Forest Resources of the United States, 2002: Mapping the Renewable Resource Planning Act Data

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Abstract.—Forest Inventory and Analysis (FIA), a national program of the Forest Service, U.S. Department of Agriculture conducts and maintains comprehensive inventories of the forest resources in the United States. The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 mandates a comprehensive assessment of past trends, current status, and the future potential of forest resources across the United States. Data for the RPA represent the highest level of aggregation of timberland and forest land statistics generated by the FIA program. This article describes several forest attributes that make up the FIA 2002 RPA national map atlas series and presents several of the maps. The maps are a crucial tool for visualizing, analyzing, and presenting forest resource information essential to national and regional forest planning and policymaking.

Introduction

In response to the mandate in the Forest and Rangeland Renewable Resources Planning Act of 1974, P.L. 93-378, 88 Stat. 475, the 2002 Renewable Resources Planning Act Assessment (2002 RPA) was prepared. The Forest Inventory and Analysis (FIA) program currently provides updates of forest assessment data every 5 years as required by the Agriculture Research, Extension and Education Reform Act of 1998 (also known as the 1998 Farm Bill). Since the passage of the McSweeney-McNary Forest Research Act of 1928, FIA's emphasis has evolved from solely an economic focus on timber supply and demand to a concern about national resource conditions, ecosystem health, sustainability, and the international resource situation. RPA data are useful to gauge the status of forest resources and make informed strategic-level policy decisions. Currently, RPA is the only format available for exploring long-term trends in the forest resources of the United States across all forest ownerships. Data for the assessment represent the highest level of aggregation of timberland and forest land statistics generated by the FIA regional units.

In support of the 2002 RPA report, national atlas choropleth maps were produced. The maps display a variety of forest characteristics across the United States, including Alaska and Hawaii, and present FIA data in a more dynamic fashion than printed reports using only supporting tables. The project objective was to compile and present a series of thematic maps that evoke the overall county-level geographical distribution of a given forest attribute for the United States. More than 100 maps were created covering 17 attributes.

Data and Methods

FIA plot data, aggregated by county, were downloaded from the 2002 RPA plot summary database in the form of a dBase file (http://www.fia.fs.fed.us). Data were joined to the National Atlas of the United States County Boundaries 2001 shapefile (http://nationalatlas.gov/atlasftp.html) using Federal Information Processing Standards (FIPS) county codes. Data were not available for interior Alaska, the Pacific Basin, Puerto Rico, the U.S. Virgin Islands, and a number of counties in the lower 48 States.

In creating the map series it was important for each map to have the same format with components that meld into a coherent,

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consistent graphic design (Robinson *et al.* 1995). Thus, to standardize map layout and automate production, a map template was designed. The template incorporated normalizing data factors, symbolism, projection, class numbers and limits, color use, typographical relationships, general line weights, and lettering sizes.

Mapping procedures used PC–based Environmental Systems Research Institute ArcMap™ version 9.1 ArcGIS software.[5] Classes were based on natural groupings inherent in the data. To reveal underlying groupings and spatial patterns in the data, categories were first classified using natural breaks. Natural breaks identify breakpoints between classes using a Geographic Information System statistical (Jenks 1963) optimization method. The optimization method minimizes within-class variance and maximizes between-class variance in an iterative series of automated calculations. The breakpoints optimally group similar class values and maximize the differences between classes. Class breaks were manually rounded to ease interpretation. For a complete listing of data sources and estimation procedures (e.g., biomass and mortality) for the 2002 RPA database, see Smith *et al.* (2004) and Miles *et al.* (2004).

The suite of RPA maps include the following map attributes:

- Area of forest land (acres).
- Area of timberland (acres).
- Number of live trees 1.0 in diameter at breast height (d.b.h.) (4.5 ft) and larger on timberland.
- Number of live trees 5.0 in d.b.h. and larger on timberland.
- Volume of growing stock trees on timberland (ft^3).
- Volume of rough and rotten cull trees on timberland (ft^3).
- All live tree biomass on timberland (dry lbs).
- Proportion of land that is forested.
- Proportion of land that is timberland.
- Number of live trees 1.0 in d.b.h. and larger per acre of timberland.
- Number of live trees 5.0 in d.b.h. and larger per acre of timberland.
- Volume of growing stock trees per acre of timberland (ft^3/acre).
- Volume of rough and rotten cull trees per acre of timberland (ft^3/acre).
- Average annual net growth of growing stock trees on timberland (ft^3/acre/year).
- Average annual mortality of growing stock trees on timberland (ft^3/acre/year).
- All live tree biomass on timberland (dry lbs/acre).
- All live merchantable tree biomass on timberland (dry lbs/acre).

In addition, select attributes display hardwood and softwood categories.

The following definitions are adapted and expanded from documentation for the 2002 RPA assessment (Smith *et al.* 2004). Implicit or explicit in these categories is the concept of a size threshold that defines the lower size limit for a tree to be included in the estimate (Birdsey and Schreuder 1992). *Forest land* is defined as land at least 10-percent stocked by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest uses, with a minimum area classification of 1 acre. *Timberland* is defined as forest land capable of producing crops of industrial wood (20 ft^3 per acre per year in natural stands) that is not withdrawn from timber utilization by statute or administrative regulation. *Growing stock trees* are live trees of commercial species which meet specified standards of quality and vigor. Trees classified as growing stock are commercial species of good form that are at least 5.0 in d.b.h. Trees not classified as growing stock are classified as cull trees. *Cull volume* is defined as the volume of rotten or missing wood in a live or dead tally tree. *Net annual growth* is the average annual net growth in tree volume between remeasurement periods. The components of net growth include the increment in net volume of live remeasure trees, plus the net volume of trees that reached a minimum size threshold during the remeasurement period, minus the volume of trees that died during the period. *Net annual mortality* is the net volume of sound wood in growing stock trees that died during the remeasurement period. *Biomass* is a measure of the total aboveground, oven-dry weight

[5] Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

for live sample trees 1.0 in in diameter or larger, including all tops and limbs (excluding foliage).

Results

Forest Land

Figure 1 shows the spatial distribution of the nation's forest land in 2002 as a percentage of total census land area for each county. Nationwide, an average of 37 percent (749 million acres) of all land is forest land. The accompanying graph (fig. 2) displays the number of counties in relation to the proportion of land that is forested.

Figure 1.—*Proportion of forest land across the United States, 2002.*

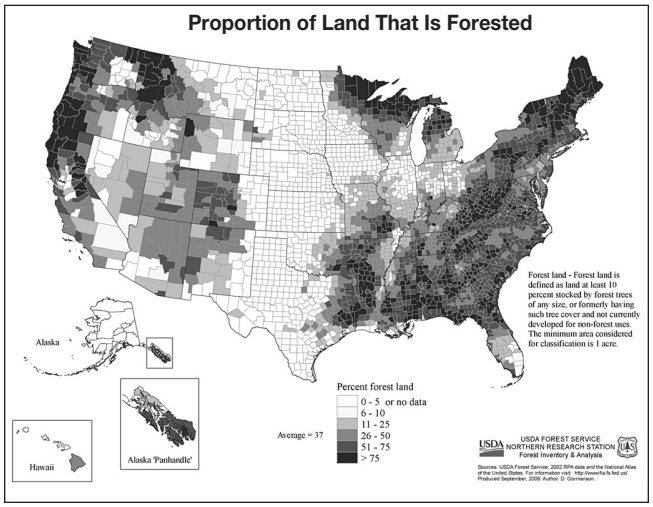
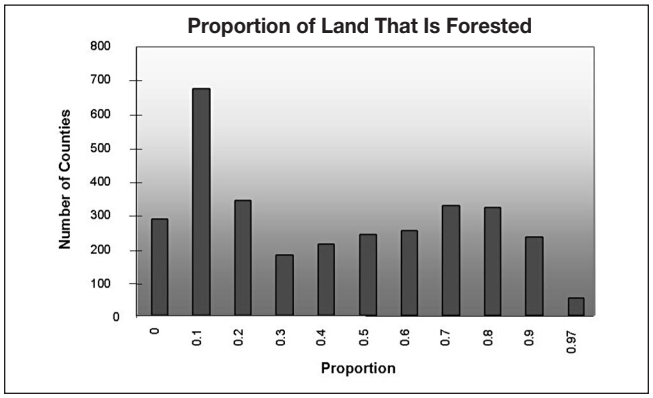


Figure 2.—*Distribution graph of forest land across the United States, 2002.*



Annual Growth

Figures 3 and 4 show side-by-side comparisons of annual growth to mortality, implying that counties with negative growth are likely to have increased annual mortality. Potential causes of negative growth are biological (e.g., insect infestations) or natural disasters (e.g., fire). Several issues must be understood, however, to prevent spurious conclusions (Luppold and McWilliams 2004), especially when examining forest change characteristics such as net growth and mortality.

Figure 3.—*Average annual net growth of growing stock trees per acre of timberland across the United States, 2002.*

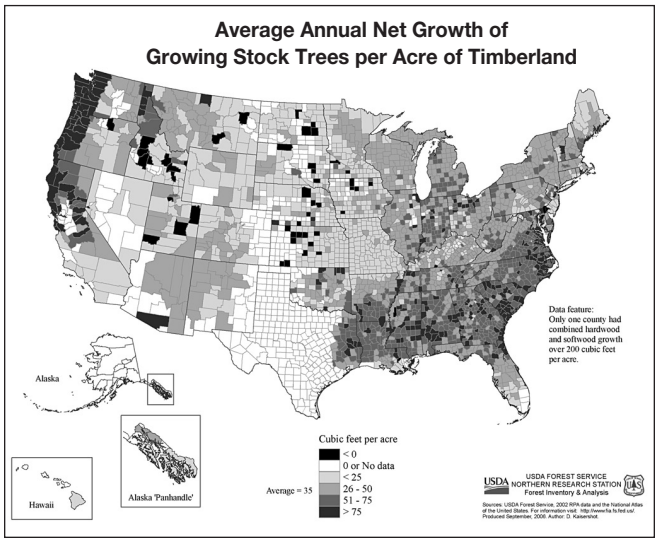
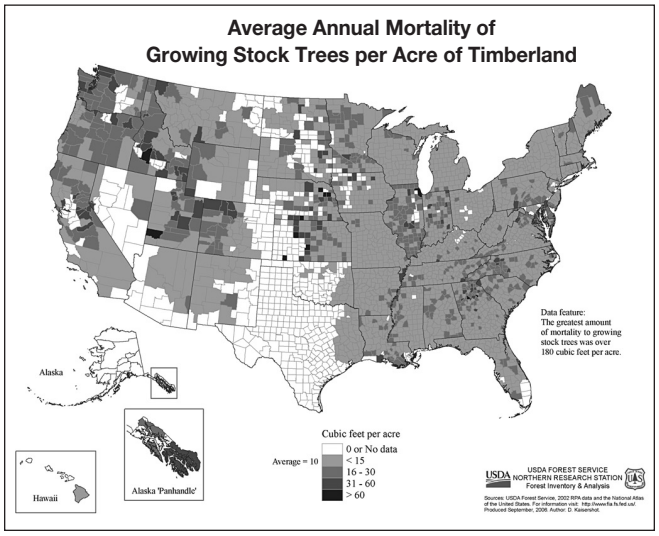


Figure 4.—*Average annual mortality of growing stock trees per acre of timberland across the United States, 2002.*



FIA statistics are developed using sampling procedures and are subject to sampling error; see Bechtold and Patterson (2005) for details of FIA estimation. As the size of the forest area under scrutiny decreases, the number of observations used to develop FIA statistics decreases. In smaller inventory units, the number of observations used to calculate FIA statistics may be particularly inadequate when examining forest components of change; i.e., net growth, removals, and mortality. A small sample size can thus dramatically influence the outcome of the data. This observation may be evidenced by counties in the plains States that have little forest land, particularly Kansas and Nebraska. Overall, 54 counties show negative growth. The smallest negative growth, -.3 ft^3 per acre, is equivalent to the loss of half the volume of a 5-in tree.

Annual Mortality

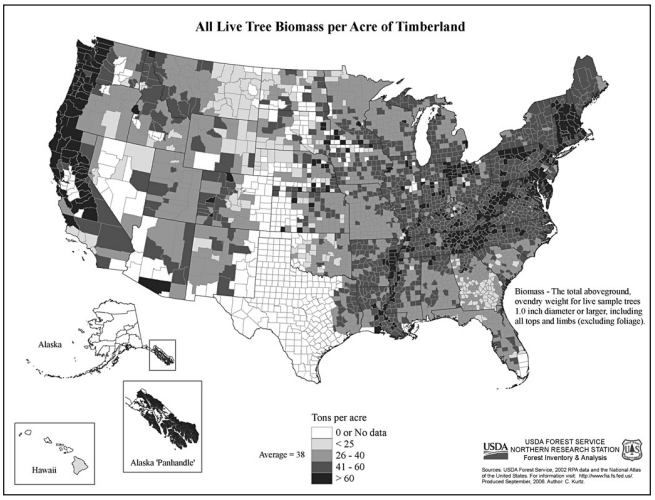
Figure 4 displays average annual mortality of growing stock trees per acre of timberland. The range is from 0 (or no data available at the time of the assessment) to 187 ft^3 per acre with an average of 10 ft^3 per acre. The greatest amount of mortality to growing stock trees occurred in Cuming County, NE. Because Nebraska is sparsely forested, this amount of mortality is likely the result of a small sampling size and further investigation is recommended.

Biomass

RPA inventory data are used in the estimation of live tree biomass (an indicator of carbon) and applied to a number of studies of national and international importance. Biomass data are used for reports on greenhouse gas emissions as documented by the Environmental Protection Agency (EPA 2006) and wildland fuel management as seen in the LANDFIRE Prototype Project (Rollins *et al.* 2006). In addition, live tree biomass has an important role in the global carbon cycle (Brown 2001).

Live tree biomass per acre of timberland (fig. 5) ranges from 0 (or no data) to 210 dry tons per acre with an average of 38 dry tons per acre. The top five counties are all located in California; San Benito County has the greatest live biomass per acre of timberland. In the United States, the highest average biomass per acre is predictably along the Pacific Coast, where larger trees reside.

Figure 5.—*All live tree biomass per acre of timberland across the United States, 2002.*



Past, Present, and Future

The original RPA Plot Summary database format was developed in 1987 to meet RPA reporting requirements (Waddell *et al.* 1989). FIA has developed the only forest resource database of sample plots across the United States. This unique database is continually evolving and is used by a wide range of researchers both within and outside the Forest Service, natural resource agencies, State, regional economic development and special interest groups, industry, and landowner associations.

Forest inventory data are available to create custom tables and maps using FIA's online services at www.fia.fs.fed.us/tools-data/tools. More than 100 maps created with the 2002 RPA data are available at http://www.fia.fs.fed.us/program-features/rpa/. Previous RPA reports can be found at http://svinet2.fs.fed.us/pl/rpa/list.htm. Future plans include mapping the 2007 RPA data and providing enhanced Web services.

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