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New Mexico's Forest Resources, 2008-2012

Sara A. Goeking, John D. Shaw, Chris Witt, Michael T. Thompson, Charles E. Werstak, Jr., Michael C. Amacher, Mary Stuever, Todd A. Morgan, Colin B. Sorenson, Steven W. Hayes, and Chelsea P. McIver

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Abstract

This report presents a summary of the most recent inventory of New Mexico's forests based on field data collected between 2008 and 2012. The report includes descriptive highlights and tables of area, numbers of trees, biomass, volume, growth, mortality, and removals. Most sections and tables are organized by forest type or forest type group, species group, diameter class, or owner group. The report also describes the inventory's design, inventory terminology, and data reliability. Results show that New Mexico's forest land covers 24.8 million acres. Forty-four percent (10.8 million acres) of this forest land is privately owned, and another 31 percent (7.8 million acres) is administered by the USDA Forest Service. The State's most abundant forest type is pinyon/juniper woodland, which covers more than 10 million acres. Pinyon/juniper woodlands, combined with pure juniper woodland, cover a total of 13.6 million acres, or more than half of New Mexico's forest land area. Gambel oak is the most abundant tree species by number of trees, and ponderosa pine is the most abundant by volume or biomass. New Mexico's forests contain 17.5 billion cubic feet of net volume in trees 5.0 inches diameter and larger. Gross growth of all live trees 5.0 inches diameter and larger averaged 211.5 million cubic feet per year. Average annual mortality totaled 165.1 million cubic feet per year, and net growth was 46.4 million cubic feet per year, or 0.26 percent of the State's total wood volume.

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Report Highlights

Forest Area

- New Mexico's forest land area totals 24.8 million acres.
- Unreserved forest land accounts for most of the forest land in New Mexico (94 percent) and totals 23.4 million acres.
- More than 18 percent, or 4.3 million acres, of New Mexico's unreserved forest land is classified as timberland and the remaining 82 percent is classified as unproductive forest land.
- Privately owned forest land totals 10.8 million acres, or 44 percent of New Mexico's total forest land area.
- About 31 percent of New Mexico's total forest land area, or 7.8 million acres, is administered by the USDA Forest Service.
- Pinyon/juniper woodlands are the most abundant forest type in New Mexico, covering over 10 million acres and accounting for 41 percent of forest land.
- The combination of all pinyon/juniper, Rocky Mountain juniper, and pure juniper woodlands covers 13.6 million acres.
- Mesquite woodlands cover nearly 3.5 million acres and are the second most abundant forest type.

Numbers of Trees, Volume, and Biomass

- There are nearly 6.7 billion live trees in New Mexico.
- Softwood species total more than 4.3 billion trees or 65 percent of all live trees.
- Numbers of Gambel oak trees total nearly 1.7 billion, making this species the single most abundant tree in New Mexico.
- The net volume of live trees in New Mexico on forest land totals 17.5 billion cubic feet.
- Growing-stock volume on timberland in New Mexico totals 7.4 billion cubic feet, or 42 percent of the total live volume on forest land. Most of this volume occurs on National Forest System lands (67 percent), with 29 percent on private lands and 3 percent on State lands.
- The net volume of sawtimber trees on timberland is more than 32 billion board feet.
- The above-ground weight for all trees on New Mexico forest land is 318 million tons of oven-dry biomass.

Forest Growth, Mortality, and Removals

- Gross annual growth of all live trees 5.0 inches diameter and larger on New Mexico forest land totaled 211.5 million cubic feet. Net growth totaled about 46.4 million cubic feet.
- Average annual mortality of trees 5.0 inches diameter and larger totaled about 165.1 million cubic feet. The leading causes of mortality were insects (35 percent of all mortality), fire (22 percent), and diseases (13 percent).
- Mortality exceeded gross growth for four of the eight tree species with the greatest volume in New Mexico, including Douglas-fir, Engelmann spruce, white fir, and aspen.

- Total removals in 2007 were slightly less than 47.5 million cubic feet.
- Commercial timber harvest in 2007 was 39.8 million board feet (Scribner), most of which came from private and tribal lands (83 percent). Ponderosa pine accounted for more harvested timber volume than any other species (47 percent).

Current Issues in New Mexico's Forests

- Pinyon/juniper woodlands that are old enough to produce harvest-worthy quantities of pine nuts occupy about 8 million acres in New Mexico.
- Pinyon/juniper woodlands, followed by spruce/fir forests, contain the greatest number of suitable snags for two cavity-nesting bird species, the northern flicker and the acorn woodpecker.
- About 18 percent of New Mexico's forest land area occurs in stands older than 150 years.
- During the drought-related die-off of trees in pinyon/juniper woodlands just prior to New Mexico's annual forest inventory, about 8 percent of pinyon basal area and less than 2 percent of juniper basal area died.
- Aspen forests cover more than 380 thousand acres in New Mexico, and aspen trees occur on 1.6 million acres. The area and volume of aspen have not changed appreciably over the past decade.
- Damages to live trees in New Mexico consist primarily of form-related damage agents, while low rates of disease and insect damage were also recorded.
- Less than 1 percent of all forest plots fell within the perimeters of recent large fires.
- Ten different invasive species were found on 35 plots, or only 1 percent of all forest plots. Three species – saltcedar, bull thistle, and musk thistle – accounted for more than 70 percent of all occurrences.
- Since the last periodic forest inventory of New Mexico, live tree volume has decreased and total tree volume has changed very little. Average annual mortality increased and growth decreased during that time.

Authors

Sara A. Goeking is a Biological Scientist and a member of the Analysis Team with the Interior West Forest Inventory and Analysis Program at the USFS Rocky Mountain Research Station in Ogden, Utah.

John D. Shaw is a Biological Scientist and Analysis Team Leader with the Interior West Forest Inventory and Analysis Program at the USFS Rocky Mountain Research Station in Ogden, Utah.

Chris Witt is an Ecologist and a member of the Analysis Team with the Interior West Forest Inventory and Analysis Program at the USFS Rocky Mountain Research Station in Ogden, Utah.

Michael T. Thompson is a Forester and a member of the Analysis Team with the Interior West Forest Inventory and Analysis Program at the USFS Rocky Mountain Research Station in Ogden, Utah.

Charles E. Werstak, Jr. is a Biological Scientist and a member of the Analysis Team with the Interior West Forest Inventory and Analysis Program at the USFS Rocky Mountain Research Station in Ogden, Utah.

Michael C. Amacher is a Research Soil Scientist in the Forest and Woodland Ecosystems Research Program at the USFS Rocky Mountain Research Station in Logan, Utah.

Mary Stuever is the Chama District Forester for New Mexico's Forestry Division, Energy, Minerals, and Natural Resources Department, and served as program manager for the ARRA FIA data collection from 2010-2012.

Todd A. Morgan is the Director of the Forest Industry Research Program at The University of Montana's Bureau of Business and Economic Research in Missoula, Montana.

Colin Sorenson is a Research Economist with the Forest Industry Research Program at The University of Montana's Bureau of Business and Economic Research in Missoula, Montana.

Steven W. Hayes is a Research Forester with the Forest Industry Research Program at The University of Montana's Bureau of Business and Economic Research in Missoula, Montana.

Chelsea P. McIver is a Research Assistant with the Forest Industry Research Program at The University of Montana's Bureau of Business and Economic Research in Missoula, Montana.

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Contents

Introduction

For the first time in many years, forest scientists, managers, and users have access to a comprehensive forest inventory dataset for the State of New Mexico. New Mexico encompasses a wide variety of environments and forest types that are valued for their scenic beauty, wood products, traditional forms of food and shelter, wildlife habitat, and ecological functions. This report contains highlights of the status of New Mexico's forest resources, with discussions of pertinent issues based on the first few years of inventory under the new Forest Inventory and Analysis (FIA) annual system (Gillespie 1999).

This chapter briefly describes the recent implementation of the national FIA sample design in New Mexico, as well as some basic differences between this inventory and previous inventories of New Mexico's forests. The following chapters describe specific inventory methods; an overview of traditional forest attributes measured by the FIA program, such as forest land area and timber volume; descriptions of selected resources that New Mexico's forests provide; current issues and events affecting New Mexico's forests; and comparisons of current forest attributes with previous forest inventories. The appendices include supplemental information, including a glossary of terms used in this report, standard forest resource tables, descriptions of forest types and forest type groups, lists of tree species, and documentation for the equations used to estimate tree volume and site index.

New Mexico's Annual Forest Inventory

The annual forest inventory of New Mexico's forests follows sampling procedures specified by Federal legislation and the national FIA program. In 1998, the Agricultural Research Extension and Education Reform Act, also known as the Farm Bill, mandated that inventories would be conducted throughout the forests of the United States on an annual basis. This annual system integrates FIA and Forest Health Monitoring (FHM) sampling designs into a mapped-plot design, which includes a nationally consistent plot configuration with four fixed-radius subplots; a systematic national sampling design consisting of one plot per approximately 6,000 acres; annual measurement of a constant proportion of permanent plots; data or data summaries within 6 months after yearly sampling is completed; and a State summary report after 5 years. The inventory strategy for the Western United States involves measurement of 10 systematic samples, or subpanels, where one subpanel is completed each year and all subpanels are measured over a 10-year period. Each subpanel is pre-assigned to be surveyed during a specific calendar year, which is referred to as inventory year (see Appendix A for standard FIA terminology). The year in which each plot was actually surveyed is recorded as its measurement year. In most States, inventory year and measurement year are the same for the vast majority of field plots, but this does not hold true for New Mexico's annual forest inventory thus far.

Interior West Forest Inventory and Analysis (IWFIA) implemented the new annual inventory strategy in New Mexico in 2008. In 2009, the State of New Mexico received funding from the American Recovery and Reinvestment Act (ARRA) to accelerate sampling and broaden the data collection effort to subpanels that would have been measured had the inventory started in 2005. Under this accelerated sampling, eight subpanels were completed within the 3-year period between 2010 and 2012. These eight subpanels represent inventory years 2005-2007 and 2009-2013, so their inventory years are typically not the same as their measurement years. Data from these subpanels were combined with data from the 2008 subpanel, which was collected primarily in 2008 and 2009.

This report is based on the aggregated data collected in measurement years 2008-2012 from nine subpanels whose scheduled inventory years range from 2005 to 2013.

The aggregated dataset includes a total of 11,792 plots, where 3,444 plots contained at least one forested condition, 7,340 plots were entirely nonforest, and 1,008 plots were not sampled. Specific details on the ARRA contracts and the Federal/State partnership that galvanized New Mexico's annual forest inventory are presented by Stuever and Capuano (in prep.).

The New Mexico inventory will resume a regular inventory schedule in 2014. Annual inventory summaries are updated each spring to include the most recent subpanels of data available to the public. After 2014, an assessment of the full cycle of data from ten subpanels will be included in the upcoming 10-year report. In 2015, the remeasurement phase of the inventory will begin as plots from the 2005 subpanel are re-measured, and the new plot data can then be compared to the data collected in 2010-2012. Note that remeasurement periods for the first few subpanels will range from 3 years, for portions of the 2005 subpanel that were measured as late as 2012, to 10 years for plots that were measured during their scheduled inventory years, such as plots from the 2008 subpanel and subsequent subpanels. Future estimates of growth, removals, and mortality will account for these different remeasurement periods.

Previous Inventories of New Mexico's Forests

Prior to implementation of the annual forest inventory, New Mexico's forests attributes were estimated from inventories that were conducted over a period of 2 to 5 years and repeated roughly every 10 years. Because these inventories were conducted periodically, they are referred to as periodic inventories. The most recent periodic inventories of New Mexico's forest resources were completed in 2000 (O'Brien 2003) and 1993 (Van Hooser and others 1993). The nominal years assigned to these inventories, 1993 and 2000, do not specifically represent years that field surveys were completed but rather represent the year the dataset was compiled and analyzed for reporting purposes. The 1993 inventory included measurements from 1985 through 1987 that used a variety of plot designs. A separate 1994 inventory was conducted on the Gila National Forest (Shaw 2008). Between 1996 and 2000, another periodic inventory was conducted throughout most of the State, and this inventory's plot design was very similar to the design currently used for the annual inventory. The 2000 statewide inventory was combined with the 1994 Gila National Forest inventory in O'Brien's (2003) summary of the State's forest resources. Other periodic inventories were conducted as far back as 1952. However, inventories from 1952 to the early 1980s were primarily conducted using aerial photographs rather than measurements at ground plots, so the national FIA database does not include any data for these earlier inventories.

Data from new inventories are often compared with data from earlier inventories to quantify forest trends. However, for the comparisons to be valid, the procedures used in the inventories must be compatible. New Mexico's procedures for past inventories are different enough from present procedures that direct comparisons between them are not recommended. However, it is possible to compare individual plots that were measured during both inventories. The plot design used during the 2000 periodic inventory was very similar to the annual inventory's plot design. Therefore, plots on forest land that were sampled during both inventories can be compared to evaluate changes in attributes such as per-acre estimates of live volume, mortality, growth, and biomass. A more detailed description of the differences between the periodic and annual forest inventories of New Mexico, as well as results of plot-to-plot comparisons of periodic and annual inventory data, can be found in this report in the section "Comparisons Between New Mexico's Periodic and Annual Forest Inventories."

Accessing New Mexico's Forest Inventory Data

FIA data are publicly available from the national FIA website at fia.fs.fed.us. This site includes data downloads; online tools that allow users to perform custom queries; and documentation of FIA's field inventory protocols, database structure, and publications. Plot data may be downloaded in table form or summarized using a variety of online tools (http://fia.fs.fed.us/tools-data/default.asp). For assistance with finding information on this site or with performing custom analyses, data users are encouraged to contact one of the members of the Analysis Team of the Interior West FIA Program who are listed as authors at the beginning of this report.

The national FIA database contains data from the 1993 and 2000 periodic inventories as well as annual forest inventory data, which is updated each year as additional measurements are collected. Note that within the FIA database, the 2000 inventory is assigned an inventory year of 1999. However, here it is referred to as the 2000 inventory to be consistent with the previous report by O'Brien (2003). The 1993 inventory is assigned an inventory year of 1993. Data collected as part of the annual inventory is assigned an inventory year that corresponds to the year in which the plot was scheduled for measurement on a 10-year remeasurement cycle.

Overview of Standard and Supplemental Tables

Forest Inventory and Analysis produces a set of standard tables that incorporates most of the core FIA program, using both Phase 2 and Phase 3 data. Appendix B presents tables B1-B39, which summarize annual forest inventory data collected in New Mexico between 2008 and 2012 in terms of traditional FIA attributes. These tables encompass statistics for land area, numbers of trees, wood volume, biomass (oven-dry weight), growth, mortality, and sampling errors. Table B1 is the only table that includes all land cover types, and it summarizes the proportions of sample plots that were recorded as forest, nonforest, and nonsampled (e.g., due to inaccessibility). All other tables exclude nonforest land and therefore include only accessible forest land or timberland (see Appendix A for definitions). Table B37 shows sampling errors for area, volume, net growth, and mortality at the 67 percent confidence level.

This report also contains supplemental tables within the body of the report. To avoid confusion between supplemental tables found in individual report chapters and the standard FIA tables found in Appendix B, supplemental tables in the body of this report are labeled consecutively as they appear, beginning with table 1. Standard tables will be referred to beginning with the appendix letter followed by the table number (e.g., table B1).

Inventory Methods

This chapter briefly describes five key aspects of the FIA program. The first four sections describe configuration of field plots, the national sample design, the three-phase inventory system, and sources of error, which are consistent among all states. The last section describes FIA's quality assurance program and presents the results of quality assessments in the current forest inventory of New Mexico.

Plot Configuration

The national FIA plot design consists of four 24-foot radius subplots configured as a central subplot and three peripheral subplots (USDA Forest Service 2011; see figure 1). Centers of the peripheral subplots are located at distances of 120 feet and at azimuths of 360 degrees, 120 degrees, and 240 degrees from the center of the central subplot. Each standing tree with a diameter at breast height (d.b.h.) for timber trees, or a diameter at root collar (d.r.c.) for woodland trees, of five inches or larger is measured on these subplots. Each subplot contains a 6.8-foot radius microplot with its center located 12 feet east of the subplot center on which each tree with a d.b.h./d.r.c. from one inch to 4.9-inches is also measured.

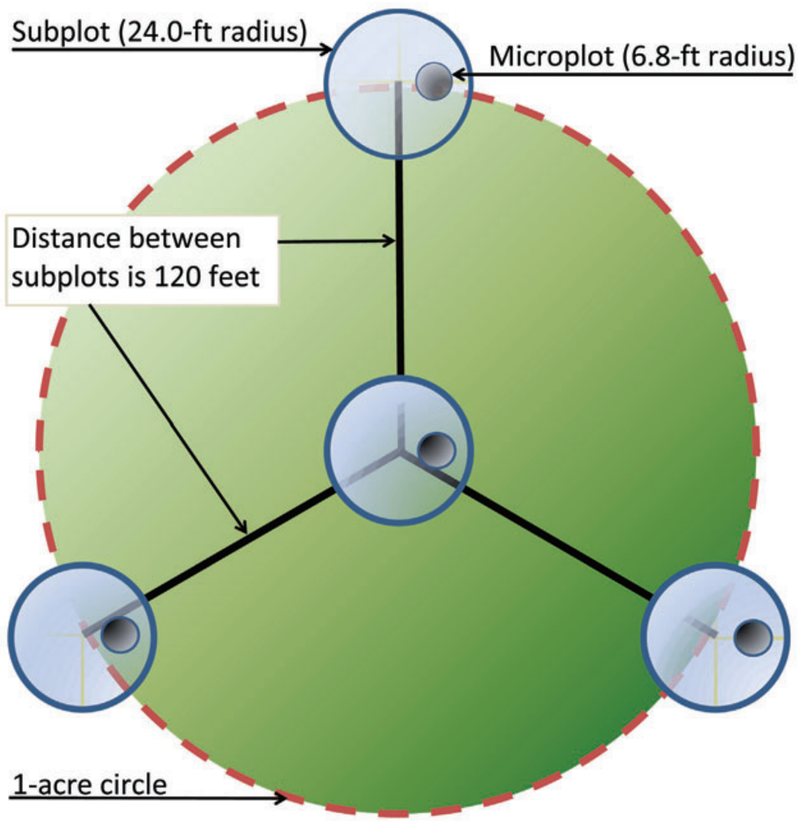


Figure 1. Plot configuration used by the Forest Inventory and Analysis program. Each plot consists of four subplots with a 24-foot radius. The three outer subplots are located 120 feet from the central subplot's center at azimuths of 0, 120, and 240 degrees. Microplots with radii of 6.8 feet are located on each subplot, and the microplot centers are located 12 feet from the subplot center at an azimuth of 90 degrees.

To enable division of the forest into various domains of interest for analysis, it is important that the tree data recorded on these plots are properly associated with stand-level data. In addition to the tree data recorded on FIA plots, data are also gathered about the condition class in which the trees are located. A condition class (or condition) is the combination of discrete landscape and forest attributes that define and describe the area associated with a plot. The six variables that define distinct condition classes are forest type, stand origin, stand size, ownership group, reserved status, and stand density (Bechtold and Patterson 2005). In some cases, the plot footprint spans two or more conditions if there is a distinct change in any of these six variables. For example, the four subplots on a plot may intersect both forest and nonforest areas, the plot may include distinct stands differentiated by forest type and/or stand size, or the plot may straddle an ownership boundary. All three of these examples would result in more than one condition per plot. Field crews assign numbers to condition classes in the order they are encountered on a plot. Each tree is assigned the number of the condition class in which it stands to enable partitioning of tree data into meaningful categories for analysis.

Sample Design

Based on historic national standards, a sampling intensity of approximately one plot per 6,000 acres is necessary to satisfy national FIA precision guidelines for area and volume. Therefore, FIA divided the area of the United States into non-overlapping, 5,937-acre hexagons and established one plot in each hexagon using procedures designed to preserve existing plot locations from previous inventories. These sample plots, designated as the Federal base sample, were divided into five spatially interpenetrating panels and ten subpanels, where each panel consists of two subpanels. In the eastern United States, two subpanels are measured each year such that the inventory cycle is on a 5-year rotation, while in the western United States, including New Mexico, one subpanel is measured each year and inventory cycles are completed on a 10-year rotation (Gillespie 1999). For estimation purposes, the measurement of each subpanel of plots can be considered an independent, equal probability sample of all lands in a State, or all plots can be combined to represent the State.

Three-Phase Inventory

FIA conducts inventories in three phases. In Phase 1, remote sensing data are digitally analyzed to stratify each State into homogeneous groups such as forest and nonforest areas. Phase 2 relates to a permanent network of ground plots, where traditional inventory variables such as forest type and tree diameter are measured. In Phase 3, additional variables associated with forest and ecosystem health are measured on a subset of Phase 2 plots. The three phases of the enhanced FIA program are discussed in the following sections.

Phase 1—Phase 1 uses remote sensing data to delineate homogeneous areas, or strata, throughout the entire State. Currently in the Interior West, only forest and nonforest strata are identified. The purpose of this delineation is to reduce the variance of FIA estimates through post-sampling stratification of field data. The initial Phase 1 strata map consisted of forest, nonforest, and census water strata (see Appendix A for definitions), which were delineated at a spatial resolution of 250 meters using a combination of 2004 MODIS satellite imagery, other geospatial datasets, and plot-based calibration data (Blackard and others 2008). Calibration data in New Mexico consisted of periodic inventory plot locations that had been classified as forest, nonforest, or census water, based on field surveys or human interpretation of aerial photographs. Due to the small amount of census water in New Mexico, the census water stratum was combined with the nonforest stratum.

In most Interior West States, post-sampling stratification is based solely on forest and nonforest strata under the assumption that any nonresponse plots occur randomly across the plot grid. Nonresponse plots are defined as plot locations that cannot be sampled by a field crew. These situations typically occur when land owners or managers do not grant permission for field crews to access plot locations on their lands, although some plots are not sampled due to hazardous conditions that may be permanent in nature, such as sheer cliffs, or temporary hazards, such as current wildfires or active logging operations. A large proportion of private land plots in New Mexico were not sampled because some landowners denied requests for permission to access plot locations on their property. Only 2.1 percent of plots on non-private lands were not sampled, while 13.9 percent of plots located on private lands were not sampled. The percentage of non-sampled plots on privately owned land in New Mexico is comparable to the percentages in some other western States, but higher than for many States in the Midwest and East. The fact that nonresponse plots occurred at higher proportions on private lands than on non-private lands required modifying the stratification scheme to reduce nonresponse bias (Patterson and others 2012). Therefore, the stratification for the New Mexico inventory was based on ownership strata (private and non-private) in addition to the forest and nonforest strata described above (figure 2). Goeking and Patterson (2013) describe the stratification process for the New Mexico forest inventory in detail.

FIA produces estimates at the scale of individual States, which can then be aggregated into regional estimates, as well as at smaller scales within each State. Within-state population estimates are constructed at two scales: survey units that are comprised of groups of counties, and smaller estimation units that represent individual counties. New Mexico consists of four survey units and 33 estimation units denoted as g, each containing n_g ground plots. The area of each estimation unit is divided into strata of known size using the State's stratification map (figure 2), which divides the total area of the estimation unit into 250-meter pixels and assigns each pixel to one of H strata. Each stratum, h, within an estimation unit, g, then contains n_{hg} ground plots where the Phase 2 attributes of interest are observed.

To illustrate, the area estimator for forest land within an estimation unit in New Mexico is defined as:

$$\hat{A}_g = A_{Tg} \sum_{h=1}^{H} w_{hg} \frac{\sum_{i=1}^{n_{hg}} Y_{ihg}}{n_{hg}}$$

where:

$\hat{A}_g$ = total forest area (acres) for estimation unit g

A_{Tg} = total land area (acres) in estimation unit g

H = number of strata

W_{hg} = proportion of Phase 1 pixels in estimation unit g that occur in stratum h

Y_{ihg} = forest land condition proportion on Phase 2 plot i stratum h in estimation unit g

n_{hg} = total number of Phase 2 plots in stratum h in estimation unit g

Phase 2—Phase 2 pertains to FIA's network of permanent plot locations, where each plot is assigned spatial coordinates and represents roughly 6,000 acres. To minimize inventory costs, plots that are obviously and entirely nonforest are not designated for field sampling, and these plots are recorded as nonforest. A human interpreter examines each plot location using digital imagery from the National Agriculture Imagery Program and distinguishes plots that potentially contain forest or wooded land from those that do not intersect any forest or wooded land.

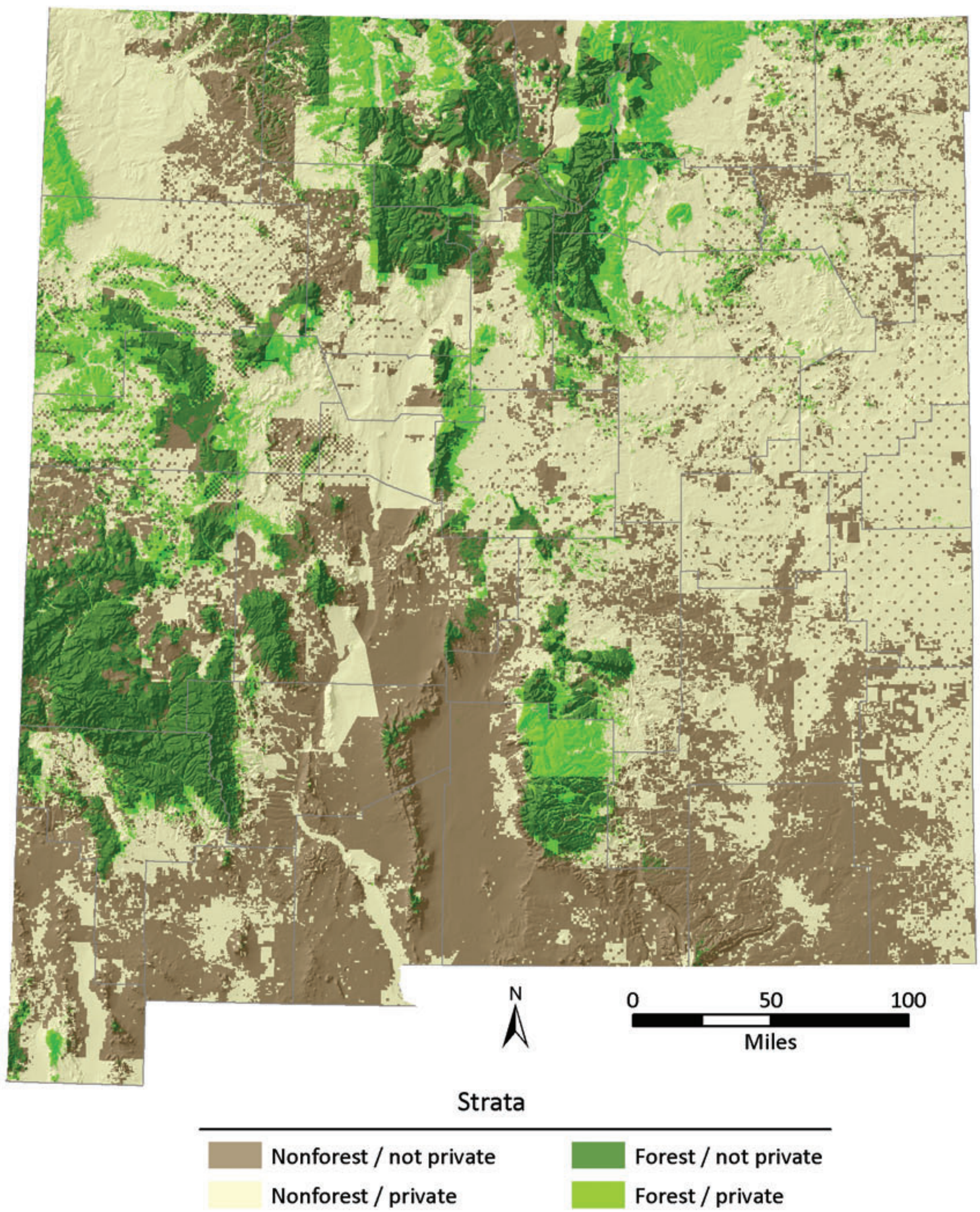


Figure 2. The four strata used for post-stratification of New Mexico's forest inventory, 2008-2012; background shows shaded relief and county boundaries.

This process is known as prefield interpretation, and it was historically considered part of Phase 1 because both prefield interpretation and Phase 1 relied on remote sensing data. However, Phase 1 delineation of forest and nonforest strata occurs independently of current prefield interpretation of the Phase 2 grid. Therefore, prefield data collection is considered part of Phase 2 and not part of Phase 1.

The status of each plot in the Phase 2 grid is eventually assigned as accessible forest land, nonforest land, or not sampled (figure 3). Plots that were not designated for field sampling by prefield interpreters are automatically recorded as nonforest plots.

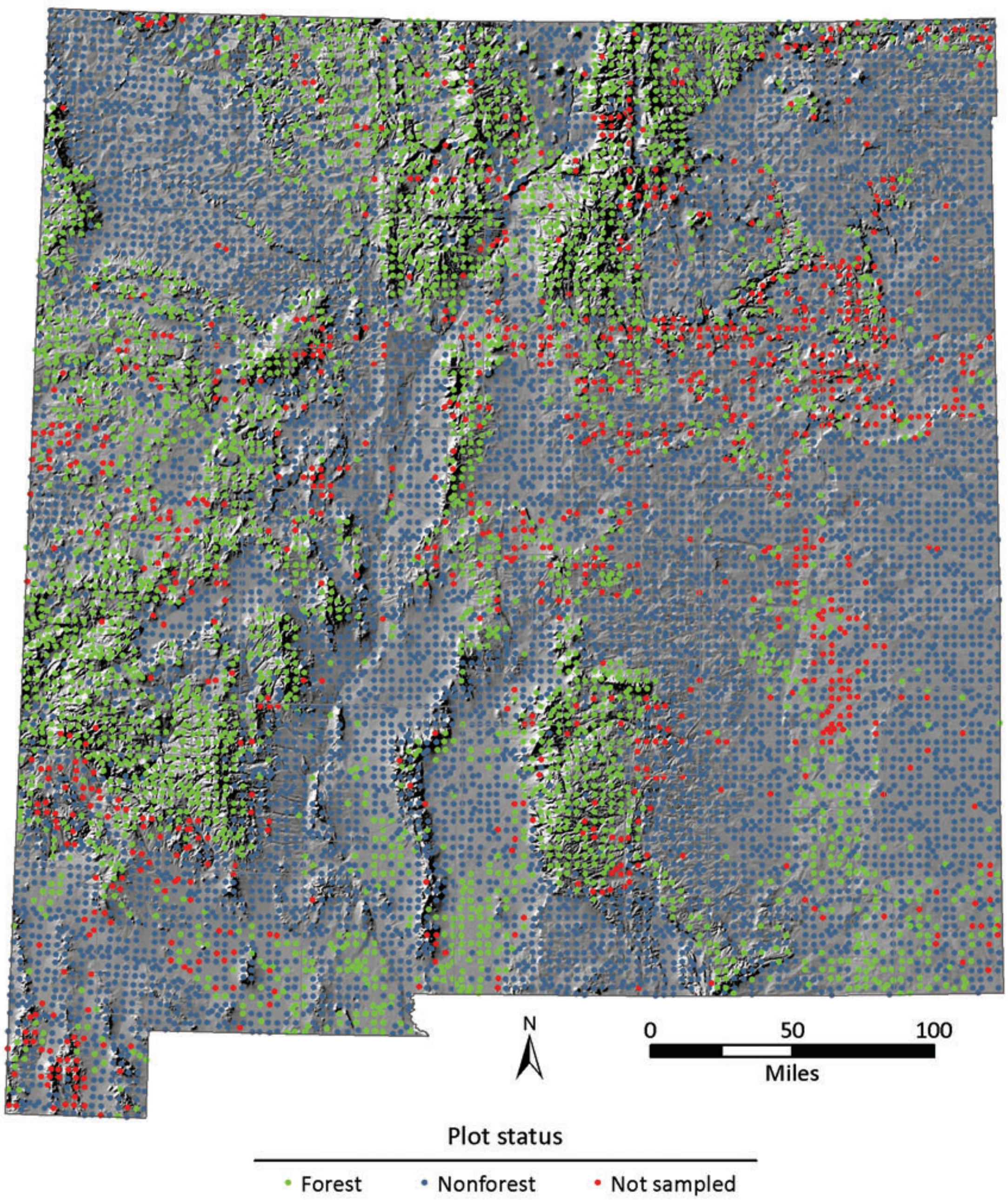


Figure 3. Plot status of the 11,792 Phase 2 plots in New Mexico's annual forest inventory, 2008-2012. (Note: plot locations are approximate; some plots on private land were randomly swapped.)

For plots that are designated for field sampling, field crews record the plot status as accessible forest land if (a) they can physically visit the plot location, and (b) the plot satisfies FIA's definition of forest land (see Appendix A). Some field plots are recorded as nonforest because the field crew determines that they do not meet FIA's definition of forest land. A field plot may be recorded as non-sampled if a field crew cannot safely measure the plot or if they cannot obtain permission to access the plot location. Before visiting privately owned plot locations, FIA crews identify each plot's ownership status by consulting county land records and then seek permission from private landowners to measure plots on their lands. Information about individual landowners and the existence of FIA plots on their property is considered confidential and is never shared outside the FIA program, regardless of whether permission to access the plot location is granted. Table B1 shows the total percentage of Phase 2 plot areas that represent forest, nonforest, and non-sampled conditions. Note that figure 3 and table B1 are the only portions of this report that include summaries of non-sampled plots; all other summaries of forest and nonforest are based on sampled plots, and estimates have been adjusted to account for missing observations at non-sampled plots as described in Goeking and Patterson (2013).

Field crews record a variety of data on plot locations that contain accessible forest land. Crews locate the geographic center of the plot using geographic positioning system (GPS) receivers and then establish markers to facilitate relocation of the plot for future remeasurement. They record condition-level variables that include land use, forest type, stand origin, stand-size class, stand age, site productivity class, forest disturbance history, silvicultural treatment, slope, aspect, and physiographic class. Some of these area attributes are measured or observed (e.g., regeneration status), some are assigned by definition (e.g., ownership group), and some are computed from tree data (e.g., percent stocking). For each tree on the plot, field crews record a variety of attributes including species, live/dead status, diameter, height, crown ratio, crown class, damage, and decay status. The field procedures used in New Mexico's forest inventory are described in detail in the FIA field guide (USDA Forest Service 2006; USDA Forest Service 2011). Data analysts apply statistical models using field measurements to calculate additional variables such as volume and biomass for individual trees, as well as volume, biomass, growth, mortality, and number of trees per unit area.

Phase 3—The third phase of the enhanced FIA program focuses on forest and ecosystem health. The Phase 3 sample consists of a 1/16 subset of the Phase 2 plots, which equates to one Phase 3 plot for approximately every 96,000 acres. Phase 3 plots include all the measurements collected on Phase 2 plots, plus an extended suite of ecological data pertaining to soil samples, down woody materials, lichen communities, tree crowns, and understory vegetation structure. Phase 3 measurements are obtained by field crews during the growing season. The entire suite of Phase 2 measurements is collected on each Phase 3 plot at the same time as the Phase 3 measurements.

Sources of Error

Sampling error—The process of sampling (selecting a random subset of a population and calculating estimates from this subset) causes estimates to contain error they would not have if every member of the population had been observed and included in the estimate. The 2008-2012 FIA inventory of New Mexico is based on a sample of 10,784 plots systematically located across the State. The total area of New Mexico is 77.8 million acres, so the sampling rate is approximately one plot for every 7,216 acres.

The statistical estimation procedures used to provide the estimates of the population totals presented in this report are described in detail in Bechtold and Patterson (2005).

Along with every estimate is an associated sampling error that is typically expressed as a percentage of the estimated value, but can also be expressed in the same units as the estimate or as a confidence interval (the estimated value plus or minus the sampling error). This sampling error is the primary measure of the reliability of an estimate. An approximate 67 percent confidence interval constructed from the sampling error can be interpreted to mean that under hypothetical repeated sampling, approximately 67 percent of the confidence intervals calculated from the individual repeat samples would include the true population parameter if it were computed from a 100-percent inventory. The sampling errors for State-level estimates are presented in table B37.

Because sampling error increases as the area or volume considered decreases, users should aggregate data categories as much as possible. Sampling errors obtained from this method are only approximations of reliability because homogeneity of variances is assumed. Users may compute statistical confidence for subdivisions of the reported data using the formula below:

$$SE_s = SE_t \frac{\sqrt{X_t}}{\sqrt{X_s}}$$

SE_s = SE_t

SE_s = sampling error for subdivision of State total.

SE_t = sampling error for State total.

X_s = sum of values for the variable of interest (area, volume, biomass, etc.) for subdivision of State total.

X_t = sum of values (area, volume, biomass, etc.) for State total.

Measurement error—Measurement errors are errors associated with the methods and instruments used to observe and record the sample attributes. On FIA plots, attributes such as the diameter and height of a tree are measured with specialized instruments; other attributes, such as species and crown class, are observed without the aid of an instrument. On a typical FIA plot, 30 to 70 trees are observed with 15 to 20 attributes recorded on each tree. In addition, many attributes that describe the plot and conditions on the plot are observed. Errors in any of these observations affect the quality of the estimates. If a measurement is biased--such as tree diameters consistently taken at a height other than 4.5 feet from the ground--then the estimates that use this observation (e.g., calculated volume) will reflect this bias. Even if measurements are unbiased, high levels of random error in the measurements will add to the total random error of the estimation process. To ensure that FIA observations meet the highest standards possible, a quality assurance program, described below, is integrated throughout all FIA data collection efforts.

Prediction error—Prediction errors are associated with using mathematical models (such as volume models) to provide information about attributes of interest based on sample attributes. Area, number of trees, volume, biomass, growth, removals, and mortality are the primary attributes of interest presented in this report. FIA estimates of area and number of trees are based on direct observations and do not involve the use of prediction models; however, estimates of volume, biomass, growth, and mortality use model-based predictions in the estimation process and are thus subject to prediction errors.

Quality Assurance

FIA employs a Quality Assurance (QA) program to ensure the quality of all collected data. The goal of the QA program is to provide a framework to assure the production of complete, accurate, and unbiased forest information of known quality. There are two primary facets of FIA's QA program: quality control and quality assessment.

FIA's quality control process operates via data quality inspectors, who assess individual field crews and then provide timely feedback to improve the crews' performance. This is accomplished by means of hot checks and cold checks. During a hot check, an inspector accompanies a field crew to a plot and provides immediate feedback on the quality of their measurements. Cold checks occur when an inspector visits a recently completed plot, typically in possession of the original crew's data but without the crew present, and then verifies each measurement and provides the crew an overall score as well as feedback on measurements that did not meet FIA specifications. Typically, the overall score for each plot must be above 90 percent. During the 2010 field season in New Mexico, plots measured by private contractors were subject to a minimum score of 85 percent; nonetheless, nearly all cold checks that year still met the higher standard of 90 percent. Hot checks were conducted for about one percent, and cold checks were completed for about 11 percent, of all field plots.

The second facet of FIA's QA program is quality assessment, which serves to assess the overall precision of field measurements by comparing two independent measurements of the same plot. Specific Measurement Quality Objectives (MQO) for precision are designed to provide a performance objective that FIA strives to achieve for every field measurement. These data quality objectives were developed from knowledge of measurement processes in forestry and forest ecology, and based on the requirements of the FIA program. MQOs for each variable consist of a compliance standard and a measurement tolerance. The practicality of these MQOs, as well as the measurement uncertainty associated with a given field measurement, can be tested by comparing data from blind check plots. Blind check data consist of paired observations where, in addition to the field measurements of the standard FIA crew, a second QA measurement of the plot is taken by a crew without knowledge of the first crew's results (Pollard and others 2006). Therefore, for many FIA variables, the data quality is measured by the repeatability of two independent measurements.

Quality assessment data for New Mexico's current inventory were collected between 2011 and 2012. The results of the QA analysis for this reporting period are presented in tables 1 and 2. Table 1 describes tolerances for condition-level variables, and table 2 describes tree-level variables. Tolerances define the acceptable range of variability between two independent observations. Each variable and its associated tolerance are followed by the percentage of total paired records that fall within one, two, three, and four times the tolerance. The last four columns show the number of times out of the total records the data fell outside the tolerance. For example, table 1 shows that there were 145 paired records for the variable "percent crown cover." At the 1X tolerance level, about 88 percent of those records fell within plus or minus 10 percent of each other. This percentage is referred to as the observed compliance rate, which can be compared to the compliance standard for each variable's MQO to determine that variable's performance.

The information in tables 1 and 2 shows variables with varying degrees of repeatability. For example, one condition-level regional variable that appears to be fairly repeatable is "forest type." At the 1X tolerance level, its observed compliance rate was 95 percent for 147 paired observations. In contrast, the compliance rate for "habitat type 1," which has no tolerance variability, was only 71 percent. This low compliance rate warrants further investigation into the potential repeatability issues associated with evaluating habitat type, which can provide insight into successional status when

Table 1. Results of quality assessment for condition-level variables, New Mexico, 2008-2012.

		Percentage of data within tolerance				Number of times data exceeded tolerance				
Variable	Tolerance	@1x	@2x	@3x	@4x	@1x	@2x	@3x	@4x	Records
National variables										
Condition status	No tolerance	100.0				0				161
Reserve status	No tolerance	100.0				0				154
Owner group	No tolerance	100.0				0				161
Forest type (type)	No tolerance	94.6				8				147
Stand-size class	No tolerance	81.6				27				147
Regeneration status	No tolerance	99.3				1				147
Tree density	No tolerance	100.0				0				147
Owner class	No tolerance	100.0				0				161
Stand age	±10 %	95.9	96.6	97.3	97.3	6	5	4	4	147
Disturbance 1	No tolerance	89.1				16				147
Disturbance 1 year	±1 yr	50.0	57.1	64.3	71.4	7	6	5	4	14
Disturbance 2	No tolerance	64.3				5				14
Disturbance 2 year	±1 yr	100.0				0				2
Disturbance 3	No tolerance	100.0				0				2
Disturbance 3 year	±1 yr									
Treatment 1	No tolerance	97.3				4				147
Treatment year 1	±1 yr	75.0	100.0			1	0			4
Treatment 2	No tolerance	100.0				0				4
Treatment year 2	±1 yr									
Treatment 3	No tolerance									
Treatment year 3	±1 yr									
Physiographic class	No tolerance	59.9				59				147
Regional variables										
Percent crown cover	±10 %	87.6	97.2	97.9	98.6	18	4	3	2	145
Percent bare ground	±10 %	84.4	93.9	95.2	98.6	23	9	7	2	147
Habitat type 1	No tolerance	71.4				42				147
Habitat type 2	No tolerance	68.0				47				147

combined with existing vegetation (such as tree numbers, size class, and species by habitat types or series). Habitat types are represented as a categorical value; it is likely that the compliance rate for habitat types would be higher if we could consider habitat type groups (or groups of types that are very similar) in our quality assurance analysis. Table 1 also demonstrates the strengths and weaknesses of condition-level variables describing forest disturbances. Up to three disturbance codes may be recorded on each condition, where the variable "disturbance 1" represents the primary disturbance, and the variables "disturbance 2" and "disturbance 3" represent increasingly less important disturbances. The variable "disturbance 1," which indicates presence/absence as well as type of disturbance, has no tolerance variability. Compliance for this variable was fairly high at 89 percent, while compliance for the variable "disturbance 1 year" was low at only 50 percent. This implies that disturbance type is a repeatable variable, but the exact year of the disturbance is repeatable only half of the time.

Table 2. Results of quality assessment for tree-level variables, New Mexico, 2008-2012.

Variable	Tolerance	Percentage of data within tolerance				Number of times data exceeded tolerance				Records
		@1x	@2x	@3x	@4x	@1x	@2x	@3x	@4x	
National variables										
D.b.h. (timber tree species)	±0.1/20 in.	92.9	97.5	98.9	99.3	124	44	19	13	1,748
D.r.c. (woodland tree species)	±0.2 in. X # stems	86.6	93.9	96.3	97.3	270	122	75	55	2,012
Azimuth	±10 º	98.8	99.7	99.8	99.8	44	13	8	8	3,760
Horizontal distance	±0.2/1.0 ft	67.7	78.6	83.1	87.1	65	43	34	26	201
Tree species	No tolerance	98.8				44				3,760
Tree status	No tolerance	99.5				17				3,760
Rotten/missing cull	±10 %	96.6	98.1	98.7	99.1	117	67	45	30	3,446
Total length	±10 %	86.0	96.7	98.9	99.6	525	124	43	16	3,760
Actual length	±10 %	85.3	96.5	98.6	99.4	553	133	51	23	3,760
Compacted crown ratio	±10 %	100.0				0				3,286
Uncompacted crown ratio (P3)	±10 %	82.3	94.0	97.4	98.8	527	179	76	35	2,972
Crown class	No tolerance	15.8				2,766				3,286
Decay class	±1 class	100.0				0				457
Mortality year	No tolerance	38.8				186				304
Condition class	No tolerance	99.1				34				3,760
Regional variables										
Mistletoe	±1 class	96.6	98.2	99.5	99.8	113	59	17	7	3,286
Number of Stems	±1 stem	95.4	97.9	99.2	99.6	93	42	16	9	2,012
Percent missing top	±10 %	97.0	97.0	97.0	97.0	103	103	103	103	3,446
Sound dead	±10 %	57.4	57.4	57.4	57.4	1,467	1,467	1,467	1,467	3,446
Form defect	±10 %	67.7	67.7	67.7	67.7	203	203	203	203	628
Current tree class	No tolerance	97.9				79				3,760
Tree age	±5 %	38.7	48.4	56.3	61.8	233	196	166	145	380
Horiz Dist-timberland	±0.2/1.0 ft	71.4	74.3	77.1	80.0	10	9	8	7	35
Horiz Dist-woodland	±0.2/1.0 ft	66.9	79.5	84.3	88.6	55	34	26	19	166

The tree measurements that have the biggest influence on estimates of forest volume are tree species, tree diameter, and tree height. As shown in table 2, the compliance rate for the variable "tree species" was almost 99 percent. The variables "d.b.h." and "d.r.c." represent the respective diameters of timber and woodland tree species (see Appendix D). For timber species, which are measured at breast height (4.5 feet above ground level), the tolerance for d.b.h. is plus or minus 0.1 inches per 20.0 inches of diameter observed. Woodland species are measured near ground level at root collar, and tolerance for d.r.c. is plus or minus 0.2 inches per stem, which allows for larger tolerances on multi-stemmed woodland trees. The 1X compliance rate for d.b.h. was 93 percent based on the 0.1-inch tolerance. The 1X compliance rate for d.r.c. was lower, at 87 percent for the 0.2-inch per stem tolerance. Tree height is represented by the variables "total length" and "actual length." Both variables have a tolerance level of 10 percent of the observed length, and compliance rates at the 1X level were about 86 percent and 85 percent, respectively.

As more blind check information becomes available, it might become apparent that a variable's MQO needs to be adjusted accordingly to better reflect the realistic expectation of quality for that variable. As a result, MQOs should be used not only to assess the reliability of FIA measurements and their ability to meet current standards, but also to identify areas of improvement of data collection protocols and training. This ongoing process can improve repeatability or even lead to elimination of variables that prove to be unrepeatable.

Overview of New Mexico's Forests

This chapter summarizes the current status of New Mexico's forests in terms of traditional forest attributes such as forest ownership, forest type, stand age, numbers of trees, volume, biomass, growth, mortality, removals, and stand density index. Nearly all attributes are based directly on FIA measurements, except where noted in individual sections.

Ecoregion Provinces of New Mexico

The multitude of factors that influence forest conditions often occur across political and ownership boundaries. Forest scientists and land managers must assess and manage for these issues regardless of such boundaries. Ecological units provide an alternative spatial framework for assessing and managing forest resources because they characterize areas of similar vegetation, climate, soils, hydrologic processes, disturbance regimes, topography, geology, and other processes such as nutrient cycling and plant community succession (Cleland and others 1997). Each ecological unit is therefore similar with regard to natural processes and probable responses to management activities (Bailey 1983). Ecoregions in the United States are hierarchically subdivided, in descending order of size, into domains, divisions, provinces, sections, and subsections. Provinces are defined largely by vegetation patterns and are therefore the most relevant units for describing forest lands.

FIA uses the modifications to Bailey (1995) of Cleland and others (2007) to assign plots to ecological provinces, sections, and subsections. New Mexico spans six ecological provinces (figure 4): (1) the Southern Rocky Mountains Steppe – Open Woodland – Coniferous Forest – Alpine Meadow; (2) the Arizona-New Mexico Mountains Semi-Desert – Open Woodland – Coniferous Forest – Alpine Meadow; (3) the Colorado Plateau Semi-Desert; (4) the Great Plains – Palouse Dry Steppe; (5) the Southwest Plateau and Plains Dry Steppe and Shrub; and (6) the Chihuahuan Semi-Desert. All six provinces contain some amount of forest land, although the composition and extent varies widely. The percentage of all plots in each province that include forest land, as well as the major forest types and tree species in each province, are described below.

The Southern Rocky Mountains Steppe – Open Woodland – Coniferous Forest – Alpine Meadow ecological province contains a higher proportion of forest inventory plots on forest land (86 percent) than any other province in New Mexico, and it is the only province where timber forest types are more abundant than woodland forest types (see Appendix C). This province occurs in the southern Rocky Mountains of northern New Mexico and is subject to a seasonal moisture regime with relatively dry winters and rainy summers, similar to adjacent lowland areas. Vegetation patterns exhibit zonation that is controlled by a combination of elevation, latitude, direction of prevailing winds, and slope exposure. The three most common forest types in this province are ponderosa pine (25 percent of forest plots), pinyon/juniper (20 percent), and Douglas-fir (14 percent). Most other plots occur in timber forest types such as white fir, Engelmann spruce, Engelmann spruce/subalpine fir, and aspen, although a small proportion occur within the oak woodlands forest type. The most abundant tree species is ponderosa pine, followed by Douglas-fir, aspen, Engelmann spruce, common pinyon, Gambel oak, and oneseed juniper.

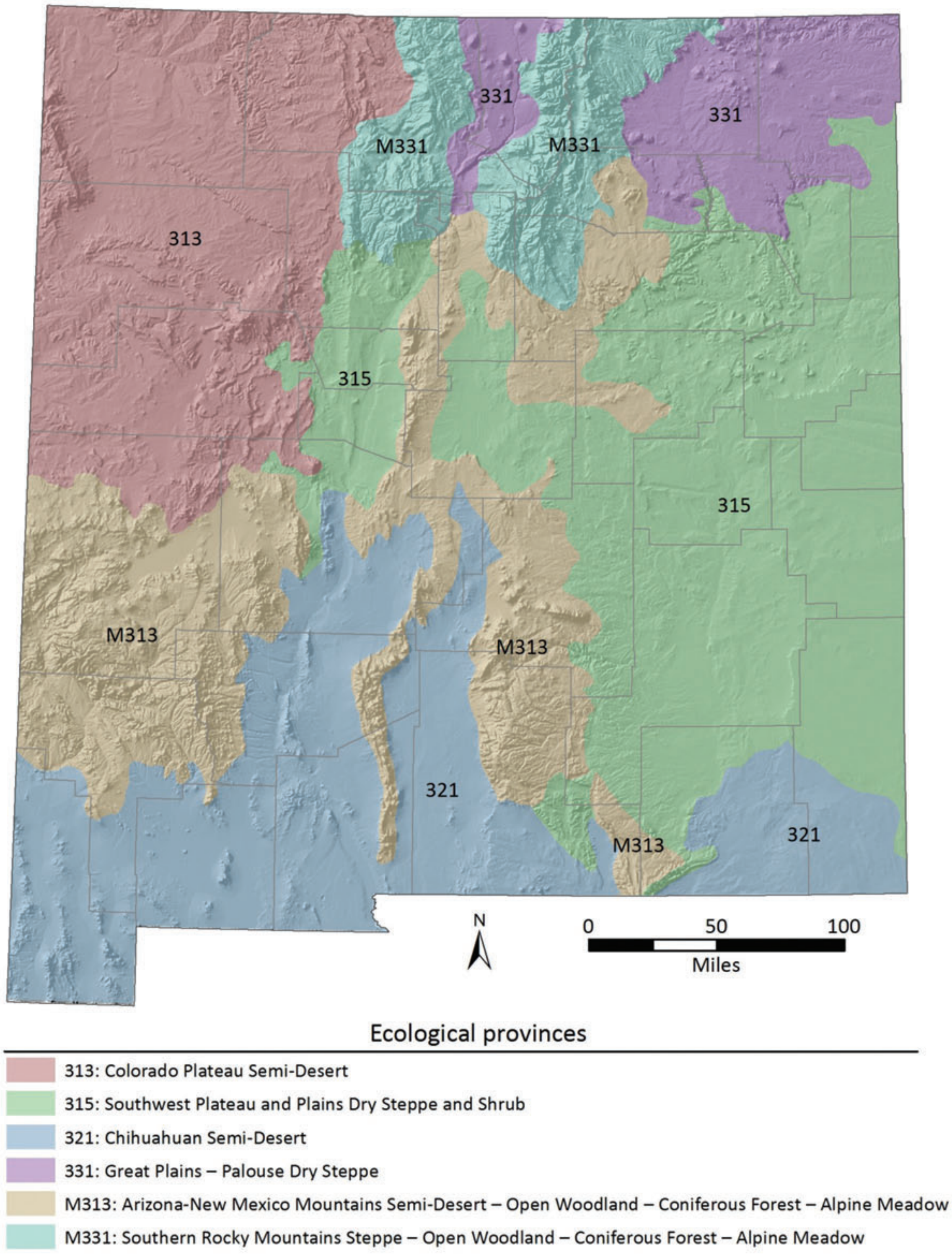


Figure 4. The six ecological provinces in New Mexico; background shows shaded relief and county boundaries.

The Arizona-New Mexico Mountains Semi-Desert – Open Woodland – Coniferous Forest – Alpine Meadow province occurs farther south in the central mountains of New Mexico and Arizona. While this province may receive snow during winter months, most of its precipitation falls during summer rains. More than half of the plots in this province are on forest land (61 percent). Common forest types are pinyon/juniper (51 percent of forest plots), ponderosa pine (18 percent), Douglas-fir (6 percent), and pure juniper woodlands (6 percent). The most abundant tree species in this province, in order of decreasing numbers of trees, are common pinyon, oneseed juniper, ponderosa pine, alligator juniper, Gambel oak, Douglas-fir, and gray oak.

The Colorado Plateau Semi-Desert province and the Great Plains – Palouse Dry Steppe province cover the lower elevations of northern New Mexico. Although these two provinces contain different proportions of forest land (43 and 17 percent of plots, respectively), they are described together here because they encompass the same types of forest vegetation. Both provinces are subject to cold winters and seasonally variable precipitation. The Colorado Plateau Semi-Desert province occurs in northwestern New Mexico as well as parts of Colorado, Utah, and Arizona, and receives most of its precipitation in winter. The Great Plains – Palouse Dry Steppe province occurs in northeastern New Mexico, east of the Southern Rocky Mountains and in their rain shadow. Within both provinces, about 62 percent of forest plots contain pinyon/juniper woodland forest types, with smaller proportions of plots occurring in ponderosa pine forest types and pure juniper woodland forest types. The pure juniper woodland forest types within the Colorado Plateau Semi-Desert province consist of mainly oneseed juniper, with some Rocky Mountain and Utah juniper. In contrast, pure juniper woodland forest types within the Great Plains – Palouse Dry Steppe province have approximately equal numbers of oneseed and Rocky Mountain juniper, but Utah juniper is absent.

The Southwest Plateau and Plains Dry Steppe and Shrub province has the lowest proportion of forested plots of any province (14 percent). This province occurs in eastern New Mexico and extends into western Texas, and is characterized by mean temperatures greater than 32 degrees Fahrenheit during every month of the year. Forest types in this province are primarily mesquite woodland (41 percent), pinyon/juniper woodland (25 percent), or pure juniper woodland comprised primarily of one-seed juniper (16 percent). Nearly all of the State's mesquite woodland forest types occur within either this province or the Chihuahuan Semi-Desert province, which spans southern New Mexico from southeastern Arizona to western Texas. Its climate is characterized by extremely high temperatures and less than 8 inches of annual precipitation. Only 21 percent of the plots in this province occur on forest land, and the vast majority of those (83 percent) fall in mesquite woodlands.

Forest Land Classification

New Mexico's forest land area totals 24.8 million acres. Unreserved forest land accounts for most of the forest land in New Mexico (94 percent) and totals 23.4 million acres. More than 18 percent, or 4.3 million acres, of New Mexico's unreserved forest land is classified as timberland and the remaining 82 percent is classified as unproductive forest land.

FIA uses a nationally consistent standard for defining different categories of forest land based on reserved status and productivity. These categories were originally developed for the purpose of separating forest land deemed suitable for timber production from forest land that was either not suitable or unavailable for timber harvesting activity, which includes woodland forest types. The first division of forest land is unreserved forest land and reserved forest land. Unreserved forest land is considered available for harvesting activity where wood volume can be removed for wood products. Reserved forest land is considered unavailable for any type of wood utilization management practice through administrative proclamation or legislation.

Both unreserved and reserved forest lands are further divided based on productivity. Unreserved forest land is subdivided into timberland and unproductive forests. Timberland is defined as unreserved forest land capable of producing 20 cubic feet of wood per acre per year of trees designated as a timber species. Unproductive forests, because of a combination of species' characteristics and site conditions, are not capable of producing 20 cubic feet of wood per acre per year of trees designated as a timber species (see Appendix A). Reserved forest land is also divided into productive and nonproductive forests. Some characteristics that contribute to productivity can be visibly obvious, such as the presence or absence of non-commercial species, rocky substrates, steep slopes, and high elevation. While these distinctions may be important for understanding reserved area management concerns (e.g., their effect on visitor experience), wood production capability on reserved forest land is useful only as a potential indicator of non-timber values.

The State of New Mexico encompasses 77.8 million acres of land area, of which 24.8 million acres (32 percent) are estimated to be forest land by FIA. Unreserved forest land accounts for 94 percent of the forest land in New Mexico and totals 23.4 million acres (table B2). Timberland constitutes more than 18 percent (4.3 million acres) of New Mexico's unreserved forest land, and the remaining 82 percent (19.1 million acres) is classified as unproductive forest land. Reserved forests account for less than 6 percent (1.4 million acres) of total forest land, with nearly equal proportions of productive and unproductive forests on reserved lands.

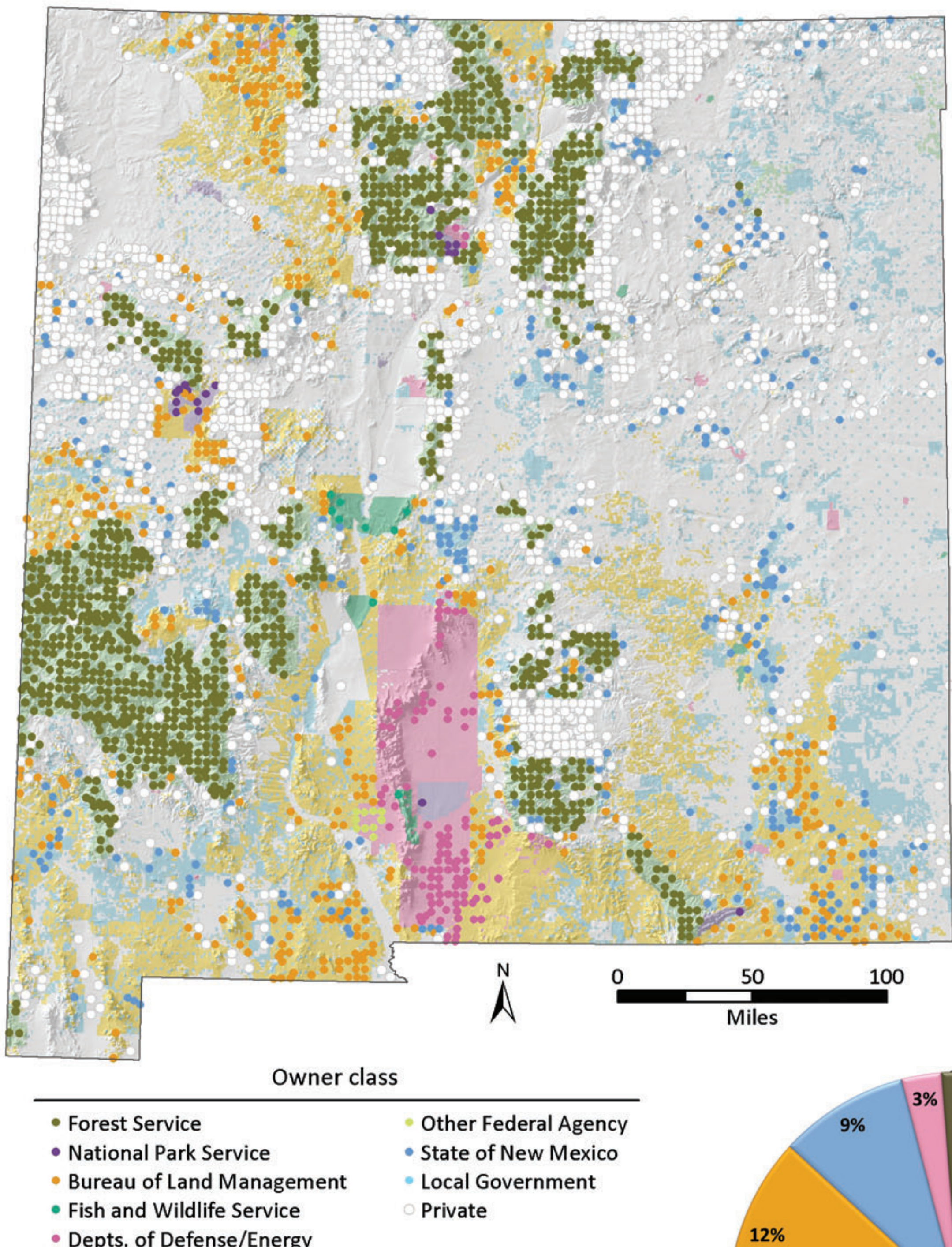
Forest Land Ownership

> Privately owned forest land totals 10.8 million acres, or 44 percent of New Mexico's total forest land area. About 31 percent of New Mexico's total forest land area, or 7.8 million acres, is administered by the USDA Forest Service.

Private landowners manage more forest land in New Mexico than any other land ownership or management group (table B2). Privately owned forest land totals 10.8 million acres, or 44 percent of the State's total forest land area (figure 5). New Mexico's diverse array of private landowners consists of private individuals/families, corporations, tribes, and non-governmental organizations such as private associations or conservation groups. Although conservation easements cover thousands of acres of private land, all private forest land is categorized as unreserved. More than 1.4 million acres, or 13 percent of all private forest land, are classified as timberland while 9.4 million acres are classified as unproductive forest land. Average annual net growth is higher overall on private lands than any other owner class (table B21).

New Mexico's second-largest manager of forest land is the USDA Forest Service's National Forest System (NFS), which manages about 7.8 million acres of forest land. This represents nearly 10 percent of New Mexico's total land area and 31 percent of its forest land area. NFS lands in New Mexico consist of five different National Forests and portions of several National Grasslands. More than 85 percent, or 6.7 million acres, of the forest land managed by NFS is classified as unreserved forest land. About 34 percent, or 2.7 million acres, of unreserved forest land managed by NFS is further classified as unreserved timberland, while the remaining 66 percent is classified as unproductive (table B2). The net volume of live trees (table B12), as well as the average annual tree mortality (table B25), is higher on NFS lands than any other owner class.

Other public agencies managing large portions of New Mexico's forest land include the Bureau of Land Management (BLM), the Departments of Defense and Energy (DOD/DOE), the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), and the State of New Mexico. The BLM manages nearly 3 million acres, or 12 percent of the State's forest land, and the DOD/DOE manages 698 thousand acres, or three percent. Another 127 thousand acres are managed by the NPS, and 59 thousand acres are managed by the FWS. The State government manages 2.3 million acres, or 9 percent, of the forest land in New Mexico. All of New Mexico's State-managed forest land is classified as unreserved, and about 128 thousand acres qualify as unreserved timberland.



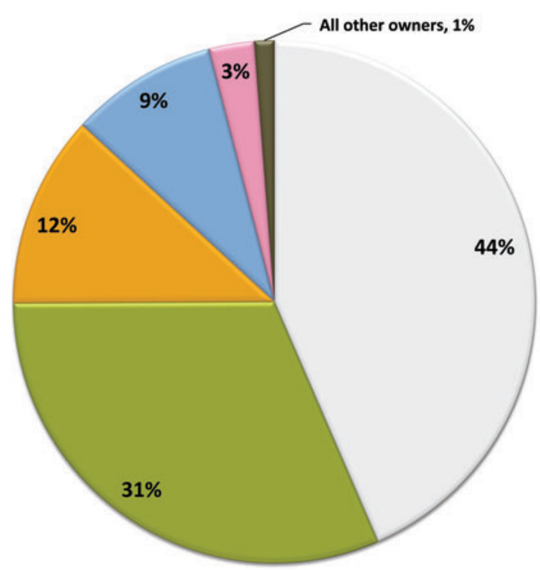


Figure 5. Distribution and percentage of inventory plots on forest land by owner class, New Mexico, 2008-2012. (Note: plot locations are approximate; some plots on private land were randomly swapped.)

Most State land is managed by the New Mexico State Land Office, although the New Mexico Department of Game and Fish and the New Mexico State Parks Division also hold substantial properties.

Forest Types and Forest Type Groups

The pinyon/juniper forest type group includes three forest types (pinyon/juniper, Rocky Mountain juniper, and pure juniper woodlands) and covers 13.6 million acres. The pinyon/juniper woodlands forest type is the most abundant forest type in New Mexico, covering over 10 million acres and accounting for 41 percent of forest land. Mesquite woodlands cover nearly 3.5 million acres and are the second most abundant forest type.

Forest type is a classification of forest land based on the species forming a plurality of living trees growing in a particular forest. Forest type names may be based on a single species or groups of species. Forest types are an important measure of diversity, structure, and successional stage. The distribution of forest types across the landscape is determined by factors such as climate, soil, elevation, aspect, and disturbance history. The loss or gain of a particular forest type over time can help assess the impact of major disturbances related to fire, weather, climate, insects, disease, and human-caused disturbances such as timber harvesting or ecosystem restoration.

Forest types are aggregated into forest type groups to simplify interpretation of large-scale forest trends. New Mexico's forests represent 11 forest type groups that are further classified into 21 distinct forest types, all of which are described in Appendix C. Some forest type groups contain only one forest type, while other forest type groups include several individual forest types. An example of a forest type group with multiple forest types is the pinyon/juniper forest type group, which consists of the Rocky Mountain juniper forest type, the pinyon/juniper forest type, and the juniper woodland forest type. The distribution of forest types as well as individual tree species may vary among ecological provinces. Figure 6 shows the area occupied by each forest type group in New Mexico. Figures 7-10 illustrate the spatial distribution of inventory plots in the most common forest type groups and the forest types within those groups.

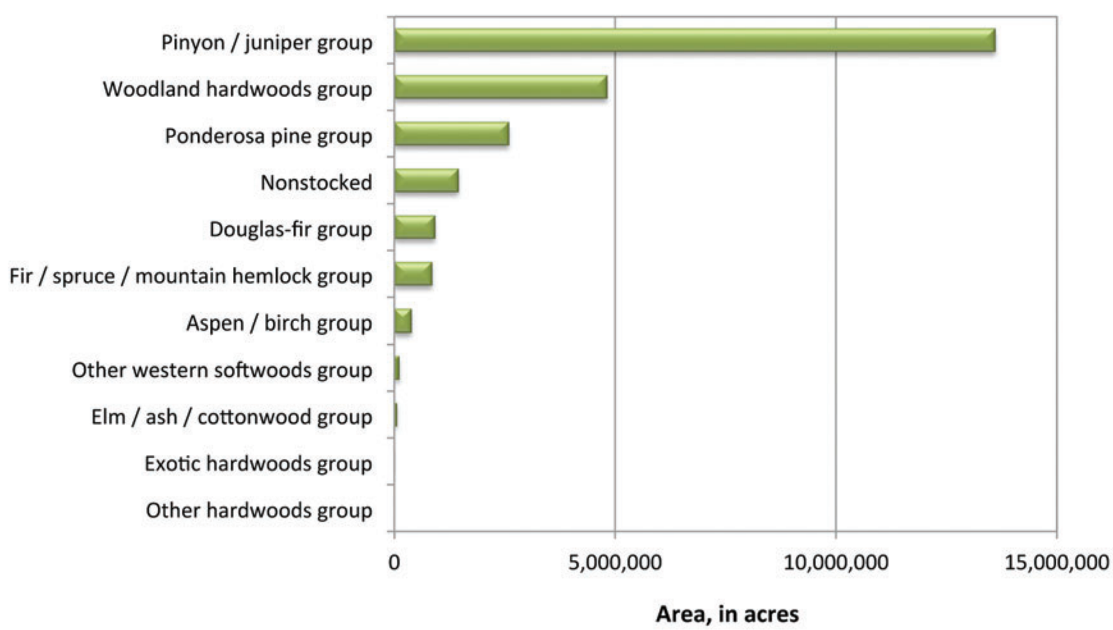


Figure 6. Area of land by forest type group, New Mexico, 2008-2012. See Appendix C for forest types and tree species included in each group.

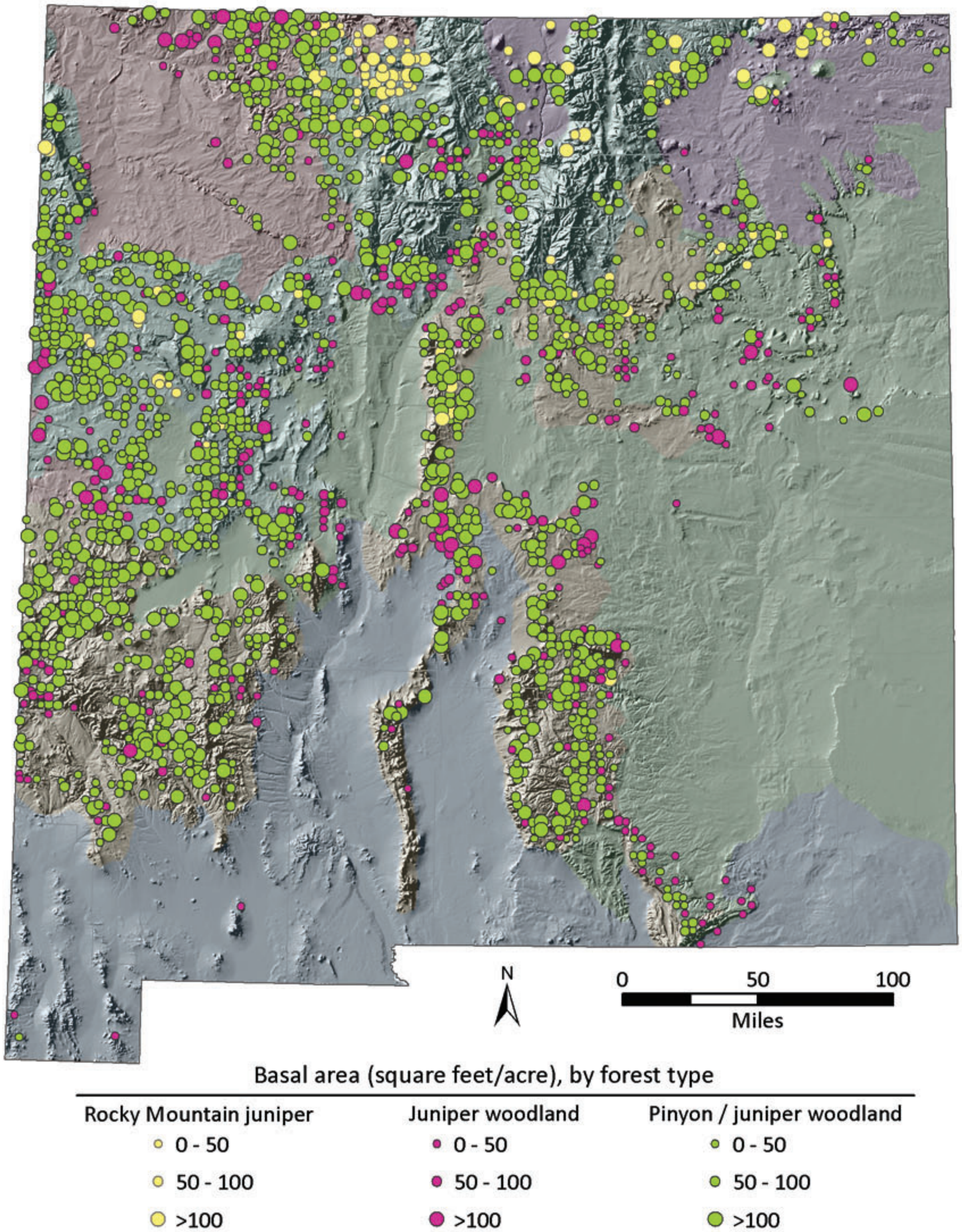


Figure 7. Distribution of inventory plots in the pinyon/juniper forest type group, by forest type and basal area class, New Mexico, 2008-2012. (Note: plot locations are approximate; some plots on private land were randomly swapped.)

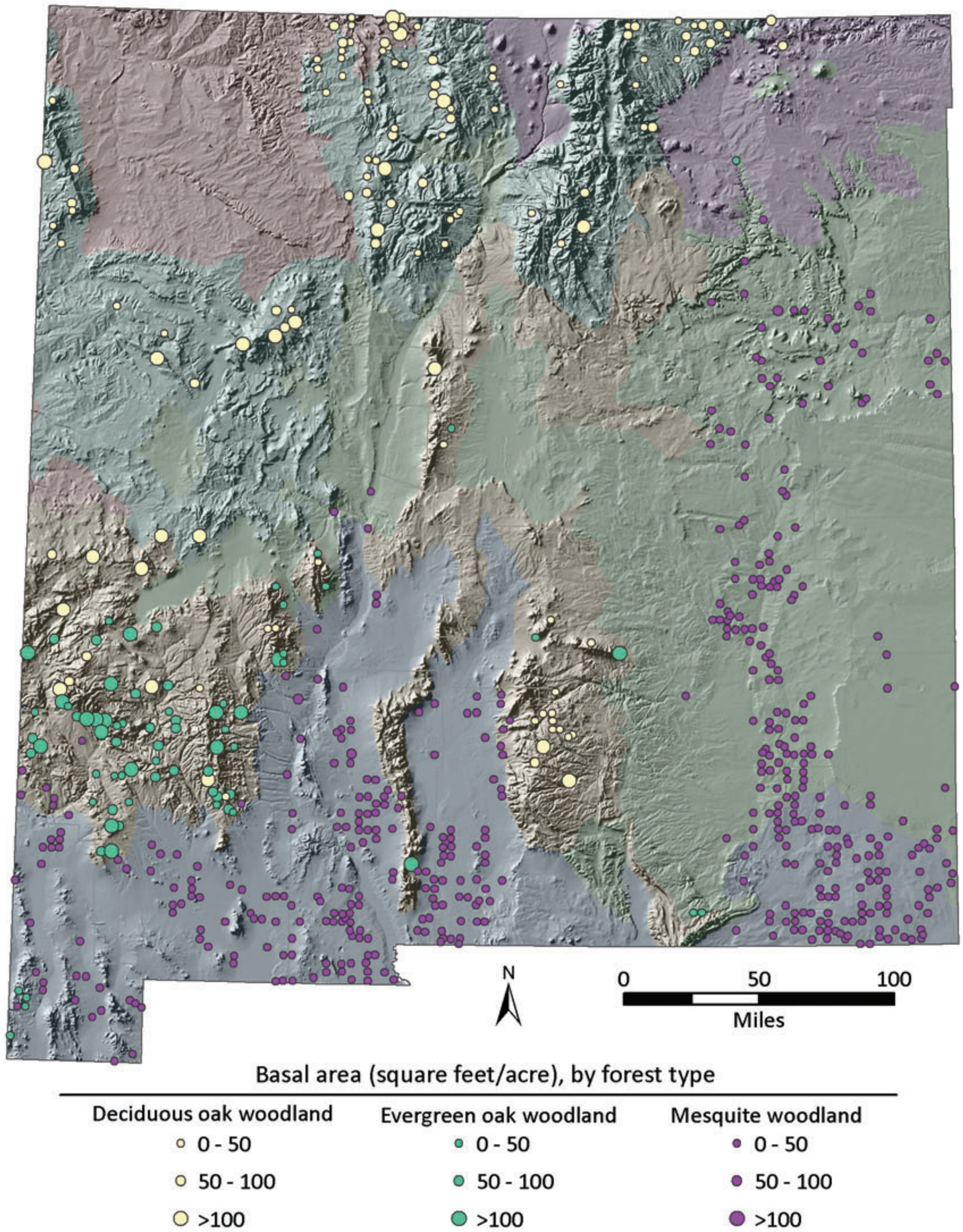


Figure 8. Distribution of inventory plots in the woodland hardwoods forest type group, by forest type and basal area class, New Mexico, 2008-2012. (Note: plot locations are approximate; some plots on private land were randomly swapped.)

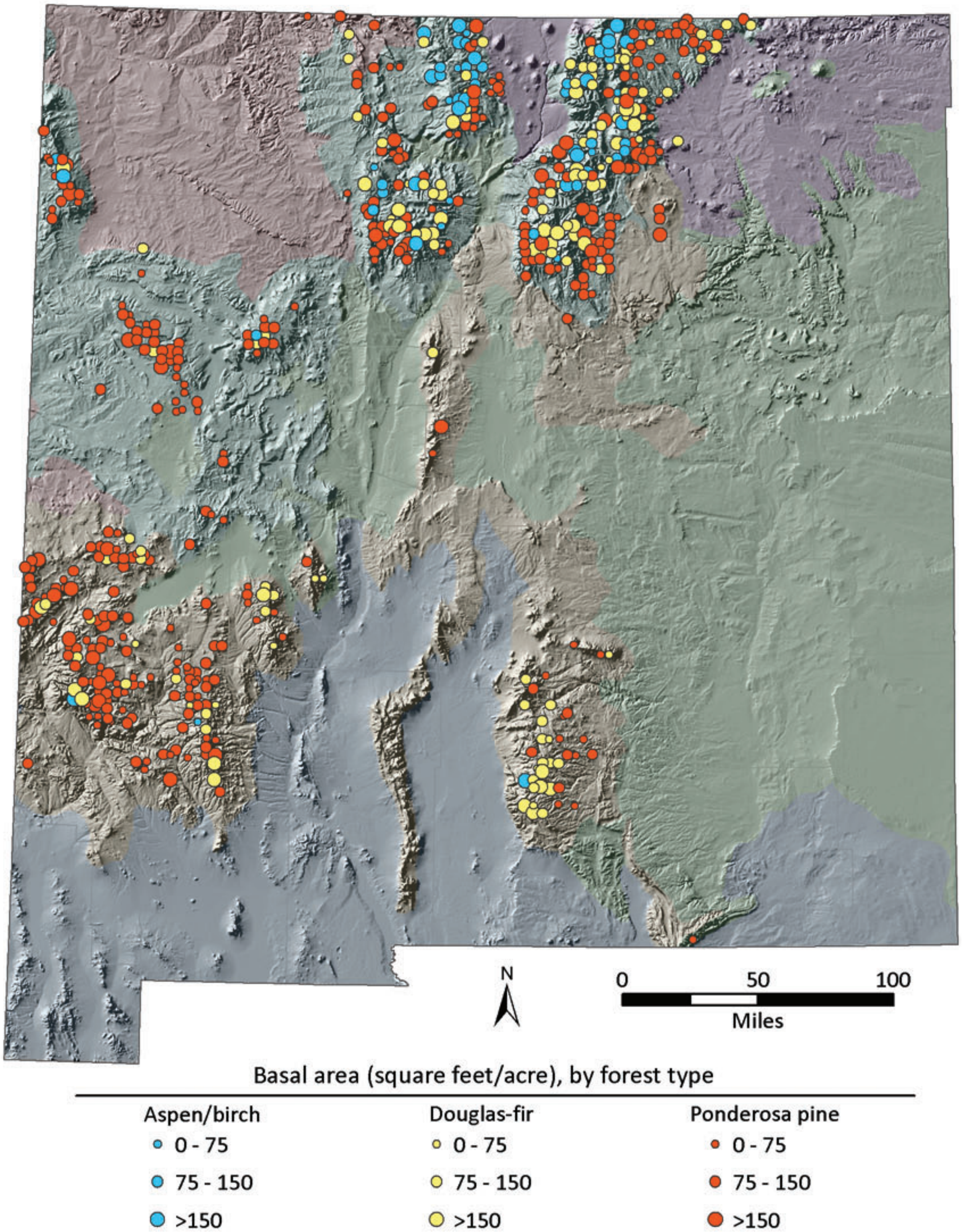


Figure 9. Distribution of inventory plots in the aspen/birch, Douglas-fir, and ponderosa pine forest type groups, by forest type and basal area class, New Mexico, 2008-2012. Each of these forest type groups contains only one forest type. (Note: plot locations are approximate; some plots on private land were randomly swapped.)

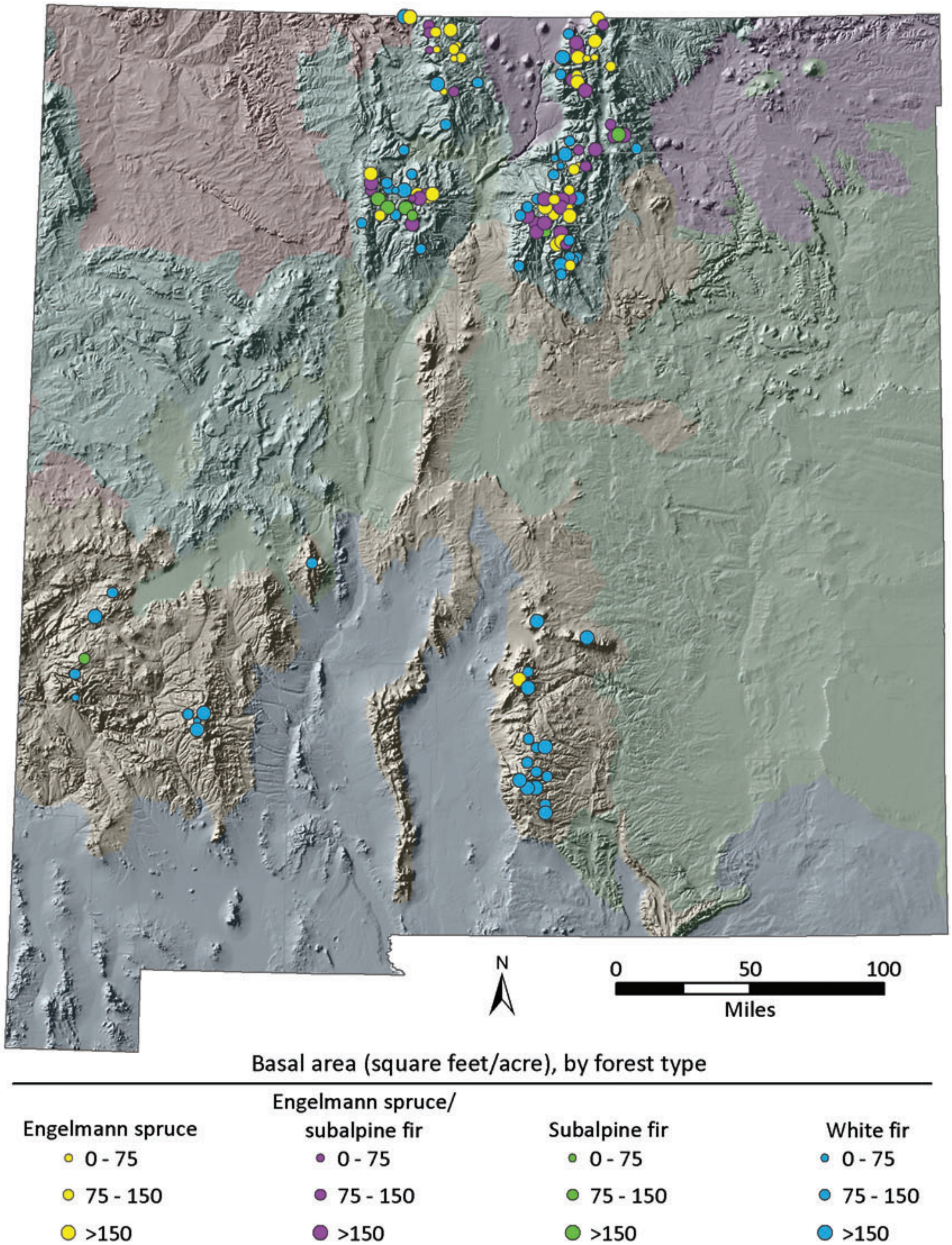


Figure 10. Distribution of inventory plots in the fir/spruce/mountain hemlock forest type group, by forest type and basal area class, New Mexico, 2008-2012. (Note: plot locations are approximate; some plots on private land were randomly swapped.)

New Mexico's most abundant forest type group is the pinyon/juniper group, which covers more than 13.6 million acres and accounts for 55 percent of forest land in the State (table B3). Within this forest type group, the pinyon/juniper forest type is most abundant (10.3 million acres), followed by the juniper woodlands forest type (2.6 million acres) and the Rocky Mountain juniper forest type (0.8 million acres). New Mexico's second most abundant forest type group is the woodland hardwoods group, which comprises 4.8 million acres and 19 percent of the State's forest land. This forest type group includes the mesquite forest type (3.5 million acres), the deciduous oak woodland forest type (0.9 million acres), and the evergreen oak woodland forest type (0.5 million acres). The ponderosa pine forest type group is New Mexico's third most abundant group, covering 2.6 million acres and more than 10 percent of the State's forest land. Next in order of areal extent are nonstocked forests (1.5 million acres), the Douglas-fir forest type group (922 thousand acres), the fir/spruce/mountain hemlock group (858 thousand acres), the aspen/birch group (388 thousand acres), and the other western softwoods group (113 thousand acres). New Mexico's forests include three other forest type groups that collectively occupy less than 100 thousand acres (table B3): the elm/ash/cottonwood, other hardwoods, and exotic hardwoods forest type groups.

Stand Age

The age structure of forest land provides insight into prospective shifts in stand structure and composition over time. On every FIA plot that samples forest land and includes suitable trees for increment core extraction, stand age is estimated based on the average age of only those trees that fall within the calculated stand-size category. For example, suppose an FIA plot sampled a softwood forest type where about 30 percent of the live trees were in the large diameter stand-size class (trees at least 9.0 inches d.b.h. and larger) and 70 percent were in the medium diameter size class (trees between 5.0 and 9.0 inches d.b.h.). The stand would be classified as a medium diameter stand-size class, and therefore only the medium size trees would be used in determining stand age.

There are limitations to collecting data for stand age computation. Repeatable measurements of increment cores are difficult to collect from certain tree species, particularly woodland species or those that may be very long-lived. Stand age may not accurately depict the age structure of uneven-aged stands, which encompass multiple age classes. Stand ages are difficult to accurately determine for stands that are predominated by small-diameter tree species such as Gambel oak trees. Stand ages are not assigned to nonstocked conditions, which are stands that contain less than 10 percent stocking of live trees because of disturbance.

Table B6 shows the area of forest land, by age class and forest type group, with 20-year intervals representing stand-age classes. Nearly half of New Mexico's forest land, or 12.1 million acres, is between 60 and 140 years of age. Stands between 80 and 100 years of age represent the largest single 20-year age class and comprise 3.7 million acres, or 15 percent of New Mexico's forest land area. Forests younger than 60 years cover 5.8 million acres, while forests older than 140 years cover 5.5 million acres. About 12 percent of New Mexico's forest land, or 2.9 million acres, is in stands less than 20 years of age; 6 percent, or 1.4 million acres, is over 200 years of age.

There is a considerable difference in stand age distribution among the major forest type groups in the State (figure 11). Four of the six most abundant forest type groups have more forest land area in the 81-100 year age class than any other class. The pinyon/juniper forest type group has the most even distribution among age classes, with 24 percent of its area younger than 80 years old, 42 percent between 80 and 140 years old, and 33 percent older than 140 years. The ponderosa pine, Douglas-fir, and fir/spruce/mountain hemlock forest type groups all have a very small proportion of forest land area that is younger than 60 years (8 percent, 2 percent, and 2 percent, respectively).

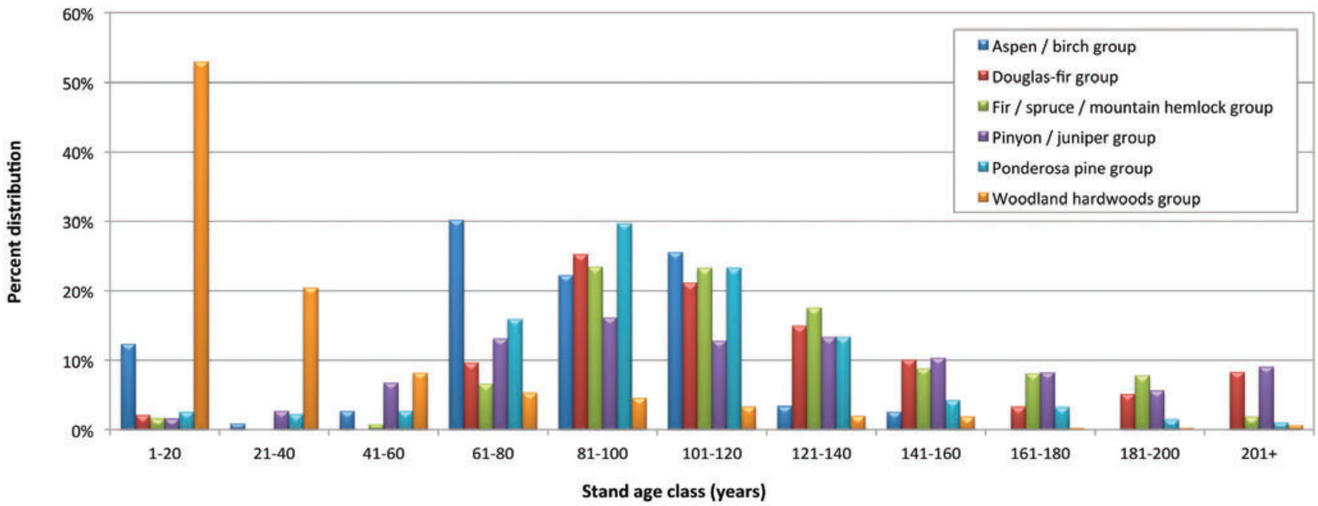


Figure 11. Distribution of forest land by stand age class for major forest type groups, New Mexico, 2008-2012.

Compared to these coniferous forest type groups, aspen forests have a slightly higher percentage of area that is younger than 60 years (16 percent). More than 12 percent of aspen forest area is less than 20 years old, less than four percent is between 20 and 60 years old, about 30 percent is between 60 and 80 years old, and almost 54 percent is older than 80 years. A very small percentage of aspen stands are older than 120 years (6 percent). Compared to other forest type groups, the woodland hardwoods group has the greatest proportion of its area in young stands: 53 percent is younger than 20 years, and another 20 percent is in the 21-40 year age class.

Numbers of Trees

There are nearly 6.7 billion live trees in New Mexico. Softwood species total more than 4.3 billion trees or 65 percent of all live trees. Numbers of Gambel oak trees total nearly 1.7 billion, making this species the single most abundant tree in New Mexico.

Estimates of the numbers of trees are beneficial to a variety of silvicultural, forest health, and habitat management applications. These estimates are typically combined with information about the size and species of the trees to provide meaningful summaries of forest dynamics and stand structure. Younger forest stands usually consist of large numbers of small-diameter trees, whereas older forest stands contain small numbers of large-diameter trees. FIA classifies individual tree species into species groups, and also categorizes each species and species group as either softwood or hardwood (Appendix D).

New Mexico contains an estimated 6.7 billion live trees 1 inch in diameter or larger (table B10) and almost 321 million dead trees 5 inches in diameter or larger. Softwood species total 4.3 billion trees or 65 percent of the State's live trees. Almost 51 percent of live softwood trees are under 5.0 inches in diameter and 6 percent are 15.0 inches and larger in diameter. The woodland softwoods species group accounts for 66 percent (2.9 billion live trees) of the softwood trees (figure 12). Oneseed juniper and common pinyon are the most abundant tree species in this group, which also includes Pinchot juniper, redberry juniper, alligator juniper, Utah juniper, Rocky Mountain juniper, Mexican pinyon, and Arizona pinyon. The second most abundant softwood group is the ponderosa and Jeffrey pine group with 606 million trees, all of which are ponderosa pines. Third and fourth in abundance are, respectively, the Douglas-fir species group with 334 million trees and the true fir species group with 275 million trees. The true fir species group consists of white fir, corkbark fir, and a small number of subalpine fir.

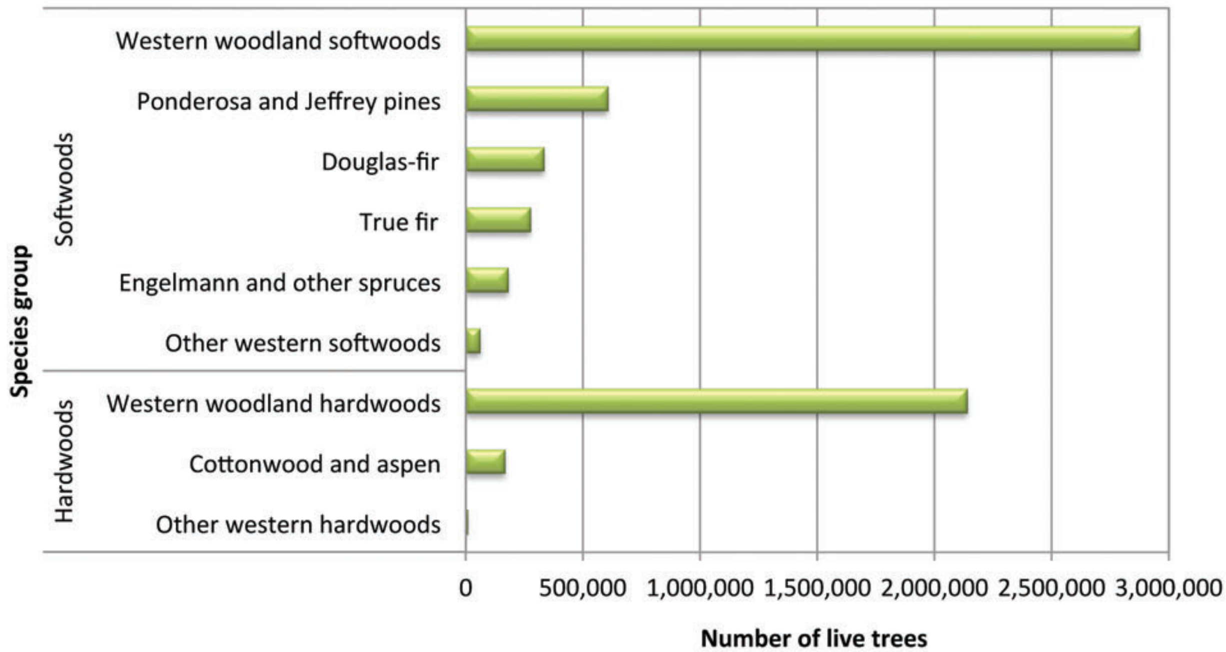


Figure 12. Number of live trees 1.0 inch diameter and larger on forest land, by species group, New Mexico, 2008-2012. (Note that the number of live trees in the "Other western hardwoods" species group is too small to appear on this graph.)

Hardwood species account for 2.3 million trees, or 35 percent of New Mexico's live trees. The woodland hardwoods species group comprises the majority (92 percent) of the hardwood species occurring in New Mexico. The hardwood species group also includes Gambel oak (which constitutes about two-thirds of the trees in this group), bigtooth maple, honey mesquite, velvet mesquite, Arizona white oak, Emory oak, Mexican blue oak, silverleaf oak, gray oak, and netleaf oak. The second most abundant hardwood group is the cottonwood and aspen species group, which consists of 162 million quaking aspen and much smaller numbers of Fremont cottonwood and narrowleaf cottonwood. Most aspen trees in New Mexico are concentrated in the smaller diameter classes. Forty-seven percent of all live aspen stems are less than 5 inches in diameter, and more than half of these are smaller than 3 inches.

Figure 13 shows the number of live trees by diameter class for seven species groups in New Mexico. The pattern of many smaller trees compared to larger ones is expected for most species, but it also illustrates the different life histories of various species groups. For example, 89 percent of the trees in the woodland hardwoods species group, which includes several species of oak and mesquite, occur in the small diameter classes (less than 5" diameter). In contrast, all other species groups have between 40 percent (ponderosa pine) and 63 percent (true firs) in these small diameter classes. Twenty-one percent of ponderosa pines are 11 inches diameter or larger, while only 16 percent of Douglas-firs and 15 percent of Engelmann and other spruces are that large.

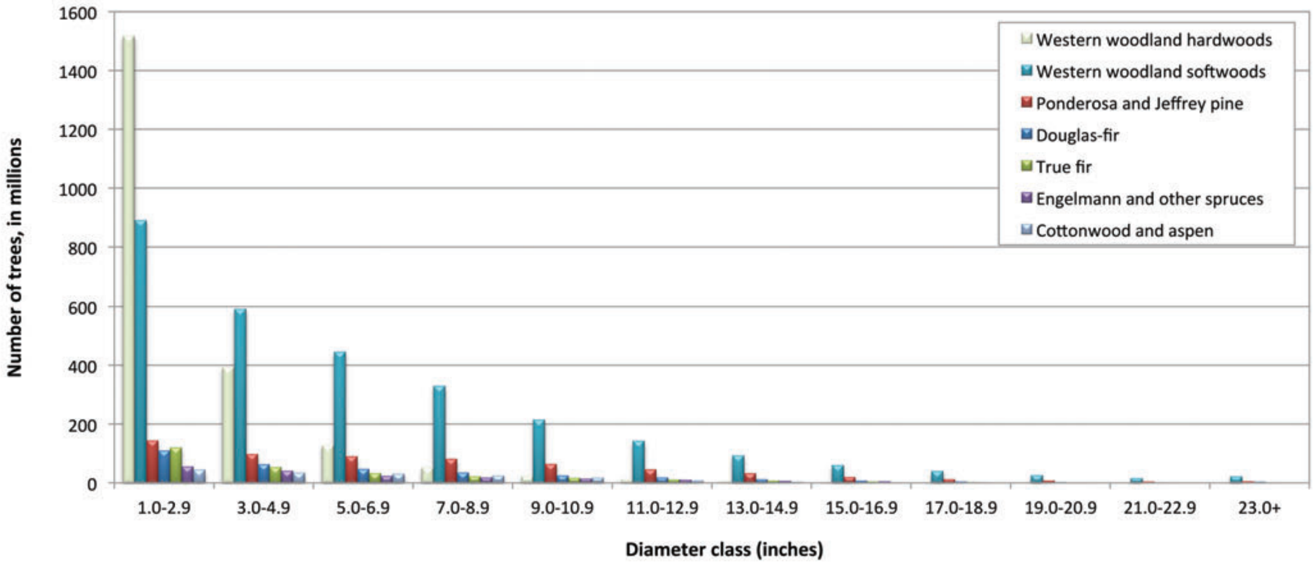


Figure 13. Number of live trees on forest land, by species group and diameter class, New Mexico, 2008-2012.

Tree Volume and Biomass

The net volume of live trees in New Mexico on forest land totals 17.5 billion cubic feet.

The amount of cubic-foot volume of wood in a forest is important for determining the sustainability of current and future wood utilization. The forest products industry and forest managers are interested in knowing the tree species composition and size distribution, as well as the geographic location and ownership status, of available wood volume. Estimates of gross and net volume include only the merchantable portion or sawlog portion (e.g., cubic-foot or board-foot) of live trees 1.0-inch in diameter and larger. Net volume is computed by deducting rotten, missing, or form defects from gross volume. Net volume is reported below as net volume of all live trees, net volume of growing-stock trees, net volume of sawtimber, and net volume of sawlogs. All of these terms are defined below as well as in Appendix A. Tree biomass estimates are based on gross volumes and describe aboveground tree weight (oven-dry) by various components (merchantable bole and bark, tops and limbs, saplings). This method of estimating tree biomass is referred to as the component ratio method, and is described by Woudenberg and others (2010, Appendix J). Note that FIA's biomass estimates are produced in units of oven-dry weight; estimates of bone-dry weight can be calculated using the following conversion: one bone-dry unit equals 2,400 pounds of oven-dry wood (Morgan and others 2006).

Tables B12 through B16 show the net volume of all live trees 5.0 inches diameter and larger on New Mexico's forest land, by various categories. The net volume of all live trees on New Mexico's forest land totals 17.5 billion cubic feet (table B12). More than 56 percent of the live volume, or 9.8 billion cubic feet, is located on lands managed by the National Forest System (NFS). About 21 percent of the NFS-managed volume exists on reserved lands and is unavailable for harvest. Privately owned forests contain 35 percent of the State's total live volume, or 6.1 billion cubic feet. Five percent, or 0.9 billion cubic feet, exists on lands managed by various Federal agencies other than the National Forest System. The remainder, about 0.8 billion cubic feet, is on lands managed by State and local government. Among all owner classes, unreserved forests include approximately equal volumes on timberland and unproductive forest land. The total live volume on unreserved timberland is 7.7 billion cubic feet.

Live tree volume can also be reported by forest type group and tree species group. The pinyon/juniper forest type group contains more live tree volume than any other forest type group (table B13). Similarly, the woodland softwoods species group, which includes all of New Mexico's pinyon and juniper species, contains more live tree volume than any other species group (tables B14 and B15). The woodland softwoods include 38 percent of the State's live tree volume and 35 percent of the standing dead volume (figure 14). Pinyon and juniper species are not considered to be timber species, so they are not included in the estimates of growing-stock volume and sawtimber volume that are presented below and in tables B17-B20. When the volumes of individual tree species are compared, ponderosa pine has more volume than any other species with 4.6 billion cubic feet statewide.

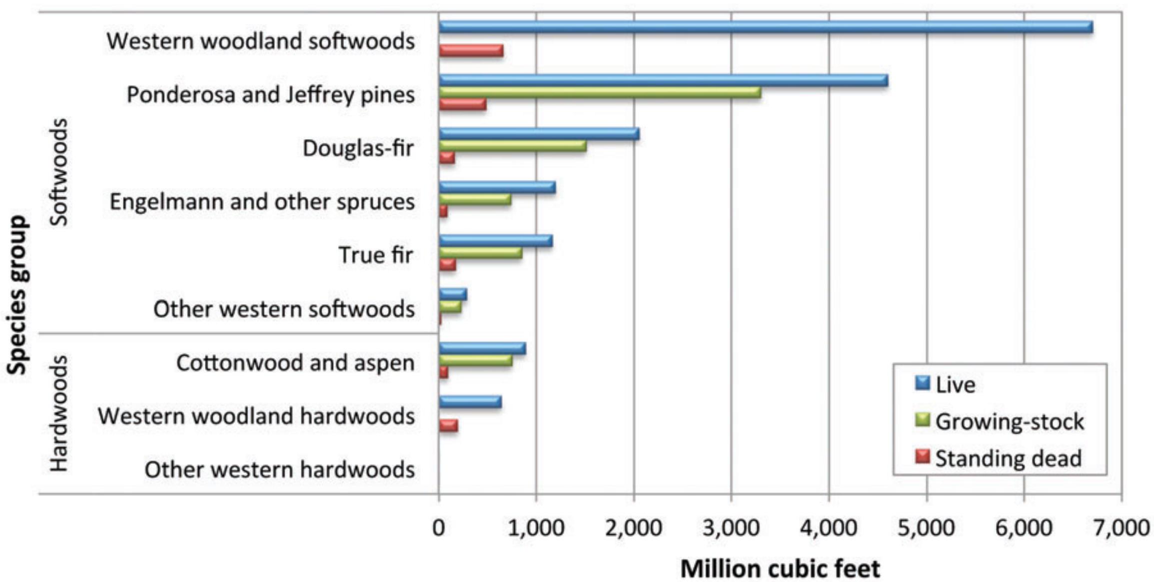


Figure 14. Net cubic-foot volume of trees 5.0 inches diameter or larger on forest land, by species group, New Mexico, 2008-2012. (Note that the volume of trees in the "Other western hardwoods" species group is too small to appear on this graph.)

> Growing-stock volume on timberland in New Mexico totals 7.4 billion cubic feet, or 42 percent of the total live volume on forest land. Most of this volume occurs on National Forest System lands (67 percent), with 29 percent on private lands and 3 percent on State lands. The net volume of sawtimber trees on timberland is more than 32 billion board feet.

The availability of timber volume for harvest is affected by three primary factors: reserved status, productivity, and merchantability. Timberland is defined as unreserved forest land capable of producing in excess of 20 cubic feet per acre per year of wood at culmination of mean annual increment. Merchantability refers to growing-stock trees, which are at least 5 inches in diameter and contain, or have the potential to produce, an 8-foot sawlog that is reasonably free of defects. Therefore, growing-stock volume on timberland represents the amount of timber that is potentially available for harvest. The net volume of growing-stock trees on timberland in New Mexico totals 7.4 billion cubic feet (table B17), or 42 percent of the total live volume on forest land.

The distribution of growing-stock volume varies by species or species group and also by owner class (table B18). Across all owner classes, nearly two-thirds of the State's growing-stock volume is composed of two species: ponderosa pine and Douglas-fir (figure 14). Ponderosa pine constitutes 45 percent of New Mexico's growing-stock volume, or 3.3 billion cubic feet, and Douglas-fir contains 20 percent, or 1.5 billion cubic feet (table B18). The true fir species group makes up 12 percent (851 million cubic feet) of the State's growing stock; Engelmann and other spruces represent roughly 10 percent, and the cottonwood and aspen species group represents another 10 percent. The remaining 3 percent consists of the other western softwoods species group, which consists primarily of pinyon pine and various juniper species. National Forest System lands include 5 billion cubic feet, or 67 percent of the State's growing stock. Almost 2.2 billion cubic feet, or 29 percent of the total growing stock, occur on privately owned lands. State-managed lands contain 215 million cubic feet of growing stock, or 3 percent of the State's total. Live volume is also reported for sawtimber trees, which are defined as softwood trees 9.0 inches in diameter or larger, or hardwood trees 11.0 inches in diameter or larger (International ¼-inch rule). The net volume of sawtimber trees on timberland totals 32.3 billion board feet (table B19).

The above-ground weight for all trees on New Mexico forest land is 318 million tons of oven-dry biomass.

The total weight of oven-dry above-ground biomass on New Mexico's forest land is 318 million tons, 66 percent (209 million tons) of which exists on public lands (table B29). Although biomass is typically sold by green weight, the water content of wood is highly variable geographically, seasonally, and even across portions of a single tree. Therefore, live-tree inventory estimates of green biomass may be unreliable or even misleading. In contrast, oven-dry weight does not change due to fluctuations in tree water content.

Volume and biomass can also be expressed in terms of the amount per acre. Table 3 shows live tree volume (in cubic feet per acre) and biomass (in tons per acre) by forest type. The estimates for each forest type include all of the different species that occur within that forest type. Because estimates for forest types with small samples may not be representative, only forest types sampled on at least 20 plots are included in this discussion. The Engelmann spruce/subalpine fir forest type has the highest per-acre net volume of live trees 5.0 inches diameter and larger, with 3,199 cubic feet per acre, and also has the highest biomass of live trees 1.0 inches diameter and larger with 52.5 dry tons per acre. Not surprisingly, the forest types with the six largest net volumes and biomasses are all timber types. The woodland forest type with the highest per-acre net volume is the Rocky Mountain juniper forest type, with 724 cubic feet. Deciduous oak woodlands contain more biomass per acre (13.2 dry tons per acre) than other woodland forest types.

Table 3. Net volume (cubic feet per acre) of live trees 5.0 inches diameter and larger, and biomass (tons per acre) of live trees 1.0 inches diameter and larger, averaged by common forest types, New Mexico, 2008-2012.

Forest type	Number of plots	Net volume	Biomass
Engelmann spruce/subalpine fir	31	3,199	52.5
Engelmann spruce	38	2,691	42.4
White fir	54	2,235	41.0
Douglas-fir	136	2,128	42.2
Aspen	59	1,905	35.7
Ponderosa pine	380	1,490	28.1
Rocky Mountain juniper	109	724	13.2
Deciduous oak woodland	119	593	15.6
Pinyon/juniper woodland	1,388	555	9.3
Evergreen oak woodland	67	460	9.6
Juniper woodland	348	268	4.2
Nonstocked	150	45	0.9
Mesquite woodland	303	23	1.1

Forest Change Components: Growth, Mortality, and Removals

Forest vigor, sustainability, and timber supply are often assessed by what are referred to as forest change components: growth, mortality, and removals. The relationship among these three change components quantifies the change in tree volume over time. Growth is typically expressed as net annual growth and is defined as the gross, or total, average annual growth in tree volume minus the volume lost through mortality. Mortality is the average annual net volume of trees dying over a given time period due to natural causes and excludes the volume removed through harvesting. Tree mortality often occurs at low and predictable rates due to insects and disease, suppression by overstory trees, or advanced tree age. Occasionally, highly concentrated and localized losses occur due to insect and disease epidemics, wildfire, or severe weather events. Removals represent the net volume of growing-stock trees removed from the inventory by harvesting or other cultural operations (such as timber-stand improvement), by land clearing, or by changes in land use (such as designation as Wilderness or other reserved status).

The three components of forest change – growth, mortality, and removals – are typically analyzed using measurements of the same plot at two points in time. It is possible, however, to also estimate growth and mortality rates based on a single inventory, as described below. In contrast, removals cannot be reliably estimated without having two measurements of the same set of plots, and the New Mexico inventory will not begin remeasurement until 2015. Therefore recent removals can only be estimated using information about the amount of wood cut and processed by the forest products industry. Due to this difference in analysis methods, growth and mortality are analyzed and discussed separately from removals.

Gross annual growth of all live trees 5.0 inches diameter and larger on New Mexico forest land totaled 211.5 million cubic feet. Net growth totaled about 46.4 million cubic feet. Average annual mortality of tree 5.0 inches diameter and larger totaled about 165.1 million cubic feet. The leading causes of mortality were insects (35 percent of all mortality), fire (22 percent), and diseases (13 percent). Mortality exceeded gross growth for 4 of the 8 tree species with the greatest volume in New Mexico, including Douglas-fir, Engelmann spruce, white fir, and aspen.

Growth and mortality—In New Mexico, the procedures used to estimate tree growth and mortality depended on the remeasurement status of the plot. A remeasured or paired plot refers to a plot where a periodic inventory plot was established in the previous inventory (time 1), and the field crews were able to relocate the plot during the current inventory (time 2) and account for all trees previously measured. In most cases, the previous and current plots are co-located. About 10 percent of all plots that sample forest land in New Mexico were remeasured, so the same trees were measured at two points in time. For trees that were alive at time 1 and time 2, growth is calculated based on the change in volume over the time interval between plot visits. The time interval between remeasured plot visits in New Mexico varied between 8 and 16 years with an average interval of about 13 years. Mortality volume is based upon the volume of any tree that qualifies as a mortality tree over the time interval between plot visits. A tree is classified as mortality if it was alive at time 1 but dead at time 2. A new plot is a plot established for the first time where there was no previous co-located plot to be remeasured. On new plots, annual growth is estimated from a sample of increment core measurements based on the previous 10 years of radial growth. Mortality is estimated from trees that died in the 10 years prior to the year of measurement.

The annual estimate of gross growth of all live trees 5.0 inches diameter and greater on forest land in New Mexico totaled nearly 211.5 million cubic feet. This is the sum of growth on all survivor and ingrowth trees. Survivor trees are live trees 5.0 inches and larger in diameter at time 1 and still alive at time 2 on remeasured plots, and live trees determined to be 5.0 inches and larger in diameter 10 years prior to the current measurement on new plots. Ingrowth trees are live trees 5.0 inches and larger in diameter that grew over the 5.0-inch threshold between time 1 and time 2 on remeasured plots or during the previous 10 years on new plots. The average annual mortality of trees 5.0 inches and larger in diameter was 165.1 million cubic feet (table B25). The difference between the live tree growth and mortality indicates a net annual growth estimate of 46.4 million cubic feet on forest land in New Mexico (see tables B21-B24).

The 46.4 million cubic feet of net annual growth in New Mexico signifies an inventory of live trees that is increasing annually in the absence of trees removed from human-caused activities. The annual increase is relatively small; net annual growth as a percentage of net volume of all live trees 5.0 inches and larger in diameter averages only 0.26 percent per year. High levels of tree mortality are offsetting gains from live tree growth. In figure 15, the map of net annual growth at individual plots shows that plots with large values of net growth, whether positive or negative, are dispersed throughout the State. Some plots with large negative net annual growth are clustered, representing areas affected by major disturbances such as fires.

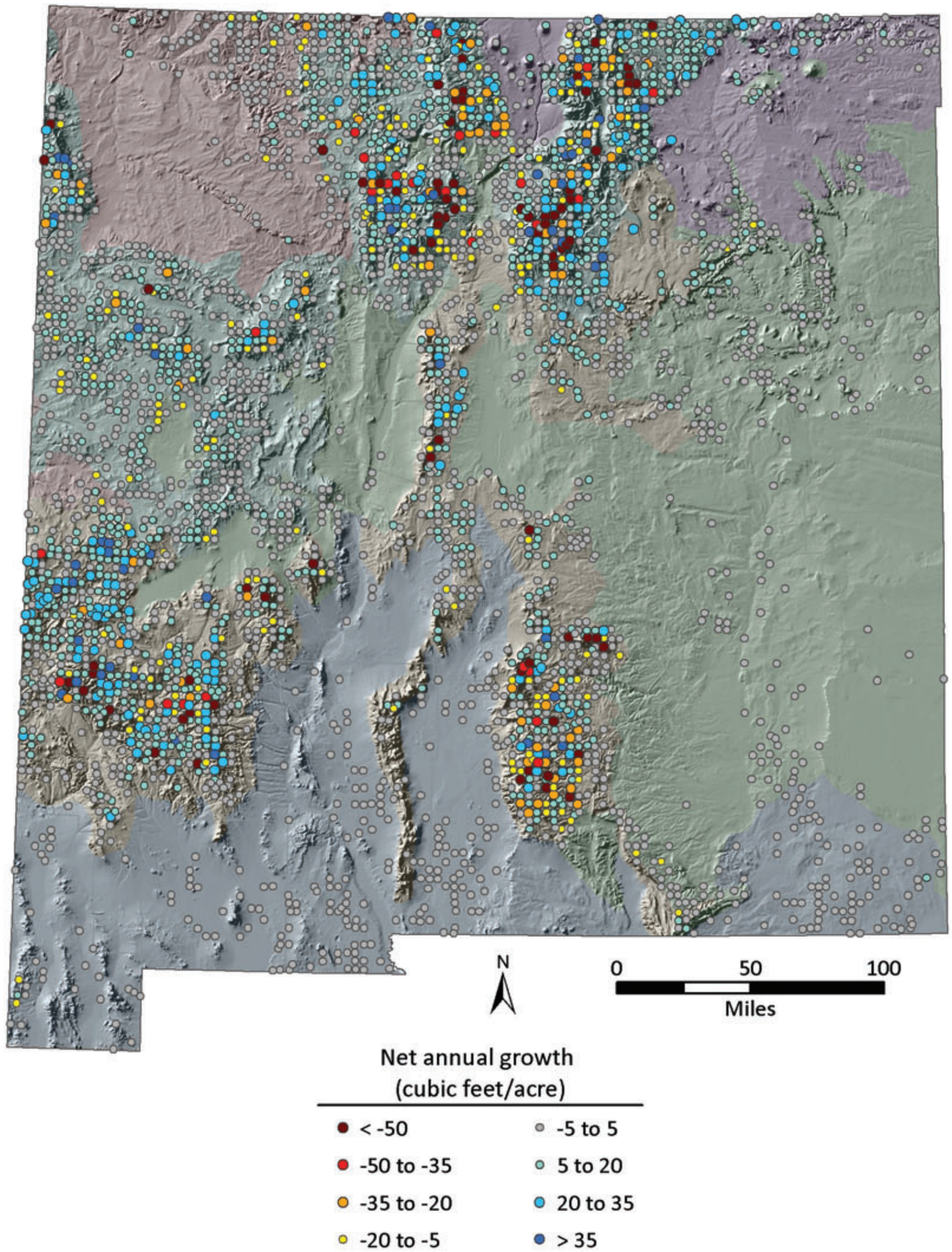


Figure 15. Net annual growth at inventory plots on forest land, New Mexico, 2008-2012. Negative values indicate plots where mortality exceeded gross growth. (Note: plot locations are approximate; some plots on private land were randomly swapped.)

Net growth varies considerably by major owner group. Figure 16 illustrates the relationship between net growth and mortality by owner group in New Mexico. Mortality of all trees on forest lands managed by National Forest Systems totaled 122.4 million cubic feet (table B25) compared to –6.7 million cubic feet of net annual growth (table B21). In contrast, net annual growth exceeded mortality on privately owned forests; net growth totaled 44.1 million cubic feet compared to 34.6 million cubic feet of mortality.

Figure 17 illustrates the relationship between net growth and mortality for the eight major inventory species—those with the greatest total volume—in New Mexico. With the exception of the two juniper species, annual mortality exceeded growth for all other major species. Douglas-fir, Engelmann spruce, and quaking aspen recorded negative net growth. Annual mortality of ponderosa pine totaled 35.2 million cubic feet compared to 23.4 million cubic feet of net growth. Annual mortality of common pinyon totaled 30.5 million cubic feet compared to 12.6 million cubic feet of net growth. Oneseed juniper recorded the most positive ratio of growth to mortality where 18 million cubic feet of net growth exceeded mortality nine fold.

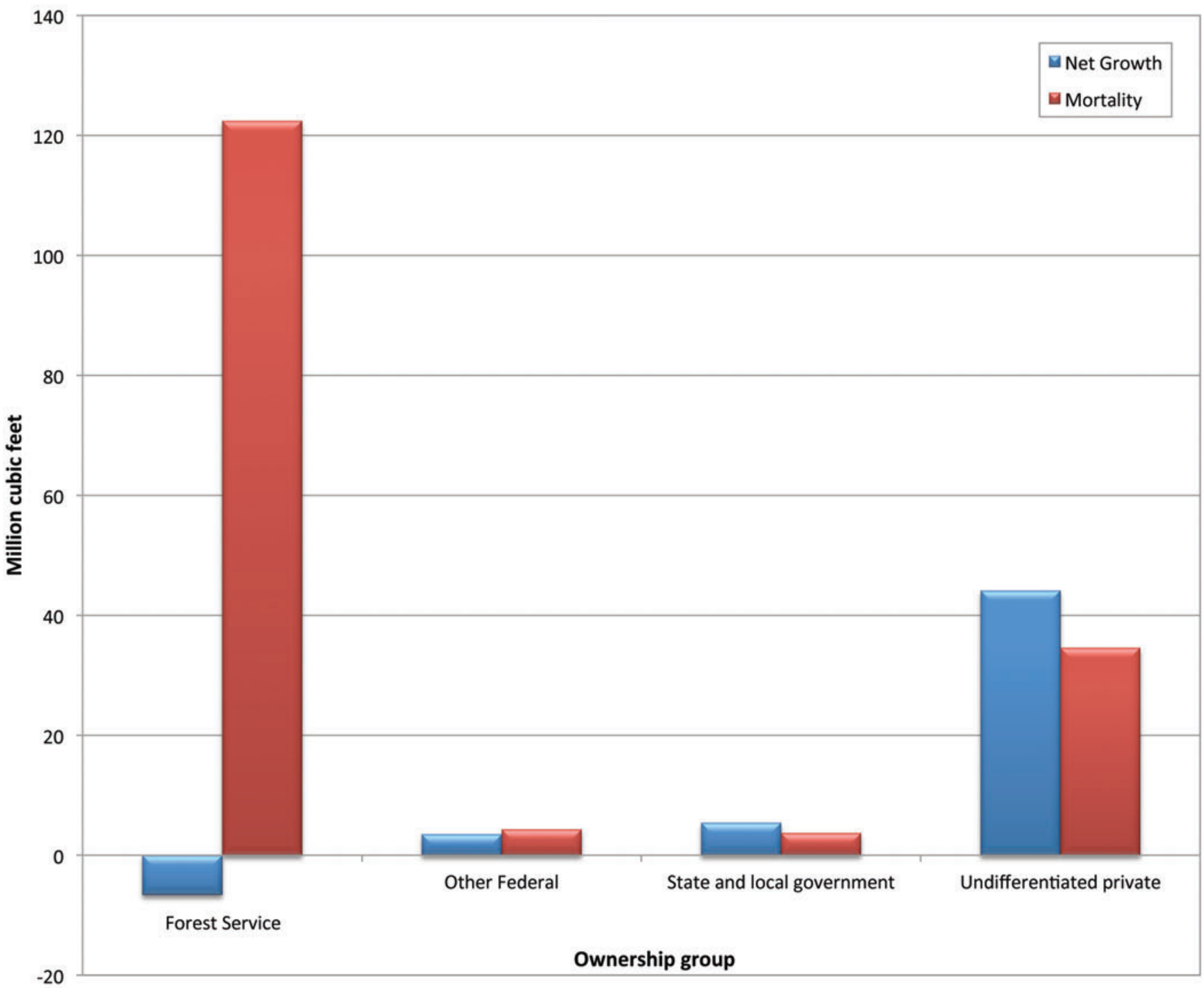


Figure 16. Net annual growth and mortality on forest land by ownership group, New Mexico, 2008-2012.

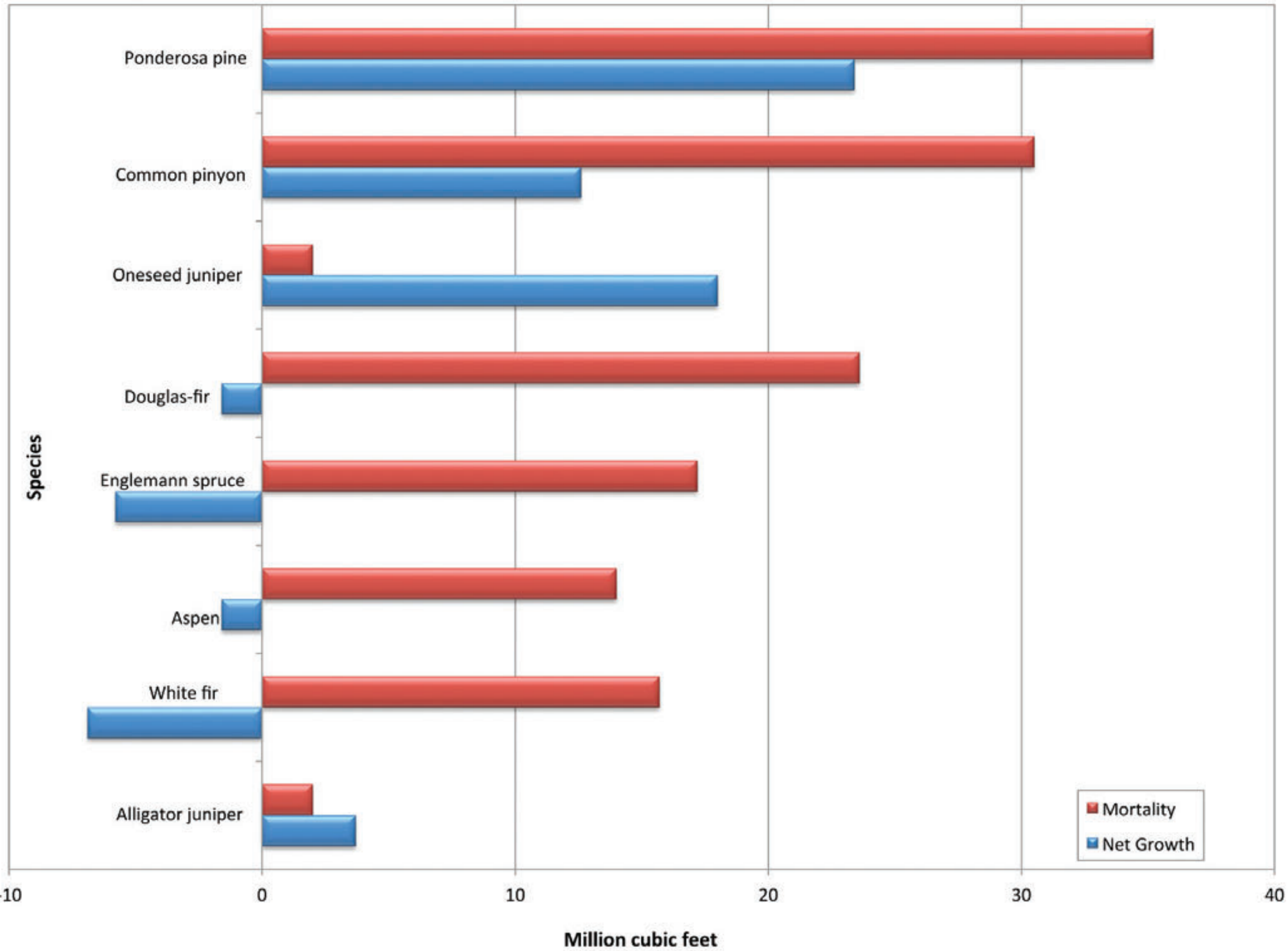


Figure 17. Net annual growth and mortality on forest land by eight major species, New Mexico, 2008-2012.

Since high mortality is the driving force behind the large differences between gross and net growth, further examination of this change component by other resource attributes can help explain the factors behind the high level of tree volume estimated to have died in the previous 10 years. Substantial differences were observed in per-acre estimates of mortality between major ownership groups and reserved statuses. Converting the state-level estimates of mortality into per-acre estimates removes the effect of differences in the amount of forest land controlled by different ownership groups. The per-acre estimate of annual mortality volume averages 6.6 cubic feet per year on forest land across all ownerships. Mortality on reserved forest land was appreciably higher than unreserved land. Average annual mortality on reserved land averaged 22.3 cubic feet per acre, compared to 5.7 cubic feet per acre on unreserved forest land. Figure 18 illustrates per-acre estimates of mortality by two major owner categories and reserved status. Reserved lands managed by the National Forest System recorded the highest average level of per-acre mortality at 26.6 cubic feet, which is almost 11 times higher than the per-acre estimate recorded on unreserved land controlled by private landowners, other Federal agencies, and State agencies.

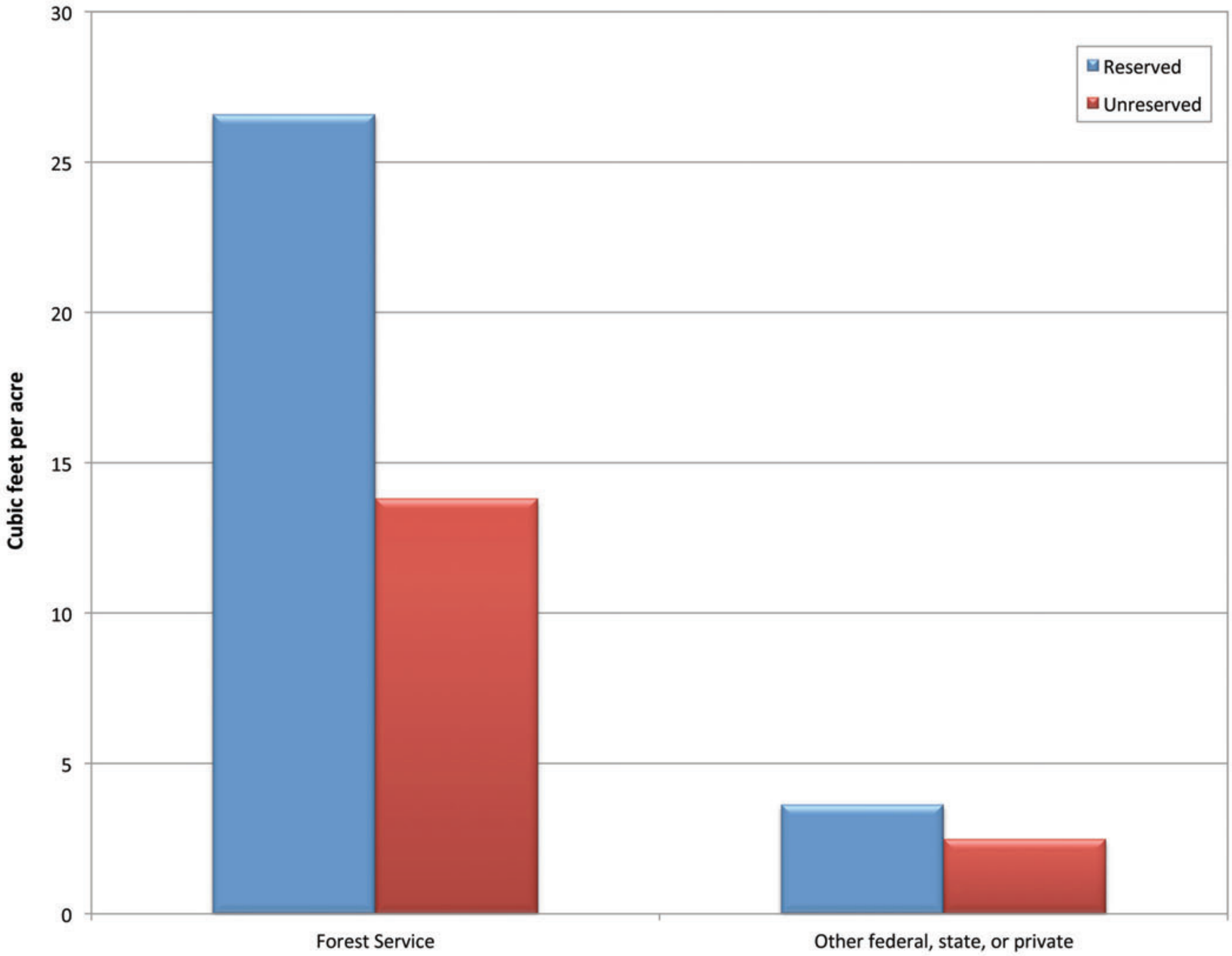


Figure 18. Average annual per-acre mortality on forest land by two major owner categories and reserved status, New Mexico, 2008-2012.

All trees classified as mortality trees are assigned a cause of death in the field. Drawing conclusions from mortality estimates by cause of death should be done with caution because the actual agent that caused a tree's death may be difficult, if not impossible, to determine. The 'other' cause of death category includes trees that have died due to reasons the field crews are unable to determine. Interactions between insects and diseases are complex and make identification of causal agents difficult. Figure 19 illustrates per-acre estimates of mortality by reserved status and cause of death. Substantial differences were noted between reserved and unreserved forest land for mortality caused by insects and fire. Mortality due to insects accounted for the majority (35.4 percent) of total mortality. Fire was the second leading contributor to mortality, accounting for 21.8 percent of total mortality. Disease accounted for 12.8 percent.

The high mortality resulted in a large reduction in net growth for several species and species groups. By ownership, mortality is highest on land managed by the National Forest System, especially forest land classified as reserved. Insects were the leading contributor to mortality estimates. Nearly 34 percent of total ponderosa pine mortality and over 59 percent of common pinyon pine mortality was attributable to insects. Ponderosa pine accounted for almost 40 percent of mortality caused by fire. The reasons behind the differences in levels of tree mortality by owner class and reserved status deserve further investigation. These differences have been observed in other state inventories (Menlove

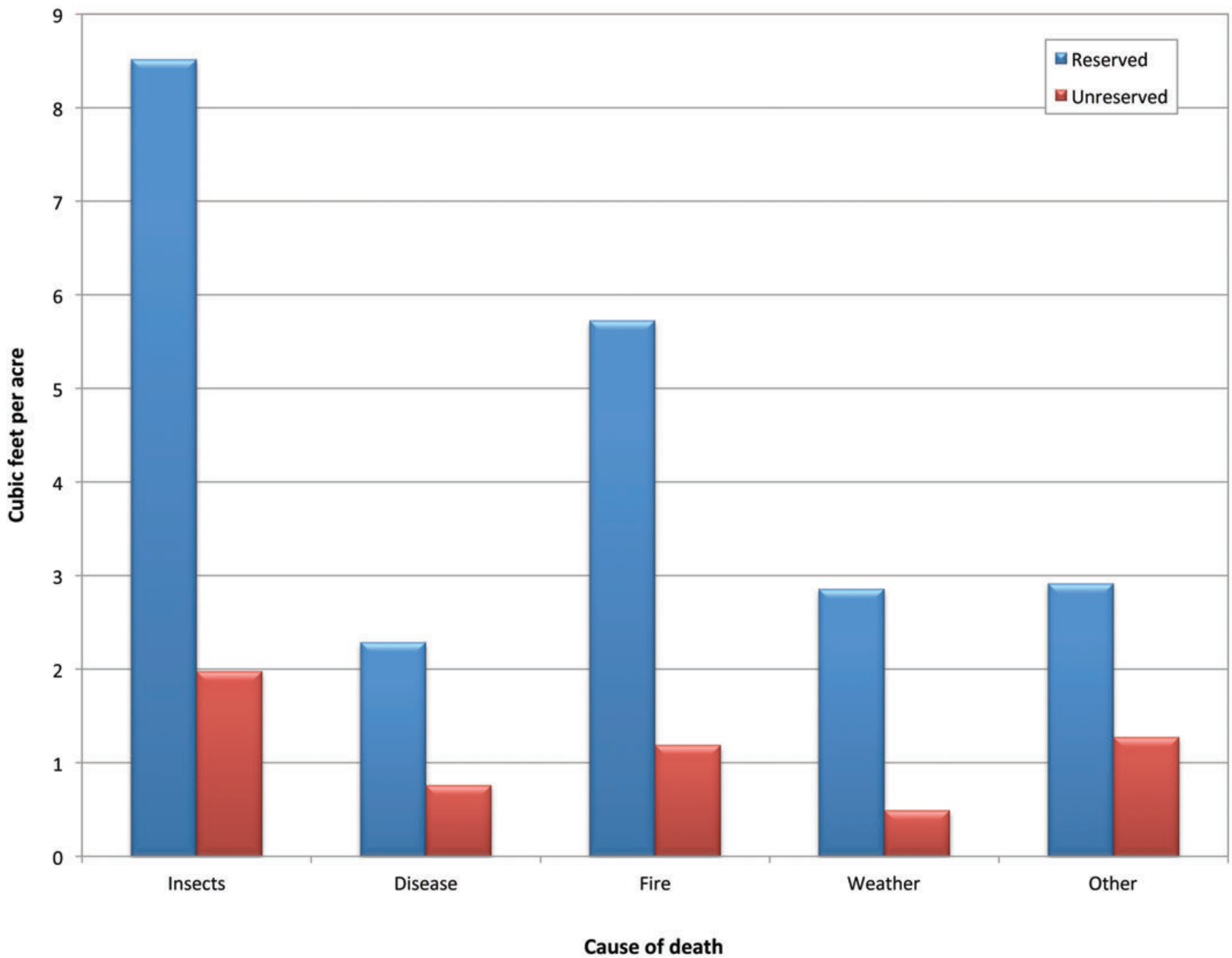


Figure 19. Average annual per-acre mortality on forest land by reserved status and cause of death, New Mexico, 2008-2012.

and others 2012; Witt and others 2012), which may suggest that reserved National Forest System lands have a larger share of aging forest stands that are more susceptible to insect and disease. This assumption could be verified with additional analysis of stand age, structure, density, species composition, and management regimes.

> Total removals in 2007 were slightly less than 47.5 million cubic feet. Commercial timber harvest in 2007 was 39.8 million board feet (Scribner), most of which came from private and tribal lands (83 percent). Ponderosa pine accounted for more harvested timber volume than any other species (47 percent).

Removals—Removals are another forest change component and an important indicator of the sustainability of timber harvest levels. Live tree removals that exceed growth for extended periods could indicate over-harvesting and decreasing forest inventory. Conversely, growth that greatly exceeds removals could signal the need for vegetation management to regulate density, inhibit insect and disease outbreaks, or manage fuels.

Removals can come from two sources: the growing-stock portion of live trees (live trees of commercial species meeting specified standards of quality or vigor), or dead trees and other non-growing-stock sources. The two general types of removals are timber products harvested for processing by mills and logging residue (i.e., volume cut or killed but not utilized). Removals, as reported here, are based on a 2007 census of New Mexico's primary forest products industry (Hayes and others 2012) and various logging utilization studies (McLain 1989a; Morgan and others 2005; Morgan and Spoelma 2008). Removals data for 2012 are being developed, but were not available in time for this report. Estimates of removals based on FIA plot data will not be available until New Mexico's forest inventory enters its second cycle, which is scheduled to begin in 2015.

Total removals from New Mexico's forests during 2007 were slightly less than 47.5 million cubic feet (table 4). This included 44.6 million cubic feet of timber used for roundwood products (including fuelwood) and almost 2.9 million cubic feet of logging residue left in the forest as slash. Fuelwood accounted for 72 percent (34.2 million cubic feet) of total removals, and residential firewood was estimated to be approximately 33.9 million cubic feet, nearly all from non-growing stock sources. Softwoods were the largest component of New Mexico's removals, accounting for 89 percent of total removals and 89 percent of removals for timber products. Hardwoods were used mostly for fuelwood and pulpwood.

Growing-stock removals totaled 9.8 million cubic feet, with softwoods accounting for almost 8.5 million cubic feet (86 percent). Nearly 95 percent (9.3 million cubic feet) of growing-stock removals went to wood products, including fuelwood. Sawlogs were the largest component (47 percent) of growing-stock removals, followed by pulpwood (31 percent) and logs for posts and small poles (10 percent). Just 3 percent (0.3 million cubic feet) of growing-stock removals were used as fuelwood, and 5 percent (0.5 million cubic feet) of growing-stock removals were logging residue (i.e., not utilized).

Private and tribal timberlands accounted for 67 percent (6.6 million cubic feet) of growing-stock removals, while National Forests accounted for 22 percent (2.2 million cubic feet). State lands were the source of the remaining 11 percent (1.0 million cubic feet) of growing-stock removals.

Total roundwood output from all sources in New Mexico during 2007 was 44.6 million cubic feet, more than three-quarters of which came from non-growing-stock sources for use as fuelwood (table 5). Of the 9.3 million cubic feet of roundwood output sourced from growing stock, sawlogs were the leading product type, accounting for 4.6 million cubic feet of output. Pulpwood was 3.0 million cubic feet of the output from growing stock, and post and pole output from growing stock was 1.0 million cubic feet. Sawtimber trees (i.e., softwood trees 9.0 inches or larger in diameter, and hardwood trees 11.0 inches or larger in diameter) accounted for 79 percent of the roundwood output from growing stock, while the remainder was poletimber size (i.e., softwoods with diameters 5.0 to 8.9 inches, and hardwoods with diameters 5.0 to 10.9 inches).

New Mexico's timber harvest in 2007 was about one-quarter of what it was in 1986 and 40 percent of what it was in 1997. These decreases in harvest volume were largely the result of harvest reductions from National Forests, which declined 95 percent, falling from almost 140 million board feet (Scribner rule) in 1986 to less than 6 million board feet in 2007 (Hayes and others 2012; McLain 1989b). Harvest volume from private and tribal lands increased during that period, growing from 26 million board feet in 1986 to more than 85 million board feet in 1997, and 33 million board feet in 2007. Such radical changes in New Mexico's timber harvest volumes pose significant challenges to both the industry and forest sustainability, because the ability to conduct vegetation management and mitigate mortality impacts has decreased as timber processors and forest operators have gone out of business.

Synthesis of growth, mortality, and removals—Sustainability of New Mexico's forests depends, in part, on management activities that generate sustainable harvest levels and support a forest products industry. Statewide, average annual gross growth of growing-stock trees on timberland was 87.7 million cubic feet, nearly 9 times the 2007 growing-stock harvest (i.e., removals) of 9.8 million cubic feet (table 4).

Table 4. Volume of wood removals (in thousand cubic feet) by source of material, species group, and removal type, New Mexico, 2007.

Removal type	Source of material						All sources		
	Growing stock			Other sources					
		Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Roundwood products									
Saw logs	4,606	0	4,607	1,085	0	1,085	5,691	0	5,692
Veneer logs	0	0	0	0	0	0	0	0	0
Pulpwood	1,741	1,300	3,041	24	87	111	1,765	1,387	3,152
Composite products	0	0	0	0	0	0	0	0	0
Fuelwood (including residential)*	305	0	305	30,342	3,567	33,909	30,646	3,567	34,213
Posts, poles, and pilings	979	0	979	124	0	124	1,103	0	1,103
Miscellaneous products	402	0	402	60	0	60	462	0	462
Total roundwood products	8,033	1,300	9,333	31,634	3,654	35,289	39,667	4,955	44,622
Logging residues	427	72	499	2,147	220	2,366	2,574	292	2,865
Total removals	8,459	1,372	9,832	33,781	3,874	37,655	42,241	5,246	47,487

*Includes residential fuelwood consumption reported by U.S. Energy Information Administration (http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=US#Consumption).

Table 5. Total roundwood output (in thousand cubic feet) by product, softwood/hardwood, and source of material, New Mexico, 2007.

Product and species group	Source of material: Growing-stock trees: Sawtimber	Poletimber	Other sources	All sources
Sawlogs				
Softwood	4,073	534	1,085	5,692
Hardwood	0	0	0	0
Total	4,073	534	1,085	5,692
Veneer logs				
Softwood	0	0	0	0
Hardwood	0	0	0	0
Total	0	0	0	0
Pulpwood				
Softwood	1,539	202	24	1,765
Hardwood	1,149	151	87	1,387
Total	2,689	352	111	3,152
Composite panels				
Softwood	0	0	0	0
Hardwood	0	0	0	0
Total	0	0	0	0
Poles and posts				
Softwood	1	978	124	1,103
Hardwood	0	0	0	0
Total	1	978	124	1,103
Other miscellaneous				
Softwood	355	47	60	462
Hardwood	0	0	0	0
Total	355	47	60	462
Total industrial products				
Softwood	5,968	1,760	1,293	9,021
Hardwood	1,150	151	87	1,388
Total	7,118	1,911	1,380	10,408
Fuelwood (including residential)[a]				
Softwood	269	35	30,342	30,646
Hardwood	0	0	3,567	3,567
Total	269	35	33,909	34,213
All products				
Softwood	6,237	1,795	31,634	39,667
Hardwood	1,150	151	3,654	4,955
Total	7,387	1,946	35,289	44,622

[a] Includes residential fuelwood consumption reported by U.S. Energy Information Administration (http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=US#Consumption).

When average annual growing-stock mortality on timberland (77.3 million cubic feet; table B28) is taken into account, average annual net growth was just 10.4 million cubic feet (table B24), slightly greater than 2007 growing-stock removals. With approximately 37 million cubic feet of non-growing stock (i.e., mostly dead) timber removed, and the majority (34 million cubic feet) being used for fuelwood, less than half of annual mortality is being utilized. The very high levels of tree mortality on New Mexico's timberlands not only have an impact on the forest inventory, but greatly influence the harvest-to-growth relationship, sustainability, and the availability of timber for the forest products industry.

The caveat of this analysis is that annual rates of growth and mortality were estimated based on the 10 years prior to each plot's measurement, while annual removals were quantified for a single year, 2007. When New Mexico's forest inventory begins its second cycle in 2015, removals will be estimated using remeasurement data from permanent plots. Thus, growth, mortality, and removals will eventually be estimated using consistent methods and timeframes.

Stand Density Index (SDI)

Stand density index (SDI; Reineke 1933) is a relative measure of stand density, based on quadratic mean diameter of the stand and the number of trees per acre. In the western States, silviculturists often use SDI as one measure of stand structure to meet diverse objectives such as ecological restoration and wildlife habitat (e.g., Lilieholm and others 1994; Long and Shaw 2005; Smith and Long 1987).

SDI is usually presented as a percentage of a maximum SDI for each forest type. Maximum SDI is rarely, if ever, observed in nature at the stand scale because the onset of competition-induced (self-thinning) mortality occurs at about 60 percent of the maximum SDI, and natural canopy gaps and non-stockable patches tend to limit the potential crowding of trees. Average maximum density, which is used in normal yield tables and is equivalent to the A-line in Gingrich-type stocking diagrams (Gingrich 1967), is equal to approximately 80 percent of maximum SDI. There are several reasons why stands may have low SDI. Stands typically have low SDI following major disturbances, such as fire, insect attack, or harvesting. These stands remain in a low-density condition until regeneration fills available growing space. Stands that are over-mature can also have low SDI, because growing space may not be re-occupied as fast as it is released by the mortality of large, old trees. Finally, stands that occur on very thin soils or rocky sites may remain at low density indefinitely, because limitations on physical growing space do not permit full site occupancy. A site is considered to be fully occupied at 35 percent of maximum SDI. At lower densities, individual tree growth is maximized but stand growth is below potential, while at higher densities, individual tree growth is below potential but stand growth is maximized (Long 1985).

Originally developed for even-aged stands, SDI can also be applied to uneven-aged stands (Long and Daniel 1990; Shaw 2000). Stand structure should influence the selection of the appropriate SDI computation method, so the definition of maximum SDI must be compatible with the selected method. Because FIA data include stands covering the full range of structure, maximum SDIs have been developed specifically for FIA forest types. The revised maximum SDIs, which are compatible with FIA computation methods, are shown in table 6. SDI was computed for each condition that sampled forest land using the summation method (Shaw 2000), and the SDI percentage was calculated using the maximum SDI for the field-determined forest type found on the condition. The field-determined forest type is used instead of the computed forest type because recently disturbed conditions are frequently classified as "nonstocked" by FIA's forest type algorithm (Arner and others 2001). SDI percentage cannot be calculated for these conditions because there is no maximum SDI associated with the nonstocked forest type.

Table 6. Maximum Stand Density Index by forest type, New Mexico, 2008-2012.

Forest type	Maximum SDI
182 Rocky Mountain juniper	425
184 Juniper woodland	385
185 Pinyon/juniper woodland	370
201 Douglas-fir	485
221 Ponderosa pine	375
261 White fir	500
265 Engelmann spruce	500
266 Engelmann spruce/subalpine fir	485
268 Subalpine fir	470
269 Blue spruce	500
366 Limber pine	410
703 Cottonwood	360
901 Aspen	490

In fact, most nonstocked conditions are actually specific forest types with very low SDI. By using field-determined forest types for nonstocked conditions, we are better able to estimate the area of forest with low stocking in comparison to its potential.

Despite recent fires, the early 2000s outbreak of pinyon ips (Shaw and others 2005), and other disturbances, forests in New Mexico appear to remain well-stocked. Over 53 percent of the State's forest land area is fully occupied (figure 20). This compares favorably with recent figures for neighboring States, such as Arizona (45 percent) and Utah (54 percent). Just over 18 percent of New Mexico's forest land area is considered overstocked, meaning that self-thinning mortality is imminent or currently occurring. Overstocked stands are unlikely to include much regeneration of shade-intolerant species, and any shade-tolerant species in the understory are likely to be growing slowly. Heavily stocked stands typically contain relatively sparse herb and shrub communities as well. In many cases, heavily stocked stands can be considered at increased risk for accelerated mortality. The increased stress of competition can lead to more successful insect attacks or accelerated disease effects, and high density can make stands more prone to wildfire.

Over time, stand density index varies within the life cycle of each stand. However, at the scale of a forest or whole State, the area of forest that is becoming more dense will generally be offset by other areas that are becoming less dense, resulting in a roughly stable range of densities at large scales. FIA's ongoing forest inventory will eventually be able to evaluate the trend in density as one of many indicators of forest change.

New Mexico's Forest Resources

Forests provide myriad values and resources to the people and wildlife of New Mexico. This chapter describes selected forest resources in New Mexico, including timber and the economic impacts of timber harvest, traditional resources such as pinyon nuts, wildlife habitat, old forests, understory vegetation, down woody material, and soils.

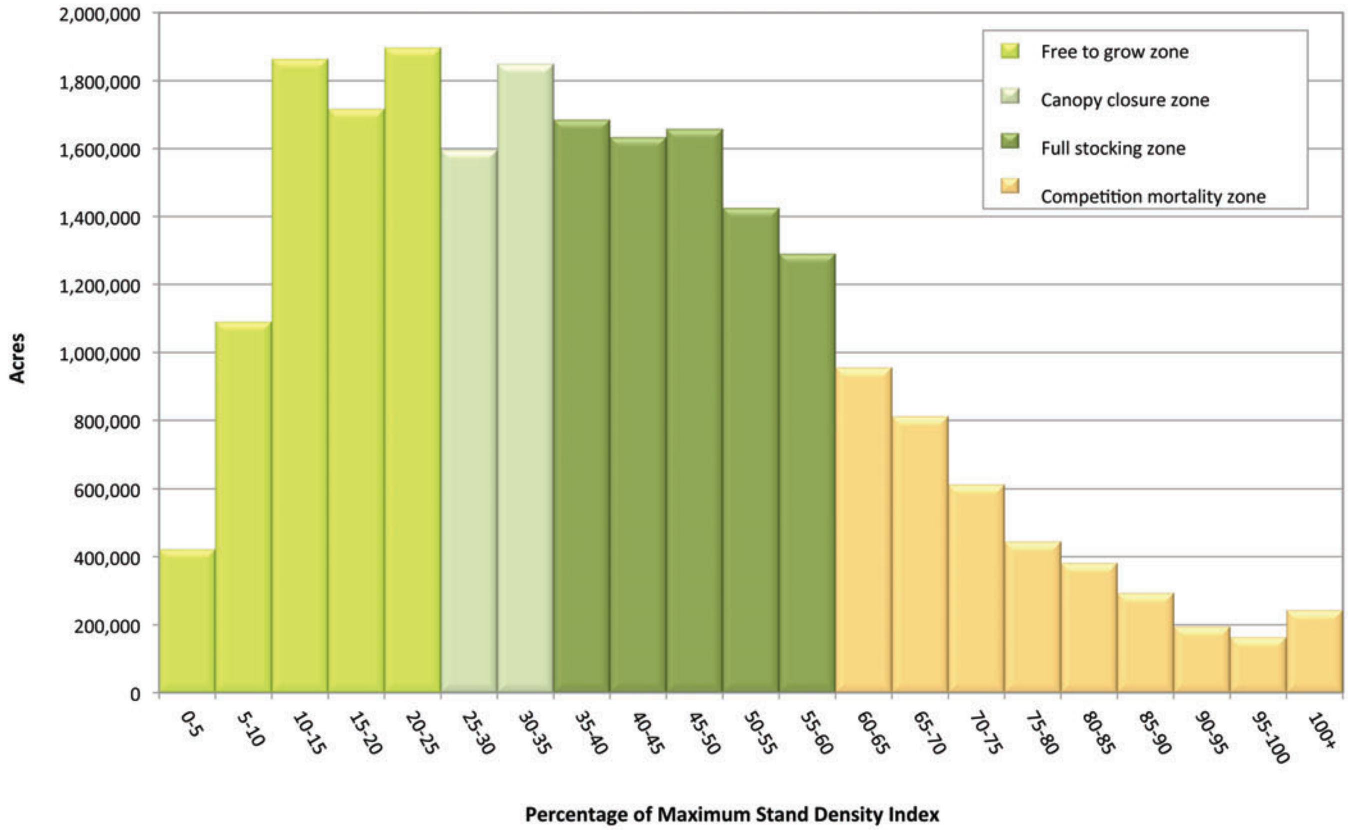


Figure 20. Distribution of Stand Density Index for forest land in New Mexico, 2008-2012.

New Mexico Timber Harvest and Forest Products Industry

The University of Montana's Bureau of Business and Economic Research (BBER), in cooperation with the Interior West FIA Program, conducts periodic censuses of New Mexico's primary forest products industry (Hayes and others 2012; Morgan and others 2006). The last censuses in New Mexico measured 2002 and 2007 activities. This section reports key aspects of the 2007 industry census, including timber harvest levels by product and ownership class as well as forest industry conditions like employment, sales value, and production levels. BBER is currently conducting the census of 2012 activities; summarized results should be publicly available in June 2014 at the BBER's website (http://www.bber.umt.edu/FIR/H_states.asp).

Primary forest products facilities process timber (i.e., logs) into manufactured products such as lumber, and also include facilities that use bark or wood residue directly from timber processors. A total of 24 facilities were active in 12 New Mexico counties during 2007 (figure 21), including a dozen sawmills, five *viga* and *latilla* manufacturers, and seven other facilities, producing log homes, firewood, bark, and a combination of posts and poles. Preliminary information suggests that roughly two dozen facilities are currently operating in New Mexico, although one of the State's largest facilities became inactive in late 2012.

The commercial timber harvest in New Mexico during 2007 was 39.8 million board feet (Scribner rule), or approximately 10.7 million cubic feet. The 2007 harvest was just over half of the 2002 harvest and 40 percent of the 1997 harvest (Hayes and others 2012).

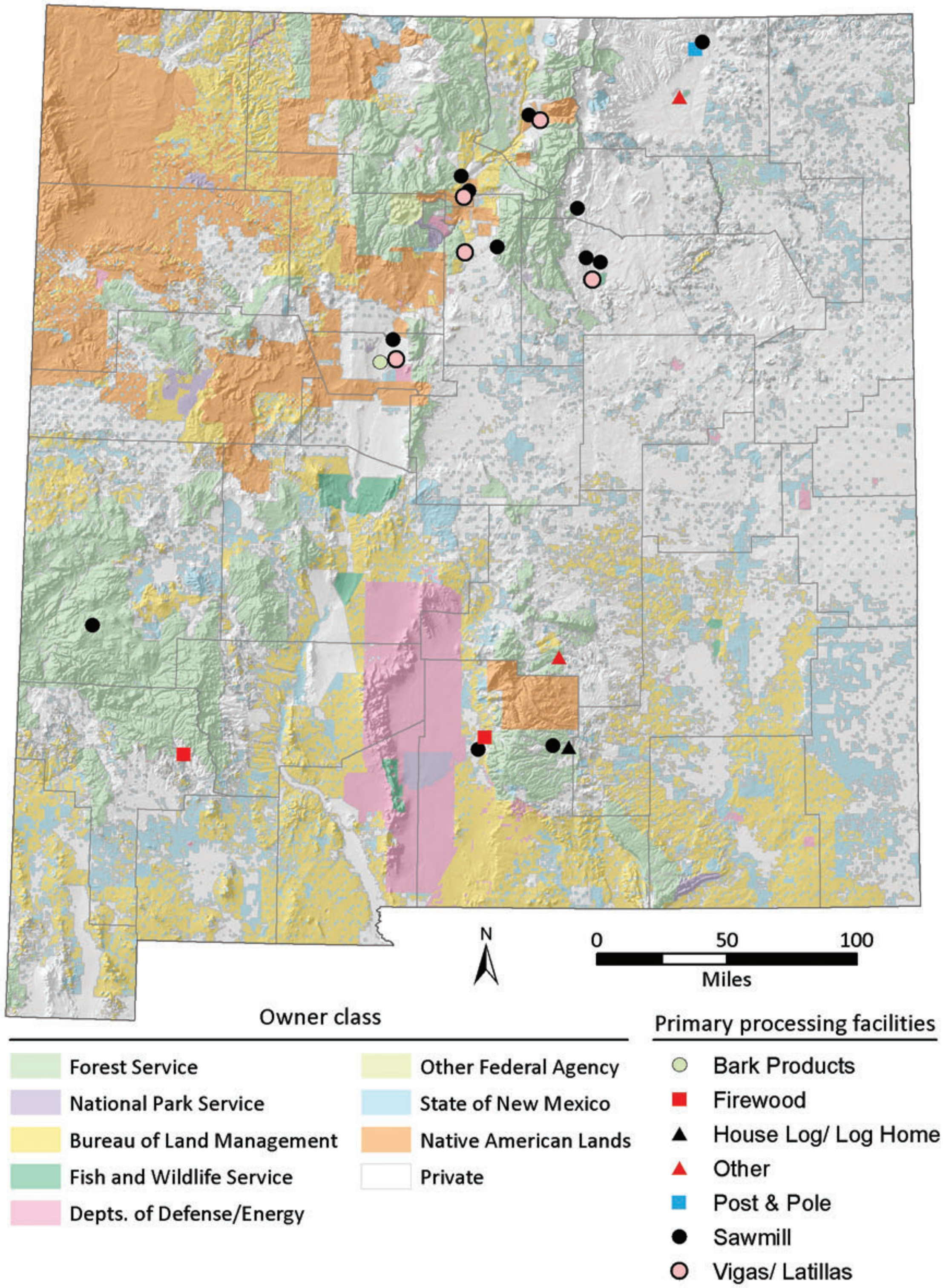


Figure 21. Primary wood processing facilities in New Mexico, 2007.

Private and tribal lands supplied 83 percent of the 2007 harvest, and 17 percent came from public lands. Sawlogs (i.e., timber used for manufacturing lumber and other sawn products; see Appendix A) accounted for more than 80 percent of the harvest volume. Ponderosa pine was the leading species harvested, accounting for 47 percent of the 2007 harvest volume, followed by Douglas-fir (25 percent), true firs (17 percent), and other species (11 percent). Otero County in south-central New Mexico produced 47 percent of the commercial timber harvest volume, and Colfax County in the northeast accounted for almost 24 percent. The majority (93 percent) of timber harvested in New Mexico during 2007 was processed within the State. Almost 3 million board feet (Scribner) of timber was processed outside the State, primarily in Colorado, and just over 1 million board feet of timber from Colorado was processed by mills in New Mexico.

Timber processors in New Mexico received 37.9 million board feet (Scribner) during 2007. The 12 sawmills in the State used about 31 million board feet (Scribner) of logs and produced slightly less than 40 million board feet of lumber, with a sales value of $12.6 million (all sales value figures are in 2007 dollars). The six largest sawmills in the State accounted for 97 percent of lumber production and had an average annual production of 6.4 million board feet of lumber. The five *viga* and *latilla* manufacturers operating in 2007 used about 1.7 million board feet (Scribner) of timber and had sales of $3.1 million. Manufacturers of log homes, log furniture, post, poles, firewood, and bark products used 4.9 million board feet (Scribner) of timber and had combined sales of $10.1 million.

The forest products industry includes private sector foresters, loggers, and other forest workers, as well as employees at primary and secondary wood and paper products manufacturing facilities. Employment data from the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System (BEA 2012) showed that employment in the State's forest products industry totaled about 3,120 workers in 2007, with about 320 in forestry and logging, 800 in paper products, and 2,000 in wood products. The BBER's 2007 census of New Mexico's forest products industry indicated about 320 full-time-equivalent employees at primary wood products manufacturing facilities (see Appendix A for definitions). Secondary wood and paper manufacturing employment was estimated to be about 2,480 workers.

Until the completion of BBER's 2012 census, information on the current status of New Mexico's forest industry is limited. Available data from National Forest cut and sold reports (USDA Forest Service 2013), BEA (2012), and preliminary BBER results suggest that timber harvest volume, employment in the various forest industry sectors, and the number of active wood products facilities in New Mexico have all decreased from 2007 levels. The State's industry, like much of the West, continues to wrestle with the impacts of steep timber harvest reductions from Federal lands from the 1990s (Keegan and others 2006; Morgan and others 2006), as well as the more recent Great Recession and U.S. home-building collapse (Keegan and others 2012). Collaborative efforts at forest restoration and fire hazard reduction treatments in the region (Bradley 2009; Shultz and others 2012), recovery of U.S. home-construction, and increasing domestic demand for wood products are offering some potential for timber harvest increases and improved forest industry operating conditions in New Mexico.

Traditional Forest Uses

New Mexico is home to not only diverse forests, but also to diverse groups of people who value the State's forests in different ways. Two traditional forest resources in New Mexico include pine nuts and lichens. Pine nuts are harvested as a food source and provide income to commercial pine nut gatherers, and lichens include dozens of species that may be used for dyes, food, fiber, or medicine. The current status of New Mexico's pine nut and lichen resources is summarized below.

Pinyon/juniper woodlands that are old enough to produce harvest-worthy quantities of pine nuts occupy about 8 million acres in New Mexico.

The pine nut resource of pinyon/juniper woodlands—Pinyon/juniper woodlands cover an estimated 10.3 million acres in New Mexico, making it the most abundant forest type in the State. This woodland type usually consists of two-needle pinyon (*Pinus edulis*) and one or more species of juniper (*Juniperus* spp.). Pinyon/juniper woodlands commonly occur in the mid-elevation belts between the lower grass/shrublands and either subalpine forests or tree line above (Lanner 1981). Trees from these woodlands have been utilized by indigenous peoples for thousands of years, providing them with building materials for basketry and clothing, hunting tools, shelter, fire wood, and medicine (Floyd and Kohler 1990; Janetski 1999). Pinyon and juniper trees continue to be used as fuel wood in many rural communities in New Mexico, which makes these woodlands an important local resource. However, the most important utilization of pinyon/juniper woodlands has been, and continues to be, the abundant and nutritious seeds of the pinyon pine.

Pinyon pine seeds, or "pine nuts," are an extraordinary food resource that is high in protein and fats and contains all 20 amino acids required for human growth (Janetski 1999). Unlike many other food items used in the past by native cultures, pine nuts were able to be stored for several years, making them a critical food in winter, times of drought, and periods of game scarcity. Pine nuts continue to be an important cultural and economic staple of contemporary tribal communities in New Mexico. Each year, pine nuts supplement the diets and incomes of those who know how and where to collect, process, store, and sell them. U.S. pine nut production is estimated to be 400-500 tons per year, contributing about 10 to 20 percent of the $100 million domestic pine nut market (Sharashkin and Gold 2004).

Two-needle pinyon generally begins producing seeds at around 25 years of age. Although important to wildlife at this stage, the numbers of seeds produced by these young trees are not economical to harvest. Not until tree age reaches 75 years or so do pinyon trees start producing pine nuts in sufficient quantities to harvest. Two-needle pinyon trees reach maximum seed production about 160 years old and continue until roughly 300 years old, at which time seed production often falls off considerably (Lanner 1981). Thus, it is useful to know how many acres of pinyon/juniper woodlands are currently of sufficient age to provide a useful crop of pine nuts, and how many acres are close to moving into and out of the most productive age-classes.

Here we use FIA data to estimate the extent and age distribution of New Mexico's pinyon/juniper woodlands and relate the estimates to potential seed production. Estimates were stratified by the age-class groups that reflect the varying seed productivity levels discussed above. In addition, the portion of each age-class that will change over the next 20 years (in the absence of natural or human-caused disturbance) is identified. This information is useful to resource managers interested in perpetuating pinyon/juniper woodlands that produce large quantities of pine nuts. The results of this analysis are displayed in figure 22.

The bulk of New Mexico's pinyon/juniper woodlands (nearly 57 percent) are in the 75-160 year age-class. This age-class represents fully mature trees that yield harvest-worthy quantities of pine nuts. The second-most abundant age-class, at 22 percent, is 160-300 years. These stands produce the most pine nuts of any age-class. While very few pinyon/juniper woodlands are expected to move from a productive class to an unproductive one, many acres of woodland are within 20 years of moving into a more productive age-class. Barring a major disturbance, nearly 66 percent (1.17 million acres) of the 25-74 year age-class will move into the 75-160 year class, roughly equal to the number of acres moving from this category to the older 161-300 class. The most productive age-class, 161-300 years, will see a 42 percent net increase in area, or nearly one million acres, over the next 20 years.

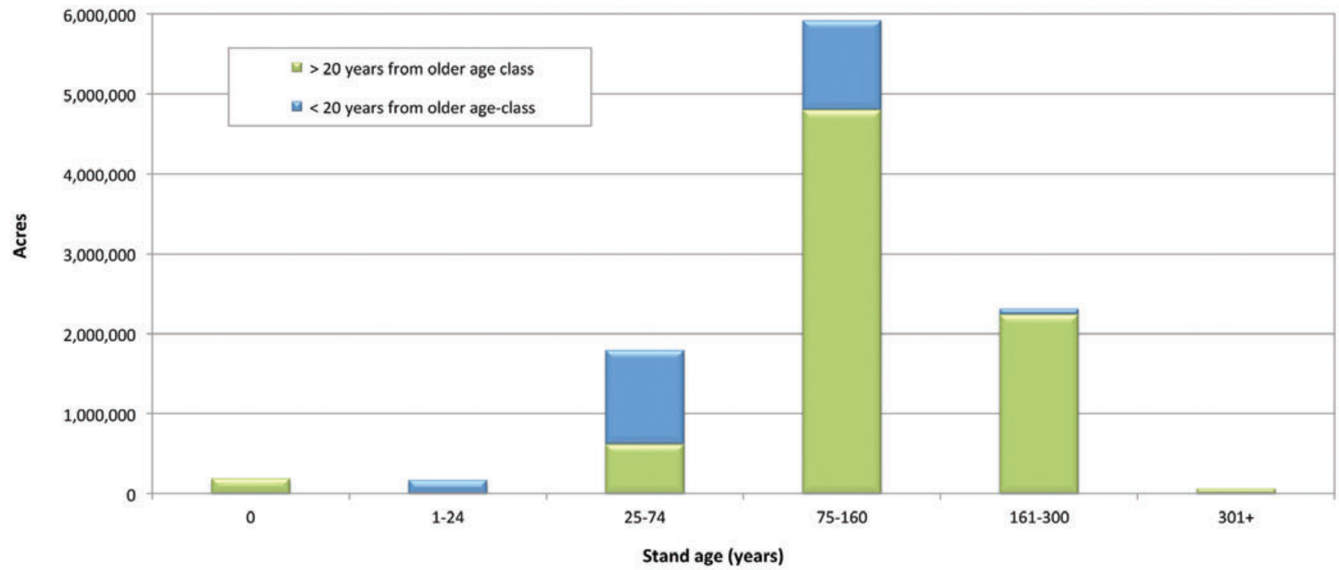


Figure 22. Area of pinyon/juniper forest type, by age-class groups that reflect the varying seed productivity levels, New Mexico, 2008-2012.

These data suggest that in the absence of a major disturbance, New Mexico's pine nut output will likely increase over the next 20 years. However, should a major disturbance convert large areas of seed-producing woodlands into zero-aged (nonstocked) sites, net productivity in the State could decline. For example, the drought of the 2000s contributed to the death of about 8 percent of pinyon basal area in New Mexico and the surrounding Four Corners States (see the section "Drought-related Effects on Pinyon/Juniper Woodlands" in this report). Pinyon/juniper woodlands become more susceptible to wildfire, disease, and insect outbreaks as they age and become more heavily stocked. As time passes, the likelihood and amplitude of major disturbances in these more heavily stocked woodlands increases. In addition, as these woodlands become more productive in terms of pine nut production, they often become less valuable to many wildlife species due to changes in stand structure and understory plant composition (Miller and others 2008). Therefore, there are trade-offs that need to be considered when managing pinyon/juniper woodlands for the pine nut resource.

Traditional uses of forest lichens—Many North American native cultures use multiple lichen species for food, fiber, medicine, dye, and other uses (Brodo and others 2001). Lichens also provide food for several wildlife species (Ward and Marcum 2005) and may be used to monitor air quality (Root and others 2013). For these reasons and more, lichens are an important indicator of forest health. Specially trained FIA crews perform a census of lichen species on all Phase 3 plots, which consist of a 1/16 subset of Phase 2 plots. At this time, lichen data for New Mexico consist of a list of lichen species and the number of plots on which each species occurred.

Nearly 70 lichen species have been documented thus far on forest plots in New Mexico. Based on their entries in Crawford's (2013) compendium of lichens and their uses, seven of these species are known to provide traditional values such as medicinal uses, dyes, fiber, or food or beverage ingredients (table 7). The most common lichens with known uses are *Flavopunctelia soredica* and *Usnea hirta*, which are used for flesh-colored dyes. Both of these occurred on more than 40 plots; several other lichens with known uses were recorded less frequently.

Table 7. Frequency of occurrence of lichen species on Phase 3 forest plots in New Mexico, along with traditional uses listed by Crawford (2013).

Species	Number of occurrences	Traditional uses
Cladonia chlorophaea	1	medicinal uses
Flavopunctelia soredica	41	dyes (flesh-colored)
Parmelia sulcata	4	dyes; medicinal uses
Physcia sp.	8	dyes (may be mixed with pinyon resin for a deep yellow paint)
Usnea sp.	3	dyes; medicinal uses; fermentation catalyst; fiber
Usnea ceratina	1	fiber
Usnea hirta	47	dyes (flesh-colored)

Of the roughly 60 lichen species that were recorded but not reported here, some may provide traditional values to local or native people beyond those listed here. Thus, the FIA dataset may be an untapped tool for monitoring traditional forest resources such as lichens. Future research should include efforts to identify additional lichen species and their uses and values. Such research could help New Mexico's forest inventory be useful for as many groups as possible.

Wildlife Habitat

Assessments of wildlife habitat often rely on forest attributes that describe stand structure and composition. Different forest attributes may serve as habitat indicators for different wildlife species, and they may include forest type, stand size and/or age, number of dead versus live trees, understory vegetation, and down woody material. This section presents two case studies where FIA data is being used as a wildlife habitat monitoring tool. The first case study uses FIA data to monitor the available habitat of a threatened species, the Mexican spotted owl; and the second demonstrates the use of FIA data to quantify available habitat for two cavity-nesting bird species.

FIA data as a habitat monitoring tool: The Mexican spotted owl as a case study—As additional forest attributes such as understory vegetation have been added to the Phase 2 protocols, FIA data has become increasingly useful for estimating and monitoring wildlife habitat and tracking changes in its quality and quantity over time. These data can be especially useful in monitoring the changes in habitat of organisms listed under the Endangered Species Act (ESA). Species listed under ESA are afforded certain legal protections, one being a Recovery Plan developed by the U.S. Fish and Wildlife Service (FWS). Such plans usually outline a monitoring protocol for assessing the effectiveness of the recovery actions over time. Monitoring is often expensive and logistically cumbersome and might not provide useful information to FWS biologists in a timely fashion. The FIA program can help mitigate this issue. FIA data can be useful for estimating habitat over large areas and comparing trends over time, with little or no additional costs to the agencies managing the habitat in question. If FIA currently collects data on forest attributes that are important to a listed species, estimates of these attributes can be quickly produced. By comparing past and present estimates, FWS staff can develop trends in habitat for a species over large geographic areas in perpetuity.

The Mexican spotted owl (*Strix occidentalis lucida*; referred to below as "owl") is a resident of the coniferous forests and canyon country of the southwestern United States, including much of New Mexico. The owl prefers heavily stocked mixed-conifer and pine-oak forests with large diameter trees and a complex understory for nesting and roosting (USFWS 2012). The FWS listed the owl as threatened under the ESA in 1993 and implemented a Recovery Plan in 1995, citing the alteration of the owl's habitat due to timber management practices and the threat of stand-replacing wildfire in its remaining habitat. The Plan describes minimum thresholds for forest stand characteristics known to be important for owl nesting and roosting in mixed-conifer and pine-oak forests. These include the percentage of live basal area comprised of medium (12 to 18 inches d.b.h.) and large (18 inches d.b.h. or greater) diameter trees, the density of large trees, the total basal area of a stand, and canopy cover.

In the following application, we used FIA condition and tree data to identify plots that meet the Plan's definition of mixed-conifer and pine-oak forest types. FIA forest type, habitat type, and the contribution of certain tree species to live basal area were the most important components used to redefine forest types in the context of owl habitat. We then produced estimates of current suitable nesting/roosting habitat in the mixed-conifer and pine-oak forest types of New Mexico. Area of suitable habitat in mixed-conifer forests from past periodic inventory data (1993-2000) is used to illustrate trend analysis capabilities of FIA data. However, pine-oak estimates from the periodic inventories were not included in this analysis due to inconsistencies in data collection methodology, definitions, and spatial resolution between inventories for this forest type (see Appendix C). However, estimates for current pine-oak forest habitat were produced. Area estimates for individual habitat characteristics are presented as well as those for forest lands that satisfy all habitat characteristics concurrently.

Currently, there are an estimated 1.49 million acres of mixed-conifer forest in New Mexico compared to an estimated 1.57 million acres in 2000 (figure 23). Thus the total area of mixed-conifer habitat was relatively constant over the years between inventories. In 2000, 55 percent (863,964 acres) of all mixed-conifer forests met the total basal area requirement, compared to nearly 45 percent (661,445 acres) in 2012. This is the most

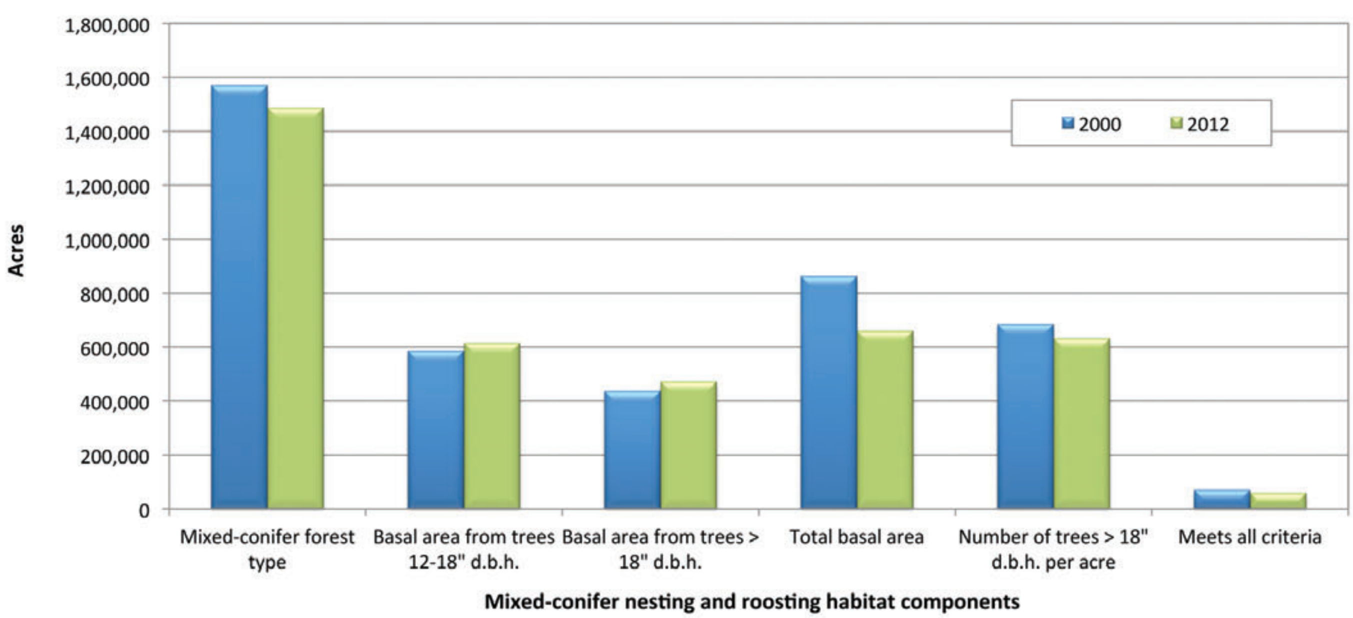


Figure 23. Area of different components of Mexican spotted owl habitat in mixed-conifer forest types, New Mexico, 2000 and 2008-2012.

frequently satisfied component of owl habitat in mixed-conifer forests in either time period. Basal area from large trees (18 inches d.b.h. or larger) was the rarest habitat feature found in either inventory. In both inventories, only a small percentage of the potential habitat, or approximately 4 percent of mixed-conifer forest area, was estimated to meet all of the minimum nesting/roosting requirements outlined in the Plan.

Pine-oak forests currently cover an estimated 128,483 acres in New Mexico (figure 24). This is less than one-tenth of the area covered by mixed-conifer forests. However, the percentage of pine-oak forests that meet all owl nesting/roosting habitat criteria in 2012 (5 percent) is similar to that of mixed-conifer. The percentage of stand basal area made up of medium-sized trees is the least abundant habitat component in pine-oak forests, while the forest area meeting or exceeding the total stand basal area requirement is most common.

This exercise illustrates the utility of FIA data for future monitoring applications where methodology and temporal distribution of sampling will remain consistent. These estimates can be compared to data collected in the future to assess continuing trends of habitat quality in each forest type. This can help assess the effectiveness of management actions taken to either maintain or increase habitat for the owl over a given period of time. The Interior West FIA plot remeasurement schedule closely approximates the monitoring timeline described in the Plan and allows FIA data to be easily used as a habitat monitoring tool with little additional investment to data collection and monitoring efforts.

Pinyon/juniper woodlands, followed by spruce/fir forests, contain the greatest number of suitable snags for two cavity-nesting bird species, the northern flicker and the acorn woodpecker.

Snags as wildlife habitat—Standing dead trees (snags) provide important habitat in many of the forested ecosystems of New Mexico. There are many organisms that utilize snags at some point in their life history, including bacteria, fungi, insects, rodents, cavity-nesting birds, bats, raptors, mustelids, and black bears. The diameter of a snag is important to species that use snags as a nesting, roosting, or den site. Larger snags tend to have a longer retention time, provide better thermal insulation, and can provide better protection from predators than smaller snags.

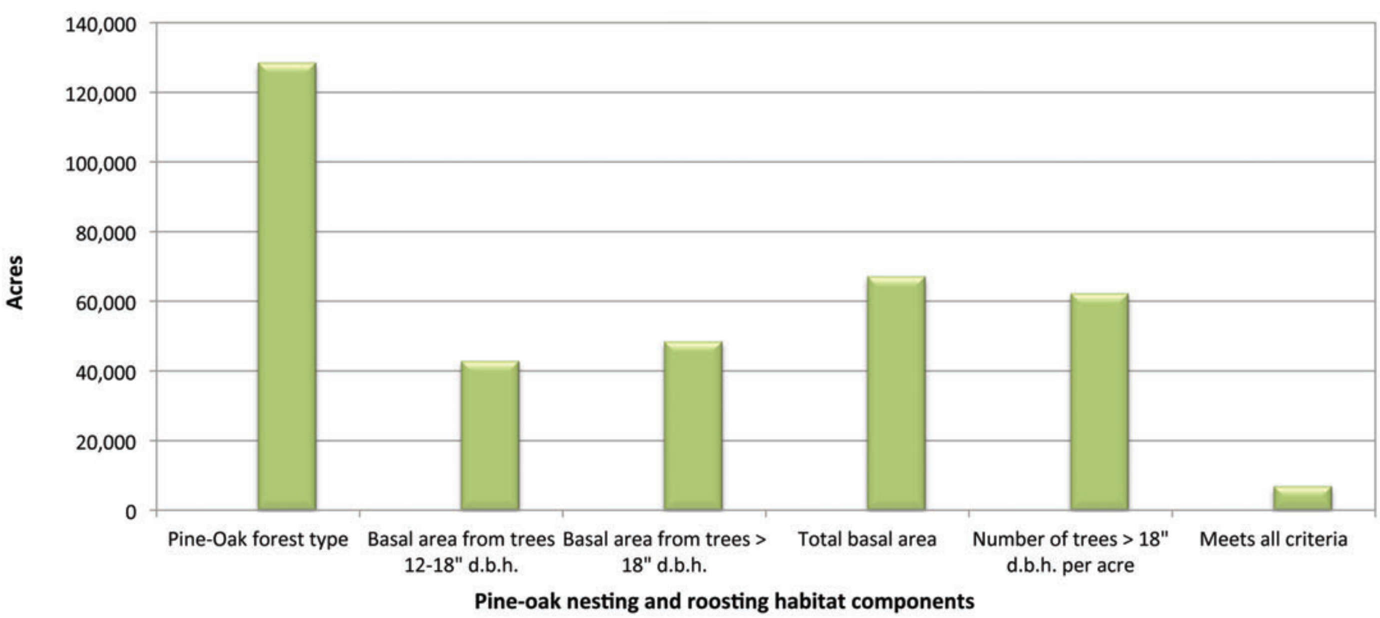


Figure 24. Area of different components of Mexican spotted owl habitat in pine-oak forest types, New Mexico, 2008-2012.

Many cavity-nesting birds in New Mexico are dependent on snags for nesting. There are a handful of bird species that act as primary excavators of nest sites for a suite of other birds and mammals. These birds create a cavity during one breeding season, but often abandon it and create a new cavity the following year. The old cavities are often occupied by secondary cavity-nesting birds. Secondary cavity-nesters do not excavate their own nest sites and are dependent on primary excavators for their nest cavities. The suitability of an old cavity for a secondary cavity-nester often depends on the species of primary cavity-nester that created it.

We present data reflecting the number of snags in New Mexico that are suitable for two primary cavity-nesting birds that provide the bulk of cavities for secondary nesters. The northern flicker (*Colaptes auratus*) and the acorn woodpecker (*Melanerpes formicivorus*) create different sized openings and cavities and are also relatively abundant and widespread throughout the different forest types of New Mexico (Ligon 1961). While flickers are found in many forest types, acorn woodpeckers are generally confined to forests that have oaks as a major component (Koenig and others 1995). Both of these birds prefer trees with diameters of 20 inches or larger at breast height. This diameter is large enough to accommodate almost all secondary cavity-nesting birds in New Mexico (Ehrlich and others 1988; Scott and others 1980). Since these two species provide suitable nest sites for a wide variety of secondary-nesting species over a large ecological range, their nest site availability can be used to assess the nest availability of most cavity-nesting birds in New Mexico.

A general estimate of suitable snags was produced for all of New Mexico's primary and secondary cavity-nesting birds by estimating the number of snags meeting the size preferences for the two focal species described above. For this analysis, snags with diameters at least 20 inches d.b.h. were used. The results of this analysis are presented as the estimated number of suitable snags found in a given forest type group, and suitable snags per acre within a forest type group.

Figure 25 shows the estimated number of snags in New Mexico that meet the minimum diameter requirements for the northern flicker and acorn woodpecker. With an estimated 19.5 million snags, the pinyon/juniper forest type group contains the most suitable snags, followed by the fir/spruce group with roughly 6.4 million snags. The majority of suitable snags in softwood groups are found in the 81 to 120 year age-class while the hardwood groups tend to have most of these large snags in younger stands. The nonstocked forest type often includes areas disturbed by wildfire, disease, and insect infestations. These types of stands are represented in the 0 year age-class, which accounts for all of the snags in the nonstocked forest type group.

Although having a good estimate of the total number of snags available to cavity-nesting birds can be valuable, the density of snags in different forest types is a more useful metric for gauging habitat quality. Figure 26 shows the estimated number of suitable snags per acre of forest in a given forest type group. By comparing figures 25 and 26, one can see that although the pinyon/juniper group has the most snags, the density of snags within this forest type group is lower than any other softwood group. There is a noticeable difference between the age-classes that contain the highest numbers of snags and those that hold the highest densities. Older forests tend to have higher snag densities while younger forests hold more snags overall. This is partially explained by the fact that there are more acres of younger forest (under 120 years old) in New Mexico than older forests (over 120 years old).

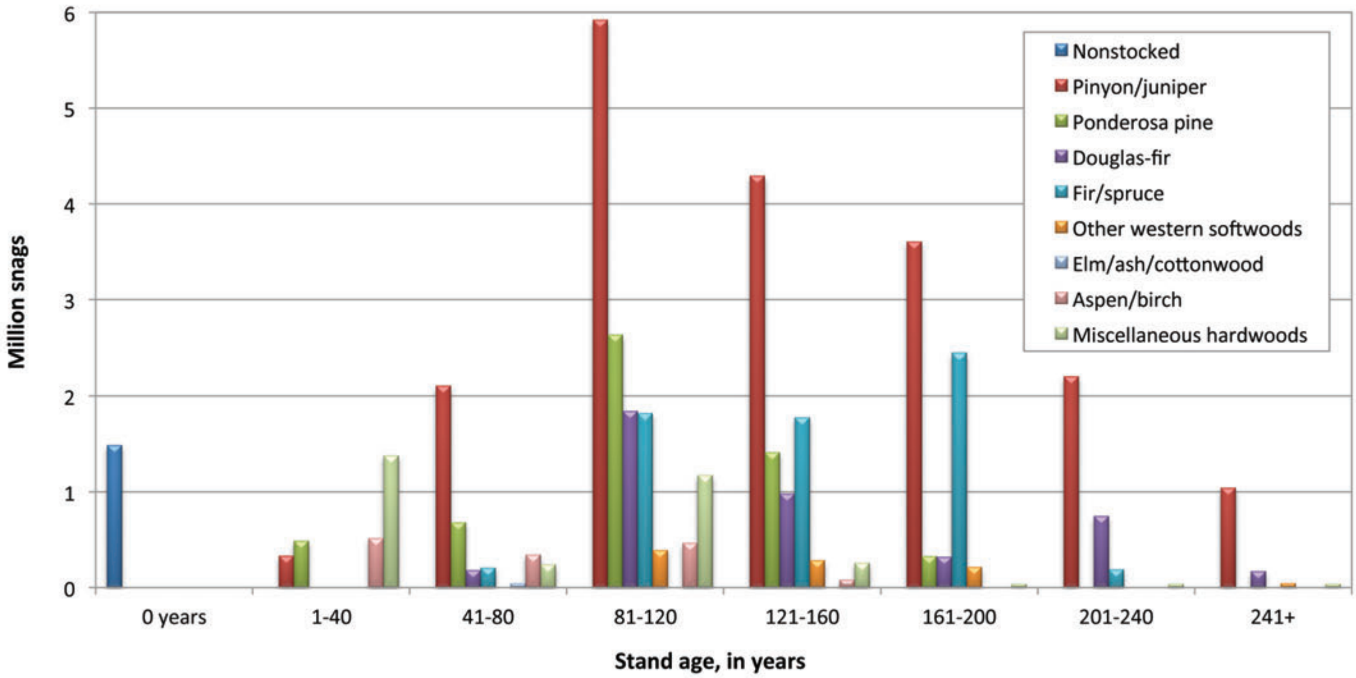


Figure 25. Estimated number of snags in New Mexico that meet the minimum diameter requirements for the northern flicker and acorn woodpecker, by forest type group and stand age, New Mexico, 2008-2012.

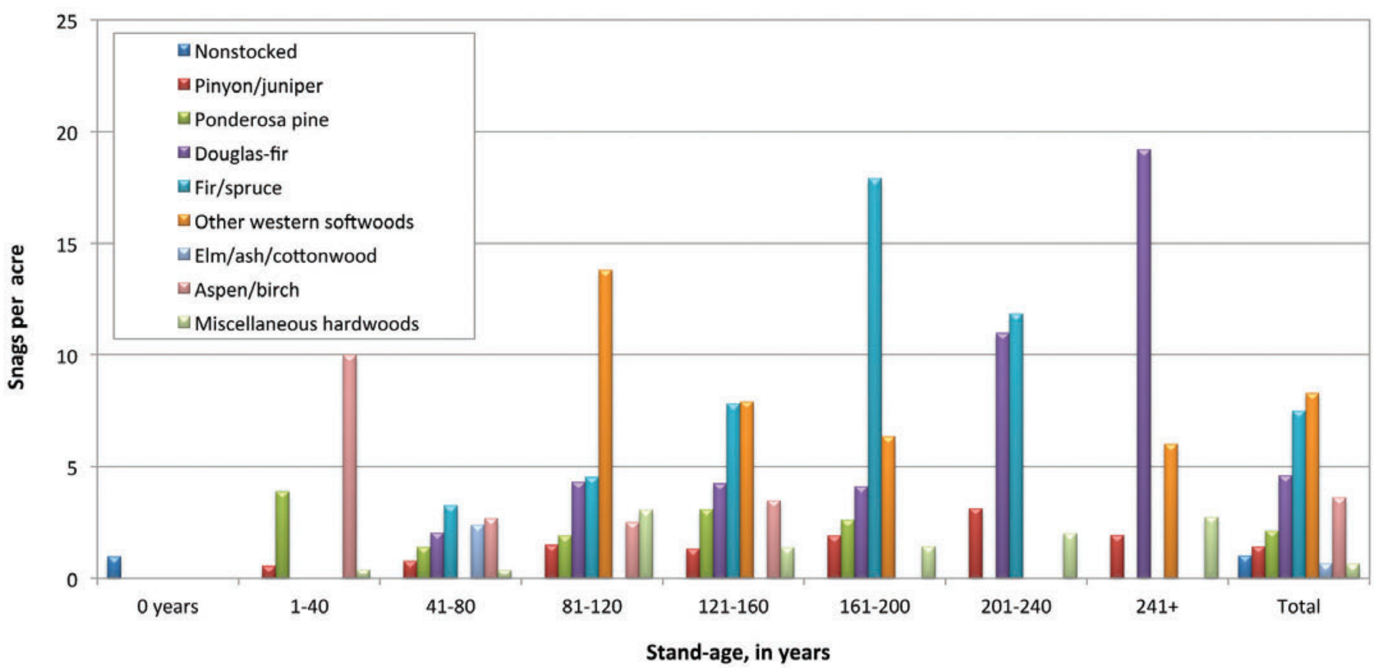


Figure 26. The estimated number of suitable snags per acre of forest land, by forest type group, New Mexico, 2008-2012.

The results of this analysis suggest that snags suitable for a large suite of cavity-nesting birds are found in a wide range of forest types and age-classes, but the highest density of these snags are found in older (over 120 years) stands of softwoods growing at mid to high elevations. An exception to this trend is the high density of snags found in the aspen/birch forest type group. Aspen forests are particularly important for some primary and secondary nesting birds because of the relationship between diseased aspen, primary excavators, and secondary nesters (Hart and Hart 2001). Few aspen trees live past 100 years in New Mexico. Almost all snags found in aspen forests (94 percent) are found in the 1-120 year age-classes.

Variables other than snag diameter and stand age need to be considered when predicting suitable wildlife habitat for forest-dwelling species. Proximity to forest edge and density of live trees is important to many cavity-nesting birds. The state of decay of a tree and its distance to foraging also plays a role in nest site suitability. FIA data can address many of these factors, and there are current efforts to build predictive models for these species by using data collected by FIA crews. These models can be valuable tools for Federal and State land managers, as a large portion of the forests containing suitable snags occur on public lands.

Old Forests

> About 18 percent of New Mexico's forest land area occurs in stands older than 150 years.

An important aspect of managing for ecologically sustainable and diverse ecosystems is the maintenance of forest stands representing the full range of forest succession. As forests mature, stand structure changes in ways that affect the stand's ecological and habitat function. Historically, these last stages of forest growth have been difficult to define or describe. Terminology has included primeval, pristine, primary, late seral or successional, climax, mature, overmature, and old growth, among others (Helms 2004). Standardized definitions are problematic because the final structure and age of a given forest stand depends on many biological and physical components, such as climate and geology, dominant tree species, fire regimes, and others (Kaufman and others 2007; Vosick and others 2007). Therefore, the forest structural indicators used to assess old forests may differ with changes in these components. In addition, the characteristics of old growth can change with the scale of observation, from patches to stands and landscapes (Kaufman and others 2007). Some of the structural indicators of relatively old forests may include the size (diameter) and age of the oldest trees, the number of large and/or old trees per acre, overall stand density, canopy characteristics, and downed logs (Fiedler and others 2007; Helms 2004).

One approach for assessing old forests using FIA data simply defines old forests as those with a stand age of 150 years or older. Based on this threshold, about 18 percent of New Mexico's forest land occurs in old forests (table 8), and the percentage varies by forest type group. Four forest type groups have more than 10 percent of their total area in stands at least 150 years old; in descending order of their total area, these include the pinyon/juniper, Douglas-fir, fir/spruce/mountain hemlock, and other western softwoods forest type groups. The group with the highest percent of old forests (43 percent) was the other western softwoods forest type group, which consists of limber pine, bristlecone pine, and a small amount of southwestern white pine. Nearly 28 percent of the area covered by the pinyon/juniper forest type group, or 4.5 million acres, occurs in stands at least 150 years old. The Douglas-fir and fir/spruce/mountain hemlock forest type groups have similar percentages of stands that are 150 years old or older (22 and 20 percent, respectively). Although ponderosa pine forests cover more than 2.5 million acres in New Mexico, less than 8 percent of their total area occurs in stands older than 150 years.

Table 8. Total area (acres) of each forest type group, area (acres) of each forest type group with stand age of at least 150 years, and percentage of each group's total area that has a stand age of at least 150 years.

Forest-type group	Acreage		Percentage of stands 150+ years
	All stands	Stand age 150+ years	
Pinyon/juniper group	13,606,726	3,762,459	27.7%
Woodland hardwoods group	4,818,080	113,423	2.4%
Ponderosa pine group	2,596,959	202,256	7.8%
Nonstocked	1,454,539	0	0.0%
Douglas-fir group	922,038	201,295	21.8%
Fir/spruce/mountain hemlock group	858,171	171,440	20.0%
Aspen/birch group	388,299	0	0.0%
Other western softwoods group	112,844	48,715	43.2%
Elm/ash/cottonwood group	64,196	4,751	7.4%
Exotic hardwoods group	15,934	0	0.0%
Other hardwoods group	1,589	0	0.0%
All forest type groups	24,839,375	4,504,340	18.1%

The large differences between forest type groups illustrate the need for type-specific definitions for identifying old forests. Some tree species are longer lived, or typically grow larger, than others. Life histories of different species may affect how much area would be expected to be dominated by large, old trees of a given species. For example, a larger proportion of old forest might be expected in limber or bristlecone pine than in aspen forest types. As noted above, the forest type group that includes the limber and bristlecone pine forest types had the highest proportion of its area in old forests; in contrast, almost no aspen or cottonwood stands met the 150-year stand age criterion. Some species or forest types are also more susceptible to disturbances that can result in decreased stand ages. For example, ponderosa pine comprised nearly half of the 2007 timber harvest in New Mexico, and more than 80 percent of the harvested timber came from trees 9 inches in diameter or larger (see Appendix A and the section, "New Mexico's Timber Harvest and Forest Products Industry"). This may partly explain why a relatively low percentage of ponderosa pine stands meet the 150-year stand age criterion.

One caveat of this approach is that stand age does not portray the range of individual tree ages within a stand. Stand age is calculated as the mean age of trees from the stand-size class that has the plurality of stocking. This can diminish the significance of older trees by averaging tree ages of both old and young trees, so using stand age to identify old forests may exclude stands that include both very old and very young trees. To address this issue, other criteria have been applied to FIA data from Idaho (Witt and others 2012), Montana (Menlove and others 2012), and Utah (Deblander and others 2010), including a minimum density of trees that are at least 150 years old; minimum tree diameters; and minimum stand density (basal area per acre). These analyses found that using various criteria to identify old forests produced widely different results. Therefore, any analysis of old forests must use carefully selected criteria that represent the specific stand structure of interest. Future research may use the FIA database to validate or even help to establish surrogate measurements for defining old forest structure by forest type, and under different site conditions, in different regions.

Understory Vegetation

The structure and composition of understory vegetation represents the diversity, productivity, and habit structure of forest ecosystems. FIA collects understory vegetation data using two distinct protocols that characterize overall vegetation structure as well as species composition. Under the vegetation structure protocol, field crews record the height class and percent cover that is occupied by each of four plant growth habits: forbs, graminoids, shrubs, and understory trees, which are defined as trees less than 5 inches d.b.h. Under the species composition protocol, height class, growth habit, and percent cover are recorded for plant species that individually occupy at least 5 percent of the ground area. If more than four species occupy more than 5 percent cover, then only the most abundant four species per life form are recorded. Note that in New Mexico, the threshold for recording individual species was lowered from 5 percent to 3 percent beginning in 2012 (USDA Forest Service 2006; USDA Forest Service 2011).

Figure 27 depicts the average percent cover of each plant growth habit within nine of New Mexico's most abundant forest types. Understory trees cover more area than the other three growth habits on all forest types except for juniper woodlands and mesquite woodlands, which both have more graminoid cover than understory tree cover. Graminoids occupy more area than forbs or shrubs on all forest types. Average graminoid cover ranges from 2.2 percent under white fir forests to 6.8 percent in juniper woodlands. Average forb cover is less than 2 percent on all forest types except for aspen, where the mean cover of both forbs and graminoids is just over 5 percent. More than 500 individual plant species were recorded on New Mexico's forest inventory plots. The most frequently recorded species within each growth habit are listed in table 9. New Mexico's State grass, blue grama (*Bouteloua gracilis*), was the most frequently encountered species by a large margin and was recorded on more than one-third of all forested plots. On average, blue grama covered 15 percent of all plots where it occurred. This species is not only common but is also relatively abundant where it occurs, compared to the other understory species listed in table 9.

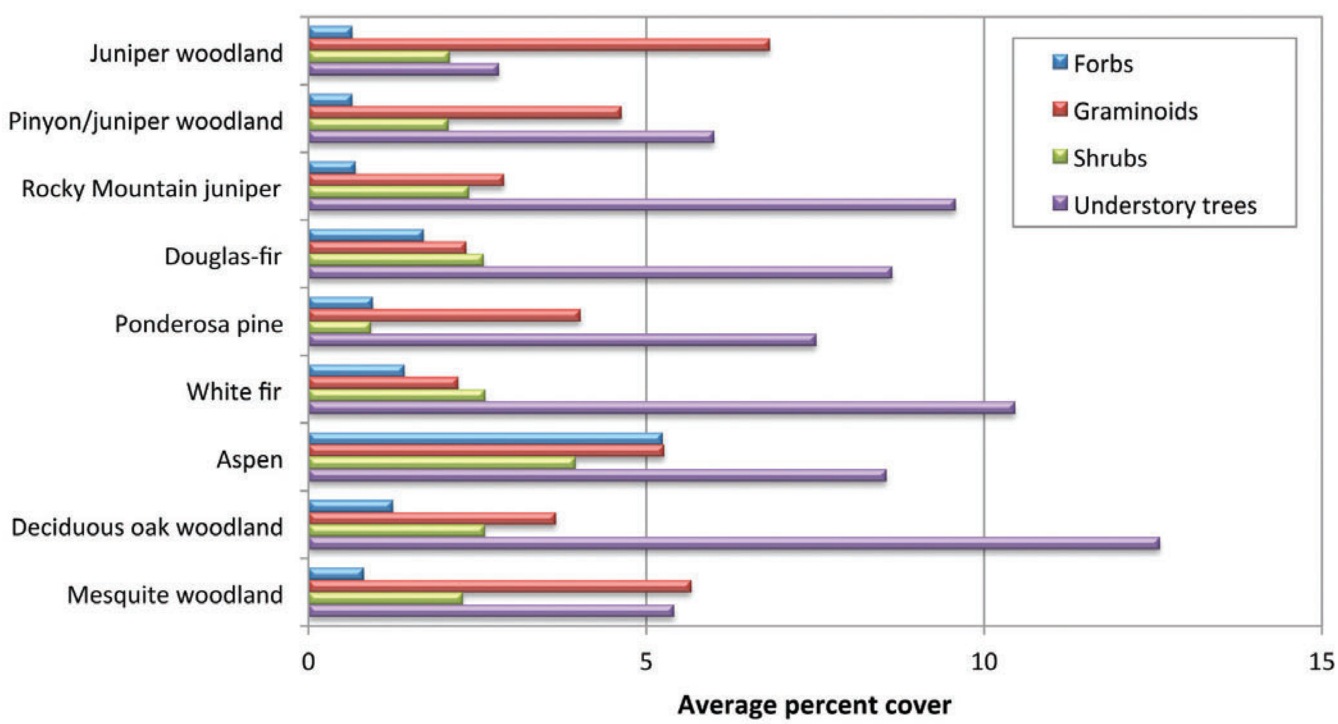


Figure 27. The average percent cover of the four understory vegetation growth habits, by forest type, New Mexico, 2008-2012. Only forest types that occurred on at least 50 plots are presented.

Table 9. The most frequently recorded plant species in each growth habit, as well as the number of plots where they occurred and their average percent cover, New Mexico, 2008-2012.

Growth habit	Species	Common name	Number of plots	Average cover
Forb	*Erigeron* sp.	fleabane	22	7.3
	Chenopodium graveolens	fetid goosefoot	16	6.3
	Achillea millefolium	common yarrow	13	5.7
	Lathyrus lanszwertii	Nevada pea	13	11.4
Graminoid	*Bouteloua gracilis*	blue grama	1231	15.2
	Bouteloua curtipendula	sideoats grama	323	9.1
	Festuca arizonica	Arizona fescue	205	9.2
	Muhlenbergia montana	mountain muhly	196	10.9
Shrub	*Cercocarpus montanus*	alderleaf mountain mahogany	369	8.4
	Gutierrezia sarothrae	broom snakeweed	308	6.8
	Artemisia tridentata	big sagebrush	182	10.9
	Atriplex canescens	fourwing saltbush	105	6.4
Understory tree	*Pinus edulis*	common pinyon	746	7.1
	Quercus gambelii	Gambel oak	656	16.0
	Prosopis glandulosa	honey mesquite	472	14.1
	Quercus x pauciloba	wavyleaf oak	352	15.2

Down Woody Material

The down woody material (DWM) component of forests influences fire behavior, wildlife habitat, soil stabilization, and carbon storage. Some examples of DWM are fallen trees, branches, and leaf litter, which are all commonly found in various stages of decay. The main components of DWM include fine woody debris (FWD), coarse woody debris (CWD), litter, and duff. FWD comprises the small diameter (1 to 3 inches) fire-related fuel classes (1-hour, 10-hour, and 100-hour), and CWD comprises the large diameter (3 inches or larger) 1,000-hour fuels.

Nationally, DWM is measured on Phase 3 plots. In 2006, due to the increasing need for more intensive DWM information, IWFIA initiated a Phase 2 DWM inventory throughout the Interior West region. This DWM analysis used regional Phase 2 protocols for data collected in New Mexico from 2008 to 2012. Due to the presence of snow or other hazardous conditions, not all DWM components could be sampled on all plots.

Figure 28 shows the geographic distribution of P2 DWM plots measured in New Mexico, as well as the total DWM biomass (tons per acre) at each plot. In general, DWM biomass abundance follows patterns of live biomass, which in turn follow regional climatic gradients (Garbarino and others, in review). Moist, high-elevation forest types common in the Southwest, like Engelmann spruce/subalpine fir, have relatively high DWM biomass. In contrast, drier forest types, such as pinyon/juniper and pure juniper woodlands, have relatively low DWM biomass.

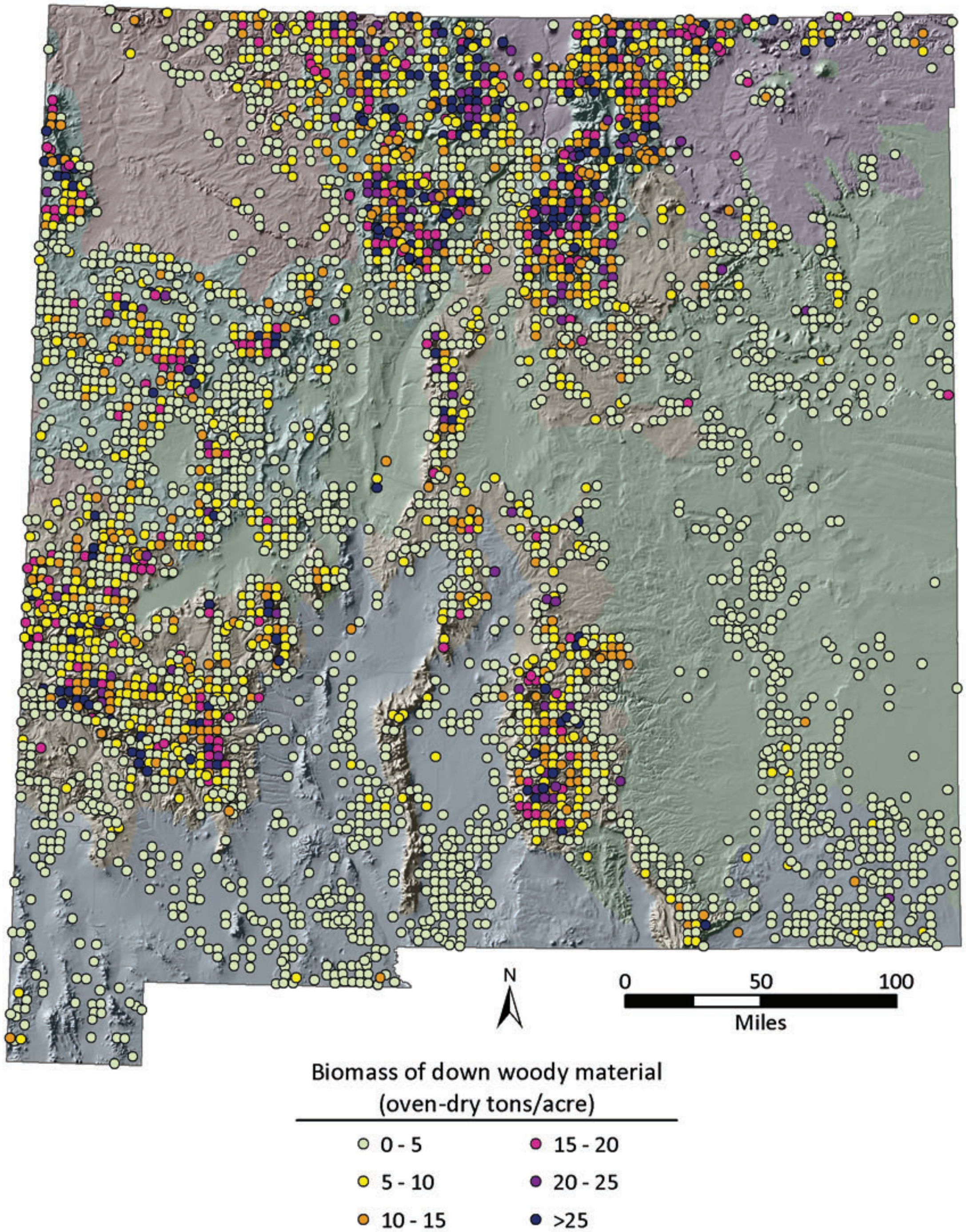


Figure 28. Total biomass of down woody material, New Mexico, 2008-2012. (Note: plot locations are approximate; some plots on private land were randomly swapped.)

Table 10 shows the number of conditions where DWMs were sampled, as well as mean biomass (tons per acre) by DWM component and by forest type. Among forest types with at least 10 observations, the Engelmann spruce/subalpine fir forest type has the highest mean DWM at 25.0 tons per acre, and mesquite woodlands have the lowest DWM biomass at 1.1 tons per acre. Mean biomass for some of the forest types in this analysis may not be representative due to small sample sizes; for example, the southwestern white pine forest type has a very high total DWM biomass but this is based on only one plot. The mean DWM biomass for New Mexico's forests is approximately 6.7 tons/acre.

Fuel loadings by DWM component are essential for predicting fire behavior. Table 10 shows that the duff DWM component has the highest mean fuel loadings overall, followed by the litter component and then the CWD component. Several forest types show some variation from this general trend.

Surface fuel classifications of duff, litter, FWD, and CWD for estimating fire effects were compiled from a wide variety of recent fuel sampling projects conducted across the contiguous United States (Lutes and others 2009). For each FIA condition, fuel loading ranges from these four fuel classes were used to identify one of 21 potential fuel loading models (FLMs) described by Lutes and others (2009). All of the 21 possible FLMs were identified on at least one plot. Figure 29 displays the number of conditions identified

Table 10. Number of conditions sampled and mean biomass (tons per acre) by DWM component, New Mexico, 2008-2012.

Forest type (field)	N	FWD, small	FWD, medium	FWD, large	CWD	Duff	Litter	Total DWM
Rocky Mountain juniper	29	0.2	0.5	0.6	0.7	3.8	4.0	9.5
Juniper woodland	363	0.0	0.1	0.3	0.1	0.6	0.8	1.9
Pinyon/juniper woodland	1,784	0.1	0.3	0.7	0.9	1.4	1.7	5.1
Douglas-fir	206	0.3	0.8	2.2	4.6	4.7	4.0	16.5
Ponderosa pine	572	0.1	0.6	1.1	2.5	5.0	4.0	13.2
White fir	66	0.3	0.9	2.2	5.0	7.7	3.0	18.5
Engelmann spruce	36	0.2	0.5	1.3	5.1	9.9	3.1	20.2
Engelmann spruce/subalpine fir	49	0.2	0.8	2.0	11.1	8.9	2.3	25.0
Subalpine fir	1	0.3	1.0	4.2	14.7	8.2	7.5	35.9
Blue spruce	11	0.2	0.4	1.6	3.9	5.4	3.0	14.3
Southwestern white pine	1	0.3	0.5	4.2	2.1	19.2	9.5	35.7
Bristlecone pine	2	0.1	0.2	1.3	2.0	0.5	1.9	6.0
Limber pine	6	0.3	0.8	2.4	1.9	2.2	3.0	10.6
Cottonwood	9	0.2	0.6	1.6	3.1	2.1	3.1	10.1
Aspen	40	0.1	0.5	2.1	5.6	11.7	4.3	24.3
Other hardwoods	1	0.0	0.0	0.0	0.0	0.0	0.8	0.9
Deciduous oak woodland	82	0.1	0.5	1.4	2.0	5.4	5.8	15.3
Evergreen oak woodland	54	0.1	0.3	0.7	1.0	1.8	2.2	6.2
Mesquite woodland	904	0.1	0.1	0.1	0.0	0.1	0.7	1.1
Intermountain maple woodland	1	0.0	0.2	0.8	3.8	0.0	0.8	5.7
Other exotic hardwoods	1	0.0	0.2	0.0	0.0	0.0	0.0	0.2
Total	4,218	0.1	0.3	0.7	1.3	2.2	2.0	6.7

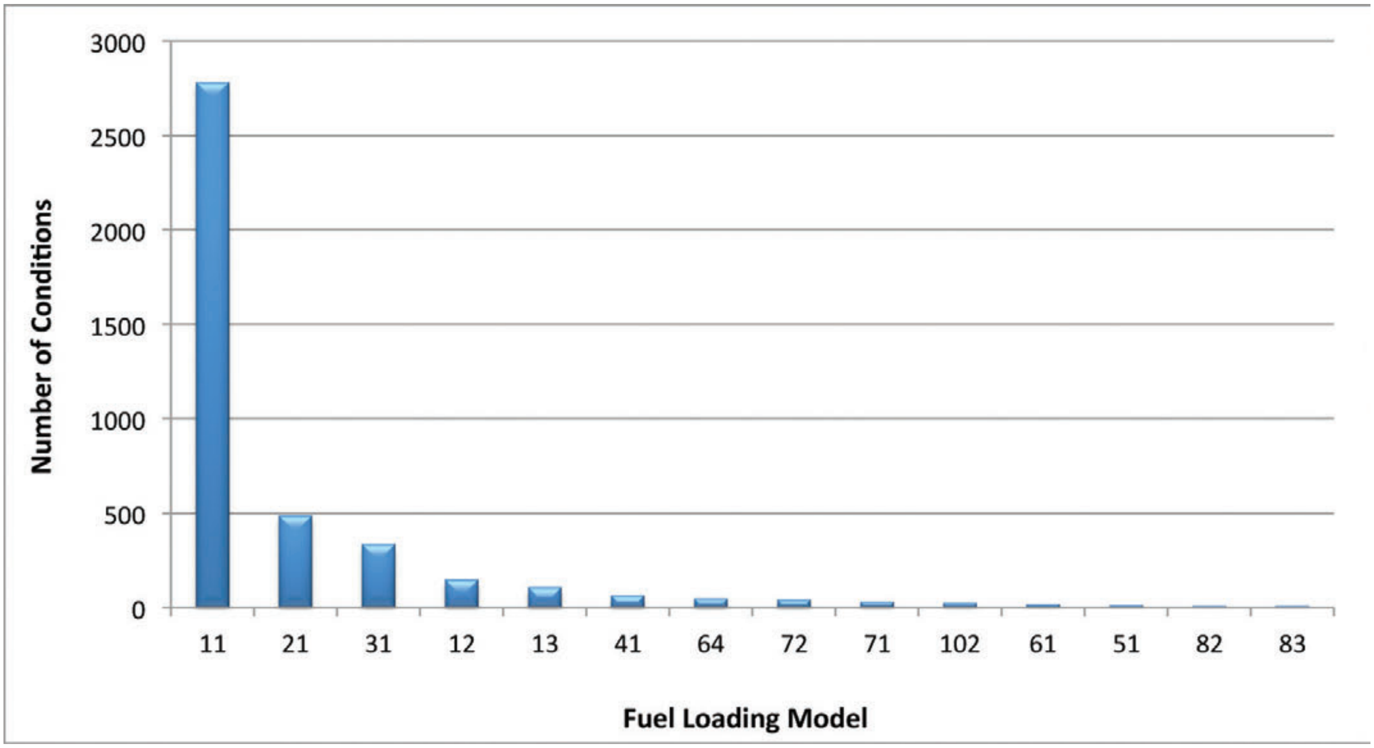


Figure 29. Most common fuel loading models (FLMs) for conditions in New Mexico, 2008-2012. FLMs found on fewer than 10 conditions are not shown.

by each FLM class, for all FLMs that were found on at least 10 conditions. The largest proportion of all conditions occurred in the class 11 FLM (2,782 conditions, or 67 percent), followed by classes 21 (489 conditions, or 12 percent) and 31 (336 conditions, or 8 percent). Although these plot classifications are currently under review, once they are objectively classified they can be used as inputs to fire effects models to compute smoke emissions, fuel consumption, and carbon released to the atmosphere.

Structural diversity in terms of CWD diameters and decay classes are important determinants of wildlife habitat quality. For example, wildlife species may use hollow, large-diameter logs for habitat. As part of IWFIA's Phase 2 DWM protocol, field crews record both large-end diameter class and decay class for each CWD piece tallied. Figure 30 displays the percentage of CWD pieces in each of five large-end diameter classes by forest type. At over 5 percent, the Engelmann spruce forest type has the highest percentage of CWD pieces in the 21.0-inch and larger class. All other forest types have less than 3 percent of their CWD pieces in the 21.0-inch and larger class. Only ponderosa pine, Engelmann spruce, and Engelmann spruce/subalpine fir forest types have more than 9 percent of pieces in the next smaller size class (15.0 to 21.9 inches). For all forest types, the plurality (38 to 49 percent) of CWD pieces fall into the 5.0 to 8.9-inch class.

Figure 31 displays the percentage of CWD pieces in each decay class by forest type. Decay classes can range from class 1, which characterizes newly fallen trees with no decay, to class 5, which includes pieces that still resemble logs but often blend into the duff and litter layers. For most forest types, the vast majority of CWD pieces are in decay classes 3 and 4, with decay class 2 being the third most abundant class for all forest types. Relatively few CWD pieces are found in decay classes 1 and 5.

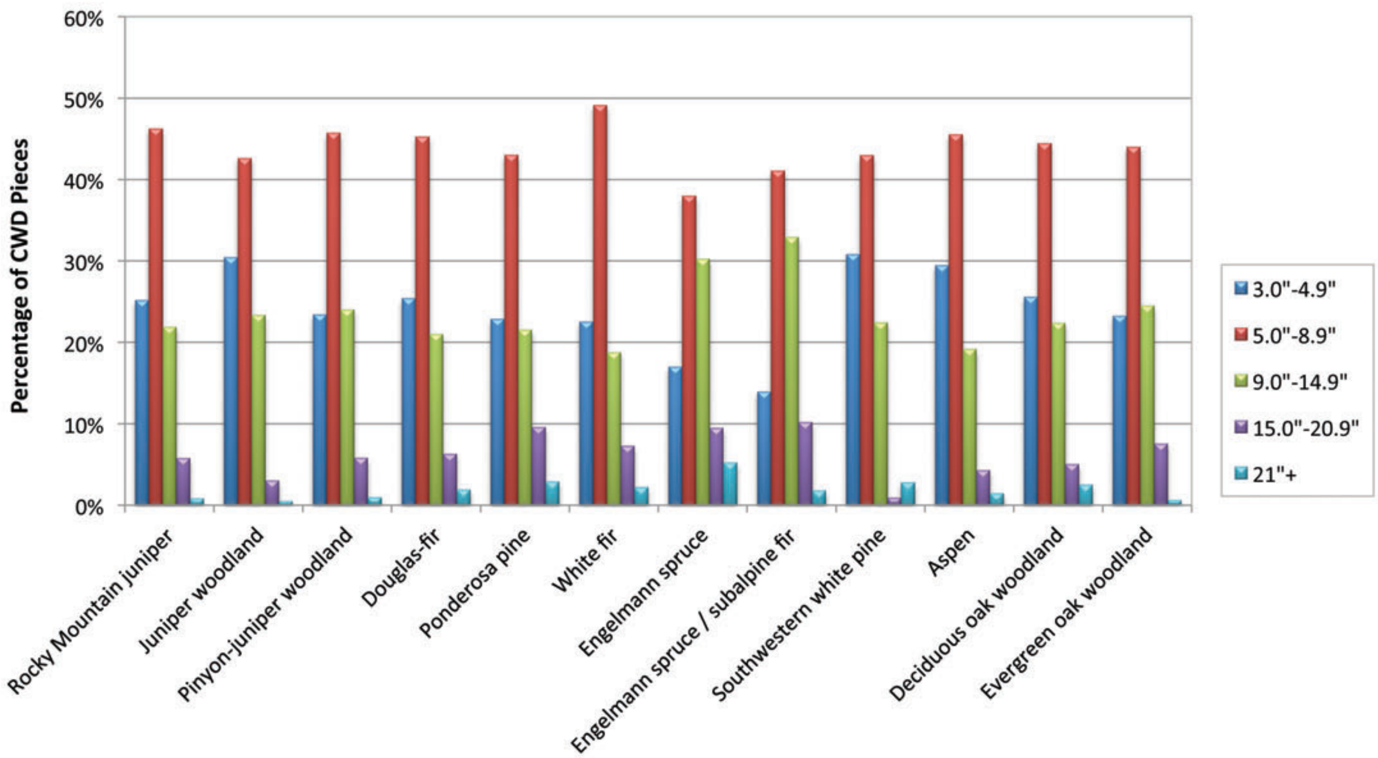


Figure 30. Distribution of coarse wood debris (CWD) piece sizes for forest types with tallies of at least 100 pieces, New Mexico, 2008-2012.

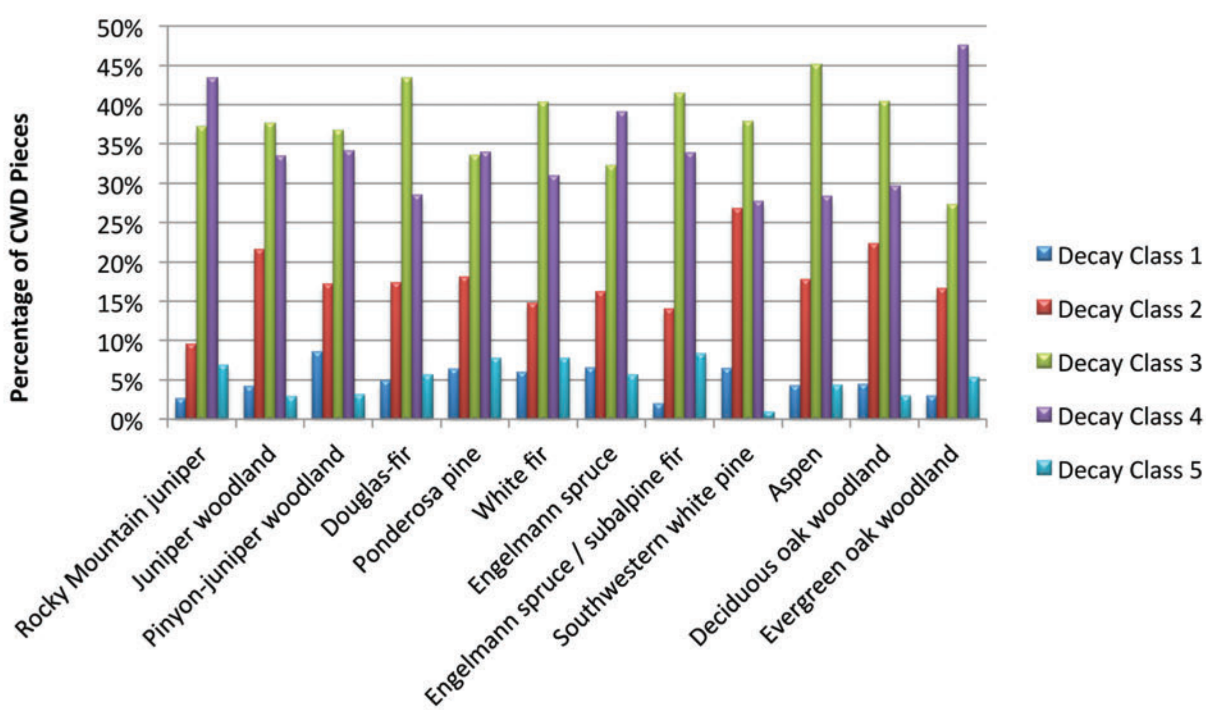


Figure 31. Distribution of coarse wood debris (CWD) pieces by decay class for forest types with tallies of at least 100 pieces, New Mexico, 2008-2012.

Although this analysis included only condition-level, per-acre estimates of DWM attributes, future analyses will allow the expansion of plot-level information to statewide population estimates based on IWFIA's regional Phase 2 DWM database. Furthermore, a national Phase 2 DWM protocol has been adopted to support a more robust and spatially consistent dataset for future fire fuel, wildlife structure, and carbon assessments. The new protocols will be compatible with IWFIA's current regional DWM protocols, permitting continuous monitoring of DWM status and trends. As estimates of DWM are improved and refined and then combined with FIA's understory vegetation and standing tree inventory, FIA will be better positioned to estimate total forest biomass.

Forest Soils

Soils on the landscape are the product of five interacting soil-forming factors: parent material, climate, landscape position (topography), organisms (vegetation, microbes, other soil organisms), and time (Jenny 1994). Many external forces can have a profound influence on forest soil condition and hence forest productivity. These include agents of change or disturbances to apparent steady-state conditions such as shifts in climate, fire, insect and disease activities, land use activities, and land management actions.

The FIA Soil Indicator of forest health was developed to assess the status and trend of forest soil resources in the U.S. across all ecoregions, forest types, and land ownership categories (O'Neill and others 2005). For this report, data were analyzed and are reported by forest type groups (see Appendix C for descriptions of forest type groups and forest types). Tables B38 and B39 present a complete listing of mean soil properties in New Mexico, by forest type group. These are least-squares means generated by the SAS GLMMIX data analysis software program. Some of the key soil properties were graphed by forest type group in New Mexico and are highlighted in the discussion below.

Forest soil resource data are available for five forest type groups in New Mexico: woodland hardwoods (deciduous oak, evergreen oak, and mesquite woodlands forest types); pinyon/juniper group (Rocky Mountain juniper, juniper woodlands, and pinyon/juniper woodlands forest types); ponderosa pine; Douglas-fir; and spruce/fir group (Engelmann spruce, mixed Engelmann spruce/subalpine fir, subalpine fir, and white fir forest types). Most of the soil samples represent the woodland hardwoods and pinyon/juniper groups with only a limited sampling in the other forest type groups in New Mexico.

Generally, soil moisture increases with elevation and latitude, which are both associated with cooler temperatures, and forest types tend to reflect this climatic gradient. The woodland hardwood and pinyon/juniper forest type groups tend to occupy drier lower-elevation sites whereas the spruce/fir forest type group is found in wetter environments at higher elevations. When expressed in terms of megagrams of carbon (C) per hectare of forest area, C stocks generally increase with elevation and/or soil moisture storage (figure 32, top; figure 33, top). Carbon stocks in the forest floor component of the woodland hardwoods and pinyon/juniper forest type groups are the smallest of all the stocks measured. The forest canopies of these forest types tend to be more open and there is much less forest floor accumulation than in wetter higher-elevation forests. Among all forest types, most soil C is stored in the top 10 centimeters of mineral soil, followed by the 10 to 20-centimeter increment, followed by forest floor. Soil nitrogen (N) stocks also tend to increase with elevation and soil water content (figure 32, bottom) with the largest stocks measured under the spruce/fir forest type group.

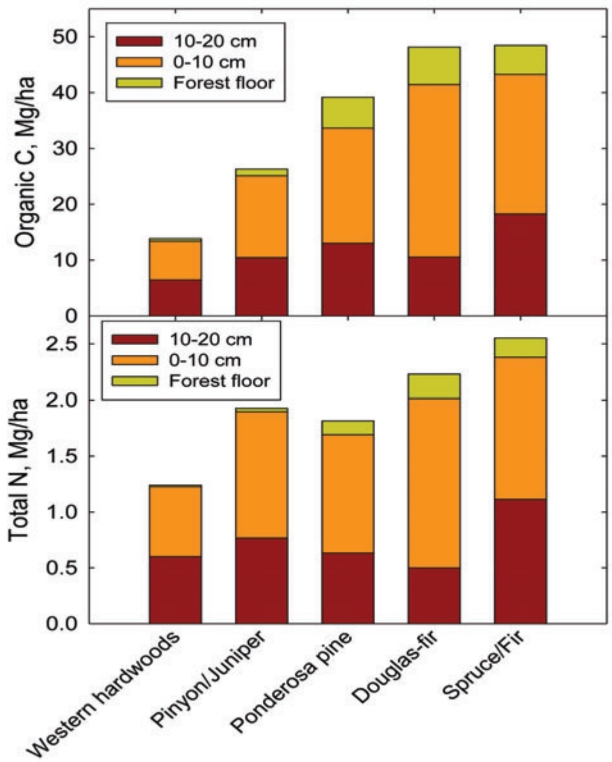


Figure 32. Distribution of organic carbon (top) and total nitrogen (bottom) stocks in Mg/ha in the forest floor, 0-10 cm, and 10-20 cm mineral soil depths in five forest type groups in New Mexico, 2008-2011, Phase 3 plots. Soil samples were collected from western hardwoods, pinyon/juniper, ponderosa pine, Douglas-fir, and spruce/fir forest type groups.

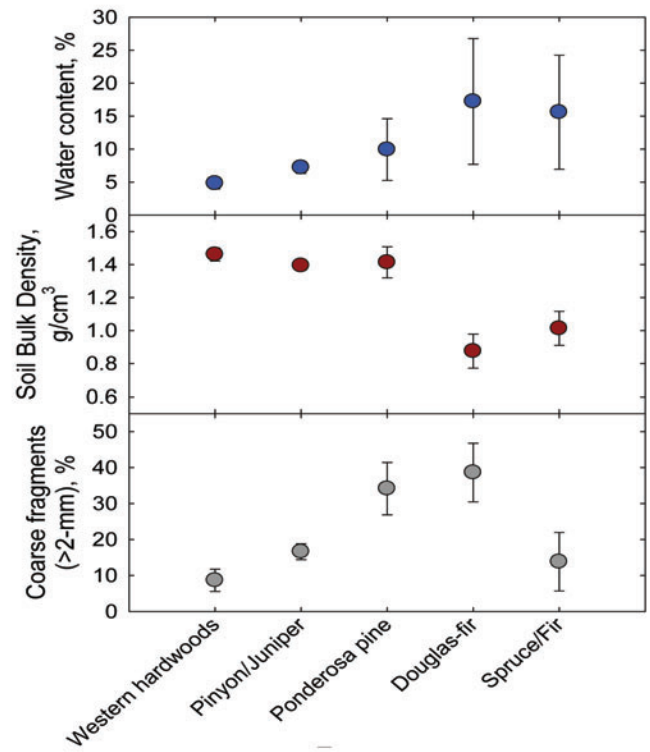


Figure 33. Soil water content (top), bulk density (middle), and coarse fragment (>2mm) content (bottom) of the top 20 cm of mineral soil in five forest type groups in New Mexico, 2008-2011, Phase 3 plots (note that soils were not sampled in 2012).

Soil bulk density (weight of soil per unit volume) influences many other soil properties including porosity and water-holding capacity. In forest soils, bulk density tends to be controlled by soil organic matter (SOM) content where bulk density decreases exponentially with increasing SOM (O'Neill and others 2005). In New Mexico, the lowest soil bulk densities tend to be found under Douglas-fir and spruce/fir forests (figure 33, middle), and these forests have the highest organic C concentrations (figure 34, top). Ponderosa pine and Douglas-fir forests tend to be found on rockier sites with high coarse fragment content (figure 33, bottom).

It is important to distinguish between organic and inorganic forms of C in soils. The organic forms participate in a wide array of biogeochemical reactions including serving as substrate for microbial decomposition and contributing to atmospheric CO_2. Inorganic forms, which are stored as carbonate minerals such as calcite ($CaCO_3$), tend to be more biologically inert but can be dissolved during physical, chemical, and biologically mediated mineral weathering reactions. In New Mexico, significant amounts of soil C are stored in carbonate minerals under forests in the woodland hardwood and pinyon/juniper forest type groups (figure 34, top). In contrast, the wetter, higher-elevation Douglas-fir and spruce/fir forest soils store higher concentrations of organic C (figure 34, top). Soil N concentrations tend to track organic C concentrations, with more soil N found in higher-elevation forest type groups (figure 34, bottom).

Soil pH is often closely related to the presence of carbonate minerals in soils. Thus, the higher-pH forest soils are found under woodland hardwoods and pinyon/juniper forest type groups (figure 35, top), which are the same forest type groups with relatively high

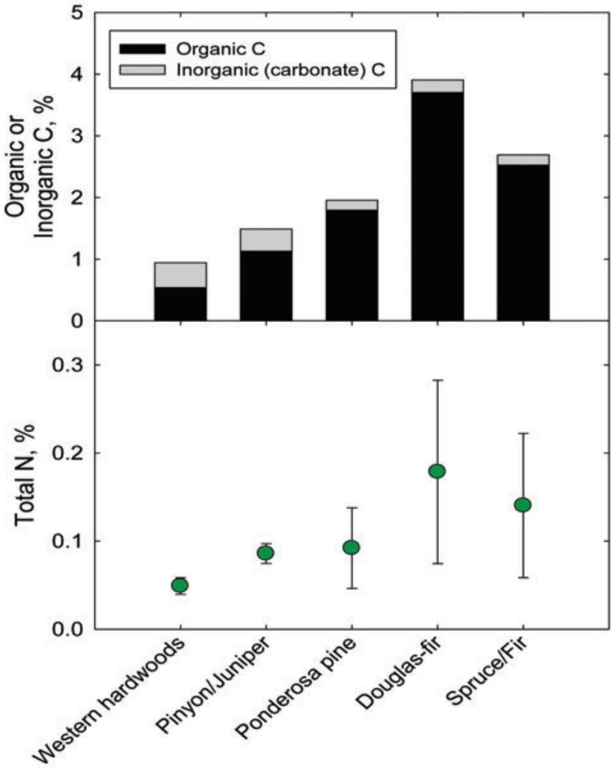


Figure 34. Carbon forms (organic, carbonate) (top) and total nitrogen (bottom) in the top 20 cm of mineral soil in five forest type groups in New Mexico, 2008-2011, Phase 3 plots (note that soils were not sampled in 2012).

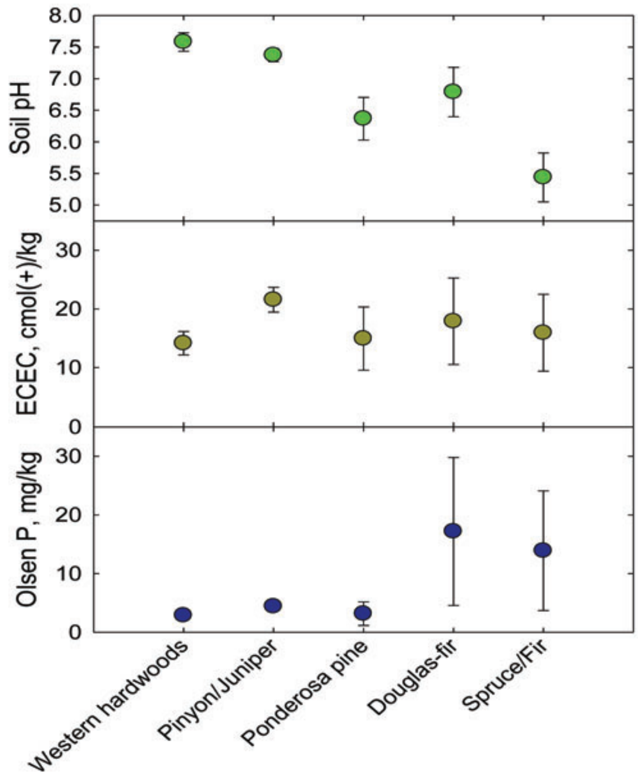


Figure 35. Soil pH (top), effective cation exchange capacity (ECEC) (middle), and Olsen (pH 8.5, 0.5 M $NaHCO_3$) extractable P (bottom) in the top 20 cm of mineral soil in five forest type groups in New Mexico, 2008-2011, Phase 3 plots (note that soils were not sampled in 2012).

amounts of soil carbonates. These soils are near-neutral to alkaline. Moderately acidic forest soils are not found until the higher-elevation spruce/fir forests are encountered. All the forest soils in New Mexico store appreciable amounts of exchangeable base cations as evidenced by the relatively high effective cation exchange capacities (ECEC) of these soils (figure 35, middle). The lower-elevation, higher-pH soils under the woodland hardwoods, pinyon/juniper, and ponderosa pine forest type groups tend to have low levels of bicarbonate-extractable phosphorus (P; figure 35, bottom). Bicarbonate-extractable P is used as a measure of bioavailable P for plant uptake. Higher amounts of bioavailable P are not found until soils in the Douglas-fir and spruce/fir forest type groups are encountered, but the range of values is considerable.

The Soil Quality Index (SQI) concept integrates 19 measured physical and chemical properties into a single value that serves as a means of tracking overall soil quality in time and space (Amacher and others 2007). Lower values indicate increased risk of soils-related forest health decline. Spatial changes in SQI on the landscape can be used to identify areas of higher or lower overall soil quality, and trends over time can be used to track potential declines in overall soil condition and thus provide an alert to potential declines in soils-related forest health. The increase in SQI with elevation tends to reflect the higher organic matter and higher overall productivity (higher nutrient content) of higher-elevation Douglas-fir and spruce/fir forests (figure 36). This is closely tied to the huge effect of soil moisture in controlling overall forest productivity.

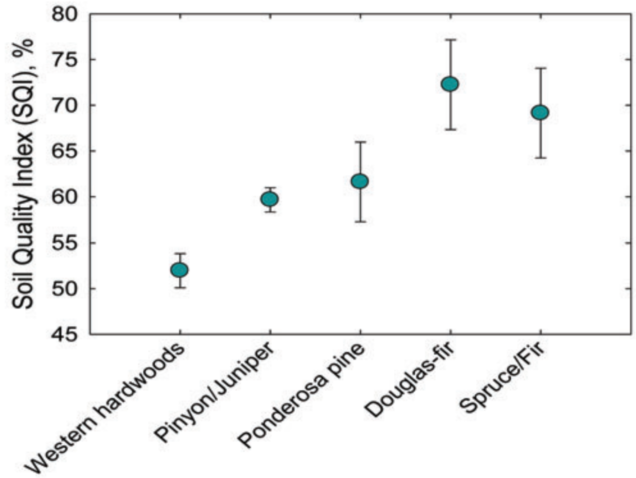


Figure 36. Soil quality index (SQI) in the top 20 cm of mineral soil in five forest type groups in New Mexico, 2008-2011, Phase 3 plots (note that soils were not sampled in 2012).

Current Issues in New Mexico's Forests

This chapter discusses issues of interest and concern to forest managers in New Mexico: effects of recent droughts on New Mexico's forests; the status and trends of aspen; damage to live trees including insects, diseases, and other damaging agents; the extent and effects of recent wildfires; and invasive and noxious weeds on New Mexico's forest land. Because of the long interval between New Mexico's periodic forest inventory and the implementation of the annual inventory, the final section discusses the differences between these two inventories and identifies trends that have occurred over the past decades. Although these topics do not represent all issues of concern to New Mexico's forest stakeholders, they provide an illustration of the types of information that can be analyzed using a comprehensive forest inventory dataset.

Drought-related Effects on Pinyon/juniper Woodlands

During the drought-related die-off of trees in pinyon/juniper woodlands just prior to New Mexico's annual forest inventory, about 8 percent of pinyon basal area and less than 2 percent of juniper basal area died.

Collectively, pinyon/juniper and juniper woodlands make up the most common forest type in the American Southwest, covering over 36 million acres in 10 U.S. States and extending into Mexico. In New Mexico, these types account for 13.6 million acres, or nearly 55 percent of the State's forest land. Within the pinyon/juniper forest type group, FIA distinguishes three main forest types: pinyon/juniper woodlands, juniper woodlands, and Rocky Mountain juniper woodlands (see Appendix C). The pinyon/juniper forest type is defined by the presence of one or more pinyon species – usually common or singleleaf pinyon – and one or more juniper species; pure stands of pinyon are not considered a separate type by the FIA program. Juniper woodland types are dominated by various juniper species, but other species – exclusive of pinyons – may be present as a minor component. To most laypersons and many managers, the term pinyon/juniper woodland (or P-J, for short) includes all lands dominated by pinyons, junipers, or both. For convenience, in this section the term "pinyon/juniper woodland" refers to all lands covered by this common use of the term and thus includes the juniper and Rocky Mountain juniper forest types as well as the pinyon/juniper forest type.

The Interior West FIA program operates in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming; these States include most of the range of pinyon/juniper woodlands in the United States. A drought began across much of the Southwest, including New Mexico (figure 37), about the time that an annual forest inventory was started in the Interior West States. As a result, forest managers and researchers began to notice an increase in the incidence of insects and disease in several forest types, including pinyon/juniper. As the drought progressed, tree mortality appeared to be increasing and there was increasing interest in using FIA data to quantify the effects of drought, insects, and disease on pinyon/juniper woodlands (Shaw and others 2005). The drought-related mortality episode has provided an opportunity to test the utility of the FIA annual inventory system for quantifying rapid change in pinyon/juniper woodlands over a large geographic area (Shaw 2006).

Since the annual inventory system was not implemented in New Mexico until 2008, the progression of drought-related mortality was not captured as it occurred in the early 2000s. In addition, if the 5-year mortality window used in other States had been applied in New Mexico, most of the mortality in New Mexico would not have been classified as recent mortality; it would have been considered "old dead" in the current inventory. Due to the lag between the greatest amount of mortality and the start of annual inventory in New Mexico, data collection and analysis methods were modified to capture the early 2000s mortality trees. FIA's usual 5-year mortality window was extended to 10 years, and field crews were asked to make their best estimate of actual mortality year. Assignment of mortality year for visits up to 5 years post-mortality is known to be relatively reliable because of rapid changes in tree condition (Kearns and others 2005), but correct assignment becomes increasingly difficult with time. Most mortality trees removed by firewood cutting, blown down, or no longer "on the stump" for other reasons would still

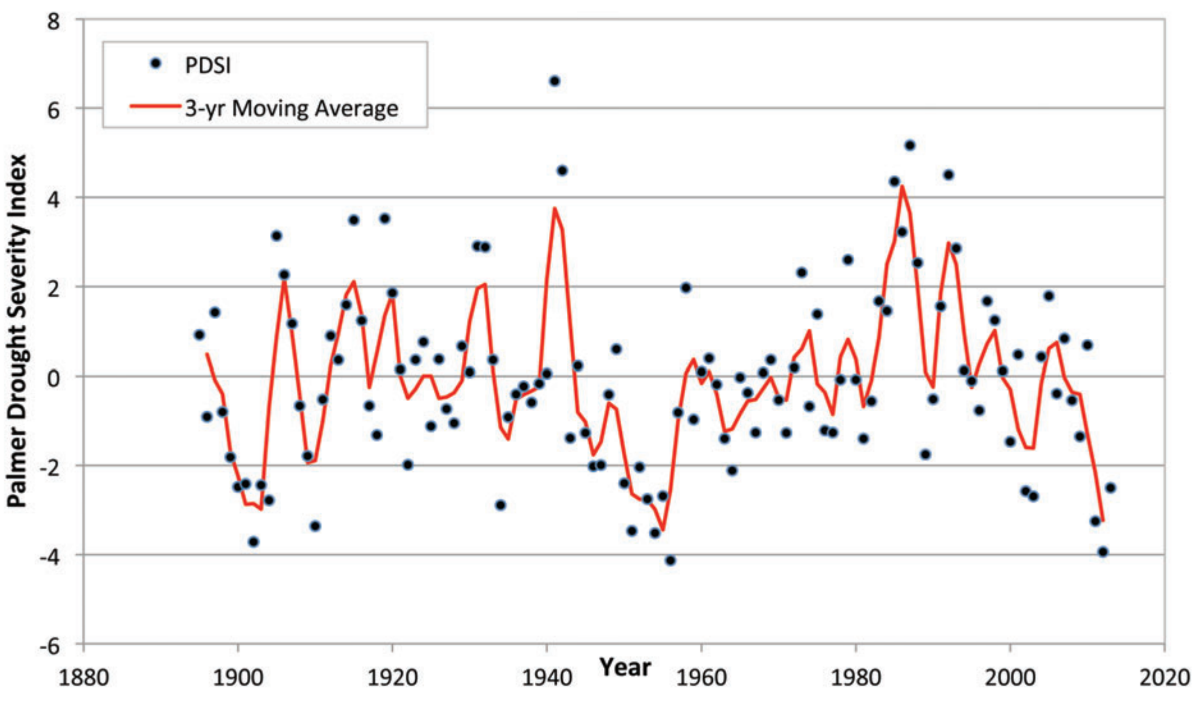


Figure 37. Palmer drought severity index (PDSI) for New Mexico, 1895-2013. Positive values indicate relatively moist conditions and negative values indicate drought. Points are average for all climate divisions in New Mexico (National Climatic Data Center 1994) and red line is the 3-year moving average.

be missed by the current inventory, but these situations cover only a small percentage of tally trees. As a result, we consider our estimate of drought-related mortality in New Mexico to be a good approximation, but not as precise as in other States where annual inventory was implemented earlier.

Because the New Mexico annual inventory was phased in over a short period of time and plot visits tended to be concentrated in different areas in different years, the data collected thus far cannot be used to show annual trend as for other States. Therefore, average mortality on all plots collected between 2008 and 2012 is shown as a reference line in a plot of annual data from the Four Corners States (figure 38). Similarly, the trend for all Interior West States combined reflects the addition of States as annual inventory progressed, so the data points for many years reflect somewhat different geographic coverage. This causes some noise when the data are plotted as a time series, but the general trend is apparent.

a

b

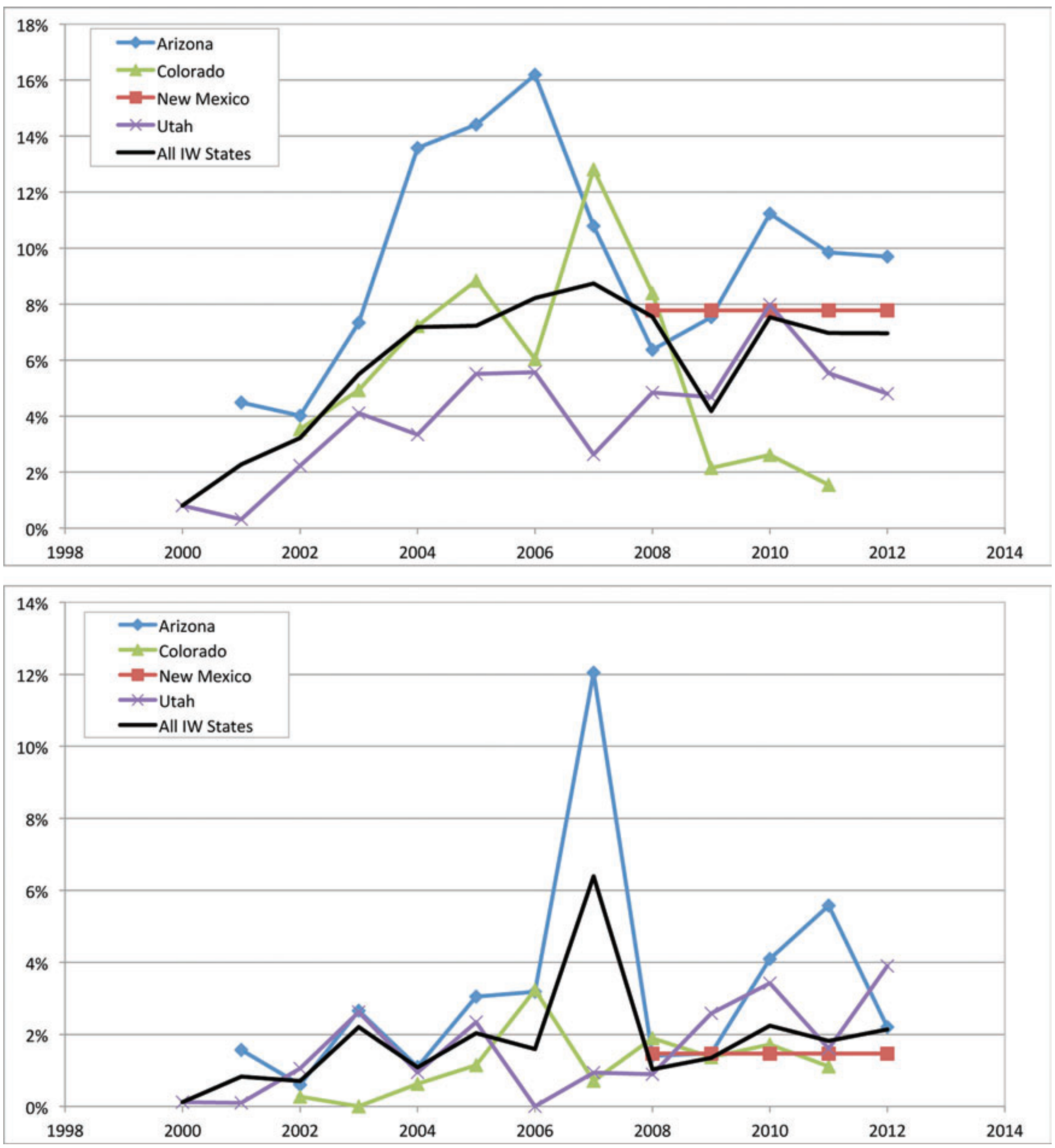


Figure 38. Annual mortality, by measurement year, for pinyon (a) and juniper (b) species in the Interior West States.

Pinyon mortality from all causes in the Interior West began to increase in 2001, and appears to have peaked between 2005 and 2007 (figure 38a). Since then, mortality rates have decreased and some States appear to be returning to background mortality rates. However, drought persists in the Southwest, including in New Mexico (figure 37), and fire continues to impact pinyon juniper woodlands in many areas. Mortality of pinyon in New Mexico in the 2000s appears to be about equal to the mortality rate of pinyons in all Interior West States combined – about 8 percent of the total basal area. Among the Four Corners States, the level of pinyon mortality in New Mexico is somewhat higher than in Utah and lower than in Colorado. It is unlikely that total pinyon mortality in New Mexico approached the levels found in Arizona—where it was almost twice as high—even when considering that some mortality in New Mexico could have been missed due to the late start of the annual inventory.

Juniper species have shown to be much more resistant to drought-related mortality than pinyon species. From 2000 to 2003 the mortality rate of juniper species in the Interior West States, from all causes, rose from a very small fraction to about 2 percent, and has remained relatively steady since then (figure 38b). The apparent spike in juniper mortality seen in 2007 is largely a result of a large number of "catch-up" plots in Arizona that were located in burned areas. As with the pinyon species, the juniper mortality rate in New Mexico is about on par with the mortality rate for the Interior West as a whole.

The dramatic visual effect of drought-related mortality of pinyon species – dying trees with reddened foliage covering entire landscapes – brought public and media attention to the event. Because there were typically localized hot spots of mortality that were surrounded by large areas of relatively low mortality, it was difficult to obtain unbiased, quantitative estimates of the true extent of mortality. In some cases, mortality estimates were extrapolated from local sites to entire States. For example, one account reported that 90 percent of the pinyon trees in the State of Arizona had been killed (Society of American Foresters 2004). However, a preliminary analysis of the available data in Arizona, Colorado, and Utah (Shaw and others 2005) showed that there was clearly an upward trend in mortality but population-level mortality was not nearly as high as initially feared. Mortality in New Mexico's pinyon/juniper woodlands was thought to be comparable to what was found in surrounding States, but no plot-based estimate was possible until the implementation of the annual inventory.

Pinyon/juniper woodlands in New Mexico have maintained positive net growth during a decade when many other forest type groups have experienced negative net growth (see table B22). However, elevated rates of mortality have resulted in lower net growth in the pinyon/juniper forest type group than was estimated during the 2000 periodic inventory. Today it appears that mortality remains above the background rate that would be expected for pinyon species during non-drought times, but the year-to-year change in mortality appears to be decreasing.

One persistent question about the current episode of drought-related mortality is: "How does the current episode compare with previous drought-related die-offs?" The climatic record shows that similar droughts occurred in the Southwest during the early 1900s and mid-1950s (National Climatic Data Center 1994). Breshears and others (2005) characterized the recent mortality event as a response to "global-change-type drought," and suggested that recent conditions have been hotter than in the 1950s. Some of the conclusions about the relative magnitude of recent mortality and the mortality of the 1950s are based on the lack of evidence, in the form of remaining dead woody material, from the 1950s. However, despite the perceived long-term persistence of woody material in the arid Southwest, pinyons may decay or physically break down relatively quickly. Although Kearns and others (2005) found that pinyon snags could persist as long as 25 years, they found that "extremely fragmented" trees were dead for an average of 16.2 years. Because the impacts of the 1950s drought were not well-studied and there is a great deal of uncertainty surrounding the possible surviving evidence of pinyon mortality, the relative magnitude of the two mortality episodes remains uncertain.

The recent drought has undoubtedly impacted the pinyon/juniper resource in New Mexico, but the magnitude of impact varies widely between the pinyon and juniper components. Differential mortality among species on the same site has been shown by Mueller and others (2005), who found mortality of common pinyon to be 6.5 times higher than oneseed juniper mortality during two drought events in northern Arizona. Future mortality rates will likely depend on temperature and precipitation trends. The mortality event of the early 2000s corresponded with a shift of the Palmer Drought Severity Index (PDSI) from positive (wetter) to negative (drier) values, while the decrease in mortality rate corresponded with a temporary shift back to positive values. However, in recent years PDSI has once again become negative. Whether there is a resurgence in mortality or not depends on a number of factors, including what effects the earlier drought-induced thinning of dense stands will have on competition and water relations. The dynamics of this forest type have important implications for carbon storage, because dead trees have released growing space to the survivors and new regeneration. Although there has been a short-term loss in living biomass, there may be a long-term increase in carbon storage while dead wood persists and new growth accumulates. It will be possible to determine the actual trends as FIA continues to monitor these woodlands into the future.

Aspen Status and Trends

Aspen forests cover more than 380 thousand acres in New Mexico, and aspen trees occur on 1.6 million acres. The area and volume of aspen have not changed appreciably over the past decade.

Aspen is the widest-ranging tree species in North America. It is present in all States in the Interior West and occupies a wide elevational range, from 2000 feet in northern Idaho to 11,700 feet in Colorado. It is also found on a wide range of sites, and occurs in 26 of the forest types that occur in the Interior West. The species is intolerant of shade and relatively short-lived, which makes it prone to replacement by conifers through successional change. In the Interior West, it also reproduces infrequently by seeding, relying mostly on root sprouting for reproduction. However, aspen responds well to fire and cutting, and it is able to dominate heavily disturbed sites for many years following severe disturbance. In addition, there is some evidence that aspen is able to persist in conifer-dominated forests by exploiting gaps in the conifer canopy that are caused by insects, disease, windthrow, and other smaller-scale disturbances.

In recent years, there has been concern about the future of aspen on the landscape, primarily due to the characteristics of aspen and how they relate to changes in disturbance regimes. The earliest concerns were related to successional change in the Interior West, where fire suppression has decreased disturbance rates and, as a result, aspen regeneration rates. In addition, it has been shown that large populations of herbivores can inhibit aspen regeneration where it occurs spontaneously or after disturbance (e.g., Hessl and Graumlich 2002). The lack of disturbance allows conifers to gain dominance where they are present; in pure aspen stands, consumption of regeneration by ungulates could lead to loss of senescing overstory trees without replacement. More recent concerns are related to a period of drought that has affected aspen and other forest types (e.g., Shaw and others 2005; Thompson 2009). Drought appears to have contributed to mortality in many low-elevation stands (Worrall and others 2008), and in some of these stands regeneration is either lacking or suppressed by herbivores.

Johnson (1994) suggested that the acreage of aspen-dominated stands had declined as much as 46 percent in Arizona and New Mexico between the 1960s and late 1980s, with most of these acres becoming dominated by mixed conifer forest types. Bartos (2001) suggested that similar changes – aspen acres dropping by 88 percent – had occurred in New Mexico as compared with "historical" extent, although the time scale over which this change is believed to have occurred was not specified. These assessments of "lost" aspen acres were based on the assumption that forested acres with a minority aspen component were, at one time in the recent past, dominated by aspen in pure or nearly pure stands. This assumption may not be reasonable because there are many situations where aspen may persist normally as a minor stand component.

Current inventory data show that there are just over 380,000 acres of the aspen forest type in New Mexico, compared to over 365,000 acres found during the 2000 inventory (O'Brien 2003). When considering all acres where aspen is present, the current inventory data show that at least one live aspen stem is present on about 1.6 million acres in both inventories. The proportions of forest types that contain an aspen component are effectively the same in both inventories (figure 39). On a live volume basis, there were approximately 887 million cubic feet of live aspen volume found in the current inventory, compared to an estimate of about 906 million cubic feet in the 2000 inventory.

Another way to compare the previous and current inventories is to normalize data on a common basis, such as volume per acre. During the 2000 periodic inventory in aspen-dominated stands (aspen forest type), the average volume per acre of all aspen (live and standing dead) was just over 1,717 cubic feet per acre, with nearly 1,431 cubic feet per acre in live aspen. In the current inventory, aspen-dominated stands averaged 1,659 cubic feet per acre of live and dead aspen volume, with 1,446 cubic feet per acre of live aspen. The results are similar for all stands with an aspen component of trees at least 1 inch in diameter. Aspen cubic-foot volume in these stands averaged just over 695 cubic feet per acre in the periodic inventory, with about 553 cubic feet per acre of live aspen. These numbers were comparable in the current inventory: 687 cubic feet per acre of live and dead aspen, and 555 cubic feet per acre of live aspen.

Comparisons between the 2000 periodic inventory results and current inventory data suggest that there has been no significant net change in aspen extent or stocking during the past decade in New Mexico. The small differences between inventories are within the error ranges of the estimates. This is not to say that there have not been changes to the aspen population over time. The normal expectation for undisturbed forest land is a general increase in volume over time. As a result, our finding of relatively unchanged volume and extent suggests that positive net growth of the late 1990s (O'Brien 2003) was equally offset by the drought-related and fire-caused mortality of the 2000s. Net growth of aspen is currently negative (see the Forest Change Components section of this report), possibly because of the large fires that occurred during the mortality estimation period (i.e., 10 years prior to measurement).

Whether aspen returns to positive net growth in the short-term or long-term largely depends on the causes of mortality. Natural senescence of stands is occurring constantly, as aspen stems reach the end of their natural lifespan (Schier 1975). During periods of drought, large areas of older, less resilient stands may die off (Worrall and others 2008). Although naturally declining stands also regenerate naturally, high browsing pressure from ungulates, both wild and domestic, can effectively suppress regeneration (Hart and Hart 2001; Kay 2001) and lead to elimination of some clones (Schier 1975). Although this is known to occur, it does not yet appear to have made a significant impact in terms of acres occupied by aspen in New Mexico.

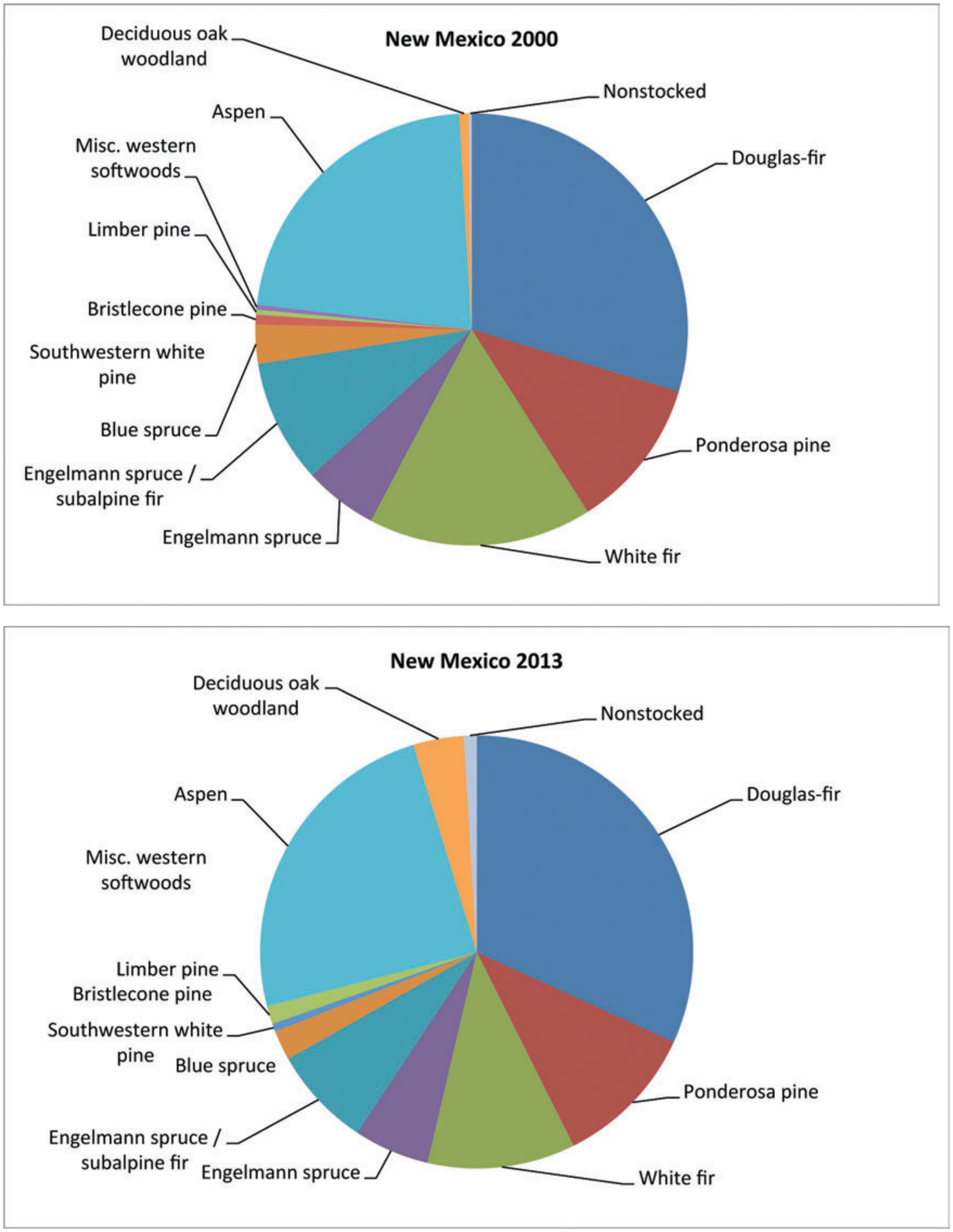


Figure 39. Proportion of acreage in each forest type with an aspen component in New Mexico, 2000 and 2013. The aspen forest type is defined as having at least 50 percent stocking of aspen.

Aspen stand replacement by fire, on the other hand, is expected to have a generally beneficial effect on aspen in the long term. Pearson (1914) observed that remnant aspen were scattered throughout many spruce forests in New Mexico. Given that these stands were likely in a late stage of succession, they were likely dominated by aspen in the late 1700s or early 1800s. Even when aspen remains as a minor component in mixed stands, it can quickly reassert dominance following stand-replacing fire. For example, Patton and Avant (1970) documented aspen densities of over 10,000 stems per acre following a fire in spruce/fir forest on the Santa Fe National Forest. Unburned areas of the stand were estimated to have only 100 stems per acre. Fire-related regeneration events can be episodic. Touchan and others (1996) reconstructed the fire history for several sites in Jemez Mountains. Although major fires occurred throughout the 1800s, aspen regeneration was associated with only a few events and with different events in different places. Today, aspen stems or stands of this age class (>120 years old) are the ones in greatest need of regeneration.

Many studies have shown aspen to be in decline at local scales (e.g., Bartos and Campbell 1998; Di Orio and others 2005; Johnson 1994; Worrall and others 2008), while other analyses have shown increased dominance of aspen in some landscapes (Kulakowski and others 2004). It is not surprising that studies documenting loss are more numerous, because unexplained or unexpectedly high mortality events tend to attract the attention of managers, researchers, and the public. Because these changes are evident to a wide range of observers, there is a tendency to extrapolate local conditions to larger areas. Although we have detected substantial mortality in the current inventory, our results do not support the assertion of wide-scale decline in New Mexico. In fact, the amount of aspen-dominated acreage estimated during the two most recent inventories (O'Brien 2003; table B3) is greater than the acreage estimated to exist in 1986 by Johnson (1994); Johnson's projection that "aspen will cease to exist as a distinct cover type" before the year 2020 is highly unlikely.

Aspen is found in many forest types with a wide variety of associate tree species, so the characteristics of aspen-dominated stands and stands with aspen as a minor component vary considerably over the range of the species. This makes generalization difficult, especially when based on the limited data available in most studies. In addition, local or regional trends may differ from those of the population as a whole, because agents like drought and fire are not regularly distributed over the landscape. However, with continued monitoring under the annual inventory system, FIA will be able to assess regional- and population-scale trends in aspen with a higher degree of confidence than has been possible in the past.

Damage to Live Trees

Damages to live trees in New Mexico consist primarily of form-related damage agents, while low rates of disease and insect damage were also recorded.

The Interior West FIA program has used a regionally defined damage protocol for most of the periodic and annual inventories since 1981. Throughout this time, the protocol has remained consistent, with only a few modifications to the damage categories. Damage agents are recorded only for live trees, in contrast to mortality agents, which are recorded only for trees that recently died. Not all damage agents are potential mortality agents, so there is only partial overlap in the two agent lists. A nationally consistent protocol for non-lethal damage to trees was implemented by the FIA program in 2013. A vast majority of the damage categories used in the national protocol correspond directly with the Interior West regional categories, ensuring that it will be possible to track trends in damaging agents over time.

Between 2008 and 2012, FIA used 50 damage codes representing a wide range of biotic, abiotic, and human-caused damage agents. A single tree may be assigned up to three damage agents, in decreasing order of their impact on the tree. The protocol is based on a threshold system, where only trees with evidence of serious physical damage, insect infestation, or pathogen infection are assigned damage agent codes. Although this is somewhat subjective, the general rule is that damage should be recorded when it will cause at least one of the following:

1. Prevent the tree from living to maturity, or surviving 10 more years if already mature.
2. Prevent the tree from producing marketable products.
3. Reduce (or has seriously reduced) the quality of the tree's products.

These rules roughly correspond to two main categories of damage agents. Agents that are likely to prevent a tree from living to maturity or surviving for 10 years after the inventory date tend to be those related to insects, disease, fire, and atmospheric effects (drought, flooding, wind, etc.), whereas agents that preclude or reduce a tree's merchantability are more likely to be problems with form, such as forks, broken tops, or bole scars. Trees with form-related damages may or may not be affected with respect to survival. Therefore, not all trees with damages recorded are expected to die, and some of those with poor merchantability may live to typical upper ages for their species.

New Mexico's annual forest inventory tallied 76,342 trees between 2008 and 2012. About 23 percent of all trees 5.0 inches in diameter or larger had at least one damage agent recorded (table 11). However, the percentage of trees with recorded damages differed between timber (about 30 percent) and woodland (19 percent) tree species (see Appendix D for definitions of timber and woodland species). Since the live tree damage protocol has been in effect since 1981, we can compare the proportion of trees with recorded damages between the periodic and annual inventories. Due to differences between the two inventories, we cannot directly compare numbers of trees or population-scale estimates. During periodic inventories of New Mexico between 1986 and 2000,

Table 11. Percentage of timber trees, woodland trees, and all tallied trees assigned each damage agent group as a primary damage agent, New Mexico, 1986-2000 (periodic inventory) and 2008-2012 (annual inventory).

	Periodic inventory (1986-2000)			Annual inventory (2008-2012)		
Damage agent group	Timber	Woodland	All species	Timber	Woodland	All species
No damage	57.3%	72.8%	67.1%	70.5%	81.0%	77.1%
Insects	1.7%	0.2%	0.8%	4.8%	2.6%	3.4%
Diseases	5.9%	6.5%	6.3%	4.5%	3.6%	3.9%
Fire	0.1%	0.1%	0.1%	1.0%	0.4%	0.6%
Animals	1.0%	1.5%	1.3%	0.6%	0.6%	0.6%
Weather	1.0%	0.6%	0.7%	0.3%	1.3%	1.0%
Suppression	0.5%	0.2%	0.3%	0.7%	0.4%	0.5%
Form	32.2%	17.4%	22.8%	17.5%	9.2%	12.3%
Human	0.2%	0.8%	0.5%	0.1%	0.9%	0.6%
All damage agent groups	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

80,316 trees were tallied. Damage agents were assigned to about 33 percent of all trees, including 43 percent of timber trees and 27 percent of woodland trees. Both the periodic and annual inventories had very small percentages of trees with two or three damages recorded. From 2008 to 2012, only 5 percent of all tallied trees were assigned two or more damage agents, and less than 1 percent had three damage agents recorded. Between 1986 and 2000, 7 percent of all trees were assigned two or more damage agents, and only 1 percent was assigned three damage agents.

Damage agents related to form or merchantability accounted for the majority of primary damage agents (table 11). For both timber and woodland species, form-related damage agents were recorded roughly twice as frequently during 1986-2000 as 2008-2012, suggesting that thresholds for form damages may have been interpreted differently between the periodic and annual inventories. Note that this temporal discrepancy in form-related damage agents accounts for the magnitude of the differences in total damage percentages between the two inventories.

Insects were recorded as the primary damage agent for about 3 percent of trees between 2008 and 2012. Defoliators accounted for the vast majority of timber trees with insect damage, while nearly twice as many woodland trees were damaged by bark beetles compared to defoliators. Note that although a major pinyon mortality event occurred in New Mexico in the early 2000s (Shaw and others 2005), most of these trees had died before the annual inventory began. Although the total number of trees with insect damage was fairly small between 2008 and 2012, insect damage rates among timber trees were about three times, and woodland trees about ten times those recorded during the periodic inventory.

Diseases were recorded for 4 percent of all live trees between 2008 and 2012, compared to 6 percent between 1986 and 2000. The most common diseases recorded for timber species were stem and butt rots (including conks), cankers, dwarf mistletoe, and broom rusts. Among woodland trees, the most common diseases were stem and butt rots, true mistletoe, and dwarf mistletoe. The current percentage of woodland trees with true mistletoe is less than half the rate recorded during the pre-2000 inventories.

Each of the other primary damage agents affected less than 1 percent of all trees between 2008 and 2012, and none changed appreciably since the periodic inventory. These damage agents include fire, animals, weather, suppression, and human impacts. Less than 1 percent of live trees had fire recorded as a damaging agent; this low percentage could be expected given that less than 1 percent of all forest plots in New Mexico fell within the perimeters of large fires (see the "Recent Fires" section of this report, below). More timber trees than woodland trees were damaged by fire. Most of the animal-related damages to timber trees can be attributed to big game species, although both timber and woodland trees had low rates of damage caused by porcupines and sapsuckers. Weather-related damage to trees shifted from primarily flood-related damage during the periodic inventory to more drought-caused damage between 2008 and 2012, particularly among woodland trees. (Note that the major drought-related mortality event of the early 2000s occurred prior to this inventory.) The primary human-caused damage agent consisted of woodland cutting.

Recent Fires

> Less than one percent of all forest plots fell within the perimeters of recent large fires.

Fire is an important disturbance that influences the structure and dynamics of New Mexico's forests. In some forest types, such as ponderosa pine, fire can maintain open stands and stimulate the growth of grasses and forbs in the understory. Throughout the Interior West, a century of fire suppression has led to a buildup of fuels and stand densification, which may lead to uncharacteristically intense fires (Reinhardt and others 2008).

Areas that burn intensely may experience slow regeneration, but others may recover relatively quickly. For example, the area inside the boundary of the large 1910 fires in Idaho and Montana (Cohen and Miller 1978; Egan 2009; Pyne 2008) now carries about the same amount of live tree volume per acre as areas outside the fires, although the mean stand age is somewhat lower and the volume is generally distributed among smaller trees (Wilson and others 2010).

There were many fire complexes in New Mexico during the period covered by this report. Some FIA plots within fire boundaries were measured before and some were measured after the fires occurred. As a result, some fire perimeters contain both pre-fire and post-fire plots, while others may contain only pre-fire or only post-fire plots. Pre-fire plots represent the original conditions in areas that later burned, while only post-fire plots provide insight into the short-term effects of fire. This means that normal data compilation methods cannot be used without introducing some element of temporal bias. These limitations on analysis will be reduced as the current inventory cycle is completed and remeasurement data are acquired during the next cycle. However, there are some general analyses that can be conducted with the current data.

We used data from the Monitoring Trends in Burn Severity (MTBS) project, which is an interagency effort being conducted and maintained by the USDA Forest Service Remote Sensing Applications Center and the U.S. Geological Survey National Center for Earth Resources Observation and Science. The purpose of the MTBS project is to map the perimeters and severities of large wildland fires (including wildfire, wildland fire use, and prescribed fire) across all lands of the United States. In western States, the project includes all fires larger than 1,000 acres (Eidenshenk and others 2007). The analysis presented here is based on fire perimeters identified by the MTBS program between 2005 and 2011 and FIA plot data collected between 2008 and 2012 in New Mexico. These fire perimeters included about 3 percent of all plots in New Mexico (341 plots). Forty percent of the plots within fire perimeters were forest plots, 53 percent were nonforest plots, and 7 percent were nonsampled or inaccessible plots.

MTBS data showed that 325 fire perimeters from 275 different fires burned a total of 2.1 million acres in New Mexico between 2005 and 2011. These fires ranged from 617 acres to nearly 151 thousand acres, with an average size of 16.3 thousand acres. Forested plots measured between 2008 and 2012 fell within the boundaries of 56 fire perimeters. The remaining 269 fire perimeters encompassed only nonforest plots, non-sampled plots, plots that have not yet been measured in the current cycle, or no FIA plots. The largest fire—the 151,000-acre Las Conchas Fire—encompassed 19 single-condition forest plots, which constitutes more forest conditions than any other fire. The next five largest fires were all greater than 75,000 acres and encompassed between 10 and 16 FIA plots, some of which included multiple conditions.

When comparing plot-based area estimates to MTBS fire area estimates, inconsistencies related to spatial scale illustrate the sampling noise inherent in small area estimation. Most of the plot-based area estimates were smaller than the MTBS fire area estimates. For example, the plot-based area estimate for the Los Conchas fire is nearly 126 thousand acres of forest land, which is about 13 percent less than the MTBS fire area estimate, and indicates that this fire burned mostly forested areas. The McDonald and Miller fires were the only fires where the plot-based area estimates were larger (15 and 14 percent, respectively) than the MTBS fire area estimates. The McDonald fire was the fourth largest fire and had 16 nonforest plots. The Miller fire was the fifth largest fire and had 15 plots, where 13 were single-condition forest plots and 2 were nonforest plots. These two fires help to demonstrate that although the plot-based estimates and MTBS fire area estimates for smaller fires can be similar, it is not appropriate to draw inferences about the proportions of forest and nonforest areas within small, individual fires.

At this point in the New Mexico inventory, the scaling factor for a single plot is just over 6.6 thousand acres, which is smaller than most of the fires in the MTBS database for the time period analyzed. As a result, the proportion of burned acreage in forest versus nonforest should be estimated by aggregating a large number of plots and burned areas.

Given that population-scale estimates are difficult to produce with a partial inventory, another approach is to compare per-acre estimates of forest attributes. Using FIA data to construct such estimates requires examining individual forest conditions, rather than entire plots, because forested plots may comprise a single forested condition, multiple forested conditions, or a combination of forested and nonforested conditions (see "Inventory Methods: Plot Configuration" for more information about conditions). There were 3,605 forested conditions measured on 3,444 plots in New Mexico between 2008 and 2012. Of these forest conditions, 3,471 were located outside the MTBS fire boundaries and 134 were located inside (figure 40). Of the 134 conditions located inside the fire perimeters, 41 were measured prior to the fires and 96 were measured after the fires occurred. These two values do not add up to the 134 conditions mentioned above but rather add up to 137 due to the fact that three conditions burned multiple times and thus constituted both pre-fire and post-fire measurements. Conditions located outside the burned areas had an average of 82 square feet of total basal area per acre in live and dead trees, and 69 square feet in only live trees. Conditions within the burned areas that were measured before the fires occurred averaged 90 square feet of total basal area per acre and 76 square feet per acre of only live trees. Thus, the pre-fire conditions within the fire perimeters appear to have slightly more basal area than conditions outside the burned areas. However, the proportion of live basal area relative to total basal area (live plus dead) was 84 percent for both pre-fire plots and plots outside fire perimeters. This suggests that the burned areas did not have extraordinarily high basal area of standing dead trees prior to the fires, but the higher total basal area indicates that these stands may have had higher stand density, larger trees, or less down wood than stands outside fire perimeters.

When comparing within-fire pre-burn conditions to within-fire post-burn conditions, it is possible to estimate the proportion of trees killed within burned areas. Conditions located within fire boundaries and measured after the fires averaged 86 total square feet of basal area per acre, with 59 square feet of basal area remaining in live trees. Comparing the average live basal area from the post-fire conditions to the pre-fire conditions (59 versus 76 square feet per acre) is consistent with the expectation that fire would result in a reduction of the basal area for live trees. If it is assumed that the pre-burn conditions are representative of the post-burn conditions, then it would appear that the average fire-caused mortality was about 17 square feet per acre, or about 22 percent of the pre-fire live basal area. The ratio of live to total basal area was 69 percent in post-burn stands, compared to the 84 percent ratio observed on pre-fire and unburned plots. The lower average total basal area found in post-burn conditions as compared to pre-burn conditions (86 versus 90 square feet per acre) is consistent with the expectation that fire would result in some basal area being consumed and/or falling down after burning.

One beneficial effect of fire is the potential stimulation of aspen regeneration. Although there are only about 388 thousand acres of the aspen forest type in New Mexico, approximately 1.4 million acres have some aspen component. Of the 220 conditions measured with some aspen component, only 10 were located within MTBS fire boundaries, and six of these were measured post-fire. Although this sample is very small, it suggests that the number of potentially fire-disturbed acres with aspen present is about 42 thousand acres, or about 3 percent of all acres with an aspen component.

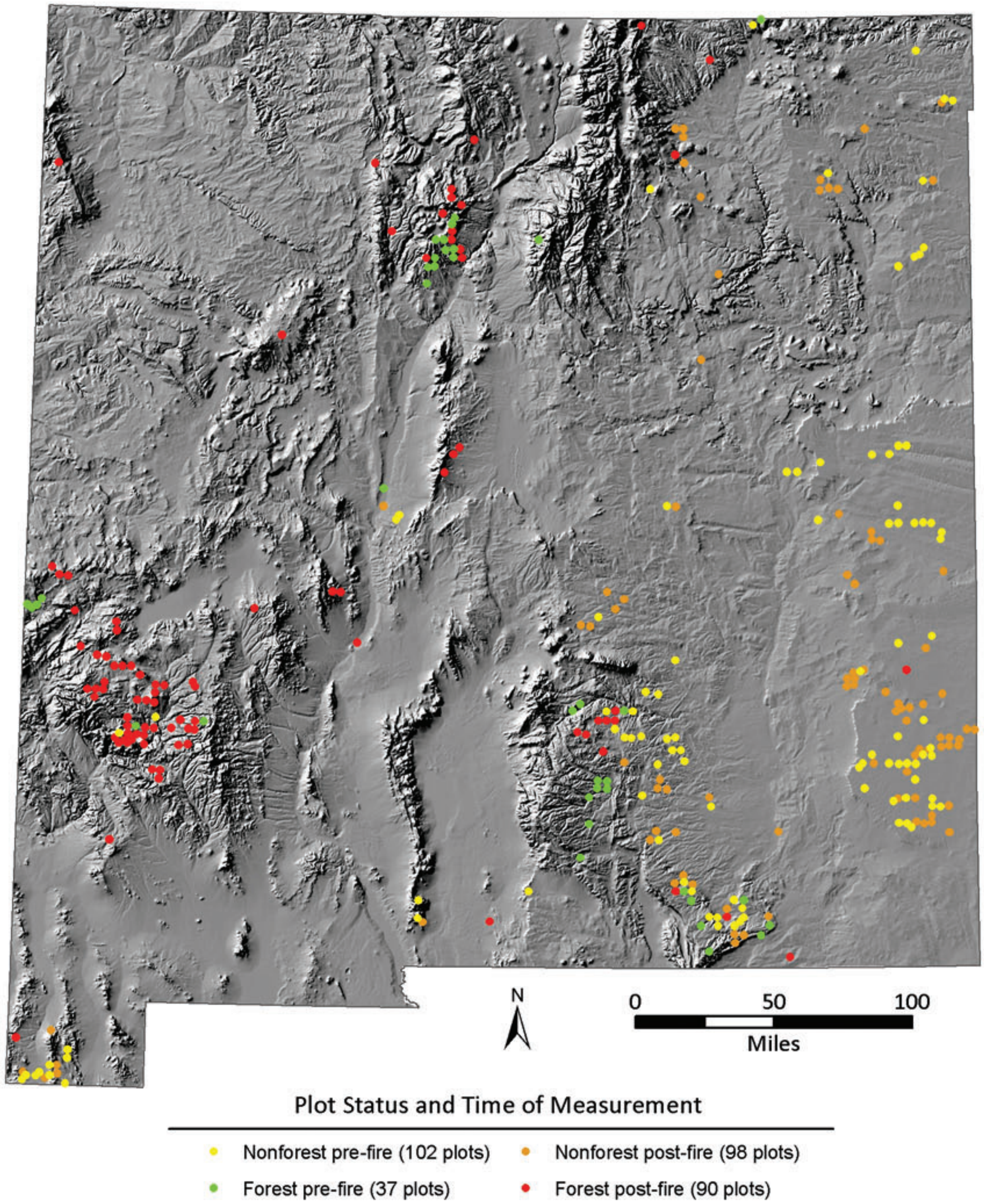


Figure 40. Distribution of plots that occur within MTBS fire perimeters from 2005-2011, by plot status (forest versus nonforest) and time of measurement (pre-fire versus post-fire), New Mexico, 2008-2012.

Converting this figure to an annual rate and assuming that fire will be evenly distributed over time and area, it implies that it would take over 200 years for all acres with aspen present to be disturbed by fire. This rate may be lower than would be necessary to maintain aspen across the New Mexico landscape. However, other inventory data show that aspen forest types are fairly stable throughout New Mexico (see the "Aspen Status and Trends" section of this report). Given the short time period over which the estimate of aspen stand disturbance has been made, ongoing monitoring will provide more precise estimates of disturbance intervals and long-term trends.

The analyses in this section should be considered only a first approximation of fire effects on New Mexico's forests. Although the results are generally consistent with expectations, the magnitude of fire-related mortality cannot be stated with precision at this point in the inventory. Nonetheless, the data confirm that there has been only partial mortality within fire boundaries. Additional data and analysis will be required to determine whether, for example, mortality is more or less evenly distributed among plots within the burned areas or mortality tends to be all-or-none at the plot scale. Remeasurement data will be necessary to confirm the portions of standing live and dead trees that are consumed by fire and converted to the down woody material pool. The Accelerated Remeasurement and Evaluation of Burned Areas (AREBA) project may also shed light on the actual rates of mortality and conversion of standing dead trees to down woody material. The objective of AREBA is to remeasure FIA plots that fall within MTBS perimeters within 1 year of the fire (Megown and others 2011). AREBA was initiated in New Mexico during 2013 with the remeasurement of 66 recently burned FIA plots (Bob Rhoads, pers. comm.). Future remeasurements of FIA plots, whether on regularly scheduled inventory cycles or immediately following fire under the AREBA project, will not only enable analysis of fire's effects on specific forest types such as aspen, but they will also provide important information on the amount and rate of recovery in all burned areas over time.

Invasive and Noxious Weeds

Ten different invasive species were found on 35 plots, or only 1 percent of all forest plots. Three species – saltcedar, bull thistle, and musk thistle – accounted for more than 70 percent of all occurrences.

Noxious plant species can have many negative effects on forest communities. Noxious species can displace native flora, alter fire regimes, reduce diversity in the plant and pollinator communities, and generally reduce the diversity and resiliency of forest ecosystems. FIA field crews record any instance where a noxious weed is found on a plot that contains a forested condition. This allows the spatial and temporal extent of these species to be documented as plots are revisited. A total of 3,444 sample plots included a forested condition within the boundaries of the four subplots, and these plots were used to assess the occurrence of noxious plants in New Mexico.

Ten different invasive species were recorded on 1 percent of all field-sampled plots, for a total of 35 plots, in New Mexico (table 12). Saltcedar (*Tamarix ramosissima*), bull thistle (*Cirsium vulgare*), and musk thistle (*Carduus nutans*) were the most common invasive species, collectively accounting for over 70 percent of weed occurrences. Invasive species were recorded on 17 nonforest plots. The pinyon/juniper forest type group included eight invasive species occurrences, and cottonwood and mesquite woodlands forest types each had five occurrences. Several other forest types had between one and three occurrences.

Table 12. Invasive plant species recorded on plots that contain at least one forest condition, New Mexico, 2008-2012. Note: some plots had more than one condition and more than one invasive species recorded.

Species	Common name	Species code	Number of occurrences
Acroptilon repens	Russian knapweed, hardheads	ACRE3	1
Carduus nutans	musk thistle	CANU4	7
Cirsium arvense	Canada thistle	CIAR4	3
Cirsium vulgare	bull thistle	CIVU	8
Convolvulus arvensis	field bindweed	COAR4	1
Elaeagnus angustifolia	Russian olive	ELAN	2
Halogeton glomeratus	halogeton, saltlover	HAGL	1
Onopordum acanthium	Scotch cottonthistle	ONAC	1
Tamarix ramosissima	saltcedar	TARA	10
Ulmus pumila	Siberian elm	ULPU	2

The number of plots with invasive species was too small to permit analysis of site factors that may allow or facilitate invasion by weedy species. However, as New Mexico's forest inventory enters its second cycle, additional data may illuminate such factors. For example, specific forest types may be more prone to noxious plant infestation than others. Factors that may affect a site's propensity for infestation include soil conditions, accessibility to livestock grazing, road and foot traffic, high frequency of both natural and man-induced disturbance such as burning or flooding, and/or edge effects.

Riparian Forests

New Mexico's riparian forests serve as oases in the desert in this relatively arid region. FIA's forest types include only one riparian forest type, the cottonwood forest type, which is New Mexico's sole forest type within FIA's elm/ash/cottonwood forest type group. These riparian cottonwood forests are referred to as bosques, from the Spanish word meaning "woods" or "forest." To qualify as a cottonwood forest type, cottonwoods must make up at least 50 percent of the total stocking on the condition. Fremont cottonwood and narrowleaf cottonwood are the two most dominant species in New Mexico's bosques. Only 11 plots, or less than 1 percent of all forest plots in the current forest inventory of New Mexico, include cottonwood forest types. This small number of plots precludes making robust assessments of the status of the State's riparian forests. Nonetheless, the ecological importance of these forests warrants a brief summary of their composition.

Six of the cottonwood forest plots consisted of Fremont cottonwood and occurred below 6,000 feet in elevation. The remaining five plots were at higher elevations and consisted of narrowleaf cottonwood. Five of the 35 plots where invasive or noxious weeds were recorded (14 percent) fell within cottonwood forests (see "Invasive and Noxious Weeds" section). Four cottonwood forest plots included saltcedar (also known as tamarisk), which was recorded more frequently than any other plant species among the 11 riparian forest plots. Russian olive was recorded at only one cottonwood forest plot.

This description of New Mexico's riparian forests is based on a small sample size and therefore should not be treated as a comprehensive assessment of the State's riparian resources. The small number of plots in riparian forests underscores FIA's inability thus far to adequately sample riparian areas, which can be attributed to two aspects of the sample and plot design. First, riparian areas are proportionally rare in terms of their area across the landscape, so it is unlikely that many plots will intersect them. Second, riparian areas are linear and sometimes narrow. Therefore, when a plot falls near a riparian area, a portion of the plot footprint may intersect a riparian area that is too small, or intersect too small an area within the plot, to be sampled as frequently as other forest types. Despite these limitations, in addition to the 11 plots that occurred within cottonwood forest types, individual Fremont cottonwood or narrowleaf cottonwood trees were recorded at more than 70 additional plots. Future analyses will examine the status of forest areas that include cottonwood species, regardless of the predominant forest type. As New Mexico's forest inventory enters its second cycle, remeasurement of these plots will allow assessment of trends over time.

Comparisons Between New Mexico's Periodic and Annual Forest Inventories

One purpose of New Mexico's annual forest inventory is to provide information about changes in forest attributes over time. Prior to the implementation of the annual inventory, several periodic inventories were conducted in the State. The 2000 periodic inventory was the most comprehensive of these earlier inventories (O'Brien 2003; note that this inventory is labeled as the 1999 inventory in the national FIA database), whereas the annual inventory is the most comprehensive inventory overall. If the definitions and methods used during the 2000 inventory were compatible with those used during the annual inventory, we could quantify trends that occurred between 2000 and 2012. However, the plot designs, sample designs, forest definitions, and estimation procedures used during the two inventories were different enough to preclude reliable trend analysis. Pre-2000 periodic inventories are even more dissimilar from the annual inventory. Therefore, direct comparisons of periodic and annual inventories, in their entireties, are not recommended. This section describes the primary differences between the periodic and annual inventories, and then presents an appropriate and robust comparison of periodic and annual inventory data at plots that were measured during both inventories. Although the following analysis is needed to bridge dissimilar inventories, the sampling consistency provided by adoption of the annual inventory system should preclude the need for similar analyses in the future.

Differences between periodic and annual forest inventories in New Mexico—The primary differences between New Mexico's periodic and annual forest inventories pertain to the plot design, sample design, estimation procedures, and definitions used to distinguish trees from tree-like vegetation and forest from nonforest areas. Each of these differences, as well as the implications for assessing forest trends over time, is discussed below.

The plot design and data collection procedures varied widely throughout New Mexico's historical forest inventories. The earliest periodic inventories relied more on stand delineation using aerial photographs than on plot data to produce estimates of forest area, while wood volumes were estimated from plot data (Choate 1966). Later periodic inventories used variable-radius plots with varying numbers of subplots, and the plot data were used for both area and volume estimation. Plots measured between 1996 and 2000 incorporated the current four-subplot, fixed-radius design. As described in the Plot Configuration section of this report's Inventory Methods chapter, annual inventory plots encompass four subplots in a fixed-radius design.

Sample designs also changed appreciably, from random or targeted samples to a spatially representative plot grid. The annual inventory is designed to be a representative sample of all lands within the State that meet the current FIA definition of forest land. In contrast, most of the individual periodic inventories excluded specific woodland forest types, ownership types, ecoregions, and/or counties. Some periodic inventories omitted National Forest lands, while data collected in 1993 and 1994 sampled only the Gila

National Forest. The sample intensity, or grid spacing of field plots, was not consistent among the various periodic inventories. Finally, the statistical estimation procedures of past inventories did not account for bias introduced when plots are non-sampled, which can result in under-estimation of attributes such as forest land area (Patterson and others 2012); this issue has been addressed in the annual inventory (Goeking and Patterson 2013).

The periodic inventories of the 1980s and early 1990s differentiated between tree-form and shrub-form trees. For example, pinyon pines that were less than 6 feet tall and were not expected to eventually produce a straight, 8-foot trunk section were not considered to be trees and were not measured. Therefore, many woodland plots in the current annual inventory would not have been measured under previous definitions. Although the 2000 periodic inventory did not differentiate tree-form from shrub-form trees, it did utilize data from plots measured in the 1980s if no disturbances had occurred at those plots. As a consequence, the definitional differences from the 1980s inventory were introduced into the 2000 inventory dataset. In contrast, the annual inventory identifies trees strictly by their species, regardless of growth form.

Examples of inappropriate comparisons between periodic and annual inventories range from comparing the volume on a specific forest type to directly comparing the total area of forest land. For example, a direct comparison of the area occupied by ponderosa pine forests shows a decrease of nearly 2 million acres between 1966 and 2000 (table 13). This discrepancy is likely not due to real change, but rather due to changes in FIA's forest type algorithm. As late as the 1980s, forests were classified as timberland if timber species constituted at least 5 percent cover, even if woodland species had more cover in the stand (USDA Forest Service 1986). By the 1990s, forest types were assigned based on a plurality of stocking (USDA Forest Service 1998). Therefore, the apparent decline in ponderosa pine area is probably an artifact of inconsistent methods for assigning forest types, and it may partially explain increases in woodland and nonstocked forest types.

Table 13. New Mexico's estimated forest land area (thousands of acres) by forest type in 1966 (from Choate 1966), 2000 (from O'Brien 2003), and 2012.

Forest type group	1966	2000	2012
Douglas-fir	1,109	918	922
Ponderosa pine	4,487	2,805	2,597
Fir-spruce	641	972	858
Aspen	400	365	388
Cottonwood	0	32	64
Pinyon/juniper	10,635	9,937	13,607
Woodland hardwoods[a]	652	1,148	4,818
Other western softwoods	43	76	113
Other western hardwoods	0	27	18
Nonstocked	220	402	1,455
Total forest land area	18,187	16,682	24,840

[a] Referred to as chaparral in Choate (1966); includes mesquite, oak (evergreen and deciduous).

Over this same period, the total area of forest land area was estimated at 18.2 million acres in 1966, 16.7 million acres in 2000, and 24.8 million acres in 2012 (table 13). The huge difference in 2012 is not because the area of forest land increased over the past few decades, but is primarily due to changes in the sample design and a new definition of forest land that is more inclusive of woodland forests. The 1966 and 2000 area estimates for woodland forest type groups (pinyon/juniper and woodland hardwoods, including oaks and mesquites) differed by about 7 million acres, which accounts for nearly all of the discrepancy in total forest land area. Vast areas of woodland forest types that are now known to be forested were not sampled at all during the periodic inventories (figure 41). Those that were visited often failed to meet the current definition of forest land, which stipulates 10 percent cover of tally tree species, regardless of form or size. Therefore, woodlands that are covered by a high density of small trees may not have met previous definitions of forest land that used stocking rather than cover criteria or differentiated tree-form from shrub-form trees, but they now meet the 10 percent cover criterion and thus qualify as forest land.

Comparisons of total volume and biomass on woodland forest types may also be deceptive, in large part because many shrub-form trees were not measured during previous inventories. These artifacts of inconsistent inventory methods and definitions illustrate why direct comparisons of periodic to annual inventory data may be misleading.

Since the last periodic forest inventory of New Mexico, live tree volume has decreased and total tree volume has changed very little. Average annual mortality increased and growth decreased during that time.

Comparisons of plots measured in both periodic and annual forest inventories—An appropriate method of quantifying trends is to first identify forest plots that were measured during both periodic and annual inventories, and then assess trends at only those plots. FIA refers to such plot locations as co-located plots. Comparisons of multiple measurements at co-located plots are useful for quantifying trends in attributes such as volume and biomass per acre. The caveat of this approach is that the comparisons cannot be scaled to the entire State because co-located plot analyses cannot overcome the limitations of the periodic sample design. For example, if the periodic inventory under-sampled a particular forest type, an analysis of co-located plots will still under-represent that forest type and will instead exhibit trends that occurred on forest types that were sampled more representatively.

This section presents the results of two analyses of co-located plot data collected during periodic versus annual inventories. First, plots that were measured at two points in time, first between 1996 and 2000 and again between 2008 and 2012, were compared. Plots that were measured in the 1980s, and then brought forward into the 2000 inventory if they were undisturbed, were not included in this comparison. On a plot-by-plot basis, this comparison is quite robust because plots measured after 1996 encompassed the same plot design that is used in the annual inventory. Second, data collected at plots that were measured three times—once during the 1980s, a second time between 1996 and 2000, and a third time between 2008 and 2012—were compared. Therefore this comparison consisted of co-located measurements conducted roughly once each decade and provides a longer-term assessment of forest trends. Although the second comparison is based on measurements collected using different plot designs, each design allows estimation of volume and biomass per acre as well as stand-level variables such as forest type and stand age. Note that none of the plots measured on the Gila National Forest in 1993 and 1994 were co-located during the 1996-2000 inventory or in the annual inventory, so they are not included in these analyses.

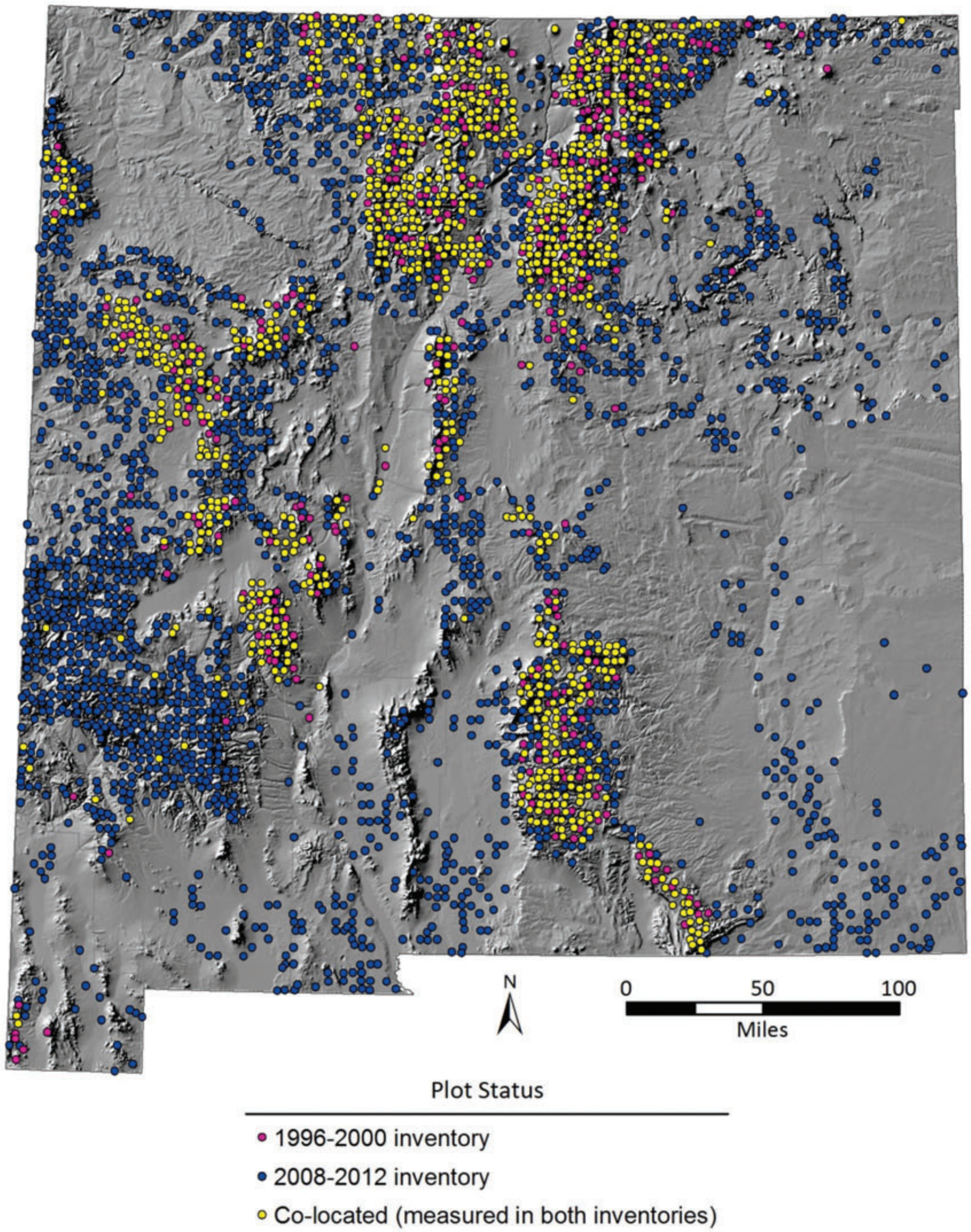


Figure 41. Distribution of all plots in the 1996-2000 periodic inventory (n = 1,272), all plots in the 2008-2012 annual inventory (n = 3,220), and co-located plots that were measured during both inventories (n = 947).

The first comparison consisted of 947 co-located plots, which were first measured between 1996 and 2000 using the current plot design and again during the annual inventory between 2008 and 2012. Figure 41 shows the distribution of all plots in the 1996-2000 inventory, all plots in the annual inventory, and the 947 co-located plots. Note that large portions of the State were not sampled during the periodic inventory and are therefore not included in the set of co-located plots. Figure 42 depicts the distribution of these co-located plots by forest type group. The 1996-2000 inventory under-represented woodland forest types and over-represented timber forest types relative to their actual distribution in the State, as indicated by the distribution of all annual inventory plots among forest type groups. Using co-located plots cannot completely mitigate under-representation of some forest types or regions in the periodic inventory. Therefore, conclusions based on co-located plots may be biased toward timber forest types or particular areas within the State.

The results of co-located plot comparisons are sometimes different from those produced by direct comparisons of periodic versus annual inventories in their entireties. Figure 43 illustrates the conflicting conclusions that result from comparing estimates of tree volume per acre, first using all plots in each inventory and then using only co-located plots. By comparing all periodic plots to all annual plots, the mean volume appears to decrease by almost half. In contrast, comparing co-located plots shows that total volume changed very little, dead volume increased slightly, and live volume decreased. Paired t-tests suggested that changes in total volume and dead volume were not significant ($p = 0.17$ and 0.10, respectively), while the decrease in live volume was significant ($p = 0.02$).

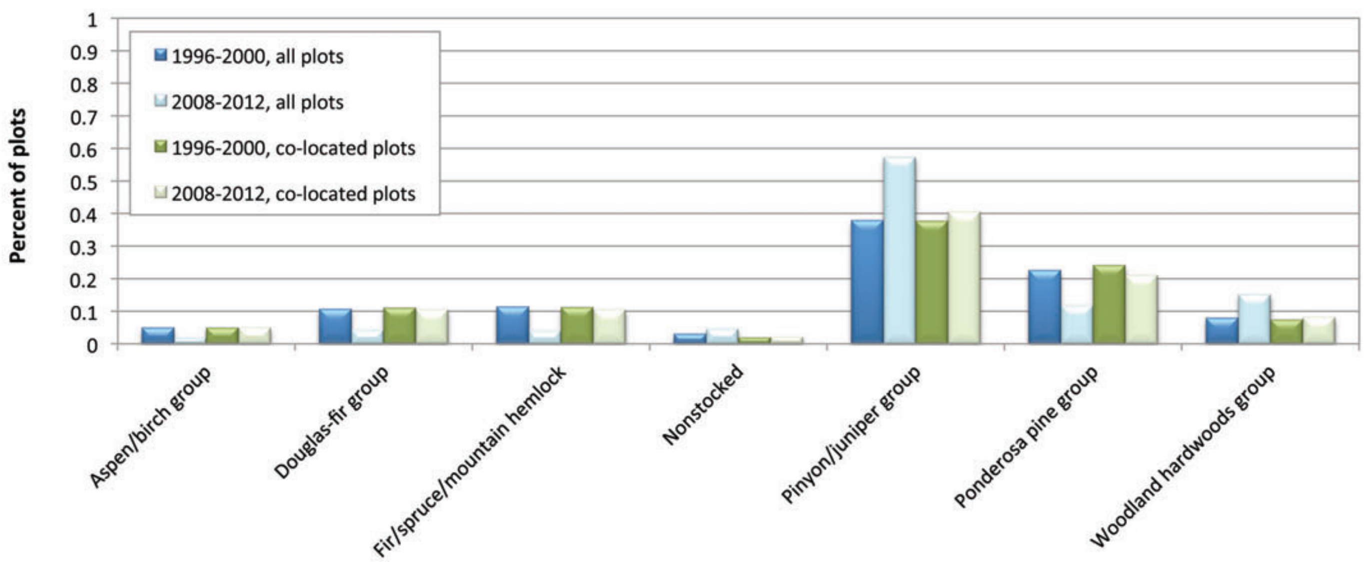


Figure 42. The percentage of plots in each forest type group in the periodic and annual inventories of New Mexico. (A) All plots measured between 1996 and 2000 (n = 1,272). (B) All plots measured between 2008 and 2012 (n = 3,220). (C) Co-located plots, by forest type group as recorded between 1996 and 2000 (n = 947). (D) Co-located plots, by forest type group as recorded between 2008 and 2012 (n = 947). Four forest type groups (elm/ash/cottonwood, exotic hardwoods, other hardwoods, and other western softwood groups) were not presented here because they constituted less than 1 percent of both inventories.

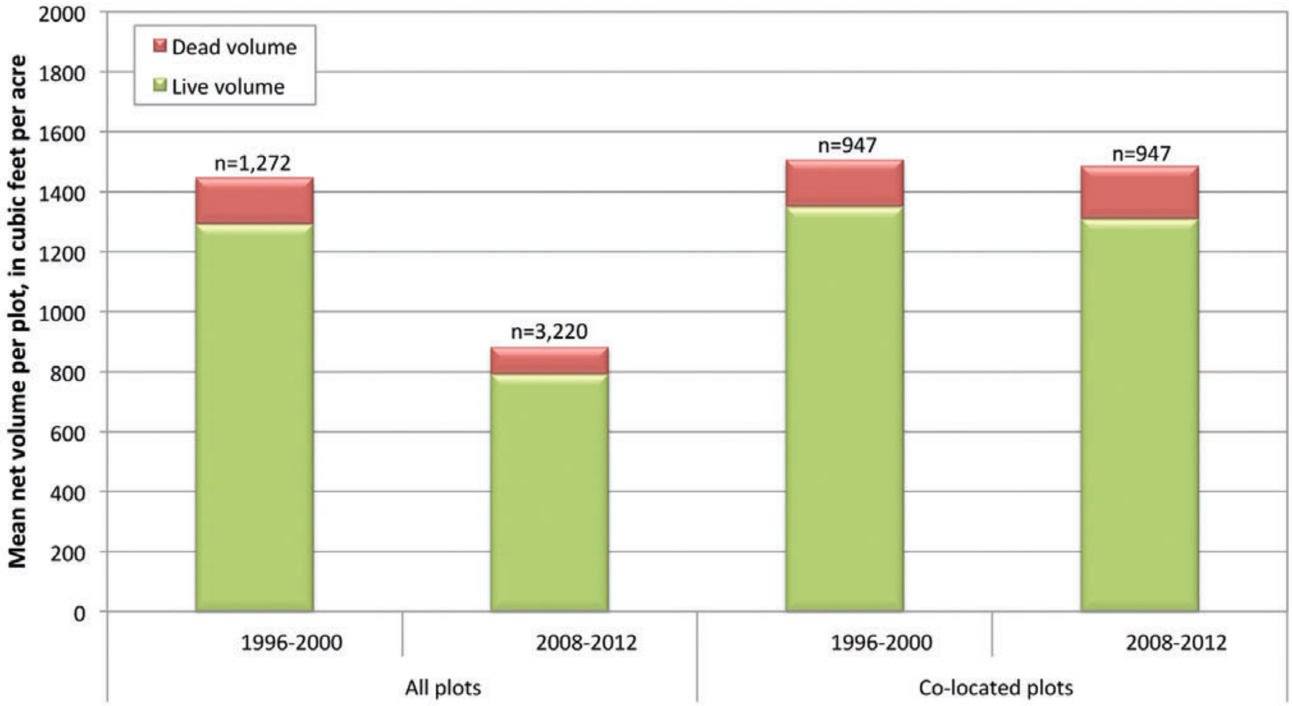


Figure 43. Mean net volume per plot at all plots in the 1996-2000 inventory and all plots in the 2008-2012 inventory (left), and only at plots that were co-located and measured during both inventories (right). The number of plots represented is shown at the top of each bar.

It is important to note that in Figure 43, the bar showing the estimated mean volume for all plots in the annual inventory is the most representative of the mean volume per acre throughout all forest lands in the State between 2008 and 2012. This is because the annual plot grid constitutes a representative sample across New Mexico's forest landscapes. However, the two bars representing only co-located plots are more representative of temporal trends because they consist of two measurements of the same sample. The fact that the annual inventory estimates for all plots (figure 43, second bar from left) is smaller than that for annual measurements at co-located plots (figure 43, bar on far right) signifies that the periodic sample design, as well as the set of co-located plots, tended to sample relatively high-volume stands and forest types.

Growth and mortality changed dramatically over the same period (figure 44). The average annual net growth on co-located plots decreased from 22.8 to -5.1 cubic feet per acre, and average annual mortality increased from 4.8 to 18.4 cubic feet per acre. Note that if the entire 1996-2000 inventory is compared to the entire 2008-2012 inventory, comparisons of growth and mortality produce misleading conclusions regarding the magnitude of these changes. Comparing the inventories en masse suggests that mortality increased by less than 100 percent, when in reality it increased at co-located plots by more than 300 percent. Similarly, co-located plot data show that net growth has not only decreased, but it has become negative. These differences between comparisons of wholesale inventories versus co-located plots imply that changes in tree growth and mortality were more severe at periodic plot locations than across the broader forest landscape.

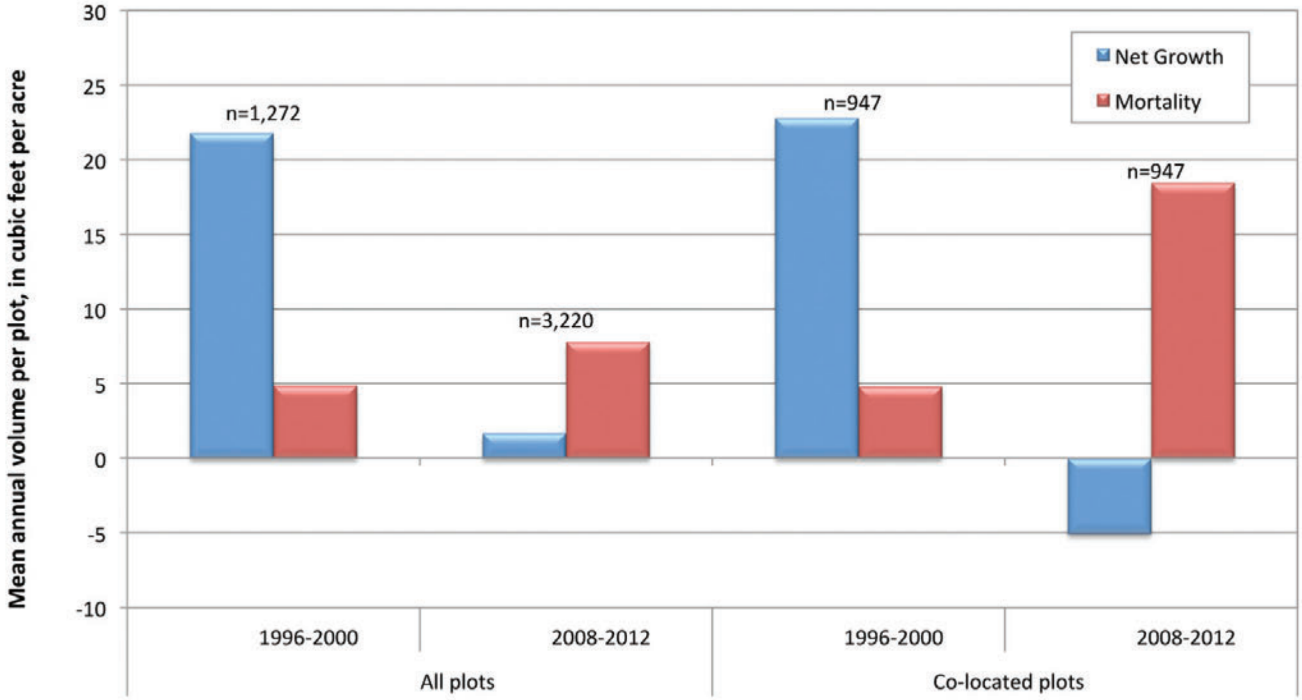


Figure 44. Mean annual volume of net growth and mortality per plot, first at all plots in the 1996-2000 inventory and all plots in the 2008-2012 inventory (left), and only at plots that were co-located and measured during both inventories (right). The number of plots represented is shown at the top of each set of bars.

Only 252 plots met the criteria for the second comparison, which consisted of one measurement in the 1980s, a second measurement between 1996 and 2000, and a third measurement between 2008 and 2012. More than two-thirds of the co-located plots were located on private lands. Because the magnitude of forest attributes is only representative of the 252 plots included in this analysis, changes are reported as percentages rather than absolute values. The overall trend since the periodic inventory of the 1980s began with high growth, low mortality, and overall accumulation of volume, followed by a decade of high mortality and negative growth leading up to the current annual inventory. Total volume increased by 28 percent between the 1980s and the 1990s, and then by only 2 percent in the 2000s. Live volume increased by 25 percent and 3 percent, respectively, over the same two intervals. Mean annual net growth increased by 20 percent during the first interval and decreased by 71 percent during the second. Mean annual mortality increased by only 5 percent in the first interval and then experienced a 30-fold increase in the 2000s. Factors such as insects, diseases, and fire have led to high mortality in recent years and were described in earlier sections of this report. Although the tremendous increase in mortality at co-located plots seems alarming, it characterizes conditions at the 252 plots that were measured as far back as the 1980s and does not represent statewide conditions in New Mexico's forests.

In its entirety, the 2008-2012 inventory is the most representative sample of New Mexico's forests to date. However, the most robust analyses of changes over time are those based on measurements of the same plots in multiple years. As New Mexico's forest inventory continues into its second cycle and plots are remeasured at a consistent 10-year interval, FIA's ability to quantify trends in forest attributes will expand from analyses of co-located periodic plots to statewide estimates of change based on the spatially representative annual plot grid.

Conclusions and Future Analyses

New Mexico's forests blanket a wide variety of environments, from the mesquite and juniper woodlands in the southern deserts and steppes, to the timber forests in the southern Rocky Mountains. These diverse forests provide watershed, recreational and scenic values; wildlife habitats; traditional resources such as food and dyes; wood products; and the economic benefits that accompany all of these resources and values. Thanks to a successful partnership between the State of New Mexico and the Interior West FIA program, as well as funding from the American Recovery and Reinvestment Act, New Mexico's forest stakeholders now have access to a comprehensive, statewide forest inventory dataset.

The most important broad-scale trends in New Mexico's forests include increasing mortality and declining growth. Among the tree species that make up most of New Mexico's timber volume, ponderosa pine is the only species whose gross growth exceeds its mortality. Net growth is also positive for the State's most important pinyon and juniper species, which may be important for fuelwood and biomass utilization. Statewide, net growth is only 0.26 percent of net live volume per year because gross growth is being nearly offset by increases in mortality. Some of the major factors affecting recent mortality include insects, wildfires, and disease, all of which are likely related to multi-year weather patterns such as drought. Mortality was higher on National Forest lands than any other ownership category, and mortality currently exceeds growth on National Forest lands in New Mexico. Timber harvests from National Forest lands decreased by 95 percent over the previous decade, even as mortality increased on those lands. The total volume of wood harvested from New Mexico's forests has decreased by more than half over the past decade. Economic analyses point to a shrinking forest products industry, which diminishes the ability of forest managers to mitigate high-mortality events through vegetation management.

Given that private landowners manage 44 percent of the State's forest lands, and 83 percent of the 2007 commercial timber harvest came from private and tribal lands, it is critical that the FIA program work with landowners and landowner associations to communicate the value of this inventory and enlist their support in obtaining sample data from private forest lands. The FIA program is designed by law to report resource status and trends for general ownership categories, such as private land, while preserving the confidentiality of individual ownership details. Because the natural processes that affect forest dynamics do not observe ownership boundaries, a representative sample of all forest lands is necessary to fully understand current trends and make predictions about the future of New Mexico's forests.

Many of the analyses included in this report demonstrate the utility of FIA data as a monitoring and planning tool for a wide range of objectives. Not all relevant analyses could be included here, however, and more in-depth analyses will be conducted in the future by FIA analysts and FIA data users on a wide range of topics. A few examples of future research and analyses include, but are not limited to:

- Investigating the reasons behind the different tree mortality rates among ownership groups and reserved status.
- Identifying additional lichen species and their traditional uses, as well as their utility in monitoring air quality.
- Monitoring wildlife habitat quality over time for species of interest, such as the Mexican spotted owl.
- Developing more robust definitions of "old forests" based on criteria that can be applied to different regions, forest types, or site conditions.

- Expanding per-acre estimates of down woody materials attributes to the State level, and also using down woody materials data to update fuel and fire models for New Mexico.
- Monitoring the effects of ongoing drought on mortality in pinyon/juniper woodlands.
- Quantifying the effects fire on specific forest types, using immediate post-fire data from the AREBA project in addition to regularly scheduled plot remeasurements, and quantifying the rate of recovery in burned areas.
- Testing novel analytical methods to assess status and trends of New Mexico's cottonwood bosques, either using all plots with a cottonwood component (regardless of the dominant forest type) or augmenting FIA plot data with remote sensing data.
- Using remeasurement data to identify type changes, such as conversion of shrublands to woodlands (e.g., expansion of mesquite or juniper woodlands) or coniferous forests to woodlands (e.g., ponderosa pine forest to oak woodland following severe fire), over long time scales.

All of these issues have been identified as important by land managers in New Mexico. As New Mexico's forest inventory enters its second cycle in 2015, the existence of remeasurement data will enable more robust analyses of trends in forest dynamics.

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Appendix A: Standard Forest Inventory and Analysis Terminology

Average annual mortality—The average annual volume of trees 5.0 inches d.b.h./d.r.c. and larger that died from natural causes.

Average annual net growth—Average annual net change in volume of trees 5.0 inches d.b.h./d.r.c. and larger in the absence of cutting (average annual gross growth minus average annual mortality).

Basal area (BA)—The cross-sectional area of a tree stem/bole (trunk) at the point where diameter is measured, inclusive of bark. BA is calculated for trees 1.0 inch and larger in diameter, and is expressed in square feet. For timber species, the calculation is based on diameter at breast height (d.b.h.); for woodland species, it is based on diameter at root collar (d.r.c.).

Biomass—The quantity of wood fiber, for trees 1.0 inch d.b.h./d.r.c. and larger, expressed in terms of oven-dry weight. It includes above-ground portions of trees: bole/stem (trunk), bark, and branches. Biomass estimates can be computed for live and/or dead trees.

Board-foot volume—A unit of measure indicating the amount of wood contained in an unfinished board 1 foot wide, 1 foot long, and 1 inch thick**.** Board-foot volume is computed for the sawlog portion of a sawtimber-size tree; the sawlog portion includes the part of the bole on sawtimber-size tree from a 1-foot stump to a minimum sawlog top of 7 inches diameter outside bark (d.o.b.) for softwoods, or 9 inches d.o.b. for hardwoods. **Net board-foot volume** is calculated as the gross board-foot volume in the sawlog portion of a sawtimber-size tree, less deductions for cull (note: board-foot cull deductions are limited to rotten/missing material and form defect—referred to as the **merchantability factor—board-foot**). Board-foot volume estimates are computed in both Scribner and International ¼-inch rule, and can be calculated for live and/or dead (standing or down) trees.

Census water—Streams, sloughs, estuaries, canals, and other moving bodies of water 200 feet wide and greater, and lakes, reservoirs, ponds, and other permanent bodies of water 4.5 acres in area and greater.

Coarse woody debris—Down pieces of wood leaning more than 45 degrees from vertical with a diameter of at least 3.0 inches and a length of at least 3.0 feet.

Condition class—The combination of discrete landscape and forest attributers that identify, define, and stratify the area associated with a plot. Such attributes include reserved status, owner group, forest type, stand-size class, stand origin, and tree density.

Crown class—A classification of trees based on dominance in relation to adjacent trees in the stand as indicated by crown development and amount of sunlight received from above and the sides.

Crown cover (Canopy cover)—The percentage of the ground surface area covered by a vertical projection of plant crowns. Tree crown cover for a sample site includes the combined cover of timber and woodland trees 1.0 inch d.b.h./d.r.c. and larger. Maximum crown cover for a site is 100 percent; overlapping cover is not double counted.

Cubic-foot volume (merchantable)—A unit of measure indicating the amount of wood contained in a cube 1-by-1-by-1 foot. Cubic-foot volume is computed for the merchantable portion of timber and woodland species; the merchantable portion for timber species includes that part of a bole from a 1-foot stump to a minimum 4-inch top d.o.b, or above the place(s) of diameter measurement for any woodland tree with a single 5.0-inch stem or larger or a cumulative (calculated) d.r.c. of at least 5.0 inches to the 1.5-inch ends of all branches. **Net cubic-foot volume** is calculated as the gross cubic-foot volume in the merchantable portion of a tree, less deductions for cull.

Diameter at breast height (d.b.h.) —The diameter of a tree bole/stem (trunk) measured at breast height (4.5 feet above ground), measured outside the bark. The point of diameter measurement may vary for abnormally formed trees.

Diameter at root collar (d.r.c.)—The diameter of a tree stem(s) measured at root collar or at the point nearest the ground line (whichever is higher) that represents the basal area of the tree, measured outside the bark. For multi-stemmed trees, d.r.c. is calculated from an equation that incorporates the individual stem diameter measurements. The point of diameter measurement may vary for woodland trees with stems that are abnormally formed. With the exception of seedlings, woodland stems qualifying for measurement must be at least 1.0 inch in diameter or larger and at least 1.0 foot in length.

Diameter class—A grouping of tree diameters (d.b.h. or d.r.c.) into classes of a specified range. For some diameter classes, the number referenced (e.g., 4", 6", 8") is designated as the midpoint of an individual class range. For example, if 2-inch classes are specified (the range for an individual class) and even numbers are referenced, the 6-inch class would include trees 5.0- to 6.9 inches in diameter.

Diameter outside bark (d.o.b.)—Tree diameter measurement inclusive of the outside perimeter of the tree bark. The d.o.b. measurement may be taken at various points on a tree (e.g., breast height, tree top) or log, and is sometimes estimated.

Field plot/field location—A reference to the sample site or plot; an area containing the field location center and all sample points. A field location consists of four subplots and four microplots.

- **Subplot**—A 1/24-acre fixed-radius area (24-foot horizontal radius) used to sample trees 5.0 inches d.b.h./d.r.c. and larger and understory vegetation.
- **Microplot**—A 1/300-acre fixed-radius plot (6.8-foot radius), located 12 feet from the center of each subplot at an azimuth of 90 degrees, used to inventory seedlings and saplings.

Fixed-radius plot—A circular sample plot of a specified horizontal radius: 1/300 acre = 6.8-foot radius (microplot); 1/24 acre = 24.0-foot radius (subplot).

Forest land—Land that has at least 10 percent cover of live tally tree species of any size, or land formerly having such tree cover, and not currently developed for a nonforest use. The minimum area for classification as forest land is 1 acre. Roadside, stream-side, and shelterbelt strips of trees must be at least 120 feet wide to qualify as forest land. Unimproved roads and trails, streams and other bodies of water, or natural clearings in forested areas are classified as forest if less than 120 feet in width or 1 acre in size. Grazed woodlands, reverting fields, and pastures that are not actively maintained are included if the above qualifications are satisfied. (Note that the canopy cover threshold for forest land was formerly 5 percent rather than 10 percent, and field crews in New Mexico from 2008 to 2012 used the 5 percent threshold. However, sampled conditions with 5-9 percent cover were treated as nonforest for the purposes of this report, and forest attributes are therefore based on the new 10-percent threshold.)

Forest type—A classification of forest land based on the species forming a plurality of live-tree stocking.

Gross growth—The annual increase in volume of trees 5.0 inches d.b.h. and larger in absence of cutting and mortality. Gross growth includes survivor growth, ingrowth, growth on ingrowth, growth on removals before removal, and growth on mortality prior to death.

Growing-stock trees—A live timber species, 5.0 inches d.b.h. or larger, with less than 2/3 (67 percent) of the merchantable volume cull, and containing at least one solid 8-foot section, now or prospectively, reasonably free of form defect, on the merchantable portion of the tree.

Growing-stock volume—The cubic-foot volume of sound wood in growing-stock trees at least 5.0 inches d.b.h. from a 1-foot stump to a minimum 4-inch top d.o.b. to the central stem.

Hardwood trees—Dicotyledonous trees, usually broadleaf and deciduous.

Inventory year—The year in which a plot was scheduled to be completed. Within each subpanel, all plots have the same inventory year. Inventory year may differ from measurement year.

Land use—The classification of a land condition by use or type.

Litter—The uppermost layer of organic debris on a forest floor; that is, essentially the freshly fallen, or only slightly decomposed material, mainly foliage, but also bark fragments, twigs, flowers, fruits, and so forth. Humus is the organic layer, unrecognizable as to origin, immediately beneath the litter layer from which it is derived. Litter and humus together are often termed duff.

Logging residue/products—

- **Bolt**—A short piece of pulpwood; a short log.
- **Industrial wood**—All commercial roundwood products, excluding fuelwood.
- **Logging residue**—The unused sections within the merchantable portions of sound (growing-stock) trees cut or killed during logging operations.
- **Mill or plant residue**—Wood material from mills or other primary manufacturing plants that is not used for the mill's or plant's primary products. Mill or plant residue includes bark, slabs, edgings, trimmings, miscuts, sawdust, and shavings. Much of the mill and plant residue is used as fuel and as the raw material for such products as pulp, palletized fuel, fiberwood, mulch, and animal bedding. Mill or plant residue includes bark and the following components:
- **Coarse residue**—Wood material suitable for chipping, such as slabs, edgings, and trim.
- **Fine residue**—Wood material unsuitable for chipping, such as sawdust and shavings.
- **Pulpwood**—Roundwood, whole-tree chips, or wood residues that are used for the production of wood pulp.
- **Roundwood**—Logs, bolts, or other round sections cut from trees.

Mapped-plot design—A sampling technique that identifies (delineates or maps) and separately classifies distinct "conditions" on the field location sample area. Each condition must meet minimum size requirements. At the most basic level, condition class delineations include forest land, nonforest land, and water. Forest land conditions can be further subdivided into separate condition classes if there are distinct variations in reserved status, owner group, forest type, stand-size class, stand origin, and stand density, given that each distinct area meets minimum size requirements.

Measurement year—The year in which a plot was completed. Measurement year may differ from inventory year.

Merchantable portion—For trees measured at d.b.h. and 5.0 inches d.b.h. and larger, the merchantable portion (or "merchantable bole") includes the part of the tree bole from a 1-foot stump to a 4.0-inch top (d.o.b.). For trees measured at d.r.c., the merchantable portion includes all qualifying segments above the place(s) of diameter measurement for any tree with a single 5.0-inch stem or larger or a cumulative (calculated) d.r.c. of at least 5.0 inches to the 1.5-inch ends of all branches; sections below the place(s) of diameter measurement are not included. Qualifying segments are stems or branches that are a minimum of 1 foot in length and at least 1.0 inch in diameter; portions of stems or branches smaller than 1.0 inch in diameter, such as branch tips, are not included in the merchantable portion of the tree.

Mortality tree—All standing or down dead trees 5.0 inches d.b.h./d.r.c. and larger that were alive within the previous 5 years (in most States); for the 2008-2012 New Mexico inventory, this includes trees that were alive within the previous 10 years.

National Forest System (NFS) lands—Public lands administered by the Forest Service, U.S. Department of Agriculture, such as National Forests, National Grasslands, and some National Recreation Areas.

National Park lands—Public lands administered by the Park Service, U.S. Department of the Interior, such as National Parks, National Monuments, National Historic Sites (such as National Memorials and National Battlefields), and some National Recreation Areas.

Noncensus water—Portions of rivers, streams, sloughs, estuaries, and canals that are 30 to 200 feet wide and at least 1 acre in size; and lakes, reservoirs, and ponds 1 to 4.5 acres in size. Portions of rivers and streams not meeting the criteria for census water, but at least 30 feet wide and 1 acre in size, are considered noncensus water. Portions of braided streams not meeting the criteria for census water, but at least 30 feet in width and 1 acre in size, and more than 50 percent water at normal high-water level are also considered noncensus water.

Nonforest land—Land that does not support, or has never supported, forests, and lands formerly forested where tree regeneration is precluded by development for other uses. Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining rights-of-way, power line clearings of any width, and noncensus water. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide, and clearings, etc., more than 1 acre in size, to qualify as nonforest land.

Nonstocked stand—A formerly stocked stand that currently has less than 10 percent stocking, but has the potential to again become 10 percent stocked. For example, recently harvested, burned, or windthrow-damaged areas.

Other Federal lands—Public lands administered by Federal agencies other than the Forest Service, U.S. Department of Agriculture, or the Bureau of Land Management, U.S. Department of the Interior.

Other public lands—Public lands administered by agencies other than the Forest Service, U.S. Department of Agriculture. Includes lands administered by other Federal, State, county, and local government agencies, including lands leased by these agencies for more than 50 years.

Poletimber-size trees—For trees measured at d.b.h, softwoods 5.0 to 8.9 inches d.b.h. and hardwoods 5.0 to 10.9 inches d.b.h. For trees measured at d.r.c., all live trees 5.0 to 8.9 inches d.r.c.

Primary wood processing plants—An industrial plant that processes roundwood products, such as sawlogs, pulpwood bolts, or veneer logs.

Private lands—All lands not owned or managed by a Federal, State, or other public entity, including lands owned by corporations, trusts, or individuals, as well as Tribal lands.

Productive forest land—Forest land capable of producing 20 cubic feet per acre per year of wood from trees classified as a timber species (see Appendix D) on forest land classified as a timber forest type (see Appendix C).

Productivity—The potential yield capability of a stand calculated as a function of site index (expressed in terms of cubic-foot growth per acre per year at age of culmination of mean annual increment). Productivity values for forest land provide an indication of biological potential. Timberland stands are classified by the potential net annual growth attainable in fully stocked natural stands. For FIA reporting, Productivity Class is a variable that groups stand productivity values into categories of a specified range. Productivity is sometimes referred to as "yield" or "mean annual increment."

Removals—The net volume of sound (growing-stock) trees removed from the inventory by harvesting or other cultural operations (such as timber-stand improvement), by land clearing, or by changes in land use (such as a Wilderness designation).

Reserved land—Land withdrawn from management for production of wood products through statute or administrative designation; examples include Wilderness areas and National Parks and Monuments.

Sampling error—A statistical term used to describe the accuracy of the inventory estimates. Expressed on a percentage basis in order to enable comparisons between the precision of different estimates, sampling errors are computed by dividing the estimate into the square root of its variance.

Sapling – A live tree 1.0-4.9 inches d.b.h./d.r.c.

Sawlog portion —The part of the bole of sawtimber-size trees between a 1-foot stump and the sawlog top.

Sawlog top —The point on the bole of sawtimber-size trees above which a sawlog cannot be produced. The minimum sawlog top is 7 inches d.o.b. for softwoods, and 9 inches d.o.b. for hardwoods.

Sawtimber-size trees—Softwoods 9.0 inches d.b.h. and larger and hardwoods 11.0 inches and larger.

Sawtimber volume—The growing-stock volume in the sawlog portion of sawtimber-size trees in board feet.

Seedlings— Live trees less than 1.0 inch d.b.h./d.r.c.

Site index—A measure of forest productivity for a timberland tree/stand. Expressed in terms of the expected height (in feet) of trees on the site at an index age of 50 (or 80 years for aspen and cottonwood). Calculated from height-to-age equations.

Site tree—A tree used to provide an index of site quality. Timber species selected for site index calculations must meet specified criteria with regards to age, diameter, crown class, and damage.

Snag—A standing dead tree.

Softwood trees—Coniferous trees, usually evergreen, having needle- or scale-like leaves.

Stand—A community of trees that can be distinguished from adjacent communities due to similarities and uniformity in tree and site characteristics, such as age-class distribution, species composition, spatial arrangement, structure, etc.

Stand density—A relative measure that quantifies the relationship between trees per acre, stand basal area, average stand diameter, and stocking of a forested stand.

Stand density index (SDI) —A widely used measure developed by Reineke (1933), and is an index that expresses relative stand density based on a comparison of measured stand values with some standard condition; **relative stand density** is the ratio, proportion, or percent of absolute stand density to a reference level defined by some standard level of competition. For FIA reporting, the SDI for a site is usually presented as a percentage of the maximum SDI for the forest type. Site SDI values are sometimes grouped into SDI classes of a specified percentage range. Maximum SDI values vary by species and region.

Standing dead tree—To qualify as a standing dead tally tree, dead trees must be at least 5.0 inches in diameter, have a bole that has an unbroken actual length of at least 4.5 feet, and lean less than 45 degrees from vertical as measured from the base of the tree to 4.5 feet. Portions of boles on dead trees that are separated greater than 50 percent (either above or below 4.5 feet), are considered severed and are included in Down Woody Material (DWM) if they otherwise meet DWM tally criteria. For western woodland species with multiple stems, a tree is considered down if more than 2/3 of the volume is no longer attached or upright; do not consider cut and removed volume. For western woodland species with single stems to qualify as a standing dead tally tree, dead trees must be at least 5.0 inches in diameter, be at least 1.0 foot in unbroken actual length, and lean less than 45 degrees from vertical.

Stand-size class—A classification of forest land based on the predominant diameter size of live trees presently forming the plurality of live-tree stocking. Classes are defined as follows:

- **Sawtimber stand (Large-tree stand)**—A stand at least 10 percent stocked with live trees, in which half or more of the total stocking is from live trees 5.0 inches or larger in diameter, and with sawtimber (large tree) stocking equal to or greater than poletimber (medium tree) stocking.
- **Poletimber stand (Medium-tree stand)**—A stand at least 10 percent stocked with live trees, in which half or more of the total stocking is from live trees 5.0 inches or larger in diameter, and with poletimber (medium tree) stocking exceeding sawtimber (large tree) stocking.
- **Sapling/seedling stand**—A stand at least 10 percent stocked with live trees, in which half or more of the total stocking is from live trees less than 5.0 inches in diameter.
- **Nonstocked stand**—A formerly stocked stand that currently has less than 10 percent stocking, but has the potential to again become 10 percent stocked. For example, recently harvested, burned, or windthrow-damaged areas.

Stocking—An expression of the extent to which growing space is effectively utilized by live trees.

Timber species—Tally tree species traditionally used for industrial wood products. These include all species of conifers, except pinyon and juniper. Diameters for timber species are measured at breast height (d.b.h.).

Timber-stand improvement—A term comprising all intermediate cuttings or treatments, such as thinning, pruning, release cutting, girdling, weeding, or poisoning, made to improve the composition, health, and growth of the remaining trees in the stand.

Timberland—Unreserved forest land capable of producing 20 cubic feet per acre per year of wood from trees classified as a timber species (see Appendix D) on forest land designated as a timber forest type (see Appendix C).

Unproductive forest land—Forest land not capable of producing 20 cubic feet per acre per year of wood from trees classified as a timber species (see Appendix D) on forest land designated as a timber forest type and all forest lands designated as a woodland forest type (see Appendix C).

Unreserved forest land—Forest land not withdrawn from management for production of wood products through statute or administrative designation.

Wilderness area—An area of undeveloped land currently included in the Wilderness System, managed to preserve its natural conditions and retain its primeval character and influence.

Woodland species—Tally tree species that are not usually converted into industrial wood products. Common uses of woodland trees are fuelwood, fenceposts, and Christmas trees. These species include pinyon, juniper, mesquite, locust, mountain-mahogany (*Cercocarpus* spp.), Rocky Mountain maple, bigtooth maple, desert ironwood, and most oaks (note: bur oak and chinkapin oak are classified as timber species). Because most woodland trees are extremely variable in form, diameter is measured at root collar (d.r.c.).

Note: For the FIA national glossary please go to http://socrates.lv-hrc.nevada.edu/fia/ab/issues/pending/glossary.html.

Table B1. Percentage of plot area by land status, New Mexico, 2008-2012.

Land status			Percentage of area
Accessible forest land			
	Unreserved forest land		
		Timberland	5.0
		Unproductive	20.6
		Total unreserved forest land	25.7
	Reserved forest land		
		Productive	0.9
		Unproductive	0.8
		Total reserved forest land	1.7
Total accessible forest land			**27.4**
Nonforest and other land			
	Nonforest land		63.7
	Water		
		Census	0.1
		Non-Census	0.1
Total nonforest and other land			**63.9**
Nonsampled land			
	Access denied		8.4
	Hazardous conditions		0.3
	Other		0.0
Total nonsampled land			**8.6**
All land			**100.0**

All table cells without observations in the inventory sample are indicated by --.
Table value of 0.0 indicates the acres round to less than 0.1 percent. Column and rows may not add to their totals due to rounding.

Table B2. Area of accessible forest land, in thousand acres, by owner class and forest land status, New Mexico, 2008-2012.

Owner class	Unreserved forests			Reserved forests			All forest land
	Timberland	Unproductive	Total	Productive	Unproductive	Total	
Forest Service							
National forest	2,655.4	3,936.3	6,591.8	679.7	471.4	1,151.2	**7,743.0**
National grassland	--	13.6	13.6	--	--	--	**13.6**
Other national forest	44.8	--	44.8	--	--	--	**44.8**
Other Federal							
National Park Service	--	--	--	56.9	70.0	126.9	**126.9**
Bureau of Land Management	29.8	2,864.8	2,894.6	--	67.8	67.8	**2,962.4**
U.S. Fish and Wildlife Service	--	--	--	--	59.4	59.4	**59.4**
Department of Defense or Energy	--	688.1	688.1	--	9.5	9.5	**697.6**
Other Federal	--	71.3	71.3	--	--	--	**71.3**
State and local government							
State	128.4	2,137.0	2,265.4	--	--	--	**2,265.4**
Local (county, municipal, etc.)	7.3	41.7	48.9	--	--	--	**48.9**
Private							
Undifferentiated private	1,412.5	9,393.5	10,806.0	--	--	--	**10,806.0**
All owners	**4,278.2**	**19,146.4**	**23,424.6**	**736.6**	**678.2**	**1,414.8**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B3. Area of forest land, in thousand acres, by forest-type group and productivity class, New Mexico, 2008-2012.

	Site-productivity class (cubic feet/acre/year)							
Forest-type group	**0-19**	**20-49**	**50-84**	**85-119**	**120-164**	**165-224**	**225+**	**Total all classes**
Pinyon/juniper group	13,606.7	--	--	--	--	--	--	13,606.7
Douglas-fir group	13.7	643.1	246.4	18.9	--	--	--	922.0
Ponderosa pine group	59.0	2,159.7	356.7	14.7	--	--	6.9	2,597.0
Fir/spruce/mountain hemlock group	6.6	340.1	424.4	81.9	5.2	--	--	858.2
Other western softwoods group	7.3	81.4	18.4	--	5.8	--	--	112.8
Elm/ash/cottonwood group	20.6	42.4	1.3	--	--	--	--	64.2
Aspen/birch group	7.3	178.2	181.6	21.2	--	--	--	388.3
Other hardwoods group	--	1.6	--	--	--	--	--	1.6
Woodland hardwoods group	4,818.1	--	--	--	--	--	--	4,818.1
Exotic hardwoods group	7.8	8.1	--	--	--	--	--	15.9
Nonstocked	1,277.6	169.2	7.8	--	--	--	--	1,454.5
All forest-type groups	**19,824.5**	**3,623.7**	**1,236.6**	**136.6**	**11.0**	**--**	**6.9**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B4. Area of forest land, in thousand acres, by forest-type group, ownership group, and forest-land status, New Mexico, 2008-2012.

Forest-type group	Forest Service		Other Federal		State and local government		Undifferentiated private		All forest land
	Timber-land	Other forest land	Timber-land	Other forest land	Timber-land	Other forest land	Timber-land	Other forest land	
Pinyon/juniper group	--	3,580.6	--	1,791.0	--	1,137.9	--	7,097.2	13,606.7
Douglas-fir group	481.2	153.2	--	--	32.6	--	255.0	--	922.0
Ponderosa pine group	1,370.5	278.5	29.8	57.7	73.7	--	762.1	24.6	2,597.0
Fir/spruce/mountain hemlock group	449.3	220.3	--	--	13.2	--	175.4	--	858.2
Other western softwoods group	60.5	10.1	--	--	--	--	35.0	7.3	112.8
Elm/ash/cottonwood group	6.6	--	--	--	8.0	2.7	29.0	17.8	64.2
Aspen/birch group	246.9	32.6	--	--	6.5	--	95.0	7.3	388.3
Other hardwoods group	--	--	--	--	1.6	--	--	--	1.6
Woodland hardwoods group	--	734.1	--	1,347.8	--	856.4	--	1,879.9	4,818.1
Exotic hardwoods group	--	--	--	--	--	--	8.1	7.8	15.9
Nonstocked	85.0	91.9	--	691.4	--	181.7	52.9	351.6	1,454.5
All forest-type groups	**2,700.3**	**5,101.2**	**29.8**	**3,887.8**	**135.6**	**2,178.7**	**1,412.5**	**9,393.5**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B5. Area of forest land, in thousand acres, by forest-type group and stand-size class, New Mexico, 2008-2012.

	Stand-size class				
Forest-type group	Large diameter	Medium diameter	Small diameter	Nonstocked	All size classes
Pinyon/juniper group	11,659.7	1,555.6	391.4	--	13,606.7
Douglas-fir group	821.7	80.8	19.5	--	922.0
Ponderosa pine group	2,281.8	210.7	104.5	--	2,597.0
Fir/spruce/mountain hemlock group	771.1	72.9	14.2	--	858.2
Other western softwoods group	105.8	--	7.1	--	112.8
Elm/ash/cottonwood group	34.3	15.5	14.4	--	64.2
Aspen/birch group	151.7	185.1	51.4	--	388.3
Other hardwoods group	--	--	1.6	--	1.6
Woodland hardwoods group	734.9	342.7	3,740.5	--	4,818.1
Exotic hardwoods group	--	--	15.9	--	15.9
Nonstocked	--	--	--	1,454.5	1,454.5
All forest-type groups	**16,561.0**	**2,463.2**	**4,360.6**	**1,454.5**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B6. Area of forest land, in thousand acres, by forest-type group and stand-age class, New Mexico, 2008-2012.

	Non-	Stand-age class (years)											All
Forest-type group	stocked	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141-160	161-180	181-200	201+	classes
Pinyon/juniper group	- -	220.6	368.1	926.2	1,785.9	2,198.5	1,748.5	1,816.1	1,408.6	1,123.3	769.7	1,241.2	13,606.7
Douglas-fir group	- -	19.5	- -	- -	89.0	232.8	195.0	137.8	92.9	30.6	47.7	76.8	922.0
Ponderosa pine group	- -	66.9	58.3	70.3	414.1	772.0	605.7	346.5	110.3	85.8	39.0	28.0	2,597.0
Fir/spruce/mountain hemlock group	- -	14.2	- -	6.8	56.7	201.0	199.8	150.6	76.2	69.6	67.1	16.1	858.2
Other western softwoods group	- -	- -	7.1	- -	- -	16.5	11.8	15.8	20.3	19.9	14.2	7.4	112.8
Elm/ash/cottonwood group	- -	14.4	- -	- -	18.2	9.8	14.6	2.4	4.8	- -	- -	- -	64.2
Aspen/birch group	- -	48.0	3.5	10.5	117.4	86.4	99.2	13.3	10.1	- -	- -	- -	388.3
Other hardwoods group	- -	1.6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1.6
Woodland hardwoods group	- -	2,552.8	986.7	394.2	257.3	221.9	160.6	95.7	91.7	12.8	12.6	31.8	4,818.1
Exotic hardwoods group	- -	7.8	8.1	- -	- -	- -	- -	- -	- -	- -	- -	- -	15.9
Nonstocked	1,454.5	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1,454.5
All forest-type groups	**1,454.5**	**2,945.9**	**1,431.7**	**1,408.0**	**2,738.7**	**3,738.8**	**3,035.3**	**2,578.2**	**1,814.8**	**1,342.1**	**950.2**	**1,401.4**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B7. Area of forest land, in thousand acres, by forest-type group and stand origin, New Mexico, 2008-2012.

Forest-type group	Stand origin: Natural stands	Stand origin: Artificial regeneration	All forest land
Pinyon/juniper group	13,606.7	--	13,606.7
Douglas-fir group	922.0	--	922.0
Ponderosa pine group	2,589.1	7.8	2,597.0
Fir/spruce/mountain hemlock group	858.2	--	858.2
Other western softwoods group	112.8	--	112.8
Elm/ash/cottonwood group	64.2	--	64.2
Aspen/birch group	388.3	--	388.3
Other hardwoods group	1.6	--	1.6
Woodland hardwoods group	4,809.8	8.3	4,818.1
Exotic hardwoods group	15.9	--	15.9
Nonstocked	1,454.5	--	1,454.5
All forest-type groups	**24,823.2**	**16.1**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B8. Area of forest land, in thousand acres, by forest-type group and primary disturbance class, New Mexico, 2008-2012.

	Disturbance class											
Forest-type group	None	Insects	Disease	Fire	Wild animals	Domestic animals	Weather	Vegetation	Other	Human	Geological	All forest land
Pinyon/juniper group	11,850.6	542.2	273.2	158.7	15.0	360.1	215.0	6.7	52.2	113.8	19.3	13,606.7
Douglas-fir group	662.5	149.4	70.3	19.0	- -	- -	12.4	- -	- -	8.4	- -	922.0
Ponderosa pine group	2,187.6	14.1	149.9	168.0	6.3	12.1	36.3	15.2	- -	7.5	- -	2,597.0
Fir/spruce/mountain hemlock group	584.8	175.6	56.2	4.5	- -	19.1	11.4	- -	6.6	- -	- -	858.2
Other western softwoods group	99.0	13.8	- -	- -	- -	- -	- -	- -	- -	- -	- -	112.8
Elm/ash/cottonwood group	50.5	- -	6.6	- -	- -	- -	- -	- -	- -	7.1	- -	64.2
Aspen/birch group	230.9	70.3	51.9	21.6	7.1	6.6	- -	- -	- -	- -	- -	388.3
Other hardwoods group	1.6	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	1.6
Woodland hardwoods group	4,217.9	34.3	63.2	108.5	- -	218.4	128.1	- -	- -	36.6	11.1	4,818.1
Exotic hardwoods group	15.9	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	15.9
Nonstocked	1,231.0	3.0	6.9	88.9	- -	62.3	37.8	- -	- -	19.4	5.2	1,454.5
All forest-type groups	**21,132.3**	**1,002.7**	**678.1**	**569.1**	**28.4**	**678.6**	**441.0**	**21.9**	**58.9**	**192.9**	**35.7**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B9. Area of timberland, in thousand acres, by forest-type group and stand-size class, New Mexico, 2008-2012.

	Stand-size class				
Forest-type group	Large diameter	Medium diameter	Small diameter	Nonstocked	All size classes
Douglas-fir group	682.9	66.4	19.5	--	768.8
Ponderosa pine group	1,996.1	157	83.1	--	2,236.20
Fir/spruce/mountain hemlock group	567.3	56.4	14.2	--	637.9
Other western softwoods group	95.5	--	--	--	95.5
Elm/ash/cottonwood group	27.2	8	8.4	--	43.6
Aspen/birch group	148.3	157.2	43	--	348.5
Other hardwoods group	--	--	1.6	--	1.6
Exotic hardwoods group	--	--	8.1	--	8.1
Nonstocked	--	--	--	138	138
All forest-type groups	**3,517.2**	**445**	**178**	**138**	**4,278.2**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

Table B10. Number of live trees (at least 1 inch d.b.h./d.r.c.), in thousand trees, on forest land by species group and diameter class, New Mexico, 2008-2012.

	Diameter class (inches)														
Species group	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	21.0-24.9	25.0-28.9	29.0-32.9	33.0-36.9	37.0+	All classes
Softwood species groups																
Western softwood species groups																
Douglas-fir	110,416	63,622	47,490	35,395	25,322	18,587	11,975	7,866	4,770	2,726	3,746	1,461	666	167	47	334,255
Ponderosa and Jeffrey pines	143,961	98,200	90,277	81,731	63,909	45,933	32,641	19,679	12,250	7,723	7,154	2,083	481	236	93	606,352
True fir	119,900	53,794	33,015	22,428	16,659	11,312	7,318	4,441	2,588	1,635	1,884	531	219	--	--	275,725
Engelmann and other spruces	56,104	41,423	23,987	18,518	14,631	10,628	6,980	4,975	2,232	1,123	1,109	262	82	--	--	182,054
Other western softwoods	21,320	10,711	9,451	7,112	4,541	3,527	2,143	916	870	391	526	166	--	--	--	61,676
Other																
Woodland softwoods	891,504	592,158	446,504	329,897	215,209	143,120	93,071	60,117	40,594	26,027	24,171	8,683	2,837	1,532	797	2,876,220
All softwoods	1,343,205	859,908	650,723	495,082	340,272	233,107	154,128	97,995	63,304	39,625	38,589	13,186	4,285	1,936	938	4,336,283
Hardwood species groups																
Western hardwood species groups																
Cottonwood and aspen	44,759	34,222	30,521	24,243	17,656	8,091	3,862	2,215	1,073	494	353	92	52	--	--	167,634
Other western hardwoods	5,536	2,317	242	187	35	36	--	--	--	--	--	--	--	--	--	8,353
Other																
Woodland hardwoods	1,517,267	394,133	127,917	52,665	22,726	11,844	5,379	3,388	2,276	972	875	330	39	90	45	2,139,946
All hardwoods	1,567,562	430,673	158,679	77,095	40,417	19,971	9,241	5,603	3,349	1,466	1,228	421	91	90	45	2,315,934
All species groups	**2,910,767**	**1,290,581**	**809,403**	**572,177**	**380,689**	**253,078**	**163,369**	**103,599**	**66,653**	**41,091**	**39,817**	**13,607**	**4,376**	**2,026**	**983**	**6,652,216**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B11. Number of growing-stock trees (at least 5.0 inches d.b.h.), in thousand trees, on timberland by species group and diameter class, New Mexico, 2008-2012.

	Diameter class (inches)													
Species group	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	21.0-24.9	25.0-28.9	29.0-32.9	33.0-36.9	37.0+	All classes
Softwood species groups														
Western softwood species groups														
Douglas-fir	36,428	28,165	19,643	13,771	8,641	5,786	3,778	1,837	3,015	734	340	81	47	122,266
Ponderosa and Jeffrey pines	61,851	58,514	46,078	33,080	22,542	13,453	8,966	5,151	4,812	1,415	313	236	93	256,505
True fir	23,444	16,303	13,069	8,984	5,340	3,266	1,727	1,111	1,265	369	219	--	--	75,097
Engelmann and other spruces	17,206	14,001	11,022	6,895	4,794	3,461	1,208	622	254	182	82	--	--	59,727
Other western softwoods	6,991	5,398	3,469	2,768	1,565	594	581	240	526	166	--	--	--	22,299
All softwoods	145,920	122,380	93,282	65,498	42,883	26,559	16,260	8,962	9,872	2,866	953	318	140	535,893
Hardwood species groups														
Western hardwood species groups														
Cottonwood and aspen	21,955	20,055	14,884	7,078	3,356	1,922	719	331	268	92	--	--	--	70,660
Other western hardwoods	47	36	--	36	--	--	--	--	--	--	--	--	--	119
All hardwoods	22,003	20,091	14,884	7,114	3,356	1,922	719	331	268	92	--	--	--	70,779
All species groups	**167,923**	**142,471**	**108,166**	**72,612**	**46,239**	**28,480**	**16,979**	**9,293**	**10,140**	**2,958**	**953**	**318**	**140**	**606,672**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B12. Net volume of live trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, by owner class and forest land status, New Mexico, 2008-2012.

	Unreserved forests			Reserved forests			All
Owner class	Timberland	Unproductive	Total	Productive	Unproductive	Total	forest land
Forest Service							
National forest	5,072.5	2,646.5	7,718.9	1,665.4	333.6	1,999.0	9,717.9
National grassland	--	2.5	2.5	--	--	--	2.5
Other national forest	116.2	--	116.2	--	--	--	116.2
Other Federal							
National Park Service	--	--	--	30.1	23.3	53.4	53.4
Bureau of Land Management	32.9	661.5	694.3	--	34.2	34.2	728.5
Fish and Wildlife Service	--	--	--	--	7.6	7.6	7.6
Department of Defense or Energy	--	54.0	54.0	--	2.4	2.4	56.4
Other Federal	--	5.9	5.9	--	--	--	5.9
State and local government							
State	208.7	550.0	758.8	--	--	--	758.8
Local (county, municipal, etc.)	15.2	7.5	22.7	--	--	--	22.7
Private							
Undifferentiated private	2,301.8	3,764.4	6,066.2	--	--	--	6,066.2
All owners	**7,747.3**	**7,692.2**	**15,439.5**	**1,695.5**	**401.1**	**2,096.6**	**17,536.1**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B13. Net volume of live trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, on forest land by forest-type group and stand-size class, New Mexico, 2008-2012.

	Stand-size class				
Forest-type group	Large diameter	Medium diameter	Small diameter	Nonstocked	All size classes
Pinyon/juniper group	6,564.7	620.4	28.9	--	7,214.1
Douglas-fir group	1,890.6	124.8	7.3	--	2,022.8
Ponderosa pine group	3,864.3	162.1	34.7	--	4,061.1
Fir/spruce/mountain hemlock group	2,296.1	93.1	0.9	--	2,390.1
Other western softwoods group	199.8	--	0.9	--	200.8
Elm/ash/cottonwood group	37.2	7.7	0.9	--	45.8
Aspen/birch group	469.6	353.1	8.4	--	831.1
Woodland hardwoods group	379.4	157.3	203.7	--	740.4
Exotic hardwoods group	--	--	1.2	--	1.2
Nonstocked	--	--	--	28.8	28.8
All forest-type groups	**15,701.9**	**1,518.5**	**287.0**	**28.8**	**17,536.1**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B14. Net volume of live trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, on forest land by species group and ownership group, New Mexico, 2008-2012.

	Ownership group				
Species group	Forest Service	Other Federal	State and local government	Undifferentiated private	All owners
Softwood species groups					
Western softwood species groups					
Douglas-fir	1,550.7	1.3	55.5	445.3	2,052.8
Ponderosa and Jeffrey pines	2,921.4	82.3	102.3	1,496.3	4,602.3
True fir	904.3	--	39.2	220.9	1,164.4
Engelmann and other spruces	971.9	--	5.8	219.3	1,197.1
Other western softwoods	214.1	--	0.5	73.5	288.0
Other					
Woodland softwoods	2,267.6	742.1	520.9	3,171.5	6,702.1
All softwoods	8,829.9	825.7	724.2	5,626.9	16,006.7
Hardwood species groups					
Western hardwood species groups					
Cottonwood and aspen	639.2	--	33.3	214.6	887.1
Other western hardwoods	0.9	--	--	0.0	1.0
Other					
Woodland hardwoods	366.5	26.2	24.0	224.7	641.4
All hardwoods	1,006.7	26.2	57.3	439.3	1,529.5
All species groups	**9,836.6**	**851.9**	**781.5**	**6,066.2**	**17,536.1**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B15. Net volume of live trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, on forest land by species group and diameter class, New Mexico, 2008-2012.

	Diameter class (inches)													
Species group	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	21.0-24.9	25.0-28.9	29.0-32.9	33.0-36.9	37.0+	All classes
Softwood species groups														
Western softwood species groups														
Douglas-fir	83	152	207	249	232	222	184	134	282	151	107	33	15	2,053
Ponderosa and Jeffrey pines	128	320	485	588	629	548	474	398	600	261	85	58	28	4,602
True fir	53	98	138	161	164	139	109	81	132	57	33	--	--	1,164
Engelmann and other spruces	47	98	150	183	176	186	113	74	111	41	18	--	--	1,197
Other western softwoods	17	29	34	42	38	25	34	17	36	17	--	--	--	288
Other														
Woodland softwoods	532	818	931	893	793	678	578	434	508	266	123	80	68	6,702
All softwoods	860	1,516	1,945	2,115	2,032	1,799	1,492	1,138	1,669	793	365	171	111	16,007
Hardwood species groups														
Western hardwood species groups														
Cottonwood and aspen	72	149	200	150	108	89	50	31	22	7	9	--	--	887
Other western hardwoods	0	0	0	0	--	--	--	--	--	--	--	--	--	1
Other														
Woodland hardwoods	155	126	86	74	50	43	34	22	28	10	1	9	4	641
All hardwoods	227	276	286	224	158	132	83	53	50	17	10	9	4	1,529
All species groups	**1,087**	**1,792**	**2,231**	**2,339**	**2,191**	**1,931**	**1,576**	**1,191**	**1,719**	**810**	**375**	**180**	**114**	**17,536**

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volume rounds to less than 1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B16. Net volume of live trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, on forest land by forest-type group and stand origin, New Mexico, 2008-2012.

Forest-type group	Stand origin		All forest land
	Natural stands	Artificial regeneration	
Pinyon/juniper group	7,214.1	--	7,214.1
Douglas-fir group	2,022.8	--	2,022.8
Ponderosa pine group	4,060.1	1.0	4,061.1
Fir/spruce/mountain hemlock group	2,390.1	--	2,390.1
Other western softwoods group	200.8	--	200.8
Elm/ash/cottonwood group	45.8	--	45.8
Aspen/birch group	831.1	--	831.1
Woodland hardwoods group	740.4	--	740.4
Exotic hardwoods group	1.2	--	1.2
Nonstocked	28.8	--	28.8
All forest-type groups	**17,535.1**	**1.0**	**17,536.1**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B17. Net volume of growing-stock trees (at least 5 inches d.b.h.), in million cubic feet, on timberland by species group and diameter class, New Mexico, 2012.

	Diameter class (inches)													
Species group	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	21.0-24.9	25.0-28.9	29.0-32.9	33.0-36.9	37.0+	All classes
Softwood species groups														
Western softwood species groups														
Douglas-fir	64	123	162	186	171	168	148	92	230	80	58	13	15	1,510
Ponderosa and Jeffrey pines	91	239	362	435	456	387	357	259	398	179	53	58	28	3,302
True fir	37	69	106	123	115	102	73	61	93	41	33	--	--	851
Engelmann and other spruces	33	73	110	116	119	125	61	34	24	27	18	--	--	741
Other western softwoods	12	23	26	32	29	16	24	12	36	17	--	--	--	227
All softwoods	238	528	765	892	890	798	662	457	781	344	161	71	43	6,631
Hardwood species groups														
Western hardwood species groups														
Cottonwood and aspen	53	128	173	134	97	79	38	22	19	7	--	--	--	751
Other western hardwoods	0	0	--	0	--	--	--	--	--	--	--	--	--	0
All hardwoods	54	128	173	134	97	79	38	22	19	7	--	--	--	751
All species groups	**292**	**656**	**938**	**1,027**	**987**	**877**	**700**	**480**	**799**	**351**	**161**	**71**	**43**	**7,382**

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the volume rounds to less than 1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B18. Net volume of growing-stock trees (at least 5 inches d.b.h.), in million cubic feet, on timberland by species group and ownership group, New Mexico, 2008-2012.

	Ownership group				
Species group	Forest Service	Other Federal	State and local government	Undifferentiated private	All owners
Softwood species groups					
Western softwood species groups					
Douglas-fir	1,086.8	--	55.4	367.4	1,509.6
Ponderosa and Jeffrey pines	2,055.1	27.7	88.7	1,130.3	3,301.8
True fir	609.8	--	33.9	207.7	851.4
Engelmann and other spruces	517.3	--	5.8	217.7	740.9
Other western softwoods	159.6	--	0.5	67.0	227.1
All softwoods	4,428.6	27.7	184.3	1,990.2	6,630.7
Hardwood species groups					
Western hardwood species groups					
Cottonwood and aspen	545.4	--	30.9	174.7	751.0
Other western hardwoods	0.3	--	--	0.0	0.4
All hardwoods	545.8	--	30.9	174.7	751.4
All species groups	**4,974.4**	**27.7**	**215.1**	**2,164.9**	**7,382.1**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B19. Net volume of sawtimber trees, in million board feet (International ¼-inch rule), on timberland by species group and diameter class, New Mexico, 2008-2012.

	Diameter class (inches)											
Species group	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-24.9	25.0-28.9	29.0-32.9	33.0-36.9	37.0+	All classes
Softwood species groups												
Western softwood species groups												
Douglas-fir	533	802	834	888	811	506	1,338	461	357	82	94	6,707
Ponderosa and Jeffrey pines	1,224	1,915	2,321	2,101	2,088	1,561	2,401	1,062	343	357	183	15,555
True fir	407	557	553	512	376	322	494	219	167	--	--	3,605
Engelmann and other spruces	475	588	647	700	349	198	136	156	103	--	--	3,351
Other western softwoods	80	131	136	80	126	65	207	102	--	--	--	929
All softwoods	2,719	3,993	4,492	4,282	3,750	2,652	4,575	2,000	970	439	276	30,148
Hardwood species groups												
Western hardwood species groups												
Cottonwood and aspen	--	711	536	466	212	129	105	38	--	--	--	2,197
Other western hardwoods	--	1	--	--	--	--	--	--	--	--	--	1
All hardwoods	--	712	536	466	212	129	105	38	--	--	--	2,198
All species groups	**2,719**	**4,705**	**5,028**	**4,747**	**3,961**	**2,781**	**4,681**	**2,037**	**970**	**439**	**276**	**32,346**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B20. Net volume of sawlog portion of sawtimber trees, in million cubic feet, on timberland by species group and ownership group, New Mexico, 2008-2012.

	Ownership group				
Species group	Forest Service	Other Federal	State and local government	Undifferentiated private	All owners
Softwood species groups					
Western softwood species groups					
Douglas-fir	937.6	--	42.1	277.0	1,256.7
Ponderosa and Jeffrey pines	1,763.1	23.0	75.1	977.6	2,838.8
True fir	506.9	--	29.6	170.4	706.9
Engelmann and other spruces	421.9	--	5.0	170.3	597.2
Other western softwoods	130.6	--	--	52.9	183.6
All softwoods	3,760.2	23.0	151.8	1,648.2	5,583.2
Hardwood species groups					
Western hardwood species groups					
Cottonwood and aspen	267.7	--	11.7	66.0	345.4
Other western hardwoods	0.2	--	--	--	0.2
All hardwoods	267.9	--	11.7	66.0	345.5
All species groups	**4,028.1**	**23.0**	**163.5**	**1,714.2**	**5,928.8**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B21. Average annual net growth of live trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, by owner class and forest-land status, New Mexico, 2008-2012.

	Unreserved forests			Reserved forests			All
Owner class	Timberland	Unproductive	Total	Productive	Unproductive	Total	forest land
Forest Service							
National forest	-3.6	5.2	1.6	-9.3	0.7	-8.6	-7.0
National grassland	--	0.0	0.0	--	--	--	0.0
Other national forest	0.3	--	0.3	--	--	--	0.3
Other Federal							
National Park Service	--	--	--	-0.1	0.1	0.0	0.0
Bureau of Land Management	0.1	2.8	2.9	--	0.0	0.0	2.9
Fish and Wildlife Service	--	--	--	--	0.1	0.1	0.1
Department of Defense or Energy	--	0.5	0.5	--	-0.1	-0.1	0.4
Other Federal	--	0.1	0.1	--	--	--	0.1
State and local government							
State	1.5	3.7	5.2	--	--	--	5.2
Local (county, municipal, etc.)	0.2	0.0	0.2	--	--	--	0.2
Private							
Undifferentiated private	13.8	30.3	44.1	--	--	--	44.1
All owners	**12.4**	**42.5**	**54.9**	**-9.4**	**0.9**	**-8.5**	**46.4**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B22. Average annual net growth of live trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, on forest land by forest-type group and stand-size class, New Mexico, 2008-2012.

	Stand-size class				
Forest-type group	**Large diameter**	**Medium diameter**	**Small diameter**	**Nonstocked**	**All size classes**
Pinyon/juniper group	36.6	10.7	-0.1	--	47.2
Douglas-fir group	-2.6	1.5	0.0	--	-1.0
Ponderosa pine group	28.3	2.6	0.8	--	31.6
Fir/spruce/mountain hemlock group	-13.5	0.6	0.1	--	-12.8
Other western softwoods group	-1.7	--	0.0	--	-1.7
Elm/ash/cottonwood group	0.0	0.1	0.0	--	0.1
Aspen/birch group	-0.9	2.2	-4.6	--	-3.3
Woodland hardwoods group	1.3	2.3	-3.7	--	-0.1
Exotic hardwoods group	--	--	-0.2	--	-0.2
Nonstocked	--	--	--	-13.4	-13.4
All forest-type groups	**47.4**	**20.1**	**-7.7**	**-13.4**	**46.4**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B23. Average annual net growth of live trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, on forest land by species group and ownership group, New Mexico, 2008-2012.

Species group	Ownership group				
	Forest Service	Other Federal	State and local government	Undifferentiated private	All owners
Softwood species groups					
Western softwood species groups					
Douglas-fir	-4.0	0.0	0.0	2.3	-1.6
Ponderosa and Jeffrey pines	9.5	0.1	0.9	12.9	23.4
True fir	-15.5	--	0.0	-1.9	-17.4
Engelmann and other spruces	-6.0	0.0	0.0	0.6	-5.4
Other western softwoods	-0.5	--	0.0	0.7	0.2
Other					
Woodland softwoods	8.3	3.0	3.8	26.5	41.7
All softwoods	-8.2	3.1	4.6	41.2	40.8
Hardwood species groups					
Western hardwood species groups					
Cottonwood and aspen	-1.5	--	0.3	-0.1	-1.4
Other western hardwoods	0.0	--	--	0.0	0.0
Other					
Woodland hardwoods	3.1	0.3	0.5	3.0	6.9
All hardwoods	1.6	0.3	0.8	2.9	5.5
All species groups	**-6.6**	**3.5**	**5.4**	**44.1**	**46.4**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B24. Average annual net growth of growing-stock trees (at least 5 inches d.b.h.), in million cubic feet, on timberland by species group and ownership group, New Mexico, 2008-2012.

	Ownership group				
Species group	Forest Service	Other Federal	State and local government	Undifferentiated private	All owners
Softwood species groups					
Western softwood species groups					
Douglas-fir	-1.4	--	0.4	2.5	1.5
Ponderosa and Jeffrey pines	11.0	0.1	0.9	10.5	22.5
True fir	-9.7	--	0.0	-1.9	-11.6
Engelmann and other spruces	-2.8	--	0.0	0.6	-2.2
Other western softwoods	-0.7	--	0.0	0.6	0.0
All softwoods	-3.7	0.1	1.2	12.4	10.0
Hardwood species groups					
Western hardwood species groups					
Cottonwood and aspen	-0.4	--	0.2	0.6	0.4
Other western hardwoods	0.0	--	--	0.0	0.0
All hardwoods	-0.4	--	0.2	0.6	0.4
All species groups	**-4.0**	**0.1**	**1.4**	**13.0**	**10.4**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B25. Average annual mortality of trees (at least 5 inches d.b.h.), in million cubic feet, by owner class and forest-land status, New Mexico, 2008-2012.

	Unreserved forests			Reserved forests			All
Owner class	Timberland	Unproductive	Total	Productive	Unproductive	Total	forest land
Forest Service							
National forest	64.3	26.9	91.1	26.4	4.2	30.6	121.7
Other national forest	0.7	--	0.7	--	--	--	0.7
Other Federal							
National Park Service	--	--	--	0.5	0.1	0.6	0.6
Bureau of Land Management	0.2	2.9	3.2	--	0.2	0.2	3.4
Department of Defense or Energy	--	0.3	0.3	--	0.1	0.1	0.3
State and local government							
State	1.5	2.1	3.6	--	--	--	3.6
Local (county, municipal, etc.)	0.0	0.1	0.1	--	--	--	0.1
Private							
Undifferentiated private	15.7	18.9	34.6	--	--	--	34.6
All owners	**82.4**	**51.1**	**133.6**	**26.9**	**4.6**	**31.6**	**165.1**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B26. Average annual mortality of trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, on forest land by forest-type group and stand-size class, New Mexico, 2008-2012.

Forest-type group	Stand-size class				All size classes
	Large diameter	Medium diameter	Small diameter	Nonstocked	
Pinyon/juniper group	33.3	3.8	1.0	--	38.1
Douglas-fir group	21.2	0.5	0.1	--	21.7
Ponderosa pine group	19.8	1.4	0.5	--	21.7
Fir/spruce/mountain hemlock group	36.0	1.3	--	--	37.3
Other western softwoods group	3.6	--	--	--	3.6
Elm/ash/cottonwood group	0.4	0.0	--	--	0.4
Aspen/birch group	6.4	4.4	4.8	--	15.6
Woodland hardwoods group	2.9	1.6	7.9	--	12.5
Exotic hardwoods group	--	--	0.2	--	0.2
Nonstocked	--	--	--	14.0	14.0
All forest-type groups	**123.6**	**12.9**	**14.6**	**14.0**	**165.1**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B27. Average annual mortality of trees (at least 5 inches d.b.h./d.r.c.), in million cubic feet, on forest land by species group and ownership group, New Mexico, 2008-2012.

	Ownership group				
Species group	Forest Service	Other Federal	State and local government	Undifferentiated private	All owners
Softwood species groups					
Western softwood species groups					
Douglas-fir	19.4	--	0.6	3.7	23.6
Ponderosa and Jeffrey pines	27.6	1.0	0.7	5.9	35.2
True fir	25.0	--	0.4	4.6	30.0
Engelmann and other spruces	15.7	0.0	0.1	2.4	18.2
Other western softwoods	2.7	--	0.1	0.1	2.9
Other					
Woodland softwoods	18.1	3.4	1.4	12.6	35.4
All softwoods	108.5	4.4	3.1	29.1	145.2
Hardwood species groups					
Western hardwood species groups					
Cottonwood and aspen	10.6	--	0.4	3.3	14.3
Other western hardwoods	0.0	--	--	0.0	0.0
Other					
Woodland hardwoods	3.3	0.0	0.2	2.1	5.6
All hardwoods	13.9	0.0	0.6	5.4	20.0
All species groups	**122.5**	**4.4**	**3.7**	**34.6**	**165.1**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B28. Average annual mortality of growing-stock trees (at least 5 inches d.b.h.), in million cubic feet, on timberland by species group and ownership group, New Mexico, 2008-2012.

	Ownership group				
Species group	Forest Service	Other Federal	State and local government	Undifferentiated private	All owners
Softwood species groups					
Western softwood species groups					
Douglas-fir	11.8	--	0.2	2.4	14.3
Ponderosa and Jeffrey pines	14.8	0.2	0.4	2.6	18.0
True fir	15.9	--	0.3	4.5	20.7
Engelmann and other spruces	8.9	--	0.1	2.3	11.3
Other western softwoods	2.2	--	0.0	0.1	2.3
All softwoods	53.5	0.2	1.0	11.9	66.7
Hardwood species groups					
Western hardwood species groups					
Cottonwood and aspen	8.2	--	0.4	2.0	10.6
Other western hardwoods	--	--	--	0.0	0.0
All hardwoods	8.2	--	0.4	2.0	10.6
All species groups	61.7	0.2	1.4	13.9	77.3

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic feet. Columns and rows may not add to their totals due to rounding.

Table B29. Aboveground dry weight of live trees (at least 1 inch d.b.h./d.r.c.), in thousand dry short tons, by owner class and forest-land status, New Mexico, 2008-2012.

	Unreserved forests			Reserved forests			All
Owner class	Timberland	Unproductive	Total	Productive	Unproductive	Total	forest land
Forest Service							
National forest	94,822	47,094	141,916	29,666	6,512	36,179	178,095
National grassland	--	37	37	--	--	--	37
Other national forest	1,973	--	1,973	--	--	--	1,973
Other Federal							
National Park Service	--	--	--	547	382	929	929
Bureau of Land Management	587	11,677	12,264	--	530	530	12,795
Fish and Wildlife Service	--	--	--	--	110	110	110
Department of Defense or Energy	--	1,030	1,030	--	39	39	1,069
Other Federal	--	132	132	--	--	--	132
State and local government							
State	4,101	9,337	13,438	--	--	--	13,438
Local (county, municipal, etc.)	303	124	427	--	--	--	427
Private							
Undifferentiated private	43,262	65,874	109,136	--	--	--	109,136
All owners	**145,047**	**135,305**	**280,351**	**30,213**	**7,574**	**37,787**	**318,138**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B30. Aboveground dry weight of live trees (at least 1 inch d.b.h./d.r.c.), in thousand dry short tons, on forest land by species group and diameter class, New Mexico, 2008-2012.

	Diameter class (inches)															
Species group	**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**	**21.0-22.9**	**23.0-24.9**	**25.0-26.9**	**27.0-28.9**	**29.0+**	**All classes**
Softwood species groups																
Western softwood species groups																
Douglas-fir	334	1,047	1,742	3,139	4,209	5,007	4,646	4,422	3,653	2,655	3,338	2,214	1,555	1,400	3,034	42,394
Ponderosa and Jeffrey pines	256	975	2,410	5,876	8,804	10,555	11,232	9,727	8,386	7,009	6,162	4,382	2,494	2,069	2,981	83,317
True fir	294	865	916	1,639	2,303	2,649	2,687	2,272	1,771	1,318	1,285	861	537	397	530	20,325
Engelmann and other spruces	138	501	731	1,499	2,262	2,727	2,607	2,734	1,674	1,086	1,148	462	269	326	268	18,432
Other western softwoods	41	121	312	531	601	744	679	452	603	308	309	331	34	258	--	5,324
Other																
Woodland softwoods	2,414	5,163	7,916	12,129	13,777	13,130	11,554	9,918	8,520	6,358	4,480	2,924	2,397	1,475	3,891	106,047
All softwoods	3,478	8,672	14,026	24,813	31,956	34,811	33,404	29,526	24,609	18,734	16,724	11,174	7,286	5,924	10,703	275,838
Hardwood species groups																
Western hardwood species groups																
Cottonwood and aspen	149	668	1,456	2,822	3,598	2,624	1,852	1,517	832	515	307	68	129	--	139	16,676
Other western hardwoods	18	73	8	13	1	6	--	--	--	--	--	--	--	--	--	119
Other																
Woodland hardwoods	6,636	6,511	2,999	2,448	1,665	1,420	967	841	640	414	250	278	172	17	246	25,505
All hardwoods	6,803	7,252	4,463	5,283	5,264	4,050	2,820	2,358	1,472	929	556	346	302	17	385	42,300
All species groups	**10,281**	**15,924**	**18,489**	**30,096**	**37,219**	**38,861**	**36,224**	**31,883**	**26,080**	**19,663**	**17,280**	**11,520**	**7,588**	**5,941**	**11,088**	**318,138**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B31. Area of forest land, in thousand acres, by inventory unit, county and forest-land status, New Mexico, 2008-2012.

	Unreserved forests			Reserved forests			All
Inventory unit and county	Timberland	Unproductive	Total	Productive	Unproductive	Total	forest land
Northwestern							
Bernalillo	--	162.8	162.8	8.8	9.4	18.2	181.0
Cibola	246.9	1,102.1	1,349.0	36.4	98.6	135.0	1,484.0
Los Alamos	19.5	19.5	39.1	6.5	9.5	16.1	55.1
McKinley	88.6	1,239.7	1,328.3	--	--	--	1,328.3
Rio Arriba	740.2	1,680.8	2,421.0	86.4	12.1	98.5	2,519.5
Sandoval	286.7	631.7	918.4	21.0	35.0	55.9	974.3
San Juan	94.5	457.5	552.0	--	5.6	5.6	557.6
Santa Fe	74.3	438.2	512.5	57.3	12.9	70.3	582.8
Taos	446.7	301.6	748.3	21.2	--	21.2	769.5
Valencia	8.9	35.8	44.7	--	1.3	1.3	46.0
Total	2,006.3	6,069.8	8,076.1	237.6	184.4	422.0	8,498.1
Northeastern							
Colfax	532.8	466.5	999.3	--	--	--	999.3
Guadalupe	--	466.3	466.3	--	--	--	466.3
Harding	--	237.7	237.7	--	--	--	237.7
Mora	229.7	175.1	404.7	53.0	--	53.0	457.7
Quay	8.1	223.9	232.0	--	--	--	232.0
San Miguel	278.2	1,125.7	1,404.0	59.4	6.6	66.0	1,469.9
Torrance	14.6	574.2	588.8	--	8.3	8.3	597.1
Union	--	239.9	239.9	--	--	--	239.9
Total	1,063.3	3,509.3	4,572.7	112.4	14.9	127.3	4,699.9

(Table B31 continued on next page)

(Table B31 continued)

Inventory unit and county	Unreserved forests			Reserved forests			All
	Timberland	Unproductive	Total	Productive	Unproductive	Total	forest land
Southwestern							
Catron	632.3	1,928.4	2,560.7	154.0	126.3	280.2	2,840.9
Dona Ana	--	671.2	671.2	--	13.4	13.4	684.6
Grant	75.8	746.7	822.5	68.9	184.3	253.2	1,075.7
Hidalgo	--	341.1	341.1	--	--	--	341.1
Luna	--	326.1	326.1	--	--	--	326.1
Sierra	61.2	422.0	483.2	98.0	25.3	123.3	606.5
Socorro	90.3	852.6	943.0	22.5	82.8	105.3	1,048.3
Total	859.5	5,288.1	6,147.7	343.4	432.0	775.5	6,923.1
Southeastern							
Chaves	--	848.1	848.1	--	--	--	848.1
DeBaca	--	167.4	167.4	--	--	--	167.4
Eddy	7.9	686.5	694.5	--	6.4	6.4	700.8
Lea	--	467.3	467.3	--	--	--	467.3
Lincoln	44.0	777.8	821.8	43.2	40.5	83.7	905.4
Otero	297.2	1,324.4	1,621.6	--	--	--	1,621.6
Roosevelt	--	7.6	7.6	--	--	--	7.6
Total	349.1	4,279.0	4,628.1	43.2	46.8	90.0	4,718.1
All counties	**4,278.2**	**19,146.4**	**23,424.6**	**736.6**	**678.2**	**1,414.8**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Columns and rows may not add to their totals due to rounding.

Table B32. Area of forest land, in thousand acres, by inventory unit, county, ownership group and forest-land status, New Mexico, 2008-2012.

Inventory unit and county	Forest Service		Other Federal		State and local government		Undifferentiated private		
	Timber-land	Other forest land	Timber-land	Other forest land	Timber-land	Other forest land	Timber-land	Other forest land	All forest land
Northwestern									
Bernalillo	--	71.3	--	--	--	15.5	--	94.2	181.0
Cibola	153.1	113.1	18.9	249.2	--	55.2	74.9	819.6	1,484.0
Los Alamos	19.5	19.5	--	16.1	--	--	--	--	55.1
McKinley	31.8	112.0	--	110.0	6.7	73.6	50.2	944.1	1,328.3
Rio Arriba	545.0	657.8	--	321.5	13.3	83.6	181.9	716.4	2,519.5
Sandoval	270.3	172.2	--	159.0	--	6.8	16.4	349.6	974.3
San Juan	--	--	--	225.2	--	44.3	94.5	193.6	557.6
Santa Fe	74.3	137.5	--	49.2	--	55.5	--	266.3	582.8
Taos	358.5	124.6	--	77.2	--	--	88.2	121.1	769.5
Valencia	--	1.3	--	--	--	--	8.9	35.8	46.0
Total	1,452.5	1,409.2	18.9	1,207.3	20.0	334.5	514.9	3,540.8	8,498.1
Northeastern									
Colfax	56.5	6.5	--	--	87.7	13.7	388.6	446.3	999.3
Guadalupe	--	--	--	--	--	82.1	--	384.2	466.3
Harding	--	13.6	--	--	--	55.7	--	168.4	237.7
Mora	26.5	53.0	--	7.1	7.1	22.6	196.1	145.4	457.7
Quay	--	--	--	--	--	50.5	8.1	173.4	232.0
San Miguel	143.4	174.7	--	16.8	--	120.0	134.9	880.2	1,469.9
Torrance	14.6	117.1	--	--	--	70.3	--	395.2	597.1
Union	--	--	--	--	--	66.7	--	173.2	239.9
Total	240.9	364.9	--	23.9	94.8	481.6	727.6	2,766.2	4,699.9

(Table B32 continued on next page)

(Table B32 continued)

Inventory unit and county	Forest Service Timber-land	Forest Service Other forest land	Other Federal Timber-land	Other Federal Other forest land	State and local government Timber-land	State and local government Other forest land	Undifferentiated private Timber-land	Undifferentiated private Other forest land	All forest land
Southwestern									
Catron	618.5	1,374.7	6.9	198.3	6.9	117.1	--	518.6	2,840.9
Dona Ana	--	--	--	560.4	--	93.2	--	31.0	684.6
Grant	71.8	675.1	4.0	53.2	--	54.5	--	217.1	1,075.7
Hidalgo	--	33.3	--	72.0	--	91.6	--	144.2	341.1
Luna	--	--	--	144.6	--	67.1	--	114.4	326.1
Sierra	61.2	263.9	--	171.0	--	42.2	--	68.2	606.5
Socorro	67.7	290.9	--	266.0	8.0	145.1	14.6	256.1	1,048.3
Total	819.1	2,637.9	10.9	1,465.4	14.9	610.8	14.6	1,349.5	6,923.1
Southeastern									
Chaves	--	20.3	--	146.9	--	211.2	--	469.7	848.1
DeBaca	--	--	--	--	--	67.8	--	99.6	167.4
Eddy	6.4	84.2	--	318.6	1.6	215.4	--	74.6	700.8
Lea	--	--	--	107.0	--	126.4	--	233.9	467.3
Lincoln	44.0	334.2	--	41.4	--	68.4	--	417.5	905.4
Otero	137.5	250.4	--	577.2	4.4	55.2	155.3	441.7	1,621.6
Roosevelt	--	--	--	--	--	7.6	--	--	7.6
Total	187.8	689.1	--	1,191.1	6.0	751.8	155.3	1,737.0	4,718.1
All counties	**2,700.3**	**5,101.2**	**29.8**	**3,887.8**	**135.6**	**2,178.7**	**1,412.5**	**9,393.5**	**24,839.4**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

Table B33. Area of timberland, in thousand acres, by inventory unit, county and stand-size class, New Mexico, 2008-2012.

Inventory unit and county		Stand-size class				
		Large diameter	Medium diameter	Small diameter	Nonstocked	All size classes
Northwestern	Cibola	217.0	15.1	7.3	7.5	246.9
	Los Alamos	6.5	--	13.0	--	19.5
	McKinley	68.1	13.4	7.2	--	88.6
	Rio Arriba	581.6	107.7	40.9	10.0	740.2
	Sandoval	258.7	8.7	14.0	5.2	286.7
	San Juan	85.9	8.6	--	--	94.5
	Santa Fe	74.3	--	--	--	74.3
	Taos	341.6	98.0	7.1	--	446.7
	Valencia	8.9	--	--	--	8.9
	Total	1,642.6	251.6	89.4	22.7	2,006.3
Northeastern	Colfax	413.1	64.0	29.9	25.9	532.8
	Mora	202.7	11.5	10.7	4.7	229.7
	Quay	--	--	8.1	--	8.1
	San Miguel	210.6	36.6	16.8	14.3	278.2
	Torrance	14.6	--	--	--	14.6
	Total	840.9	112.1	65.5	44.8	1,063.3
Southwestern	Catron	534.4	34.6	15.6	47.8	632.3
	Grant	71.2	1.6	--	2.9	75.8
	Sierra	61.2	--	--	--	61.2
	Socorro	60.7	23.6	6.0	--	90.3
	Total	727.4	59.9	21.6	50.6	859.5
Southeastern	Eddy	6.4	--	1.6	--	7.9
	Lincoln	32.0	--	--	12.0	44.0
	Otero	267.9	21.5	--	7.8	297.2
	Total	306.2	21.5	1.6	19.8	349.1
All counties		**3,517.2**	**445.0**	**178.0**	**138.0**	**4,278.2**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

Table B34. Area of timberland, in thousand acres, by inventory unit, county and stocking class, New Mexico, 2008-2012.

Inventory unit and county		Stocking class of growing-stock trees					
		Nonstocked	Poorly stocked	Moderately stocked	Fully stocked	Overstocked	All classes
Northwestern	Cibola	8.1	72.4	101.0	65.4	--	246.9
	Los Alamos	--	6.5	6.5	6.5	--	19.5
	McKinley	--	43.3	38.1	7.2	--	88.6
	Rio Arriba	10.0	292.7	247.7	160.7	29.1	740.2
	Sandoval	12.2	63.2	101.7	109.6	--	286.7
	San Juan	--	34.4	42.9	17.2	--	94.5
	Santa Fe	--	14.8	51.8	7.7	--	74.3
	Taos	--	90.0	175.5	168.9	12.3	446.7
	Valencia	--	8.9	--	--	--	8.9
	Total	30.3	626.1	765.2	543.3	41.4	2,006.3
Northeastern	Colfax	27.0	226.8	154.2	111.5	13.2	532.8
	Mora	5.2	49.1	110.7	55.6	9.1	229.7
	Quay	--	8.1	--	--	--	8.1
	San Miguel	14.3	67.2	130.1	66.6	--	278.2
	Torrance	--	6.2	--	8.3	--	14.6
	Total	46.5	357.4	395.0	242.0	22.4	1,063.3
Southwestern	Catron	47.8	339.9	215.2	29.4	--	632.3
	Grant	2.9	36.1	30.2	6.6	--	75.8
	Sierra	--	42.7	18.5	--	--	61.2
	Socorro	--	58.1	27.7	4.5	--	90.3
	Total	50.6	476.8	291.7	40.5	--	859.5
Southeastern	Eddy	--	6.4	--	--	1.6	7.9
	Lincoln	12.0	11.1	18.0	--	3.0	44.0
	Otero	7.8	95.1	130.2	64.1	--	297.2
	Total	19.8	112.5	148.2	64.1	4.5	349.1
All counties		**147.1**	**1,572.9**	**1,600.1**	**889.8**	**68.3**	**4,278.2**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

Table B35. Net volume of growing-stock trees (at least 5 inches d.b.h.), in million cubic feet, and sawtimber trees, in million board feet (International ¼-inch rule), on timberland by inventory unit, county, and major species group, New Mexico, 2008-2012.

Inventory unit and county	Growing stock: Major species group: Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Sawtimber: Major species group: Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species
	(In million cubic feet)					(In million board feet)				
Northwestern										
Cibola	345.7	54.3	19.5	--	419.4	1,601.1	217.3	53.9	--	1,872.3
Los Alamos	--	34.1	3.8	--	37.9	--	194.6	21.4	--	216.0
McKinley	104.0	2.9	--	--	107.0	457.4	17.4	--	--	474.8
Rio Arriba	424.2	636.8	303.9	--	1,365.0	2,045.7	2,952.1	949.7	--	5,947.4
Sandoval	262.9	371.0	74.2	--	708.1	1,185.1	1,766.0	233.5	--	3,184.5
San Juan	187.2	16.3	20.0	--	223.6	1,095.9	53.5	66.1	--	1,215.5
Santa Fe	99.8	36.0	0.6	--	136.4	529.8	132.2	--	--	662.0
Taos	151.0	604.9	200.9	--	956.8	753.4	2,625.3	535.5	--	3,914.2
Valencia	--	--	--	2.0	2.0	--	--	--	4.9	4.9
Total	1,574.8	1,756.3	623.0	2.0	3,956.1	7,668.4	7,958.3	1,860.0	4.9	17,491.6
Northeastern										
Colfax	339.1	320.1	76.3	--	735.5	1,456.3	1,207.3	213.4	--	2,876.9
Mora	224.1	152.0	5.4	--	381.5	1,048.4	652.4	--	--	1,700.8
San Miguel	220.1	196.6	6.8	--	423.4	873.3	735.3	10.9	--	1,619.5
Torrance	21.3	1.9	--	--	23.3	67.5	6.7	--	--	74.2
Total	804.6	670.7	88.4	--	1,563.7	3,445.5	2,601.7	224.3	--	6,271.4
Southwestern										
Catron	719.4	154.0	10.4	--	883.8	3,353.3	685.4	49.9	--	4,088.7
Grant	90.8	21.2	--	--	112.0	416.7	95.4	--	--	512.1
Sierra	63.6	6.0	--	--	69.5	285.9	24.4	--	--	310.3
Socorro	57.0	29.6	1.0	12.9	100.6	266.2	126.7	0.8	35.9	429.6
Total	930.8	210.8	11.4	12.9	1,166.0	4,322.1	931.9	50.7	35.9	5,340.6
Southeastern										
Eddy	2.7	--	--	--	2.7	9.7	--	--	--	9.7
Lincoln	23.6	44.2	--	0.3	68.2	110.2	207.9	--	0.9	318.9
Otero	192.3	419.9	13.2	0.0	625.4	928.4	1,963.7	21.2	--	2,913.3
Total	218.6	464.1	13.2	0.4	696.3	1,048.2	2,171.6	21.2	0.9	3,241.9
All counties	**3,528.9**	**3,101.8**	**736.0**	**15.3**	**7,382.1**	**16,484.2**	**13,663.5**	**2,156.1**	**41.6**	**32,345.5**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic or board feet. Columns and rows may not add to their totals due to rounding.

Table B36. Average annual net growth of growing-stock trees (at least 5 inches d.b.h.), in million cubic feet, and sawtimber trees, in million board feet (International ¼-inch rule), on timberland by inventory unit, county, and major species group, New Mexico, 2008-2012.

Inventory unit and county	Growing stock: Major species group: Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Sawtimber: Major species group: Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species
Northwestern		(In million cubic feet)					(In million board feet)			
Cibola	2.4	-0.3	0.5	--	2.6	14.9	-1.2	1.9	--	15.6
Los Alamos	-0.3	-0.8	-0.4	--	-1.4	-0.9	-4.0	-0.1	--	-5.1
McKinley	0.9	0.0	--	--	0.9	5.4	0.1	--	--	5.5
Rio Arriba	2.7	-4.8	-1.5	--	-3.5	19.3	-9.8	10.2	--	19.7
Sandoval	2.2	0.3	0.0	--	2.5	13.4	5.4	-0.9	--	17.8
San Juan	1.2	-0.1	0.1	--	1.3	8.2	-0.4	-0.3	--	7.5
Santa Fe	-0.2	-0.1	-0.1	--	-0.4	1.3	1.9	--	--	3.2
Taos	1.2	-4.8	1.8	--	-1.8	8.6	-6.2	5.8	--	8.1
Valencia	--	--	--	0.0	0.0	--	--	--	0.0	0.0
Total	10.2	-10.5	0.5	0.0	0.2	70.2	-14.3	16.6	0.0	72.4
Northeastern										
Colfax	2.9	0.6	0.1	--	3.7	19.8	13.7	-0.2	--	33.2
Mora	2.0	-1.4	-0.1	--	0.6	13.1	-1.7	--	--	11.5
San Miguel	1.2	-1.5	0.1	--	-0.2	8.6	-3.7	0.1	--	5.0
Torrance	0.1	0.0	--	--	0.1	0.1	0.0	--	--	0.0
Total	6.3	-2.3	0.1	--	4.2	41.7	8.2	-0.2	--	49.7
Southwestern										
Catron	7.8	1.5	-0.2	--	9.1	44.0	11.1	-1.3	--	53.8
Grant	0.6	0.1	--	--	0.6	4.1	1.7	--	--	5.9
Sierra	0.1	0.1	--	--	0.1	-0.4	0.2	--	--	-0.3
Socorro	-0.2	-0.4	0.0	0.1	-0.5	-1.4	-2.0	0.0	0.2	-3.2
Total	8.3	1.2	-0.2	0.1	9.3	46.3	11.1	-1.3	0.2	56.2
Southeastern										
Eddy	0.0	--	--	--	0.0	0.5	--	--	--	0.5
Lincoln	-2.1	-0.4	--	0.0	-2.4	-9.6	-1.5	--	0.0	-11.1
Otero	-0.3	-0.5	-0.1	0.0	-0.9	0.0	6.8	3.3	--	10.1
Total	-2.3	-0.8	-0.1	0.0	-3.3	-9.2	5.3	3.3	0.0	-0.5
All counties	**22.4**	**-12.4**	**0.3**	**0.1**	**10.4**	**148.9**	**10.3**	**18.5**	**0.2**	**177.9**

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the volume rounds to less than 0.1 million cubic or board feet. Columns and rows may not add to their totals due to rounding.

Table B37. Sampling errors (in percent) by inventory unit and county for area of timberland, volume, average annual net growth, average annual removals, and average annual mortality on timberland, New Mexico, 2008-2012.

Inventory unit	Forest	Timberland	Growing stock (on timberland)				Sawtimber (on timberland)			
and county	area	area	Volume	Growth	Removals	Mortality	Volume	Growth	Removals	Mortality
Northwestern										
Bernalillo	10.28	--	--	--	--	--	--	--	--	--
Cibola	3.44	15.38	18.71	28.80	--	50.58	19.66	26.26	--	54.00
Los Alamos	13.58	51.64	100.00	68.84	--	67.20	100.00	69.40	--	72.86
McKinley	3.74	26.11	29.66	41.72	--	71.95	29.81	47.66	--	76.66
Rio Arriba	3.02	9.46	12.46	100.00	--	21.91	13.97	100.00	--	25.19
Sandoval	4.25	10.53	15.30	54.86	--	28.76	16.42	41.45	--	32.08
San Juan	7.80	22.02	28.31	46.41	--	45.21	29.86	41.06	--	47.52
Santa Fe	6.01	29.40	33.02	100.00	--	47.10	34.12	100.00	--	49.73
Taos	3.17	8.10	10.62	100.00	--	19.70	12.15	100.00	--	23.94
Valencia	33.50	88.51	88.51	88.51	--	--	88.51	88.51	--	--
Total	1.53	5.03	6.48	100.00	--	12.47	7.17	37.65	--	14.52
Northeastern										
Colfax	3.01	7.45	10.53	38.42	--	19.38	11.41	22.91	--	22.73
Guadalupe	16.08	--	--	--	--	--	--	--	--	--
Harding	12.10	--	--	--	--	--	--	--	--	--
Mora	5.42	12.89	17.56	100.00	--	35.66	18.32	42.36	--	45.73
Quay	15.30	80.83	--	--	--	--	--	--	--	--
San Miguel	4.10	15.20	18.04	100.00	--	55.85	19.04	100.00	--	64.62
Torrance	6.05	68.94	83.63	100.00	--	95.50	81.11	100.00	--	98.80
Union	10.82	--	--	--	--	--	--	--	--	--
Total	2.59	6.23	8.26	93.70	--	22.88	8.78	37.34	--	28.61

(Table B37 continued on next page)

(Table B37 continued)

Inventory unit and county	Forest area	Timberland area	Growing stock (on timberland)				Sawtimber (on timberland)			
			Volume	Growth	Removals	Mortality	Volume	Growth	Removals	Mortality
Southwestern										
Catron	1.77	8.87	11.56	27.90	--	42.56	12.33	26.72	--	49.60
Dona Ana	8.18	--	--	--	--	--	--	--	--	--
Grant	4.62	29.35	37.02	91.56	--	80.60	39.66	60.58	--	94.29
Hidalgo	12.71	--	--	--	--	--	--	--	--	--
Luna	12.82	--	--	--	--	--	--	--	--	--
Sierra	6.58	30.88	33.19	100.00	--	95.64	35.55	100.00	--	100.00
Socorro	5.54	26.05	33.36	100.00	--	49.78	38.99	100.00	--	51.84
Total	1.87	7.85	10.08	30.29	--	30.48	10.85	28.49	--	34.92
Southeastern										
Chaves	7.60	--	--	--	--	--	--	--	--	--
DeBaca	18.00	--	--	--	--	--	--	--	--	--
Eddy	8.00	83.30	100.00	100.00	--	--	100.00	100.00	--	--
Lea	10.13	--	--	--	--	--	--	--	--	--
Lincoln	10.65	38.41	53.83	84.77	--	69.32	55.35	97.69	--	80.07
Otero	4.05	12.35	14.22	100.00	--	21.53	14.66	69.95	--	22.52
Roosevelt	95.53	--	--	--	--	--	--	--	--	--
Total	3.29	11.73	13.83	74.02	--	26.25	14.26	100.00	--	32.13
All counties	1.08	3.37	4.40	71.46	--	9.65	4.82	21.80	--	11.50

All table cells without observations in the inventory sample are indicated by --. Sampling errors that exceed 100% are reported as 100%.

Table B38. Mean water, carbon, and nitrogen contents of forest floor and soil cores by forest type group, New Mexico, 2008-2011.

Forest-type group	Soil layer (cm)	Number of plots	Water content (percent)	Organic carbon (percent)	Inorganic carbon (percent)	Total nitrogen (percent)	C/N ratio	Forest floor mass (Mg/ha)	Organic carbon (Mg/ha)	Total nitrogen (Mg/ha)
Woodland hardwoods group	Forest floor	16	7.06	27.75	--	0.698	39.6	1.89	0.43	0.013
	0–10	21	4.10	0.58	0.36	0.052	11.2	--	6.97	0.627
	10–20	20	5.59	0.50	0.45	0.047	10.9	--	6.43	0.600
Pinyon/juniper group	Forest floor	51	7.63	32.45	--	0.753	45.3	3.90	1.20	0.030
	0–10	42	6.75	1.38	0.34	0.107	12.9	--	14.66	1.131
	10–20	37	8.99	0.90	0.38	0.067	13.4	--	10.45	0.766
Ponderosa pine group	Forest floor	6	9.63	40.52	--	0.757	57.5	14.38	5.54	0.124
	0–10	4	9.64	2.36	0.17	0.123	19.2	--	20.63	1.059
	10–20	3	10.54	1.34	0.15	0.071	18.7	--	13.00	0.633
Douglas-fir group	Forest floor	3	28.64	26.63	--	0.810	33.4	24.53	6.72	0.214
	0–10	3	23.93	6.17	0.24	0.302	20.4	--	30.90	1.515
	10–20	3	12.39	2.22	0.17	0.105	21.1	--	10.53	0.499
Fir/spruce/mountain hemlock group	Forest floor	3	36.94	35.23	--	1.087	33.0	15.21	5.17	0.172
	0–10	3	15.63	3.34	0.20	0.169	19.7	--	25.01	1.267
	10–20	3	15.56	1.91	0.14	0.116	16.4	--	18.25	1.113

Water content and forest floor mass are reported on an oven-dry basis (105C). Soil samples were not collected in New Mexico in 2012. All table cells without observations in the inventory sample are indicated by --.

Table B39a. Mean physical and chemical properties of soil cores by forest type group, New Mexico, 2008-2011.

Forest-type group	Soil layer (cm)	Number of plots	SQI (percent)	Bulk density (g/cm3)	Coarse fragments (percent)	pH H2O	pH CaCl2	Bray 1 extractable phosphorus (mg/kg)	Olsen extractable phosphorus (mg/kg)
Woodland hardwoods group	0–10	21	53.8	1.43	8.54	7.57	7.06	7.3	2.9
	10–20	20	50.1	1.49	8.80	7.59	7.10	4.4	2.8
Pinyon/juniper group	0–10	42	62.3	1.32	15.44	7.34	6.93	15.5	5.8
	10–20	37	57.0	1.47	17.82	7.41	6.91	7.2	3.3
Ponderosa pine group	0–10	4	63.0	1.26	28.24	6.44	5.98	10.5	2.2
	10–20	3	60.3	1.57	40.07	6.29	5.78	8.9	4.5
Douglas-fir group	0–10	3	80.2	0.68	23.89	6.77	6.45	45.1	31.0
	10–20	3	64.2	1.07	53.37	6.81	6.38	23.4	9.5
Fir/spruce/mountain hemlock group	0–10	3	71.6	0.94	17.08	5.63	5.02	37.0	14.5
	10–20	3	66.7	1.08	10.62	5.24	4.72	36.3	13.3

Table B39b. Mean exchangeable cation concentrations in soil cores by forest type group, New Mexico, 2008-2011.

Forest-type group	Soil layer (cm)	Number of plots	1 M NH4Cl Exchangeable cations (mg/kg) Na	K	Mg	Ca	Al	ECEC (cmolc/kg)
Woodland hardwoods group	0–10	21	6	198	118	2358	0.0	13.80
	10–20	20	18	155	116	2498	0.3	14.49
Pinyon/juniper group	0–10	42	30	279	278	3764	0.0	23.27
	10–20	37	32	197	265	3268	0.5	20.00
Ponderosa pine group	0–10	4	34	253	271	2638	0.0	16.79
	10–20	3	49	157	215	2073	1.6	13.29
Douglas-fir group	0–10	3	18	372	302	3660	0.0	21.95
	10–20	3	31	261	232	2313	7.7	14.58
Fir/spruce/mountain hemlock group	0–10	3	44	209	302	2437	2.7	15.59
	10–20	3	65	169	352	2452	14.9	16.26

Soil samples were not collected in New Mexico in 2012.

Table B39c. Mean extractable trace element concentrations in soil cores by forest type group, New Mexico, 2008-2011.

Forest-type group	Soil layer (cm)	Number of plots	1 M NH4Cl Exchangeable cations Mn (mg/kg)	Fe	Ni	Cu	Zn	Cd	Pb	S
Woodland hardwoods group	0–10	21	2.2	0.1	0.00	0.00	0.00	0.02	0.05	4.1
	10–20	20	1.9	0.2	0.00	0.00	0.36	0.01	0.09	7.2
Pinyon/juniper group	0–10	42	3.8	0.3	0.01	0.00	0.00	0.14	0.05	56.9
	10–20	37	2.9	0.2	0.01	0.00	0.01	0.11	0.10	10.7
Ponderosa pine group	0–10	4	9.8	0.2	0.00	0.00	0.00	0.02	0.19	4.9
	10–20	3	12.0	1.0	0.06	0.00	0.00	0.05	0.01	4.9
Douglas-fir group	0–10	3	8.5	0.3	0.00	0.00	0.00	0.06	0.17	6.6
	10–20	3	9.4	0.0	0.02	0.00	0.05	0.04	0.10	3.6
Fir/spruce/mountain hemlock group	0–10	3	23.5	0.1	0.02	0.00	0.37	0.07	0.12	3.3
	10–20	3	18.0	0.6	0.33	0.00	0.37	0.03	0.13	1.7

Soil samples were not collected in New Mexico in 2012.

Appendix C: New Mexico Forest Type Groups and Forest Types, with Descriptions and Timber (T) or Woodland (W) Designations

Forest type groups and forest types are usually named for the predominant species (or group of species) on the condition. In order to determine the forest type, the stocking (site occupancy) of trees is estimated by softwoods and hardwoods. If softwoods predominate, then the forest type will be one of the softwood types and if hardwoods predominate, then the forest type will be one of the hardwood types. Some other special stocking rules apply to individual forest types, and are described below.

Associate species are defined as those that regularly form the majority of the non-predominant species stocking of mixed-species conditions. These descriptions are applicable to the current inventory; species importance, including predominance in some cases, will vary for other States or inventory years. When species are listed, they are in decreasing order of overall forest type stocking.

ASPEN/BIRCH GROUP (T)

Aspen

Predominant species: quaking aspen

Associate species: Engelmann spruce, white fir, Douglas-fir, ponderosa pine, corkbark fir, blue spruce

Other species: Gambel oak, limber pine, Rocky Mountain bristlecone pine, Rocky Mountain juniper, subalpine fir, common or two-needle pinyon, southwestern white pine

DOUGLAS-FIR GROUP (T)

Douglas-fir

Predominant species: Douglas-fir

Associate species: ponderosa pine, white fir, quaking aspen, Gambel oak, southwestern white pine, limber pine, Engelmann spruce

Other species: Rocky Mountain juniper, common or two-needle pinyon, blue spruce, corkbark fir, Rocky Mountain bristlecone pine, alligator juniper, Arizona white oak, bigtooth maple, boxelder, subalpine fir, velvet ash, gray oak

ELM/ASH/COTTONWOOD GROUP (T)

Cottonwood

Predominant species: Fremont cottonwood, narrowleaf cottonwood

Associate species: Gambel oak

Other species: ponderosa pine, white fir, Rocky Mountain juniper, oneseed juniper, honey mesquite, common or two-needle pinyon

Special rules: Stocking of cottonwoods must be at least 50 percent of total stocking.

EXOTIC HARDWOODS GROUP (T)

Other exotic hardwoods

Predominant species: Siberian elm

Associate species: none identified

Other species: common or two-needle pinyon, Gambel oak, oneseed juniper, alligator juniper

Special rules: A "catch-all" type for non-native hardwood species.

FIR/SPRUCE/MOUNTAIN HEMLOCK GROUP (T)

Blue spruce

Predominant species: blue spruce
Associate species: quaking aspen, ponderosa pine, Douglas-fir, white fir
Other species: corkbark fir, limber pine, Gambel oak

Engelmann spruce

Predominant species: Engelmann spruce
Associate species: quaking aspen, corkbark fir, Douglas-fir
Other species: limber pine, ponderosa pine, Rocky Mountain bristlecone pine, white fir, subalpine fir
Special rules: In order to use Engelmann spruce stocking predominance, subalpine fir and/or corkbark fir stocking must be less than 5 percent of the total. If subalpine fir and/or corkbark fir stocking is 5 percent or more, Engelmann spruce stocking must be at least 75 percent of the total.

Engelmann spruce/subalpine fir

Predominant species: Engelmann spruce, corkbark fir, subalpine fir
Associate species: quaking aspen, Douglas-fir
Other species: blue spruce, white fir, Rocky Mountain bristlecone pine
Special rules: The combined stocking of Engelmann spruce with subalpine fir and/or corkbark fir is predominant. Stocking of both Engelmann spruce and subalpine fir/corkbark fir must each be between 5 and 74 percent of the total.

White fir

Predominant species: white fir
Associate species: Douglas-fir, quaking aspen, ponderosa pine, Gambel, oak limber pine
Other species: southwestern white pine, bigtooth maple, Rocky Mountain juniper, common or two-needle pinyon, blue spruce, gray oak, corkbark fir, Engelmann spruce, velvet ash

NONSTOCKED

Nonstocked

Predominant species: various, most commonly honey mesquite, but many nonstocked conditions have no live-tree stocking.
Associate species: various, frequently common or two-needle pinyon
Other species: seldom more than two species on a condition. Complete species list: honey mesquite, oneseed juniper, ponderosa pine, common or two-needle pinyon, velvet mesquite, Douglas-fir, Utah juniper, Rocky Mountain juniper, Fremont cottonwood, gray oak, alligator juniper, Gambel oak, quaking aspen
Special rules: Used when all live stocking is less than ten percent. Implies disturbance, but may be used for sparse stands with no disturbance, especially with woodland species.

OTHER HARDWOODS GROUP (T)

Other hardwoods

Predominant species: Arizona walnut
Associate species: none
Other species: none
Special rules: A “catch-all” type, typically for species with a limited geographical range.

OTHER WESTERN SOFWOODS GROUP (T)

Foxtail pine/bristlecone pine

Predominant species: Rocky Mountain bristlecone pine

Associate species: Engelmann spruce

Other species: corkbark fir

Special rules: This is mostly an "either/or" forest type. Foxtail pine does not occur in New Mexico, so this will always be Rocky Mountain bristlecone pine predominance.

Limber pine

Predominant species: limber pine

Associate species: Douglas-fir, ponderosa pine, white fir, quaking aspen

Other species: Engelmann spruce, Gambel oak

Southwestern white pine

Predominant species: southwestern white pine

Associate species: Douglas-fir, white fir, Gambel oak, ponderosa pine

Other species: quaking aspen, alligator juniper, Rocky Mountain juniper, common or two-needle pinyon, blue spruce, bigtooth maple

PINYON/JUNIPER GROUP (W)

Juniper woodland

Predominant species: oneseed juniper, alligator juniper, Utah juniper, Pinchot juniper, redberry juniper

Associate species: ponderosa pine, gray oak, honey mesquite

Other species: Arizona white oak, Gambel oak, silverleaf oak, Rocky Mountain juniper, Emory oak, Douglas-fir, velvet ash, netleaf oak, limber pine, velvet mesquite

Special rules: Predominance of any combination of junipers other than Rocky Mountain juniper, and live pinyons are NOT present.

Pinyon/juniper woodland

Predominant species: oneseed juniper, common or two-needle pinyon, alligator juniper, Utah juniper, Mexican pinyon pine, redberry juniper, Arizona pinyon pine

Associate species: Rocky Mountain juniper, ponderosa pine, gray oak, Gambel oak, Arizona white oak

Other species: Douglas-fir, Emory oak, silverleaf oak, Mexican blue oak, southwestern white pine, honey mesquite, chinkapin oak, bigtooth maple, velvet ash, white fir, limber pine

Special rules: Any combination of pinyons and junipers other than Rocky Mountain juniper predominate. Pinyons must be present.

Rocky Mountain juniper

Predominant species: Rocky Mountain juniper

Associate species: common or two-needle pinyon, Gambel oak, ponderosa pine, oneseed juniper

Other species: Douglas-fir, alligator juniper, Utah juniper, Arizona pinyon pine, white fir

PONDEROSA PINE GROUP (T)

Ponderosa pine

Predominant species: ponderosa pine

Associate species: Gambel oak, Douglas-fir, common or two-needle pinyon, Rocky Mountain juniper, alligator juniper, white fir

Other species: Arizona white oak, oneseed juniper, quaking aspen, gray oak, silverleaf oak, southwestern white pine, limber pine, velvet ash, Chihuahua pine, blue spruce, chinkapin oak, netleaf oak, corkbark fir, Arizona walnut

WOODLAND HARDWOODS GROUP (W)

Deciduous oak woodland

Predominant species: Gambel oak

Associate species: ponderosa pine, Rocky Mountain juniper, Douglas-fir, common or two-needle pinyon, alligator juniper, white fir

Other species: gray oak, Utah juniper, oneseed juniper, quaking aspen, narrowleaf cottonwood, Engelmann spruce, limber pine, southwestern white pine

Special rules: Gambel oak is the only New Mexico species evaluated for this type.

Evergreen oak woodland

Predominant species: gray oak, Arizona white oak, silverleaf oak, Emory oak, netleaf oak, Mexican blue oak

Associate species: alligator juniper, common or two-needle pinyon, ponderosa pine, oneseed juniper, Gambel oak

Other species: Douglas-fir, honey mesquite, Rocky Mountain juniper, Utah juniper, southwestern white pine, Mexican pinyon pine, bigtooth maple, velvet ash

Special rules: Any combination of southwestern evergreen oaks. The only New Mexico oaks not included are Gambel oak and chinkapin oak.

Intermountain maple woodland

Predominant species: bigtooth maple

Associate species: too few occurrences to evaluate

Other species: chinkapin oak, Rocky Mountain juniper, alligator juniper, ponderosa pine, southwestern white pine

Special rules: Currently, bigtooth maple is the only species evaluated for this type. In the previous periodic inventory, Rocky Mountain maple was included.

Mesquite woodland

Predominant species: honey mesquite, velvet mesquite

Associate species: oneseed juniper

Other species: redberry juniper

Appendix D: Tree Species Groups and Tree Species Measured in New Mexico's Annual Inventory, with Common Name, Scientific Name, and Timber (T) or Woodland (W) Designation

HARDWOODS

Cottonwood and aspen group (T)

Fremont cottonwood (*Populus fremontii*)

Narrowleaf cottonwood (*Populus angustifolia*)

Quaking aspen (*Populus tremuloides*)

Other western hardwoods group (T)

Arizona walnut (*Juglans major*)

Boxelder (*Acer negundo*)

Chinkapin oak (*Quercus muehlenbergii*)

Siberian elm (*Ulmus pumila*)

Velvet ash (*Fraxinus velutina*)

Woodland hardwoods group (W)

Arizona white oak (*Quercus arizonica*)

Bigtooth maple (*Acer grandidentatum*)

Emory oak (*Quercus emoryi*)

Gambel oak (*Quercus gambelii*)

Gray oak (*Quercus grisea*)

Honey mesquite (*Prosopis glandulosa*)

Mexican blue oak (*Quercus oblongifolia*)

Netleaf oak (*Quercus rugosa*)

Silverleaf oak (*Quercus hypoleucoides*)

Velvet mesquite (*Prosopis velutina*)

SOFTWOODS

Douglas-fir group (T)

Douglas-fir (*Pseudotsuga menziesii*)

Engelmann and other spruces group (T)

Blue spruce (*Picea pungens*)

Engelmann spruce (*Picea engelmannii*)

Other western softwoods group (T)

Chihuahua pine (*Pinus leiophylla*)

Limber pine (*Pinus flexilis*)

Rocky Mountain bristlecone pine (*Pinus aristata*)

Southwestern white pine (*Pinus strobiformis*)

Ponderosa and Jeffrey pines group (T)

Ponderosa pine (*Pinus ponderosa*)

True fir group (T)

Corkbark fir (*Abies lasiocarpa* var. *arizonica*)

Subalpine fir (*Abies lasiocarpa*)

White fir (*Abies concolor*)

Woodland softwoods group (W)

Alligator juniper (*Juniperus deppeana*)

Oneseed juniper (*Juniperus monosperma*)

Pinchot juniper (*Juniperus pinchotii*)

Redberry juniper (*Juniperus coahuilensis*)

Rocky Mountain juniper (*Juniperus scopulorum*)

Utah juniper (*Juniperus osteosperma*)

Arizona pinyon pine (*Pinus monophylla* var. *fallax*)

Common or two-needle pinyon (*Pinus edulis*)

Mexican pinyon pine (*Pinus cembroides*)

Appendix E: *Volume and Site Index Equation Sources*

Volume

Chojnacky (1988) was used for bigtooth maple, honey mesquite, velvet mesquite, Arizona white oak, Emory oak, Gambel oak, Mexican blue oak, silverleaf oak, gray oak, and netleaf oak volume estimation.

Chojnacky (1994) was used for Pinchot juniper, redberry juniper, alligator juniper, Utah juniper, Rocky Mountain juniper, oneseed juniper, common pinyon, Mexican pinyon, and Arizona pinyon volume estimation.

Hann and Bare (1978) was used for white fir, corkbark fir, Engelmann spruce, blue spruce, bristlecone pine, limber pine, southwestern white pine, Chihuahuan pine, ponderosa pine, Douglas-fir, and aspen volume estimation.

Kemp (1956) was used for narrowlead cottonwood and Fremont cottonwood volume estimation.

Volume equations provided by the USDA Forest Service's Northern Research Station were used for boxelder, velvet ash, Arizona walnut, chinkapin oak, and Siberian elm volume estimation. [Documentation on file at Rocky Mountain Research Station, Ogden, UT.]

Site Index

Brickell (1968) was used for Douglas-fir site index estimation.

Brickell (1970) was used for bristlecone pine, limber pine, Chihuahua pine, ponderosa pine, and southwestern white pine site index estimation.

Clendenen (1977) was used for subalpine fir, corkbark fir, Engelmann spruce, and blue spruce site index estimation.

Edminster and others (1985) was used for boxelder, velvet ash, narrowleaf cottonwood, Fremont cottonwood, aspen, gray oak, chinkapin oak, netlead oak, and Siberian elm site index estimation.

McArdle and others (1961) was used for white fir site index estimation