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This appendix begins by briefly recounting the origins of the forest inventories that for more than a century have tracked the volume and condition of U.S. forests. It then focuses on the current status of the forest sector, including the extent of forests across the country, their ownership, and the state of the forest products market.

Forest inventories

In the 1860s and 1870s, wood-fired steam boilers were driving the industrial revolution, powering both factories and the trains and steamers that delivered manufactured goods across the

country. Dr. Franklin Hough, a retired medical doctor from New York State who had analyzed 1855, 1860, 1865, and 1870 census data on forested acres, observed that the reliance on wood energy was reducing the extent of forestland. At the August 1873 meeting of the American Association for the Advancement of Science, Hough delivered a paper, “On the Duty of Governments in the Preservation of Forests,” arguing that Mediterranean countries’ overuse of their resources—especially trees—had caused irrevocable harm to the environment. Three years later, in 1876, Congress approved \$2,000 to study the situation and Hough was appointed “special forestry agent” in the U.S. Department of Agriculture. By then, Hough had compiled forest inventory information from census data for all the U.S. states and also from countries around the world. His multivolume *Report upon Forestry* (Hough 1878, 1880, 1882) was highly critical of contemporary American attitudes and practices and provided the basis for a serious discussion about the situation. Scientists’ concerns led to creation of the American Forestry Association in 1875, the first nongovernmental organization devoted to conservation. A year later, the first state forestry association was formed in Minnesota. These and other entities began to influence political discussions in the U.S. Congress.

In 1630, historians estimate, forests covered 1,038 million acres of what is now the United States—46 percent of the total land area in the country. By 1900, 257 million acres of forest had been cleared and converted to other uses, primarily agriculture. Nearly two-thirds of that net conversion occurred from 1850 to 1900, when an average of 8,400 acres of forest was cleared per day. Even more forest area was cutover and then abandoned, left to regenerate naturally. By 1910, the area of forest had declined to 754 million acres, or 34 percent of the total land area.

As the railroad network extended its reach, coal from remote mines could be delivered to factories and homes at a cost competitive with locally harvested fuelwood. By the 1890s, coal had largely replaced wood for powering factories and trains. Although logging continued in many areas because wood for construction and papermaking was still in high demand, the decline in fuelwood demand, the shifting of agriculture to better lands in the Midwest, and the regrowth of trees on previously harvested timberland and abandoned agricultural land meant that the area of forest stabilized at roughly 750 million acres. Since the 1880s, the area of forestland

in the United States has varied by only about 5 percent, even as the U.S. population has tripled (Figure 1).

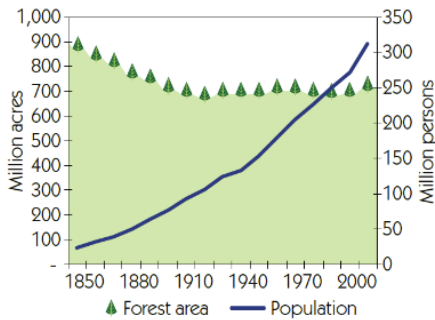


Figure 1. U.S. forest area and population trends, 1850–2010

Hough’s reports, based on forest inventories from census data, had led to two outcomes: additional assessments (a dozen more between 1900 and 1950¹) and the desire for more and better inventory information about forest area and forest conditions. The first scientific inventories of U.S. forests began in the early 1930s, following passage of enabling legislation, the McSweeney-McNary Act of 1928. Early inventories were organized by the U.S. Forest Service Research & Development division and conducted on a rotating state-by-state basis as part of the Forest Inventory and Analysis (FIA) program (<http://www.fia.fs.fed.us>). The first reports for individual states were issued in the late 1930s. In the late 1980s and early 1990s, FIA program funding levels stretched out the remeasurement cycle for some regions and states to 12 to 15 years or longer. But in the South, where trees grow fast, long inventory cycles no longer met the needs of state foresters or the forest industry. Consequently, in the mid-1990s, that “periodic” inventory approach was largely changed to an “annualized” inventory program: a proportion of the plots in each state is re-inventoried each year. Since 2000, annual inventories have been implemented in the lower 48 states and Southeast Alaska. Hawaii and the western Pacific islands are still inventoried on a periodic basis, and during 2015–2016, a limited annual inventory program was begun in interior Alaska.

¹ U.S. Forest Service (1982, preface) lists them.

Global context

The United States has 5 percent of the world's population, 7 percent of the land area, 8 percent of the forestland, 6 percent of the woody biomass, and 10 percent of the timber inventory. However, the United States uses 28 percent of the world's annual harvest of industrial wood (excluding fuelwood), 96 percent of which comes from domestic supplies harvested from privately owned forestland. Less than 2 percent of the U.S. annual harvest of wood comes from public lands (mostly state-owned forestland). There is virtually no harvesting of wood from federal forestland.

Current situation²

The total forest area of the United States is 766 million acres, an increase of roughly 1 percent between 2007 and 2012. This is a continuation of the slight upward trend from 2002 to 2007. The national figure, however, masks considerable regional variation. Most states gained or lost less than 5 percent of their forest area. The largest percentage gains were in the Great Plains states, but because these states have small areas of forest, the absolute changes were small. Only Delaware and New Jersey experienced losses of more than 5 percent, but again, the total affected area is small.

Changes since 2007 at the regional level were less than 1 percent everywhere except in the U.S. Forest Service's Northern region, which experienced a 2 percent change (Oswalt et al. 2014).

Definitions

Trends in forest area are based on international definitions for consistency with U.S. data reported to the United Nations' Food and Agriculture Organization. *Forest* is land having at least 10 percent tree crown cover that is more than 1 acre and at least 120 feet wide, with tree species that can reach at least 16.5 feet at maturity. It includes land that formerly had such tree cover and

² The information in this section and all the figures, except Figures 7 and 8, are drawn from Oswalt and Smith (2014).

will be naturally or artificially regenerated to trees. Young natural stands and all plantations established for forestry purposes are considered forest even if they have yet to reach the minimum crown density or tree height, as are areas that were formerly forest but are temporarily unstocked as a result of human intervention (e.g., wood harvesting) or natural causes (e.g., wildfire) and expected to revert to forest.

Timberland is a subcategory of forest that meets two additional criteria: it is capable of producing 20 cubic feet of wood per acre per year, and it is not legally reserved from timber harvest (e.g., by being designated a wilderness area or national park).

Reserved forest is land legally removed from timber harvest, such as federally designated wildernesses and national parks, and state-designated areas, such as steep slopes (where best management practices prohibit logging) and mandatory streamside buffer zones (where trees protect habitat for threatened and endangered aquatic species).

Other forest is land that is not reserved but whose trees do not meet the minimum annual productivity requirement (20 cubic feet per acre per year).

The most recent compilation of data by Oswalt et al. (2014) has introduced another category, *woodland*. This includes scrub forests, chaparral, and land with trees that are not expected to achieve the minimum height at maturity that defines *forest*. In general, woodlands are found in arid regions of the Southwest (West Texas, New Mexico, Arizona, Utah, Nevada and southern Colorado). In 2012, the country had an estimated 53 million acres of woodland. Woodland is not shown in Figure 2.

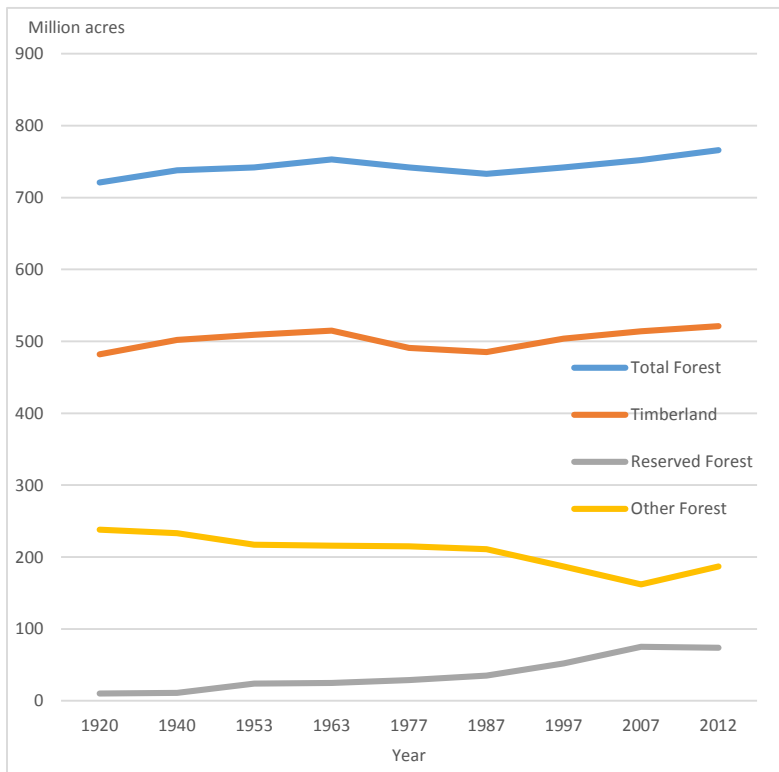


Figure 2. U.S. forestland area, by category, 1920–2012

Regional differences in forest area

The South, with 40 percent of the nation’s timberland, is often called the nation’s wood basket because its timber is abundant, fast growing, easily transported on the region’s roads and railroads, and available for harvesting: 87 percent of the South’s forests are privately owned. The North has 32 percent of the nation’s timberland, and thus 72 percent of the nation’s timberland lies east of the Great Plains.

The West has 85 percent of the nation’s reserved forests because of the predominance of federally designated wilderness areas and national parks.

Forest age and species composition

The age structure of forests varies by region (Figure 3). In the South, where southern pines are widely planted, 51 percent of the timberland stands are less than 40 years old,

compared with 20 percent of stands in the North and 22 percent in the West. In contrast, 56 percent of timber stands in the North are more than 60 years old, compared with 27 percent in the South and 69 percent in the West.

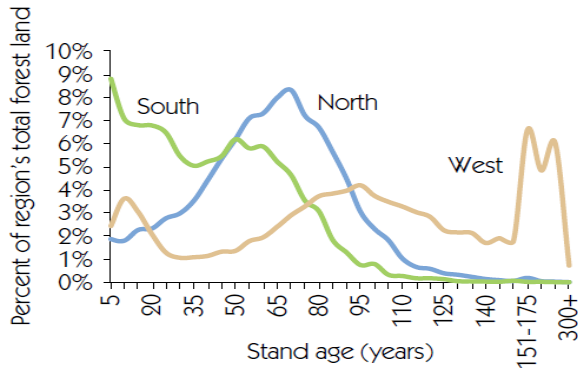


Figure 3. Forestland distribution, by region and age of stand, 2012

U.S. forests are predominantly natural stands of native species. Planted forests are most common in the eastern half of the country and consist primarily of planted native southern pines in the South. Roughly 12 percent of southern forests originated as plantations, and on average, 2 million acres are planted each year. In the West, planting is generally used to augment natural regeneration, and only 5 percent of western stands are planted.

Two federal programs have had major effects on tree planting. The Soil Bank Program caused large spikes in planting in the South in the 1950s, and the Conservation Reserve Program planted nearly 3 million acres in the 1980s. In recent years, tree planting has diminished substantially in the West, a trend that mirrors reduced harvesting in that region (Figure 4).

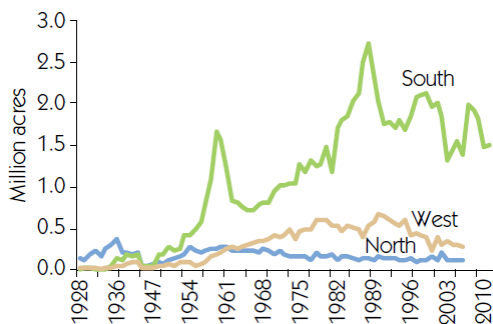
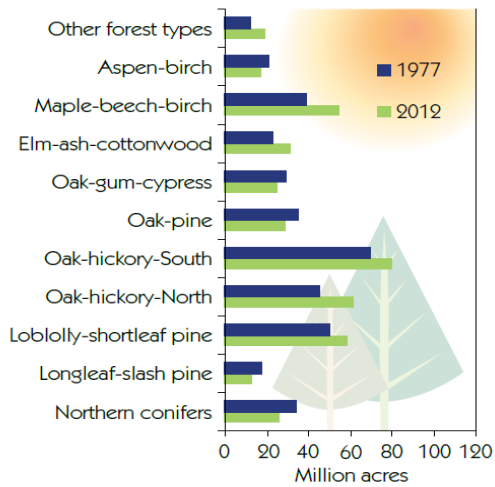


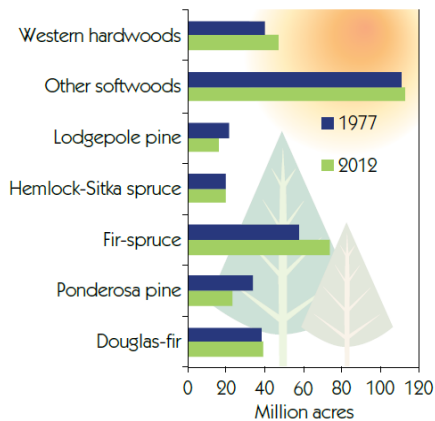
Figure 4. Forest planting trends, 1952–2011

The species composition in the three regions varies with landform and precipitation (Figure 5). In the East, deciduous hardwoods and yellow pines are the dominant types. Since 1977, rapid-growing maples have seen an uptick, and the South’s longleaf–slash pine forests have seen a decline. In the West, hemlock–Sitka spruce forests and ponderosa pine stands have declined.



Forest type trends in the East, 1977 to 2012.

Figure 5a. Trends in forest type, eastern United States, 1977–2012



Forest type trends in the West, 1977 and 2007.

Figure 5b. Trends in forest type, western United States, 1977–2007

Forest productivity

The eastern half of the country has experienced the largest gains in productivity (technically, growing stock volume per acre): volumes today are nearly double what they were in 1953 (Figure 6). The West has seen lesser productivity increases.

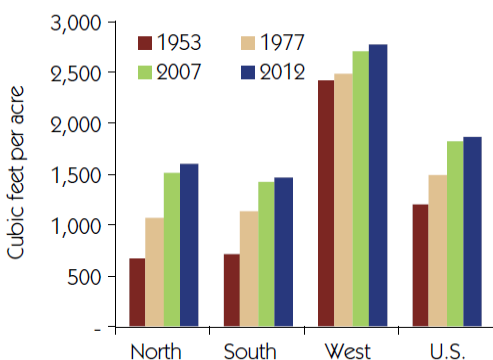


Figure 6. Trends in growing-stock volume per acre on timberland, 1953–2012

During the past 60 years, net growing-stock growth³ has consistently exceeded growing-stock removals. As a percentage of standing volume, removals between 2007 and 2012 were at the lowest levels since 1953. Growth has also slowed as trees have matured. The annual volume of net growing-stock growth is currently twice the volume of annual removals. Mortality rates remain similar to 2006—less than 1 percent of standing inventory annually at the national level.

Wildfires create spotty but large areas of mortality. In all regions, today’s higher growing-stock volumes mean higher fuel loads, particularly on federal lands, where removals by harvesting are currently virtually zero. When pest outbreaks hit, the dead zones created are measured in thousands to hundreds of thousands of acres. For example, net annual growth has slowed by 48 percent in the Rocky Mountain region since 2007 because of mountain pine beetle infestations: softwood mortality (spruce, pine, fir) in that region increased by 57 percent between 2006 and 2011, and for the 20 years following 1991, by 92 percent. Current reports from the Forest Service’s Forest Health Monitoring program indicate that mortality is beginning to taper off. In 2009, insect mortality affected 11.8 million acres, and in 2012, 4.6 million acres.

The future risk of both wildfire (Figure 7) and pest infestations (Figure 8) remains high.

³ Net growing-stock growth is gross growing-stock growth minus mortality.

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Wildland fire potential 2012

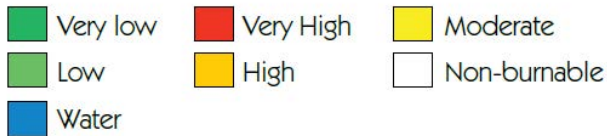


Figure 7. Land at risk of wildfire, 2012

Source: Fire Modeling Institute (2013)

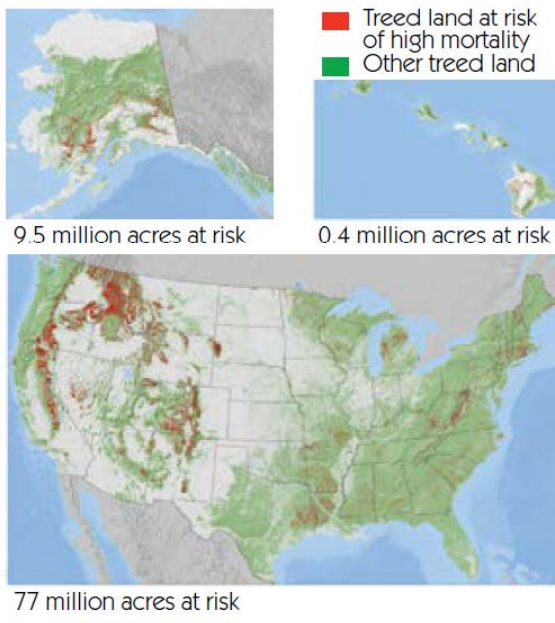


Figure 8. Forested land at risk of high mortality from insects and diseases, 2012

Source: U.S. Forest Service (2014)

The characteristics of timberland are also changing. The proportion of timberland area occupied by large trees (sawtimber) has increased consistently in the North and South since the 1950s, accompanied by a slow but steady decline in the area of smaller trees. This structural change has been a source of concern because of wildlife species that require early-successional forest habitat. For example, the species of songbirds in eastern forests are changing as trees age and canopies become denser. Western forests do not have consistent trajectories.

Landownership in transition

The majority of forestland—58 percent, including tribal lands—continues to be privately owned. Federal, state, and local governments own the remainder. Private land dominates in the North (74 percent) and South (87 percent). Vertically integrated corporations with wood-processing facilities were traditionally the major private forest landowners: in 2001, forest industry owned 66 million acres (13 percent) of the nation’s timberland, and those corporate lands provided 29 percent of the wood supplied to processing facilities. But in the past 15 years, many forest products firms have divested some or all of their land. Much of the land went into timber investment management organizations (TIMOs) or real estate investment trusts (REITs). Families and individuals also purchased some lands.

Market conditions

The most significant recent event that affected market conditions for wood and forest products was the collapse of the home mortgage industry in 2007, which led to the housing market collapse and the Great Recession. The economic downturn hit the forest products industry especially hard. After record highs in 2005–2006, construction of single-family homes dropped by 75 percent (Figure 9).

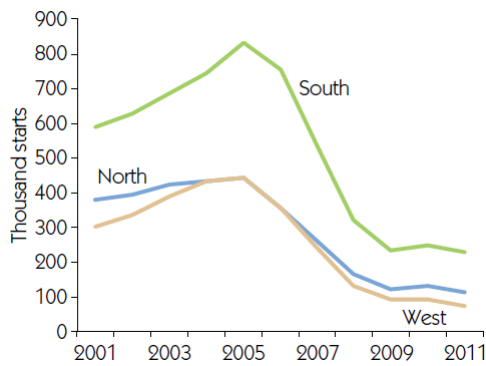


Figure 9. Single-family housing starts, 2001–2011

The fall in construction, coupled with the movement of furniture production to other countries, contributed to sharp declines in output of solid wood products. Meanwhile, the globalization of manufacturing and expanded use of electronic communications hastened a decline in U.S. pulp, paper, and paperboard output. Job losses in forestry and related economic sectors exceeded 1 million, or nearly 9 percent of all recession-related unemployment. Further fallout came with the closures—some temporary, many permanent—of nearly 1,000 wood-processing mills.

Lumber production. During the collapse in the housing market, lumber production hit its lowest level since 1981, 5.1 billion cubic feet (30 billion board feet equivalent), a floor not seen since the 1950s. As Figure 10 shows, a milder recession affected this sector in the early 1980s.

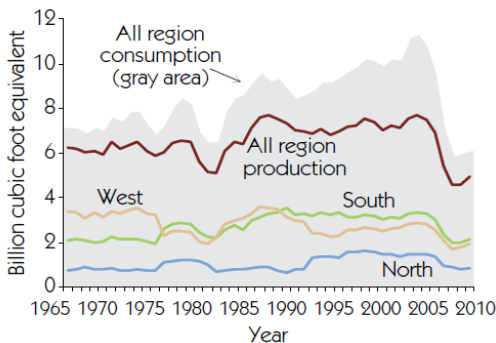


Figure 10. Lumber production and consumption, by region, 1965–2011

Solid wood and paper. Demand for U.S. solid wood and paper products is met by both domestic harvests and importation of roundwood, plus recycled paper and solid wood products

(Figure 11). Since the early 1990s, roundwood harvest for export has declined and roundwood equivalent of imports has increased. Domestic roundwood harvest increased from 1950 through the mid-1980s, peaking at 15.6 billion cubic feet in 1989. It remained at that level until the economic downturn, when it declined to 10.5 billion cubic feet. During the initial stages of the recovery, roundwood harvest increased to 11.1 billion cubic feet.

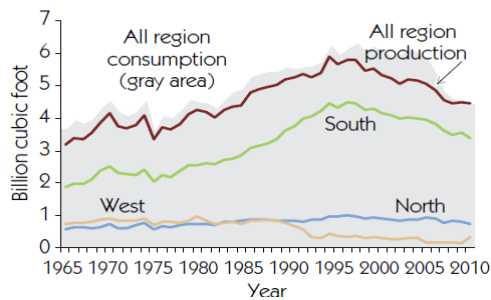


Figure 11. Pulpwood production and consumption, by region, 1965–2011

Consumption, imports, and exports. Per capita consumption of wood and paper products in 2011 was 907 pounds per year, down from 1,480 in 2006. In addition, 157 pounds of fuelwood per capita was consumed in 2011, down 20 percent from 2006. Net imports into the United States increased, from slightly more than 1 billion cubic feet in 1965 to 4.2 billion cubic feet in 2005, before dropping 90 percent to 400 million cubic feet in 2011. This large decline was mostly the result of the economic recession that started in 2006. In 2005, domestic timber harvests satisfied 69 percent of the nation’s wood needs. By 2011, that number increased to 79 percent while imports declined relatively to total consumption (Figure 12).

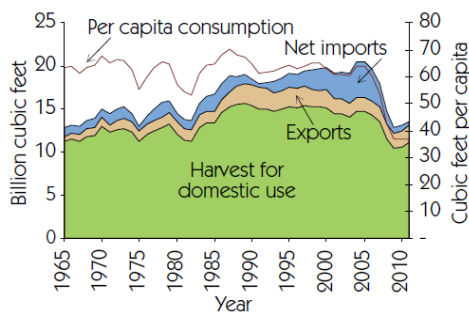


Figure 12. Roundwood consumption and trade, 1965–2011

Urban areas

The area of urban land has increased over the past 30 years, from 2.5 percent of the total land area in 1990 to 3.6 percent in 2010. Urban expansion affects both agricultural land and forestland. Nationally, urban areas (defined as more than 500 people per square mile) have an average tree cover of 35 percent (Nowak and Greenfield 2012).

Summary and conclusions

Although the area of forest in the United States has been remarkably stable since the 1880s, the distribution of forests across the country has seen many changes. Croplands were abandoned and regenerated naturally to trees, and urban areas expanded into forested areas. Yet the net effect on total forest area has been minimal.

Since 1950, stand age, average tree size, and growing-stock volume have changed substantially. Altogether, the average forest has older, larger trees than it did 60 years ago, and in these older forests, trees are beginning to compete for light and water, becoming increasingly less vigorous and more susceptible to changes in weather patterns and pest outbreaks. While pests and fires are widespread in some areas, other areas are little affected.

The forest products sector suffered its worst shock since the 1930s in the recent home mortgage crisis and subsequent Great Recession. The lumber and pulpwood industries suffered significantly, and although the lumber industry has begun to recover, the pulpwood industry has not. Further, shifts in the communications industry, once the bread and butter of American pulp and paper producers, now favor paper produced from trees not native to the United States, such as eucalyptus. This is driving the pulp and paper industry to explore new, high-value products that can be manufactured from homegrown fiber. Imports are down 90 percent since 2005, affecting several U.S. trading partners, especially Canada. That country is also working hard to create new, high-value products for global export, because exports are very important to a country with a small domestic market.

—Richard Guldin

Senior Research Fellow, Society of American Foresters

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