Appendix I: Methodology

The following section describes several different methodologies used in the Assessment.

Forest Inventory and Analysis (FIA)

The Forest Inventory and Analysis (FIA) Program of the U.S. Forest Service provides the information needed to assess America's forests. FIA is a continuous forest census and projects how forests are likely to appear 10 to 50 years from now. FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership.

FIA is managed by the Research and Development organization within the USDA Forest Service in cooperation with State and Private Forestry and National Forest Systems.

Vissage (2002) described the annualized inventory methods for Wisconsin. Since the 1996 inventory, several changes in FIA methods have improved the quality of the inventory and have met increasing demands for timely forest-resource information.

The most significant change between inventories has been the shift from periodic to annual inventories. Historically, FIA inventoried each state on a cycle that averaged about 12 years. However, the need for timely and consistent data across large geographical regions along with national legislative mandates resulted in FIA implementing an annual inventory. This system was initiated in Wisconsin in 2000.

With the NRS-FIA annual inventory system, approximately one-fifth of all field plots are measured in any single year. After 5 years, the entire inventory is completed. After this initial 5-year period, NRS-FIA will report and analyze results using a moving 5-year average. For example, NRS-FIA will be able to generate inventory results for 2000 through 2005 or for 2001 through 2006.

Other significant changes between inventories include implementing new remote-sensing technology as well as a new field-plot configuration and sample design, and gathering additional remotely sensed and field data. The use of new remote-sensing technology allows NRS-FIA to use classifications of Multi-Resolution Land Characterization data and other remote-sensing products to stratify the total area of Wisconsin and to improve estimates.

New algorithms were used in 2000-04 to assign forest type and stand-size class to each condition observed on a plot. These algorithms are being used nationwide by FIA to provide consistency from state to state and will be used to reassign the forest type and stand-size class of every plot in the 1996 inventory when it is updated. As a result, changes in forest type and stand-size class will reflect actual changes in the forest and not changes due to differences between algorithms.

The list of recognized forest types, groupings of these forest types for reporting purposes, models used to assign stocking values to individual trees, definition of nonstocked (stands with a stocking value of less than 10 percent for all-live trees), and names given to the forest types changed with the new algorithms. As a result, comparisons between the published 2000-04 results and those published for the 1996 inventory may be invalid. Contact NRS-FIA for additional information on the algorithms used in both inventories.

Sampling phases

The 2004 Wisconsin inventory was conducted in three phases. In the first phase, satellite imagery was used to stratify the State and aerial photography was used to select plots for measurement. The second phase entailed measuring the traditional suite of mensurational variables; the third phase focused on a suite of variables related to forest health. Land that could not be sampled included private tracts where field personnel were unable to obtain permission to measure a Phase 2 plot and plots that were inaccessible because of a hazard or danger to field personnel. The methods used in preparing this report were adjusted to account for such sites.

Phase 1

For the Wisconsin inventory, FIA used a classification of satellite imagery for stratification.

The imagery was used to form two initial strata: forest and nonforest. Pixels within 60 m (2-pixel widths) of a forest/nonforest boundary formed two additional strata: forest edge and nonforest edge. Forest pixels within 60 m of the boundary on the forest side were classified as forest edge and pixels within 60 m of the boundary on the nonforest side were classified as nonforest edge. All strata were divided into public or private ownership based on information available in the Protected Lands Database (DellaSala et al. 2001). The estimated population total for a variable is the sum across all strata of the product of each stratum's area (from the pixel count) and the variable's mean per unit area (from plot measurements) for the stratum.

Phase 2

Phase 2 of the inventory consisted of the measurement of an annual sample of field plots in

Wisconsin. Current FIA precision standards for annual inventories require a sampling intensity of one plot for about every 6,000 acres. FIA has tessellated the entire United States using nonoverlapping hexagons, each of which contains 5,937 acres (McRoberts 1999). An array of field plots was established by selecting one plot from each hexagon based on the following rules: (1) if an Forest Health Monitoring (FHM) plot (Mangold 1998) fell within a hexagon, it was selected as the grid plot; (2) if no FHM plot fell within the hexagon, the existing NRS-FIA plot nearest the hexagon center was selected as the grid plot; and (3) if neither FHM nor existing NRS-FIA plots fell within the hexagon, a new NRS-FIA grid plot was established (McRoberts 1999). This array of plots is designated the Federal base sample and is considered an equal probability sample; its measurement in Wisconsin is funded by the Federal government. In 2003, two additional plots were established and measured in each

hexagon. In 2000-02 and 2004, an additional plot was established and measured in each hexagon. The measurement of this intensified sample was funded by the State. The total Federal base sample was divided systematically into five interpenetrating, nonoverlapping subsamples or panels. Each year, the plots in a single panel are measured and panels are selected on a 5-year, rotating basis (McRoberts 1999). For estimation purposes, the measurement of each panel of plots can be considered an independent random sample of all land in the State. Field crews measured vegetation on plots forested at the time of the last inventory and on plots classified as forest by trained photo-interpreters using aerial photos or digital orthophotoquads.

Phase 3

NRS-FIA has two categories of field measurements: Phase 2 and Phase 3 (formerly FHM) field plots. Both types are distributed systematically geographically and temporally. Phase 3 plots are measured with the full array of vegetative and health variables as well as the full suite of measures associated with Phase 2 plots. Phase 3 plots must be measured between June 1 and August 30 to accommodate measurement of nonwoody understory vegetation, ground cover, soils, and other variables. The complete 5-year annual inventory of Wisconsin includes 165 forested Phase 3 plots. On the remaining plots, only variables that can be measured throughout the entire year are collected. In Wisconsin, the complete 5-year annual inventory includes 6,478 forested Phase 2 plots. Of these, 6,375 plots were established on timberland and 47 plots were established on reserved forest land. The national FIA four-subplot cluster configuration (Fig. 71) was first used for data collection in Wisconsin in 2000 and will be used in subsequent years. The national plot configuration requires mapping all forest conditions on each plot. Due to the small sample size each year, precision associated with estimates of components of change such as mortality will be relatively low. Consequently, we report estimates of components of change only after multiple annual panels have been measured. With completion of the annual inventory in 2004, the full range of change estimates now is available. The overall plot layout for the new configuration consists of four subplots. The centers of subplots 2, 3, and 4 are located 120 feet from the center of subplot 1. The azimuths to subplots 2, 3, and 4 are 0, 120, and 240 degrees, respectively. The center of the new plot is located at the same point as the center of the previous plot if a previous plot existed at the location. Trees that are 5 inches and larger in d.b.h. are measured on a 24-foot-radius (1/24-acre) circular subplot. All trees less than 5 inches d.b.h. are measured on a 6.8-foot-radius (1/300- acre) circular microplot located 12 feet due east of the center of each of the four subplots. Forest conditions on each subplot are recorded. Factors that differentiate forest conditions are changes in forest type, stand-size class, land use, regeneration status, reserved status, ownership, and density. Each condition that occurs on one of the subplots is identified, described, and mapped so long as the area of the condition is at least 1 acre. Field-plot measurements are combined with Phase 1 estimates in the compilation process and table production. The number of tables presented here is limited but others can be generated at http://fiatools.fs.fed.us. For additional information, contact:

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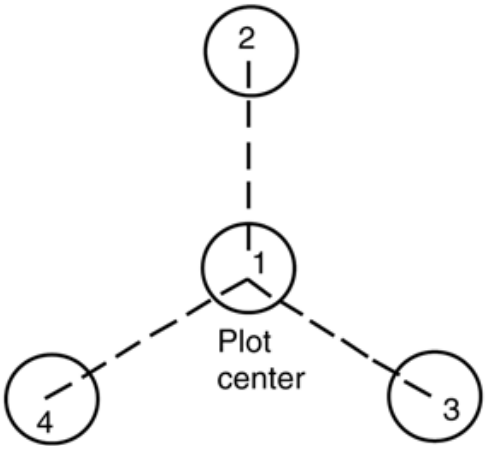

Figure I.1: Current NRS-FIA field-plot design

Timber Outputs Survey

The timber products inventory study was a cooperative effort between the Wisconsin Department of Natural Resources (WIDNR) and the Northern Research Station (NRS) (Reading and Whipple 2007). The WIDNR canvassed all primary wood-using mills within the State using mail questionnaires supplied by the NRS and designed to determine the size and composition of Wisconsin's primary wood-using industry, its use of roundwood, and its generation and disposition of wood residues. The WIDNR then contacted nonresponding mills through additional mailings, telephone calls, and personal contacts until a nearly 100-percent response was achieved. Completed questionnaires were forwarded to NRS for compilation and analysis. As part of data processing and analysis, all industrial roundwood volumes reported on the questionnaires were converted to standard units of measure using regional conversion factors. Timber removals by source of material and harvest residues generated during logging were estimated from standard product volumes using factors developed from previous NRS logging utilization studies. Data on Wisconsin's industrial roundwood receipts were added to a regional timber removals database and supplemented with data on out-of-state uses of State roundwood to provide a complete assessment of Wisconsin's timber product output.

National Woodland Landowner Survey

The National Woodland Landowner Survey is conducted annually by the USDA Forest Service to increase our understanding of private woodland owners—the critical link between society and forests. Each year, questionnaires are mailed to individuals and private groups who own the woodlands where NRS-FIA has established inventory plots (Butler et al. 2005). Twenty percent of these ownerships (about 50,000 nationwide) are contacted each year with more detailed questionnaires mailed in years that end in 2 or 7

to coincide with national census, inventory, and assessment programs. The target accuracies of the data are plus or minus 10 percent at the state level.

Ozone bioindicator species and survey history

Several bioindicator species have been tested in both laboratory and field settings over several decades and have proven to be reliable indicators of ground-level ozone stress. These include white ash, black and pin cherry, dogbane, milkweed, big leaf aster, and blackberry. In Wisconsin, the annual ozone biomonitoring by FIA began in 1994. A revised national grid emphasizing ozone exposures and forested acreage was activated in 2002. Foliar injury can be related to seasonal exposures as well as peak concentrations. Seasonal exposures measure ozone stress by summing hourly concentrations above a threshold concentration over a period of several months. For example, a common growing-season exposure index (SUM06) is the sum of all daylight hourly ozone concentrations greater than 0.06 parts per million (ppm) between June 1 through August 31. Ozone can lead to leaf damage at levels exceeding 8 ppm-hours, and the growth of seedlings in natural forest stands is affected at 10 to 15 ppm-hours (Heck and Cowling 1997). SUM06 values in Wisconsin ranged from about 3 to 24 ppm-hours during 2001-05. Presettlement seasonal SUM06 values probably would have been in the range of 0.5 to 2 ppm-hours.

GIS Methodology

For detailed methodology on how the GIS were developed, please contact Rebecca Gass, Forest Planner, Division of Forestry (rebecca.gass@wi.gov)

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