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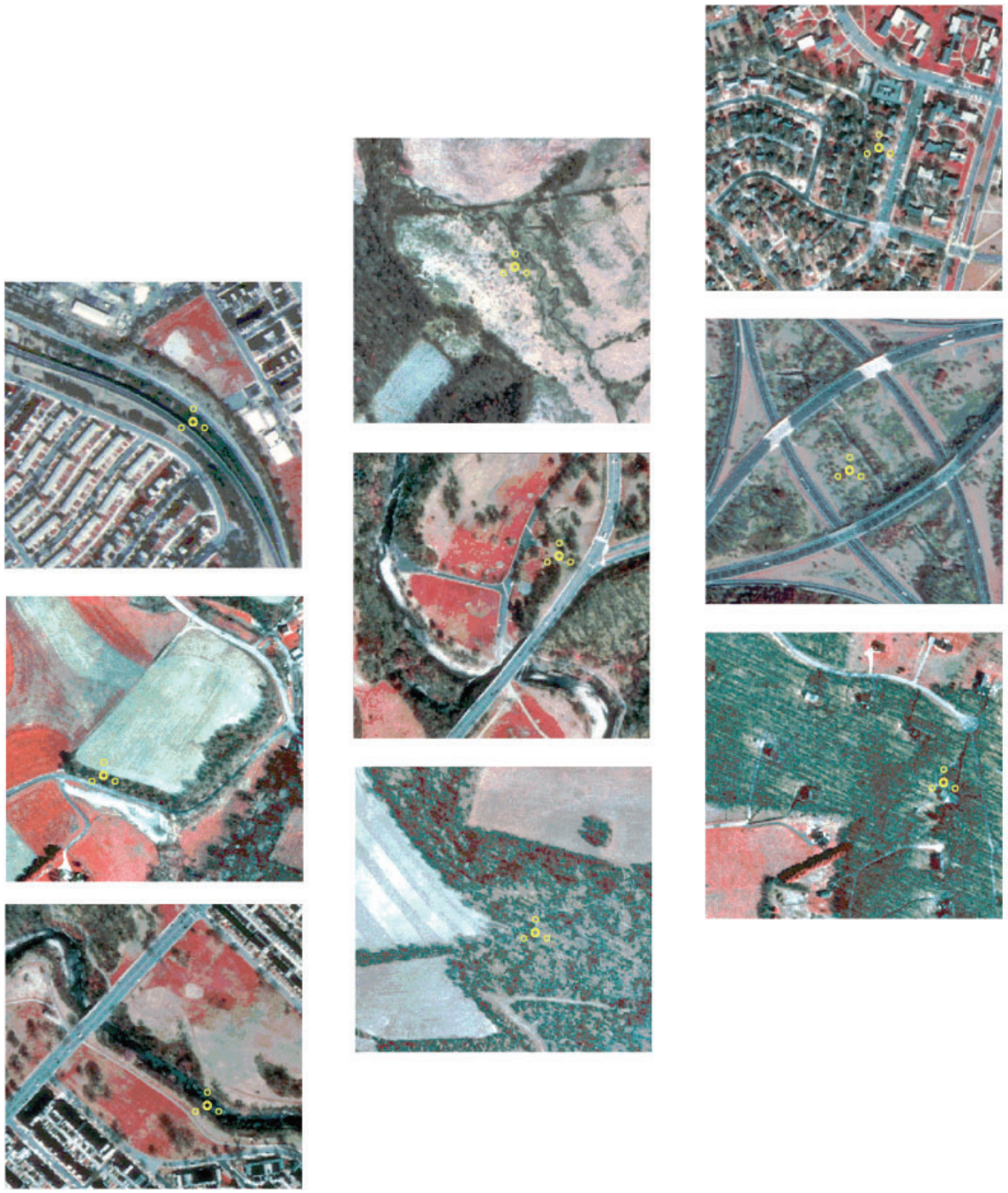
Northeastern Research Station

General Technical Report NE-312

Pilot Inventory of FIA Plots Traditionally Called 'Nonforest'

Rachel Riemann



Abstract

Forest-inventory data were collected on plots defined as “nonforest” by the USDA Forest Service’s Forest Inventory and Analysis (FIA) unit. Nonforest plots may have trees on them, but they do not fit FIA’s definition of forest because the area covered by trees is too small, too sparsely populated by trees, too narrow (e.g., trees between fields or in the middle of a divided highway), or has a disturbed understory (e.g., mowing or grazing) such that natural regeneration of trees probably does not occur. Recent inventories and associated photointerpretation work showed that 30 to 50 percent of these nonforest plots contained trees and were located in urban, suburban, industrial, and rural areas. Data were collected for trees on traditionally nonforest plots in a five-county area in Maryland that was 30 percent forested in 1999. Nonforest plots added at least 43 percent to the total-tree basal area measured on forest plots. Species composition, tree size, damage, and number of exotics differed between forest and nonforest plots. Costs were about one-third of those on a regular FIA plot. Field collection methods, including field preparation, plot design, and variables collected are outlined, and recommendations for future inventories of similar areas are presented.

The Author

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Acknowledgments

This pilot project, a group effort by the Northeastern FIA unit (NE-FIA), tested the integration of a nonforest inventory with the regular FIA process and investigated the feasibility, effectiveness, and amount of additional information provided by a nonforest inventory. By taking advantage of the current NE-FIA process of hiring and training, data quality assurance, data processing, and statistical protocols, we were able to ensure the quality, consistency, and repeatability of the data, and save time and money in conducting the nonforest inventory. The following contributed significantly to this study:

Mike Whitehill and John Higham, FIA (field inventory crew)
Stan Arner and Jim Westfall, FIA, and Sara Duke, NE (statistical support)
Tom Frieswyk, FIA (data processing)
Mike Hoppus and Andy Lister, FIA (crew preperation support)
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Anne Cumming and Dan Kincaid, NA (newspaper article and brochures)
Sean Lehman, FIA intern (data entry)
Mike Galvin, Maryland DNR
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Jen Jenkins, FIA/Global Change (NPP and carbon sequestration analysis)
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Contents

Highlights

- Seventy percent of the land area in the five-county study area in Maryland was nonforest in 1999. Thirty-six percent of that nonforest area contained trees. On average, the nonforest plots in this pilot study contain 18.4 percent of the tree basal area that occurs on forested plots, adding 43.2 percent to the total-tree basal area on forest plots. Calculations of total number of stems also are affected significantly when data from nonforest plots are included. The contribution of nonforest plots to basal area totals is even greater in specific strata such as census-designated urban areas or residential land uses, where a higher proportion of the plots tend to be nonforest.

- Species composition, average tree size, and number of saplings differed between forest and nonforest plots.

  ◊ On average, nonforest plots had fewer but larger trees (only 14 percent of the trees per acre on forest plots, but an average basal area per tree of 0.99 versus 0.74).

  ◊ Nonforest areas typically had little natural reproduction in the understory, and only 11 percent of the sapling stems per acre.

  ◊ Nonforest plots also differed in both the species occurring in the top 10 list and their ranking within it. This was true for both basal area and number of stems.

- Including data from nonforest plots can make a substantial difference in calculations of total basal area, total biomass, total number of stems, carbon stocks, and net primary productivity.

- The subset of nonforest plots that contain trees occurred largely in residential areas even though much of the suburban development in Maryland has occurred on previously agricultural land. In areas where residential development has been substantial in previously forested areas, the amount of tree basal area in residential land uses likely is even greater.

- It is interesting that nonforest areas contain fewer tree species. One might assume that interest in importing exotic species would increase raw local species diversity.[1] However people apparently reduce raw diversity in nonforest areas by their collective preference for only several popular species.

- According to the native species list used in this study, some of these species are found more frequently on nonforest than on forest plots. These include black locust, white pine, silver maple, and sugar maple. This may reflect of the types of areas that have been converted primarily to nonforest, species that are most tolerant of nonforest conditions and survive, and/or species that are preferred and cultivated by owners of nonforest land.

- Conducting a nonforest inventory in conjunction with the regular forest inventory of a state can save considerable time and costs due to increased efficiencies.

- The 0.10-acre plot design was easy to implement and limited the number of owner contacts per plot. The relative accessibility of nonforest plots, a reduction in the time-consuming timber-related variables collected, and access to ownership information prior to the fieldwork contributed to the relatively low cost of these plots. On average, one crew was able to inventory three to four plots per day and complete the entire inventory (170 plots) during one summer. Total costs were much lower than our initial estimate.

[1]No consideration for choosing only native species in the calculation.

Table 1.—Number of plots, nonforest (NF) plots, NF plots with trees, and primary use on NF land in percent of total area, by state

State	Number of plots	Number of NF plots[a]	NF plots with trees		Nonforest land use[c]			
			Number[b]	Percent[b]	Agriculture	Urban	Residential	Natural
CT	451	181.22	112.12	62	10	8	13	2
DE	215	132.16	22.05	17	48	3	5	7
ME	646	62.00	25.59	41	5	3	1	2
MD	1098	632.23	275.87	44	39	4	6	4
MA	798	298.65	178.19	60	6	7	14	4
NH	930	150.54	93.62	62	6	3	3	2
NJ	791	432.13	202.21	47	20	5	18	4
RI	178	72.71	41.89	58	4	10	15	2
VT	926	209.55	76.07	36	17	2	1	2

[a] Plot fractions occur because FIA plots are now "mapped" and a single plot can contain portions of both forest and nonforest.
[b]From the land-use code (LU) used in the regular FIA inventory. Results from this study indicate that this is an overestimation of the number of NF plots that actually contain trees within plot boundaries because the LU label is determined by assessing tree cover in the general area rather than within a specific plot area when an NF plot is not physically established on the ground.
[c]Derived from National Land Cover Dataset (NLCD) using 1992 (approx.) imagery (Vogelmann and others 1998).

Introduction

The USDA Forest Service's Forest Inventory and Analysis (FIA) units periodically assess the Nation's forest resources and also conduct forest inventories by state that provide data on the amount, status, and character of the forest resources across the country. This information is summarized from general data collected on all plots and detailed tree data collected on forested plots. The latter are defined by FIA as areas at least 1 acre in size, at least 120 feet wide, and at least 10 percent stocked with trees. Also, forest plots must have an understory that is undisturbed by another land use.[2] FIA usually does not collect data on nonforest plots because they cannot be used to describe "forest lands," a national definition used when summarizing information across the United States.

However, classification of "nonforest" does not mean that a plot is devoid of trees. The most recent inventory cycle and the standard photointerpretation work by the Northeastern FIA revealed many areas in the Northeast that contain trees that do not fit FIA's definition of forest land. For example, more than 62 percent of the "nonforest" conditions[3] in Connecticut and New Hampshire contained trees, and 44 percent of the plots defined as nonforest in Maryland have a land-use code indicating some type of tree cover. The percentage of nonforest plots with trees in nine Northeastern States inventoried since 1995 is shown in Table 1. These plots represent a portion of the tree resource for which information on species, health, and biomass is not currently collected. We are interested in determining the amount of tree biomass in these areas. A substantial amount of biomass could affect the accuracy of regional models developed from FIA data, e.g., those for net primary productivity (NPP) or carbon sequestration, as well as FIA's ability to accurately describe and monitor tree cover both in urban areas and in more developed counties and states. Although FIA does not claim that its data capture more than forested areas, this information is sometimes used by assumption to describe all of the trees in a state because it is the only inventory that exists over large areas. The accuracy of this assumption depends on the amount of tree cover in areas classified as nonforest.

The Northeastern United States is heavily impacted by the increasing spread of suburban and urban areas into

[2]U.S. Department of Agriculture, Forest Service. 2000. Forest inventory and analysis national core field guide, volume 1: field data collection procedures for phase 2 plots, version 1.6. Internal report on file at U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis, Washington, DC.

[3]A "condition" equals a plot or a portion of a plot if mixed conditions occur (see Mixed Conditions).

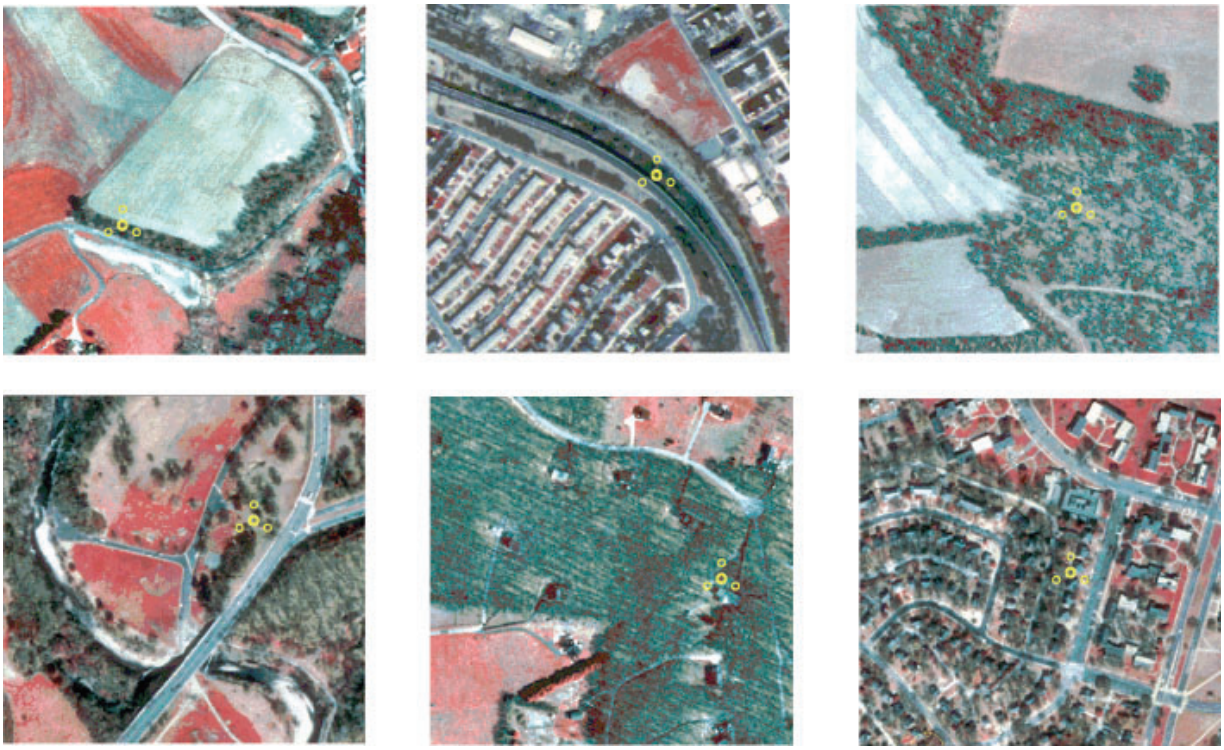

Figure 1.—Aerial view of "nonforest" areas that contain trees.

forest and agricultural land. Some areas previously inventoried as forest land may have lost that status as residential development has divided them into pieces that are too small to fit FIA's definition, or the degree of understory disturbance has increased sufficiently to require a different classification. In other areas, residential development on previously open agricultural areas may be old enough to contain large, planted tree cover that today constitutes a substantial resource. As such areas increase, so does the amount of land with tree cover that is not captured by the regular FIA inventory. In fact, the amount of tree cover that is missed in the FIA inventory may be considerable and probably is increasing.

Non-FIA inventories do exist, for example, city tree inventories conducted periodically by Nowak et al. (1996). However, these inventories are conducted almost exclusively within city limits, and so trees in suburban, rural-residential, and rural-agricultural areas that occur outside those city limits are not captured. These areas may contain trees in backyards, small woodlots in the middle of developments, strips of trees along roads or along highway medians, or patches of remnant woodland between scattered, low-density housing, riparian buffer strips, or between agricultural fields. Thus, there is a potentially large gap in the information available from current inventories. Examples of these "nonforest" areas are shown in Figure 1. Trees in these areas are rarely used for timber on a continuing basis, but they do sequester carbon, produce oxygen, modify the climate, create habitat for wildlife species, support casual recreation, and generally contribute to the quality of life. Such trees are an important resource that is receiving increasing attention and questions with respect to its health, characteristics, increase, or decline.

In 1999 in Maryland, nonforest plots were inventoried in five counties: Anne Arundel, Baltimore, Carroll, Harford, and Howard (Fig. 2). In 2000, this area covered 2,237 square miles and had a combined population of 2,512,431.[4] The five counties together capture a gradient of population density, urbanization, and land use and coincide with the Baltimore Urban LTER (Long Term Ecological Research) site. The City of Baltimore is entirely urban, four counties have large areas of suburban, and one county extends into largely rural-agricultural areas. Population density ranges from 336 per square mile in agricultural Carroll County to 1,261 per square mile in Baltimore County (excluding the city), to 8,059 per square mile in the City of

[4]Source: U.S. Census Bureau, Census 2000 Redistricting Data (Public Law 94-171) Summary File, Matrices PL1, PL2, PL3, and PL4.

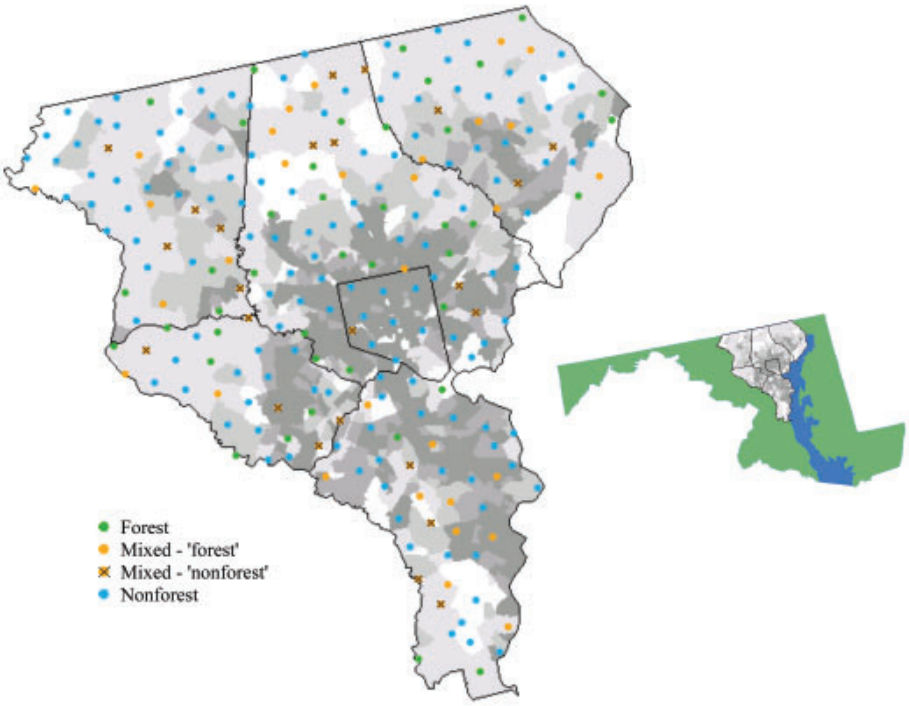

Figure 2.—The five-county study area and FIA plots. Any FIA plot with nonforest at the center subplot was visited by the nonforest inventory (NFI) crew; this included both nonforest and mixed nonforest plots.

Baltimore (Table 2). Heavily populated Baltimore County is the most forested of the five counties. The distribution of land use/land cover and human population in this region is shown in Figures 3-4. The pilot inventory was conducted simultaneously with the regular FIA inventory of the area to maximize the integration of the two inventories, and thus the efficiency of data collection. For example, by using FIA protocols, the nonforest inventory (NFI) crew could effectively reduce the number of plots that the regular FIA crews had to visit.

Table 2.—Population density (2000 census), percent forest (1999 inventory), and percent urban area (1990 census) in the five-county study area (includes City of Baltimore)

County	Forested	Urban	Population density
			Persons/mi²
City of Baltimore	2.8	100	8059
Anne Arundel	24.7	46	1177
Baltimore	35.4	40	1261
Howard	30.6	35	983
Harford	33.6	22	496
Carroll	23.5	6	336

Goals

The pilot inventory of nonforest plots addressed the following questions:

- How many trees are on nonforest plots in the five-county study area?
- Is the amount of nonforest tree biomass sufficient to make a substantial difference in global and regional modeled estimates of total biomass, NPP, and carbon sequestration?
- Does the character of that resource differ from that of the traditionally forested resource in species composition, tree size, total basal area, forest structure, and/or health? And if certain types of forest conditions or tree species are more prevalent in nonforest areas, does this affect interpretations of regular FIA data when describing the entire tree resource?
- Can these data be used to extend FIA summary statistics into areas considered as nonforest or to generate statistics of "all tree cover" in a particular area, e.g., number of trees by species and diameter class, total basal

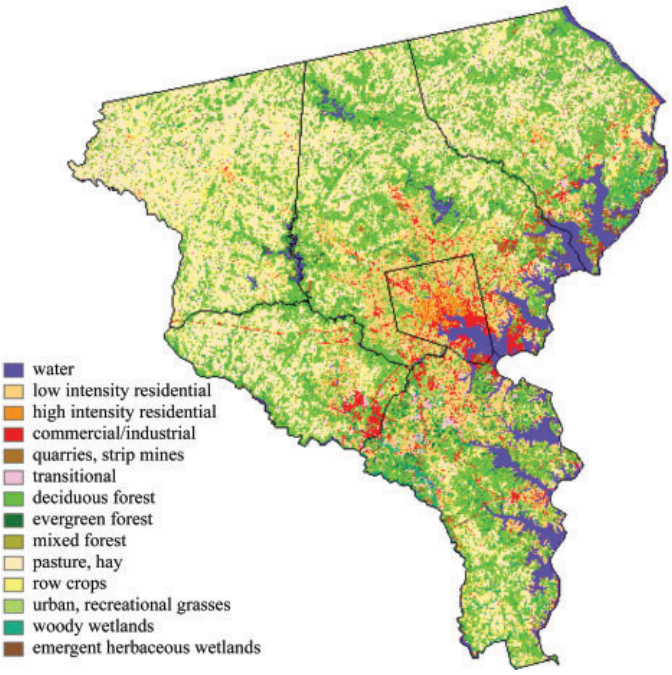

Figure 3.—General land use/land cover in the five-county study area. Source: National Landscape Characterization Dataset, derived from 1992 Landsat TM imagery (NLCD'92) (Vogelmann and others 1998).

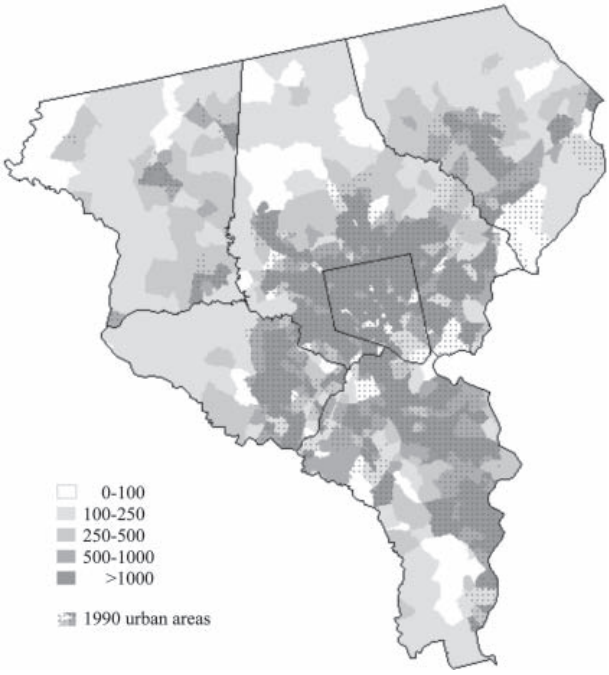

Figure 4.—Population density and census-designated urban areas in the five-county study area (1990 census).

area, and number of saplings and shrubs by species and stand-size class? How easy or difficult is it to integrate data from the two inventories?

- Would this additional information add to our current knowledge of the "urban forest" in a state?

- How well are we able to inventory these areas using FIA plots? For example, are Forest Health Monitoring (FHM) variables and indicators appropriate in these areas? Is FIA sampling intensity and the 1/10th-acre plot design sufficient to capture tree biomass in these areas, and/or related data on forest characteristics? What kinds of plot designs and inventory protocols are necessary for data collection in these areas?

- What is the cost of an FIA nonforest inventory?

- What areas contain the most tree biomass that the FIA inventory is missing, i.e., is there a way to capture most of this tree biomass if funds are not available to inventory the entire area?

Methods

The nonforest inventory was conducted from June 1 to August 31, 1999. Leaf-on conditions allowed the collection of data on crown condition and characteristics. The regular FIA plot "grid" for Maryland was used in the pilot study to ensure an unbiased procedure. Plots were determined to be nonforest by the previously mentioned FIA standard definition. A 0.10-acre nonforest plot (37.24-foot radius circle) was established if any nonforest condition occurred on the center subplot (subplot 1) of the standard FIA plot (Fig. 5). The nonforest portion of that 0.10-acre plot was inventoried by the NFI crew. Forest plots were visited by regular FIA crews and standard data were collected. To maximize efficiency, the nonforest inventory was coordinated with the regular FIA inventory. To avoid revisiting plots, the NFI crew also completed the standard FIA plot sheet for all plots visited, and conducted the regular FIA inventory on the forested portions of mixed plots. This occurred on 24 of the 162 non-water plots inventoried by the NFI crew.

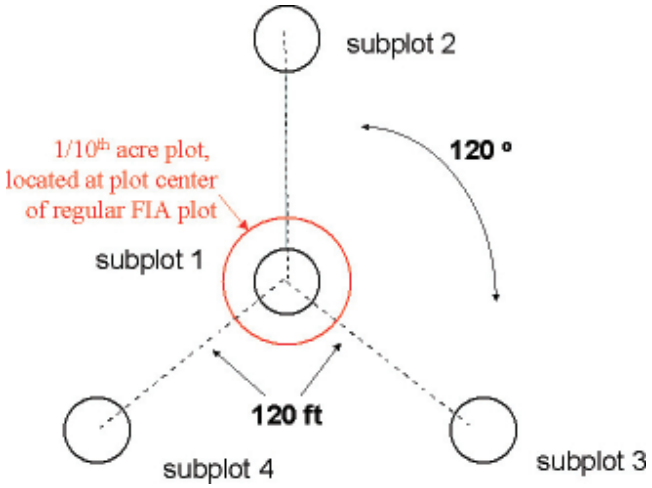

Figure 5.—Plot design for the nonforest and standard FIA inventory plots.

The same methods and protocols were used by the regular FIA and NFI crews when possible.[2,5] Differences between the two inventories included the inventory season, plot design, certain variables for which data were collected, protocols for addressing unique circumstances in nonforest areas, e.g., buildings on plots and planted exotic species, and media publicity prior to the inventories.

Plot Design

The 0.10-acre plot size was a compromise between being small enough to avoid multiple ownerships and large enough to capture sufficient tree data. This plot size also has been used in citywide inventories of urban forest (McPherson et al. 1994). With the higher spatial density of ownerships expected in these areas, contacting numerous owners on a single distributed cluster plot could slow the inventory considerably.

Mixed Conditions

All FIA plots inventoried since 1995 can contain more than one condition (nonforest or forest or both). On such plots, all conditions are mapped and inventoried separately. If a nonforest condition occurred on subplot 1, a 0.10-acre nonforest plot was established on plot center. If nonforest conditions occurred on any of subplots 2-4 but not on subplot 1, no nonforest plot was established (Fig. 6). Although there should be no bias to this procedure, it is possible that this sampling design underestimates slightly the nonforest area because it misses the nonforest portion of those plots where nonforest occurred only on subplots 2-4. Once the nonforest plot was established, no further breakdown of conditions was mapped and the entire 0.10-acre plot (or the nonforest portion of it) was treated as a single nonforest condition.

Variables

Data collected on each plot consisted of a subset of standard FIA variables plus additional variables designed to better describe the health, biodiversity, and ground cover of trees in nonforest areas. FIA variables considered to be less important in nonforest areas, e.g., timber-related cull and board-foot measures, were excluded from the nonforest inventory. FIA variables describing location, site, and tree characteristics were retained. Additional variables for crown size, condition, and damage used in the nonforest inventory were developed for the FHM plots (USDA For. Serv. 1999). Ground cover variables that were added were based on those from city inventories (Nowak et al. 1996) and describe characteristics such as the percentage of impervious surfaces, vegetation, and tree canopy cover on the plot (Nowak and Crane 2000).

Several plot-level variables specific to this inventory also were included. First, to better distinguish the types of areas with nonforest plots and large amounts of tree basal area, three variables were added: a land-use class, an owner class, and primary reason for nonforest status. The variable for NFI land-use class, unlike the regular FIA land-use variable, provided an additional breakdown of residential land uses by density and industrial/commercial land uses by type. The owner-class codes were the same as those used in the regular inventory. The variable for "primary reason for nonforest" consisted of five codes: 1 = stocking less than 10 percent; 2 = forest area less than 1 acre in size; 3 = forest area less than 120 feet wide; 4 = a disturbed understory due to nonforest land use; 0 = no trees. A fourth variable, "obstruction at plot center," was included to identify plots for which distances and azimuths were measured via photo rather than on the ground because the plot center could not be occupied. Finally, "number of forested subplots" was included to determine the additional time that the NFI crew was on the plots that was unrelated to the nonforest inventory itself. This information was collected to gain a better understanding of the types of areas missed by the regular forest inventory and perhaps help to identify in the future nonforest areas that contain the most tree cover.

[5]Alerich, D. 1999. Field instructions for the fourth inventory of Maryland. Unpublished report on file at USDA Forest Service, Northeastern Research Station, Forest Inventory and Analysis, Newtown Square, PA.

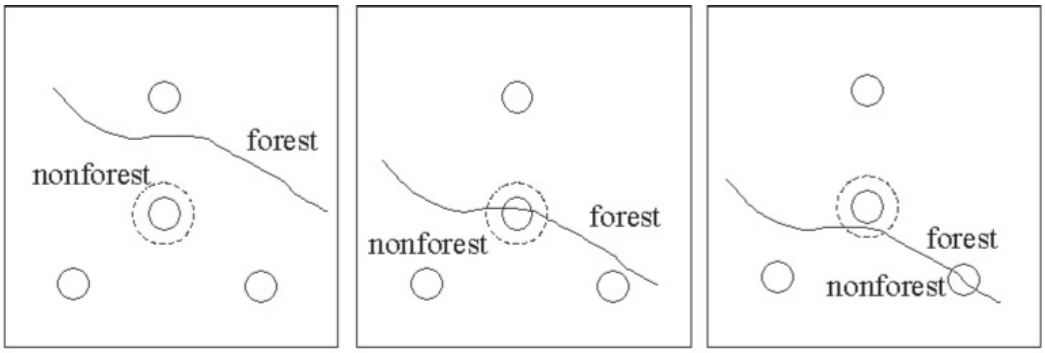

Figure 6.—Nonforest plots were established if a nonforest condition occurred entirely (a) or partially (b) on the center subplot of the standard FIA plot. A nonforest plot was not established if the center subplot was entirely forested, i.e., even if nonforest conditions occurred on another subplot.

Plot, tree, and sapling variables and their sources are listed in Appendix I. All trees (≥ 5 inches in d.b.h.) and saplings (1 to 4.9 inches d.b.h.) were measured on the entire 0.10-acre plot. The resulting data were used to summarize species and forest type, biomass, NPP, carbon storage and sequestration, and indicators of health (crown condition, sustainability, species diversity) and structure (tree size, density, d.b.h. distribution, ground vegetation, ratio of height to crown).

Codes for all new variables (non-FIA and non-FHM) are listed in Appendix II. Codes were added for exotic and planted tree species on nonforest plots that are not listed in the Eastwide Database (Hansen et al. 1992), the Westwide Database (Woudenberg and Farrenkopf 1995) or the FIA's national core field guide.[2] Most of these species were identified and recorded by species group only, e.g., the willows and crabapples.

Special Situations

Plots that were on tops of buildings or in the middle of streets were inventoried, but distances and azimuths to trees were calculated from a photo when the plot center could not be occupied. To accomplish this, the NFI crew used 1:4000 prints of a digital orthophotoquad (DOQQ) for each plot. The DOQQs were from photos taken from 1986 to 1992. The 1:40,000 NAPP (National Aerial Photography Program) photography that crews use to assist in navigating to plots was too small a scale for measuring portions of a plot. Because trees could not be marked and a permanent stake could not be placed at plot center on nonforest plots, plot location was identified for future reference by recording the distance and direction of plot center from known objects.

Owner Contact

Owner information (names, addresses, and telephone numbers) was obtained by permission from MdProperty View, a digital property map and parcel database maintained by the Maryland Department of Planning (http://www.mdp.state.md.us/data/mdview.htm). Plots were overlaid on the georeferenced pict file, read off the file manually, and placed in a spreadsheet. (The files are now available in a more user-friendly format.) This information was not always accurate due to uncertain plot locations, e.g., plots that fall near the edge of several ownerships. Nevertheless, this method substantially reduced the time typically required to locate current plot-ownership information at the local tax office.

Because most owners were not available during the day, contacting them entailed several steps: 1) distributing information about the nonforest inventory at each residence, 2) a follow-up phone call to the owner(s), and 3) upon receiving permission from an owner, returning to the plot to conduct the inventory. Since nearly every plot location was easily accessible by road, this process did not consume an inordinate amount of time. And because many owners actually resided on or near the plot, there was far less uncertainty about who the owner was or where he or she lived. The NFI crew also was aided by an article about the inventory that was published in a local newspaper prior to the pilot study.

Number of Plots

There are 243 FIA plots in the five-county study area. Of those, 146 were nonforest (NF), 44 were forest (F), and 53 were mixed (M) (25 completely forested and 28 containing some nonforest on subplot 1) (Fig. 2). The

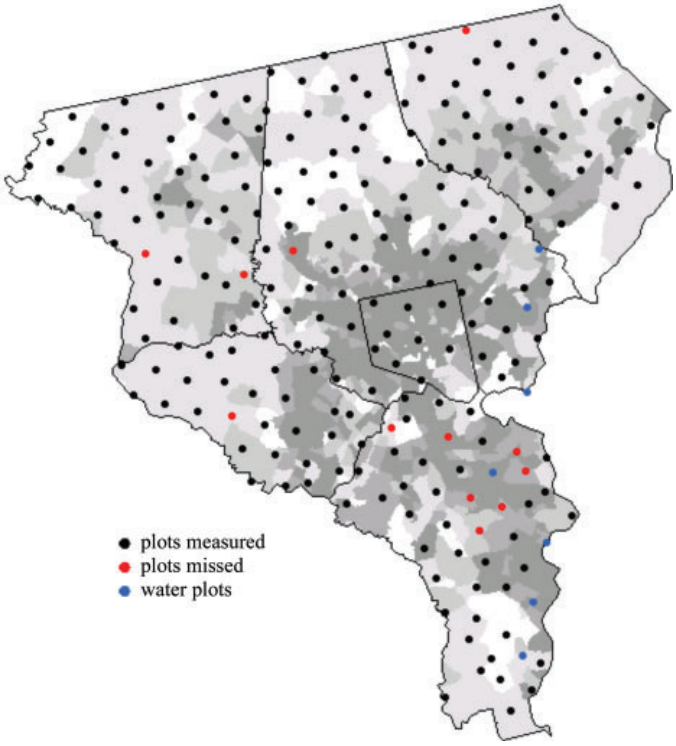

Figure 7.—All FIA plots and those missed by the nonforest inventory crew.

NFI crew inventoried 162 plots (138 NF plots and 24 M plots). Thus, eight NF plots and four M plots were missed by the NFI crew (Fig. 7). It is likely that these plots were missed because they were entirely forested at the photointerpretation stage (1996 photography in Maryland) and nonforest when the crew visited the plot (1999), or the original plot in that hex was dropped for some reason (e.g., access denied), and these were replacement plots chosen after the NFI crew had completed the inventory. In either case, they are entirely or partially nonforest and should be measured in future inventories. Thus, for calculations of total forest and nonforest area, the data from the regular FIA inventory are required and all 243 plots are used (72.49 of which are F plots). For calculations using variables inventoried on NF plots, only 231.1 plots are used (160.14 NF and 70.96 F plots), as the NF plots or portions of plots for which no data were collected were labeled as "missing data" (Table 3).[6]

[6]The total number of NF plots used in the analyses = 138 + 22.14 = **160.14**. The total number of F plots used for estimates of population basal area and number of stems = 44 + 26.96 + 1.53 = **72.49**, i.e., all F plots. The total F plots for analyses comparing F and NF characteristics = 44 + 26.96 = **70.96**, i.e., all F plots minus those mixed plots for which nonforest data were not collected.

In this study, we used data on percent forest and nonforest in the five-county area from the regular FIA inventory. One also can calculate roughly the number of nonforest plots containing trees using the current land-use variable collected on all FIA plots. The nonforest inventory introduces additional information about trees on NF plots, e.g., tree species, basal area, percent crown cover, number of trees and saplings, ground cover, crown conditions, and damage.

Although we used the regular FIA grid-based sample design for Maryland to eliminate bias, this procedure might have been compromised because the 12 plots that were missed and subsequently dropped from the pilot inventory were located primarily in one section of Anne Arundel County and thus may have had other characteristics in common.

Results and Discussion

Tree Cover in Nonforest Areas

Total basal area (ba) for all trees on F plots and portions of plots was 1,324.2 ft^2 on 72.49 $1/6^{th}$ acre plots. The total ba for all trees on NF plots and portions of plots was 323.805 ft^2 on 160.14 $1/10^{th}$-acre plots. Calculating population totals for the five-county area in Maryland results in a total ba of 46,978,517 ft^2 for forested areas and 20,312,288 ft^2 for nonforest areas. Including data from NF plots adds 43.2 percent to the total ba in the five-county area. Average ba/acre on F plots is 110 ft^2 vs. 20 ft^2 on NF plots. On average, NF plots contain 18.3 percent of the ba on F plots (Table 4).

On average there are 20.5 stems (³ 1 inch d.b.h.) per acre on NF plots vs. 148.2 on F plots. Calculating population totals results in 63,324,410 stems on F plots and 20,575,440 stems on NF plots. Including data from NF plots adds 33.5 percent to the total number of stems in the study area for trees and 26 percent to the total number for saplings (Table 5).

For Tables 8-9, population estimates were calculated using a plot/acre expansion factor and average area expansion factors. The more complex calculation used in Tables 17-25 is the same as that proposed for use nationwide by FIA. With the latter approach, a weighted mean is calculated based on stratum weightings, and a single factor is used to expand the mean to the population estimate (unpublished data).

Forest Carbon Stocks and Wood Production on Nonforest Land

Preliminary estimates based on methods of Jenkins et al. (2001a, 2003) indicate that tree-biomass stocks and

Table 3.—Number of plots by county (including City of Baltimore) and forest status

Item	Anne Arundel	Baltimore	Carroll	Harford	Howard	City of Baltimore	Total
Land area (mi^2)	416	598.6	449.2	440.4	252.2	80.8	2237.2
Completely NF plots (no.)	22	35	33	25	15	8	138
NF plots missed (no.)	5	1	1	1	0	0	8
F plots (no.)	6	17	6	9	6	0	44
F/mixed plots (no.)	6.18	7.42	5.01	5.79	2.31	0.25	26.96[b]
NF/mixed plots (no.)	4	4.9	5	2.79	4.45	1	22.14[c]
Mixed plots missed in NF inventory (no.)	2 (.91)[a]	0	1 (.37)	0	1 (.25)	0	4 (1.53)
Total plots minus missed NF plots (no.)	38.18	64.32	49.01	42.58	27.76	9.25	231.1
Total land plots inventoried by FIA (no.)	46	66	50	44	28	9	243

[a]Proportion that is forested in parentheses.
[b]Sum of forested condition percentages on all mixed plots (derived from entire 1/6th-acre plot).
[c]Sum of nonforest condition percentages on all mixed plots (derived from 0.10-acre plot).

Table 4.—Total basal area (ba) of forest (F) and nonforest (NF) plots in five-county study area (trees only (dbh ≥ 5 inches))

Plot type	Number of plots	Average ba/acre	Percent of F plots	Total ba on plots	Expansion factor[a]		Total ba (population estimate)	Percent of F plots
					No. plots/ acre	Land area/ no. plots		
		ft²		*ft²*			*ft²*	
F	72.49	110.0		1324.2	(6.02)	(5893)	46,978,517	
NF	160.1	20.2	18.4	323.8	(10)	(6273)	20,312,288	43.2

[a]Plot totals are multiplied by expansion factors to obtain population estimates. Expansion factors are a combination of a plots/acre factor (10 for NF plots and 6.02 for F plots) and the total land area that each plot represents (based on the number of plots inventoried).

Table 5.—Total number of trees and saplings on forest (F) and nonforest (NF) plots in the five-county study area

Plot type	Number of plots	Avg. no. stems/acre	Percent of F plots	Total no. stems on plots	Expansion factor[a]		Total no. stems (population estimate)	Percent of F plots
					No. plots/ acre	Land area/ no. plots		
				Trees				
F	72.49	148.2		1785	(6.02)	(5893)	63,324,410	
NF	160.1	20.5	13.8	328	(10)	(6273)	20,575,440	32.5
				Saplings				
F	72.49	294.9		286	(74.75)	(5893)	125,983,501	
NF	160.1	32.7	11	524	(10)	(6273)	32,870,520	26.1

[a]Plot totals are multiplied by expansion factors to obtain population estimates. Expansion factors are a combination of a plots/acre factor (corresponding to the 1/10th-acre NF plot, the approximately 1/6th-acre F plot, and the approximately 1/75th-acre F sapling plot) and the total land area that each plot represents (based on the number of plots inventoried).

Table 6.—Average number of stems and basal area/acre on forest plots, all nonforest plots, and nonforest plots with trees in the five-county study area (does not include 15 sapling-only plots)

Plot type	Number of plots	Trees		Saplings	
		Average no. stems/acre	Average ba/acre	Average no. stems/acre	Average ba/acre
			ft²		*ft²*
Forest	72.49	148	110	551	10
Nonforest	160.14	21 (7) [a]	20 (18)	33 (6)	1.4 (14)
Nonforest with trees	57	58 (39)	57 (52)	75 (14)	3.3 (33)

[a]Percent of forest plots in parentheses.

wood production on nonforest land are, respectively, 25 and 22 percent of the totals computed for forest land in Maryland. This result suggests that for the five-county study area, where nonforest land is substantially more common than forest land, including nonforest land could add as much as 33 percent to current estimates of forest carbon stocks and 29 percent to existing estimates of annual wood production. Depending on the ratios of nonforest to forest land and the percentage tree cover on nonforest land in different regions, carbon sequestration on nonforest land could be an important contributor to regional and national carbon balances (Jenkins and Riemann 2003).

Differences Between Forest and Nonforest Plots

What are the differences between forest and nonforest plots, and does adding the nonforest data to the area summary change our description of these five counties from what we already knew? With data from the nonforest inventory we can examine differences in average number of stems/acre, average ba/acre, species composition, percentage of exotic species found, damage, stand-size, species, and diameter-class distributions, and number and species of saplings (regeneration).

Stems and basal area/acre. Nonforest plots generally had fewer but larger trees. The average d.b.h. on F plots was 11.6 inches (0.74 ft^2 of ba) vs. 13.5 inches (0.99 ft^2) on NF plots. Relative size did vary by species. On the latter plots, the ba of chestnut oak was 2½ times that on F plots, while red maple were roughly the same size on F and NF plots. The average number of trees/acre and ba/acre was much lower on NF than on F plots (20.5 vs. 148 trees/acre, and 20.2 vs. 110 ft^2/acre). The average was 58 trees and 57 ft^2/acre on NF plots with trees (Table 6). The proportion of NF plots with trees does correspond to land use, so calculating values separately for NF plots with trees is useful when estimating the impact of a nonforest inventory where advance information on land-use composition of the area of interest is available.

Tree-species composition. On NF plots, yellow-poplar and chestnut oak were the top species by basal area, accounting for 30.3 percent of total ba. On the basis of number of stems, white pine and yellow-poplar were the top species, accounting for 20.5 percent of total stems on NF plots. On F plots, yellow-poplar and red maple accounted for 33.3 percent of the ba and 27.2 percent of total stems (Tables 7-10). When NF plots were included, the top 10 species in the study area changed only in their ranking in the list.[7]

Of the tree species inventoried, 26 were common to both F and NF plots (88 percent native, 8 percent exotic, and 4 percent unknown).[8] Twenty-eight different species were identified on F plots only (79 percent native and 21 percent exotic) and 16 species of trees were identified on NF plots only (19 percent native and 63 percent exotic). Thus, NF plots have fewer species in general and a larger percentage of exotics in the overall species mix. The types of exotics on NF plots also differed from those on F plots except for Norway maple

[7]In all tables in which the characteristics of F and NF plots are compared, only 70.49 F plots are included in the analysis, i.e., the four mixed plots in which the nonforest portion of the plot was missed in the inventory are considered missing data. The remaining 70.49 forest plots contained 1,749 stems and a total basal area of 1288.2 ft^2.

[8]Based on a list of native species compiled in 1999 by Dan Crane, USDA Forest Service, Syracuse, NY (Nowak et al. 2002), "Unknown" species are typically those identified and recorded only at the genus level and for which some species are native and others exotic. Thus, genus-level identification did not allow determination of native or exotic status.

Table 7.—Top 10 species on nonforest plots, by total basal area

Species	Basal area	Percent of total
	ft^2	
Yellow-poplar	64.6	20.0
Chestnut oak	33.4	10.3
White oak	22.0	6.8
Black locust [a]	18.9	5.8
Scarlet oak	17.7	5.5
Red maple	17.6	5.5
Black oak	16.9	5.2
White pine [a]	16.4	5.0
Black cherry	12.4	3.8
Silver maple [a]	10.7	3.3

[a]More prevalent on nonforest than forest plots.

Table 8.—Top 10 species on forest plots, by total basal area

Species	Basal area	Percent of total
	ft^2	
Yellow-poplar	303.8	23.6
Red maple	137.7	10.7
Scarlet oak	80.4	6.2
Chestnut oak	75.5	5.9
Black oak	73.4	5.7
Sweetgum [a]	72.5	5.6
Virginia pine [a]	71.9	5.6
White oak	62.2	4.8
Black cherry	58.3	4.5
Northern red oak [a]	57.2	4.4

[a] More prevalent on forest than nonforest plots.

Table 9.—Top 10 species on nonforest plots by number of trees

Species	Number of trees	Percent of total
White pine	35	10.7
Yellow- poplar	32	9.8
Red maple	28	8.5
Black locust	22	6.7
Black cherry	18	5.5
Chestnut oak	16	4.9
White oak	15	4.6
Silver maple	12	3.7
American beech	12	3.7
Scarlet oak	10	3.0

Table 10.—Top 10 species on forest plots by number of trees

Species	Number of trees	Percent of total
Yellow-poplar	263	15.0
Red maple	213	12.2
Virginia pine	151	8.6
Sweetgum	135	7.7
Black cherry	130	7.4
Chestnut oak	89	5.1
Black oak	66	3.8
White oak	61	3.5
Scarlet oak	60	3.4
Blackgum	60	3.4

and Ailanthus, which were found on both F and NF plots. This difference probably corresponds closely to species that have escaped, e.g., Paulownia found on F plots, vs. those that have been planted, e.g., pear and ornamental cherry found on NF plots (Cynthia Huebner, USDA Forest Service, 2000, pers. commun.).

We also observed differences in the presence and abundance of native species on F and NF plots. Black locust and eastern white pine were much more prevalent on NF plots (5:1), and silver maple and sugar maple were found only on NF plots. Much more prevalent on F plots were sweetgum (5:1), Virginia pine (42:1), and northern red oak (3:1). These differences might be attributed to areas that have been converted primarily to nonforest, e.g., bottomlands in the southern United States (Rudis 1995), areas that are left with trees (e.g., riparian), species that are most tolerant of and survive in nonforest conditions, and/or species that are preferred and cultivated by owners of nonforest land. For example, white pine may be a frequently planted species while black locust, a disturbance-related species, may be a frequent volunteer in disturbed nonforest areas. Also, silver maple may reflect long-linear riparian areas that are not sampled by the regular FIA inventory, and/or an area that has been preferentially converted to nonforest uses. Additional research is needed to better understand such differences.

Table 11.—Percentage of exotic, native, and unknown species on nonforest and forest plots, by number of trees and total basal area

	Nonforest plots			Forest plots		
Variable	Exotic	Native	Unknown	Exotic	Native	Unknown
Number of trees	13	83	5	2	98	0
Basal area (ft^2)	8	88	4	1	98	0

Table 12.—Percentage of trees on forest and nonforest plots that incurred "special damage"

	Trees damaged by:			
Plot type	Other bark beetle	White pine weevil	Other borers	Dieback (20-50%)
Forest	11	—	3	1.6
Nonforest	23	6	6	3

Exotics. The percentage of exotic tree species also differed between F and NF plots (Table 11). On NF plots, 83 percent of the trees were native, 13 percent were exotic, and 5 percent were unknown.[9] Summarized by basal area, exotic species made up 8 percent of the total on NF plots. By contrast, exotics accounted for only 1 percent of the trees and 2 percent of the basal area on F plots. When all plots are included, exotics made up 4 percent of the trees and 3 percent of the basal area present.

Damage. Damage to trees on F and NF plots can be compared by tree condition and special damage.[2] All but two trees in the nonforest inventory (99 percent) were recorded as being live with an intact top, and 95 percent of the trees on F plots were free of this damage. "Special damage" is noticeable damage recorded by apparent cause ("dieback" is recorded separately). On NF plots, special damage was recorded for 38 percent of the trees; 20 percent of the trees on forest plots had special damage. The types of special damage were similar on both plot types except for damage by the white pine weevil, which prefers feeding on terminal shoots of white pine in full sunlight. This condition is more common for trees on NF plots (Table 12).

Information on tree damage on NF plots also can be derived from the FHM variables that record damage by location, severity, and symptom rather than by cause. By this method, 34 percent of all nonforest trees exhibited some damage (Tables 13-14), though the accuracy of this percentage is suspect because many FHM variables failed to meet standards for quality assurance/quality control (Dan Twardus, USDA Forest Service, 2000, pers. commun.). How this compares with trees on forest plots is unknown as this variable was not included in the regular FIA inventory of Maryland in 1999. This variable has since been added for FIA forest plots to allow comparisons between F and NF plots in future inventories.[2]

Crown dieback is another indicator of tree health. Of 328 trees on NF plots, 145 (44 percent) had no dieback, 149 had dieback of 1 to 9 percent, 29 had dieback of 10 to 25 percent, and 5 trees had > 25 percent dieback. It is not known how this compares with trees on F plots as crown dieback was recorded only on the relatively few FHM plots.

Stand size. Stand size can be difficult to measure on NF plots, particularly where trees are sparse and tree size varies widely. Nevertheless, this measure is useful for understanding the types of potential habitats in these areas, and whether these habitats differ from those on F plots.

In this study, smaller stand sizes were more prevalent on NF plots. All F plots were classed as sawtimber (67 percent) or poletimber (33 percent) stands. Nonforest plots on which trees or saplings were present were classed

[9]Unknown includes six species groups that contain both exotic and native species: redwood, chestnut, ash, cherry/plum, willow, and unknown species. It is possible that many of these trees were exotics.

Table 13.—Number of trees with damage on nonforest plots, by location and incidence of damage

Location on tree	FIA code[a]	Damage incidence[b]		
		First	Second	Third
Exposed root/stump	1	23	0	0
Root/stump/lower bole	2	16	3	0
Lower bole	3	26	8	0
Lower/upper bole	4	6	2	2
Upper bole	5	8	6	1
Crownstem	6	16	8	2
Branch > 1 inch	7	14	7	5
Bud/shoot	8	0	0	1
Foliage	9	0	0	0
Trees with damage[c]	109	34	11	

[a]No damage = 0.
[b]1, 2, and 3, are the first, second, and third damage recorded on a tree. When there are multiple types of damage, damage lower in the tree is recorded first as this usually is considered more hazardous to overall tree health.
[c]328 total trees on nonforest plots.

Table 14.—Number of trees with damage on nonforest plots, by type and incidence of damage

Type of damage	FIA code	Damage incidence[a]		
		First	Second	Third
Canker/gall	1	4	3	2
Conk/cavity/sign of decay	2	67	13	1
Open wound	3	19	7	0
Resinosis/gumnosis	4	1	0	0
Crack/seam > 5 feet	5	1	1	0
Broken bole/root < 3 feet on bole	11	0	0	0
Broom on root/bole	12	0	0	0
Broken/dead root > 3 feet	13	1	0	0
Vine in crown	20	7	2	2
Dead terminal	21	0	1	2
Broken/dead branch	22	9	7	4
Excessive branching/brooms	23	0	0	0
Damaged bud/foliage/shoot	24	0	0	0
Discolored foliage	25	0	0	0
Other	31	0	0	0
Trees with damage[b]		109	34	11

[a]1, 2, and 3, are the first, second, and third damage recorded on a tree. When there are multiple types of damage, damage lower in the tree is recorded first as this is usually considered to be more dangerous to the overall health of the tree.
[b]328 total trees on nonforest plots.

Table 15.—Forest and nonforest plots by stand-size class

Size class	Nonforest		Forest	
	No. of plots	Percent of total[a]	No. of plots	Percent of total
Sawtimber	34.0	22 (48)	48.5	67
Poletimber	22.4	14 (32)	24.0	33
Seedling/sapling	14.4	9 (20)		
Nonstocked	89.2	56		

[a]Percent of plots with trees/saplings is in parentheses.

Table 16.—Number of saplings on forest and nonforest plots, by species

Species	FIA code	Saplings on forest plots		Saplings on nonforest plots	
		Number	Percent of total	Number	Percent of total
Beech	531	20	0.07	48	0.09
Black cherry	762	18	0.06	57	0.11
Blackgum	693	35	0.12	56	0.11
Blue spruce	96	0	0	15	0.03
Cherry	760	0	0	34	0.06
Dogwood	491	36	0.13	30	0.06
Eastern redcedar	68	0	0	21	0.04
Mockernut hickory	409	11	0.04	5	0.01
Red maple	316	56	0.20	34	0.06
Sassafras	931	7	0.02	38	0.07
Sweetgum	611	13	0.05	11	0.02
White ash	541	8	0.03	3	0.01
Yellow-poplar	621	23	0.08	16	0.03

as sawtimber (48 percent), poletimber (32 percent), and sapling (20 percent) stands (Table 15).

Regeneration – saplings. Differences in the number and species of saplings between F and NF plots may indicate the degree to which regeneration occurs on NF plots, and whether certain species are selected for or against relative to their occurrence on F plots (Table 16).

Black cherry and black gum saplings were found on F and NF plots in roughly equal proportions. Cherry, eastern redcedar, and blue spruce were much more abundant on NF plots, probably due to specific planting. Red maple occurred less frequently on NF than on F plots. Sapling-size yellow-poplar, sweetgum, white ash, and chestnut oak were at least twice as common on F as NF plots A study of owner attitudes would be needed to determine whether these trees/species will be allowed to grow to maturity or are preferred only as sapling-size individuals, e.g., as hedgerow or small yard trees.

Regeneration – seedlings. Data on seedlings were collected differently on F and NF plots. The number and species of seedlings also can reflect the amount and type of tree regeneration. A direct comparison of seedling data on F and NF plots was not possible because individual seedlings were not measured on NF plots. However, seedling ground cover was recorded on only 28 of 162 plots, and, on average, seedling ground cover accounted for less than 10 percent of the plot on these 28 plots. Thus, seedling regeneration on NF plots was substantially limited.

Species and diameter distributions. Three sets of standard FIA tables were calculated: using F plots only, NF plots only, and all plots (Tables 17-25). The numbers in these tables are expanded to population estimates. Including data from NF plots to Table 17 (number of live trees on forest plots) adds 22 new species and increases the number of softwood and hardwood trees by 50 and 16 percent, respectively. Including data from NF plots to Table 20 (number of saplings on F plots) adds 19 new species and increases the number of softwood and hardwood sapling stems by 168 and 11 percent, respectively. Including data from NF plots to Table 23 (basal area of live trees on F plots) adds 22 new species and increases the total ba of softwood and hardwood trees by 30 and 35 percent, respectively. Among individual species, totals for ba changed the most for eastern white pine (221 percent) followed by black locust (159 percent), and chestnut oak (76 percent). Changes in ba totals by diameter class were greatest for the 21 to 29 ft^2 class (75 percent), the 29+ ft^2 class (52 percent), and the 13 to 15 ft^2 class (44 percent).

Table 17.—Number of live trees on all forest land by species and diameter class

(thousands of trees)

Species	Species code	Diameter class (inches at breast height) 1.0-2.9	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	21.0-28.9	29+	All classes	%SE
eastern redcedar	68	814	0	206	0	0	0	0	0	0	0	0	0	1020	81.1
eastern white pine	129	0	0	113	92	174	83	144	165	0	0	0	0	771	35.8
loblolly pine	131	0	0	109	61	31	92	0	78	78	0	78	0	527	37.2
Virginia pine	132	0	610	3142	2273	1395	1045	147	382	0	0	0	0	8992	34.6
eastern hemlock	261	0	0	0	0	0	0	0	0	0	0	0	22	22	100.0
All softwoods		814	610	3570	2426	1600	1219	290	625	78	0	78	22	11332	28.5
boxelder	313	0	241	561	195	56	22	0	0	0	0	0	0	1074	37.1
red maple	316	17988	5677	4135	2506	1415	1230	424	166	242	422	301	202	34708	23.1
Norway maple	322	257	0	125	48	0	0	0	0	0	0	0	0	430	64.0
ailanthus	341	571	0	154	123	0	62	0	0	0	0	0	0	909	66.1
pawpaw	367	2346	0	0	0	0	0	0	0	0	0	0	0	2346	70.1
sweet birch	372	0	0	106	591	162	373	211	106	0	211	56	0	1815	36.5
river birch	373	0	0	166	0	0	135	0	0	0	0	0	0	301	64.3
American hornbeam	391	2345	0	161	19	83	0	0	0	0	0	0	0	2608	44.0
bitternut hickory	402	1286	0	105	0	49	56	0	0	0	0	0	0	1495	86.2
pignut hickory	403	2071	0	485	493	307	403	185	19	83	106	0	0	4153	33.3
shagbark hickory	407	0	0	83	0	83	83	0	0	0	0	0	0	248	57.7
mockernut hickory	409	3013	1754	435	379	326	49	243	132	62	0	105	0	6496	29.4
flowering dogwood	491	15611	1575	365	0	0	0	0	0	0	0	0	0	17551	33.7
common persimmon	521	571	0	481	128	0	49	0	0	0	0	0	0	1228	57.2
American beech	531	6789	1504	1349	724	261	316	267	0	45	67	101	0	11422	31.9
white ash	541	2361	3074	1284	508	83	93	84	0	83	0	75	49	7694	36.0
green ash	544	0	0	0	0	26	0	0	0	0	0	0	0	26	100.0
pumpkin ash	545	0	0	19	0	0	0	0	0	0	0	0	0	19	100.0
American holly	591	1875	938	207	97	62	0	0	0	0	0	0	0	3179	66.2
butternut	601	0	0	0	0	0	0	26	0	0	0	0	0	26	100.0
black walnut	602	0	1142	228	74	187	19	106	49	0	0	22	0	1826	64.0
sweetgum	611	5452	3982	4247	1692	846	824	1056	572	78	31	196	0	18977	32.0
yellow-poplar	621	8941	8704	3016	1297	1479	1219	1231	1397	1334	1065	1006	230	30921	23.7
apple	660	938	469	0	0	0	0	0	0	0	0	0	0	1407	74.5
mulberry	680	551	0	0	0	0	0	0	0	0	0	0	0	551	100.0
white mulberry	681	0	0	62	0	0	82	0	0	0	0	0	0	143	71.4
blackgum	693	14265	2615	1326	564	289	206	126	0	31	61	49	0	19531	28.2

Table 17.—Continued.

eastern hophornbeam	701	257	0	56	0	0	0	0	0	0	0	0	0	313	84.0
Paulownia	712	0	0	31	107	31	0	0	0	0	0	0	0	168	52.2
sycamore	731	1040	469	198	82	179	0	82	0	83	49	0	103	2283	40.0
bigtooth aspen	743	947	0	212	130	376	82	0	0	0	0	0	0	1747	57.5
quaking aspen	746	0	0	0	0	123	0	0	0	0	0	0	0	123	100.0
cherry, plum	760	0	0	0	0	139	138	0	0	0	0	0	0	277	50.8
pin cherry	761	0	0	0	31	0	0	0	0	0	0	0	0	31	100.0
black cherry	762	5480	4109	2968	1934	1257	588	362	164	319	0	0	0	17181	21.9
white oak	802	327	2060	636	456	332	716	328	394	216	83	57	144	5749	24.9
swamp white oak	804	0	0	0	0	0	0	0	0	0	22	0	0	22	100.0
scarlet oak	806	814	0	385	168	423	555	407	320	470	158	488	62	4250	23.4
northern pin oak	809	0	0	0	0	0	19	0	0	0	0	0	19	39	70.7
southern red oak	812	762	0	205	240	61	31	31	31	31	0	0	0	1390	58.2
shingle oak	817	0	0	22	0	0	0	0	0	0	0	22	0	43	70.7
swamp chestnut oak	825	0	0	146	97	0	0	0	0	0	31	0	0	273	65.0
pin oak	830	0	0	405	0	0	161	78	0	0	0	78	0	723	46.2
willow oak	831	0	0	0	0	0	83	0	0	0	0	0	0	83	100.0
chestnut oak	832	367	1402	659	606	592	390	452	83	533	57	167	0	5307	22.0
northern red oak	833	241	0	300	210	157	281	119	219	144	106	249	31	2057	22.4
black oak	837	1885	0	261	289	480	643	266	162	362	144	123	0	4615	38.7
black locust	901	0	571	367	1002	459	104	82	0	0	56	0	0	2641	30.9
willow	920	0	0	0	83	0	135	0	0	0	0	0	0	218	72.7
sassafras	931	2830	429	1405	540	157	0	0	0	22	0	0	0	5383	31.1
American elm	972	0	0	0	0	0	0	0	0	0	0	106	0	106	100.0
slippery elm	975	0	0	127	65	43	106	0	0	0	0	0	0	341	49.8
All hardwoods		102181	40713	27478	15477	10522	9250	6165	3814	4137	2667	3200	840	226445	7.5
All species		102995	41323	31048	17903	12122	10469	6456	4439	4215	2667	3278	862	237777	7.3
%SE		14.0	18.7	13.8	14.1	14.5	13.2	15.4	18.6	19.2	25.9	18.8	31.1	7.3	

Table 18.—Number of live trees on all nonforest land by species and diameter class

(thousands of trees)

Species	Species code	Diameter class (inches at breast height) 1.0-2.9	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	21.0-28.9	29+	All classes	%SE
Atlantic white-cedar	43	60	121	60	0	0	0	0	0	0	0	0	0	242	61.2
eastern redcedar	68	218	245	0	0	0	0	0	0	0	0	0	0	463	55.2
Norway spruce	91	0	73	0	0	58	0	0	0	0	0	0	0	131	71.2
blue spruce	96	57	257	343	0	0	0	0	0	0	0	0	0	657	57.9
shortleaf pine	110	85	73	0	0	0	0	0	0	0	0	0	0	158	70.9
eastern white pine	129	337	396	587	1080	569	142	76	151	0	0	0	0	3339	28.3
Scotch pine	130	0	76	76	0	0	0	0	0	0	0	0	0	151	70.7
loblolly pine	131	120	0	0	0	0	0	0	0	0	0	0	0	120	71.8
Virginia pine	132	0	0	0	81	0	0	0	0	0	0	0	0	81	100.0
redwood spp.	210	0	0	60	0	0	0	0	0	0	0	0	0	60	100.0
northern white-cedar	241	200	76	0	0	0	0	0	0	0	0	0	0	276	63.8
All softwoods		1077	1316	1126	1162	627	142	76	151	0	0	0	0	5678	19.3
maple	310	270	169	0	0	0	0	0	0	0	0	0	0	439	49.5
red maple	316	1014	672	600	481	256	199	409	85	134	0	0	0	3850	21.7
silver maple	317	164	182	307	58	115	58	0	0	58	0	115	0	1058	33.2
sugar maple	318	164	115	0	0	70	0	85	0	0	0	0	0	435	46.7
Norway maple	322	98	133	125	85	85	0	0	76	0	0	0	76	676	33.9
ailanthus	341	120	0	0	58	0	0	0	0	0	0	0	0	177	58.4
mimosa	345	285	85	0	0	0	0	0	0	0	0	0	0	369	53.9
pignut hickory	403	58	114	131	197	231	0	174	58	0	0	0	0	962	30.3
mockernut hickory	409	196	57	57	58	142	58	85	0	0	0	0	0	652	32.2
chestnut spp.	420	0	0	0	0	115	0	0	0	49	0	115	0	280	60.9
Ozark chinkapin	423	0	0	0	0	73	73	0	0	0	0	0	0	147	70.7
dogwood spp.	490	60	0	0	0	0	0	0	0	0	0	0	0	60	100.0
flowering dogwood	491	1162	517	202	0	0	0	0	0	0	0	0	0	1881	31.5
American beech	531	681	364	330	225	244	58	0	0	0	0	116	0	2016	28.5
ash	540	0	0	0	0	0	0	49	0	0	0	0	0	49	100.0
white ash	541	165	85	200	58	0	85	0	0	0	58	85	0	734	34.6
honeylocust	552	0	0	60	0	0	0	0	0	0	0	0	0	60	100.0
American holly	591	70	70	0	0	0	0	0	0	0	0	0	0	141	70.7
black walnut	602	0	0	0	0	115	0	0	0	0	115	0	0	231	70.7
sweetgum	611	257	257	0	81	81	0	49	0	49	0	0	0	776	33.0
yellow-poplar	621	521	247	258	0	174	58	424	282	300	197	892	85	3435	21.5

Table 18.—Continued.

magnolia	650	73	0	0	0	0	0	70	0	0	0	0	0	144	70.7
apple	660	200	212	0	58	0	0	0	0	0	0	0	0	470	51.0
mulberry	680	209	320	630	0	76	0	187	0	0	0	0	0	1422	36.2
white mulberry	681	200	115	0	0	0	0	0	0	0	0	0	0	316	58.3
blackgum	693	597	399	171	0	245	116	200	0	0	0	0	0	1729	28.5
sycamore	731	70	70	0	81	0	0	0	0	0	0	0	0	222	57.9
cherry, plum	760	351	469	107	213	49	0	0	0	0	0	0	0	1188	31.6
black cherry	762	1319	448	481	315	85	169	0	170	85	0	58	0	3129	25.0
pear spp.	790	0	0	488	244	0	0	0	0	0	0	0	0	732	74.5
white oak	802	143	0	73	58	147	204	281	0	0	76	175	58	1214	27.8
scarlet oak	806	98	73	0	131	0	131	0	142	58	0	115	85	834	31.0
southern red oak	812	0	0	0	0	0	0	0	81	49	0	0	0	130	72.9
chestnut oak	832	115	0	0	151	151	57	86	161	0	73	458	57	1309	35.4
northern red oak	833	149	73	114	0	289	116	0	0	0	116	0	0	858	39.3
black oak	837	57	0	0	73	58	0	131	76	58	58	245	0	755	34.4
black locust	901	49	139	115	115	498	312	437	184	0	0	57	0	1907	30.9
sassafras	931	703	230	57	0	85	0	0	0	0	0	0	0	1076	42.9
American basswood	951	60	0	0	0	0	0	0	0	0	0	0	0	60	100.0
elm	970	0	0	49	0	0	0	0	0	0	0	0	86	135	73.3
American elm	972	169	85	0	0	169	151	85	0	0	0	0	0	659	46.6
unknown or not listed tree	999	0	0	0	0	85	0	0	0	0	0	0	0	85	100.0
All hardwoods		9851	5704	4555	2739	3637	1845	2749	1314	838	693	2431	445	36803	6.4
All species		10928	7021	5681	3901	4264	1987	2825	1465	838	693	2431	445	42481	6.1
%SE		11.8	13.6	19.7	24.2	17.8	23.3	24.4	25.2	30.8	36.7	27.3	41.4	6.1	

Table 19.—Number of live trees on all forest and nonforest land by species and diameter class

(thousands of trees)

Species	Species code	Diameter class (inches at breast height) 1.0-2.9	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	21.0-28.9	29+	All classes	%SE
Atlantic white-cedar	43	60	121	60	0	0	0	0	0	0	0	0	0	242	61.2
eastern redcedar	68	1033	245	206	0	0	0	0	0	0	0	0	0	1483	58.4
Norway spruce	91	0	73	0	0	58	0	0	0	0	0	0	0	131	71.2
blue spruce	96	57	257	343	0	0	0	0	0	0	0	0	0	657	57.9
shortleaf pine	110	85	73	0	0	0	0	0	0	0	0	0	0	158	70.9
eastern white pine	129	337	396	700	1172	744	225	219	316	0	0	0	0	4110	24.0
Scotch pine	130	0	76	76	0	0	0	0	0	0	0	0	0	151	70.7
loblolly pine	131	120	0	109	61	31	92	0	78	78	0	78	0	647	33.1
Virginia pine	132	0	610	3142	2354	1395	1045	147	382	0	0	0	0	9074	34.3
redwood spp.	210	0	0	60	0	0	0	0	0	0	0	0	0	60	100.0
northern white-cedar	241	200	76	0	0	0	0	0	0	0	0	0	0	276	63.8
eastern hemlock	261	0	0	0	0	0	0	0	0	0	0	0	22	22	100.0
All softwoods		1892	1926	4696	3588	2227	1361	366	776	78	0	78	22	17010	25.6
maple	310	270	169	0	0	0	0	0	0	0	0	0	0	439	49.5
boxelder	313	0	241	561	195	56	22	0	0	0	0	0	0	1074	37.1
red maple	316	19002	6350	4735	2986	1672	1429	832	251	376	422	301	202	38557	20.9
silver maple	317	164	182	307	58	115	58	0	0	58	0	115	0	1058	33.2
sugar maple	318	164	115	0	0	70	0	85	0	0	0	0	0	435	46.7
Norway maple	322	355	133	249	132	85	0	0	76	0	0	0	76	1106	32.4
ailanthus	341	690	0	154	181	0	62	0	0	0	0	0	0	1086	56.1
mimosa	345	285	85	0	0	0	0	0	0	0	0	0	0	369	53.9
pawpaw	367	2346	0	0	0	0	0	0	0	0	0	0	0	2346	70.1
sweet birch	372	0	0	106	591	162	373	211	106	0	211	56	0	1815	36.5
river birch	373	0	0	166	0	0	135	0	0	0	0	0	0	301	64.3
American hornbeam	391	2345	0	161	19	83	0	0	0	0	0	0	0	2608	44.0
bitternut hickory	402	1286	0	105	0	49	56	0	0	0	0	0	0	1495	86.2
pignut hickory	403	2129	114	616	690	538	403	359	77	83	106	0	0	5115	27.7
shagbark hickory	407	0	0	83	0	83	83	0	0	0	0	0	0	248	57.7
mockernut hickory	409	3209	1812	492	437	468	106	327	132	62	0	105	0	7149	26.8
chestnut spp.	420	0	0	0	0	115	0	0	0	49	0	115	0	280	60.9
Ozark chinkapin	423	0	0	0	0	73	73	0	0	0	0	0	0	147	70.7
dogwood spp.	490	60	0	0	0	0	0	0	0	0	0	0	0	60	100.0
flowering dogwood	491	16773	2093	566	0	0	0	0	0	0	0	0	0	19432	30.6
common persimmon	521	571	0	481	128	0	49	0	0	0	0	0	0	1228	57.2
American beech	531	7469	1868	1678	949	505	373	267	0	45	67	217	0	13439	27.4
ash	540	0	0	0	0	0	0	49	0	0	0	0	0	49	100.0
white ash	541	2526	3158	1484	566	83	178	84	0	83	58	159	49	8428	33.0
green ash	544	0	0	0	0	26	0	0	0	0	0	0	0	26	100.0
pumpkin ash	545	0	0	19	0	0	0	0	0	0	0	0	0	19	100.0

Table 19.—Continued.

honeylocust	552	0	0	60	0	0	0	0	0	0	0	0	0	60	100.0
American holly	591	1946	1008	207	97	62	0	0	0	0	0	0	0	3320	63.5
butternut	601	0	0	0	0	0	0	26	0	0	0	0	0	26	100.0
black walnut	602	0	1142	228	74	303	19	106	49	0	115	22	0	2057	57.4
sweetgum	611	5710	4239	4247	1774	927	824	1105	572	127	31	196	0	19753	30.8
yellow-poplar	621	9462	8951	3274	1297	1652	1276	1655	1679	1634	1262	1898	315	34356	21.4
magnolia	650	73	0	0	0	0	0	70	0	0	0	0	0	144	70.7
apple	660	1138	681	0	58	0	0	0	0	0	0	0	0	1876	57.3
mulberry	680	760	320	630	0	76	0	187	0	0	0	0	0	1973	38.2
white mulberry	681	200	115	62	0	0	82	0	0	0	0	0	0	459	45.9
blackgum	693	14863	3014	1497	564	534	322	327	0	31	61	49	0	21260	26.0
eastern hophornbeam	701	257	0	56	0	0	0	0	0	0	0	0	0	313	84.0
Paulownia	712	0	0	31	107	31	0	0	0	0	0	0	0	168	52.2
sycamore	731	1110	539	198	163	179	0	82	0	83	49	0	103	2506	36.8
bigtooth aspen	743	947	0	212	130	376	82	0	0	0	0	0	0	1747	57.5
quaking aspen	746	0	0	0	0	123	0	0	0	0	0	0	0	123	100.0
cherry, plum	760	351	469	107	213	188	138	0	0	0	0	0	0	1465	27.4
pin cherry	761	0	0	0	31	0	0	0	0	0	0	0	0	31	100.0
black cherry	762	6800	4557	3448	2249	1342	757	362	335	404	0	58	0	20311	19.0
pear spp.	790	0	0	488	244	0	0	0	0	0	0	0	0	732	74.5
white oak	802	470	2060	710	514	479	919	609	394	216	158	232	202	6963	21.1
swamp white oak	804	0	0	0	0	0	0	0	0	0	22	0	0	22	100.0
scarlet oak	806	912	73	385	299	423	687	407	462	528	158	604	146	5084	20.2
northern pin oak	809	0	0	0	0	0	19	0	0	0	0	0	19	39	70.7
southern red oak	812	762	0	205	240	61	31	31	112	80	0	0	0	1520	53.5
shingle oak	817	0	0	22	0	0	0	0	0	0	0	22	0	43	70.7
swamp chestnut oak	825	0	0	146	97	0	0	0	0	0	31	0	0	273	65.0
pin oak	830	0	0	405	0	0	161	78	0	0	0	78	0	723	46.2
willow oak	831	0	0	0	0	0	83	0	0	0	0	0	0	83	100.0
chestnut oak	832	482	1402	659	757	743	447	537	244	533	130	625	57	6616	19.0
northern red oak	833	390	73	415	210	446	397	119	219	144	221	249	31	2914	19.6
black oak	837	1943	0	261	362	538	643	397	238	420	202	368	0	5370	33.6
black locust	901	49	710	482	1118	956	417	518	184	0	56	57	0	4548	22.1
willow	920	0	0	0	83	0	135	0	0	0	0	0	0	218	72.7
sassafras	931	3534	659	1463	540	241	0	0	0	22	0	0	0	6458	26.9
American basswood	951	60	0	0	0	0	0	0	0	0	0	0	0	60	100.0
elm	970	0	0	49	0	0	0	0	0	0	0	0	86	135	73.3
American elm	972	169	85	0	0	169	151	85	0	0	0	106	0	764	42.5
slippery elm	975	0	0	127	65	43	106	0	0	0	0	0	0	341	49.8
unknown or not listed tree	999	0	0	0	0	85	0	0	0	0	0	0	0	85	100.0
All hardwoods		112032	46417	32033	18216	14160	11095	8915	5128	4975	3360	5631	1286	263248	6.5
All species		113923	48344	36730	21804	16386	12456	9281	5905	5054	3360	5709	1307	280258	6.2
%SE		12.7	16.1	12.1	12.3	11.7	11.7	13.0	15.3	16.8	21.9	15.9	24.9	6.2	

Table 20.—Number of saplings on all forest land by species and stand-size class

(thousands of trees)

Species	Species code	Stand-size class			All classes	%SE
		Seedling and sapling	Pole-timber	Saw-timber		
eastern redcedar	68	814	0	0	814	100.0
Virginia pine	132	0	610	0	610	100.0
All softwoods		814	610	0	1424	71.4
boxelder	313	241	0	0	241	100.0
red maple	316	15833	7832	0	23665	26.5
Norway maple	322	257	0	0	257	100.0
ailanthus	341	0	0	571	571	100.0
pawpaw	367	2346	0	0	2346	70.1
American hornbeam	391	2345	0	0	2345	48.6
bitternut hickory	402	1286	0	0	1286	100.0
pignut hickory	403	1521	551	0	2071	51.2
mockernut hickory	409	4767	0	0	4767	49.6
flowering dogwood	491	13399	1097	2690	17186	33.0
common persimmon	521	0	0	571	571	100.0
American beech	531	4046	3477	770	8293	40.5
white ash	541	3722	0	1713	5435	57.8
American holly	591	0	2813	0	2813	100.0
black walnut	602	0	1142	0	1142	100.0
sweetgum	611	3142	6293	0	9434	57.8
yellow-poplar	621	16451	1194	0	17645	54.8
apple	660	0	1407	0	1407	100.0
mulberry	680	551	0	0	551	100.0
blackgum	693	15514	1366	0	16880	34.5
eastern hophornbeam	701	257	0	0	257	100.0
sycamore	731	938	0	571	1509	72.7
bigtooth aspen	743	947	0	0	947	100.0
black cherry	762	6998	1449	1142	9589	37.2
white oak	802	898	1489	0	2386	53.2
scarlet oak	806	0	814	0	814	100.0
southern red oak	812	762	0	0	762	100.0
chestnut oak	832	1402	0	367	1769	51.8
northern red oak	833	241	0	0	241	100.0
black oak	837	257	1629	0	1885	87.4
black locust	901	0	0	571	571	100.0
sassafras	931	2280	979	0	3259	42.1
All hardwoods		100397	33531	8966	142894	12.1
All species		101211	34141	8966	144318	12.0
%SE		14.8	23.7	36.0	12.0	

Table 21.—Number of saplings on all nonforest land by species and stand-size class

(thousands of trees)

Species	Species code	Stand-size class			All classes	%SE
		Seedling and sapling	Pole-timber	Saw-timber		
Atlantic white-cedar	43	0	181	0	181	100.0
eastern redcedar	68	125	0	338	463	75.6
Norway spruce	91	0	0	73	73	100.0
blue spruce	96	85	229	0	314	63.7
shortleaf pine	110	158	0	0	158	70.9
eastern white pine	129	494	169	70	733	47.1
Scotch pine	130	76	0	0	76	100.0
loblolly pine	131	0	70	49	120	71.8
northern white-cedar	241	227	0	49	276	84.1
All softwoods		1163	650	580	2394	26.4
maple	310	70	369	0	439	62.8
red maple	316	710	220	757	1687	38.4
silver maple	317	98	249	0	347	61.4
sugar maple	318	231	0	49	280	84.3
Norway maple	322	58	76	98	231	59.0
ailanthus	341	0	0	120	120	71.8
mimosa	345	0	320	49	369	62.8
pignut hickory	403	58	114	0	172	74.4
mockernut hickory	409	58	196	0	253	59.9
dogwood spp.	490	0	60	0	60	100.0
flowering dogwood	491	1287	392	0	1679	38.1
American beech	531	719	325	0	1045	50.5
white ash	541	116	0	134	249	60.8
American holly	591	0	141	0	141	100.0
sweetgum	611	0	163	352	515	59.7
yellow-poplar	621	652	0	116	768	57.2
magnolia	650	0	0	73	73	100.0
apple	660	0	314	98	412	58.9
mulberry	680	227	254	49	529	64.9
white mulberry	681	115	142	58	316	52.2
blackgum	693	858	139	0	997	49.7
sycamore	731	0	0	141	141	100.0
cherry, plum	760	231	468	121	819	48.3
black cherry	762	715	549	503	1767	36.1
white oak	802	86	57	0	143	72.1
scarlet oak	806	73	0	98	172	71.4
chestnut oak	832	58	57	0	115	70.7
northern red oak	833	147	76	0	223	74.3
black oak	837	0	57	0	57	100.0
black locust	901	58	81	49	188	59.1
sassafras	931	877	57	0	934	60.8
American basswood	951	0	0	60	60	100.0
American elm	972	254	0	0	254	100.0
All hardwoods	7755	4875	2925	15555	11.6	
All species	8919	5525	3505	17949	10.6	
%SE	16.4	17.0	22.4	10.6		

Table 22.—Number of saplings on all forest and nonforest land by species and stand-size class

(thousands of trees)

Species	Species code	Stand-size class			All classes	%SE
		Seedling and sapling	Pole-timber	Saw-timber		
Atlantic white-cedar	43	0	181	0	181	100.0
eastern redcedar	68	939	0	338	1277	69.4
Norway spruce	91	0	0	73	73	100.0
blue spruce	96	85	229	0	314	63.7
shortleaf pine	110	158	0	0	158	70.9
eastern white pine	129	494	169	70	733	47.1
Scotch pine	130	76	0	0	76	100.0
loblolly pine	131	0	70	49	120	71.8
Virginia pine	132	0	610	0	610	100.0
northern white-cedar	241	227	0	49	276	84.1
All softwoods		1978	1260	580	3818	54.2
maple	310	70	369	0	439	62.8
boxelder	313	241	0	0	241	100.0
red maple	316	16543	8052	757	25352	24.9
silver maple	317	98	249	0	347	61.4
sugar maple	318	231	0	49	280	84.3
Norway maple	322	314	76	98	488	59.6
ailanthus	341	0	0	690	690	83.6
mimosa	345	0	320	49	369	62.8
pawpaw	367	2346	0	0	2346	70.1
American hornbeam	391	2345	0	0	2345	48.6
bitternut hickory	402	1286	0	0	1286	100.0
pignut hickory	403	1578	665	0	2243	47.6
mockernut hickory	409	4825	196	0	5020	47.2
dogwood spp.	490	0	60	0	60	100.0
flowering dogwood	491	14686	1489	2690	18866	30.3
common persimmon	521	0	0	571	571	100.0
American beech	531	4765	3802	770	9337	36.4
white ash	541	3838	0	1846	5685	55.3
American holly	591	0	2954	0	2954	95.3
black walnut	602	0	1142	0	1142	100.0
sweetgum	611	3142	6455	352	9949	54.9
yellow-poplar	621	17103	1194	116	18413	52.6
magnolia	650	0	0	73	73	100.0
apple	660	0	1720	98	1818	78.5
mulberry	680	778	254	49	1080	60.1
white mulberry	681	115	142	58	316	52.2
blackgum	693	16372	1505	0	17877	32.7
eastern hophornbeam	701	257	0	0	257	100.0
sycamore	731	938	0	712	1650	67.1
bigtooth aspen	743	947	0	0	947	100.0
cherry, plum	760	231	468	121	819	48.3
black cherry	762	7714	1998	1645	11356	31.9
white oak	802	983	1546	0	2529	50.4
scarlet oak	806	73	814	98	986	83.5
southern red oak	812	762	0	0	762	100.0
chestnut oak	832	1460	57	367	1884	48.9
northern red oak	833	388	76	0	463	63.0
black oak	837	257	1686	0	1943	84.9
black locust	901	58	81	620	759	76.6
sassafras	931	3156	1037	0	4193	35.4
American basswood	951	0	0	60	60	100.0
American elm	972	254	0	0	254	100.0
All hardwoods		108152	38407	11890	158449	11.0
All species		110130	39666	12470	162267	10.7
%SE		13.6	20.5	26.6	10.7	

Table 23.—Basal area of live trees on all forest land by species and diameter class

(thousands of square feet)

Species	Species code	Diameter class (inches at breast height) 1.0-2.9	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	21.0-28.9	29+	All classes	%SE
eastern redcedar	68	35	0	37	0	0	0	0	0	0	0	0	0	72	60.5
eastern white pine	129	0	0	17	30	94	62	139	232	0	0	0	0	573	47.1
loblolly pine	131	0	0	23	17	15	76	0	100	149	0	230	0	610	49.7
Virginia pine	132	0	77	627	716	708	766	165	517	0	0	0	0	3576	29.9
eastern hemlock	261	0	0	0	0	0	0	0	0	0	0	0	161	161	100.0
All softwoods		35	77	704	762	816	904	305	849	149	0	230	161	4992	23.2
boxelder	313	0	21	95	66	28	15	0	0	0	0	0	0	224	33.5
red maple	316	245	445	761	821	726	959	436	245	412	849	923	1502	8325	20.0
Norway maple	322	2	0	28	13	0	0	0	0	0	0	0	0	43	56.6
ailanthus	341	9	0	25	35	0	44	0	0	0	0	0	0	113	53.8
pawpaw	367	29	0	0	0	0	0	0	0	0	0	0	0	29	76.2
sweet birch	372	0	0	24	194	84	302	201	133	0	438	155	0	1531	39.8
river birch	373	0	0	28	0	0	117	0	0	0	0	0	0	145	82.0
American hornbeam	391	28	0	33	7	38	0	0	0	0	0	0	0	106	43.8
bitternut hickory	402	31	0	25	0	28	39	0	0	0	0	0	0	123	48.7
pignut hickory	403	50	0	90	169	169	289	182	28	161	238	0	0	1377	22.9
shagbark hickory	407	0	0	20	0	53	57	0	0	0	0	0	0	131	61.9
mockernut hickory	409	56	149	86	135	167	33	277	167	97	0	288	0	1454	22.9
flowering dogwood	491	312	111	54	0	0	0	0	0	0	0	0	0	477	29.4
common persimmon	521	7	0	84	38	0	34	0	0	0	0	0	0	163	49.3
American beech	531	107	133	278	241	142	246	268	0	89	141	313	0	1957	23.1
white ash	541	63	264	236	167	38	72	96	0	143	0	219	271	1569	28.4
green ash	544	0	0	0	0	13	0	0	0	0	0	0	0	13	100.0
pumpkin ash	545	0	0	3	0	0	0	0	0	0	0	0	0	3	100.0
American holly	591	19	73	44	30	28	0	0	0	0	0	0	0	194	47.5
butternut	601	0	0	0	0	0	0	30	0	0	0	0	0	30	100.0
black walnut	602	0	72	49	26	106	17	102	62	0	0	59	0	493	34.6
sweetgum	611	88	355	802	548	473	611	1164	775	141	60	490	0	5507	19.8
yellow-poplar	621	158	583	564	453	803	949	1295	1928	2326	2364	3255	1333	16010	16.0
apple	660	36	54	0	0	0	0	0	0	0	0	0	0	90	72.1
mulberry	680	13	0	0	0	0	0	0	0	0	0	0	0	13	100.0
white mulberry	681	0	0	8	0	0	58	0	0	0	0	0	0	66	88.2

Table 23.—Continued.

blackgum	693	225	188	246	201	157	148	140	0	55	133	138	0	1630	18.1
eastern hophornbeam	701	5	0	11	0	0	0	0	0	0	0	0	0	16	75.8
Paulownia	712	0	0	5	32	19	0	0	0	0	0	0	0	56	53.9
sycamore	731	32	26	35	22	96	0	78	0	137	116	0	504	1045	43.9
bigtooth aspen	743	43	0	48	35	205	71	0	0	0	0	0	0	403	43.7
quaking aspen	746	0	0	0	0	60	0	0	0	0	0	0	0	60	100.0
cherry, plum	760	0	0	0	0	72	94	0	0	0	0	0	0	167	50.9
pin cherry	761	0	0	0	9	0	0	0	0	0	0	0	0	9	100.0
black cherry	762	119	280	556	619	681	465	390	221	602	0	0	0	3932	17.6
white oak	802	8	152	126	160	181	563	347	528	360	163	141	737	3466	21.8
swamp white oak	804	0	0	0	0	0	0	0	0	0	49	0	0	49	100.0
scarlet oak	806	6	0	70	56	227	436	421	461	861	325	1687	294	4845	21.4
northern pin oak	809	0	0	0	0	0	13	0	0	0	0	0	158	171	92.4
southern red oak	812	7	0	34	84	28	24	31	40	60	0	0	0	307	37.6
shingle oak	817	0	0	5	0	0	0	0	0	0	0	95	0	100	94.8
swamp chestnut oak	825	0	0	27	29	0	0	0	0	0	61	0	0	117	62.3
pin oak	830	0	0	81	0	0	121	84	0	0	0	307	0	593	56.5
willow oak	831	0	0	0	0	0	63	0	0	0	0	0	0	63	100.0
chestnut oak	832	14	114	129	201	324	306	477	114	947	114	458	0	3199	22.1
northern red oak	833	6	0	57	78	85	216	128	298	250	240	725	145	2228	25.5
black oak	837	48	0	49	101	251	505	278	222	637	318	371	0	2779	22.5
black locust	901	0	45	75	321	228	75	89	0	0	127	0	0	959	26.5
willow	920	0	0	0	25	0	121	0	0	0	0	0	0	146	84.7
sassafras	931	56	47	248	168	93	0	0	0	37	0	0	0	649	34.5
American elm	972	0	0	0	0	0	0	0	0	0	0	279	0	279	100.0
slippery elm	975	0	0	26	21	21	82	0	0	0	0	0	0	150	59.8
All hardwoods		1821	3110	5165	5103	5627	7145	6513	5223	7314	5736	9901	4944	67604	5.9
Total		1856	3187	5870	5866	6444	8049	6817	6073	7464	5736	10131	5105	72596	5.7
%SE		13.7	18.0	14.0	13.8	14.4	13.3	15.5	18.5	19.1	26.1	19.0	33.7	5.7	

Table 24.—Basal area of live trees on all nonforest land by species and diameter class

(thousands of square feet)

Species	Species code	Diameter class (inches at breast height) 1.0-2.9	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	21.0-28.9	29+	All classes	%SE
Atlantic white-cedar	43	2	11	12	0	0	0	0	0	0	0	0	0	25	65.5
eastern redcedar	68	6	20	0	0	0	0	0	0	0	0	0	0	26	63.9
Norway spruce	91	0	5	0	0	28	0	0	0	0	0	0	0	33	86.5
blue spruce	96	1	23	57	0	0	0	0	0	0	0	0	0	81	72.4
shortleaf pine	110	1	8	0	0	0	0	0	0	0	0	0	0	9	89.4
eastern white pine	129	7	36	131	373	334	98	84	201	0	0	0	0	1264	31.1
Scotch pine	130	0	5	10	0	0	0	0	0	0	0	0	0	15	74.7
loblolly pine	131	1	0	0	0	0	0	0	0	0	0	0	0	1	71.8
Virginia pine	132	0	0	0	33	0	0	0	0	0	0	0	0	33	100.0
redwood spp.	210	0	0	8	0	0	0	0	0	0	0	0	0	8	100.0
northern white-cedar	241	4	5	0	0	0	0	0	0	0	0	0	0	9	67.4
All softwoods		22	114	218	405	362	98	84	201	0	0	0	0	1505	26.6
maple	310	5	15	0	0	0	0	0	0	0	0	0	0	20	76.0
red maple	316	27	54	100	145	150	143	422	118	249	0	0	0	1407	32.4
silver maple	317	4	12	59	23	52	45	0	0	96	0	347	0	639	58.0
sugar maple	318	4	10	0	0	42	0	92	0	0	0	0	0	148	68.5
Norway maple	322	2	12	20	33	54	0	0	115	0	0	0	522	758	71.0
ailanthus	341	1	0	0	21	0	0	0	0	0	0	0	0	23	93.6
mimosa	345	7	9	0	0	0	0	0	0	0	0	0	0	16	63.7
pignut hickory	403	1	10	23	70	127	0	186	78	0	0	0	0	495	36.8
mockernut hickory	409	4	4	12	24	87	46	102	0	0	0	0	0	279	47.1
chestnut spp.	420	0	0	0	0	63	0	0	0	89	0	356	0	507	73.3
Ozark chinkapin	423	0	0	0	0	35	49	0	0	0	0	0	0	85	71.6
dogwood spp.	490	1	0	0	0	0	0	0	0	0	0	0	0	1	100.0
flowering dogwood	491	27	43	33	0	0	0	0	0	0	0	0	0	103	34.5
American beech	531	16	30	60	80	124	42	0	0	0	0	464	0	816	59.6
ash	540	0	0	0	0	0	0	45	0	0	0	0	0	45	100.0
white ash	541	2	9	45	18	0	62	0	0	0	130	203	0	470	53.6
honeylocust	552	0	0	10	0	0	0	0	0	0	0	0	0	10	100.0
American holly	591	2	8	0	0	0	0	0	0	0	0	0	0	10	80.0
black walnut	602	0	0	0	0	58	0	0	0	0	260	0	0	318	83.7
sweetgum	611	7	21	0	31	36	0	58	0	91	0	0	0	244	48.8

Table 24.—Continued.

yellow-poplar	621	10	22	43	0	95	51	479	408	522	456	2842	481	5409	28.8
magnolia	650	1	0	0	0	0	0	66	0	0	0	0	0	67	98.6
apple	660	4	18	0	16	0	0	0	0	0	0	0	0	38	58.3
mulberry	680	6	28	121	0	42	0	175	0	0	0	0	0	373	52.4
white mulberry	681	4	10	0	0	0	0	0	0	0	0	0	0	14	76.2
blackgum	693	13	37	37	0	133	96	219	0	0	0	0	0	535	40.6
sycamore	731	2	5	0	30	0	0	0	0	0	0	0	0	37	82.0
cherry, plum	760	8	39	21	76	25	0	0	0	0	0	0	0	169	35.3
black cherry	762	30	32	101	113	46	123	0	242	161	0	150	0	999	33.0
pear spp.	790	0	0	99	69	0	0	0	0	0	0	0	0	168	71.8
white oak	802	4	0	11	16	77	159	311	0	0	165	506	316	1565	36.5
scarlet oak	806	2	5	0	47	0	97	0	190	98	0	376	396	1210	47.7
southern red oak	812	0	0	0	0	0	0	0	111	81	0	0	0	192	71.5
chestnut oak	832	1	0	0	62	82	44	85	212	0	146	1409	386	2429	50.3
northern red oak	833	3	5	23	0	149	82	0	0	0	233	0	0	495	55.7
black oak	837	2	0	0	30	34	0	147	108	91	116	705	0	1233	46.0
black locust	901	1	15	23	39	274	260	472	245	0	0	196	0	1524	36.7
sassafras	931	11	18	10	0	52	0	0	0	0	0	0	0	91	60.7
American basswood	951	2	0	0	0	0	0	0	0	0	0	0	0	2	100.0
elm	970	0	0	7	0	0	0	0	0	0	0	0	544	551	98.7
American elm	972	4	6	0	0	87	122	85	0	0	0	0	0	304	56.8
unknown or not listed tree	999	0	0	0	0	51	0	0	0	0	0	0	0	51	100.0
All hardwoods		220	478	856	943	1975	1421	2943	1826	1478	1506	7555	2646	23847	11.2
All species		242	591	1075	1349	2337	1519	3027	2027	1478	1506	7555	2646	25352	10.6
%SE		11.9	13.9	20.5	23.8	17.9	23.9	24.1	25.2	31.0	36.8	27.3	41.5	10.6	

Table 25.—Basal area of live trees on all forest and nonforest land by species and diameter class

(thousands of square feet)

Species	Species code	Diameter class (inches at breast height) 1.0-2.9	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	21.0-28.9	29+	All classes	%SE
Atlantic white-cedar	43	2	11	12	0	0	0	0	0	0	0	0	0	25	65.5
eastern redcedar	68	40	20	37	0	0	0	0	0	0	0	0	0	98	47.7
Norway spruce	91	0	5	0	0	28	0	0	0	0	0	0	0	33	86.5
blue spruce	96	1	23	57	0	0	0	0	0	0	0	0	0	81	72.4
shortleaf pine	110	1	8	0	0	0	0	0	0	0	0	0	0	9	89.4
eastern white pine	129	7	36	148	403	427	159	224	433	0	0	0	0	1837	26.0
Scotch pine	130	0	5	10	0	0	0	0	0	0	0	0	0	15	74.7
loblolly pine	131	1	0	23	17	15	76	0	100	149	0	230	0	611	49.5
Virginia pine	132	0	77	627	748	708	766	165	517	0	0	0	0	3609	29.6
redwood spp.	210	0	0	8	0	0	0	0	0	0	0	0	0	8	100.0
northern white-cedar	241	4	5	0	0	0	0	0	0	0	0	0	0	9	67.4
eastern hemlock	261	0	0	0	0	0	0	0	0	0	0	0	161	161	100.0
All softwoods		57	190	923	1168	1179	1002	389	1050	149	0	230	161	6497	26.5
maple	310	5	15	0	0	0	0	0	0	0	0	0	0	20	76.0
boxelder	313	0	21	95	66	28	15	0	0	0	0	0	0	224	33.5
red maple	316	272	499	860	967	876	1103	858	364	661	849	923	1502	9732	17.8
silver maple	317	4	12	59	23	52	45	0	0	96	0	347	0	639	58.0
sugar maple	318	4	10	0	0	42	0	92	0	0	0	0	0	148	68.5
Norway maple	322	4	12	48	45	54	0	0	115	0	0	0	522	801	67.3
ailanthus	341	10	0	25	56	0	44	0	0	0	0	0	0	136	47.5
mimosa	345	7	9	0	0	0	0	0	0	0	0	0	0	16	63.7
pawpaw	367	29	0	0	0	0	0	0	0	0	0	0	0	29	76.2
sweet birch	372	0	0	24	194	84	302	201	133	0	438	155	0	1531	39.8
river birch	373	0	0	28	0	0	117	0	0	0	0	0	0	145	82.0
American hornbeam	391	28	0	33	7	38	0	0	0	0	0	0	0	106	43.8
bitternut hickory	402	31	0	25	0	28	39	0	0	0	0	0	0	123	48.7
pignut hickory	403	51	10	113	239	297	289	367	106	161	238	0	0	1872	19.4
shagbark hickory	407	0	0	20	0	53	57	0	0	0	0	0	0	131	61.9
mockernut hickory	409	59	152	98	159	254	79	379	167	97	0	288	0	1733	20.6
chestnut spp.	420	0	0	0	0	63	0	0	0	89	0	356	0	507	73.3
Ozark chinkapin	423	0	0	0	0	35	49	0	0	0	0	0	0	85	71.6
dogwood spp.	490	1	0	0	0	0	0	0	0	0	0	0	0	1	100.0
flowering dogwood	491	340	154	86	0	0	0	0	0	0	0	0	0	580	25.0
common persimmon	521	7	0	84	38	0	34	0	0	0	0	0	0	163	49.3
American beech	531	123	163	338	321	267	287	268	0	89	141	777	0	2773	23.9
ash	540	0	0	0	0	0	0	45	0	0	0	0	0	45	100.0
white ash	541	65	273	281	185	38	134	96	0	143	130	422	271	2038	25.1
green ash	544	0	0	0	0	13	0	0	0	0	0	0	0	13	100.0
pumpkin ash	545	0	0	3	0	0	0	0	0	0	0	0	0	3	100.0

Table 25.—Continued.

honeylocust	552	0	0	10	0	0	0	0	0	0	0	0	0	10	100.0
American holly	591	21	80	44	30	28	0	0	0	0	0	0	0	204	45.3
butternut	601	0	0	0	0	0	0	30	0	0	0	0	0	30	100.0
black walnut	602	0	72	49	26	165	17	102	62	0	260	59	0	811	39.0
sweetgum	611	95	376	802	579	509	611	1221	775	233	60	490	0	5751	19.1
yellow-poplar	621	168	605	607	453	899	1000	1774	2336	2848	2820	6097	1814	21419	14.0
magnolia	650	1	0	0	0	0	0	66	0	0	0	0	0	67	98.6
apple	660	40	72	0	16	0	0	0	0	0	0	0	0	128	53.7
mulberry	680	19	28	121	0	42	0	175	0	0	0	0	0	386	50.7
white mulberry	681	4	10	8	0	0	58	0	0	0	0	0	0	80	74.1
blackgum	693	239	225	283	201	290	243	358	0	55	133	138	0	2166	16.9
eastern hophornbeam	701	5	0	11	0	0	0	0	0	0	0	0	0	16	75.8
Paulownia	712	0	0	5	32	19	0	0	0	0	0	0	0	56	53.9
sycamore	731	34	31	35	52	96	0	78	0	137	116	0	504	1082	42.5
bigtooth aspen	743	43	0	48	35	205	71	0	0	0	0	0	0	403	43.7
quaking aspen	746	0	0	0	0	60	0	0	0	0	0	0	0	60	100.0
cherry, plum	760	8	39	21	76	97	94	0	0	0	0	0	0	335	30.9
pin cherry	761	0	0	0	9	0	0	0	0	0	0	0	0	9	100.0
black cherry	762	149	312	657	732	727	588	390	464	763	0	150	0	4931	15.6
pear spp.	790	0	0	99	69	0	0	0	0	0	0	0	0	168	71.8
white oak	802	11	152	137	177	258	722	658	528	360	328	647	1053	5031	18.8
swamp white oak	804	0	0	0	0	0	0	0	0	0	49	0	0	49	100.0
scarlet oak	806	9	5	70	102	227	532	421	651	959	325	2063	690	6054	19.6
northern pin oak	809	0	0	0	0	0	13	0	0	0	0	0	158	171	92.4
southern red oak	812	7	0	34	84	28	24	31	150	141	0	0	0	499	35.9
shingle oak	817	0	0	5	0	0	0	0	0	0	0	95	0	100	94.8
swamp chestnut oak	825	0	0	27	29	0	0	0	0	0	61	0	0	117	62.3
pin oak	830	0	0	81	0	0	121	84	0	0	0	307	0	593	56.5
willow oak	831	0	0	0	0	0	63	0	0	0	0	0	0	63	100.0
chestnut oak	832	15	114	129	264	406	350	563	326	947	260	1868	386	5628	25.1
northern red oak	833	10	5	80	78	234	298	128	298	250	473	725	145	2723	23.2
black oak	837	50	0	49	131	285	505	424	330	728	434	1075	0	4012	21.1
black locust	901	1	60	97	360	501	335	560	245	0	127	196	0	2483	24.7
willow	920	0	0	0	25	0	121	0	0	0	0	0	0	146	84.7
sassafras	931	68	65	258	168	144	0	0	0	37	0	0	0	740	31.1
American basswood	951	2	0	0	0	0	0	0	0	0	0	0	0	2	100.0
elm	970	0	0	7	0	0	0	0	0	0	0	0	544	551	98.7
American elm	972	4	6	0	0	87	122	85	0	0	0	279	0	582	56.3
slippery elm	975	0	0	26	21	21	82	0	0	0	0	0	0	150	59.8
unknown or not listed tree	999	0	0	0	0	51	0	0	0	0	0	0	0	51	100.0
All hardwoods		2041	3588	6022	6047	7602	8566	9456	7049	8792	7241	17456	7590	91451	5.2
All species		2098	3778	6944	7214	8781	9568	9845	8099	8942	7241	17685	7751	97948	5.0
%SE		12.2	15.4	12.2	12.0	11.6	11.8	13.1	15.3	16.7	22.0	16.0	26.3	5.0	

Table 26.—Primary reason for designating plot as "nonforest"

Reason	FIA code	Number of plots	Percent of nonforest plots	Percent of nonforest plots w/ trees
No trees	0	103.1	65	—
< 1 acre in size	1	5	3	9
< 120 feet in width	2	7	4	12
< 10% stocking	3	2	1	4
Disturbed understory due to nonforest land use	4	43	27	75

Table 27.—Ground cover on nonforest plots

Cover type	Number of plots with cover	Percent of nonforest ground cover	Average percent of plot where it occurs
Crops	55	29.9	88
Grass	89	24.6	45
Herb	61	8.1	21
Tar-blacktop-asphalt	34	7.7	37
Buildings	30	6.1	33
Duff	52	5.9	18
Shrubs	52	3.9	12
Soil	38	2.9	13
Cement	28	2.6	15
Wildgrass	14	2.3	26
Water	7	1.8	41
Other	7	1.6	36
Seedlings	28	1.5	9
Rock	10	0.5	9
Other impervious	7	0.4	9
Wood	6	0.2	7

Other Characteristics of Nonforest Plots

Nonforest designation. Sixty-six percent of the NF plots were so designated because there were no trees on them. Of those with trees, 75 percent were labeled as nonforest because they had a disturbed understory attributed to a land use other than forest management, i.e., the primary eliminating factor was not low stocking, small area size, or small width (Table 26).

Ground cover on nonforest plots. Crops and grass are the dominant ground cover on NF plots, accounting for 30 and 25 percent of the cover, respectively. Impervious surfaces (tar/blacktop/asphalt, buildings, cement, and other impervious) account for 17 percent of the ground cover (Table 27).

Distribution of Nonforest Plots by Land Use

Among all land uses, agricultural and residential areas had the most NF plots. There were relatively few NF plots in the open, transportation, commercial/industrial, and urban open classes. Although this distribution pattern corresponds closely to the relative proportions of each land use in the five-county study area, only low-density residential and cropland likely contain sufficient plots to allow characteristics such as tree size, health, and percent canopy cover to be summarized by land use. Plot- and tree-level variables are summarized by land-use class in Tables 28-29.

Thirty-four percent of the NF plots fell in agricultural areas (crops and pasture), but they accounted for only 5

Table 28.—Summary of plot data for all live trees, by land use

Land-use class[a]	Avg. percent canopy cover	Avg. basal area/acre	Avg. no. stems/acre		No. of nonforest plots	Total no. stems	
			Trees	Saplings		Trees	Saplings
Cropland (A)	2.3	6.0	1	3	50.3	6	14
Pasture (A)	3	0	0	46	5	0	18
Freshwater wetland (W)	27.5	118.4	65	30	2	13	6
Open land (O)	20.7	78.2	37	66	7	26	45
Multifamily residential (R)	14.3	17.8	23	14	7	16	10
High-density residential (R)	15.0	3.0	10	30	1	1	3
Medium-density residential (R)	22.1	29.4	20	39	12	24	47
Low-density residential (R)	34.3	78.0	49	67	43	210	289
Commercial (C/I)	3.0	5.9	2	50	5	1	14
Industrial (C/I)	0	0	0	0	5	0	0
Urban open (UO)	17.3	50.8	22	32	13	29	38
Transportation (T)	3.0	12.1	2	46	9.4	2	40
Water (W)	0	0	0	0	.4	0	0
TOTAL					160.1	328	524

[a]Land-use group in parentheses.

Table 29.—Summary of tree data for all live trees, by land use

Land-use class[a]	Average d.b.h.	Total basal area	Average crown dieback	Nonforest plots with trees	
				Trees	Plots
	Inches	*ft²*	*Percent*	*Number*	
Cropland (A)	6.9	1.8	15	6	3
Pasture (A)	0	0	0	0	0
Freshwater wetland (W)	12.2	11.8	7	13	1
Open land (O)	11.3	23.5	4	26	3
Multifamily residential (R)	8.5	7.1	3	16	4
High-density residential (R)	7.4	0.3	0	1	1
Medium-density residential (R)	11.2	23.5	3	24	8
Low-density residential (R)	12.3	218.4	4	210	28
Commercial (C/I)	10.4	0.6	0	1	1
Industrial (C/I)	0	0	0	0	0
Urban open (UO)	13.2	35.5	4	29	7
Transportation (T)	10.5	1.2	3	2	1
Water (W)	0	0	0	0	0
TOTAL		323.8		328	57

[a]Land-use group in parentheses.

Table 30.—Number of nonforest and forest plots and total basal area, by urban/rural designation

Designation	Nonforest plots		Nonforest plots w/ trees		Forest plots		Total basal area	
	Number	Percent	Number	Percent	Number	Percent	Nonforest plots	Forest plots[a]
							ft²	
Urban	58.4	36	29	51	19.8	28	9,472,613	12,446,435
Rural	101.7	64	28	49	51.1	72	10,839,668	35,258,687

[a]Combined total for urban and rural forest plots differs from total in Table 4 because it is based on 70.96 rather than the 72.49 forest plots.

Table 31.—Number of nonforest and forest plots and percent of NF basal area, by population density

Population density (persons/mi²)	Nonforest plots	Nonforest plots w/ trees	Forest plots	Percent of total nonforest basal area
	Number	*Number*	*Number*	
0	2	1	42	2
1-100	18	2	2	4
100-250	62	16	10	30
250-500	35	14	7	25
500-1000	10	4	3	18
1,000-20,000	35	20	5	23
Total	162	57	69	100

percent of the NF plots with trees and 0.6 percent of tree ba. By contrast, only 39 percent of the NF plots were in residential areas, but these accounted for 72 percent of the NF plots with trees and 67 percent of tree ba. Urban open was the land use with the next highest proportion of nonforest trees to area (only 8 percent of all NF plots but 12 percent of the NF plots with trees. Using this information in similar regions, one could better estimate in advance the cost of a nonforest inventory based on the relative amounts of residential and agricultural land use and their relative percent tree cover.

Effect of Nonforest Plot Data on Estimates of Tree Cover in Urban Areas

In the five-county study area, estimates of total basal area and number of stems differed greatly when data from the NF plots were added to the total. This difference was particularly dramatic for census-designated urban areas. Occupying 38 percent of the study area, these urban areas were only 25 percent forest in 1999, with subsequently only 19.8 regular FIA plots to describe the tree resource in these areas. Adding data from 57 NF plots increased total tree ba reported in these areas by 76 percent (Table 30). Since forest plots captured only 57 percent of the tree ba in urban areas, adding data from NF plots may be important if urban-area summaries of tree cover are desired.

Population Density on Nonforest Plots

The greatest amount of nonforest basal area was in the population density class of 100 to 250 persons/mi², or 30 percent of the total. Population density between 100 and 500 accounted for 55 percent of total ba and 60 percent of the plots (Table 31). Land use provides a more distinct division of nonforest areas where trees predominate than population density, and thus is a strata of greater interest to a nonforest inventory.

Changes in Land Use

Are nonforest areas increasing or decreasing? And do these areas have trees? From 1986 to 1999, forest cover in the five-county study area has decreased from

Table 32.—Basal area per acre (ba/acre) and percent sampling errors (SE) for nonforest, nonforest with trees, and forest plots, by county (includes City of Baltimore)

County	Total nonforest			Nonforest with trees			Forest		
	Plots	Ba/acre[a]	SE	Plots	Ba/acre	SE	Plots	Ba/acre	SE
	Number	*ft²*	*Percent*	*Number*	*ft²*	*Percent*	*Number*	*ft²*	*Percent*
Anne Arundel	26	9.3	51.3	7	32.5	44.2	12.2	59.4	19.4
Baltimore County	39.9	32.4	27.9	17	77.9	19.9	24.4	85.2	14.0
Carroll	38	14.7	40.0	8	69.7	24.7	11.0	63.7	24.0
Harford	27.8	30.6	32.7	14	60.8	26.8	14.8	86.9	15.0
Howard	19.4	20.1	59.3	7	57	50.0	8.3	79.5	34.0
Baltimore City	9	7.6	46.3	4	16.9	28.9	0.3	6.2	– –
Total	160.1	21.3	16.8	57	60.1	12.7	71.0	75.7	8.7

[a]Includes both trees and saplings.

Table 33.—Basal area per acre (ba/acre) and percent sampling errors (SE) for nonforest, nonforest with trees, and forest plots, by urban/rural designation

Designation	Total nonforest			Nonforest with trees			Forest		
	Plots	Ba/acre[a]	SE	Plots	Ba/acre	SE	Plots	Ba/acre	SE
	Number	*Ft²*	*Percent*	*Number*	*Ft²*	*Percent*	*Number*	*Ft²*	*Percent*
Urban	58.4	26.9	24.7	29	54.3	20.7	19.8	68.2	17.7
Rural	101.7	18.2	23.5	28	66.1	17.1	51.1	78.7	10.5
Total	160.1	21.3	17.0	57	60.1	13.3	71.0	75.7	9.0

[a]Includes both trees and saplings.

approximately 35 to 31 percent. Only 76 of the 243 plots in the study area were remeasured plots that had been inventoried in 1986. Summarizing this somewhat limited information, two plots (2.6 percent of the land area) shifted from forest to nonforest while 23 percent of the F or NF plots in the previous inventory now are classified as mixed. These latter shifts likely are due more to a change in inventory protocol in which plots are no longer rotated into a single condition but left where they fall than to an actual change in land use, though the latter could be hidden within that number. The remaining 43 NF plots did not change in use, but there was an increase in the number of plots designated as "nonforest with trees." Also, all three idle farm plots in 1986 converted to another land use by 1999. Thus, it appears that the amount of nonforest land—and perhaps the number and size of trees on this land—is continuing to increase slightly in Maryland. As a primarily agricultural state historically, it is not surprising that much of the increase in residential development in Maryland has been on formerly agricultural land. Other areas of the country, e.g., northeastern Pennsylvania, are experiencing more residential development on previously forested land. In those areas, smaller increases in the amount of residential development could result in greater conversions of forest to nonforest land with trees.

Plot Variation in Nonforest Areas

How much do nonforest areas vary in tree species, biomass, density, and size? Is the number of plots at the FIA sampling intensity sufficient to summarize the data at the county level, by population-density or land-use class, or by urban/rural designation?

Using the typical FIA recommendation that any %SE (percent sampling error) value greater than 25 suggests questionable results, one can determine which values in Tables 32-34 (and Tables 17-25) are useable, and thus how finely the nonforest data can be divided for analysis

Table 34.—Basal area per acre (ba/acre) and percent sampling errors (SE) for nonforest and nonforest with trees, by land-use groups of MacConnell and others (1991)

Land-use group	Total nonforest			Nonforest with trees		
	Plots	Ba/acre[a]	SE	Plots	Ba/acre	SE
	Number	*Ft²*	*Percent*	*Number*	*Ft²*	*Percent*
Residential	63	41.9	17.6	41	64.2	15.1
Urban	32.4	12.4	46.3	9	43.8	38.0
Agriculture	55.3	0.5	612.4	4	7.2	28.4
Open	7	36.5	60.4	3	85.3	41.8
Water/wetland	2.4	40.7	101.6	1	122.2	– –
Total	160.1	21.3	15.6	57	60.1	12.8

[a]Includes both trees and saplings.

given the sampling intensity. It should be noted that the "25 percent rule" is a function of how the information is used and whether that amount of uncertainty associated with the estimate is tolerable.

In this study, NF plots varied more than F plots in average ba/acre. Few differences were dramatic, though they usually resulted in a %SE exceeding 25 percent. Comparing sampling errors for estimates on nonforest vs. forest land, %SE values were about twice as high when summarizing by county, 40 percent higher when summarizing by census-designated urban (vs. rural) areas, and only 16 to 44 percent higher when summarizing by the land use classes of residential, urban, and open, as identified by the 1992 National Land Cover Dataset (NLCD'92) (Loveland and Shaw 1996) (Tables 32-34). With respect to individual species, %SE values were comparably high for both forest and nonforest areas. With respect to ba, %SE values on forest land generally were slightly lower for forest than nonforest land, but the reverse was true for number of live trees or saplings. Nonforest areas were more variable than forest areas by diameter class. Including the nonforest with forest areas in summary tables of "all lands" always resulted in lower %SE values.

Importantly, %SE is lower when only NF plots with trees are examined than when all NF plots are combined. Thus, if we are able to accurately identify and separate nonforest areas with and without trees into two strata, we will be able to increase the appropriateness of our estimates and lower associated sampling errors in these areas.

Costs

The cost of regular FIA plots is $800 per plot equivalent (2000 dollars) estimated at a rate of approximately one plot per day. This total includes salary, travel, vehicles, equipment, and field offices. A cost of $1,300 per plot equivalent includes plot setup, quality control, processing, and analysis. A plot containing forest land equals one plot equivalent. Entirely NF plots are typically counted as one-third or one-half of a plot equivalent in the regular inventory.

In contrast to the amount of time typically required to inventory F plots, the NFI crew was able to inventory slightly more than three plots per day, greatly reducing the cost of NF plots compared to that of F plots, and even compared to plot-equivalent estimates for NF plots when few data are collected. The NF plots usually were more accessible and had fewer trees. Also, fewer variables were recorded on NF than on F plots. The NFI crew also had advance information on ownership, which further speeded the inventory. In the interest of overall efficiency for the FIA inventory in Maryland, the NFI crew took additional time to inventory any portions of the nonforest plots they visited that were forested (13 percent). As a result, these plots did not have to be visited twice by FIA crews. This protocol is recommended when the nonforest inventory is conducted simultaneously with the FIA inventory. At about one-third the cost of an F plot, the field portion of an NF plot cost $276 (2000 dollars).

Conclusions

Across the United States there is a gap in our knowledge of tree resources. It is the gap between the national FIA inventory and city inventories, and includes all trees that are growing in areas not considered "forest" by FIA's definition. In this pilot study, we investigated the size of this gap, its characteristics, and methods for collecting data to fill in the gap. The summaries presented here assume no city inventories, but in reality this diminishes only slightly the magnitude of the numbers observed, as the area within the city limits is a small portion of both the area and the unmeasured tree resource.

There is a substantial amount of tree biomass in nonforest areas, enough to make a substantial difference in calculations of total basal area, total biomass, total number of stems, carbon stocks, and NPP. And this tree resource in nonforest areas does differ, sometimes substantially, from forest areas in species composition, average tree size, natural reproduction, species diversity, and proportion of exotic species.

The information collected on NF plots in the five-county study area in Maryland adds considerably to our knowledge of a resource about which we knew little, and the study design and implementation provide a foundation for the collection of similar information in other areas.

Additional data could be collected on these plots without revisiting them. This information would increase our understanding of the nature of nonforest trees and plots. Large-scale remotely sensed imagery could be used to identify the land use context in which the plot occurs, measure the patch or tract size, and, if historical imagery is available, measure the land-use and land-cover history of the plot. A knowledge of the spatial and temporal context associated with an FIA plot is invaluable for understanding current inventory data. Regulations that would affect future use of the properties on which plots occur, e.g., zoning codes, city ordinances, and park rules, are another valuable source of information.

With such information we can increase our understanding of the role of trees in nonforest areas with respect to forest processes, human social systems, and even climatic effects. The processes affecting trees in nonforest areas are also many and varied, and need to be better understood. What are these areas like and what are the trees on them used for? What are the patch/tract sizes and the spatial context that surrounds them? Is there a functioning understory or evidence of natural regeneration or natural forest processes at work? Are these processes being disrupted? What other vegetation grows in these areas? Where are these trees in their life cycle and how long is it? How are they changing? What is their health, and what stresses are they experiencing? What is the aesthetic value of these trees? With an effective inventory of these areas, we can better monitor the health, magnitude, and character of this increasingly significant resource and detect changes in its status on a regionwide basis, including that portion of the urban-rural continuum that is not covered by traditional inventories.

Lessons Learned

This pilot study generated several observations and recommendations for future inventories of nonforest areas.

A nonforest inventory should be conducted in conjunction with the regular forest inventory of a state. A coordinated effort can save considerable time overall due to increased efficiencies.

The 0.10-acre plot design was easy to implement and limited the number of owner contacts per plot. The relative accessibility of NF plots, a reduction in the time needed to collect timber-related variables, and access to ownership information prior to the fieldwork contributed to the relatively low cost of these plots. With this design, one crew was able to inventory an average of three or four plots per day and complete the entire inventory (170 plots) during one summer. Also, costs were much lower than our initial estimate.

Contacting owners was not inordinately time-consuming primarily because FIA was able to access Maryland's digital property database. This required additional work prior to the inventory but eliminated the need to search ownership files at local tax offices. Similar property databases are not yet available to FIA crews in all states, though there is a growing trend in this direction. It is recommended that these databases be used if possible. The two visits per plot required because owners typically were not available during the day consumed little additional time because nearly every plot was easily accessible by road and there was far less uncertainty about who the owner was or where she or he lived.

The number of refused plots was less than expected in the nonforest inventory. It is not known whether this surprising degree of owner cooperation reflected the information given to owners about the inventory, the additional media publicity, the "people skills" of this particular NFI crew, or the types of owners who hold nonforest land. The greatest concern of owners usually was related to liability issues associated with injuries incurred by crew members.

The following are additional recommendations based on this pilot study.

- A better division of exotic and native species codes would be useful. In this study, all species not typically encountered on FIA plots (and thus having no previous individual FIA code) were identified and coded only by species group. However, if identifying the presence and abundance of exotic species continues to be an issue, mixed-species groups should be placed into exotic and native classes. This might require additional training in the identification of exotic species for NFI crews.

- When the inventories are conducted simultaneously, a strong link between regular and nonforest inventories is essential, i.e., when plots are rechosen and the new plot is an NF or partially NF plot, the revised information must be conveyed to the NFI crews so that the new plot can be visited.

- To bring the nonforest database into line with the regular inventory for ease of integration, an additional FIA "condition" variable must be recorded as there may be more than one nonforest condition present (by FIA definitions) on the plot; data on these plots would be recorded by condition rather than by plot.

- The actual percent NF on the 0.10-acre plot should be recorded at the plot rather than assuming that it is the same as that on subplot 1 or mapping and calculating it manually in the office from the plot sheet.

- A better method is needed to determine the proportion of the plot that remains subject to natural forest processes, for example, adding a "percent natural ground cover" category. It was not possible to summarize the percentage of natural ground cover from the data that were collected.

- For most conditions, if a lower standard error is desired, adding more plots probably would be more effective than using a larger plot size, particularly in developed areas where travel costs between plots are relatively low.

- Many of the FHM variables failed to meet QA/QC standards in this study. The crew received training in these variables but overall accuracy and consistency were not as high as expected and need to be improved. As of 2000, FHM damage variables are being added to the regular FIA inventory, so FIA experience and QA/QC results with such variables should improve.

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Appendix I

Variables Collected in the Nonforest Inventory

Tree-level variables used in nonforest inventory (all trees ≥ 5 inches in d.b.h.)

Variable[a]	Source and manual reference
Tree number (ID)	FIA – 6.105
Species	FIA – 6.110
Horizontal distance (from point)	FIA – 6.120
Azimuth	FIA – 6.130
D.b.h.	FIA – 6.150
Tree condition	FIA – 6.170
Total height	FIA – 6.205
FHM crown ratio	FHM[a]
Crown class	FIA – 6.250
Crown dieback	FHM
Crown transparency	FHM
Crown density	FHM
Crown width (N-S)	FHM
Crown width (E-W)	FHM
Damage/cause of death	FIA – 6.270
Special damage 1	FIA – 6.280
Special damage 2	FIA – 6.280
FHM damage (for the top 3 damage symptoms found)	FHM
Location	
Damage	
Severity	
Notes	

[a]Not available on FIA forest plots for comparison.

Sapling-level variables used in nonforest (NF) inventory (all trees ≥ 1 to 5 inches in d.b.h.)

Variable[a]	Source and manual reference
Species	NF inventory[a]
1- to 2-inch size class	NF inventory
Stems (no.)	
Avg. height (inches)	
2- to 3-inch size class	NF inventory
Stems (no.)	
Avg. height (inches)	
3- to 4-inch size class	NF inventory
Stems (no.)	
Avg. height (inches)	
4- to 5-inch size class	NF inventory
Stems (no.)	
Avg. height (inches)	

[a]Unique to nonforest inventory and not available on FIA forest plots for comparison.

Plot-level variables used in nonforest (NF) inventory

Variable a	Source and manual reference
State	FIA – 3.100
Unit	FIA – 3.110
County	FIA – 3.120
Plot number	FIA – 3.130
Sample kind	FIA – 3.140
Current photo class (PI)	FIA – 3.150
Current month	FIA – 3.160
Current year	FIA – 3.170
Previous month	FIA – 3.200
Previous year	FIA – 3.210
Previous land use	FIA – 3.190
Cruiser number	FIA – 3.220
Tally person number	FIA – 3.230
Terrain position	FIA – 3.250
Why is it nonforest?	NF inventory[a]
No. of forested subplots	NF inventory
Obstruction at plot center	NF inventory
% of plot covered in tree canopies	NF inventory
Land-use class (MacConnell and others 1991)	NF inventory
Land-use class group (MacConnell and others 1991)	NF inventory
Stand size	FIA – 4.340
Physiographic class	FIA – 4.430
Owner class	FIA – 3.270
Ground-cover data	NF inventory
Buildings	
Cement	
Tar/blacktop/asphalt	
Wood	
Other impervious	
Soil	
Rock	
Duff/mulch	
Herbaceous (nongrass)	
Grass	
Wild (unmanaged grass)	
Water (including pools)	
Shrubs	
Seedlings	
Crops	
Other	
Notes	

[a]Unique to nonforest inventory and not available on FIA forest plots for comparison.

Appendix II

Variables Specific to This Inventory

Reason Plot is Nonforest

0	no trees
1	< 1 acre in size
2	< 120 feet wide
3	< 10 percent stocking
4	Disturbed understory due to other land use

Number of Forested Subplots

0	no subplots with forested ecotypes
1	one subplot contains forest land
2	two subplots contain some forest land
3	three subplots contain some forest land
4	all four subplots contain some forest land

Obstruction at Plot Center

0	no obstruction
1	building or street at plot center; cannot be occupied
2	other obstruction

Percentage of Plot Covered by Tree Canopies

When looking upward from within the plot, one will see tree canopies or areas of open sky between the canopies. The proportion of the sky that is obscured by tree crowns within the plot ranges from 0 to 100 percent. This information is necessary only if tree-cover data for the area are lacking. Does not include saplings. Data are recorded in 5-percent classes.

Land-Use Class (MacConnell)

Code		Description
10	R0	Multifamily residential (apartments and tenements)
11	R1	High-density residential (≤ 1/4-acre house lots)
12	R2	Medium-density residential (< 1/2-acre house lots)
13	R3	Low-density residential (≥ 1/2-acre house lots)
15	UC	Commercial (city buildings, shopping centers, “business parks,” etc.
16	UI	Industrial (manufacturing facilities)
17	UO	Urban open (schools, colleges, churches, cemeteries, city parks, etc.)
18	UT	Transporation (airports, docks, railroads roadways > 220 feet wide)
05	M	Mining (sand, gravel, etc.)
19	UW	Waste disposal (landfills, junkyards, sewage plants)
01	AC	Cropland (tilled and untilled fields, farm buildings)
02	AP	Pasture
21	WP	Woody perennials (orchards, Christmas trees, nurseries)
23	CB	Cranberry bog
06	O	Open land (abandoned fields and orchards, right-of-ways > 100 feet wide, dunes, heath)
20	W	Water (lakes and ponds ≥ 1 acre, rivers and streams ≥ 120 feet wide)
04	FW	Inland water (flood plain, bog, swamp, meadow, marsh, beaver pond)
14	SW	Salt wetland (salt marsh and meadow)
03	F	All forest land (³ 1 acre in size and 120 feet wide)
30	OC	Ocean

More detailed descriptions:

UI	Urban-industrial (land containing primary and secondary manufacturing facilities)
UC	Urban-commercial (land used primarily for distributing and merchandising goods and services to the public)
R0	Multifamily housing (apartments, town houses, row houses, etc.)
R1	High-density residential (single family houses on small lots, generally < ¼ of an acre)
R2	Medium-density residential (single family houses on predominantly ¼-acre lots)
R3	Low density residential (single family houses on lots of ½ to 1)
UT	Transportation (land used for airports, commercial docks, rail yards, truck and bus terminals, and divided highways with rights-of-way > 200 feet)
UO	Urban-open (undeveloped land in the midst of urban areas, or land in agricultural or forested areas that has been cleared for urban development; also, land with "green spaces" such as schools, colleges, churches, hospitals, and cemeteries)
M	Mining (land used for the extraction of sand, gravel, stone or minerals)
UW	Waste disposal (land used for sewage, waste and refuse disposal, automobile junk yards)
AC	Agriculture-crops (tilled or tillable land that is or has been farmed intensively)
AP	Agriculture-pasture (land used to raise hay)
WP	Agriculture-woody perennials (land used for fruit orchards, greenhouses, nurseries, Christmas tree plantations)
CB	Cranberry bog (productive cranberry bogs)
O	Open land (abandoned fields with < 30 percent tree crown cover, abandoned orchards, utility rights-of-way, heath, and open land)

Land-Use Class Group (MacConnell)

Code	Description
1	R0, R1, R2, R3 (residential)
2	UC, UI (urban commercial or industrial
3	UO (urban open)
4	UT (transportation/roads)
5	M, UW (mining/waste)
6	AC, P (agriculture crops/pasture)
7	WP (woody perennials)
8	CB (cranberry bog)
9	O (open)

Ground Cover

The inventory crew should note the proportion of the ground area of the plot is covered by one or more of the the following materials (the sum of these proportions should equal 100 percent; recorded in 5-percent classes):

buildings	herbaceous (excluding grass and shrubs)
cement	grass
tar/blacktop/asphalt	wild (unmaintained grass)
wood	water (including pools)
other impervious	shrubs
soil	seedlings
rock	crops
duff/mulch	other

Owner Class

Owner categories are the same as those used in the regular FIA inventory except that code 99 for nonforest will not be used.

New Species Codes

Ten species codes were added in order to account for exotics found in the nonforest inventory. Except for mimosa, these also represent additions to the 1999 version of the national manual.

210 *Sequoia* spp. (redwood)
220 *Taxodium* spp. (cypress)
250 *Torreya* spp.
345 *Albizzia julibrisson* (mimosa)
420 *Castanea* spp. (chestnut)
490 *Cornus* spp. (dogwood)
550 *Ginko* spp.
610 *Liquidambar* spp.
620 *Liriodendron* spp.
790 *Pyrus* spp. (pear)

Riemann, Rachel. 2003. **Pilot Inventory of FIA plots traditionally called 'nonforest'**. Gen. Tech. Rep. NE-312. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 44 p.

Forest-inventory data were collected on plots defined as "nonforest" by the USDA Forest Service's Forest Inventory and Analysis (FIA) unit. Nonforest plots may have trees on them, but they do not fit FIA's definition of forest because the area covered by trees is too small, too sparsely populated by trees, too narrow (e.g., trees between fields or in the middle of a divided highway), or has a disturbed understory (e.g., mowing or grazing) such that natural regeneration of trees probably does not occur. Recent inventories and associated photointerpretation work showed that 30 to 50 percent of these nonforest plots contained trees and were located in urban, suburban, industrial, and rural areas. Data were collected for trees on traditionally nonforest plots in a five-county area in Maryland that was 30 percent forested in 1999. Nonforest plots added at least 43 percent to the total-tree basal area measured on forest plots. Species composition, tree size, damage, and number of exotics differed between forest and nonforest plots. Costs were about one-third of those on a regular FIA plot. Field collection methods, including field preparation, plot design, and variables collected are outlined, and recommendations for future inventories of similar areas are presented.

Keywords: forest inventory; trees on nonforest lands; urban forestry; total tree cover; total basal area

Headquarters of the Northeastern Research Station is in Newtown Square, Pennsylvania. Field laboratories are maintained at:

Amherst, Massachusetts, in cooperation with the University of Massachusetts

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