Mapping Forest Resources of the United States

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In this chapter, we present a collection of maps designed to portray the composition, structure, ownership, utilization, and spatial patterns of forest resources across the United States. This collection is the first comprehensive compilation of national-scale, forestry-related maps. These maps complement the information presented in the preceding chapters, but the maps and chapters are not directly dependent upon one another. Forest and Rangeland Renewable Resources Planning Act (RPA) tables and summaries provide direct sources for many, but not all, of the maps. Descriptions of the maps are provided below.

Map Types

There are many options for presenting plot-level data at a broader scale, and forest attributes lend themselves naturally to different styles of presentation. These maps strike a balance between the information provided by each attribute, the context available in ancillary data sources, and the protection of landowner privacy.

Choropleth Maps

A choropleth map is a thematic map that displays patterns proportional to the measurement of the variable being represented. Plot-based summaries are portrayed in choropleth maps using generalized boundaries of counties, States, or some other polygon feature. A sampling array developed by the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP; White et al. 1992) has been incorporated into the Forest Inventory and Analysis (FIA) database, allowing for hexagon-based choropleth mapping. When the polygons are political units, the map mimics the units used for decisionmaking. The majority of maps we present are of this type (plates 6, 7, 10, 11, 13, and 15–22).

Raster Maps

Raster maps are based upon a regular grid of measurements across the area of interest. Elevation data in raster format is the basis of the reference maps (plates 1a and 1b). Satellite images serve as the foundation of thematic or continuous maps when spectral information is complemented with training data for assessment. Existing land cover maps generated from satellite imagery were adapted to portray general context for those parts of the country where more detailed information is not available. This includes the commonwealths and territories, as well as islands, in free association with the United States (plates 3–5). Raster datasets of forest-type groups (plate 2) and forest biomass (plate 14) were produced recently by modeling efforts that combine plot data with satellite imagery and other geospatial data products (plates 2 and 14). The forest-type groups map also serves as the basis in deriving forest/nonforest land in three other maps (plates 8, 9, and 12).

Hybrid Maps

Hybrid maps are produced by combining various forms of geospatial data in a single cartographic product. We combined raster data from the forest-type groups map with FIA plot-based summaries and polygon data from the Protected Areas Database (PAD; DellaSala et al. 2001) to produce map plates 8, 9, and 12.

Map Descriptions

A reference for preceding RPA analyses, as well as subsequent maps, plates 1a and 1b delineate State boundaries and show landforms, major water bodies, and a graticule of longitude and latitude. Plate 2 portrays forest composition by forest-type groups, a classification based on the assemblage of tree species present on a plot of forest land. Forest-type groups are defined for the Western and Eastern United States, separated by a sparsely forested swath of the Great Plains. For areas where comprehensive inventory data are insufficient to characterize forest composition, satellite images are classified to portray patterns of forest and other land cover (plates 3–5).

Forest land includes three subcategories of land use: timber land, reserved forest land, and other forest land. Plates 6 and 7 portray relative amounts of forest land and timber land within each county; plate 8 illustrates the spatial patterns of all three subcategories of forest land.

Ownership is a significant determinant of forest composition and structure. Spatial patterns of public forest land and relative amounts of corporate ownership on private forest land are illustrated in plate 9. Area of interior forest—a metric of landscape pattern where a forested location is interior if a surrounding square window is at least 90 percent forested—and the average size of privately owned forest parcels are portrayed in plates 10 and 11. Utilization of timber products and volume of unused residues are portrayed in plates 21 and 22.

Forest site productivity indicates the inherent capacity for tree growth and is used for defining subcategories of forest land. Spatial patterns of productivity are illustrated in plate 12. Related patterns of mortality—death from natural causes like diseases, old age, and fire—are shown in plate 13. Plate 14 portrays standing above-ground live-tree biomass on forest land. Estimates of forest carbon stocks shown in plate 15 include the tree biomass portrayed in plate 14, plus additional biomass in coarse roots, branches, and foliage.

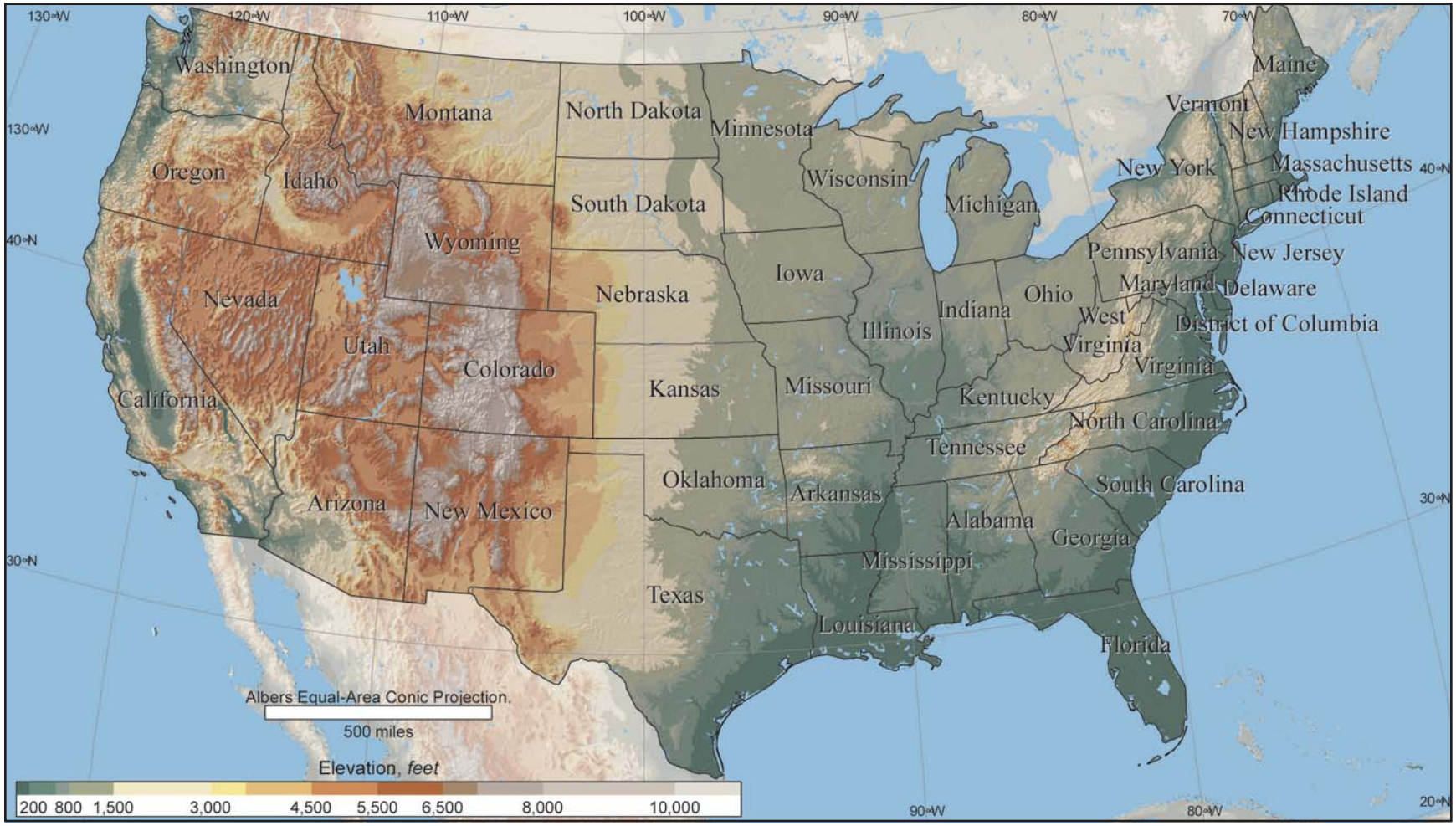
Traditional economic perspectives of forest resources generally focus on growing stock—a classification of timber inventory that includes live trees of commercial species meeting specified standards of quality or vigor. Total and unit-area volumes of growing stock for timber land, softwoods, and hardwoods are mapped in plates 16–19. The number of trees is presented in plate 20.

The utilization of roundwood—the set of timber products harvested from trees including logs, bolts, or other round sections (as well as chips made from these items) and used to manufacture wood products—and the volume of unused residues are portrayed in plates 21 and 22.

Summary

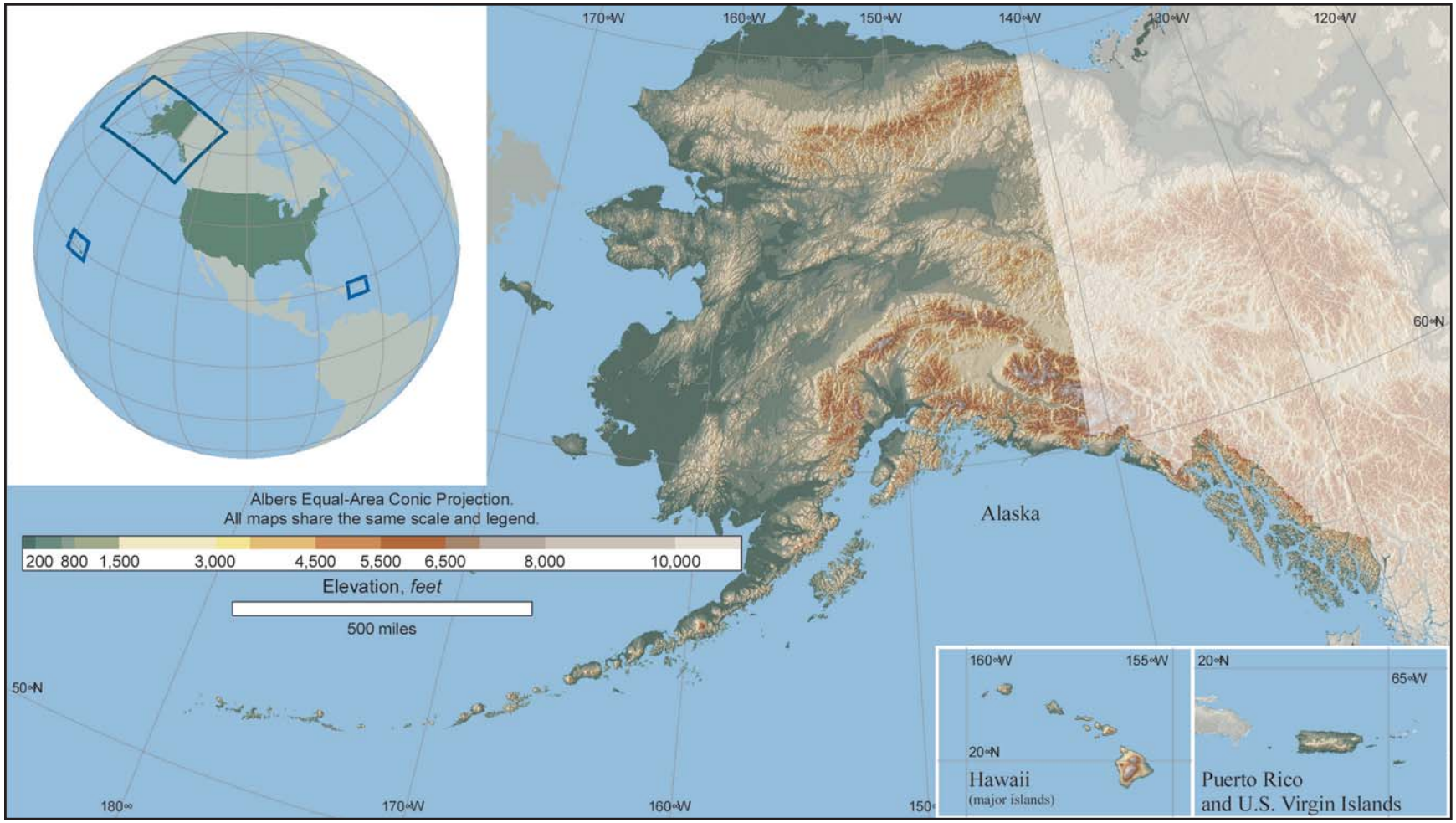
These maps portray a wide variety of forest resources across the entire United States. FIA is expanding its production and distribution of additional geospatial datasets and cartographic products for mapping forest resources. Consult with FIA resource specialists for more information and products at http://www.fia.fs.fed.us/. Also, mapping tools and data are available to the public online at http://fiatools.fs.fed.us.

Plate 1a. Landforms of the conterminous United States



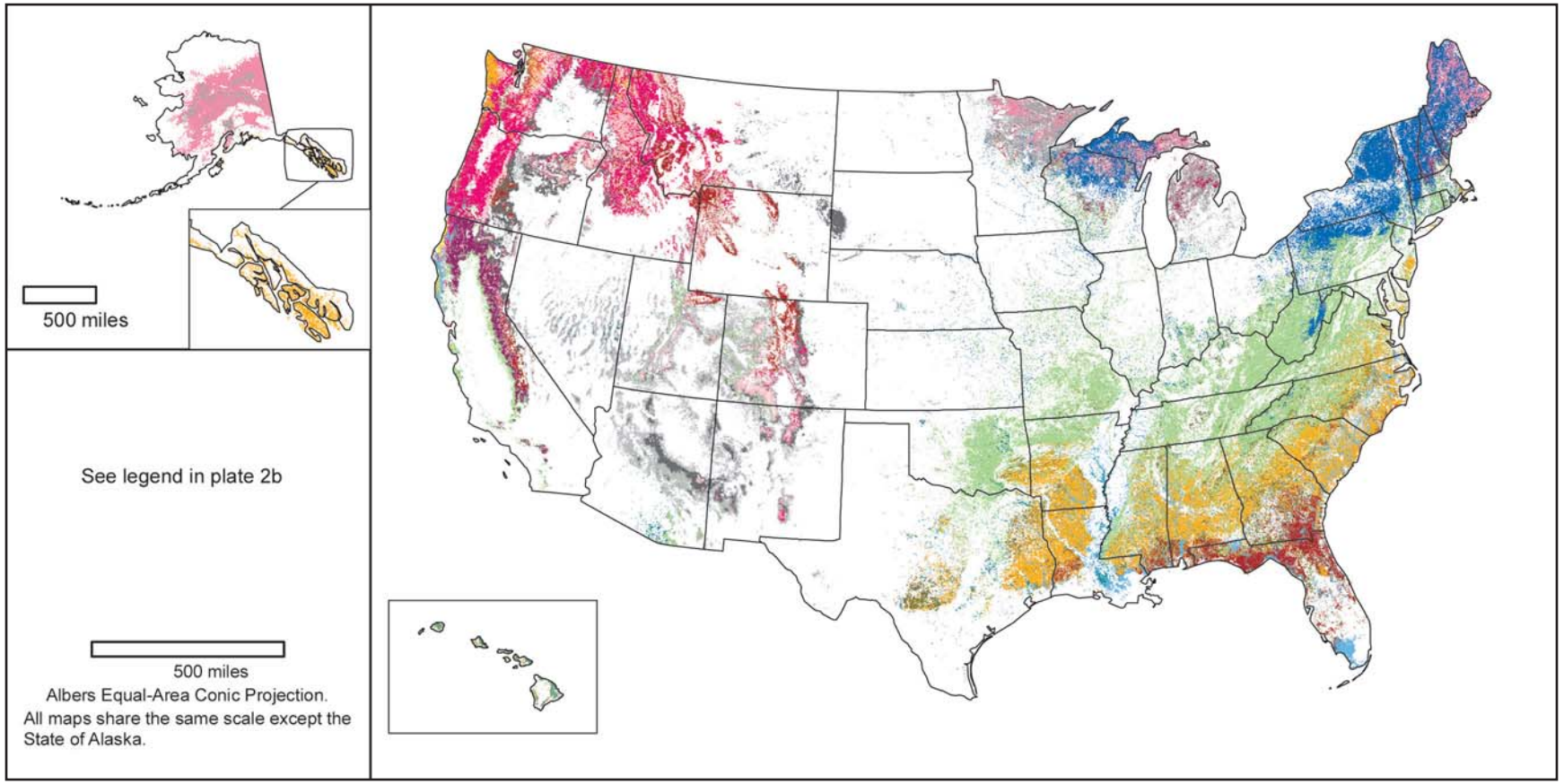
Source: Geographic base data are provided by the USDA National Agricultural Statistics Service, the National Atlas of the United States, the U.S. Geological Survey, and ESRI Data and Maps. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

Plate 1b. Landforms of Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands



Source: Geographic base data are provided by the National Atlas of the United States, U.S. Geological Survey, and ESRI Data and Maps. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

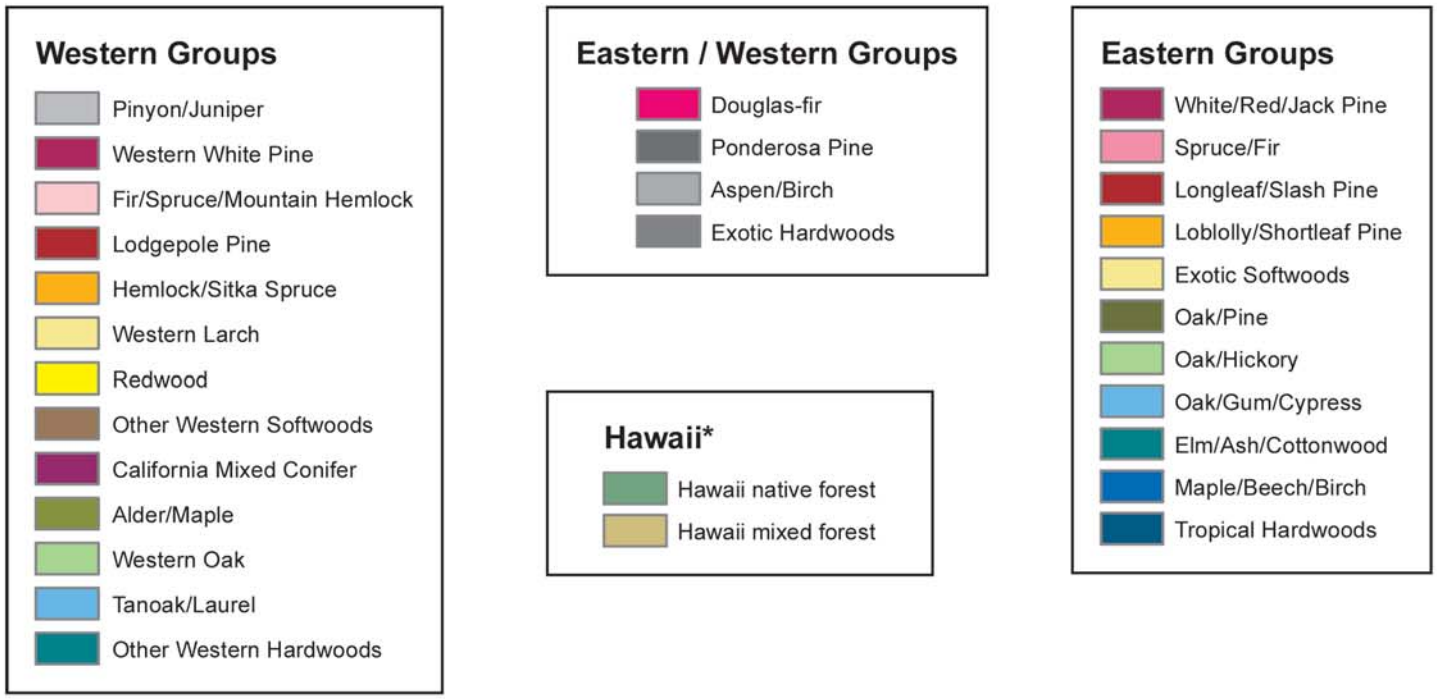
Plate 2a. FIA forest type groups of the United States



This map portrays the distribution of forest type groups, a classification based on the assemblage of tree species present on a plot of forest land. It was produced through a collaborative effort between three USDA Forest Service units—the Remote Sensing Applications Center, Forest Health Monitoring, and FIA. Forest type groups from FIA plot data were modeled as functions of more than 100 geospatially continuous predictor layers at 250-m pixel resolution, including Moderate Resolution Imaging Spectrometer (MODIS) multi-date composites, topographic variables, climate parameters, and other ancillary variables. More information may be found at http://www.asprs.org/publications/pers/2007journal/july/.

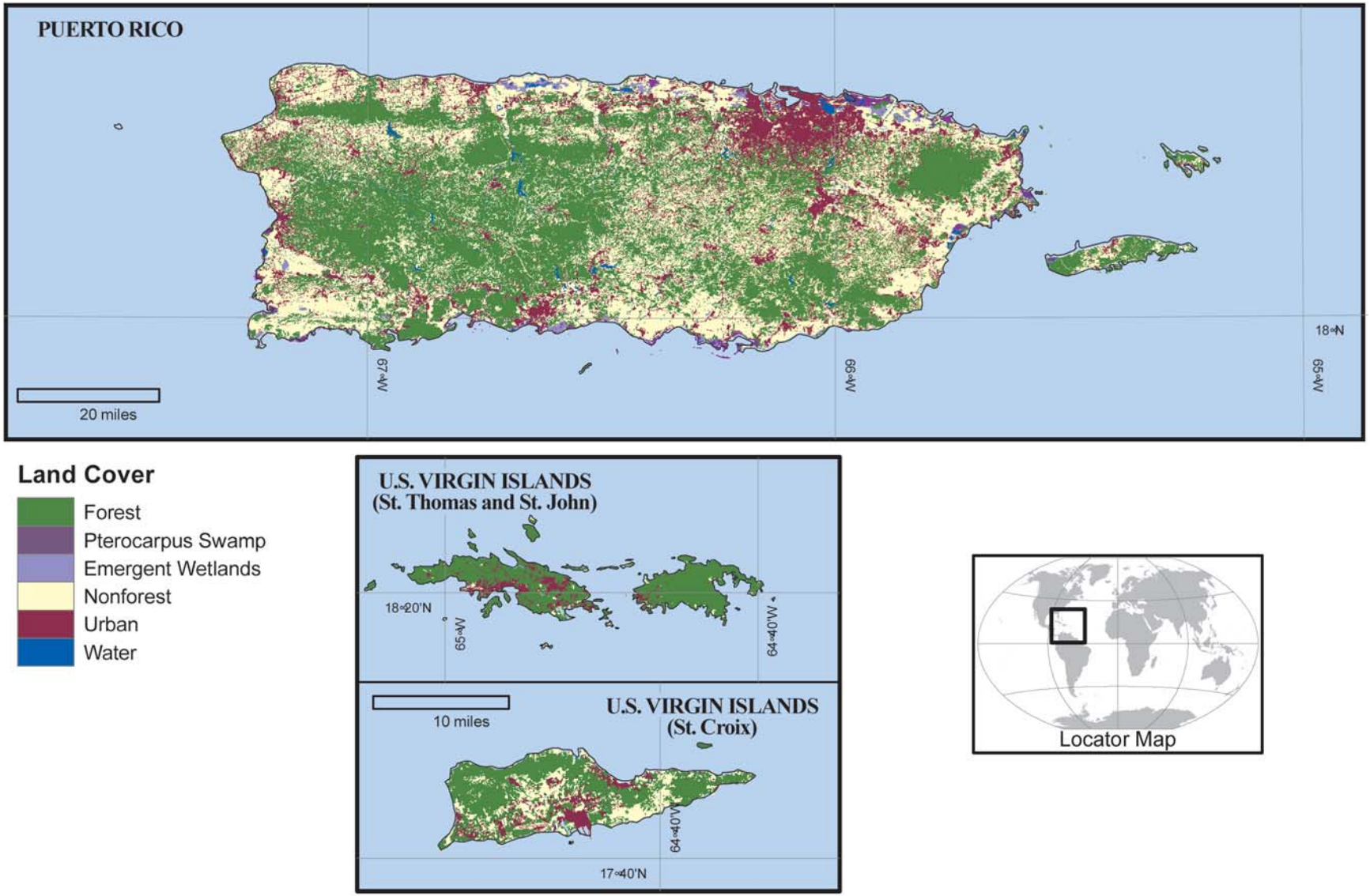
Source: Forest type raster data for the lower 48 States and Alaska are available online at http://fsgeodata.fs.fed.us/rastergateway/forest_type. Geographic base data are provided by the USDA National Agricultural Statistic Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

Plate 2b. Legend for map plate 2a, forest type groups



*Hawaii was not included in the 2004 MODIS-based FIA forest map. Data for Hawaii are from Zhu and Evans (1994) based on advanced Very High Resolution Radiometer (AVHRR) composite images recorded during the 1991 growing season. The AVHRR-based forest type data are available on-line at http://fsgeodata.fs.fed.us/rastergateway/forest_type. Date: March 2009.

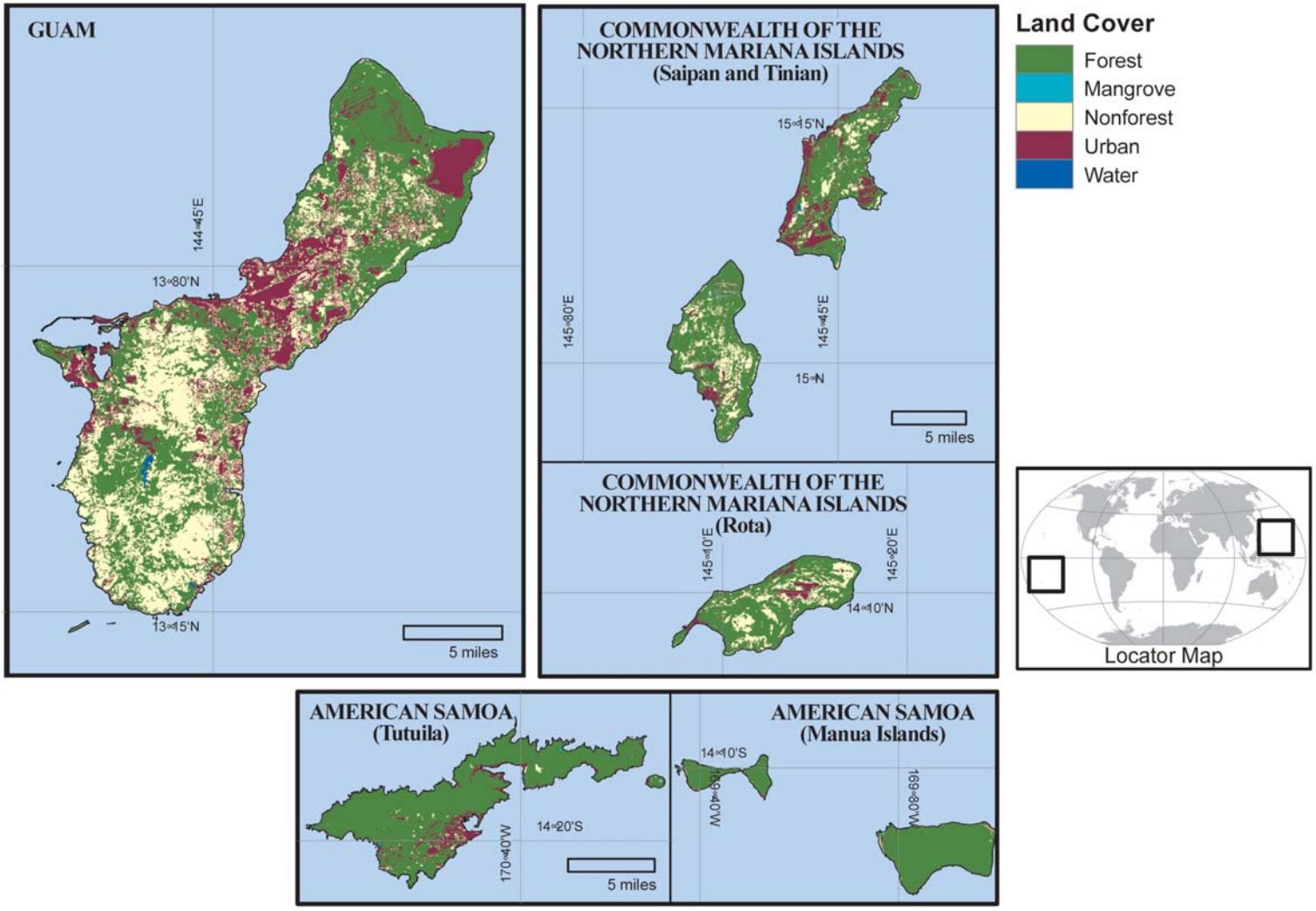
Plate 3. Major land cover of selected Caribbean commonwealths and territories of the United States



These maps display major land cover types for Puerto Rico (Kennaway and Helmer 2007) and the U.S. Virgin Islands (Kennaway et al. 2008). The maps were derived from satellite imagery using various mapping and modeling techniques. The cover type classes shown were generalized from the original map products.

Source: Geographic base data are provided by the U.S. Geological Survey, Digital Chart of the World, and ESRI data and maps. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

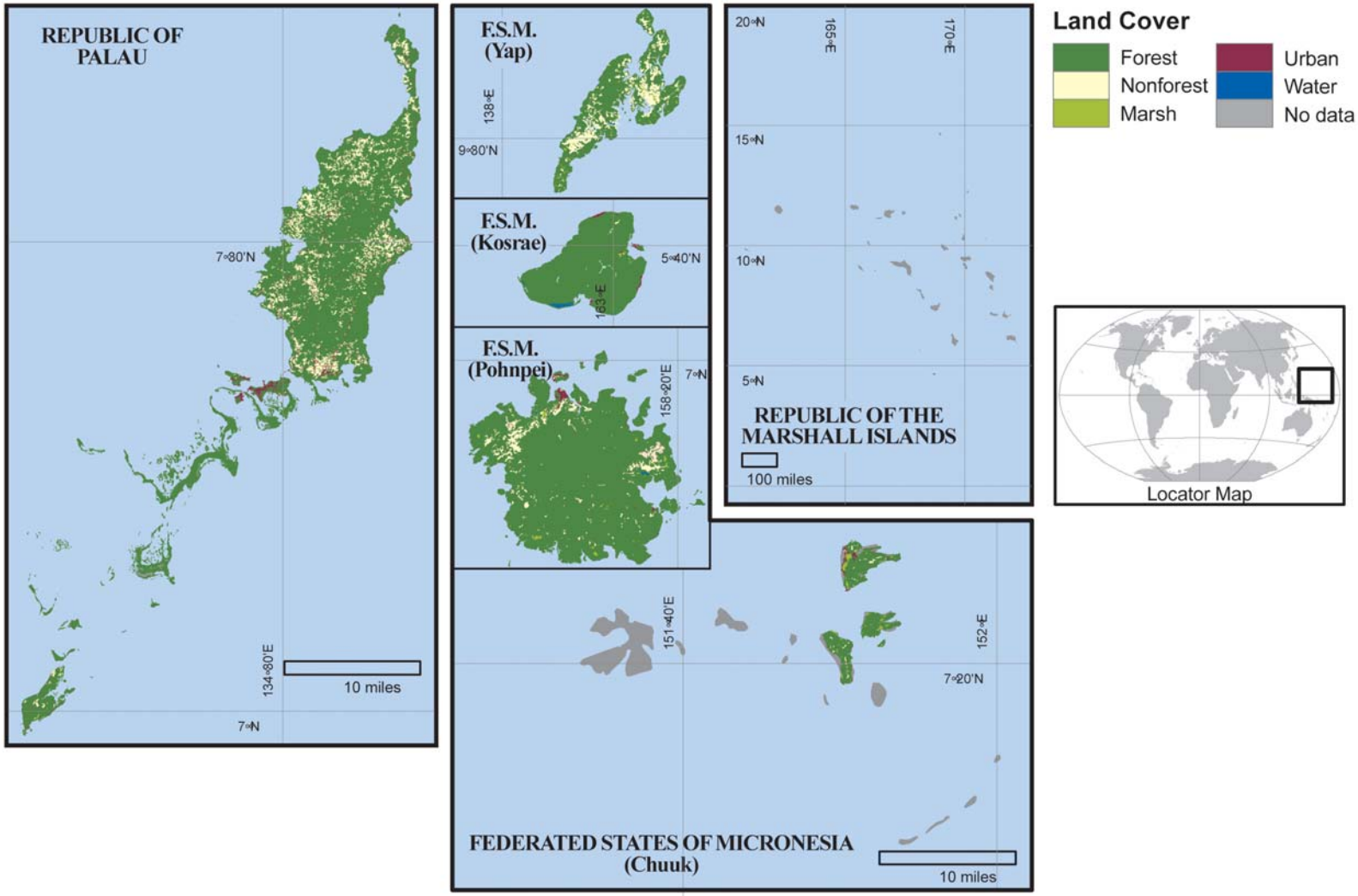
Plate 4. Major land cover of selected Pacific commonwealths and territories of the United States



These maps display major land cover types for selected Pacific commonwealths and territories of the United States. The maps were developed from a collaborative effort between Forest Service, Forest Health Protection, and Pacific Northwest Research Station, FIA program. The maps were derived from very high-resolution satellite imagery using unsupervised classification mapping techniques. Automated feature extraction tools and field reconnaissance was used for attributing nonforest and forest cover types, respectively (Liu and Fischer 2006). The cover type classes shown were generalized from the original map products.

Source: Geographic base data are provided by the U.S. Geological Survey, Digital Chart of the World, and ESRI data and maps. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

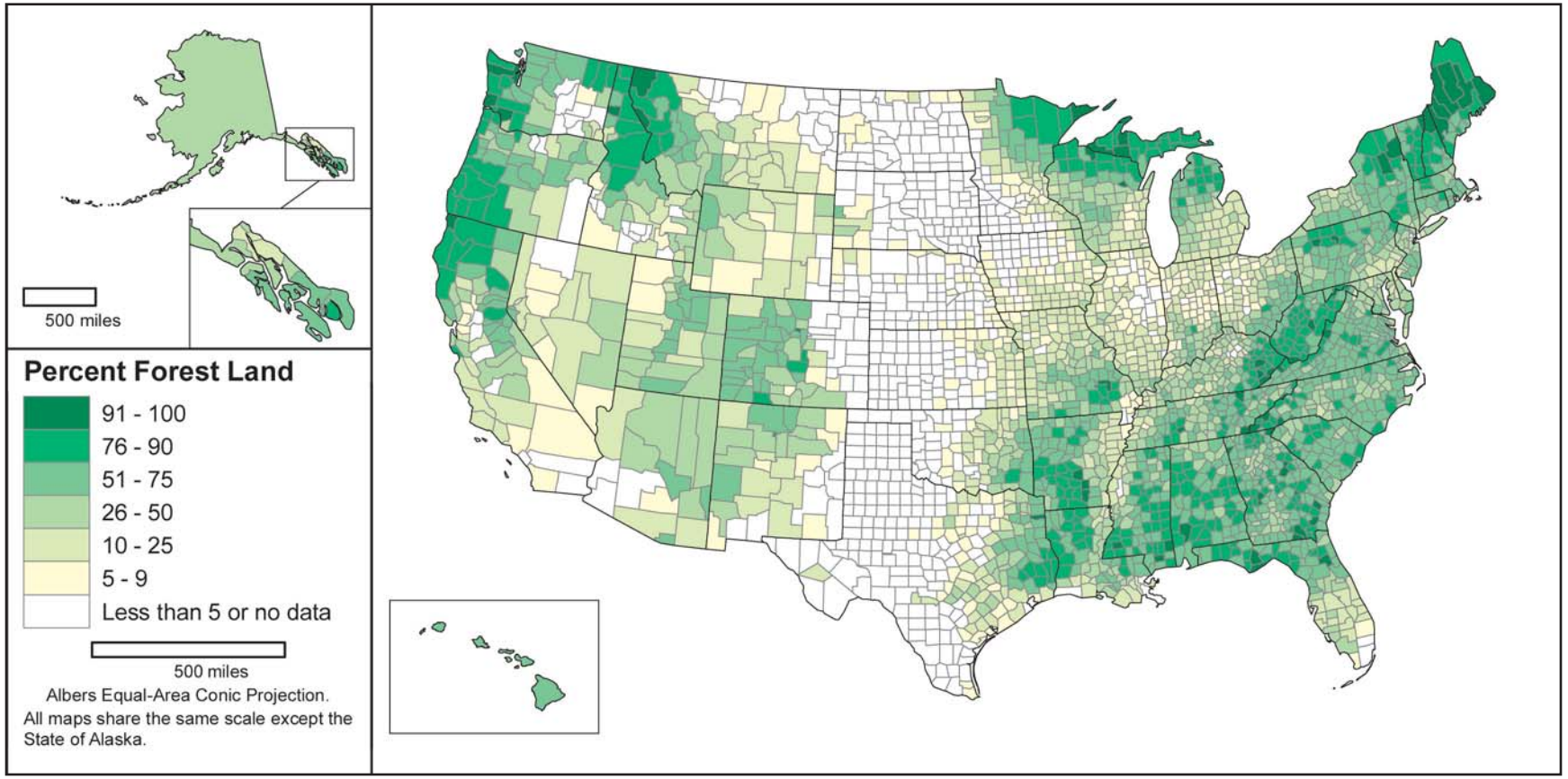
Plate 5. Major land cover of selected Pacific islands in free association with the United States



These maps display major land cover types for selected Pacific islands in free association with the United States. The map of Palau was derived from high-resolution satellite imagery using unsupervised classification mapping techniques and automated feature extraction and field reconnaissance for cover type attributing (Liu and Fischer 2006). The Federated States of Micronesia maps were produced using photo interpretation techniques (Falanruw et al. 1987a, 1987b, Maclean et al. 1986, Whitesell et al. 1986). The cover type classes shown were generalized from the original map products. Currently there is no data available for the Republic of the Marshall Islands.

Source: Geographic base data are provided by the U.S. Geological Survey, Digital Chart of the World, and ESRI data and maps. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

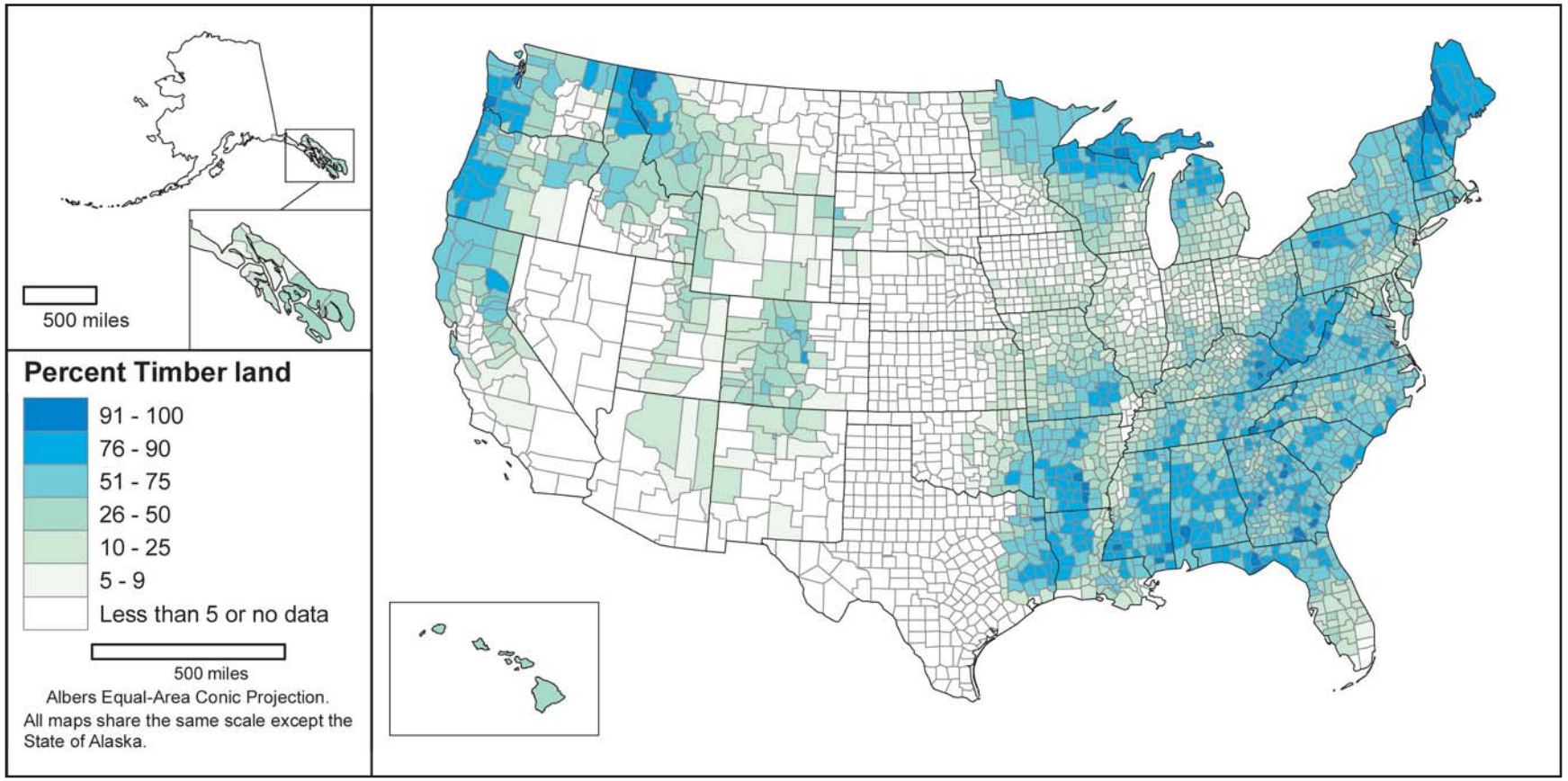
Plate 6. Percent of land that is forested by county in the United States



Forest land is land at least 120 feet wide and 1 acre in size with at least 10 percent cover (or equivalent stocking) by live trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if less than 120 feet wide. This map shows the percent of forest land by county across the United States, normalized by the total census land area of each county. Data for the map were derived from compiled FIA plots summarized by county and associated with the 2002 United States County Boundaries shapefile using Federal information processing standards (FIPS) county codes.

Source: Forest Service, FIA program, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

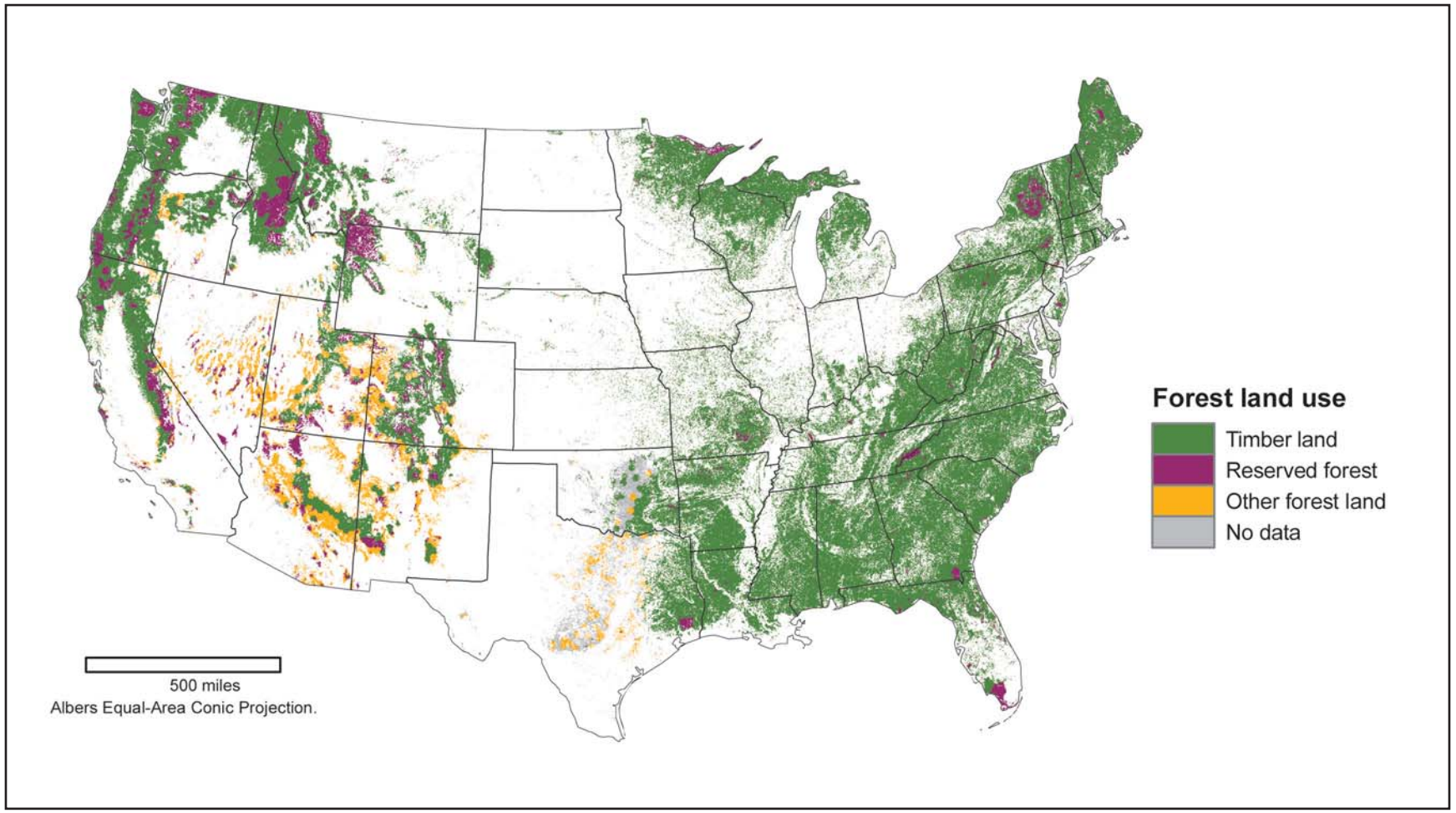
Plate 7. Percent of land that is timber land by county in the United States



Timber land is forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. Areas qualifying as timber land are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently, inaccessible and inoperable areas are included. This map shows the percent of timber land by county across the United States, normalized by the total census land area of each county. Data for the map were derived from compiled FIA plots summarized by county and associated with the 2002 United States County Boundaries shapefile using FIPS county codes.

Source: Forest Service, FIA program, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

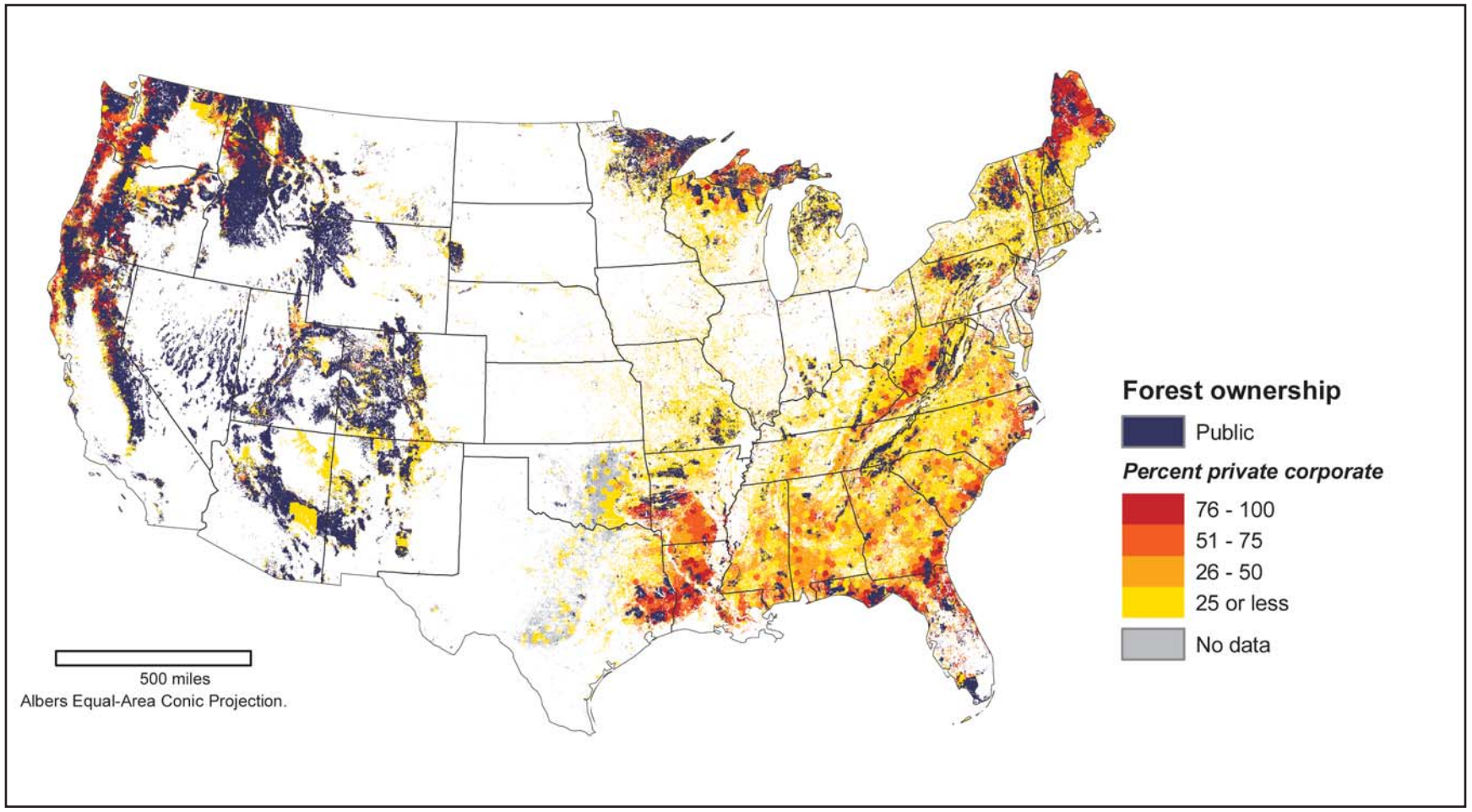
Plate 8. Timber land, reserved forest and other forest land in the conterminous United States



Forest land use is diplayed for forested pixels from the Forest Service map of Forest Type Groups (Ruefenacht et al. 2008). Timber land was derived from RPA plot data; summarized over a hexagon sampling array developed by the U.S. Environmental Protection Agency, Environmental Monitoring and Assessment Program; constrained to forest site productivity equal to or greater than 20 cubic feet/acre/year. Reserved land was derived from the Conservation Biology Institute, Protected Areas Database, version 4.5; constrained to IUCN classes I–V.

Source: Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

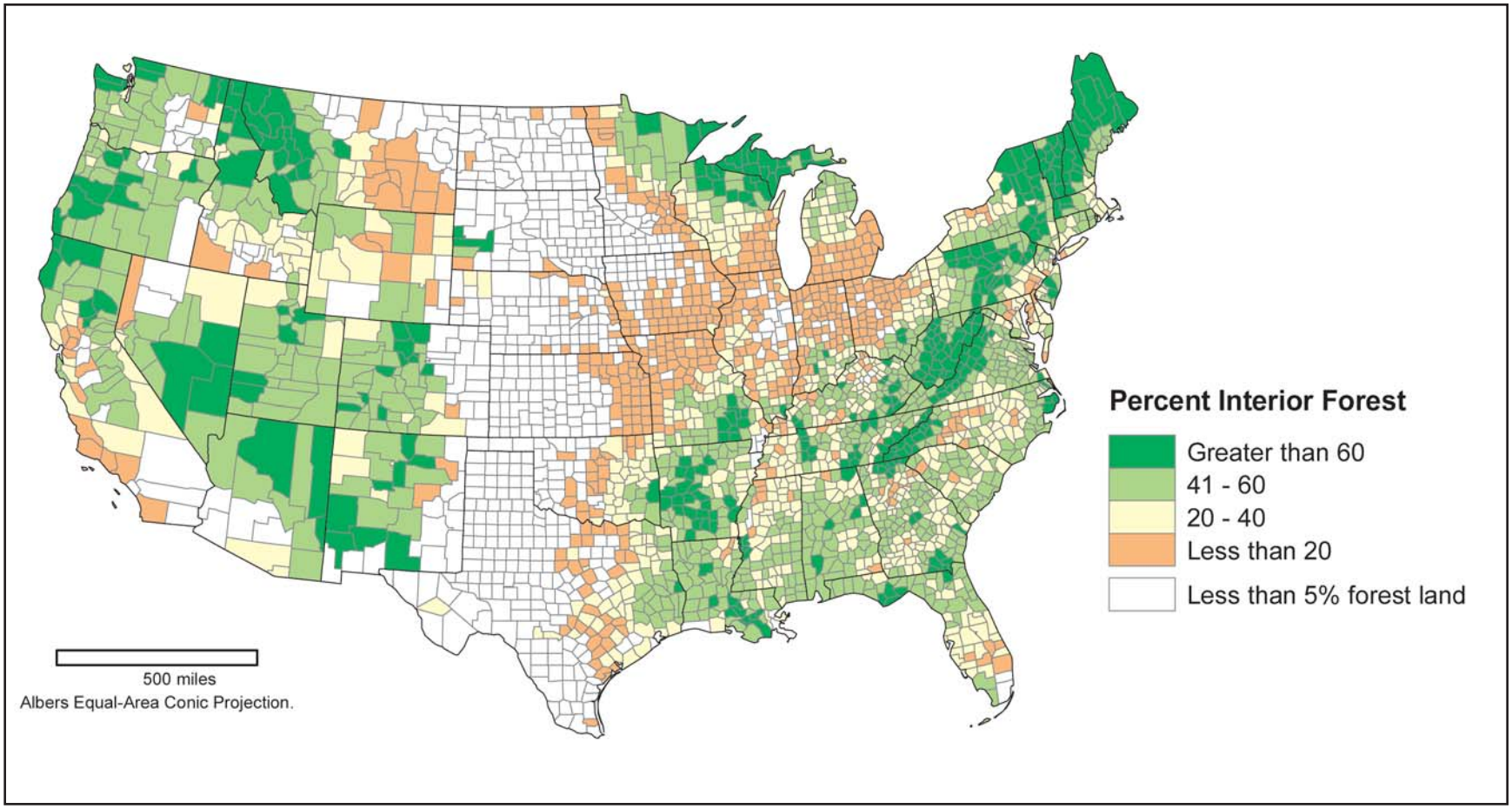
Plate 9. Forest land in the conterminous United States by ownership category



Forest land ownership is diplayed for forested pixels from the 2001 Forest Service map of Forest Type Groups (Ruefenacht et al. 2008). Public and private ownership was derived from the Conservation Biology Institute, Protected Areas Database, version 4.6, with revisions. Percent of private forest land in corporate ownership was estimated from RPA plot data, summarized over a hexagon sampling array developed by the U.S. Environmental Protection Agency, Environmental Monitoring and Assessment Program.

Source: Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

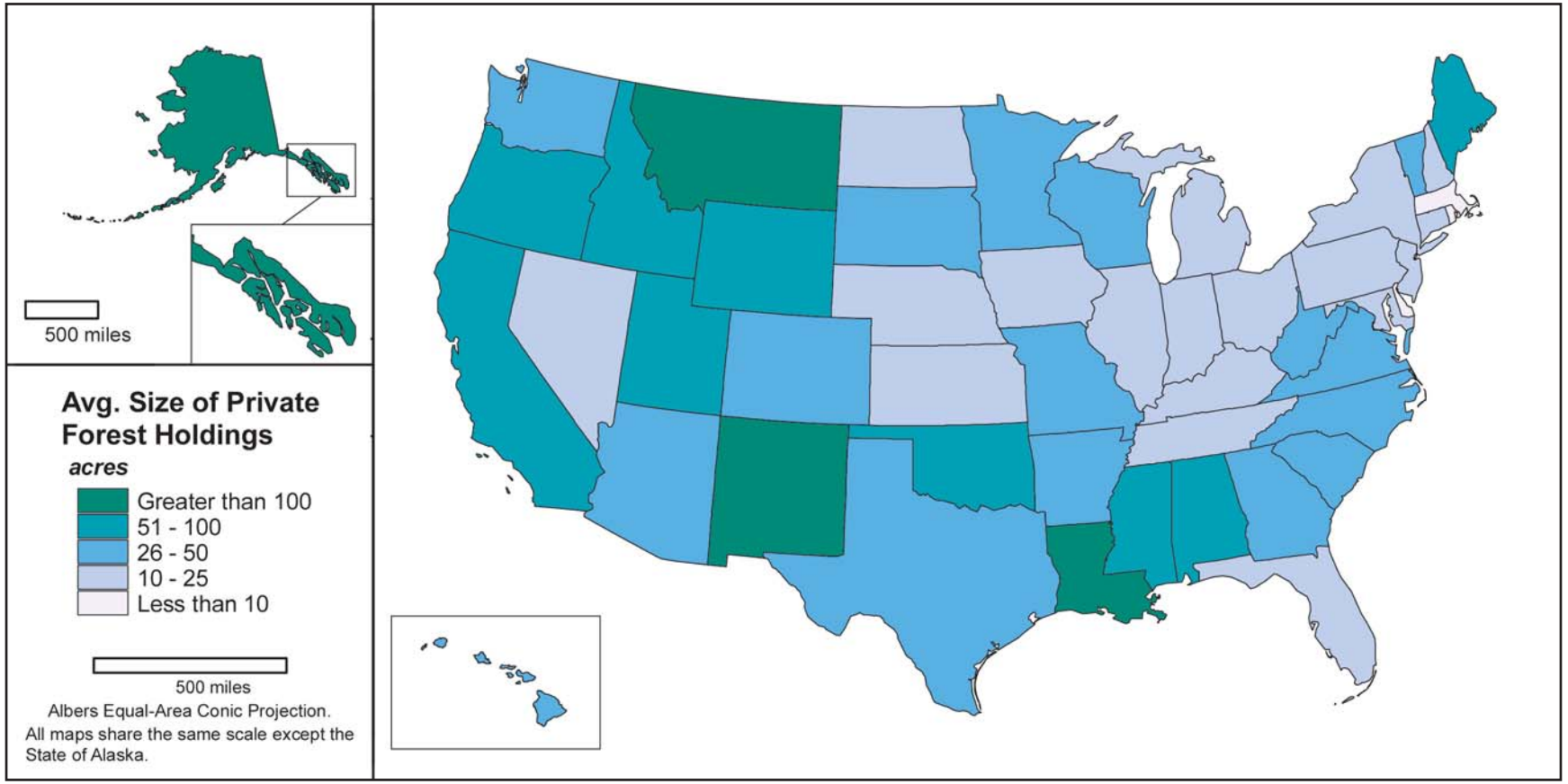
Plate 10. Percent interior forest by county in the conterminous United States



The spatial arrangement or pattern of forest affects a variety of forest amenities including wildlife, recreation opportunity, and water yield. This map shows the percentage of total forest area in each county that may be called "interior forest." The map was derived from the National Land Cover Database (Homer et al. 2007, see Chapter 2.3), which depicts land cover spatially at 30-m x 30-m pixel resolution. First, each pixel of forest land cover was classified according to the amount of forest in the surrounding 15.21 ha, and a forest pixel was called "interior forest" if the neighborhood was at least 90 percent forested. The percentage that is shown on the map is the percentage of all forest pixels in a county which met that criterion.

Source: Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

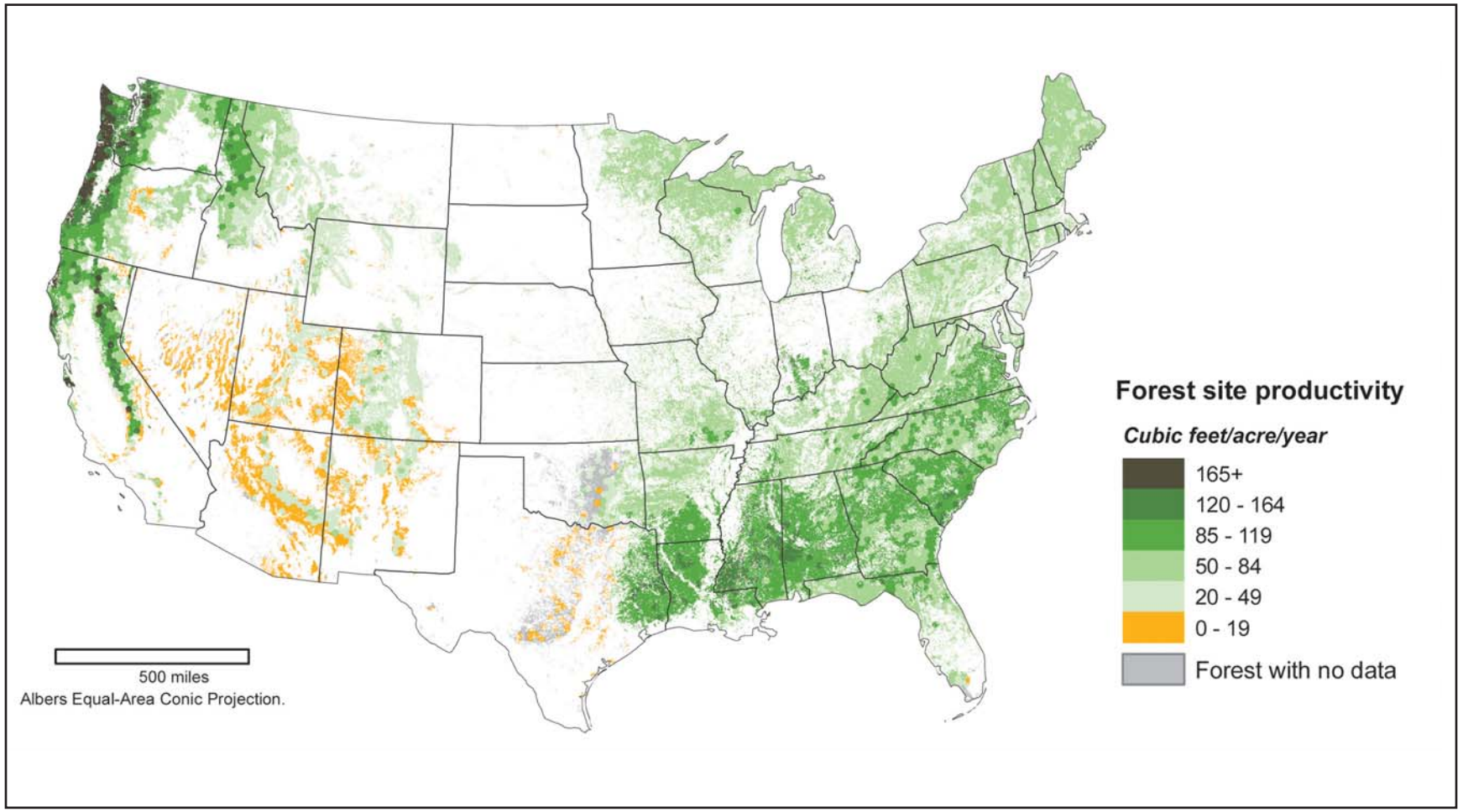
Plate 11. Average size of private forest holdings in the United States



Private forest holdings are forested lands that are privately owned. This map displays the average size of private forest holdings in the United States in the year 2006. The mapped information was derived by dividing the total number of private forest acres in a State by the total number of private forest owners in a State. Data for the map are from the Forest Service's National Woodland Owner Survey (http://www.fia.fs.fed.us/nwos).

Source: Forest Service, FIA program, Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

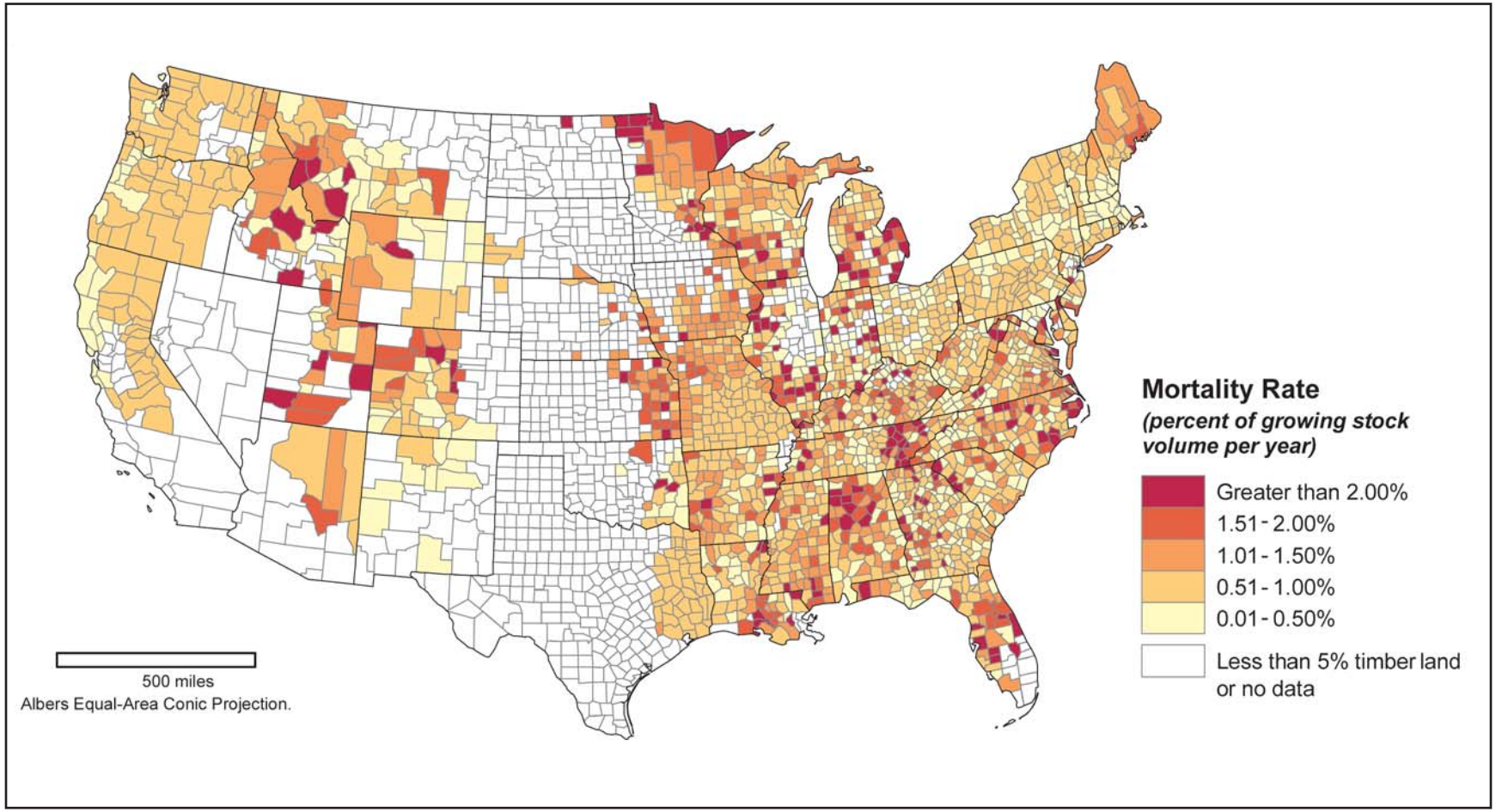
Plate 12. Net primary forest productivity in the conterminous United States



Forest site productivity is diplayed for forested pixels from the 2001 Forest Service map of Forest Type Groups (Ruefenacht et al. 2008). Forest site productivity was estimated from RPA plot data; summarized over a hexagon sampling array developed by the U.S. Environmental Protection Agency, Environmental Monitoring and Assessment Program.

Source: Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

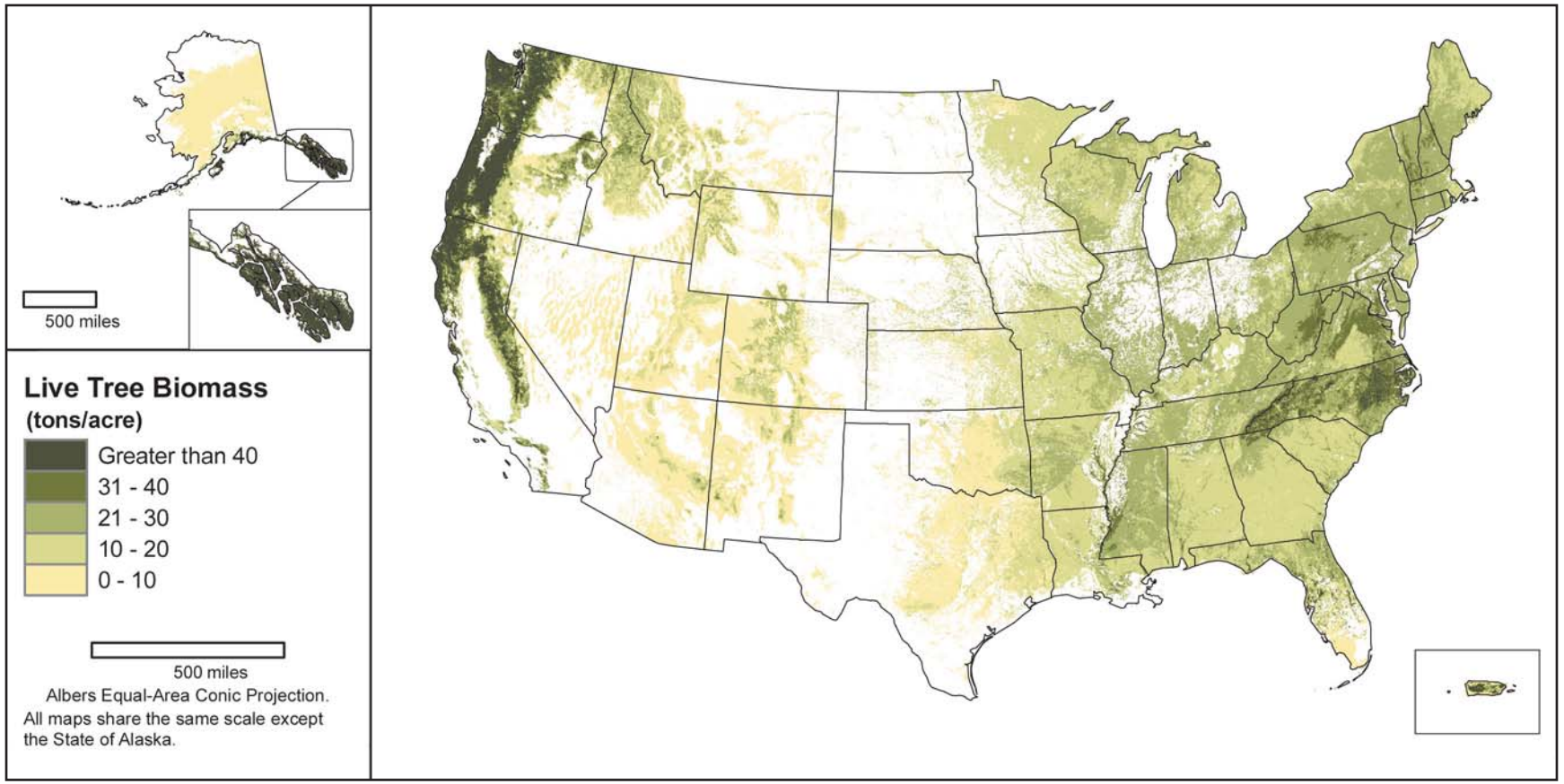
Plate 13. Mortality rates of growing stock on timber land of the conterminous United States



Mortality is the death of a tree due to natural causes. This map displays the mortality rate of growing stock on timber land by county across the conterminous United States. Data were derived from compiled FIA observations of mortality of growing stock trees on timber land (thousand cubic feet per year) and dividing by the observed total growing stock volume on timber land (thousand cubic feet). Current mortality data was not available for some States, so data from previous inventories was used to calculate mortality rates for categories defined by State group, softwood-hardwood group, and diameter class. These rates were then applied to the current standing inventory to impute an estimate of current mortality. The results were summarized by county and associated with the 2002 United States County Boundaries shapefile using FIPS county codes.

Source: Forest Service, FIA program, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

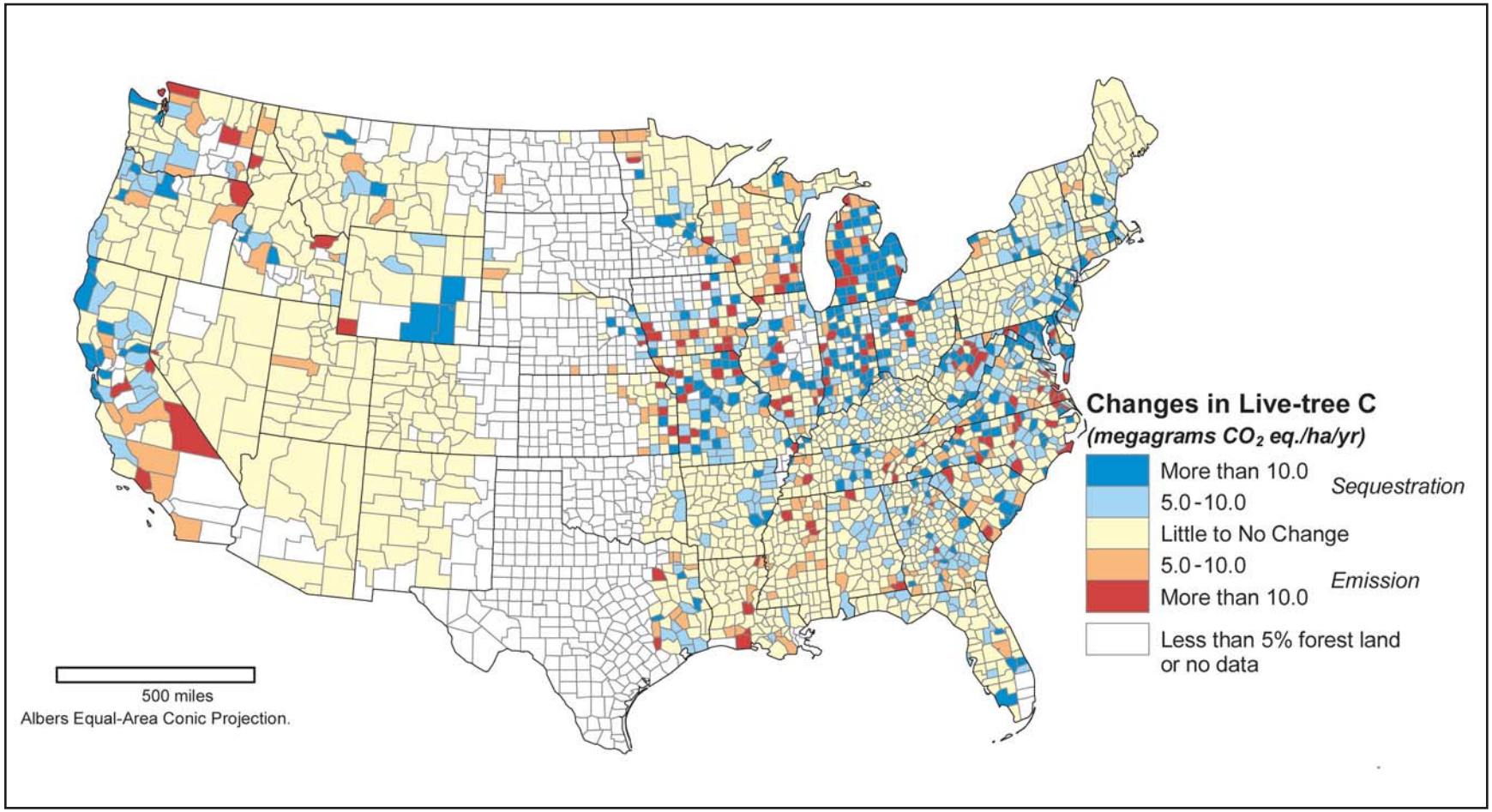
Plate 14. Above-ground live tree biomass on forest land in the United States



Above-ground biomass of live trees includes woody material contained in tree boles, forks, limbs, branches, and tops of live trees, but excludes foliage and roots. A collaborative effort between the Forest Service, FIA program, the Remote Sensing Applications Center, and the International Institute of Tropical Forestry produced this spatially explicit dataset of above-ground live tree biomass for the conterminous United States, Alaska, and Puerto Rico (note: no biomass data are available for Hawaii). Above-ground live tree biomass collected on FIA plots were modeled as functions of more than 100 geospatially continuous predictor layers, including Moderate Resolution Imaging Spectrometer (MODIS); topographic variables; monthly and annual climate parameters; and other ancillary variables (Blackard et al. 2008).

Source: Geographic base data are provided by the USDA National Agricultural Statistics Service. Biomass raster data for the lower 48 States and Alaska are available online at http://fsgeodata.fs.fed.us/rastergateway/biomass. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

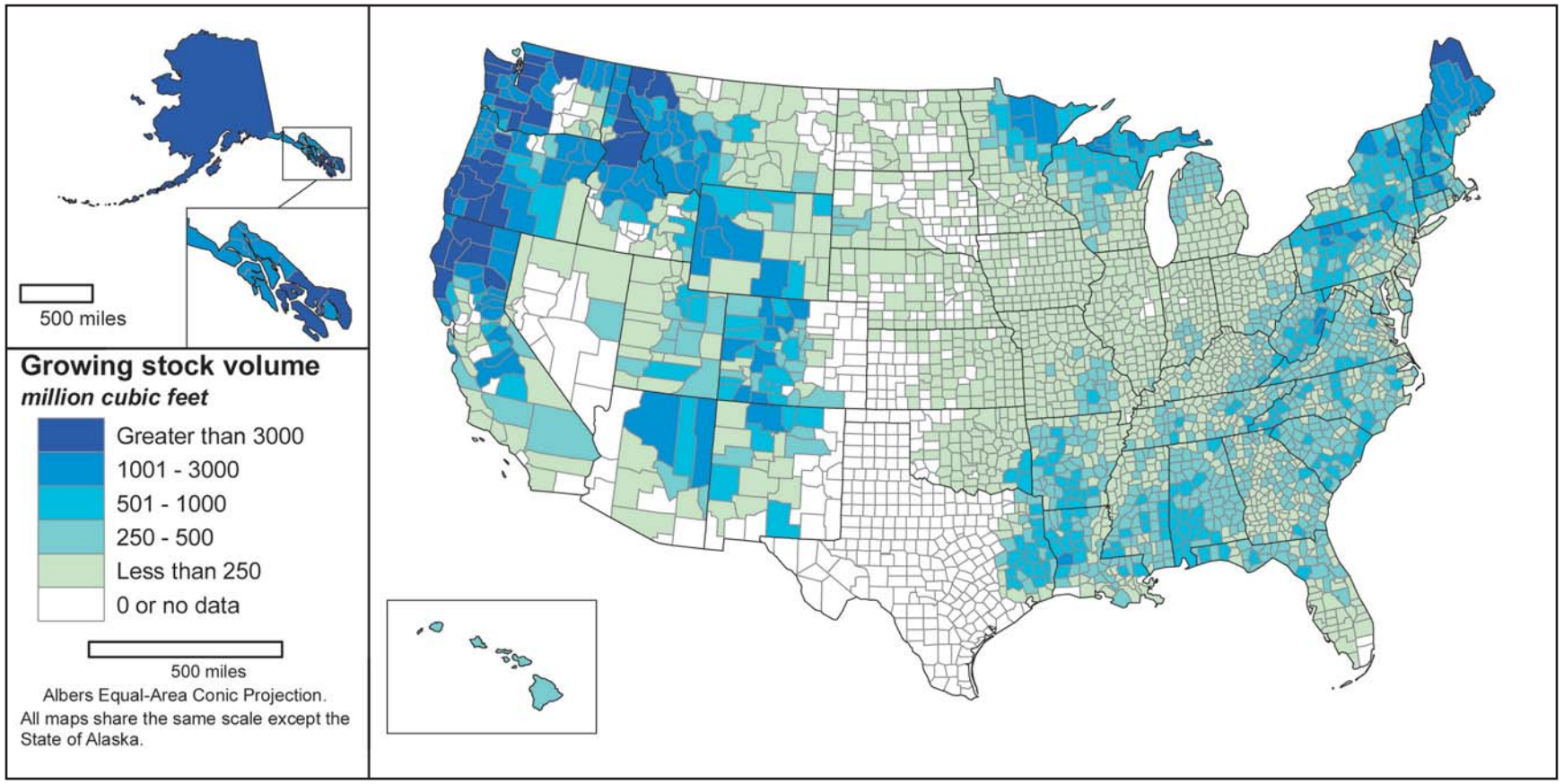
Plate 15. Net annual change in live-tree forest carbon stocks of the conterminous United States



Change in live-tree forest carbon stocks includes estimated changes in coarse roots, stems, branches, and foliage. FIA plot data are converted into county-level estimates using the FORCARB2 model (EPA 2007, Smith and others 2007). These estimates are net changes, and include the effects of harvest and land use change. The atmosphere is the common frame of reference in carbon accounting. Losses from the atmosphere—forest carbon sequestration—are denoted by blue symbols. Emissions to the atmosphere—losses of forest carbon—are represented by red symbols.

Source: J.E. Smith, L.S. Heath, and E. LaPoint, Forest Service, FIA program, 2005 data. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

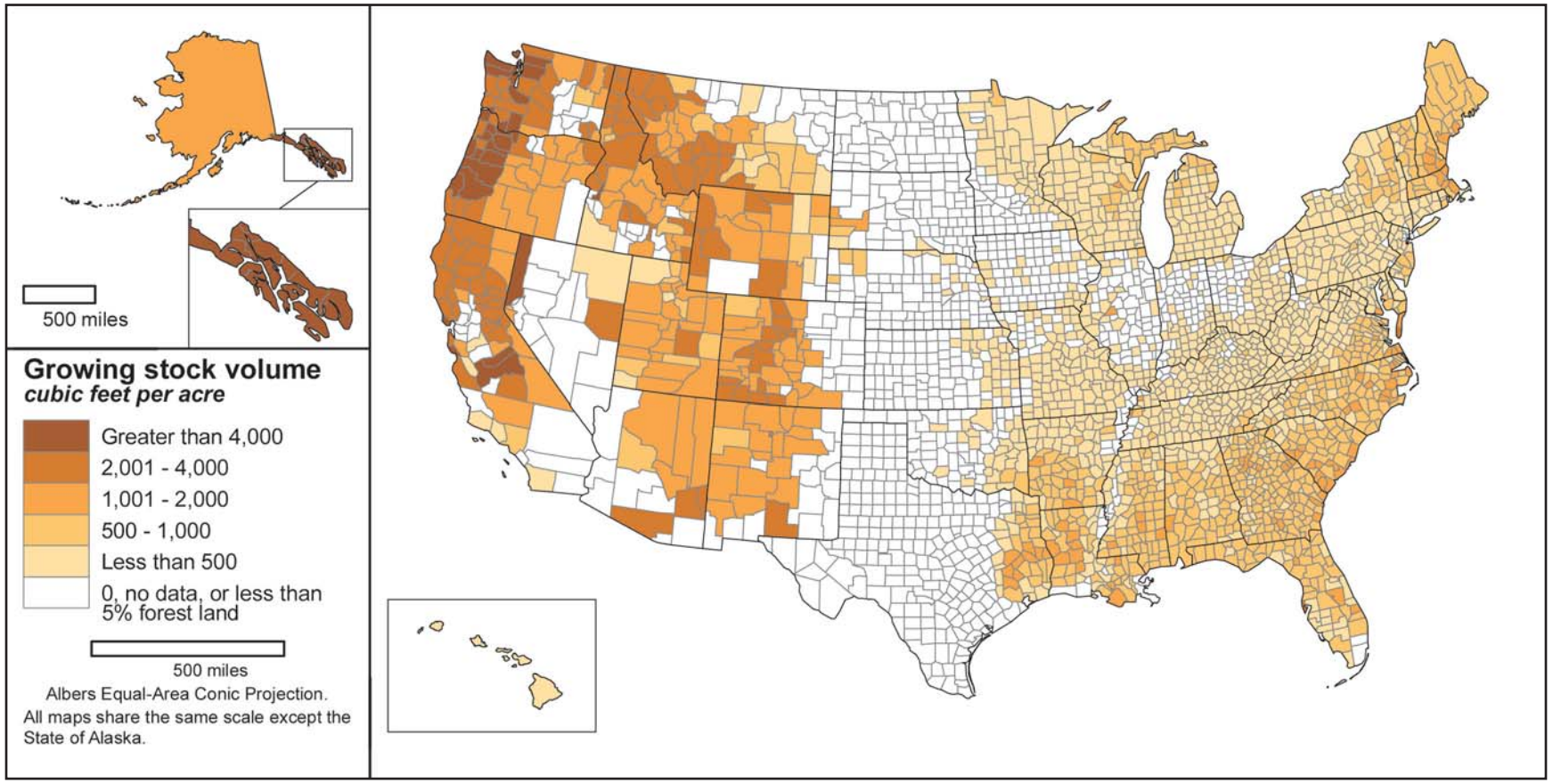
Plate 16. Net volume of growing stock on timber land in the United States



Net volume of growing-stock timber includes live trees, 5.0 inches diameter or greater, of commercial species meeting specified standards of quality or vigor, excluding cull trees. This map displays the total net cubic feet volume of growing-stock timber on timber land by county across the United States. Data for the map were derived from compiled FIA sample observations summarized by county and associated with the 2002 United States County Boundaries shapefile using FIPS county codes.

Source: Forest Service, FIA program, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

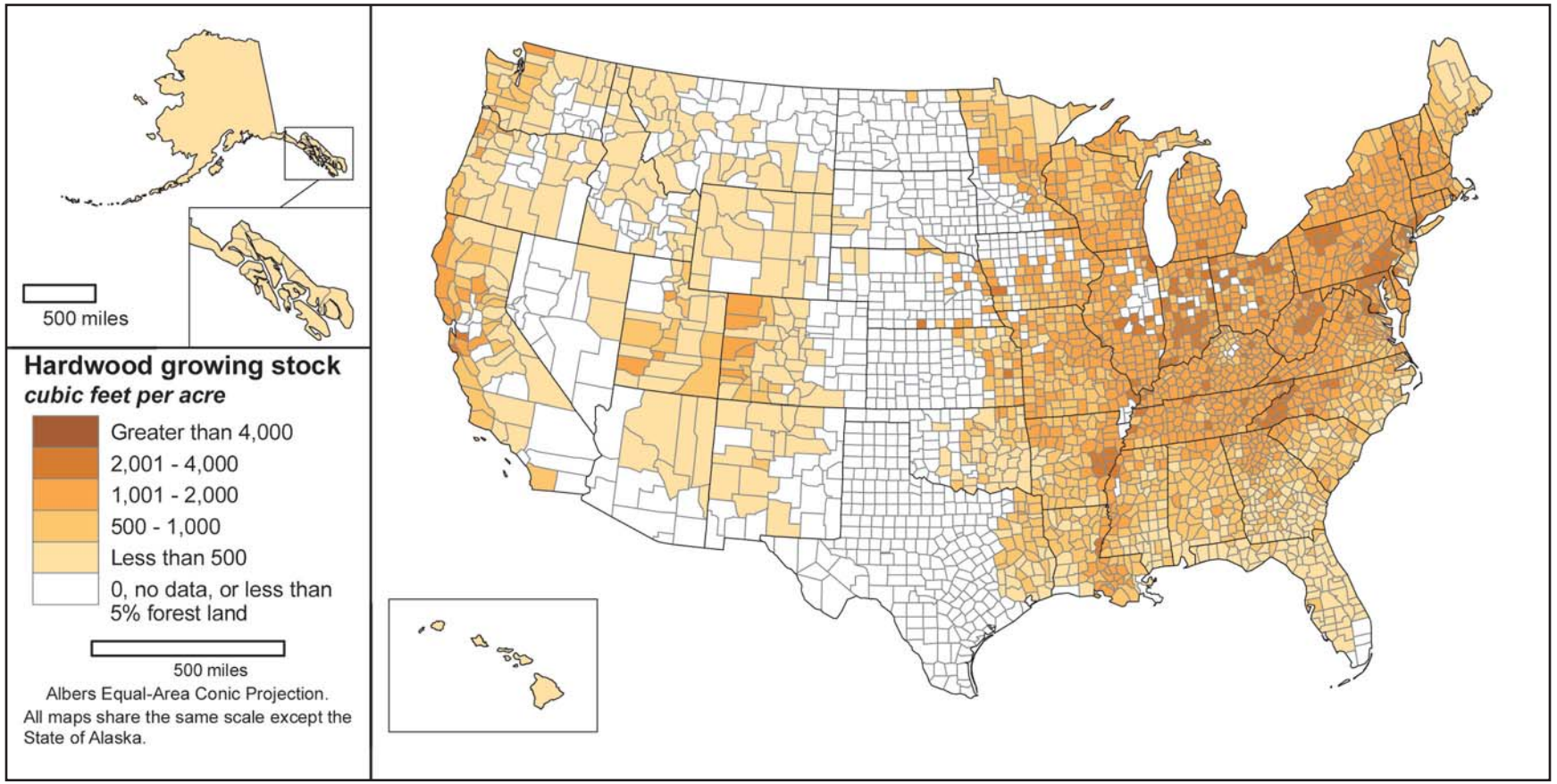
Plate 17. Net volume of softwood growing stock per acre on timber land in the United States



Net volume of growing-stock timber includes live trees, 5.0 inches diameter or greater, of commercial species meeting specified standards of quality or vigor, excluding cull trees. This map displays net cubic feet volume of softwood growing-stock per acre on timber land by county across the United States. Per acre estimates were generated by normalizing the data to the total timber land area of each county. Data for the map were derived from compiled FIA sample observations summarized by county and associated with the 2002 United States County Boundaries shapefile using FIPS county codes.

Source: Forest Service, FIA Progam, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

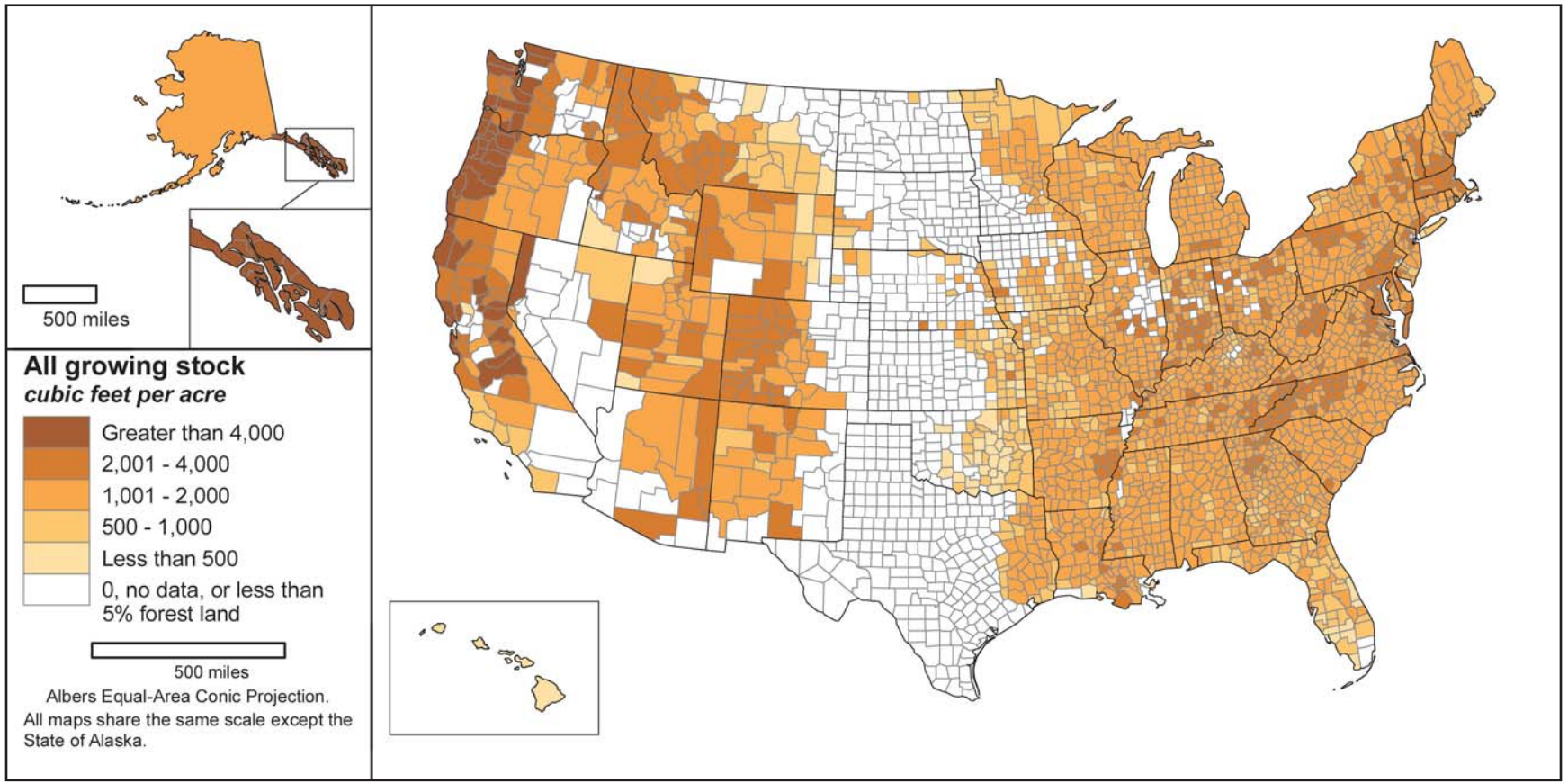
Plate 18. Net volume of hardwood growing stock per acre on timber land in the United States



Net volume of growing-stock timber includes live trees, 5.0 inches diameter or greater, of commercial species meeting specified standards of quality or vigor, excluding cull trees. This map displays net cubic feet volume of hardwood growing-stock per acre on timber land by county across the United States. Per acre estimates were generated by normalizing the data to the total timber land area of each county. Data for the map were derived from compiled FIA sample observations summarized by county and associated with the 2002 United States County Boundaries shapefile using FIPS county codes.

Source: Forest Service, FIA program, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

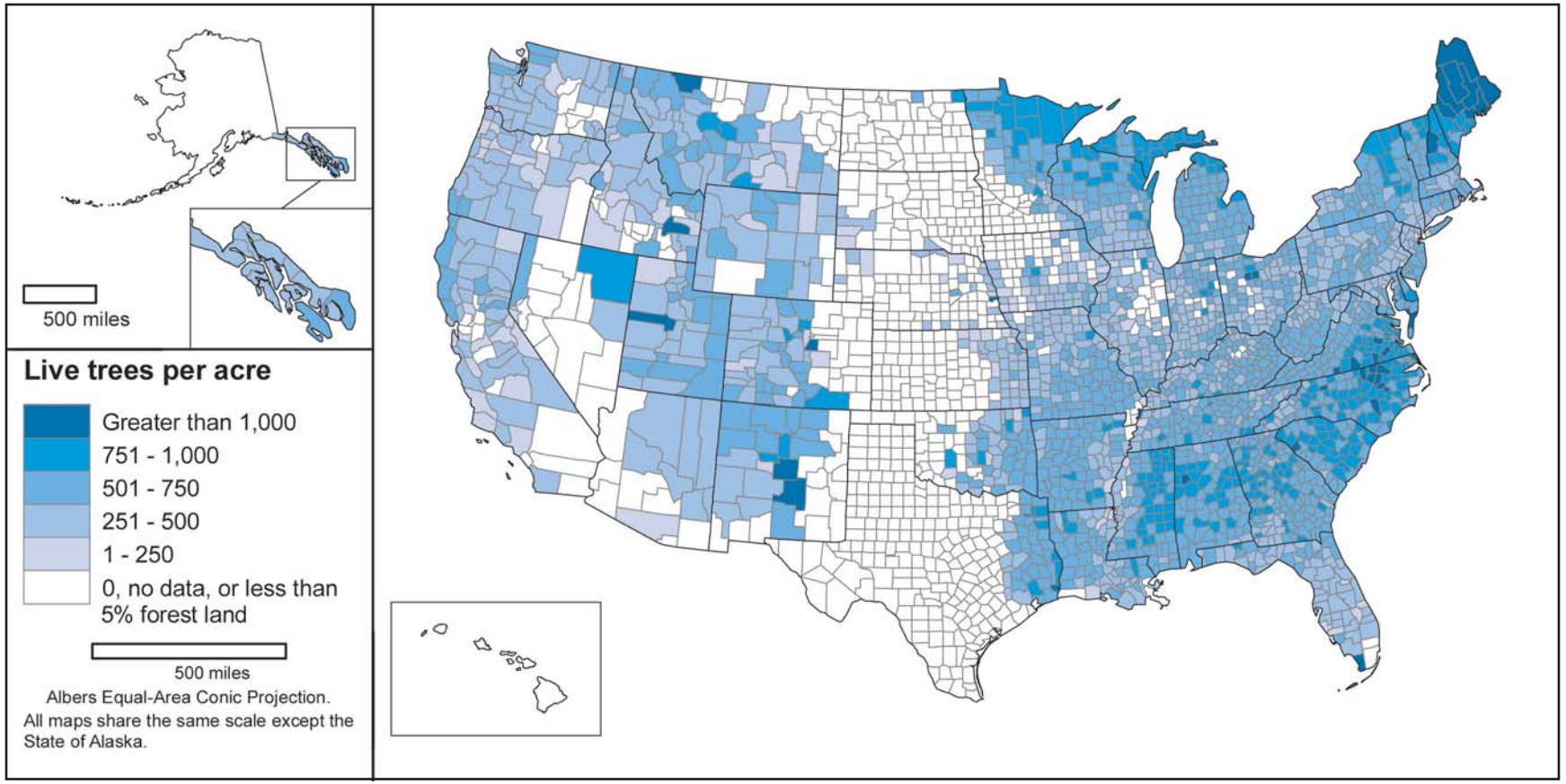
Plate 19. Net volume of all growing stock per acre on timber land in the United States



Net volume of growing-stock timber includes live trees, 5.0 inches diameter or greater, of commercial species meeting specified standards of quality or vigor, excluding cull trees. This map displays the total net cubic feet volume of all growing-stock timber per acre on timber land by county across the United States. Per acre estimates were generated by normalizing the data to the total timber land area of each county. Data for the map were derived from compiled FIA sample observations summarized by county and associated with the 2002 United States County Boundaries shapefile using FIPS county codes.

Source: Forest Service, FIA program, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

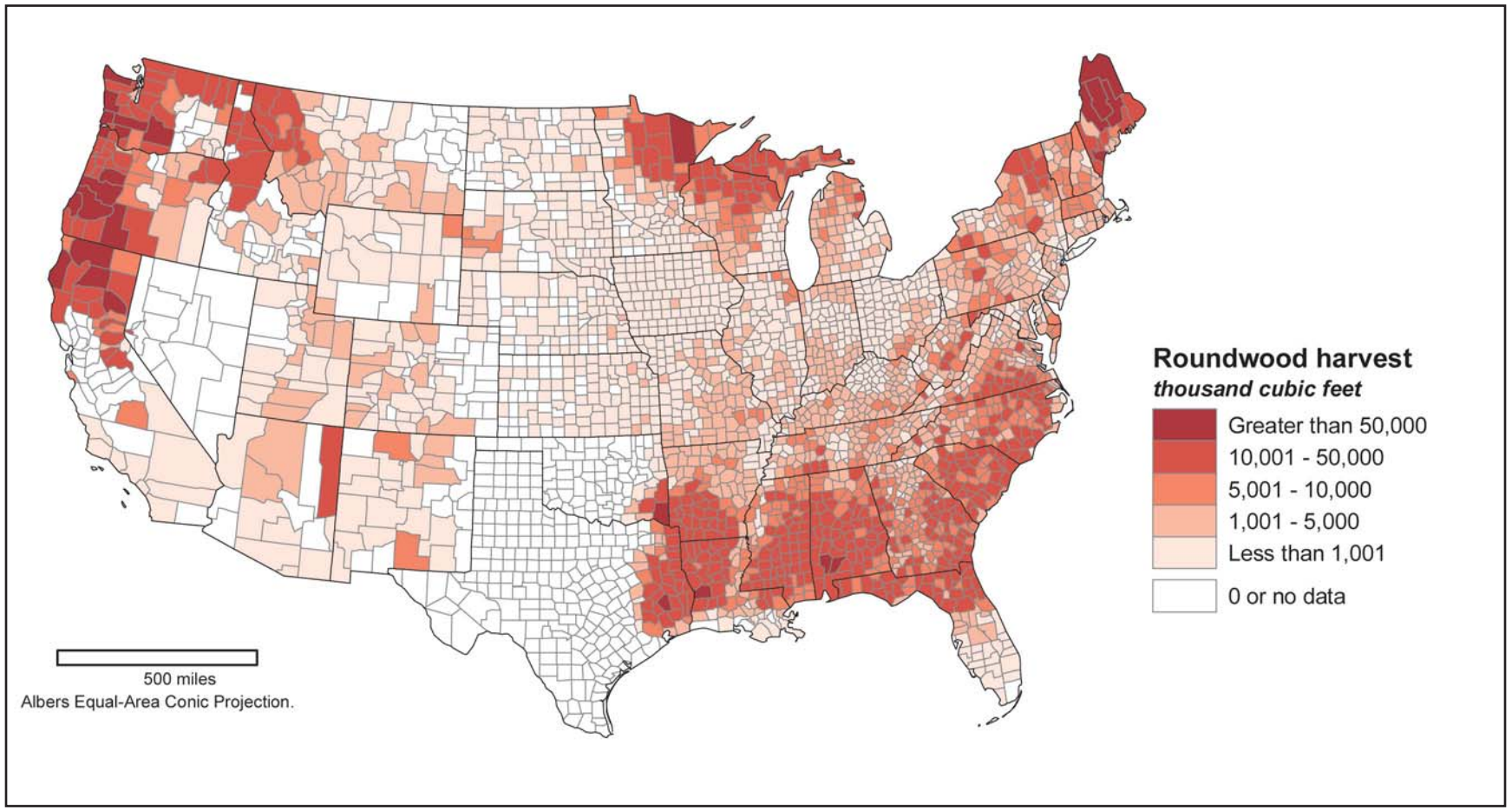
Plate 20. Number of live trees greater than 1-inch d.b.h. per acre on timber land in the United States



The number of live trees is an indicator of the composition and diversity of a forest. This map shows the number of live trees 1.0 inch diameter and greater on timber land by county across the United States. Per acre estimates were generated by normalizing the data to the total timber land area of each county. Data for the map were derived from compiled FIA sample observations summarized by county and associated with the 2002 United States County Boundaries shapefile using FIPS county codes.

Source: Forest Service, FIA program, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

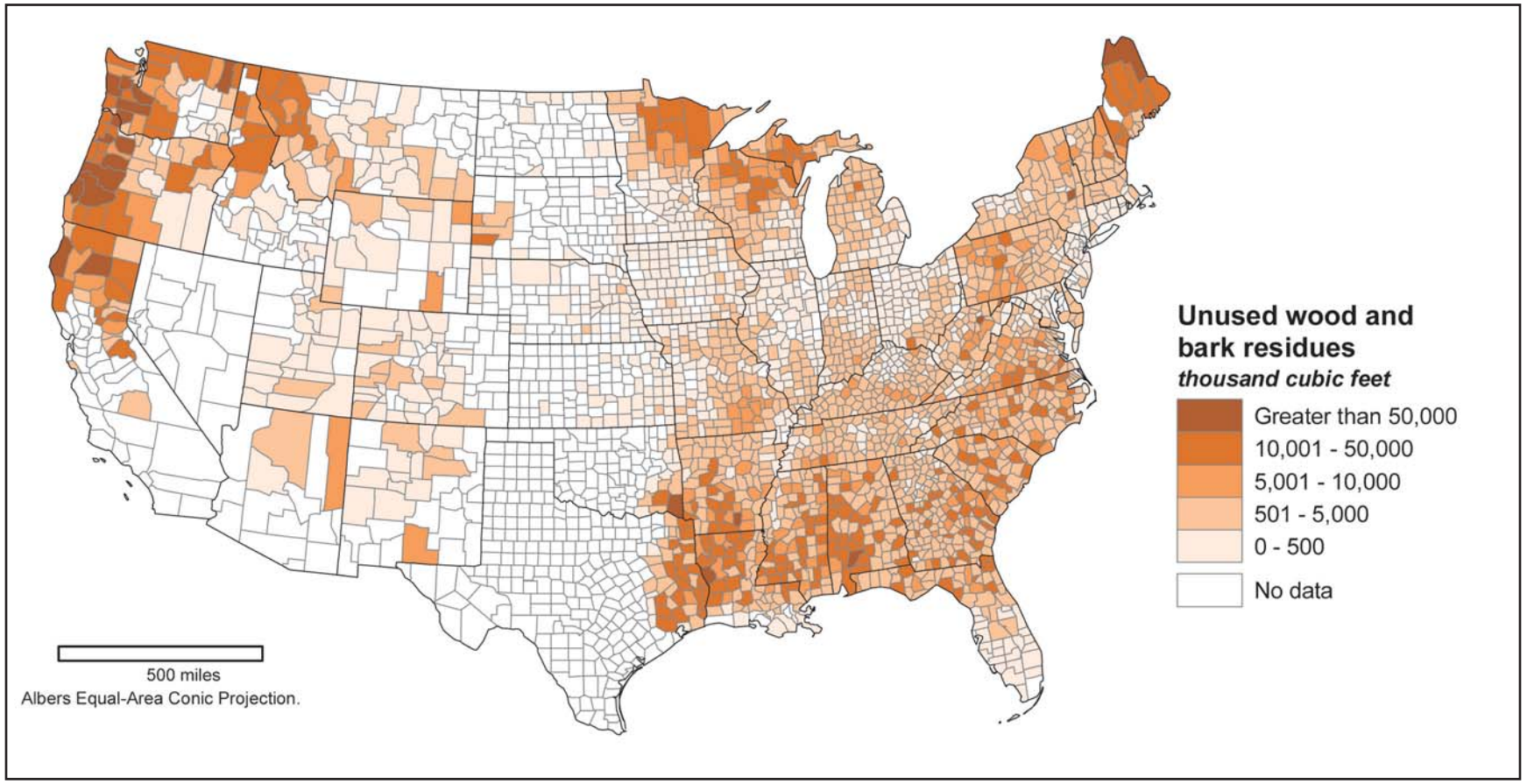
Plate 21. Volume of roundwood harvested by county in the conterminous United States



Roundwood (cubic foot volume) removed from forest land and processed into wood products was determined from: 1) annual and periodic surveys of primary wood-using mills; 2) periodic surveys of residential fuel use that have been adjusted with Department of Energy data of annual residential fuelwood consumption; and 3) Department of Energy data of annual residential fuelwood consumption. See Appendix A in this report for year of source data for each State.

Source: Forest Service, FIA program, RPA plot summary database. Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

Plate 22. Unused wood and bark residues from timber harvesting and primary wood processing mills in the conterminous United States



Unused wood and bark residues (cubic foot volume) are obtained from surveys of primary wood-using mills, based on the sum of 1) harvest residue volume, which is calculated by applying regional logging utilization factors to the volume of roundwood product harvested and 2) unused mill residue volume. See Appendix A in this report for year of source data for each State.

Source: Geographic base data are provided by the USDA National Agricultural Statistics Service. FIA data and mapping tools are available online at http://fiatools.fs.fed.us. Date: March 2009.

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