United States
Department of
Agriculture

Forest Service

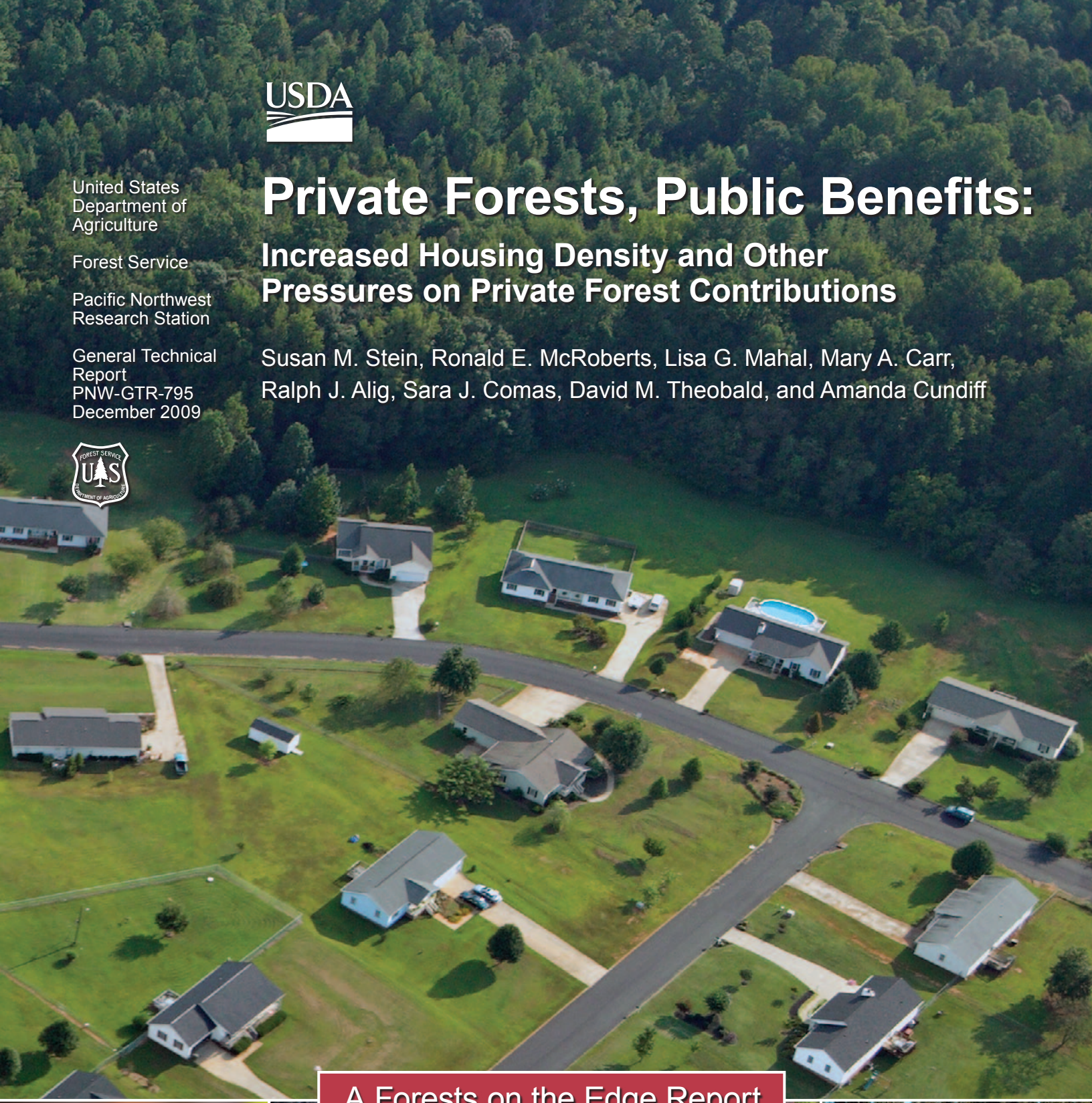
Pacific Northwest
Research Station

General Technical
Report
PNW-GTR-795
December 2009

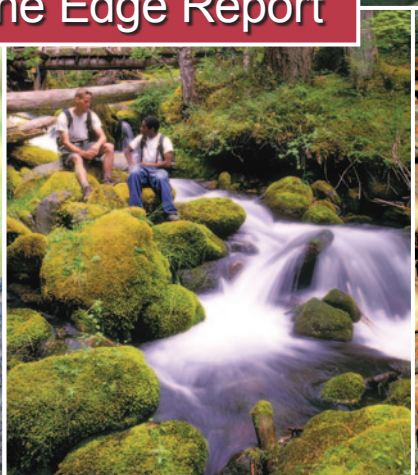
Private Forests, Public Benefits:

Increased Housing Density and Other Pressures on Private Forest Contributions

Susan M. Stein, Ronald E. McRoberts, Lisa G. Mahal, Mary A. Carr,
Ralph J. Alig, Sara J. Comas, David M. Theobald, and Amanda Cundiff



A Forests on the Edge Report



The Forest Service of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Authors

Susan M. Stein is a private forest-land studies coordinator, **Sara J. Comas** is a natural resource specialist, and **Amanda Cundiff** is an ecosystem services specialist, U.S. Department of Agriculture, Forest Service, Cooperative Forestry Staff, Mailstop 1123, 1400 Independence Avenue SW, Washington, DC 20250-1123. **Ronald E. McRoberts** is a mathematical statistician, U.S. Department of Agriculture, Forest Service, Northern Research Station, 1992 Folwell Avenue, St. Paul, MN 55108. **Lisa G. Mahal** is a computer systems analyst, University of Nevada, Las Vegas, 1992 Folwell Avenue, St. Paul, MN 55108. **Mary A. Carr** is a technical publications editor, U.S. Department of Agriculture, Forest Service, Ecosystem Management Coordination Publishing Arts, 1835 Black Lake Boulevard SW, Olympia, WA 98512. **Ralph J. Alig** is a research forester, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331. **David M. Theobald** is a research scientist, Colorado State University, Natural Resource Ecology Laboratory, Fort Collins, CO 80523-1499.

Cover photos: (top) housing development, ©Harrison Shull, Aurora Photos; (bottom) red trillium ©Hamiza Bakirci, iStockPhoto.com; red squirrel, Michael Mengak, University of Georgia, Bugwood.org; Oregon hikers, Tom Iraci; logs, U.S. Forest Service.

Back cover photos: Key deer (*Odocoileus virginianus clavium*), U.S. Fish and Wildlife Service; chanterelle mushrooms, U.S. Forest Service.

Abstract

Stein, Susan M.; McRoberts, Ronald E.; Mahal, Lisa G.; Carr, Mary A.; Alig, Ralph J.; Comas, Sara J.; Theobald, David M.; Cundiff, Amanda. 2009. Private forests, public benefits: increased housing density and other pressures on private forest contributions. Gen. Tech. Rep. PNW-GTR-795. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 74 p.

Over half (56 percent) of America's forests are privately owned and managed and provide a vast array of public goods and services, such as clean water, timber, wildlife habitat, and recreational opportunities. These important public benefits are being affected by increased housing density in urban as well as rural areas across the country. The Forests on the Edge project, sponsored by the U.S. Department of Agriculture, Forest Service, seeks to improve our understanding of where across the country housing density increases, as well as other threats, might affect these critical goods and services. For this study, we map and rank watersheds across the conterminous United States to analyze the relative contributions of private forest land to water quality, timber volume, at-risk species habitat, and interior forest. In addition, we rank watersheds according to the pressures on private forest contributions from increased housing density, wildfire, insect pests and diseases, and air pollution. Results indicate that private forest land contributions to forest cover, clean water, and timber volume are greatest in the East, but are also important in many Western watersheds. Private forests making substantial contributions to interior forest and at-risk species are more uniformly distributed across the country. Development pressures on these contributions are concentrated in the Eastern United States but are also found in the north-central region, parts of the West and Southwest, and the Pacific Northwest; nationwide, more than 57 million acres of rural forest land are projected to experience a substantial increase in housing density from 2000 to 2030. Private forests in both the Eastern and Western United States are under pressure from insect pests and diseases. The bulk of private forests most susceptible to wildfire are located in the West and parts of the Southeast. Lastly, ozone pollution affecting private forests is localized in California and several areas of the East.

Keywords: Private forest, housing density, ecosystem services, water quality, at-risk species, interior forest, wildfire, insect pests, diseases, ozone.

Contents

1 **Introduction**

3 America's Private Forests

4 Private Forest Owners

6 Forest Ownership Changes

8 Assessing Housing Density Increases and Other Pressures on Private Forest Contributions

12 **Private Forest Benefits and Housing Density Increases**

16 Water Quality

20 Timber Volume

24 Habitats for At-Risk Species

28 Interior Forests

33 **Additional Pressures**

34 Insect Pests and Diseases

40 Wildfire

46 Air Pollution

51 **Summary and Conclusions**

53 Acknowledgments

54 Metric Equivalents

54 References

66 **Appendix**

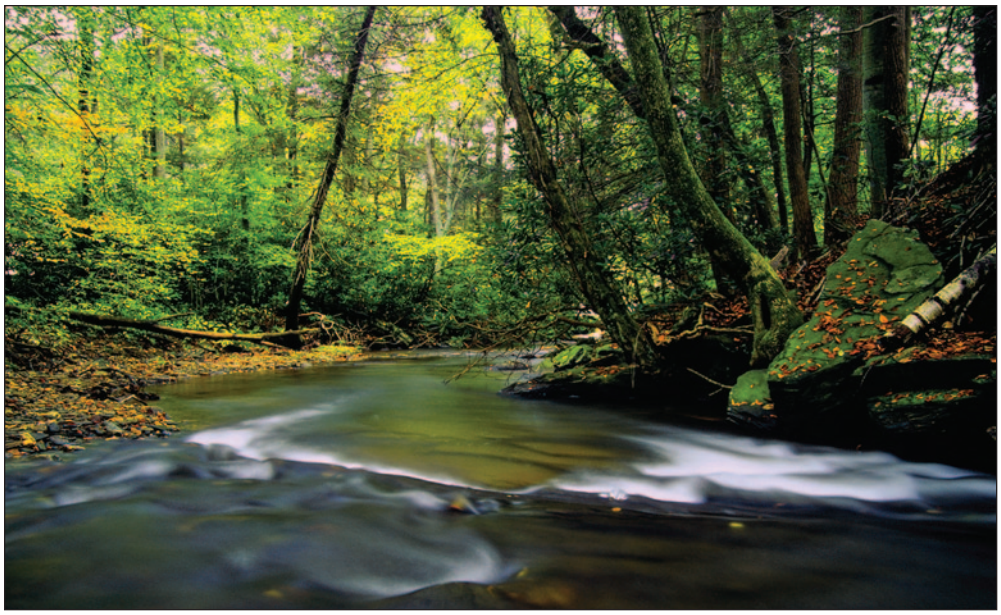
66 Methodology

67 Private Forest Contributions

70 Threats to Private Forest Lands

73 Sensitivity Analyses

Introduction



Annette Wiechmann, ©iStockphoto.com

AMERICA'S FOREST LANDS provide a wealth of goods and services to the public—from helping ensure clean water and abundant forest products, to providing wildlife habitat, open spaces, and opportunities for outdoor recreation and education. Private forest contributions to these goods and services can be affected by increased housing density. Additional threats, such as fire and forest pests, can further exacerbate the effects of increased housing density. Although the focus of this report is on increased housing density, housing density increases are typically associated with additional development, including increases in related infrastructure, such as roads and other transportation networks, which also have environmental impacts. In fact, in some urban areas, a 10-percent increase in population growth can, in certain periods, lead to a 40- to 60-percent increase in urban land cover (Daniels 1999).

America's private forests provide many public benefits, including clean water.

This report is one of several produced by the U.S. Department of Agriculture, Forest Service as part of the Forests on the Edge project. It displays and describes information at a national level that can improve understanding of forest land development issues and can help answer such questions as:

- Where, nationwide, do private forests make substantial contributions to clean water, timber volume, habitat for at-risk plant and animal species, or interior forest?
- Where are these contributions likely to change because of increased housing density in rural private forests? Our use of term "increased housing density" refers to a very specific change in housing density such that land shifts out of a rural housing density category to a higher density category (see page 9).

- Where is change from increased housing density likely to be exacerbated by other factors such as insect pests and diseases, wildfire, or air pollution?
- Where are private forest lands that are making the most important contributions also facing the greatest pressures?

© Jerry and Marcy Monkman/EcoPhotography.com

We analyzed selected contributions and pressures for which nationally consistent data were available. The pressures analyzed represent only a sampling of the numerous factors that affect private forests across the country. Similar to other Forests on the Edge reports and other national assessments, our findings may not completely capture changes at all scales or in specific watersheds.

The data are analyzed by watershed—an area of land that drains into a river, stream, or other body of water—to emphasize the vital connection between private forests and clean water. Summarizing detailed data by a larger entity such as a watershed also is a useful way to organize and communicate our results.

The first section of this report focuses on identifying areas where contributions provided by private forests could be affected by increased housing density.

About the Forests on the Edge Project

SPONSORED BY the State and Private Forestry, Cooperative Forestry staff of the USDA Forest Service, in cooperation with Forest Service Research and Development, the Forests on the Edge project uses data prepared and analyzed by scientists across the country to increase understanding of the many public benefits derived from private forests and of the pressures that might affect these benefits.

The Forests on the Edge project is one of several efforts to assess the status, condition, and trends of forests across the United States. The number, scope, and complexity of these efforts reflect the critical importance of conserving and maintaining global forest resources. Major efforts include work by the Forest Service Eastern and Western Wildland Threat Centers (USDA FS, n.d.); Resource Planning Act assessments (USDA Forest Service 2007b); national work in climate change and policy analysis; and international guidelines for sustainable forest management such as the United Nations Framework Convention on Climate Change (http://unfccc.int/2860.php), the Montréal Process (criteria and indicators) (http://www.rinya.maff.go.jp/mpci/), and the Ministerial Conference on the Protection of Forests in Europe (MCPFE) (http://www.mcpfe.org/) .

Chris Evans, River to River CWMA, Bugwood.org

Following this, we identify areas where the detrimental effects of increased housing density may be compounded by or may intensify the effects of additional pressures from insects and diseases, wildfire, and ozone pollution. An appendix provides details on methods used in each assessment.

Additional maps can be found on the Forests on the Edge Web site (http://www.fs.fed.us/openspace/fote), including completed maps and digital data that can be used to make individualized maps showing various combinations of layers.

America's Private Forests

About 56 percent, more than 420 million acres, of America's forests are privately owned (Smith et al. 2004) (fig. 1). About three-quarters of these private forests are located in the Eastern United States, but ecologically valuable private forest lands are also found in the West, where some of the fastest population growth in the country is taking place.

Fifty-six percent of U.S. forests are privately owned.

For the purpose of this study, we define forest as land with at least 25 percent tree crown cover from trees that are greater than 20 feet tall. We chose this definition because it is the one used by the U.S. Geological Survey (USGS) in creating the forest cover data used for this report (see "About the National Land Cover Data" on page 5).

Private forest is forest land owned by individuals, families, corporations, organizations, tribes, or the forest industry. Public lands—that is, lands owned by federal, state, or local governments—were not included in this study because they are not typically available for development.

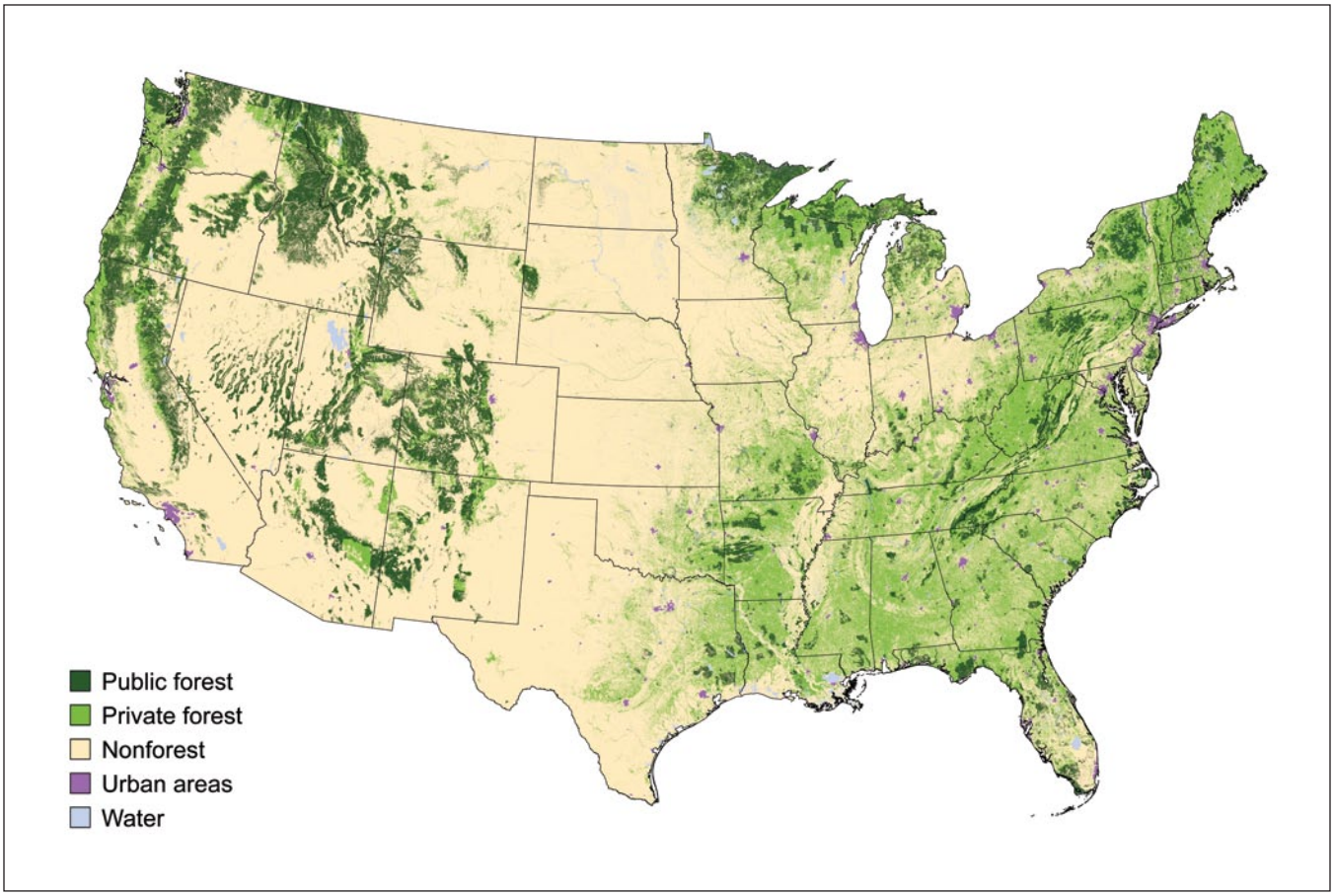


Figure 1—Location of private and public forest, nonforest, and urban areas. About three-quarters of America's private forests are in the East.

Private forests play a key role in protecting water quality, furnishing diverse habitats for fish and wildlife, providing the raw materials for timber products and other forest goods or services, and sustaining valuable ecological functions across the landscape such as flood and climate regulation (see sidebar on page 6). These benefits are often characterized as ecosystem goods or services and are subject to alteration because of housing development and environmental pressures.

Private Forest Owners

America's private forests are owned and managed by approximately 11 million private landowners, most of whom (close to 8 million landowners) have relatively small holdings of fewer than 50 acres each (Butler 2008). A quarter of private forest land acres are owned by corporations, other private organizations, and individuals who have large holdings of 5,000 acres or more (fig. 2).

About the National Land Cover Data

© Jerry and Marcy Monkman

THE 2001 NATIONAL Land Cover Data (NLCD) database was recently released and forms the basis for our forest cover layer (Homer et al. 2007). The NLCD database provides 21 land cover classes from Landsat satellite imagery and ancillary data for the conterminous 48 states (also referred to as the "Lower 48"). The detailed data are widely used for an array of applications including national environmental reporting, climate change investigations, clean water studies, and biodiversity and conservation assessments. This Forests on the Edge report uses three categories of forest vegetation as defined by the NLCD:

- **Deciduous forest**—Areas dominated by trees where 75 percent or more of the trees shed foliage in response to seasonal change.
- **Evergreen forest**—Areas dominated by trees where 75 percent or more of the trees retain their leaves all year.
- **Mixed forest**—Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

—Sources: Homer et al. 2007; USGS, n.d.; US EPA, n.d.

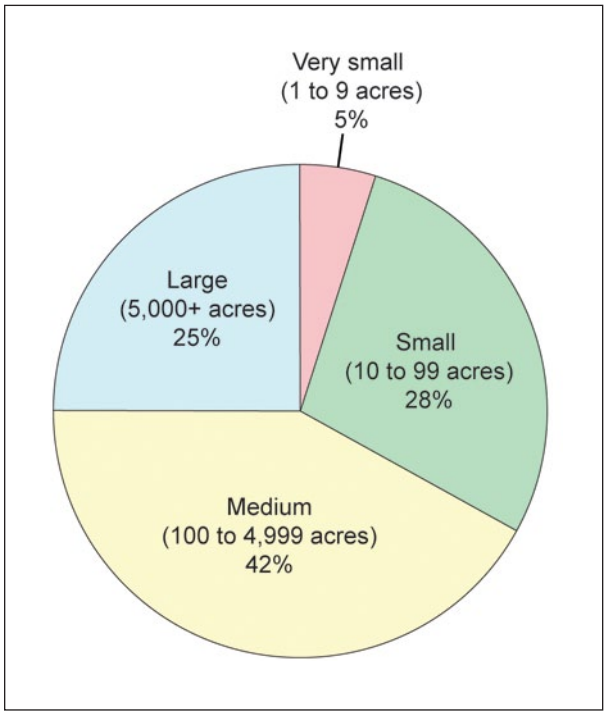


Figure 2—Percentage of private forest acres by parcel size. Source: Butler (2008).

Private landowners are key stewards of our forests, but costs for conserving and maintaining their forests can be high. Private forest landowners in many parts of the country are under pressure to sell their land for development or other uses (Alig 2007). The Forest Service and other agencies and organizations are working to find market-based approaches that provide landowners with economic incentives to retain and conserve these lands. More information on ecosystem services can be found at http://www.fs.fed.us/ecosystemservices.

Forest Ownership Changes

Millions of acres of large tracts of private forest once owned by traditional forest industry companies have been sold since the mid-1990s, owing in part to changes in tax codes, shifts in forest land market values, and business decisions (Butler 2008). The South has seen the most substantial changes—of the 23 million acres of industrial timberland sold in the United States from 2000 through 2004, approximately 18 million were in the South—but such transactions have also occurred in major timber-growing regions elsewhere in the country (Clutter et al. 2005). In northern Maine, for example, industrial landowners have subdivided and sold most of their timberland properties; one timber industry firm alone transferred 2.3 million acres to 15 owners during and since the 1990s (LeVert et al. 2008). Such a change in ownership patterns—where larger forested tracts are divided into multiple parcels owned by several owners—is known as parcelization.

David Cappaert, Michigan State University, Bugwood.org

Forests and Climate Change

FORESTS SEQUESTER (store) carbon and thereby help to reduce the amount of carbon dioxide (CO_2) in the atmosphere. Carbon dioxide is a greenhouse gas that enters the atmosphere from the burning of fossil fuels, solid waste, trees, and wood products, and also as a result of other chemical reactions. The U.S. Environmental Protection Agency (US EPA 2009b) defines a greenhouse gas as "any gas that absorbs infrared radiation in the atmosphere," such as CO_2, water vapor, methane (CH_4), and nitrous oxide (N_2O). Greenhouse gases lead to the greenhouse effect, in which heat is trapped and accumulated in the atmosphere near the Earth's surface. This in turn leads to global warming, which EPA defines as "an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns." United States forests currently sequester about 10 percent of U.S. carbon emissions (Woodbury et al. 2007). Therefore, the maintenance and proper management of private forests are critical to mitigating greenhouse gas emissions and global climate change.

Gordon Bradley, University of Washington

The impact of industry sales on forest parcelization is being studied but may not be completely understood for decades. Much of this land has been sold to institutional investors whose objective is to turn a profit in a shorter period than that pursued by traditional industrial owners. Although many timberlands sold do continue to be managed for timber production, changing ownership has led to and will likely continue to lead to the sale of some commercial timberland for real estate purposes (Clutter et al. 2005, Mendell et al. 2005). In Minnesota, for example, timber and mining industry landowners are selling thousands of acres to financial investors who value both large and small forest parcels in part for their potential to be subdivided and sold for real estate development (Johnson and Stone 2008).

Turnover in land ownership can lead to forest parcelization.

Accelerated changes in the ownership of smaller tracts that are **not** owned by forest industry or institutional investors are also likely to occur in coming decades as an aging generation of owners disposes of or transfers landholdings. More than 60 percent of current private forest landowners are age 55 or older and own a total of 170 million acres of private forest. More than 15 percent of private forest land

owners are age 75 or older and own about 52 million acres of forest (Butler 2008). Although many of these older generations own land for reasons largely unrelated to finances, these owners or their heirs may be compelled to subdivide and sell their property if confronted by daunting economic and social challenges (Butler 2008).

Susan Stein

Smaller, more fragmented (or disconnected) parcels can lead to a host of changes in water quality and aquatic species diversity, timber volume and management, native wildlife populations, forest structure and function, wildfire risk, and scenic quality and recreational opportunities (Sampson and Decoster 2000, Smail and Lewis 2009, Stein et al. 2005). The size of forest holdings is also highly correlated with behaviors and attitudes of forest owners, such as their management objectives, plans to transfer the property to others, and willingness to prepare forest management plans (Butler 2008).

Assessing Housing Density Increases and Other Pressures on Private Forest Contributions

To assess the potential for increased housing density and other factors that affect private forests, nationally consistent data layers were constructed and then summarized at the spatial scale of 4th-level watersheds (see "What Is a Watershed?" below) (Steeves and Nebert 1994). Only watersheds with at least 10 percent forest cover and containing at least 10,000 acres of private forest were considered for the study (fig. 3).

Lynn Betts, USDA Natural Resources Conservation Service

What Is a Watershed?

A WATERSHED generally is an area of land that catches rainfall and other precipitation and funnels it into a network of marshes, streams, rivers, lakes, soils, or groundwater. Watersheds also are specific hydrological units defined by the U.S. Geological Survey. The 2,108 fourth-level (also known as 8-digit) watersheds in the conterminous United States average approximately 1 million acres in size but range from approximately 22,000 acres to approximately 13 million acres.

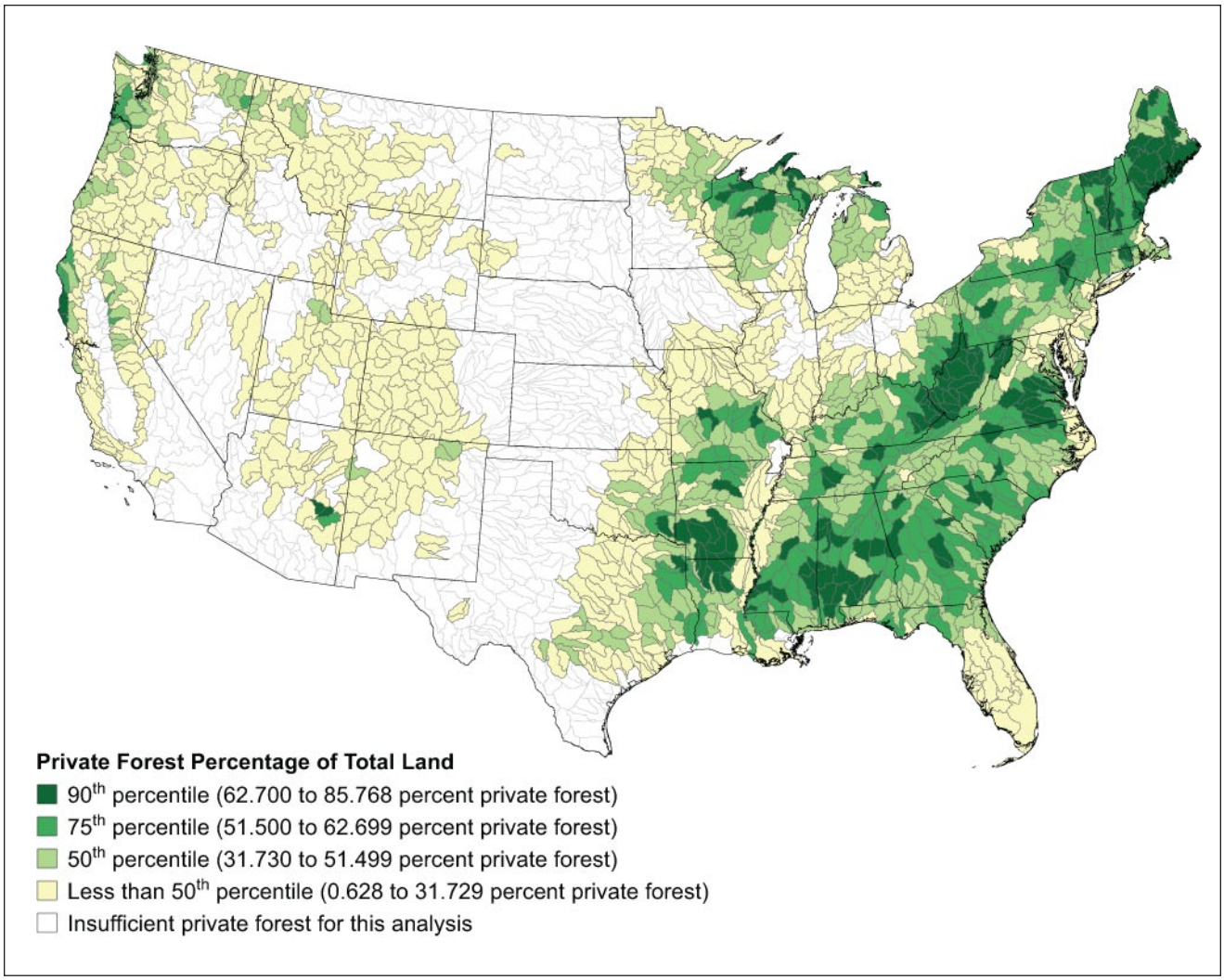


Figure 3—Watersheds by percentage of private forest cover. This map displays watersheds according to the percentage of each watershed containing private forest land. The highest ranked watersheds are found in the East and are concentrated in Maine, Vermont, West Virginia, Arkansas, and Alabama. Most of West Virginia's watersheds are also ranked in the 90th percentile.

As in previous Forests on the Edge studies, increased housing density here refers to a projected increase in housing density between 2000 and 2030—that is, an increased number of housing units per unit area on rural lands such that the housing density category would shift to a higher-level category (Stein et al. 2005, 2007; Theobald 2005). **Rural I** lands are defined as those with fewer than 16 housing units per square mile; **rural II** refers to lands with 16 to 64 housing units per square mile; and **exurban/urban** lands support more than 64 housing units per square mile. Housing density projections are based on several factors including past and current statistics on housing density and population, past growth patterns, road densities, and locations of urban areas (Theobald 2005). Our housing density projections excluded

Faces of Private Forest Owners

Bill Hull

This northern hardwood, hemlock, and oak forest owned by Hull Forest Products has extensive frontage on the federally designated "wild and scenic" Westfield River in Huntington, Massachusetts. Owner Bill Hull has used a variety of options to protect and manage the land as working forest.

"You Can't Make a Living Growing Trees in New England Anymore."

Bill Hull bought his first woodlot—12 acres of hardwoods—when he was 15 years old. Over time he created the largest and most progressive hardwood sawmill in southern New England and founded two family-owned forest products and resources companies. Hull aims to conserve working forest lands and to help preserve New England-style communities. To that end he placed the 12,000 acres of company lands in two states under conservation easements, thus protecting them from development and increasing the funds he has available to conserve more land. He also created a limited partnership to assure that the companies he established will continue, even if his children choose not to continue in the family business. Management of the Hull forests meets the Forest Stewardship Council's (FSC) management standard as certified by the FSC-accredited auditing firm, SmartWood.

Stating that "you can't make a living growing trees in New England anymore," Mr. Hull has found other ways to supplement his income and hold onto the land—such as offering recreational leases to private groups who use the properties for activities ranging from hunting and fishing to hiking, stargazing, and pure enjoyment of nature.

Primary threats facing the Hull forest properties include development and fragmentation related to increasing human population growth in the region. Countless brochures arrive from real estate companies as far away as California urging Mr. Hull to "cash in" on his land. Trespass and unauthorized all-terrain vehicle (ATV) use are related problems, resulting in substantial road damage and increased maintenance costs.

lands recorded in a national database as being protected from development by conservation easements (CBI 2007, DellaSalla et al. 2001, Theobald 2007).

For each data layer analyzed (for example, water quality, at-risk-species, increased housing density, or fire) a percentile ranking was assigned to each watershed. For example, watersheds in which private forests provide habitat for the greatest number of at-risk species fall in the highest (90th percentile) category, whereas watersheds containing the fewest at-risk species fall in the low (0 to 50th percentile) category.

To identify areas where contributions might be most likely to decline as a result of future increases in housing density, we re-ranked each watershed according to the average of the percentile categories of the two layers. For example, if a watershed was in the 96th percentile for at-risk species and the 82nd percentile for housing density increase, it would be placed in the 89th percentile for at-risk species and housing density increase.

White watersheds on each map represent areas that did not meet this study's screening criteria (10 percent forested with at least 10,000 acres of private forest). This does not mean that private forest holdings in these watersheds are not important; the white areas may actually contain small acreages of private forests of high local significance. Several maps contain white watersheds with cross-hatches. These are watersheds for which there were no data for that layer.

For a brief description of data constraints, see "Data and Analysis Considerations" on page 15. A description of how each data layer was constructed is provided in the appendix and in Stein et al. (in press). Data used to create these maps represent more up-to-date information than was available for previous Forests on the Edge papers and studies.

See the appendix for a detailed description of the methods used to make the maps in this section.

Faces of Private Forest Owners

Sandy LeTourneaux

Jim LeTourneux and his family derive a living and a lifestyle from their forest.

An Unclear Future

More than 40 years ago, **Jim Letourneux** bought the Oregon land his parents had acquired when he was a child, becoming owner of 400 acres that he and his wife Sandy now manage as the Tripletree LLC timber farm. LeTourneux family members raise trees that will become saw logs and poles, and they also enjoy the property for recreation. They take pleasure in the long-term goals and aspirations that go along with growing trees that can take decades to reach their full potential.

Some of their neighbors have begun to file claims to subdivide their land into small lots, where homes will be built on what has been private forest land for generations. The impending development and wildfire danger—which Mr. LeTourneux believes go hand-in-hand—are the main pressures on the LeTourneux property today, along with invasive species.

Although their sons are not interested in owning and running a farm, Jim and Sandy LeTourneux don't want their land partitioned—a goal that may be difficult to achieve in the face of the development trend around them.

Go to Part 2