,543	-	942,049	-
elms	14,649,827	2,603,778	2,803,426	2,077,105	2,902,751	1,505,908	1,040,448	1,113,369	-	-	603,042

Table 4.—Sawtimber volume of all live trees by species and diameter class, IN Classified Forests, 2011-2014.

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	2,250,284,146	3,525,778	128,104,253	226,821,949	315,452,488	370,189,736	325,293,263	326,005,423	554,891,255
yellow-poplar	322,870,072	-	10,096,485	27,119,610	31,329,834	46,646,257	59,772,041	49,583,598	98,322,247
white oak	300,229,092	-	9,691,527	14,161,170	32,470,883	40,867,009	32,255,186	35,543,581	135,239,736
sugar maple	222,072,760	-	27,358,731	32,254,234	61,828,252	45,220,773	21,288,748	8,346,263	25,775,759
northern red oak	200,976,712	-	3,652,344	8,765,631	14,188,639	16,136,114	46,618,246	61,252,146	50,363,592
ash species	188,257,037	-	6,196,150	13,231,397	36,614,769	30,680,879	31,644,906	30,069,737	39,819,198
other oaks	159,975,862	-	5,821,786	7,788,122	24,124,498	42,313,804	25,122,137	17,885,106	36,920,409
black oak	117,176,912	-	2,440,810	12,124,219	14,242,366	18,469,373	17,668,130	15,239,578	36,992,435
shagbark hickory	93,787,276	-	6,650,995	18,111,948	21,711,439	19,213,452	12,997,621	9,543,948	5,557,872
American beech	83,053,996	-	5,776,784	7,074,434	8,483,994	4,368,226	2,385,500	20,704,340	34,260,719
red maple	80,368,706	-	5,653,570	11,208,183	1,980,277	18,614,895	14,695,988	3,138,178	25,077,615
pignut hickory	70,161,583	-	7,417,109	13,438,962	14,379,389	17,277,459	6,704,045	5,265,571	5,679,047
other hickories	67,718,576	-	4,022,922	5,969,467	12,891,090	18,028,619	6,899,289	4,957,985	14,949,204
eastern white pine	55,123,472	290,643	1,945,322	1,928,469	1,425,819	2,000,152	7,446,971	24,379,095	15,707,001
American sycamore	41,777,194	-	3,164,882	3,036,827	-	5,305,575	7,644,713	11,937,726	10,687,471
black walnut	39,540,765	-	5,204,831	10,159,155	4,174,858	6,374,254	5,397,539	3,883,365	4,346,763
black cherry	33,241,651	-	3,074,507	6,856,517	6,303,649	9,262,652	3,715,118	4,029,208	-
sweetgum	26,293,891	-	1,590,220	4,974,347	6,078,998	7,112,013	3,267,792	3,270,520	-
other hardwood species	127,883,043	-	15,446,507	22,039,631	19,077,860	19,382,091	19,769,289	16,975,479	15,192,185
other pines and redcedar	19,775,545	3,235,135	2,898,768	6,579,627	4,145,875	2,916,140	-	-	-

Table 5.—Number of standing dead trees 5” d.b.h. and greater by species and diameter class, IN Classified Forests, 2011-2014.

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	4,815,702	1,846,067	1,192,789	678,017	383,374	246,083	183,044	123,378	121,904	10,237	30,809
sassafras	793,497	386,337	170,613	122,077	72,723	21,874	19,872	-	-	-	-
yellow-poplar	383,906	202,096	92,352	10,237	9,635	29,507	10,068	19,944	10,068	-	-
American elm	373,494	111,306	110,270	39,816	70,889	20,040	10,937	10,237	-	-	-
sugar maple	338,606	124,007	82,960	49,813	20,040	40,781	10,068	10,937	-	-	-
eastern redcedar	313,997	139,560	106,994	38,539	28,904	-	-	-	-	-	-
ashes	263,421	71,323	40,081	50,149	9,635	41,046	-	10,237	40,949	-	-
eastern white pine	228,410	125,310	52,418	9,635	21,174	10,237	9,635	-	-	-	-
slippery elm	210,351	70,068	70,286	39,816	9,972	9,972	-	-	10,237	-	-
other oaks	157,348	40,444	31,073	21,874	-	21,174	32,811	9,972	-	-	-
black oak	151,968	38,539	41,479	20,136	31,242	-	9,635	10,937	-	-	-
white oak	150,982	10,937	30,881	40,179	9,635	9,972	29,507	-	10,237	-	9,635
black cherry	141,007	80,258	29,507	10,068	-	10,937	-	10,237	-	-	-
black locust	130,644	40,153	30,181	20,040	10,068	-	-	10,068	20,136	-	-
red maple	102,663	40,179	32,112	-	-	10,068	-	-	10,068	10,237	-
red pine	99,575	49,185	19,944	20,209	10,237	-	-	-	-	-	-
pignut hickory	93,801	20,909	32,112	9,635	-	-	-	10,937	20,209	-	-
bigtooth aspen	87,497	43,749	-	43,749	-	-	-	-	-	-	-
other softwoods	83,058	20,572	20,909	10,937	10,068	-	20,572	-	-	-	-
American beech	81,321	10,937	9,635	-	9,635	10,237	10,068	9,635	-	-	21,174
other hickories	69,250	9,635	29,507	10,237	19,872	-	-	-	-	-	-
other hardwoods	560,907	210,563	159,478	110,872	39,646	10,237	19,872	10,237	-	-	-