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SOUTHERN FORESTS FOR THE FUTURE



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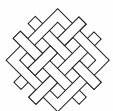
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TOYOTA

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Foreword

The forests of the southern United States are a vital natural asset for the region, the country, and the world. Among the most diverse temperate forests on earth, they provide many economic, social, and environmental benefits or “ecosystem services,” some with impacts far beyond U.S. borders.

The importance of these ecosystem services to human well-being is arguably higher now than at any time in history.

At a time when the world is concerned about climate change, southern forests are part of the answer. Comprising approximately 29 percent of the nation’s forested land, southern forests store vast amounts of carbon. In 2007, U.S. forests absorbed carbon dioxide, the leading greenhouse gas, equivalent to 13 percent of gross national greenhouse gas emissions. If southern forests recede, then the nation’s carbon sink will shrink.

At a time when we are concerned about freshwater in the South, southern forests are part of the answer. Forests recharge groundwater supplies, maintain base-flow stream levels, and lower peak flows during heavy rainfall. In addition, they prevent pollution and sediment from entering streams, lakes, and groundwater.

At a time when we are concerned about the economy and jobs, southern forests are once again part of the answer. By supplying timber for construction, pulpwood for paper, and numerous recreational opportunities, southern forests support hundreds of thousands of jobs throughout the region and are a valuable asset for millions of family forest owners.

The long-term extent and health of southern forests, however, face a number of challenges. Climate change, invasive species, and pest and pathogen outbreaks threaten to alter forest composition. Millions of forested acres in the region were lost during the suburbanization boom of the 1990s, and suburban encroachment is projected to continue reducing and fragmenting forest acreage. When the U.S. economy recovers, decoupling new housing development from forest clearance will be an important challenge to address.

Southern Forests for the Future seeks to raise awareness about this important resource and heritage. It introduces readers to the forests of the southern United States, providing data, maps, and other information about their distribution and make-up, condition, and trends. It explores questions such as: Why are southern forests important? What is their history? What factors are likely to impact the quantity and quality of these forests going forward? What measures might help ensure that southern forests continue to provide their myriad benefits over coming decades?



PHOTO: QUANTUM PHYSICS, FLICKR

This publication is designed to serve as a resource for conservation organizations, concerned citizens, landowners, and academic institutions, among others. It accompanies and supports an internet-based information portal, www.SeeSouthernForests.org. Developed by WRI, this interactive site provides a wide range of information about southern forests, including current and historic satellite images that allow users to zoom in on areas of interest, overlay maps showing selected forest features and drivers of change, historic forest photos, and case studies of innovative approaches for sustaining forests in the region.

Southern Forests for the Future and www.SeeSouthernForests.org are the first steps of a multiyear project launched by the World Resources Institute (WRI) that seeks to increase the acreage of southern U.S. forests that is conserved or sustainably managed to provide a suite of ecosystem services. Working with partners, WRI seeks to raise awareness about southern forests, their benefits to people, and the challenges they face; develop a portfolio of options that align economic incentives with forest stewardship; and pilot test and roll out the most promising incentives.

Through these activities, WRI’s aspiration is to inform, inspire, and empower citizens, forest owners, and others to ensure southern forests for the future.

Jonathan Lash

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PHOTO: CHUCK BARGERON, UNIVERSITY OF GEORGIA, BUGWOOD.ORG

TOYOTA

Summary

Stretching from Texas across to Virginia and from Kentucky down to Florida, the forests of the southern United States are a vast global, national, and local natural treasure. They provide a variety of benefits or “ecosystem services.” For instance, southern forests yield 18 percent of the world’s pulpwood for paper while comprising just two percent of the world’s forest area. They protect water quality, prevent erosion, and help regulate climate by storing carbon dioxide—the leading greenhouse gas. In addition, they provide opportunities for millions of people to hike, hunt, and experience natural beauty.

Southern forests are dynamic and have a long history of change. Prior to European colonization, these forests were shaped by natural disturbances such as climatic warming after the last ice age, hurricanes, and lightning-induced fires, as well as by fires set by Native Americans. Beginning in the 1600s, agriculture, timber extraction, and settlements built by Europeans and their descendants gradually spread across the region, affecting the extent, distribution, and composition of southern forests. Over four centuries, more than 99 percent of southern forest acreage was cut or cleared at one time or another as the region was developed. Much of the land regenerated over time as secondary forest, demonstrating the resiliency of forests. Yet the net extent of southern forests has declined by an estimated 40 percent since the dawn of European settlement.

A number of factors or “drivers of change” are projected to affect the quantity (extent and distribution) and quality (composition and health) of southern forests over the coming 2–3 decades, with some increasing and others decreasing forest quantity or quality. For example:

- Suburban residential and commercial development is projected to convert 19 million acres of forest between 2020 and 2040 and increase forest fragmentation.
- In some areas of the South, forest extent may expand as agricultural land reverts back into forest, but this trend will not sufficiently offset forest loss due to development.
- Climate change may have a number of impacts, including shifting the distribution of some plant and animal species, increasing invasive species threats, inundating low-lying coastal forests, intensifying droughts, and exacerbating wildfire dangers.
- Wildfires remain a risk as a consequence of decades of suppressing natural, low-intensity fires.
- Outbreaks of pests and pathogens—such as the gypsy moth, hemlock woolly adelgid, sirenix wood wasp, butternut canker, emerald ash borer, laurel wilt of redbay, and many more—will affect numerous types of trees—such as oak, hemlock, pine, butternut, and ash—and may alter forest species composition.

- Invasive species—such as cogon grass and Japanese stiltgrass—threaten to crowd out native species, alter natural ecosystem processes, and increase wildfire risk.

Going forward, these drivers of change will likely impact the ability of southern forests to continue to provide a full range of ecosystem services. How landowners, businesses, conservation organizations, governments, and citizens respond and adapt to these and other drivers ultimately will shape southern forests for the future.

Approximately 87 percent of southern forest acreage is privately owned. Of this amount, about two-thirds is held by individuals and families. The future of southern forests thus rests largely in the hands of private landowners. Given the entailed forgone revenue, creating protected areas out of their forests may not be a viable option for many of these landowners. However, a number of measures exist or are beginning to emerge that could create incentives for private forest owners to conserve and sustainably manage their forests. These measures include:

- Land use instruments such as conservation easements, development offsets, and transferable development rights;
- Fiscal measures such as forest management-related and conservation-related cost-share programs and incentives;
- Liability limitations such as legal assurances and the “right to prescribed burns”;
- Market incentives such as markets for sustainably harvested timber and paper, payments for carbon sequestration, payments for watershed protection, and recreational user fees; and
- Increased education and capacity building.

However, so far the performance of many of these measures has been mixed. For instance:

- Despite being already available, some of these measures are currently undersubscribed in the region;
- Awareness of some measures is low;
- Some of the market incentives, especially payments for ecosystem services such as carbon sequestration and watershed protection, are just emerging and therefore are relatively novel for most forest owners;
- The region lacks a sufficient number of pilot projects utilizing these incentives to raise awareness, stimulate adoption, and facilitate continuous improvement of incentive design; and
- Some measures, such as voluntary development offsets or transferable development rights, have been piloted in a few locations but have yet to be scaled up.



PHOTO: BEN BLANKENBURG, 2007. ISTOCKPHOTO

These observations lead to a number of questions, including:

- Which of these incentives and measures show the greatest promise for sustaining southern forests and their ecosystem services?
- What are the barriers southern forest owners face that limit utilization of these measures? How can these barriers be addressed?
- How can emerging incentives be piloted in the region to demonstrate effectiveness and refine incentive design?
- How can incentives that have successfully been piloted in a few instances in the region be scaled up?
- What other innovative incentives for sustaining forest ecosystem services are being pioneered elsewhere that could be replicated in the South?
- How can awareness of these incentives and outreach be improved?

Southern Forests for the Future sets the stage for addressing these and related questions by introducing readers to the forests of the southern United States. It provides data, maps, and other forms of information about southern forests, their condition, and trends. In particular, this publication:

- Maps many of the natural features of southern forests, including extent and species composition;
- Describes and, where possible, quantifies a range of ecosystem services that these forests provide to people, communities, and businesses at the local, regional, and global levels;

- Provides a brief history of southern forests and the forces that shaped them;
- Profiles the factors that will likely affect southern forest extent, distribution, composition, and health over the coming decades; and
- Outlines a number of markets, incentives, and practices that might help ensure southern forests continue to provide a full range of ecosystem services into the future. Although public policies have an important role to play in sustaining southern forests, this publication focuses on non-policy measures.

Southern Forests for the Future is designed to serve as a resource for conservation organizations, concerned citizens, landowners, academic institutions, the private sector, government agencies, and others involved with forest stewardship. Additional information and resources are available at www.SeeSouthernForests.org, an online interactive information portal developed by the World Resources Institute (WRI). The site includes satellite imagery of southern forests, detailed interactive maps on forest features and drivers of change, case studies, historical photos, and other data. With this information publicly available, WRI aspires to raise awareness of the importance of these forests and help empower stakeholders to implement innovative measures that will ensure southern forests for the future.

Definitions of Key Terms

Biodiversity is the variability among living organisms within species, between species, and between ecosystems.

Broadleaf plants have relatively broad rather than needle-like or scale-like leaves. Examples of broadleaf trees in the South include maples, oaks, hickories, and gums. Most broadleaf trees are also deciduous—they lose their leaves in winter—but there are exceptions, such as the live oak, which keeps its leaves virtually throughout the year, shedding them only immediately prior to leaf-out in the spring.

Carbon dioxide equivalent is the universal unit of measurement used to indicate the global warming potential of greenhouse gases.

Carbon sequestration is the uptake and storage of carbon dioxide. It can occur in forest plants, plant roots, and soil.

A **conifer** is a tree that bears its seeds in cones and has needle-like leaves. Examples of coniferous trees in the South are loblolly and longleaf pine, red cedar, hemlock, and balsam fir. Typically, coniferous trees are also evergreen—they keep their leaves year-round—although some species of coniferous trees, such as the bald cypress, lose their leaves in the winter.

Conversion refers to the transformation of land cover from one type to another; for example, from forest to row crops.

A **cubic foot** is the volume of a cube with sides of one foot (0.3048 meter) in length.

Deciduous trees lose all of their leaves at the end of the growing season for the winter, and grow new leaves in the spring. In the South, most deciduous trees are also broadleaf trees, such as oaks, maples, hickories, and gums. One coniferous species that is also deciduous is the bald cypress.

Direct drivers are factors—natural or human-induced—that cause changes in an ecosystem and affect its ability to supply ecosystem services. Direct drivers include changes in land use or land cover, overconsumption of an ecosystem's services, climate change, pollution, and invasive species.

An **ecosystem** is a dynamic complex of communities of plants, animals, and other organisms interacting with their non-living environment as a functional unit. Examples of ecosystems include deserts, coral reefs, wetlands, rain forests, temperate forests, grasslands, urban parks, and cultivated farmlands. Ecosystems can be relatively undisturbed by people, such as virgin rain forests, or can be extensively modified by human activity, such as farms.

Endemism is the ecological state of being indigenous (native) to a particular restricted geographic location. A species that is endemic to a place is found only in that area.

Evergreen trees have leaves that persist year round, staying green throughout the winter. Most evergreen trees in the South are also coniferous, such as cedars, pines, and firs. In the deep South, some broadleaf trees, such as the live oak, are also evergreen.

Fragmentation is the process by which a large expanse of habitat is transformed into a number of smaller patches of smaller total area, isolated from one another by a matrix of habitats unlike the original.

Greenhouse gases are gases in the atmosphere that absorb and emit radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. Major greenhouse gases include carbon dioxide, methane, nitrous oxide, and water vapor. Greenhouse gases greatly affect the temperature of the earth; without them, earth's surface would be on average about 33°C (59°F) colder than at present. Human activities since the start of the industrial era around 1750 have increased the levels of greenhouse gases in the atmosphere.

Hardwood trees are deciduous trees—such as hickories, maples, and oaks—with wood that tends to be harder and denser than that of softwoods.

Indirect drivers are factors that contribute to changes in direct drivers of ecosystem change. Indirect drivers could be governmental (policies, regulations, subsidies, and incentives), demographic (population growth, decline, and distribution), economic (globalization and markets), technological (new technologies), or cultural and religious (spiritual values, lifestyle decisions, and choices about what and how much to consume).

Measures are incentives, markets, and practices that are implemented to achieve a particular aspired outcome, such as the long-term, sustainable management of forests.

Pulpwood is roundwood, whole-tree chips, or wood residues used for the production of wood pulp for paper and paper products.

Roundwood refers to a length of cut tree such as a log, usually with a round cross-section, with or without bark.

Saw logs are trees or logs cut from trees with minimum diameter and length and with stem quality suitable for conversion to lumber.

A **secondary forest** is a forest or woodland area that has regenerated after a major disturbance such as fire, insect infestation, large-scale timber harvest, or clearing for agriculture.

Softwood trees are coniferous trees—such as pines, firs, and cedar—with wood that tends to be softer and less dense than that of hardwoods.

The South is the area comprised of the 13 U.S. states in the U.S. Forest Service’s Southern Region (Figure 1).

Species richness is a measure of the number of different species present within a given area.

Suburban encroachment (sometimes called “sprawl”) describes relatively low-density suburban development (defined in this publication as one housing unit per 1.7–10 acres), either at the suburban/rural fringe or in relatively isolated locations in otherwise undeveloped areas.

Temperate forests are forests located in regions in which the average temperature is $\pm 50^{\circ}\text{F}$ (10°C) for two to four months of the year.

Veneer is a thin sheet of wood of uniform thickness, produced by rotary cutting (peeling) or slicing, and sometimes by sawing. It is often used in furniture.

A **virgin forest** (sometimes called “primary forest”) is an undisturbed natural forest, virtually uninfluenced by human activities, and usually containing old-growth trees if the site has been free of natural disturbances such as hurricanes.

A **watershed** is the area of land drained by a single stream, river, or drainage network.

The **wildland-urban interface** is an area where increased human influence and land use conversion are changing natural resource goods, services, and management. This definition is based on a natural resource perspective; other definitions can be based on geographical, sociopolitical, biophysical, and fire perspectives.

Figure 1 States that Comprise the U.S. Forest Service’s Southern Region



Source: Administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Welcome

CHAPTER

I

The forests of the southern United States are a vast local, national, and global treasure. Spanning approximately 214 million acres (Smith et al. 2009), they stretch from Texas to Virginia and from Kentucky to Florida (Figure 1.1). They comprise 40 percent of the land area of the 13 states that constitute the U.S. Forest Service’s “southern region,”¹ and 29 percent of the total forest land in the United States (Conner and Hartsell 2002). They are the dominant form of land cover throughout the region (Figure 1.2 and Box 1.1).

FORESTS OF DIVERSITY

Southern U.S. forests (hereafter “southern forests”) are very diverse. They contain a range of dominant tree communities and species (Figure 1.3) that have changed in composition and extent over time as a result of both natural and human-influenced processes. The most common communities are oak/hickory, loblolly/shortleaf pine, oak/pine, and oak/gum/

cypress (Table 1.1), which combined account for approximately 86 percent of southern forest area (Conner and Hartsell 2002). Approximately 52 percent of the region’s forest area is dominated by hardwoods—deciduous broadleaf trees such as oaks. The remaining forest area is dominated by softwoods—evergreen coniferous trees such as pines—or a mixture of hardwoods and softwoods (Figure 1.4).

This range of tree communities helps make southern forests among the most biologically diverse temperate forests in the world (Trani 2002a). Southern forests contain the highest concentration of tree species in the United States.² Southern forests and their environs support 3,000 species of plants (Miller 2001), 595 species of birds, and 246 species of mammals (Trani 2002a). Home to 170 amphibian and 197 reptile species, these ecosystems are a center of amphibian and reptile diversity in North America (Trani 2002a).

Box 1.1 What is a Forest?

A forest is an ecosystem characterized by extensive tree cover with varying degrees of density. Forests often, but not always, consist of stands varying in species composition, structure, age class, and associated processes.

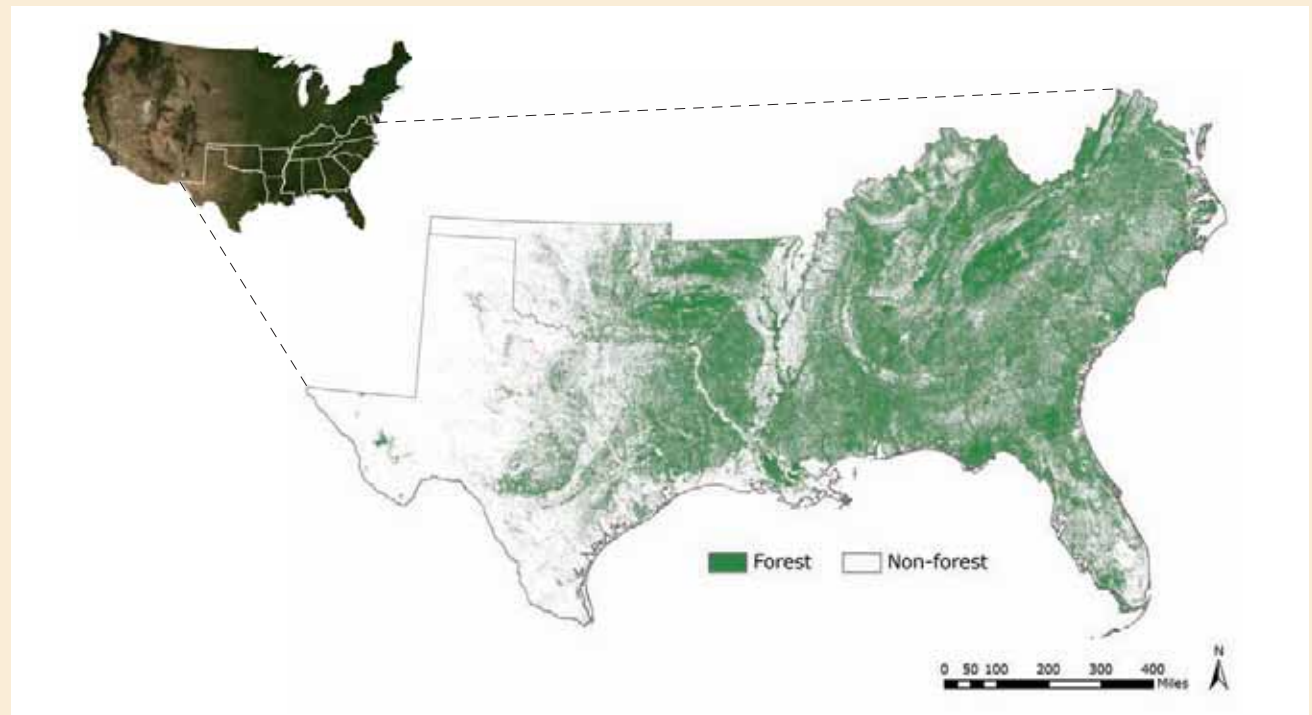
For forest acreage data in this publication, a forest is defined as a tract of land that is at least 120 feet wide and 1 acre in size with at least 10 percent forest cover (or equivalent stocking) by live trees of any size, including land that formerly had such tree cover but will regenerate with tree cover. This definition includes trees that emerge naturally as well as those planted by people.

Forest acreage includes transition zones, such as areas between forest and non-forest lands that have at least 10 percent cover (or equivalent stocking) with live trees and forest areas adjacent to urban and built-up lands. Roadside, streamside, and shelterbelt strips of trees must have a crown width of at least 120 feet and continuous length of at least 363 feet to qualify as forest land. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if they are less than 120 feet wide or an acre in size. Tree-covered areas in agricultural production settings, such as fruit orchards, or tree-covered areas in urban settings, such as city parks, are not considered forest land. This definition is used by the U.S. Forest Service and its Forest Inventory and Analysis program, which monitors the status of U.S. forests.

For this publication’s forest cover maps based on satellite imagery, a forest has a minimum of 20 percent tree canopy. This definition is based on aerial measurements and is a threshold used by the U.S. Geological Survey and the National Land Cover Dataset.

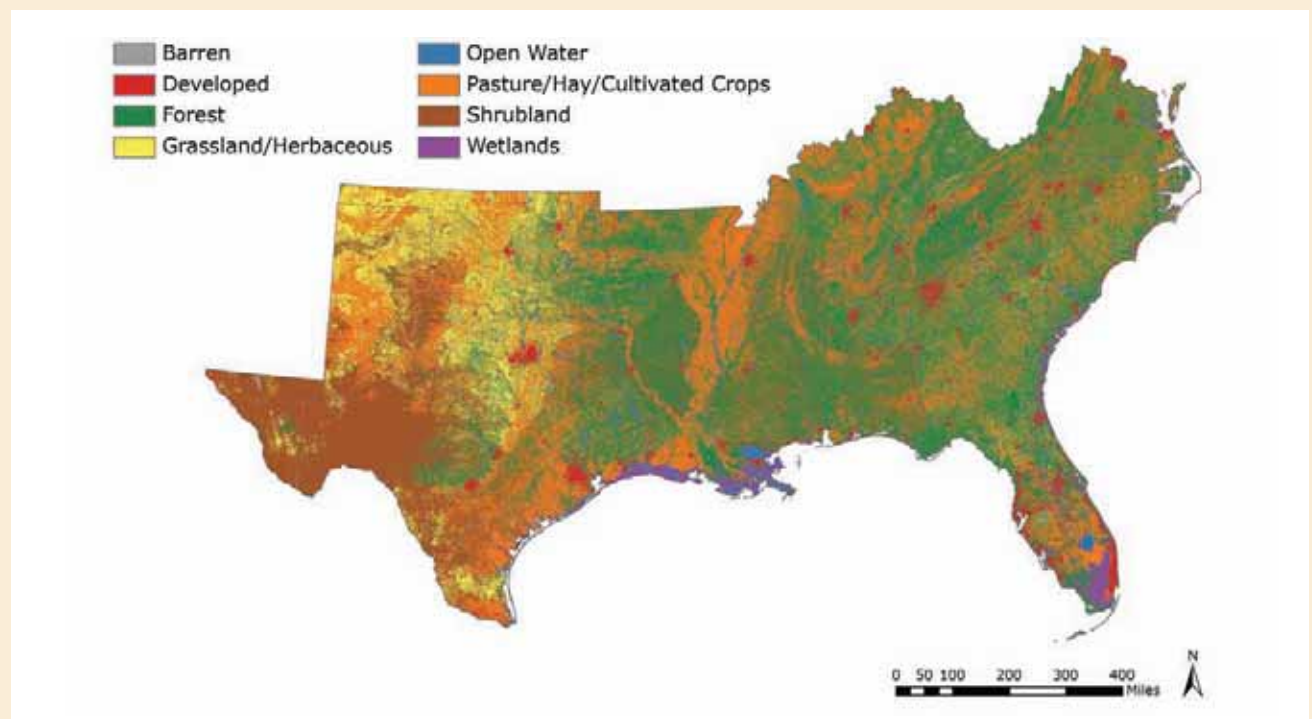
Source: Smith et al. 2009.

Figure 1.1 Extent of Southern U.S. Forests (2001)



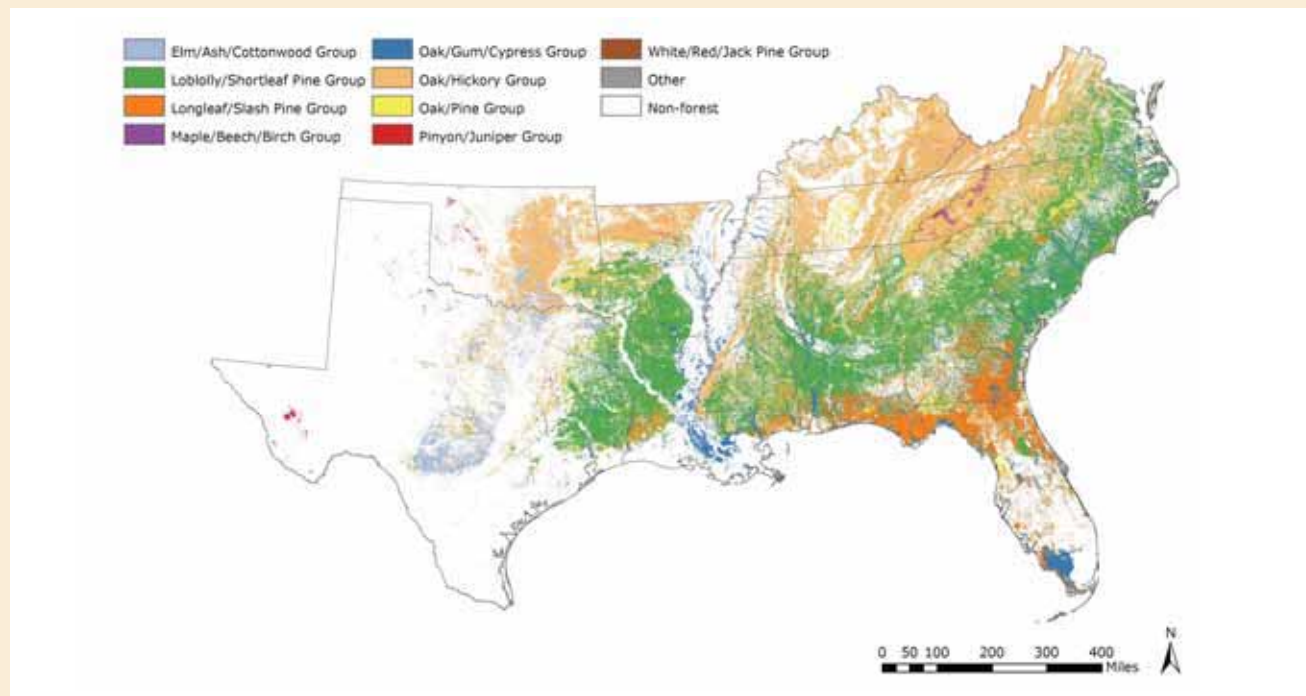
Source: Satellite imagery (ESRI 2008; ESRI, i-cubed, and GeoEye 2009), forest cover (U.S. Geological Survey 2007), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Figure 1.2 Landcover of the Southern United States (2001)



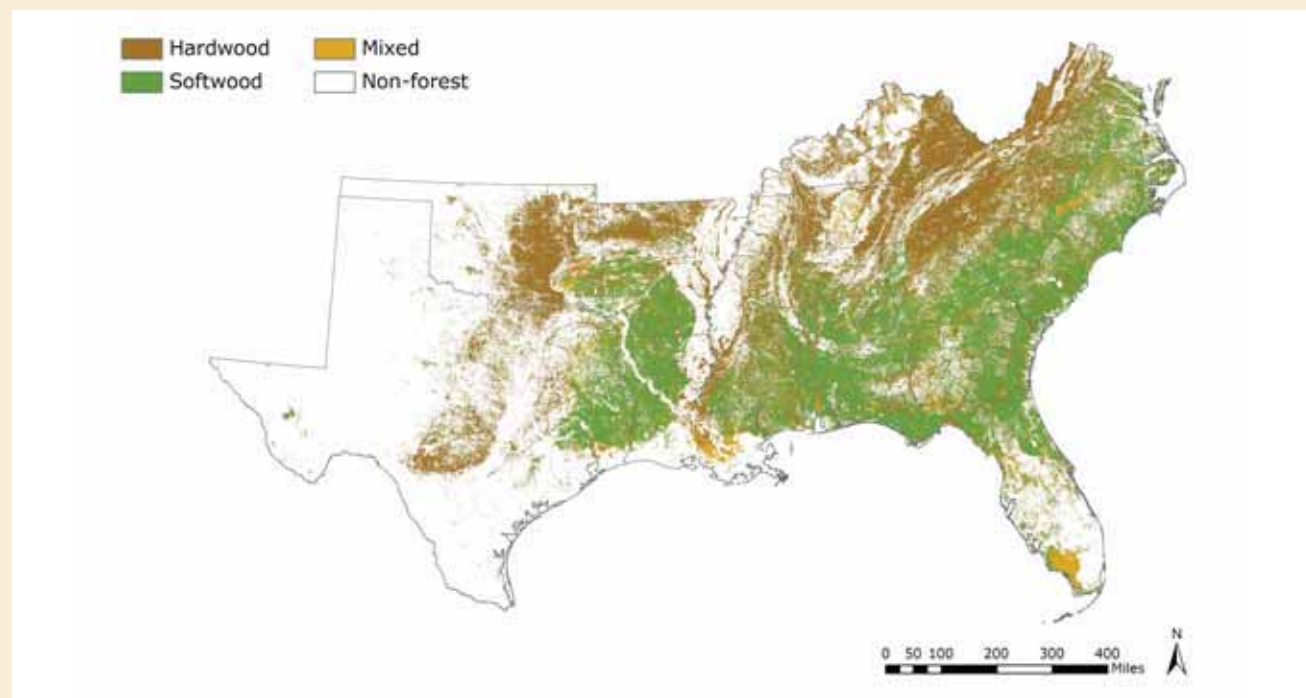
Source: Landcover (U.S. Geological Survey 2007), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Figure 1.3 Major Tree Communities of Southern Forests








Source: Forest types (USDA Forest Service FIA and RSAC, 2008), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).
Note: Data from satellite imagery taken in 2002 and 2003.

Figure 1.4 Hardwoods and Softwoods of Southern Forests



Source: Forest types (USDA Forest Service FIA and RSAC, 2008), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).
Note: Data from satellite imagery taken in 2002 and 2003.

Table 1.1 Dominant Tree Communities and Associated Tree Species in Southern Forests

Tree community	Area in 2007 (million acres)	Share of southern forest (percent)	Associated tree species*	
Oak/hickory	84.2	39.2	Red oak, white oak, scarlet oak, blackjack oak, chestnut oak, hickory, yellow poplar, sassafras, persimmon, sweet gum, black walnut, black locust, red maple	
Loblolly/shortleaf pine	54.8**	25.5	Loblolly pine, shortleaf pine, Virginia pine, sand pine, table-mountain pine, pond pine, pitch pine, spruce pine	
Oak/pine	23.8	11.1	Northern red oak, southern red oak, white ash, eastern red cedar, eastern white pine, longleaf pine, shortleaf pine, Virginia pine	
Oak/gum/cypress	21.3	9.9	Swamp chestnut oak, cherrybark oak, sweet gum, willow oak, Atlantic white cedar, bald cypress, tupelo, sweetbay, red maple	
Longleaf/slash pine	13.2	6.2	Longleaf pine, slash pine	
Other and nonstocked***	17.3	8.1	n/a	
Total	214.6	100.0		

*Not exhaustive

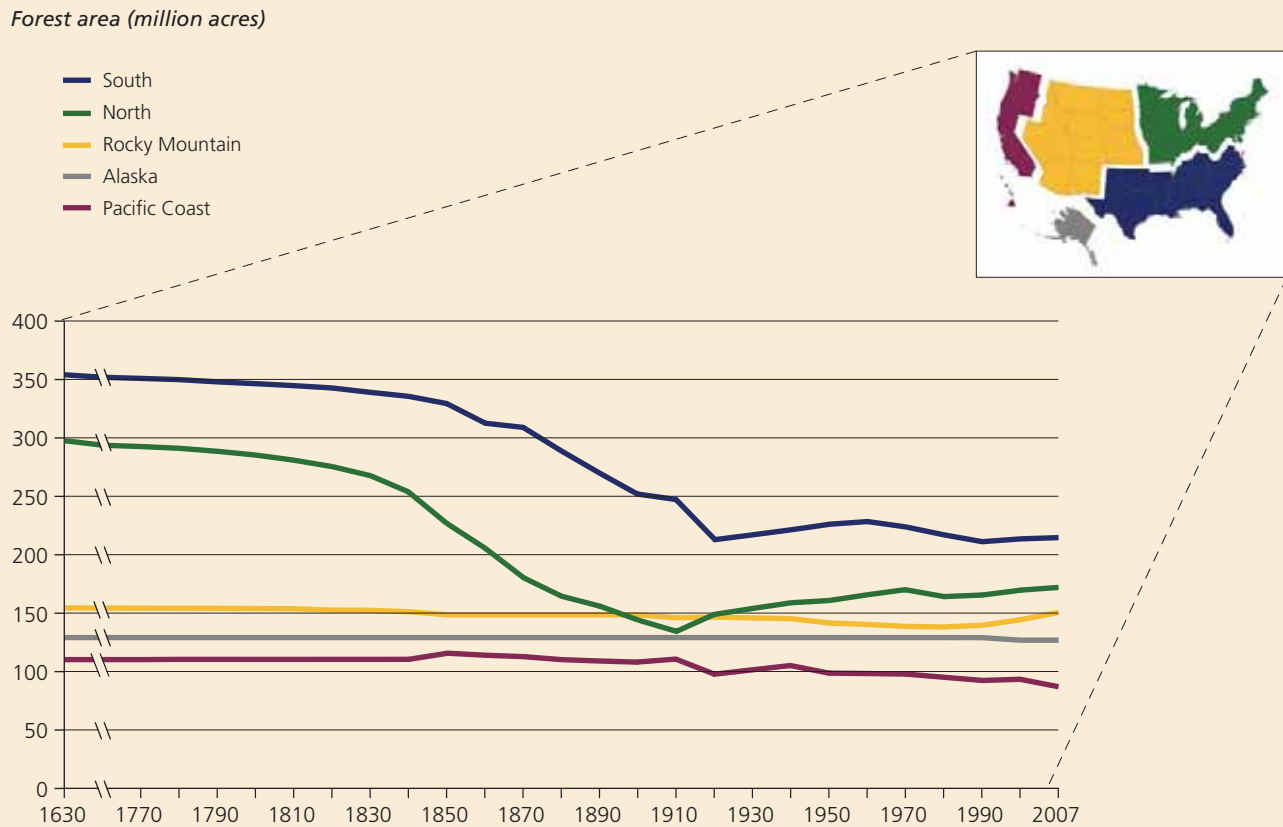
**Acreage significantly influenced by forest management practices and does not reflect historic composition.

***Nonstocked is defined by timberland less than 10 percent stocked with all live trees.

PHOTOS, FROM TOP TO BOTTOM: JUDY BAXTER, FLICKR; DAVID STEPHENS, BUGWOOD.ORG; HUNTER DESPORTES, FLICKR; KEVIN TROTMAN, FLICKR; DAVID J. MOORHEAD, UNIVERSITY OF GEORGIA, BUGWOOD.ORG

Source: Smith et al. 2009.

Figure 1.5 History of Forest Extent by U.S. Region (1630-2007)



Source: Forest data (USDA Forest Service 2000, Smith et al. 2009), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Southern forests are important not only for biodiversity, but also for people in the region and around the world. They supply lumber, plywood, and oriented strand board for construction, veneer for furniture, pulpwood for paper, and biomass fuel for industry and home heating. As a result, southern forests are the foundation for numerous jobs in the region. They protect water quality, prevent soil erosion, and help regulate climate by sequestering carbon dioxide—a major greenhouse gas. Furthermore, they offer places for people to hike, camp, hunt, and experience natural beauty. Thus, these forests support a wide range of ecosystem services.

FORESTS OF CHANGE

Southern forests are forests of continual change. Prior to European settlement, these forests were shaped by natural disturbances such as climatic warming after the last ice age, hurricanes, and natural fires, as well as by fires set by Native Americans. At the dawn of European settlement in the region in the early 1600s, southern forests covered an estimated 350 million acres or more. Over the next four centuries, greater than 99 percent of this acreage was cut at one time or another for agriculture, timber, or settlements (Trani 2002b). A testament to the renewability and resiliency of forests, much of the

land regenerated over time as secondary forest. Nonetheless, approximately 40 percent of the pre-European settlement forest acreage has been converted to other uses. Only the northern forests—from Maine to Minnesota—have experienced a comparable decline in forest cover in the United States over this time period (Figure 1.5).

Several drivers of change continue to affect the quantity (extent and distribution) and quality (composition and health) of southern forests. “Direct drivers” are factors—of natural or human origin—that cause changes in an ecosystem and thereby increase or decrease its ability to provide certain ecosystem services.³ Some drivers increase forest quantity or quality while others decrease them. Prominent drivers include:

- *Suburban encroachment.* Suburban residential and commercial development is the driver of change most likely to decrease southern forest extent over the coming decades. The U.S. Forest Service forecasts that 12 million acres of southern forest could be converted to suburban development between 1992 and 2020. Another 19 million acres could be converted between 2020 and 2040 as the region’s

population grows (Wear 2002). These combined 31 million acres are equivalent to about 15 percent of current southern forest acreage. Besides decreasing southern forest extent, suburban development also fragments these forests into smaller contiguous tracts, which can have implications for species distribution, economies of scale for timber harvesting, and the availability of hunting and recreational opportunities.⁴

- *Reversion of agricultural land.* In some areas of the South, particularly in the western part of the region, forest extent is expanding as agricultural land reverts to forest. Much of this forest growth is occurring due to active tree planting in response to market prices for timber, tree planting subsidy programs, and natural reversion on marginal farmland (Connor and Hartsell 2002).
- *Climate change.* Climate change may have a number of impacts, including shifting the distribution of some species, inundating low-lying coastal forests, increasing instances of saltwater intrusion, and stressing drought-intolerant species. Furthermore, climate change may exacerbate other direct drivers such as fire and pest and pathogen outbreaks.
- *Wildfire.* The suppression of natural, low-intensity forest fires during much of the 20th century has led to a build-up of fuel, increasing the risk of high-intensity wildfires in some areas and altering the species composition of fire-adapted forests.
- *Pests and pathogens.* Outbreaks of native insects such as the southern pine beetle, non-native insects such as gypsy moths and the hemlock woolly adelgid, native pathogens such as oak wilt, and non-native pathogens such as dogwood anthracnose and butternut canker are affecting a variety of tree species and may affect southern forest species composition and health. In addition, non-native invasive species such as cogon grass increase the risk that low-intensity fires turn into high-intensity forest fires.

Going forward, these drivers of change will likely impact the ability of southern forests to continue to provide a full range of ecosystem services. How private landowners, businesses, conservation organizations, governments, and citizens respond and adapt to these and other drivers ultimately will shape southern forests for the future.

ABOUT THIS PUBLICATION

This publication aims to introduce readers to the forests of the southern United States. It provides data, maps, and other forms of information about these forests, their condition, and trends. In particular, it explores and addresses the following questions:

- Why are southern forests important? (chapter II)
- What is the history of these forests from pre-European settlement to today? (chapter III)
- Going forward, what drivers are likely to impact the quantity and quality of these forests? (chapter IV)
- Over the next several decades, what measures might help ensure that southern forests continue to provide their myriad of benefits? (chapter V)⁵

Southern Forests for the Future is designed to serve as a resource for conservation organizations, concerned citizens, landowners, academic institutions, the private sector, and government agencies involved with forest stewardship, among others. While offering a general introduction to southern forests, it is not intended to provide an exhaustive assessment. For those interested in learning more, please visit www.SeeSouthernForests.org, an online interactive information portal developed by WRI that is dedicated to providing a wide range of information about southern forests. In particular, the website hosts “zoomable” satellite images, detailed maps, case studies, historical photos, and other data. Additional sources of information can also be found in the “Suggested Reading” at the end of this publication.

Notes

¹ This publication follows the U.S. Forest Service convention of defining the South as the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. Although the U.S. Forest Service’s Southern Region also includes Puerto Rico, lack of sufficient data limited the scope of this publication to U.S. states in the South.

² Hansen et al. 2002. The Eastwide Forest Inventory Data Base. USDA Forest Inventory and Analysis (FIA). Online at: <http://www.srs.fs.usda.gov/sustain/data/fia/eastwideguide.htm>

³ Drivers of change should not be interpreted as having a negative connotation; rather, the phrase merely refers to a factor that causes change in forests.

⁴ Trees do re-emerge in suburbanized areas, providing shade, wildlife habitat, and other benefits. However, the tree species and density may or may not be similar to the forest that preceded development.

⁵ Although public policies have an important role to play in sustaining southern forests, this publication focuses on non-policy measures.

Benefits

CHAPTER

II

The forests of the southern United States are important and valuable ecosystems because they provide people, communities, and businesses with a wide range of goods and services. For example, they provide pulp for paper, control soil erosion, help regulate climate by sequestering carbon, and offer outdoor recreation opportunities. These and other benefits collectively are known as “ecosystem services.”

The Millennium Ecosystem Assessment (Box 2.1) identified several categories of ecosystem services:

- *Provisioning services* are the goods or products obtained from ecosystems, such as food, freshwater, timber, and fiber. These services are tangible and many—but not all—are often tradable and priced in the marketplace.
- *Regulating services* are the benefits obtained from an ecosystem’s control of natural processes such as climate, erosion, water flows, and pollination. Currently, forest landowners typically do not receive payments or compensation for providing these services.
- *Cultural services* are the nonmaterial benefits obtained from an ecosystem, such as recreation, aesthetic enjoyment, and spiritual renewal.
- *Supporting services* are natural processes—such as nutrient cycling, primary production, and water cycling—that maintain the other ecosystem services. [Since supporting services benefit people not directly but rather through the other types of ecosystem services, this publication does not further discuss supporting services.]

Southern forests provide a variety of these services (Table 2.1). Beneficiaries are located at the local, regional, and/or global scale and include future generations. For instance, southern forests provide local people with fuelwood and hunting opportunities. At a regional level, they filter water

and offer recreation for urban and rural dwellers. At a global level, they sequester carbon—helping to regulate greenhouse gas concentrations in the atmosphere—and provide wood for the global forest products industry.

PROVISIONING SERVICES

Southern forests provide a wide range of provisioning services including timber, pulpwood for paper, biomass fuel, and a number of non-timber forest products.

Timber and pulpwood

Many southern forests are “working forests” in that they are actively managed to yield timber and pulpwood. Southern yellow pines are popular for construction lumber.¹ Furniture and cabinet makers use oak, hickory, and beech, among other species.² Oak is common for hardwood flooring, and is also used for wood veneer, trim, millwork, plywood, and pallets. Manufacturers convert a variety of softwood and hardwood species to pulp for making cardboard, office paper, tissue, and other paper products.

Although they comprise just 2 percent of the planet’s total forest cover, southern forests are disproportionately productive. They generate 18 percent of the world’s pulpwood for paper and paper-related products and 7 percent of its industrial roundwood.³ The region yielded 8.6 billion cubic feet of wood in 2006.⁴

Box 2.1 The Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment was a four-year international audit of the planet's ecosystems. Its findings provided the first global scientific evaluation of the condition and trends in the world's ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably. Released in 2005, the assessment involved 1,360 scientists, economists, business professionals, and other experts from 95 countries.

The Millennium Ecosystem Assessment found that people have changed ecosystems around the world more rapidly and extensively over the past 50 years than in any comparable period of time in human history. For example:

- More land was converted to cropland between 1950 and 1980 than in the 150 years spanning 1700 to 1850. With a quarter of the Earth's terrestrial surface now used for crops or confined livestock, further increases in agricultural output will likely have to come from more intensive management of existing cultivated areas.
- More than half of the synthetic nitrogen fertilizer ever used has been applied over the past two decades, contributing to an increase in the number of waterways at risk of becoming "dead zones" for commercial fisheries.
- Water withdrawals from rivers and lakes doubled since 1960, with long-term implications for the availability and flow of freshwater in some regions.
- Twenty percent of the world's coral reefs and nearly a quarter of its mangrove forests have been lost since about 1980, along with their capacity to buffer coastlines from storms.
- Wild marine fish harvests peaked in the 1980s and have since remained static, with implications for all those who rely on this maritime resource.

These changes have led to the deterioration in the quantity and/or quality of many ecosystem services. The assessment found that 15 out of the 24 ecosystem services that were evaluated degraded over the past 50 years. Five services were rated "mixed," increasing in supply or quality in some regions of the world but decreasing in others. Three provisioning services—crops, livestock, and aquaculture—were rated as "enhanced," reflecting people's focus on managing ecosystems to generate food for a growing population. Yet actions to increase these three provisioning services have inadvertently led to the degradation of many regulating and cultural services, most of which have no value in the marketplace until they become scarce or lost.

For more information about the Millennium Ecosystem Assessment, visit www.maweb.org.

Trends in the World's Ecosystem Services over the Past 50 Years

	Degraded	Mixed	Enhanced
Provisioning	<ul style="list-style-type: none"> • Capture fisheries • Wild foods • Biomass fuel • Genetic resources • Biochemicals, natural medicines, and pharmaceuticals • Freshwater 	<ul style="list-style-type: none"> • Timber and wood fiber • Other fibers (e.g., cotton, hemp, silk) 	<ul style="list-style-type: none"> • Crops • Livestock • Aquaculture
Regulating	<ul style="list-style-type: none"> • Air quality regulation • Regional and local climate regulation • Erosion regulation • Water purification and waste treatment • Pest regulation • Pollination • Natural hazard regulation 	<ul style="list-style-type: none"> • Water regulation • Disease regulation 	<ul style="list-style-type: none"> • Global climate regulation (carbon sequestration)*
Cultural	<ul style="list-style-type: none"> • Ethical values (spiritual, religious) • Aesthetic values 	<ul style="list-style-type: none"> • Recreation and ecotourism 	

*According to the Millennium Ecosystem Assessment, forests and soils were a net source of carbon dioxide (CO₂) emissions over the past two centuries. Approximately 40 percent of CO₂ emissions came from land use change, primarily through deforestation, while terrestrial ecosystems absorbed approximately only a third of all CO₂ emissions during that time period. During the 1980s and 1990s, however, terrestrial ecosystems were a net CO₂ sink. They were the source of about 20 percent of CO₂ emissions—fossil fuels accounted for the rest—but absorbed approximately a third of total CO₂ emissions during that time period. Therefore, the ability of ecosystems to sequester carbon in the 1980s and 1990s was "enhanced" relative to the past two centuries. Nevertheless, deforestation is still a major source of human-made CO₂ emissions and efforts to curb deforestation would help reduce greenhouse gas concentrations in the atmosphere.

Source: Millennium Ecosystem Assessment 2005.

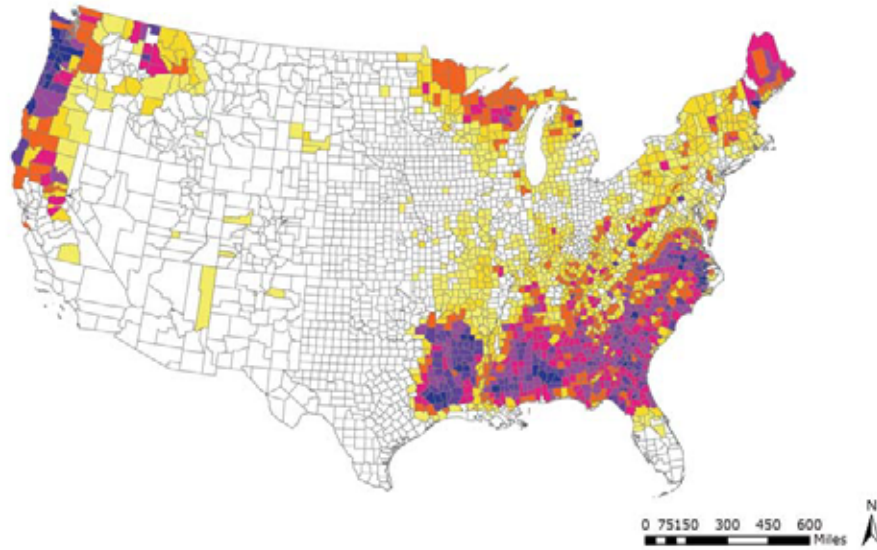
Table 2.1 Selected Ecosystem Services Provided by Southern Forests

Not Exhaustive

Service	Sub-category	Definition	Examples from the South
Provisioning services			
Timber		Solid wood products derived from trees harvested from natural forest ecosystems or plantations	<ul style="list-style-type: none"> • Lumber and plywood for homes and buildings • Wood furniture
Pulpwood		Wood fiber derived from trees harvested from natural forest ecosystems or plantations	<ul style="list-style-type: none"> • Paper • Cardboard • Diapers, textiles, and other by-products from the pulp industry
Biomass fuel		Biological material derived from living or recently living organisms—both plant and animal—that serves as a source of energy	<ul style="list-style-type: none"> • Firewood for home heating • Fuel for generating electricity and heat for industry
Non-timber forest products	Wild foods	Edible plant and animal species gathered or captured in the wild	<ul style="list-style-type: none"> • Deer • Blackberries • Mushrooms
	Natural medicines and biochemicals	Medicines, biocides, food additives, and other biological materials derived from forests for commercial or domestic use	<ul style="list-style-type: none"> • Ginseng • Saw palmetto
	Other	Entire plants or parts thereof utilized for a variety of other purposes	<ul style="list-style-type: none"> • Leaves of galax plant used in floral arrangements • Pine needles and bark for mulch and bedding
Regulating services			
Air quality regulation		Influence forests have on air quality by trapping chemicals from the atmosphere (i.e., serving as a “sink”)	<ul style="list-style-type: none"> • Forests absorb or trap particulate matter (soot), nitrogen oxides, and other pollutants released by cars, power plants, and factories
Climate regulation	Global	Influence forests have on the global climate by emitting greenhouse gases or aerosols to the atmosphere or by absorbing greenhouse gases or aerosols from the atmosphere	<ul style="list-style-type: none"> • Forests capture and store carbon dioxide
	Regional and local	Influence forests have on local or regional temperature, precipitation, and other climatic factors	<ul style="list-style-type: none"> • Through transpiration, forests can impact regional rainfall levels • Forests provide shade, creating cooler microclimates in adjacent urban/suburban areas, on the forest floor, and in nearby streams
Watershed protection	Water flow regulation	Influence forests have on the timing and magnitude of water runoff, flooding, and aquifer recharge, particularly in terms of water storage potential	<ul style="list-style-type: none"> • Permeable soil in forests facilitates aquifer recharge • River floodplains and wetland forests retain water, reducing the risk of flooding during runoff peaks
	Water purification	Role forests play in the filtration and decomposition of organic wastes and pollutants in water	<ul style="list-style-type: none"> • Forests remove excess nutrients and pollutants, preventing them from entering waterways
	Erosion regulation	Role vegetative cover plays in soil retention	<ul style="list-style-type: none"> • Vegetation prevents soil loss due to wind and rain and prevents siltation of waterways • Forests on slopes hold soil in place, thereby helping to prevent landslides
Cultural services			
Recreation and tourism		Recreational pleasure people derive from forests	<ul style="list-style-type: none"> • Hiking • Camping • Bird watching
Hunting and fishing*		Hunting of wild animals for sport and food	<ul style="list-style-type: none"> • Big game hunting • Migratory bird hunting • Bass fishing
<p>*Hunting and fishing can be considered a provisioning service, too, in that these activities yield wild food. Source: Adapted by the World Resources Institute from the Millennium Ecosystem Assessment, 2005.</p>			

Figure 2.1 U.S. Timber Production by County (2007)

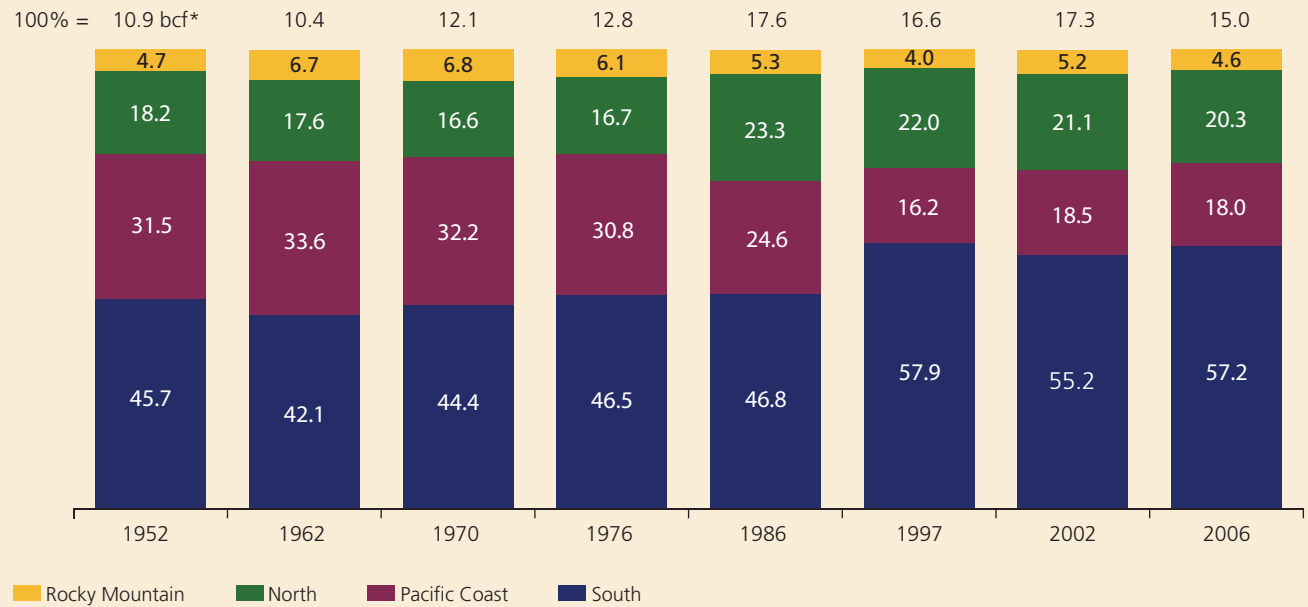
Board feet per hectare



Source: WRI analysis of national timber production (Johnson et al. 2009) and administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).
Note: 1 hectare = 2.47 acres

Figure 2.2 Share of Timber Harvest Volume by Region (United States)

Percent



*bcf = billion cubic feet

Source: WRI analysis from data in Haynes et al. 2007 and Smith et al. 2009.

Note: Figures may not add to 100 due to rounding.

Accordingly, the South is the nation’s “wood basket” (Figure 2.1). The region’s share of the U.S. wood harvest has grown over the past half century, increasing from 46 percent in 1952 to 57 percent in 2006 (Figure 2.2). This growth has been due to increased southern forest inventories via natural regeneration and tree planting efforts, strong market demand that encouraged forests to be managed for timber and pulp, new technologies that allowed for a wider variety of species to be utilized, and public policies that reduced harvesting from public lands in the western United States (Wear and Greis 2002).

Wood supplied by southern forests generates significant economic benefits in the South, particularly for more rural communities, at both the harvesting and manufacturing stages. In 2007, the value of sawtimber, veneer logs, poles, and pulpwood harvested from southern forests was nearly \$12 billion.⁵ The regional economic impact of this harvest approached \$30 billion when taking multiplier effects into account. Nearly 600,000 jobs were generated by harvest activities and the indirect and induced spending by businesses and households associated with this activity.⁶

Biomass fuel

Trees, wood, and wood residues from southern forests provide energy for families and businesses in the region. Many southern households burn cordwood in fireplaces or stoves to generate heat. Companies—particularly those in the forest products industry—burn wood chips, sawdust, bark, lignin, and other wood processing residues to generate heat and/or electricity for their manufacturing operations. Depending on technological developments for converting wood fiber into liquid sources of energy, forests might also provide feedstocks for liquid biofuels for transportation applications in the future.

In 2007, more than 300 million cubic feet of domestic fuelwood—just a portion of total biomass fuel generated—was harvested from southern forests, which is equivalent to roughly 2.5 million cords. The value of this domestic fuelwood harvest was approximately \$188 - \$375 million.⁷

Non-timber forest products

Southern forests supply a range of products besides timber, pulpwood, and biomass fuel. These goods—often called “non-

timber forest products”—have a variety of uses such as food, arts and crafts, medicinal and dietary supplements, floral and decorative applications, and landscape products.⁸ More than 10 percent of southern landowners harvested non-timber forest products from their land between 2001 and 2006.⁹ Examples from southern forests include:¹⁰

- 20 species of edible plants such as blackberries, muscadine grapes, and wild onions, as well as edible fungi such as morel and wood ear mushrooms;
- More than 200 species of floral, decorative, and landscaping plants such as southern magnolia, rhododendron, and azalea;¹¹
- Wood chips and pine needles for mulch and bedding;¹² and
- Over 125 species of medicinal and dietary supplements, including saw palmetto,¹³ black cohosh,¹⁴ and ginseng¹⁵—with 80 percent of the global ginseng harvest coming from Kentucky, Virginia, Tennessee, and North Carolina.¹⁶

Non-timber forest products contribute more than \$1 billion annually to the South’s economy (Harper 2005).

REGULATING SERVICES

Southern forests play an important role in naturally regulating air quality, global climate, regional and local climate, water flows, water purity, and erosion.

Air quality regulation

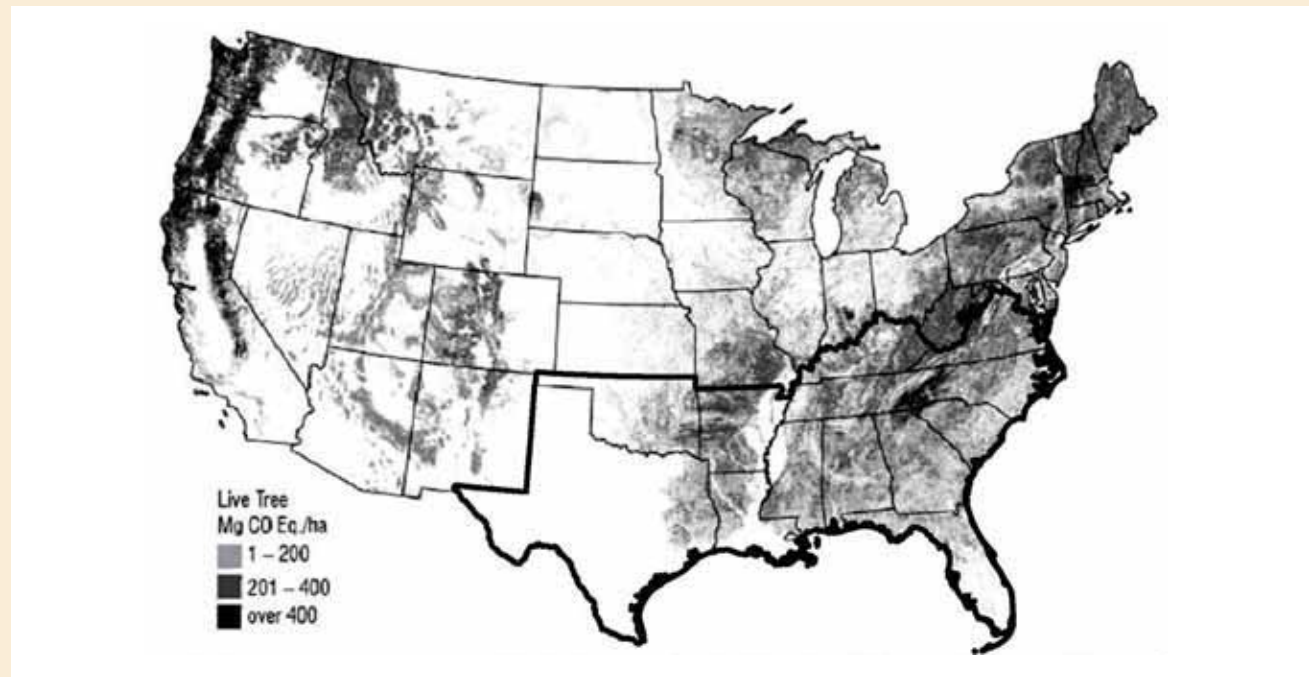
Southern forests play a role in improving local and regional air quality. Trees can absorb or trap nitrogen dioxide, sulfur dioxide, and particulate matter 10 microns or less in size (American Forests 2002a)—pollutants that can induce asthma or other respiratory problems—emitted by factories, power plants, and automobiles. According to one study in 2002, forests in the Charlottesville, Virginia area remove approximately 43 pounds of these and other air pollutants per acre per year (American Forests 2002a). The economic value of this airborne pollution removal is estimated to be \$261 per acre of forest per year (American Forests 2002b). Another study estimated that forests around Atlanta remove approximately 80–90 pounds of air pollutants per acre per year, at an estimated economic value of \$205–\$230 per acre per year.¹⁷ Similarly, the estimated economic value of airborne pollution removal by the tree canopy in the city of Miami, Florida is \$287 per acre per year (American



Left to right: Morel mushroom, blackberries, saw palmetto, and muscadine grapes

PHOTOS: MUSHROOM, BLACKBERRIES, AND PALMETTO BY CHRIS EVANS, RIVER TO RIVER CWMA, BUGWOOD.ORG. GRAPES BY DAVID NANCE, USDA AGRICULTURAL RESEARCH SERVICE, BUGWOOD.ORG

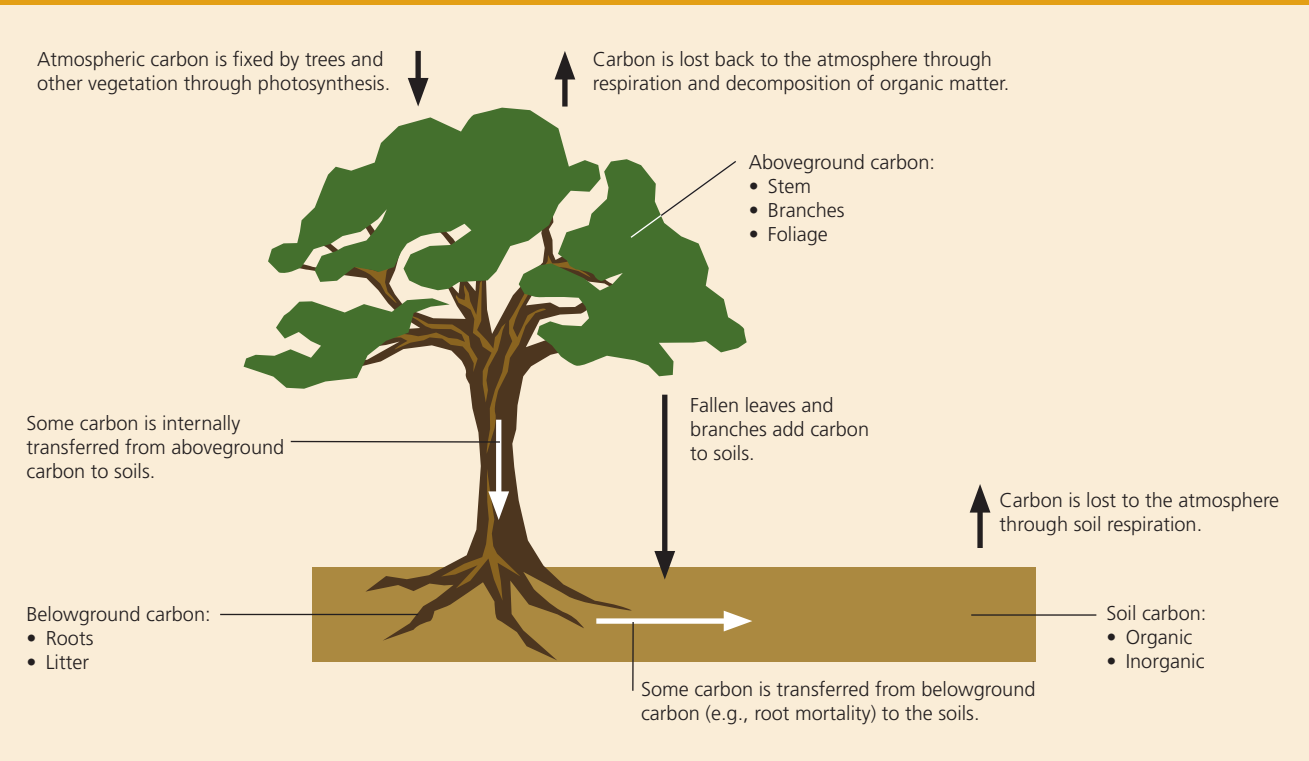
Figure 2.3 Average Carbon Density in Forests of the Contiguous United States (2008)



Source: U.S. Environmental Protection Agency (EPA) 2009.

Note: This graphic shows county-average carbon densities for live trees on forest land, including both above- and belowground biomass. These data are based on the most recent forest inventory survey in each state.

Figure 2.4 The Role of Forests in the Carbon Cycle



Source: U.S. Environmental Protection Agency (EPA) 2008.

Forests 2008). Rates of airborne pollution removal vary based on the pollutant type, leaf season length, and precipitation levels.

Global climate regulation

Forest ecosystems help regulate earth's climate—its long-term temperature, precipitation patterns, and other meteorological phenomena—by playing a role in the global carbon cycle. The carbon cycle influences global climate because atmospheric carbon, in the form of carbon dioxide, is the leading greenhouse gas. Greenhouse gases trap heat leaving the earth's surface, creating a “blanket” that warms the earth's atmosphere. Scientists, policymakers, and others are currently concerned that the marked buildup of greenhouse gas concentrations in the atmosphere—primarily through human activities since the industrial revolution—is contributing to long-term changes in the planet's climate that go above and beyond natural climatic variations (IPCC 2007).

Forests are major repositories or “sinks” of carbon (Figure 2.3). Trees absorb carbon dioxide during the process of photosynthesis. Some of this carbon becomes stored or “sequestered” in branches, trunks, and roots, while some is in soils when leaves and other parts of trees decay (Figure 2.4). By sequestering carbon, a standing forest removes carbon dioxide from the atmosphere and thereby helps prevent the buildup of greenhouse gases. Conversely, converting or degrading forests has the opposite effect. As forests degrade and disappear, the size of nature's terrestrial vegetative carbon sink shrinks.

Southern forests play an important role in global climate regulation. In 2007, U.S. forests absorbed an estimated 910 million metric tons of carbon dioxide equivalent, an amount equal to approximately 13 percent of the country's gross greenhouse gas emissions from industrial and other sources.¹⁸ In recent years, southern forests—which comprise about 29 percent of U.S. forest cover—have accounted for approximately one-third of the annual carbon sequestered by U.S. forests (Jose 2007).

Regional and local climate regulation

Southern forests can influence local and regional climate. By providing shade, forests reduce air temperatures and create cooler microclimates under the canopy. Forest interiors, for instance, are on average lower in temperature than nearby open fields. Forest canopies in urban areas block incoming sunlight, thereby serving as natural air conditioners. In fact, annual energy costs for a shaded house can be 20–25 percent lower than that of the same house without trees (Heisler 1986).

Trees also can create microclimates in bodies of water. Forest canopies can provide shade for streams and lakes, creating cooler pools of water relative to unshaded stretches. Cool water holds more oxygen, supports beneficial algae, and serves as important habitat for trout, crayfish, and the larva of invertebrates such as mayflies and caddisflies.¹⁹

Water flow regulation

Forests and forested wetlands affect the timing and magnitude of water runoff and water flows. Some forest ecosystems

act as sponges, intercepting rainfall and absorbing water through root systems. Water is stored in porous forest soils and debris, and then is slowly released into surface waters and groundwater. Through these processes, forests recharge groundwater supplies, maintain baseflow stream levels, and lower peak flows during heavy rainfall or flood events.²⁰ The ability of forests to absorb and store runoff can be approximately 20 times greater than that of an impervious parking lot and nearly six times greater than a residential lawn (Cappeilla, Schueler, and Wright 2005).

The water flow regulation services that forests provide can yield economic benefits to communities. By reducing water runoff during rainstorms, forests reduce the volume of water that a municipal stormwater containment facility or retention pond must store. Communities, therefore, do not need to invest as much in constructing stormwater control infrastructure. Based on this avoided cost of stormwater storage, one assessment estimated that forests near Atlanta saved the city \$420 per forested acre per year (American Forests 2001).

Water purification

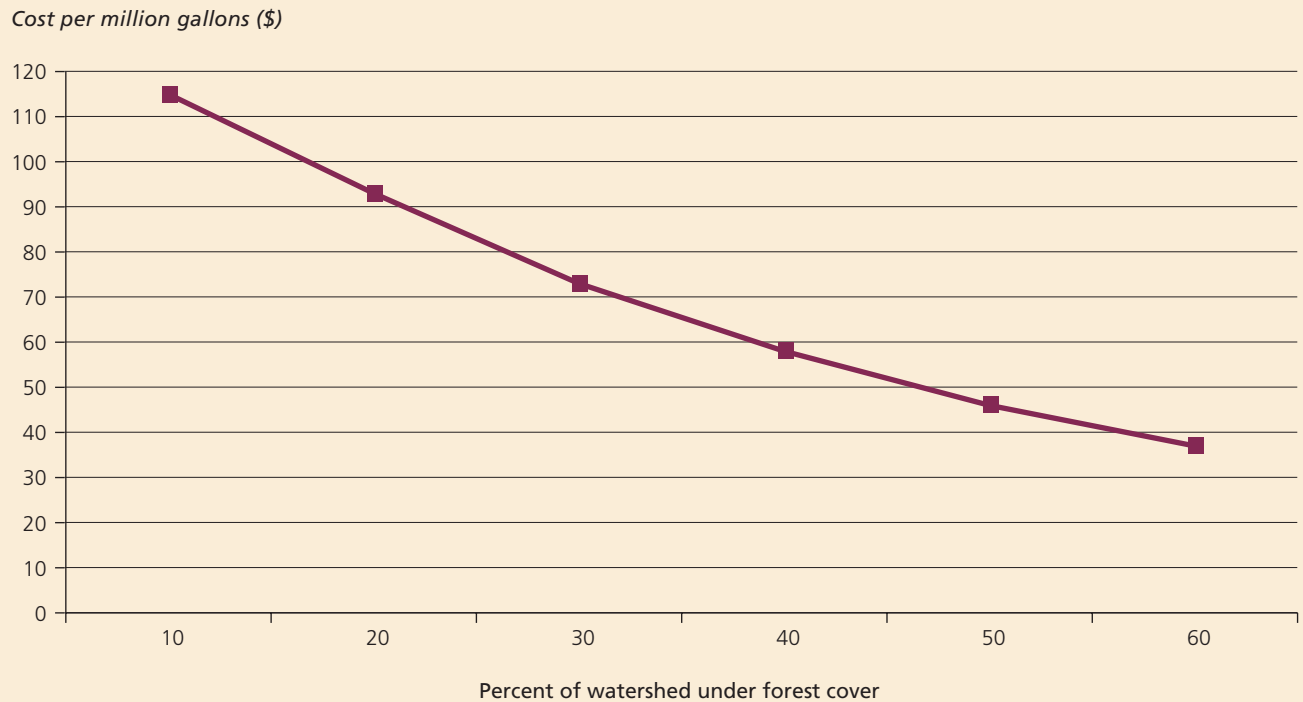
Two-thirds of the nation's clean water supply comes from precipitation that is filtered through forests and ends up in streams (Smail and Lewis 2009). Forests help prevent impurities—mostly from nonpoint source pollution²¹—from entering streams, lakes, and groundwater in a number of ways. Root systems of trees and other plants keep soils porous and allow water to filter through various layers of soil before entering groundwater. Through this process, toxins, nutrients, sediment, and other substances can be filtered from the water. Leaves and other debris on the forest floor play a role, too. Through the process of denitrification, for example, bacteria in wet forest soils convert nitrates—a nutrient that can lead to harmful algal blooms if too much of it enters bodies of water—into nitrogen gas, releasing it into the air instead of into local streams (Sprague et al. 2006).

The water purification benefits of forests are economically valuable. Studies conducted by the American Water Works Association and the Trust for Public Land concluded that drinking water treatment costs decrease as the amount of forest cover in the relevant watershed increases (Figure 2.5).²² They found that 50–55 percent of the variation in operating treatment costs could be explained by percentage of forest cover in the water source area (Ernst 2004).

Erosion regulation

Southern forests help keep soil intact and prevent it from eroding into nearby bodies of water in a number of ways. By intercepting rain, a forest canopy reduces the impact of heavy rainfall on the forest floor, reducing soil disturbance. Leaves and natural debris on the forest floor can slow the rate of water runoff and trap soil washing away from nearby fields. Tree roots can hold soil in place and stabilize stream banks. In addition, coastal forests and forested wetlands protect coastlines by absorbing some of the energy and impact of storm surges, thus reducing erosion and other on-shore impacts.

Figure 2.5 Relationship between Forest Cover and Water Treatment Costs



Source: Ernst 2004.



Forests near streams, rivers, and lakes help stabilize soil and reduce the amount of sediment entering waterbodies, as seen in the Piedmont area of North Carolina.



This erosion control provides a number of benefits to people. For instance, it can help reduce the deposition of sediment behind hydroelectric dams—the Tennessee Valley Authority alone has 30 dams (Tennessee Valley Authority 2003)—and thereby reduce the need for expensive dredging.

CULTURAL SERVICES

Southern forests provide several cultural ecosystem services, including outdoor recreation, tourism, hunting, and fishing.

Recreation and tourism

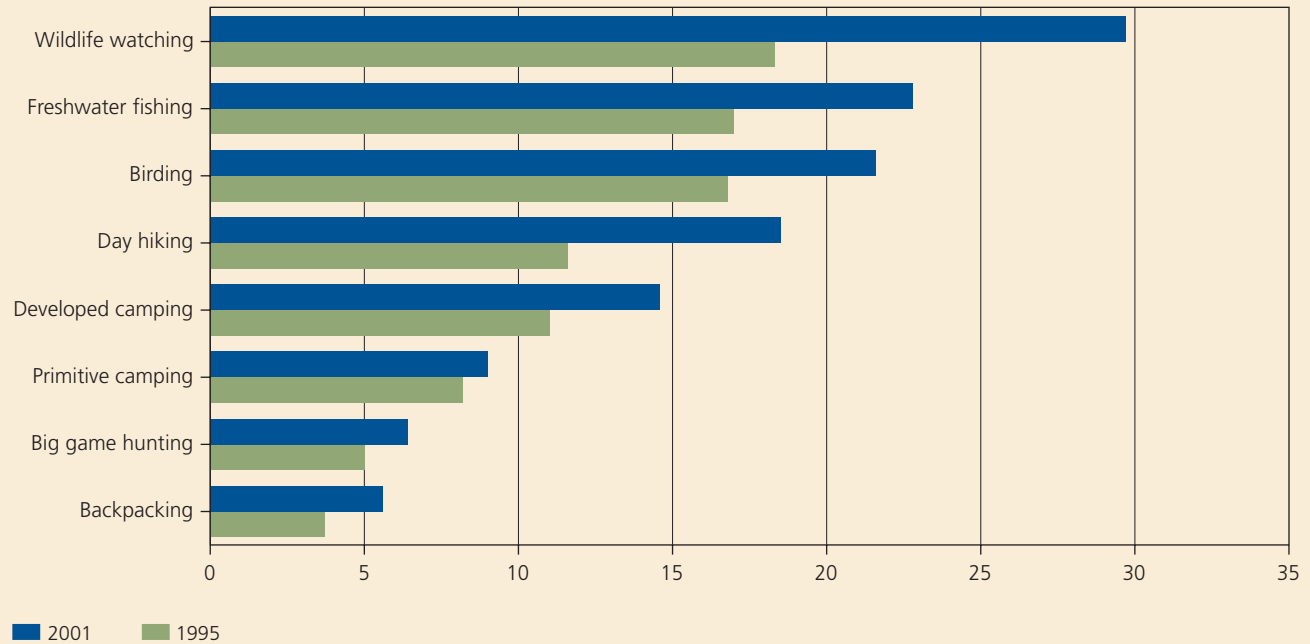
Southern forests provide a setting for a range of recreational activities, including hiking, camping, mountain biking, and viewing wildlife. People also fish, canoe, and raft in the many lakes and rivers located in southern forests. Participation in these and other forms of outdoor recreation has been growing in the South (Figure 2.6).

Of the nation's forests, those of the South are among the most popular recreation destinations. For instance, federally owned forests in the South are the third most heavily used of the nine U.S. Forest Service regions, with 25.8 million visitors

Sediment from upstream development in and around Birmingham, Alabama makes its way into nearby creeks and eventually into the Black Warrior River. Removal of trees for other land uses can result in increases in silt and sediment loads, the effects of which can be seen far downstream.

Figure 2.6 Trends in Outdoor Recreation in the South

Number of participants, millions



Source: Wear and Greis 2002.

in 2007 (USDA Forest Service 2008). Great Smoky Mountains National Park—located in the heart of southern forests—is the most frequently visited national park in the United States, with over 9 million recreational visitors in 2008.²³

Estimates vary widely regarding the economic contribution of recreation and tourism associated with southern forests. The U.S. Forest Service calculates that southern forests underpin an estimated \$19 billion to \$76 billion per year in recreational and tourism revenue. Likewise, southern forests support 250,000 to 1.15 million recreation- and tourism-related jobs in the region (Abt, Winter, and Hugget 2002).

Hunting and fishing

Many people hunt and fish in southern forests and adjacent areas. In 2000, more than 6 million people went hunting in the South for big game such as white tail deer, nearly 6 million people hunted for small game such as rabbit, and 2 million hunted for migratory birds such as ducks. In addition, nearly 23 million people that year went fishing in the freshwaters of the South (Abt, Winter, and Hugget 2002). Popular recreational fishing species include bass, catfish, and crappie.

Fishing and hunting are important recreational activities in the South.

Top: A man fishes for bass in a cypress pond in Georgia.

Bottom: A hunter and his bird dog search for quail in Louisiana.



JUDY BAXTER, FLICKR



BEN RECORD, FLICKR

These cultural services make a significant contribution to the region's economy. Expenditures on hunting, fishing, and wildlife-watching activities in the South were an estimated \$41.4 billion in 2006. This amount accounted for 34 percent of total U.S. expenditures on wildlife-associated recreation.²⁴ Spring turkey hunting alone generated \$1.8 billion in sales and related economic activity and supported 17,000 full- and part-time jobs in the South in 2003 (Southwick Associates 2003).

BIODIVERSITY

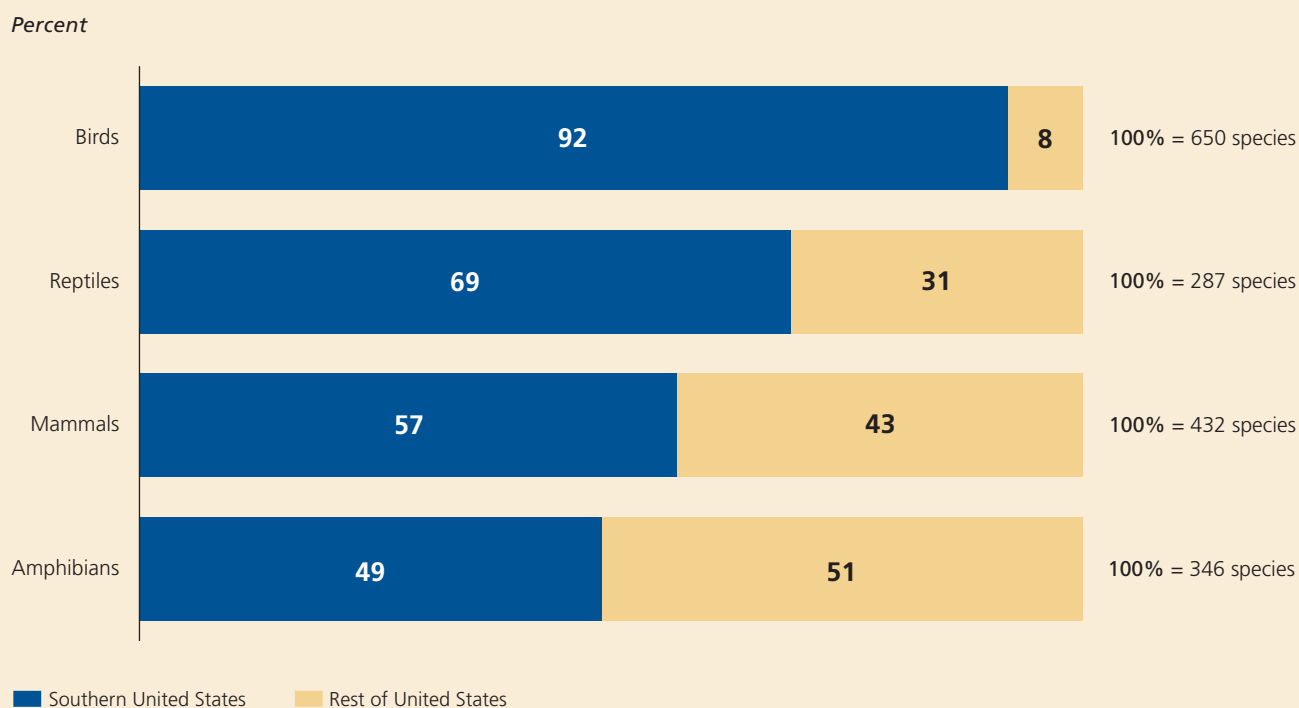
Southern forests are important for biodiversity. Healthy forests offer food, water, shelter, nesting sites, and migration paths for birds, as well as land animals. Forests located near streams and rivers maintain cool water temperatures during summer to the benefit of young fish and other organisms. Rotting wood and leaves serve as a foundation for ecosystem food chains. Although biodiversity is not itself an ecosystem service, it underpins the supply of ecosystem services.

A significant share of plants and animals found in the United States occur in the South (Figure 2.7). In particular, the South contains approximately (Trani 2002a):

- 595 species of birds, including turkey, woodpeckers, and warblers;
- 246 species of mammals, including the black bear, bobcat, and raccoon;
- 197 species of reptiles, including the southern painted turtle, glass lizard, and timber rattlesnake;
- 170 species of amphibians, including the marbled salamander, southern leopard frog, and American toad; and
- More than 130 species of trees, including oaks, dogwoods, and pines.

Since forests are the dominant natural ecosystem in the region, many of these species are forest-dependent or forest-adapted.

Figure 2.7 Share of Species Occurring in the United States that Live in the South



Source: Wear and Greis 2002.



DOUG BRADLEY, FLICKR



JASON AND KRIS CARTER, FLICKR



RICKY LAYSON, RICKY LAYSON PHOTOGRAPHY, BUGWOOD.ORG

Top: High-elevation Appalachian forests, such as this one on the North Carolina and Tennessee border, help maintain clean streams for people and wildlife.

Bottom left: Maritime forests, such as this one located at Cumberland Island, Georgia, are important for migratory birds.

Bottom right: This longleaf pine stand has high flowering plant diversity in the understory.

Figure 2.8 Southern Forests: A Center for Biodiversity

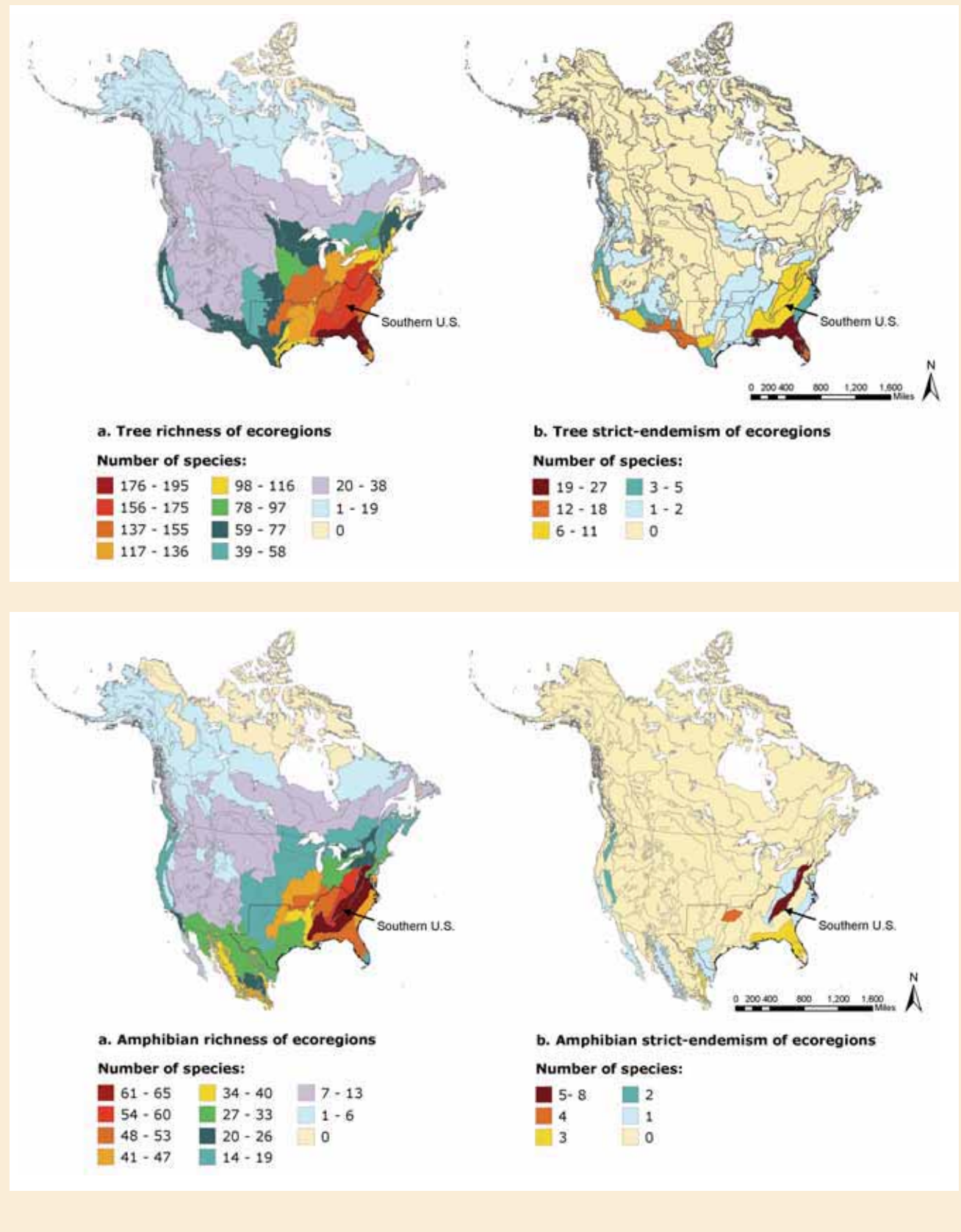
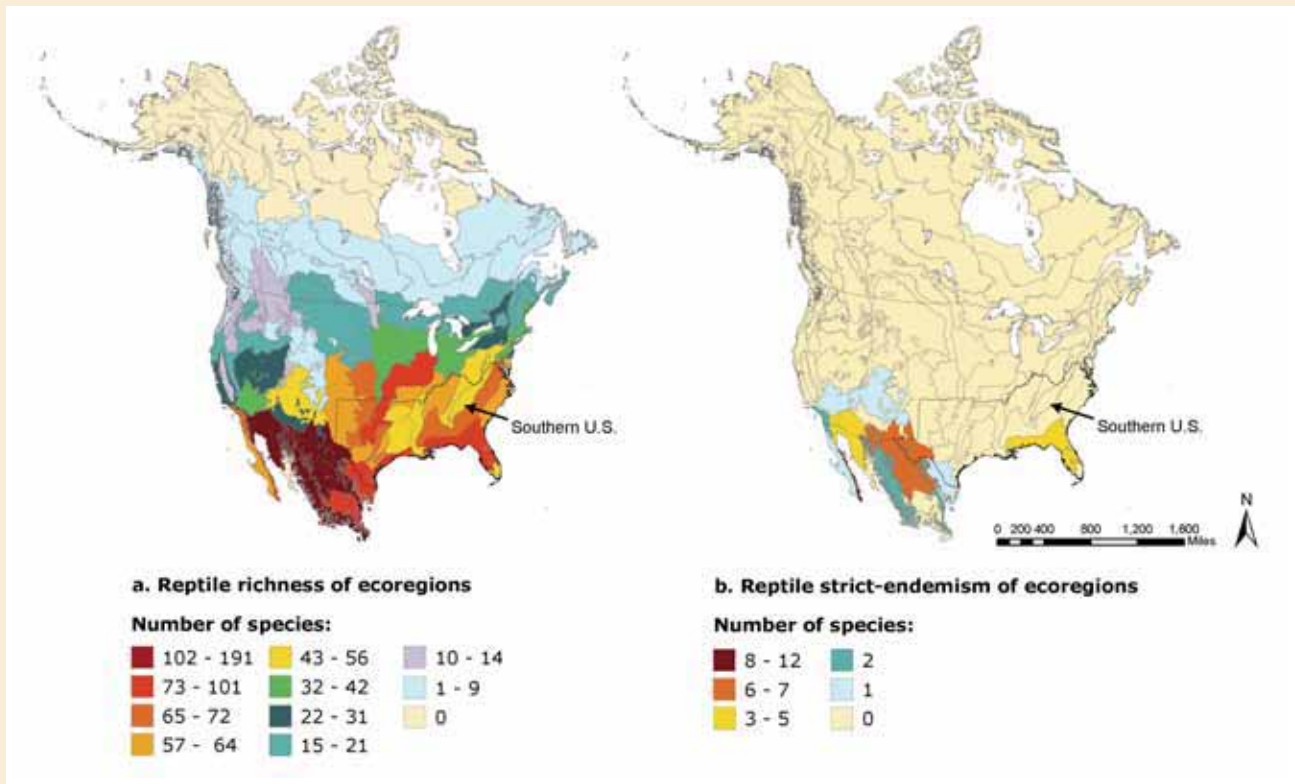


Figure 2.8 Southern Forests: A Center for Biodiversity – *continued*



Source: Tree data (Ricketts, Dinerstein, and Olson 1999), amphibian and reptile data (Ricketts, Dinerstein, and Olson 2001).

Within the region encompassed by the United States and Canada, southern U.S. forests and the terrestrial and aquatic ecosystems they contain are centers of biodiversity for several types of organisms, including trees, amphibians, and reptiles. For these types, the South hosts a high concentration of species richness—the number of species in a given area. The region is also a center of species endemism—the number of unique species found in a specific area but nowhere else (Figure 2.8).

Specific types of southern forest are particularly biodiverse. For example:

- By protecting water quality in mountain streams, high-elevation forests in the southern Appalachians are a world center of salamander diversity, including 68 species of a unique group of lungless salamanders (White, Wilds, and Thunhorst 1998).
- Coastal cypress swamps provide critical habitat for eastern North American populations of migratory and neo-tropical songbirds.²⁵
- Maritime forests on southern barrier islands are of critical importance for migratory birds (White, Wilds, and Thunhorst 1998).
- The longleaf pine savanna—an open, park-like forest ecosystem originally covering much of the southeastern United States—is one of the most diverse North American ecosystems north of the tropics (Box 2.2).

Box 2.2 Longleaf Pine Forests

Longleaf pine forests and savannas were one of the most extensive woodland ecosystems in North America prior to European settlement. Spanning approximately 90 million acres at the time, this ecosystem covered much of what would become the southeastern United States. Even as late as the mid-1800s, settlers commented on the vastness of this ecosystem. Passing through longleaf pine forests in South Carolina in 1858, Englishman Charles MacKay wrote:

*Where, northward as you go, the pines forever grow;
Where, southward if you bend, are pine-trees without end;
Where, if you travel west, Earth loves the pine-tree best;
Where, eastward if you gaze, through long, unvaried ways;
Behind you and before are pine-trees evermore.*

Longleaf pine forests are rich in biodiversity, particularly due to the species richness in the groundcover. These forests include 191 species of rare plants and an understory that can contain 130 species of plants in less than one-quarter of an acre. Of the South's native species of reptiles and amphibians, 170 are native to this ecosystem. Longleaf pine forests also support many species of carnivorous plants, including yellow pitcher-plants and the famed Venus flytrap.

Sometimes called “the forest that fire made,” longleaf pine forests adapted over millennia to fire triggered naturally or by Native Americans. Each stage of the tree's life cycle relates to fire, from the mineral soil required for seedlings to the thick bark that provides insulation and dissipates heat. Because periodic low-intensity fires clear undergrowth, natural longleaf forests are open, airy, grassy savannas, in contrast to dense, closed-canopy hardwood forests.

Longleaf pine forests are now one of the most endangered ecosystems in North America. Only about three percent of pre-European settlement longleaf pine forest area remains. In the entire South, just three counties contain more than 100,000 acres of longleaf pine.

Source: Earley 2004; White, Wilds, and Thunhorst 1998; Macie and Hermansen 2002.

Many factors underlie the biodiversity of southern forests. The region is generally warm with long summers and significant rainfall, averaging 43–55 inches per year over much of the South (White, Wilds, and Thunhorst 1998). The region's topography varies, with elevations ranging from 6,000 feet in the Blue Ridge of North Carolina to near sea level in the flats along the Atlantic and Gulf coasts (Alig et al. 2003). The region has a range of underlying soil types. Furthermore, the prevalence of geographically isolated ecosystems, such as the upland bogs of the southern Appalachians and the Lake Wales Ridge area in Florida, have created conditions conducive to the emergence of endemic species in southern forests.

Combined, these factors make southern forests a biological treasure. For many people, this biodiversity is important in its own right—it has “intrinsic value.” For all people, this biodiversity is important because it helps underpin the supply of many ecosystem services.

Notes

¹ Southern yellow pines include loblolly pine, longleaf pine, shortleaf pine, and slash pine. Available at <http://www.southernpine.com/expert/index.pl?leafcode=23> (accessed October 16, 2009).

² Tubbs, C.H., and D.R. Houston. *Fagus grandifolia* Ehrh. (American beech). Silvics of North America, United States Department of Agriculture. Available at http://www.na.fs.fed.us/spfo/pubs/silvics_manual/volume_2/fagus/grandifolia.htm (accessed June 14, 2009).



PHOTO: KESTREL360, FLICKR

A young longleaf pine emerges after a prescribed burn.



The understory of longleaf pine forests are diverse and contain a wide variety of carnivorous plants.



PHOTOS: CARNIVOROUS PLANTS BY JAMES HENDERSON, GULF SOUTH RESEARCH CORPORATION, BUGWOOD.ORG

The South is a world center of carnivorous plant diversity, which is often associated with longleaf ecosystems.

Graney, D.L. *Carya ovata* (Shagbark hickory). *Silvics of North America*, United States Department of Agriculture. Available at http://www.na.fs.fed.us/pubs/silvics_manual/volume_2/carya/ovata.htm (accessed June 14, 2009).

Sander, I.L. *Quercus valutina* Lam (Black oak). *Silvics of North America*, United States Department of Agriculture. Available at http://www.na.fs.fed.us/pubs/silvics_manual/volume_2/quercus/velutina.htm (accessed June 14, 2009).

³ Global statistics from the Food and Agriculture Organization of the United Nations (FAO) website. Global production for industrial roundwood—which includes saw logs, veneer logs, pulpwood, roundwood, and other industrial roundwood—was 115.5 billion cubic feet in 2006. The southern U.S. statistics come from the TPO regional report (2006). The South produced 3.3 billion cubic feet of pulpwood and a total of 8.6 billion cubic feet of wood in 2006.

⁴ Includes saw, veneer, pulp, composite, posts/poles/pilings, miscellaneous wood products, and domestic fuelwood. From Smith et al. 2009, Table 39.

⁵ Harvest volumes and conversion factors were taken from Johnson, Bentley, and Howell 2009. Delivered value was calculated using state-by-state price estimates published in Timber Mart South, Inc. 2007.

⁶ Regional economic impacts were calculated from RIMS II multipliers specific to the southern region provided by the Bureau of Economic Analysis. Indirect spending is spending by businesses who supply goods and services to the forest products industry. Induced spending is spending by households that earn labor income from businesses associated with the forest products industry.

⁷ The price of a cord varies, but generally falls in the \$75–\$150 range. Harvest volume of fuelwood taken from Johnson, Bentley, and Howell. 2009.

⁸ Some definitions of “non-timber forest products” include fuelwood. This publication treats fuelwood as a separate ecosystem service.

⁹ See Smith et al. 2009, Figure 6b.4.

¹⁰ Unless otherwise noted, the figures in this list are from Harper 2005.

¹¹ Moorman et al. 2002 (in Smith et al. 2009) identified more than 200 species of trees, shrubs, herbs, and vines used in landscaping that are native to the southern United States.



Great Smoky Mountains National Park, Tennessee

¹² In the South, pine straw is mostly harvested on private lands and can provide an important economic contribution to landowners and local economies. In Georgia, for example, the total estimated value of harvested pine straw increased from \$38.4 million in 2005 to more than \$62 million in 2006, representing 9.4 percent of Georgia’s total forest products industry. Source: Smith et al. 2009.

¹³ Saw palmetto is used to manage symptoms associated with benign prostatic hyperplasia (enlarged prostate). National Center for Complementary and Alternative Medicine Publication No. D275 (2006). Available at: <http://nccam.nih.gov/health/palmetto>.

¹⁴ Black cohosh was historically used for arthritis and muscle pain, but is currently used to treat symptoms of menopause and menstruation and to induce labor. National Center for Complementary and Alternative Medicine Publication No. D268 (2008). Available at: <http://nccam.nih.gov/health/blackcohosh/ataglance.htm>.

¹⁵ Some patients use ginseng in order to regulate blood sugar and boost their immune systems. MedlinePlus Herbs and Supplements, National Institutes of Health (2009). Available at: <http://www.nlm.nih.gov/medlineplus/druginfo/natural/patient-ginseng.html>.

¹⁶ Includes wild harvesting of ginseng. Source: Smith et al. 2009.

¹⁷ Pollutants assessed were nitrogen dioxide, sulfur dioxide, carbon monoxide, ground-level ozone, and particulate matter of 10 microns or less. Source: American Forests 2001.

¹⁸ This figure includes the sum of greenhouse gases emitted and absorbed by forests. Source: U.S. Environmental Protection Agency 2009.

¹⁹ These macroinvertebrates tend to indicate high water quality in a freshwater stream they inhabit and provide a foundation for the aquatic ecosystem.

²⁰ Forests, however, typically result in lower surface flows to nearby waterways because of infiltration and the transpiration of water into the atmosphere through leaves. Therefore, reducing forest cover and density generally increases surface water yield from watersheds, although these changes can be short-lived and depend on climate, soil characteristics, and the percentage and type of vegetation removal. For instance, streamflows increased 28 percent following a clear-cutting experiment in a southern Appalachian watershed. Source: McGuire, Kevin. "Water and Forest Cover Literature Review." Virginia Water Resources Research Center & Dept. of Forest Resources & Environmental Conservation, Virginia Tech. Citation in literature review taken from Swank et al. 2001.

²¹ According to the U.S. Environmental Protection Agency, nonpoint source pollution from agriculture, urban development, and suburban development accounts for more than 60 percent of impairment in U.S. waterways, including many drinking water sources. Source: Barten and Ernst 2004.

²² A "watershed" is the area of land above (in terms of elevation) a given point on a stream, lake, river, or estuary that contributes water to that waterbody. A watershed is also referred to as a "drainage basin."

²³ Great Smoky Mountains National Park. National Park Service Public Use Statistics Office. Online at <http://www.nature.nps.gov/stats/viewReport.cfm> (accessed June 15, 2009).

²⁴ Wildlife-associated recreational activities include fishing, hunting, and wildlife-watching (i.e., observing, photographing, and/or feeding fish or wildlife). These activities are not mutually exclusive. Many individuals participate in more than one of these activities at the same time. Source: U.S. Department of the Interior, Fish and Wildlife Service 2006.

²⁵ Erickson-Davis, Morgan. 2008. "Louisiana cypress mulch industry devastates old-growth forests." Online at: http://news.mongabay.com/2008/1105-morgan_cypress.html (accessed November 28, 2009).

History



CHAPTER

III

To better view the horizon of southern forests and their ecosystem services, it is helpful to briefly look at the landscape of the past. The history of these forests is one of dynamic change. Since the end of the last ice age, natural disturbances and human activities have continually shaped southern forests. Changes in climate affected species composition and distribution. Hurricanes, tornadoes, and other natural events created periodic forest clearings. Frequent low-intensity fires set by Native Americans created openings and influenced the dynamics of fire-dependent forest ecosystems.

Over the past 400 years, activities such as agriculture, timber extraction, and settlement by European colonists and their descendants have been leading sources of human-induced change in southern forests. One indicator of this change is forest extent.¹ Although information is limited (Box 3.1), some estimates suggest that forests covered more than 350 million acres throughout the South in the early 1600s (Wear and Greis 2002b). During the subsequent four centuries, more than 99 percent of these acres were cut at one time or another; very little pristine or primary southern forest remains (Box 3.2) (Trani 2002b). Demonstrating the renewability and resiliency of forests, much of the land regenerated over time as secondary forest.² However, approximately 40 percent of estimated pre-European settlement forest acreage has been converted to other uses (Wear and Greis 2002b).

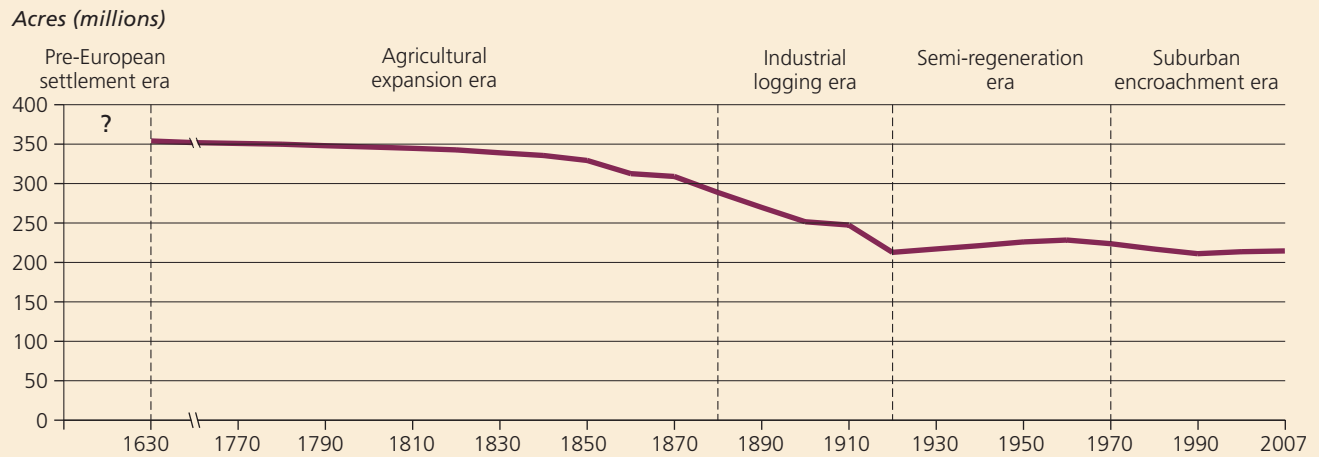
The history of southern forests since the last ice age can be viewed through a variety of lenses. One approach is to categorize it into roughly five eras: 1) pre-European settlement, 2) agricultural expansion, 3) industrial logging, 4) semi-regeneration, and 5) suburban encroachment (Figure 3.1). Each era is characterized by the leading cause or driver of change in forest quantity (extent and distribution) and/or quality (composition and health) during that time period, the implications for people and forest ecosystems, and the ecosystem services people valued.

A few caveats are worth noting. First, the drivers of change in these eras often overlap and interact. For instance, a forest may initially be harvested for timber and subsequently converted into farmland. Second, the start of one era does not necessarily mean that the previous era's leading driver of change ceased to have an impact. For example, agriculture continued to expand during the industrial logging era. Thus, these eras are simplifications of a more complex historical reality. Third, the drivers of change vary by the degree of permanence of their impacts. For example, after a timber harvest, a forest will regenerate; forests are renewable. Agriculture may suppress forest regeneration for a time, but forests will return if farming ceases. Urban and suburban settlements, on the other hand, tend to entail more long-term forest change.

Box 3.1 Data Limitations

Any profile of southern forest history is limited by data availability. Eyewitness descriptions of the extent and ecology of southern forests only exist for the past 400 or so years, with few written observations before 1650. Estimates about the state of these pre-European settlement forests, therefore, come indirectly via a range of archaeological, paleo-ecological, ecological, and geological evidence. Insights into the history of southern forests between the mid-1600s and early 1900s often depend on written accounts, inventories, archaeological evidence, and a small number of early photographs from the late 1800s. Few maps of southern forests during this time exist and surveyors often used different measurement methods and thresholds of forest cover. Information on southern forests began to become more diverse and reliable after 1945. Inventories and maps became more frequent. Photographs became more common and satellite imagery, starting in the mid-1970s, offered a new angle on forest monitoring.

Figure 3.1 Forest Cover in the Southern United States (1630-2007)



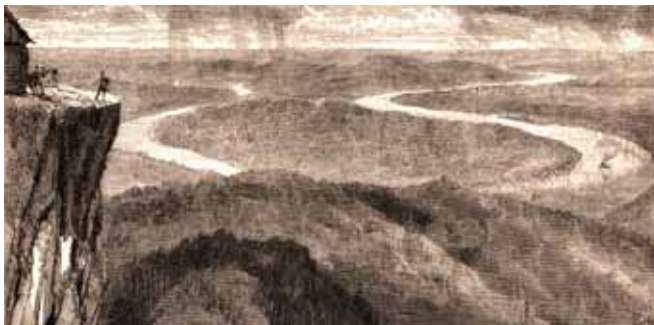
Source: Total forest extent from U.S. Department of Agriculture, Forest Inventory and Analysis (FIA) data, online at <http://www.fia.fs.fed.us/slides/major-trends.ppt>, and in Smith et al. 2009.

Note: The time boundaries of each era are estimates. The drivers of change that defined each era often overlapped in time.

1. PRE-EUROPEAN SETTLEMENT ERA (PRE-1630)

Natural climate variations and lightning-induced, as well as human-induced, fires were the two largest influences on the extent, distribution, and composition of southern forests between the last ice age and European settlement (Carroll 2002). During the peak of the most recent ice age or glacial period—about 18,000 to 20,000 years ago—the region north of present-day Atlanta was dominated by pine and spruce trees, much like Maine’s forests are today (Earley 2004). To the south, temperate deciduous species such as oaks were common. As the climate warmed after the end of this glacial period, oaks spread and dominated the landscape for certain periods, and pines dominated at others. Eventually, mixed hardwoods and spruce became common in the region’s interior, fir and northern hardwoods in the higher elevations of the Appalachian Mountains, and southern pines in the sandy uplands of the coastal plain—up to modern-day southeastern Virginia (Earley 2004).

A common romantic portrayal is that the pre-European southern landscape was a pristine, relatively untouched forest wilderness—a “forest primeval.” However, paleo-ecological, archaeological, and other evidence suggests this was unlikely.



Above: An early drawing of a primary cypress swamp forest near the Mississippi River. Note the Native American in the bottom center for scale.

Left: View of primary forests from Lookout Mountain, near what is now Chattanooga, Tennessee.

ORIGINAL SKETCHES BY J. WELLS CHAMPNEY. SOURCE: LIBRARY OF CONGRESS, WASHINGTON DC

Box 3.2 How Much Pristine Forest Remains in the Southern United States?

Various, sometimes overlapping, definitions of pristine forest exist, including “primary forest,” “old-growth forest,” and “intact forest landscapes.”

Primary forest

Although definitions vary, a primary forest often refers to a forest of native species where there are no clearly visible indications of human disturbance and where ecological processes are not significantly disturbed. Primary forests usually contain old-growth trees if the site has been free of natural disturbances such as hurricanes or catastrophic fire (Hubbard, Latt, and Long 1998). Primary forests are sometimes called “virgin forests.” Identifying primary forests with precision is difficult since Native Americans used fire to manage forests prior to European settlement and record keeping. Scientists may never know exactly which forests are truly primary.

In light of this limitation in information, one approach is to identify forests that have not been cut or cleared by people after European settlement. According to this approach, the South—as well as the rest of the continental United States—lost most of its primary forests over the past four centuries as trees were felled for timber or land was cleared for agriculture and settlements (Figure 3.2). Although many areas eventually returned to forest cover, these regenerated forests are secondary forests. Today, remaining primary forests in the South include portions of the Great Smoky Mountains National Park, the Okefenokee Swamp, and the Big Cypress National Preserve near the Florida Everglades.

Old-growth forest

Definitions of old-growth forest vary. According to one definition, an old-growth forest is characterized by having large old trees (at least 150–200 years old), an accumulation of woody debris, and multilayered canopies (Trani 2002b). According to the U.S. Forest Service, the southern United States currently contains less than 586,000 acres of old-growth forest—less than 1 percent of the forest cover present when European settlers first arrived (Trani 2002b). These patches tend to be on sites that are difficult to access, such as steep slopes or dense swamps (Trani 2002b).

Intact forest landscapes

Existing intact forest landscapes are defined as a territory that contains forest and non-forest ecosystems minimally influenced by human economic activity, with an area of at least 500 square kilometers (equivalent to 50,000 hectares or 125,000 acres) and a minimal width of 10 kilometers or 6 miles (measured as the diameter of a circle that is entirely inscribed within the boundaries of the territory).³ Areas with evidence of certain types of human influence are considered disturbed and consequently not eligible for being considered an intact forest landscape. These types of human influence include:

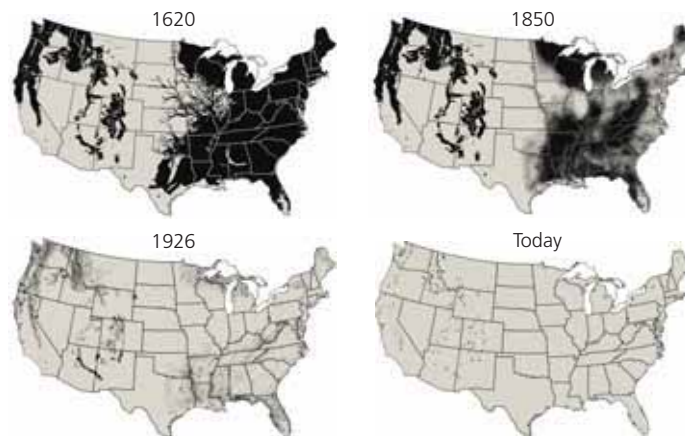
- Settlements (including a buffer zone of one kilometer);
- Agriculture and timber production;
- Industrial activities during the past 30–70 years, such as logging, mining, oil and gas exploration and extraction, and peat extraction; and
- Infrastructure used for transportation between settlements or for industrial development of natural resources, including roads (except unpaved trails), railways, navigable waterways (including seashore), pipelines, and power transmission lines (including in all cases a buffer zone of one kilometer on either side).

Similar to the definition of primary forest, three locations within southern forests today meet the criteria of intact forest landscapes (Figure 3.3):

- Portions of the Great Smoky Mountains National Park;
- Okefenokee Swamp; and
- The forests of southwestern Florida, comprised of Big Cypress National Preserve, portions of the Marjory Stoneman Douglas Wilderness Area (within Everglades National Park), and the Everglades and Francis S. Taylor Wildlife Management Area (a Florida Fish and Game State Wildlife Management Area).

Figure 3.2 Area of Primary or “Virgin” Forest in the United States

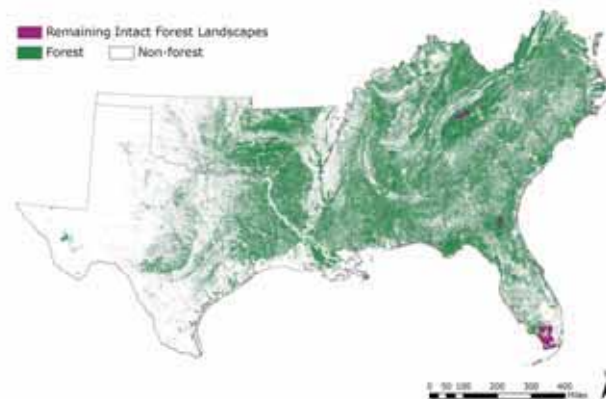
Each dot represents 25,000 acres



Source: Greeley 1925; Foreman and Wolke 1992.

Note: In the “today” map, virgin forests are defined as forests that have never been cut by humans after European settlement.

Figure 3.3 Intact Forest Landscapes of the South



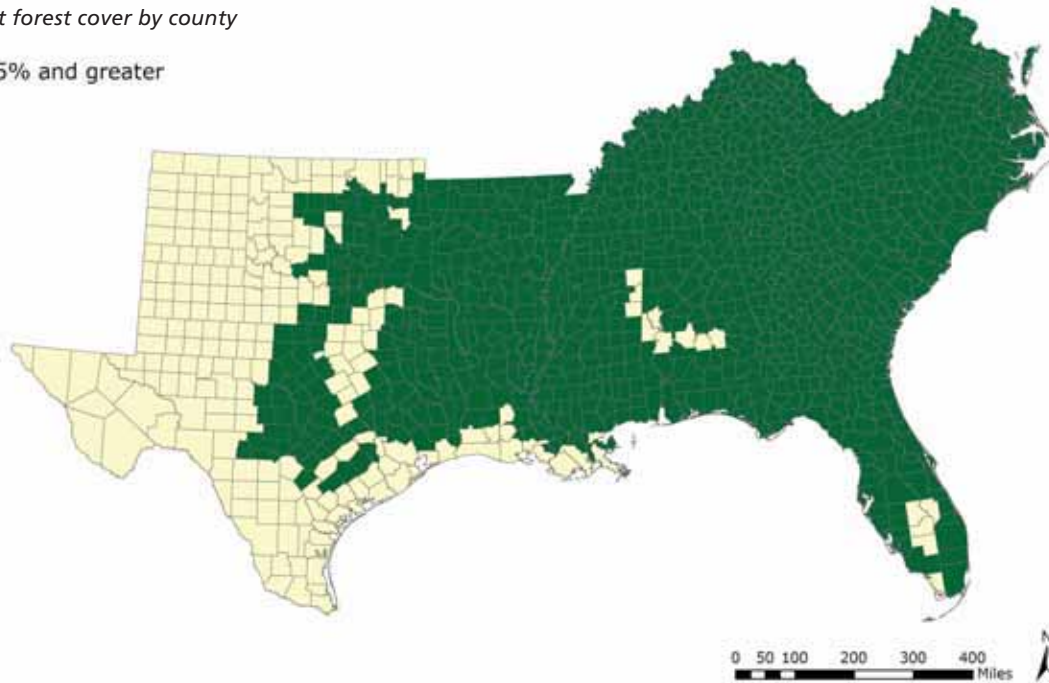
Source: Intact Forest Landscapes (Greenpeace and WRI 2006), forest cover (U.S. Geological Survey 2007), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Note: The southwest corner of Florida is woody wetlands. According to the intact forest landscape analysis, woody wetlands are considered “forest.” In some maps of historic forest cover, however, woody wetlands are not considered “forest.”

Figure 3.4 Extent of Potential Forest Cover in the South (c. 1630)*

Percent forest cover by county

75% and greater



*Based on estimates and mapped onto modern county lines to serve as a reference. Southern forests were most likely not a single contiguous block of tree cover in 1630. Like other forests, southern forests are naturally dynamic. Natural and human-induced fires and other natural disturbances such as hurricanes and ice storms likely created periodic openings in the tree canopy. Where these openings were in 1630, however, is unknown. Canopy openings shift over time due to new disturbances and regrowth via natural succession.

Source: WRI analysis based on potential forest cover (Global Forest Watch 1997) and administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Native American communities were well-established before European settlement, with an estimated 1.5 to 2 million people living in the forests of the southeastern portion of the region alone (Earley 2004). Native Americans relied on southern forests for ecosystem services including food (such as wild game and berries), fuel (wood for fire), and shelter (wood for homes). Most notably, native communities used fire to shape some of the forest to meet their needs. Many Native Americans in the region regularly set fires to clear brush and understory growth in order to facilitate travel, improve game habitat, and make it easier to hunt and grow food (Earley 2004).

These human-induced fires impacted southern forests in a number of ways. Where used, they suppressed new tree growth in the understory, creating an open, park-like forest. Captain John Smith, for instance, noted that in the forests surrounding the Jamestown, Virginia settlement in the early 1600s “a man may gallop a horse amongst these woods any waie, but where the creeks and Rivers shall hinder” (Williams 1989). Burning created conditions favorable to selected pines, oaks, and other species that thrive under periodic low-intensity fire disturbances. Fires also created openings in the forest canopy and prevented natural forest succession. Virginia’s Shenandoah Valley, for instance, was at one time a grass prairie due to annual burning by Native Americans

(MacCleery 1994). Likewise, a chronicler of Hernando De Soto’s expedition from 1539–1543 noted that, in what is today northern Florida, Native American fields of corn, beans, squash, and other vegetables “were spread out as far as the eye could see across two leagues [approximately 6 miles] of plain.” (MacCleery 1999).

As a result of these climatic and human influences, the southern landscape was a diverse mosaic of expansive forests of different ages—interspersed with savannas and swamps—by the time Europeans arrived (Trani 2002b). The landscape teemed with large herbivores such as white-tailed deer, elk, and bison—indicating the presence of forest openings made possible by Native American fires and natural disturbances. The forests included large carnivores such as bobcat, cougar, and the red wolf. Numerous other mammals such as the river otter, gray fox, and red fox populated the ecosystem, as did a plethora of birds, fish, reptiles, and amphibians (Trani 2002b).

Circa 1630, potential forest cover in the South may have extended for more than 350 million acres (Wear and Greis 2002b) (Figure 3.1) and stretched from the Atlantic Ocean to the Mississippi River and beyond (Figure 3.4). By this time, canopy openings may have started to close as European diseases introduced by explorers began to take their toll on Native American communities (MacCleery 1994).



Left: A color lithograph from 1841 of men burning girdled trees to clear land for planting.

For more than two-and-a-half centuries, the most common and widespread occupation in the region was farming. Although settlers valued southern forests for the ecosystem services of fuelwood, timber, and wild game, more importantly they valued what lay underneath the forest—land for agriculture (Williams 1989). Farmers thus started clearing and converting forest into fields (Williams 1989).

This era of agricultural expansion had a pronounced effect on the distribution and composition of the region's forest landscape in at least three ways. First, settlers reduced southern forest extent by converting large swaths of woods to agricultural fields and grazing lands. Farms with corn, other food crops, tobacco, and—after around 1784 (West 2009)—cotton became an increasingly prominent part of the landscape. In addition, forests gave way to pastures for cattle and other livestock. Between 1630 and 1880, an estimated 65 million acres of southern forest was cleared, primarily for agriculture (Figure 3.1). By the 1870s, people had transformed the South from a region pervaded by forest to one with a patchwork of forests. According to a forest survey from 1873, the dense forest cover that remained was concentrated primarily in southern Georgia, southern Alabama, Florida, and in the region's mountainous interior (Figure 3.5).

Second, settlers altered forest composition by fragmenting the forest landscape and increasing the proportion of forest that was second-growth.⁴ Farm plots broke up previously intact forest expanses. As farming expanded, demand for building material, fences, and fuel increased as well. For most of this era, trees met this demand. As late as 1840, for instance, wood supplied an estimated 95 percent of U.S. energy requirements for heating, lighting, and transportation (Williams 1980). In addition,

2. AGRICULTURAL EXPANSION ERA (c. 1630–1880)

Europeans began to permanently settle portions of the South in the 1600s, concentrated at first in southeastern Virginia. During the 1700s, settlements in the South spread along the Atlantic Coast and inland toward and over the Appalachian Mountains. Expansion westward accelerated during the 1800s.



The Black Mountains, part of the Blue Ridge of the Appalachians. Note the almost complete lack of live trees. Appeared in "Winter in the South," Harper's New Monthly Magazine Volume 0015 Issue 90 (November 1857).



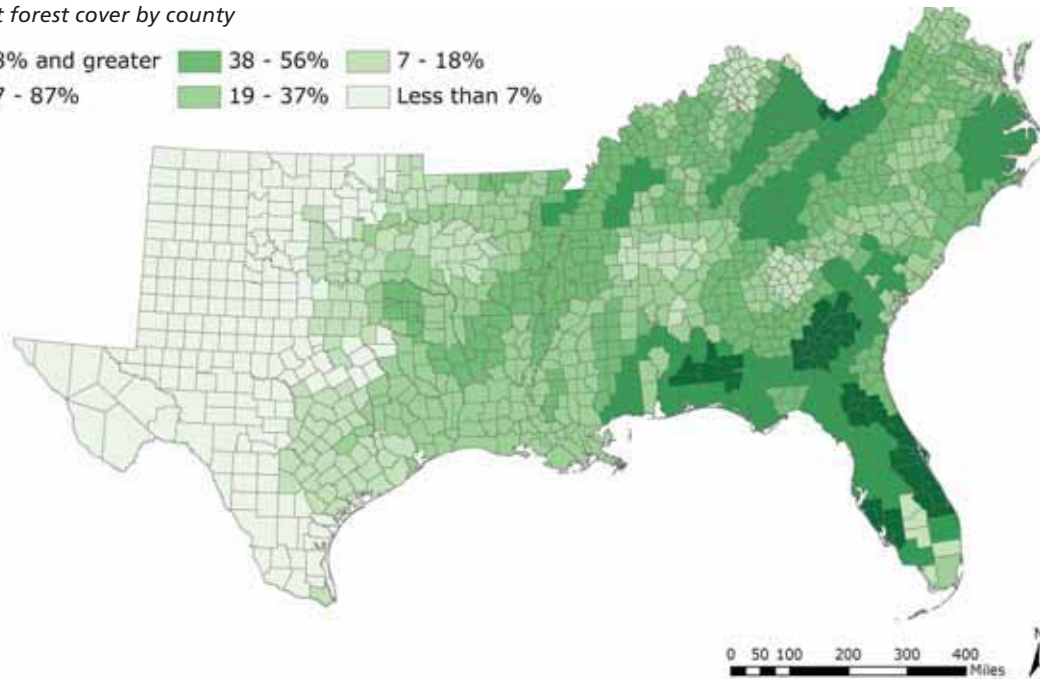
Currently known as Sharp Top, this is one of the Peaks of Otter near Bedford, Virginia. Much of the surrounding land in this 1856 engraving has been cleared for fields and pastures. Appeared in "Virginia Illustrated," Harper's New Monthly Magazine Volume 0012 Issue 68 (January 1856).



A typical homestead located at the foot of what is now Mt. Mitchell in North Carolina. Appeared in "Winter in the South," Harper's New Monthly Magazine Volume 0015 Issue 90 (November 1857).

Figure 3.5 Extent of Southern Forests (1873)

Percent forest cover by county



Source: WRI analysis based on forest cover (Brewer 1873) and administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

southern forests helped provide naval stores.⁵ Furthermore, wood was used to fuel the emerging train system and supply its ties, bridges, and trestles (Williams 1980). Harvesting trees to meet this demand continued to convert once-primary forests into secondary forests.

Third, settlers altered forest composition by disrupting Native American fire-based forest management systems. Soon after Europeans arrived, Native American populations started to decline in the South due to conflict, relocation, and the spread of European diseases such as smallpox. With fewer native communities setting fires, fire-dependent, open-canopy forest ecosystems started to become closed canopy (Baker and Hunter 2002). In some locations, however, Europeans did adopt the practice of managing lands with fire to maintain savannas and other open areas. These fires created desirable grazing conditions for domesticated animals (Trani 2002b).

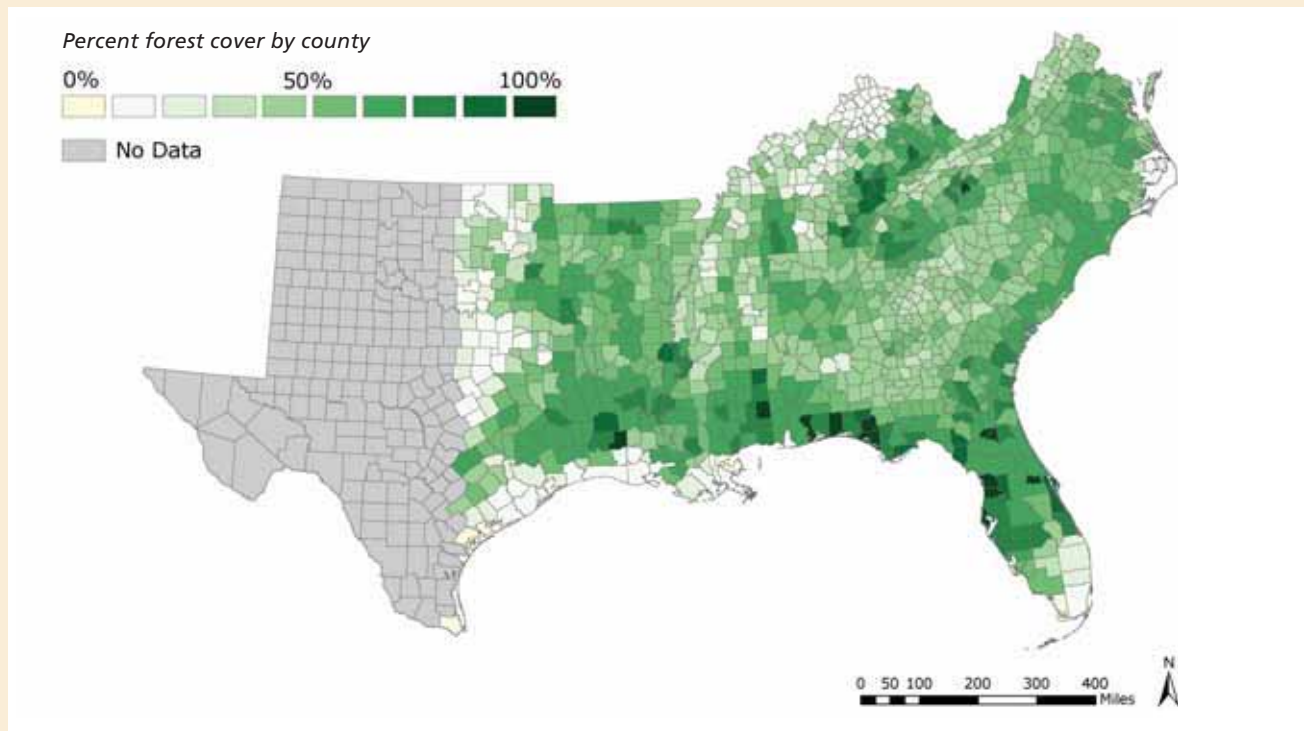
Concern about the sustainability of extensive forest cutting and clearing began to increase during the 1800s. With forests being cut with little thought for regeneration, U.S. President James Madison proclaimed in 1818 that of all the errors in the rural economy of the United States, “none is so much to be regretted, perhaps because none is so difficult to repair, as the injurious and excessive destruction of timber and firewood” (Williams 1989). But the emergence of a more widespread sustainable forest management and conservation ethic was still a century away.

3. INDUSTRIAL LOGGING ERA (c. 1880–1920)

Agricultural expansion continued after the Civil War (1861–65) and into the 20th century. By the late 1800s, large-scale timber extraction emerged as a complementary driver of change in southern forests. With diminishing supply from the Great Lakes region, industrial logging in the United States shifted its focus to the South in the 1880s (Williams 1989). Logging technology, capital, and expertise flowed into the region. Railroad networks provided relatively rapid, mass transport for logs. As a result of these and other factors,⁶ large-scale logging activity in the region accelerated; by 1919, the region was producing 37 percent of U.S. lumber (Williams 1989). In short, the ecosystem service of timber became a dominant value of the forest.

During this era, much of the remaining primary or virgin forests of the South were cut (Figure 3.2).⁷ Forests regenerated on some logged-over areas, while agriculture and grazing moved in on others. By the end of this era, southern forests reached their lowest extent in terms of acreage. After nearly three centuries, southern forest area had declined to approximately 213 million acres by 1920 (Figure 3.1). By this time, a sizable share of the South’s landscape was composed of farmland and southern forest cover had become thinner and more fragmented (Figure 3.6).

Figure 3.6 Extent of Southern Forests (1920)



Source: WRI analysis based on reconstructed historical land cover (Steyaert and Knox 2008) and administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).



Looking down a logging railroad spur through a southern white cedar cutover area. Cordwood is piled and ready to be loaded. Dismal Swamp, Pasquotank, North Carolina, 1922.

PHOTO: C. F. KORSTIAN. U.S. FOREST SERVICE SOUTHERN RESEARCH STATION COLLECTION, D.H. RAMSEY LIBRARY, SPECIAL COLLECTIONS, UNIVERSITY OF NORTH CAROLINA AT ASHEVILLE 28804



Cutover forest and stumps in western North Carolina.

PHOTO: PHOTOGRAPHER, DATE, AND LOCATION UNKNOWN. U.S. FOREST SERVICE SOUTHERN RESEARCH STATION COLLECTION, D.H. RAMSEY LIBRARY, SPECIAL COLLECTIONS, UNIVERSITY OF NORTH CAROLINA AT ASHEVILLE.

PHOTO: PHOTOGRAPHER AND DATE UNKNOWN. U.S. FOREST SERVICE

Logs being transported by railroad to a mill in Arkansas.



4. SEMI-REGENERATION ERA (c. 1920–70)

Around the 1920s, an era of forest semi-regeneration began. This era would also witness a growing appreciation of a wider suite of ecosystem services provided by southern forests, including watershed protection and recreation.

Four factors in particular fueled semi-regeneration of southern forests. First, farmers abandoned marginal cropland and pastures due to (a) soil erosion; (b) a financial crisis that hit the agricultural sector in the 1920s; and (c) the rise of urban jobs. Furthermore, the spread of crop pests such as the boll weevil—which adversely affected cotton growers—started to take their toll on farmers (Aug et al. 2003). The rate of land abandonment and subsequent succession to forest was especially high during the Great Depression and World War II.

Second, the region started adopting electricity and transportation fuels that were not wood-based. In the early 1930s, less than 15 percent of rural southern households had electricity; by 1955, however, rural electrification had reached 94 percent of the population (Wolman 2006). This and other energy transitions reduced pressure on forests for fuelwood—but increased dependence on fossil fuels.

Third, private sector investment in forest management increased during this era. Forest product companies replanted forests and encouraged tree planting on other private lands. Companies, in collaboration with universities and government agencies, invested in research to improve forest productivity and land management practices, enabling the South to generate more than its proportionate share of the nation's forest products.⁸

Fourth, in response to concerns that had been expressed earlier, the U.S. government started to strengthen forest resource management and introduce incentives for reforestation. One development was the establishment of the U.S. Forest Service in 1905. Under the U.S. Department of Agriculture, the Forest Service's mission was—and still is—to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations.⁹ The Forest Service also took charge of newly created national forests, many of which were established to ensure long-term supplies of



Six years after a 1960 strip clearcut, longleaf pine seedlings grow on the cutover land.

PHOTO: WILLIAM D. BOYER, USDA FOREST SERVICE, BUGWOOD.ORG

timber and to protect watersheds from erosion and sedimentation of waterways.¹⁰

Congress established the South's first national forest—the Ouachita National Forest in Arkansas and Oklahoma—in 1907. The purchase by the federal government of land in every southern state continued through the 1930s and culminated with the creation of the region's last national forest in 1961, the Uwharrie in North Carolina (Connor and Hartsell 2002). Many of these national forests in the South were established on cutover woodland or degraded farmland and subsequently reforested through a combination of active planting and natural regeneration.

Several laws came into effect during this era. For example, the Clarke-McNary Act of 1924 allowed for government purchase of private lands that were potentially valuable for timber production. The 1960 Multiple Use-Sustained Yield Act officially expanded the objectives of U.S. national forests to include outdoor recreation and wildlife habitat conservation in addition to watershed protection and the sustainable yield of timber.¹¹ The 1964 Wilderness Act designated selected forests and other ecosystems as dedicated to non-motorized recreation and wild-

Men from the Civilian Conservation Corps work on Tuskegee reforestation project in Macon County, Alabama in 1937.



PHOTO: ARTHUR ROTHSTEIN, LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS DIVISION, WASHINGTON DC. [HTTP://hdl.loc.gov/loc.pnp/pp.print](http://hdl.loc.gov/loc.pnp/pp.print)

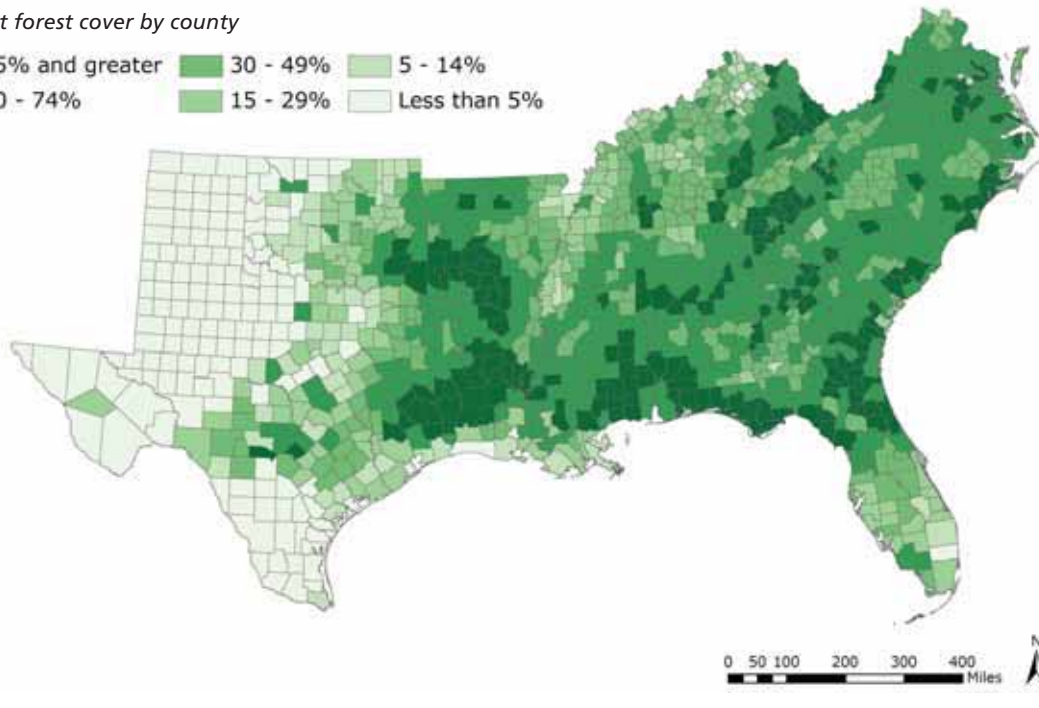
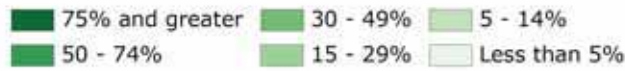
Recreational use of forests expanded during the 20th century. Here, in 1959, a sport fisherman in Pisgah National Forest shows his catch to a forest ranger.



PHOTO: LELAND J. PRATER, U.S. FOREST SERVICE

Figure 3.7 Extent of Southern Forests (1959)

Percent forest cover by county



Source: WRI analysis based on forest cover of 1959 (USDA 1967) and administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

life, off-limits to logging, mining, and other extractive uses.¹²

Several government incentive programs also helped spur forest recovery in the region. For example, the Civilian Conservation Corps carried out natural resource conservation activities such as tree planting on national, state, and municipal lands. As part of the Soil Bank Act legislation, the government initiated the Conservation Reserve Program (CRP)—commonly referred to as the “Soil Bank Program”—in 1956 and provided subsidies for shifting cropland to forest cover. The program was

quite effective; during its first four years, more than 1.9 million acres in the South were enrolled (Dangerfield et al. 1995).¹³

Due to a combination of these factors, the tide turned and southern forests made a partial comeback in terms of forest extent. Dense forest cover became particularly prevalent in Arkansas, Louisiana, the mountainous interior of the region, and the Gulf Coast (Figure 3.7). Recovery of forest area peaked in the early 1960s at approximately 228 million acres (Figure 3.1) (Alvarez 2007).



PHOTO: WILLIAM D. BOYER, USDA FOREST SERVICE, BUGWOOD.ORG



Far left: A Civilian Conservation Corps crew plants longleaf pine in a “stump orchard” in Louisiana.

Immediate left: Eroded farmland in Greene County, Georgia. May or June 1941

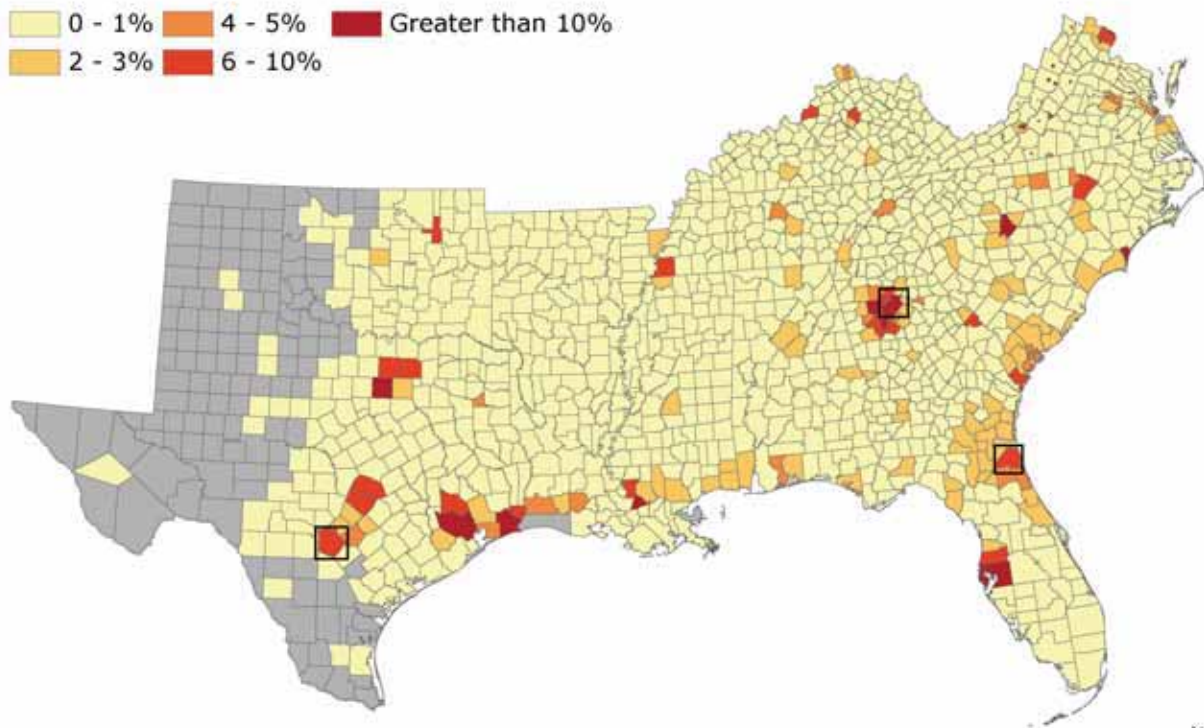
PHOTO: JACK DELANO, LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS DIVISION, WASHINGTON D.C., HDL.LOC.GOV/LOC.PNP/FSAC.1A33891, FLICKR

being lost. In 1990, for instance, southern forest land increased 1.3 million acres while conversion of forests to other uses was an estimated 841,000 acres (Conner and Hartsell 2002).

In the decade that followed, however, forest conversion once again outpaced reforestation. From 1992–2001, an estimated 15 million acres of land converted out of forest, while under

6 million acres of land converted into forest.¹⁶ Areas of forest gains and losses were dispersed throughout the region (Figures 3.9 and 3.10), although concentrations of forest loss occurred in the outskirts of major cities. During this decade, the South was a hotspot for forest conversion to development. Of the U.S. states that lost cropland, forests, and other open spaces to suburban

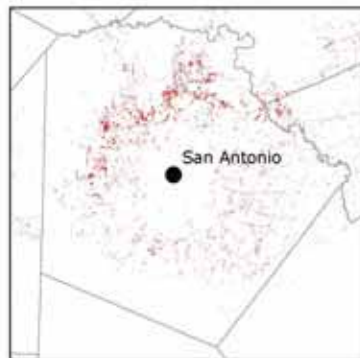
Figure 3.9 Forest Cover Loss to Urban/Suburban Development (1992-2001)



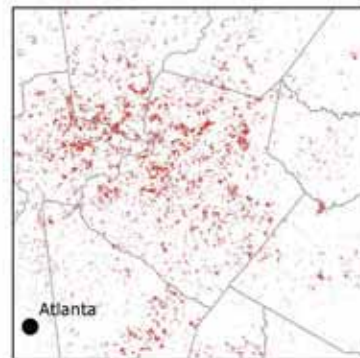
Note: Only counties that had at least 5% of land area forested in 2001 were included in these calculations.

Forest cover loss to urban/suburban development

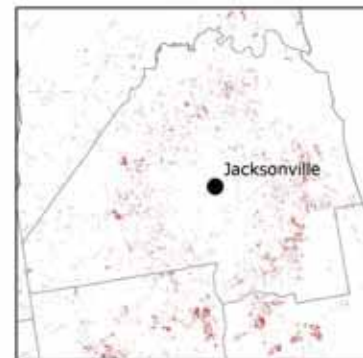
Bexar County, Texas



Gwinnett County, Georgia

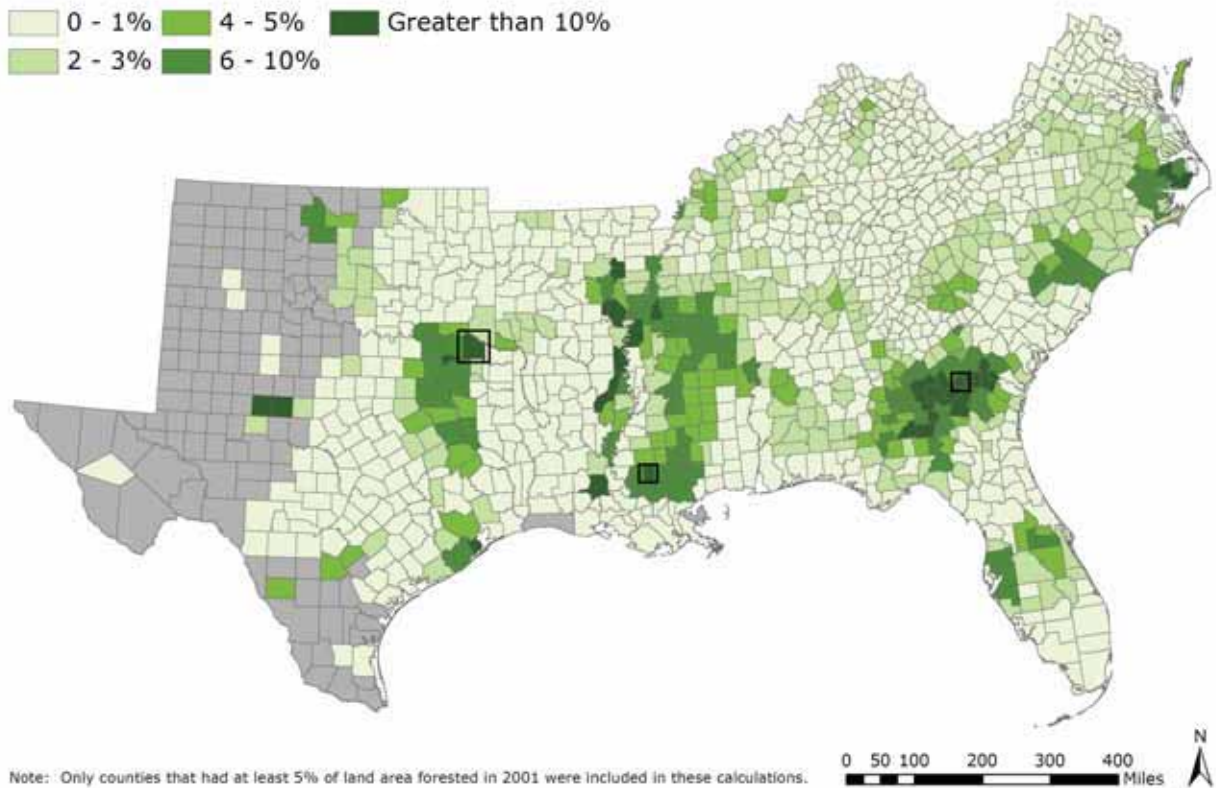


Duval County, Florida



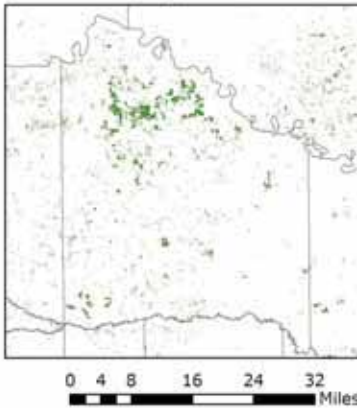
Source: WRI analysis based on land cover change (U.S. Geological Survey 2003) and administrative boundaries and cities (ESRI Data and Maps 9.3.1, ESRI 2008).

Figure 3.10 Forest Cover Gain from Agricultural Land (1992-2001)

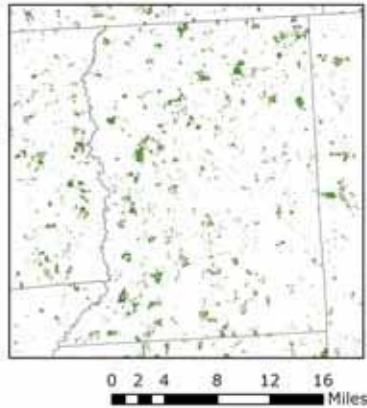


Forest cover gain from agriculture

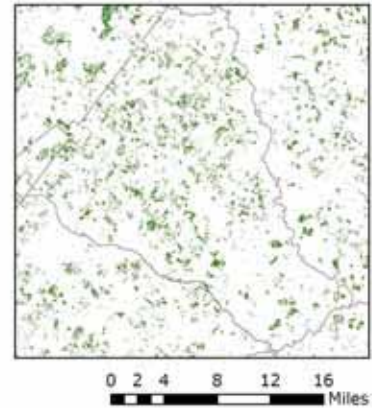
Red River County, Texas



St. Helena County, Louisiana



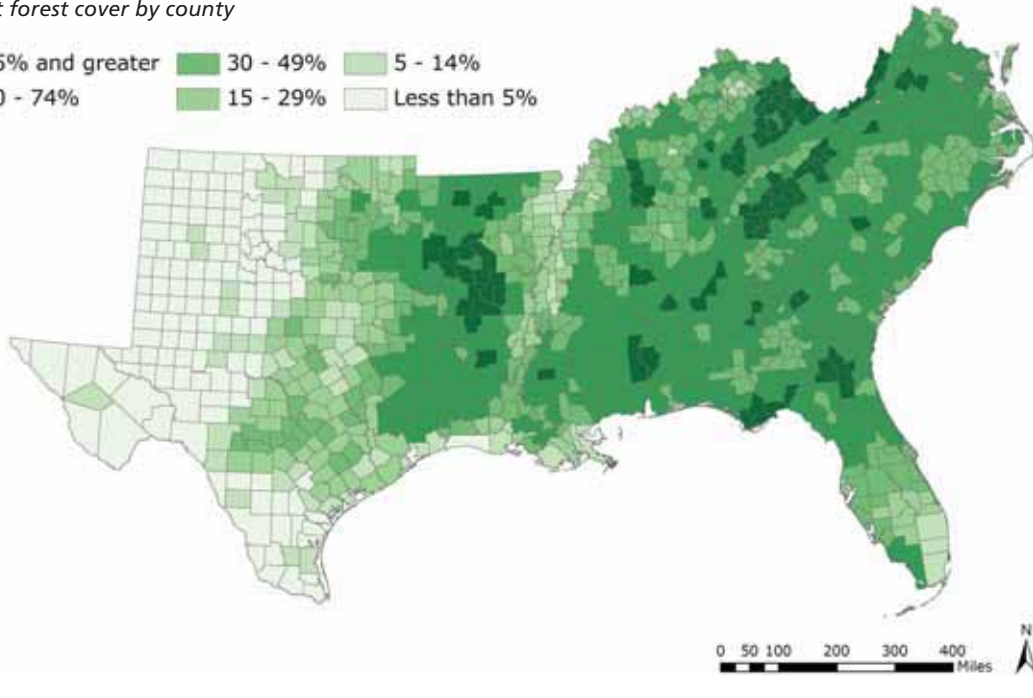
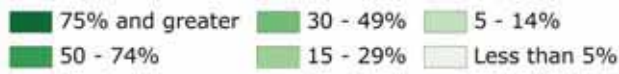
Wheeler County, Georgia



Source: WRI analysis based on land cover change (U.S. Geological Survey 2003) and administrative boundaries and cities (ESRI Data and Maps 9.3.1, ESRI 2008).

Figure 3.11 Extent of Southern Forests (early 2000s)

Percent forest cover by county



Source: WRI analysis based on forest cover (U.S. Geological Survey 2007) and administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

development during the 1990s, six of the top ten were southern states: Texas, Georgia, Florida, North Carolina, Tennessee, and South Carolina (in descending order) (Aug et al. 2003).

The net effect of these drivers of change is that southern forests started to retreat once again during the suburban encroachment era. From the previous era's peak in the early 1960s, southern forest extent declined a net 14 million acres to 214 million acres by 2007 (Figure 3.1).¹⁷ Forest cover retreated where population centers grew, particularly along the eastern foothills of the Appalachians, the Atlantic coast, and the Gulf coast. The extent of dense forest cover declined once again (Figure 3.11).

These trends in southern forests, particularly in terms of forest extent, highlight an important distinction between the two eras of the 20th century. Forests that are converted to agricultural land may one day become forest again, since farming is often a transitory land use influenced over time by economics, landowner goals, and other factors. Natural, contiguous forests that are converted to urban and suburban uses, however, are impacted usually for a longer time period. Unlike corn and cotton, houses and highways are permanent crops.



PHOTO: DANIEL LOBO-DAQUELLAMANERA.ORG

A forest near Katrina, Mississippi, is cleared for suburban development.

Notes

¹ Forest extent does not capture all of the types of change a forest may experience, but it is a “second-best” measurable proxy.

² Secondary forest is a forest or woodland area that has regenerated after a disturbance (e.g., fire, insect infestation, large-scale timber harvest) for a long enough period so that the effects of the disturbance are no longer evident.

³ Greenpeace, WRI & IFL Mapping Team. Data and methods: Definition and criteria. Intact Forest Landscapes. Online at <http://www.intactforests.org/world.methodology.html>

⁴ The forest that returns after a mature forest is cut will often have a different tree species mix than the mature forest. The pioneer tree species that emerge after the cut are often shade intolerant species (such as sumac, sweetgum, sassafras), accompanied by plant and animal species adapted to early successional forests. Through the process of succession, the forest will mature over time and become dominated by shade-tolerant species (such as oak, beech, hemlock) and associated flora and fauna.

⁵ Naval stores include masts, spars, and planking for ships as well as the products obtained from the sap of coniferous trees such as tar, pitch, turpentine, and resins for making hulls and decks waterproof. Naval stores were an important element of the economies and trading patterns of the South and northern New England. However, extracting naval stores had a relatively minor impact on southern forests compared to agricultural clearing and fuel gathering (Williams 1989).

⁶ For example, the price of cotton did not recover after the Civil War as other sources of supply had been developed. With state economies depressed, timber and labor were the few resources the region had to support economic recovery. Bill Stuart, personal communication, October 16, 2009.

⁷ As evidence of this point, by 1930, 75 percent of the wood supply in Mississippi came from second generation forests. The timber industry responded to the shift to smaller diameter logs by moving to small, portable mills. Bill Stuart, personal communication, October 16, 2009.

⁸ Bob Emory, personal communication, October 18, 2009; Bill Stuart, personal communication, October 16, 2009.

⁹ U.S. Forest Service. Online at <http://www.fs.fed.us/aboutus/mission.shtml>

¹⁰ U.S. national forests are controlled by the U.S. federal government and managed by the U.S. Forest Service under the Department of Agriculture. Unlike national parks, commercial activities in national forests—such as timber harvesting and livestock grazing—are permitted. The national forest system was created by the Land Revision Act of 1891.

¹¹ The United States Forest Service. Online at http://www.cis.drexel.edu/faculty/shelfer/public_html/busrefpapers/usforst.htm

¹² Wilderness Act. Public Law 88-577 (16 U.S. C. 1131-1136)

¹³ Figure excludes Kentucky.

¹⁴ Examples include the Forestry Incentive Program, the Forest and Rangeland Renewable Resources Planning Act, and the National Forest Management Act.

¹⁵ 1970 population data: U.S. Census, prepared by PA State Data Center. 2008 data source: U.S. Census Population Estimates. “Estimates of the Resident Population by Selected Age Groups for the United States, and Puerto Rico: July 1, 2008.” (SC-EST2008-01). Online at <http://www.census.gov/popest/states/asrh/SC-EST2008-01.html>

¹⁶ WRI analysis of the National Land Cover Dataset, 1992–2001.

¹⁷ U.S. Department of Agriculture, Forest Inventory and Analysis (FIA) data, online at <http://www.fia.fs.fed.us/slides/major-trends.ppt>; and in Smith et al. 2009.



Drivers of Change

CHAPTER

IV

Looking ahead, a number of direct and indirect drivers of change are likely to impact the quantity and quality of southern forests over the coming 2–3 decades. “Quantity” refers to forest extent and distribution, while “quality” refers to forest health and species composition. This chapter briefly elaborates on several of these direct drivers of change and their potential implications for southern forest ecosystem services.¹

DRIVERS OF CHANGE

“Direct drivers” are factors—of natural or human origin—that cause changes in an ecosystem and thereby increase or decrease its ability to provide certain ecosystem services. Two leading direct drivers expected to affect southern forest extent and distribution over the coming 2–3 decades are suburban encroachment into forests and the reversion of agricultural land back into forest (Wear and Greis 2002a). In other words, these two trends of the 20th century are likely to continue. Direct drivers expected to affect forest quality include pest and pathogen outbreaks, fire, and climate change, among others.

These direct drivers, in turn, are being influenced by a range of indirect drivers. For example, suburban encroachment is in part a function of population growth, land use policies, and land values. Combined, these and other drivers will create causal chains impacting southern forest quantity and quality over the next few decades (Figure 4.1).

The suite of direct drivers includes a mix of factors. Some increase forest quantity (or quality), while others decrease forest quantity (or quality). Similarly, a single direct driver of change can have mixed implications for southern forests. For instance, low-intensity fires can contribute to maintaining forest health, while high-intensity fires can disrupt forest ecosystems and their processes. “Drivers of change,” therefore, should not be

interpreted as necessarily having a negative connotation; rather, the phrase merely refers to a factor that causes alterations in forest quantity or quality. Furthermore, some direct drivers such as climate change affect other drivers, and thereby can have a magnified impact on forests.

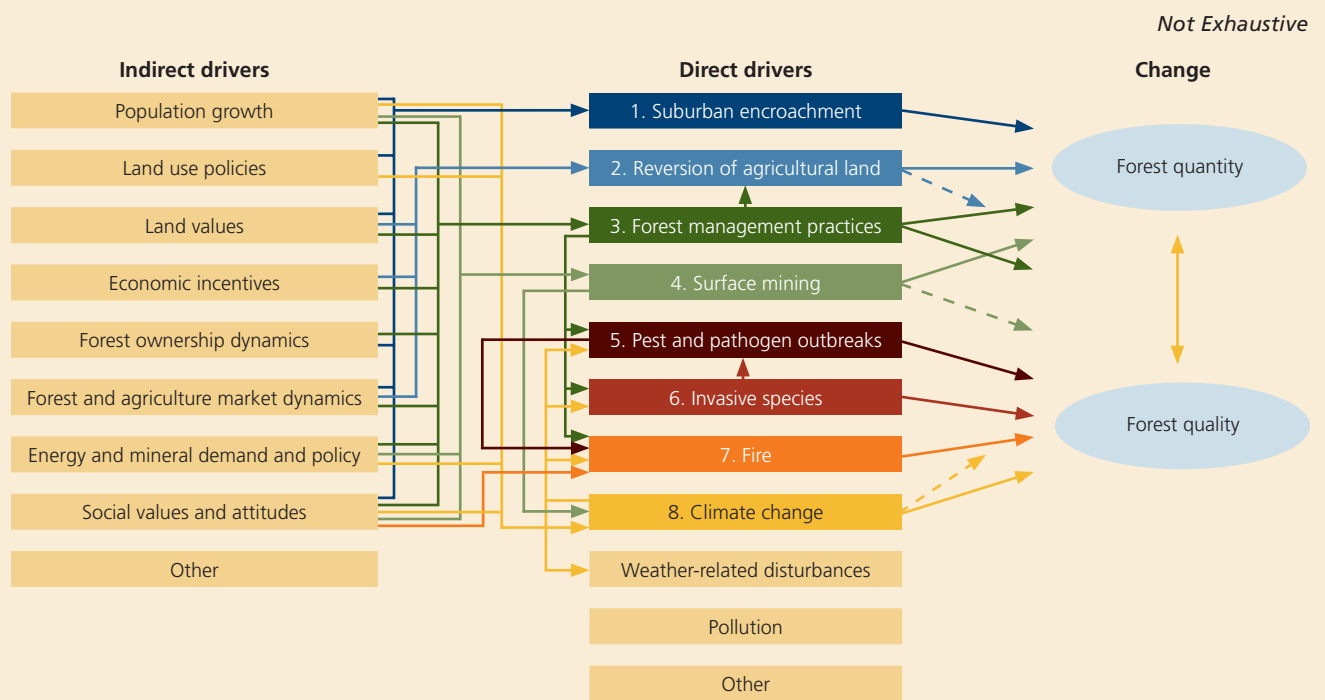
1. Suburban encroachment

Conversion of southern forests to suburban development is projected to continue well into the first half of the 21st century. The U.S. Forest Service estimates that suburban encroachment will convert approximately 12 million acres of southern forests to development between 1992 and 2020, and an additional 19 million acres between 2020 and 2040 (Wear 2002). Combined, these 31 million acres comprise an area roughly equal to the size of North Carolina.

Hotspots of projected suburban encroachment on southern forests include (Figure 4.2):

- The outskirts of cities along the Appalachian piedmont or foothills, including Charlotte and Raleigh, North Carolina; Greenville, South Carolina; and Atlanta, Georgia.
- The outskirts of cities on the Atlantic and Gulf coasts.
- The outskirts of cities in the region’s interior, such as Nashville, Tennessee and Birmingham, Alabama.
- The corridor between Washington, D.C. and Richmond, Virginia.

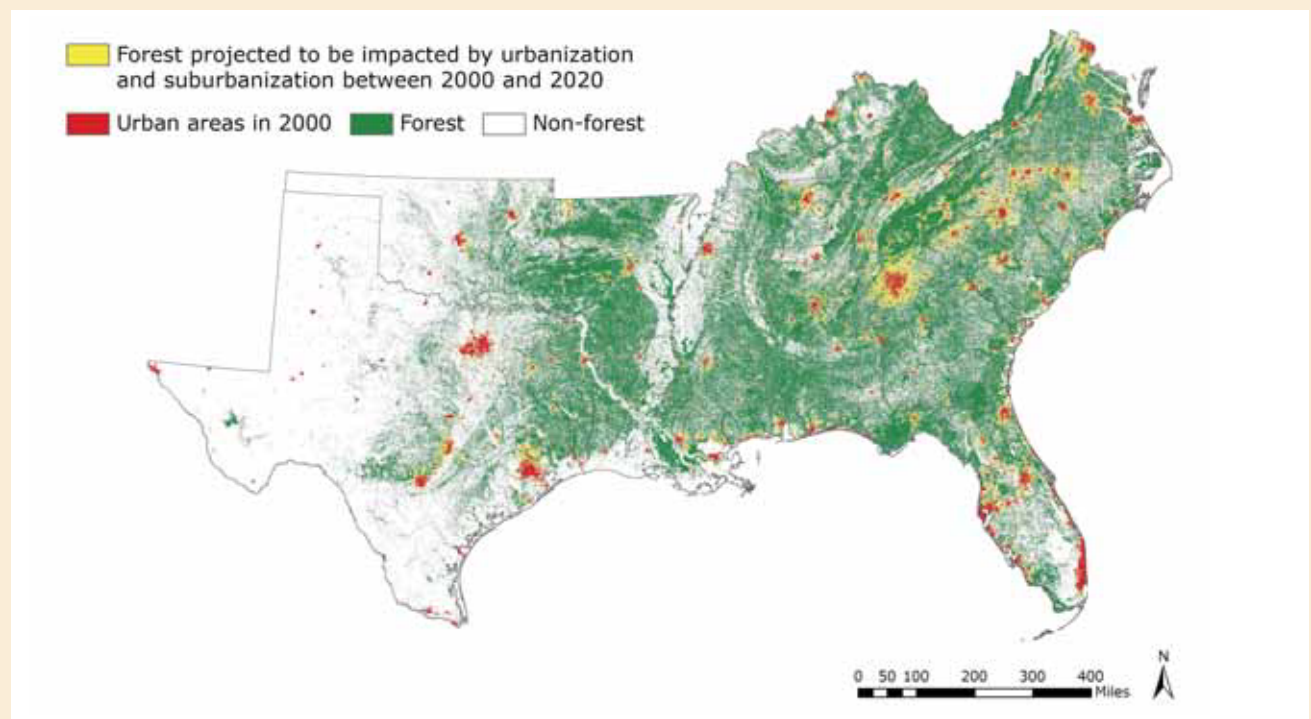
Figure 4.1 Key Drivers of Southern Forest Change



Source: WRI analysis

Note: Direct drivers are not necessarily listed in order of relative importance or impact on southern forests. Arrows are not included for direct drivers not discussed further in the text.

Figure 4.2 Hotspots of Suburban Encroachment on Southern Forests (2000-2020)



Source: WRI analysis based on housing density projections (Theobald 2008), forest cover (U.S. Geological Survey 2007), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Several indirect drivers underlie continued suburban encroachment. One factor is population growth. The region's population is expected to increase at a rate of 6 to 14 percent per decade through 2030 (Table 4.1). Most of these new residents will live in urban and suburban areas.

A second factor is land use policies that facilitate low-density development (Macie and Hermansen 2002). A third factor is land values. As the value of land rises over time, particularly on the outskirts of metropolitan areas, a private forest owner's financial return per acre of selling forest land to a commercial or residential real estate developer becomes much more attractive than managing forest land for timber, recreation, and/or conservation.

Nonetheless, people need homes. How to accommodate population growth while minimizing further southern forest loss or fragmentation will be a key challenge going forward.

2. Reversion of agricultural land

Reversion of agricultural land to forest—a trend that grew in the early 20th century—may continue in some rural parts of the South over the coming decades. This forest growth is expected to occur due to active tree planting in response to market prices for timber and biomass energy, as well as reforestation incentive programs, while some will occur naturally on marginal farmland (Wear 2002). The indirect driver of forest and agricultural market dynamics, particularly the economic returns of forestry relative to agriculture, will play a major role in determining the scale and pace of this reversion. All else being equal, timber or forest-based biomass energy prices rising relative to agricultural prices tend to encourage tree planting. Assuming timber price increases of 0.5 percent per year, the U.S. Forest Service projected approximately 10 million acres of southern agricultural land to revert to forest between 1992 and 2020, and an additional 15 million acres to revert to forest between 2020 and 2040 (Wear 2002).

This potential forest gain, however, is not a panacea for southern forests, nor will it likely occur in all parts of the region. Although it will counter some forest loss due to suburban encroachment, it will not completely offset the latter. The U.S. Forest Service projects that the region will still experience a net loss of 2 million acres from 1992–2020, and another net 4 million acre loss from 2020–2040. In addition, some of the gross forest gain will likely be dominated by selected commercially valuable species, while much of the gross forest loss due to suburban encroachment will constitute natural forests with a wider range of species. Furthermore, farmland reversion to forest is expected to occur primarily in the rural western part of the South—particularly in the states of Arkansas, Louisiana, and Mississippi—while suburban encroachment and associated forest loss is expected to occur near urban areas further east (Figure 4.3). As a result, the relative distribution of southern forests may shift westward.

Table 4.1 Population Growth in the South: 1990-2030

Year	Population (millions)	10-year growth (percent)
1990	80.3	n/a
2000	91.8	14.3
2010	104.4	13.7
2020	117.8	12.8
2030	125.2	6.3

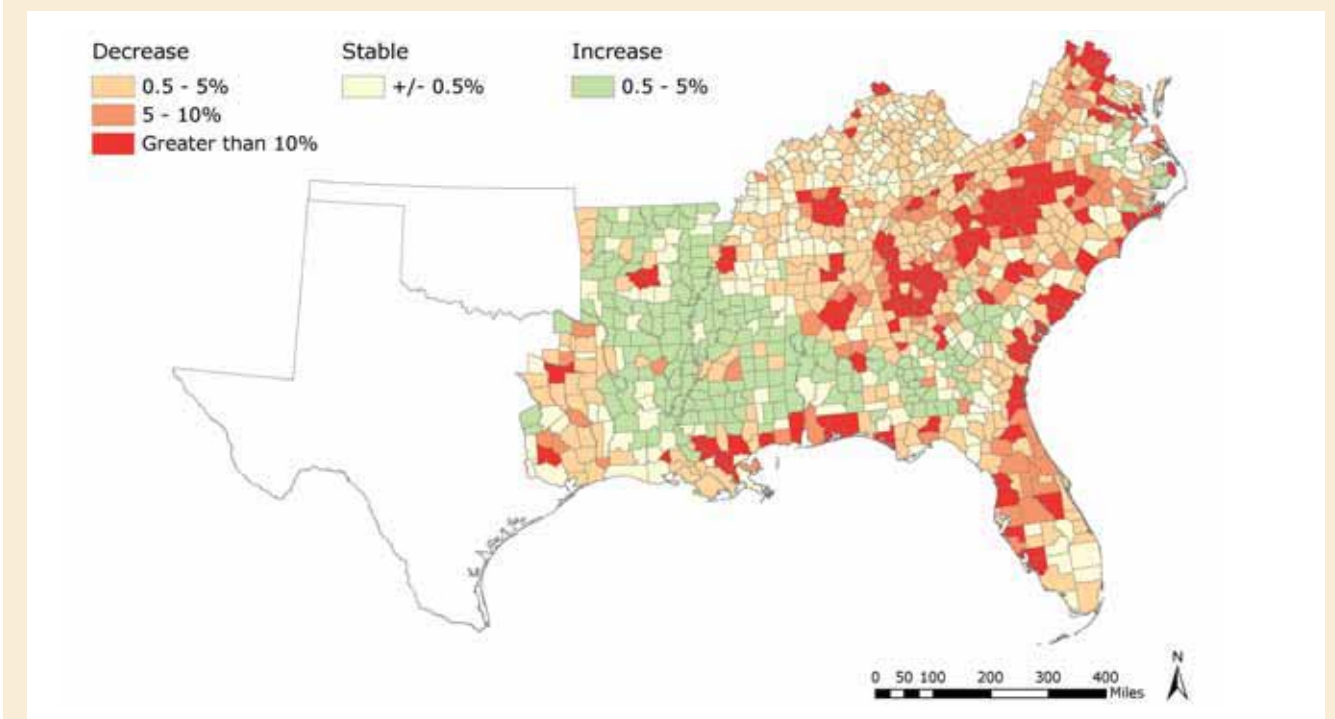
Source: U.S. Census Bureau 2005.

Absent this relative price increase, however, this projected reversion is unlikely to arise. The U.S. Forest Service estimates that stable timber and agricultural prices would lead to no transitions between agriculture and forests (Wear 2002). If this were to occur, then losses in southern forest cover would approach a net 31 million acres between 1992 and 2040 (Wear, Carter, and Prestemon 2007).

Energy demand and policies, particularly those regarding renewable energy, will be another indirect driver influencing the amount of agricultural land that may revert to forest. To the degree that non-forest, crop-based energy sources such as corn and soybeans meet this potential demand, the amount of agricultural land that reverts to forest may be lower than expected; forest conversion to agricultural land might even occur in some places if demand for crop-based bioenergy is sufficiently high. To the degree that forest-based energy sources meet this potential demand, the amount of agricultural land that reverts to forest may be high.

Other implications of a possible bioenergy boom for southern forests are still unclear, and stakeholders have expressed multiple perspectives. For instance, bioenergy could generate new income streams for forest landowners, encourage owners to keep their land in forest cover, and stimulate more forest thinning and removal of fuel buildup—helping to prevent wildfires (Dwivedi and Alavalapati 2009). At the same time, the crossover between possible end uses of logging residues and roundwood could entail that an increase in demand for forest biomass-derived energy affects the price or availability of wood resources for traditional wood products such as pulp and paper (Abt and Abt 2010). Research on these effects and possible silvicultural implications is underway.²

Figure 4.3 Projected Change in Forest Area by County (1992-2020)



Source: Forest area projections (Wear and Greis 2002a), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Note: Data from Oklahoma not available.

3. Forest management practices

How southern landowners manage their forests will shape forest quantity and quality over coming decades. The degree to which forest owners manage their land to yield forest-based ecosystem services will maintain, if not increase, southern forest extent and distribution. The degree to which they actively implement sustainable forest management practices will maintain, if not improve, forest composition and health. Examples of such practices include removing invasive species, conducting prescribed burns in fire-adapted forest ecosystems, maintaining riparian buffer zones, restocking with native species, and implementing other practices.

One challenge going forward is to ensure that forest owners, particularly family forest owners, have sufficient awareness of sustainable forest management practices and the resources to implement them. Studies indicate that only a small share of family forest owners receive advice about forest management practices. According to a 2006 survey, only approximately 15 percent of family forest owners indicated they had received advice about their forests. Similarly, only an estimated 120,000 of the nearly 4 million southern family forest owners had forest management plans (Butler 2008).

One management approach that garners much attention and that will continue to influence the character of southern forests is the establishment of forests planted mainly for the production of timber and pulpwood. Different types of planted forests exist

(Figure 4.4). The predominant species used in plantations or “productive planted forests” in the South are loblolly pine and slash pine,³ native species valued for their fast growth and versatility for construction timber and paper products. Due to incentive programs, longleaf pine is also gaining popularity.

In 1996, planted forests⁴ comprised 36 million acres, or 17 percent of all forest land in the South (Smith et al. 1997). In 2006, planted forests comprised approximately 43 million acres, or 20 percent of all forest land in the South (Smith et al. 2009). By 2040, the overall area of productive planted pine forests in the South is expected to increase to 54 million acres (Wear and Greis 2002), with Georgia, Florida, and Alabama having the most acreage (Figure 4.5). The degree to which this expected growth is achieved will be a function of global forest product market dynamics (Prestemon and Abt 2002), as well as the availability and relative value of land, among other factors.

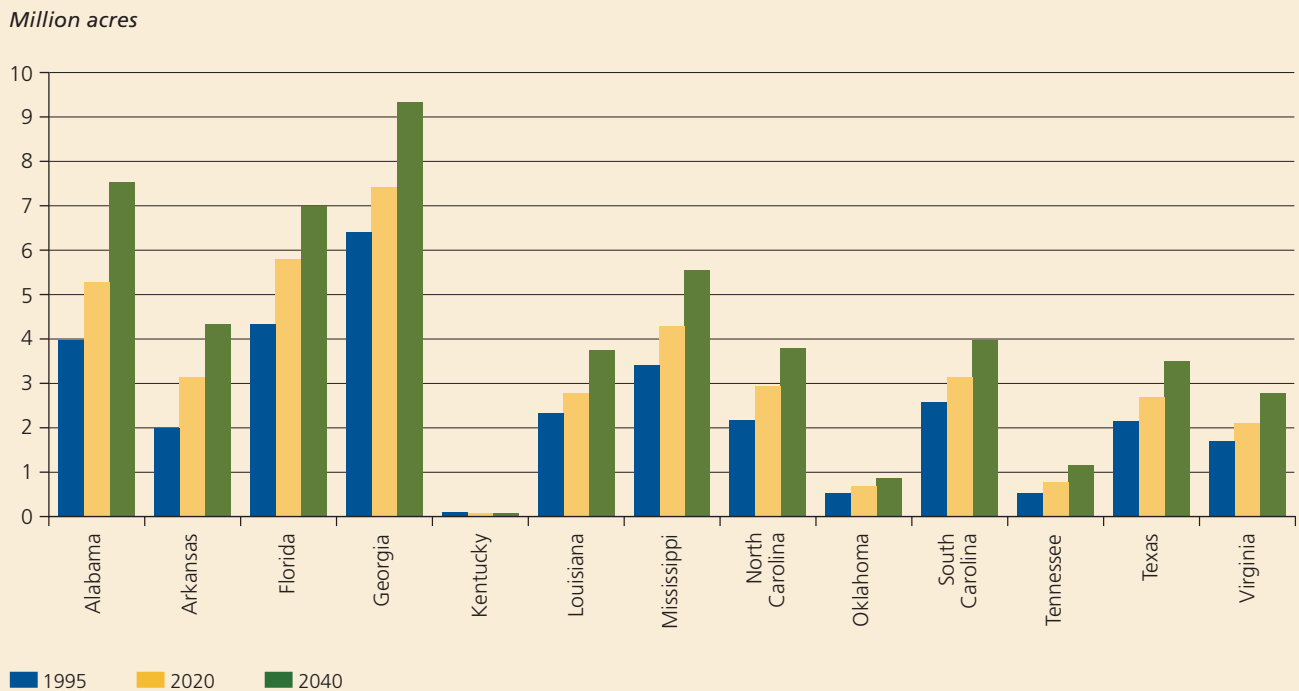
This expected expansion of productive planted pine forests may impact southern forest extent and composition. To the degree that new planted forests are established on marginal or retired farmland, forest extent will increase. To the degree that they are established in natural forests, forest extent will remain constant, yet forest composition—especially the species mix—will change in those locations. During the 1980s and 1990s, approximately 30 percent of productive planted pine forests in the South were established on agricultural land, while 70 percent were established on converted natural forests.⁵ The projected mix over the coming decades is unclear.

Figure 4.4 Scope and Concept of Planted Forests

Continuum of forest characteristics						Non-forest
Primary	Modified natural	Semi-natural		Plantation		Trees outside forests
		Assisted natural regeneration	Planted	Productive	Protective	
Forest of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed	Forest of naturally regenerated native species where there are clearly visible indications of human activities	Silviculture practices for intensive management (weeding, fertilizing, thinning, selective logging)	Forest of native species, established through planting, seeding, or coppice of planted trees	Forest of native species or introduced species, established through planting or seeding, mainly for the production of wood or non-wood goods (provisioning services)	Forest of native species or introduced species, established through planting or seeding, mainly for the provision of regulating or cultural services	Stands smaller than 0.5 hectare; trees in agricultural land (agroforestry systems, home gardens, orchards); trees in urban environments; and scattered along roads and in landscapes
Planted forests						

Source: Carle and Holmgren 2008.

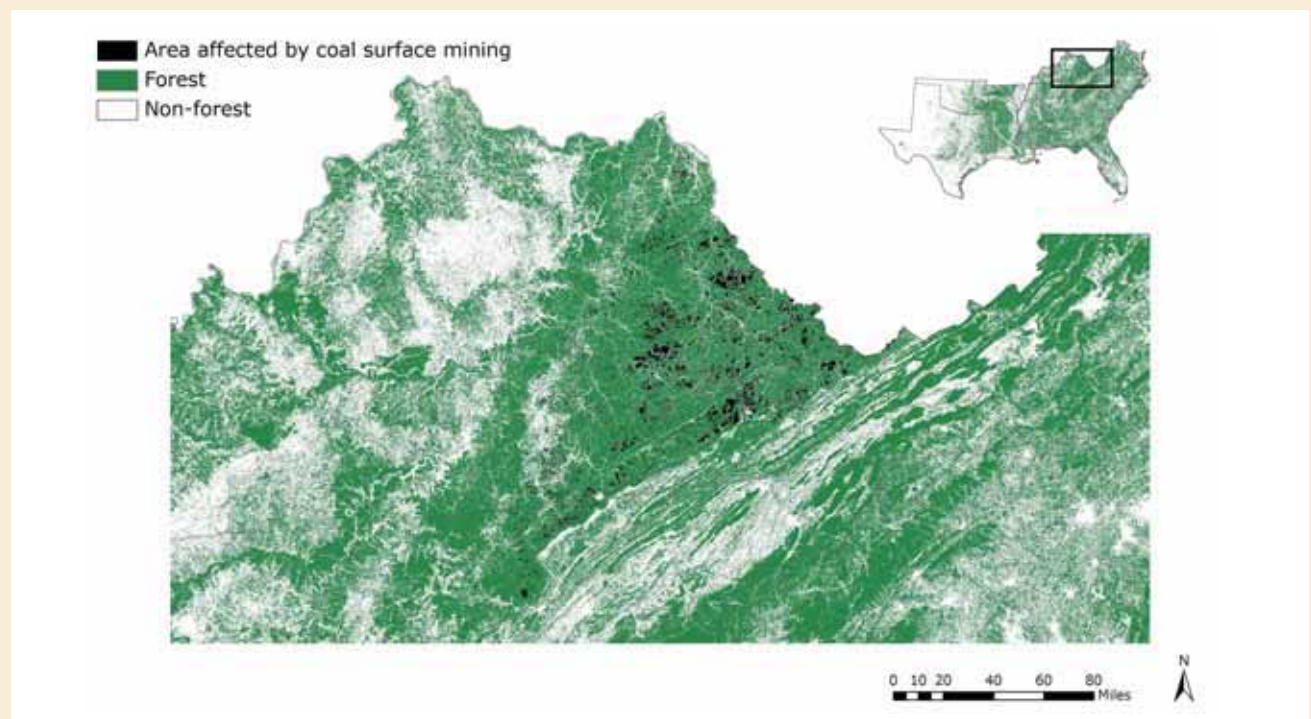
Figure 4.5 Projected Productive Planted Pine Forest Area by State (1995-2040)



Source: Prestemon and Abt 2002.

Note: As projected by the subregional timber supply model, under the IH (base case) scenario, with inelastic demand and a high pine plantation growth rate increase.

Figure 4.6 Southern Forests Impacted by Coal Surface Mining (c. 2005)



Source: Appalachian coal surface mines (Appalachian Voices 2008), forest cover (U.S. Geological Survey 2007), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Within the broad landscape of southern forests, productive planted forests have the potential to sustain the ability of natural forests to provide non-timber ecosystem services. The intensive management typically associated with productive planted forests—periodic thinning, short rotations, and other practices—nearly doubles yields compared to traditional forest management approaches (Prestemon and Abt 2002). As such, productive planted forests have the potential to more efficiently meet demand for timber products and thereby facilitate retaining natural forests for other purposes such as recreation and biodiversity conservation (Baker and Hunter 2002).

4. Surface mining

On a more localized basis, various forms of surface mining for minerals and coal can reduce forest extent, at least for a period of time. In addition, they can impact forest quality to the degree that mining degrades soils and subsequent revegetation changes plant and animal species composition.

One surface mining method affecting some portions of southern forests is mountaintop removal. Under this practice, explosives are used to remove large amounts of mountain



PHOTO: BIOTOUR13, FLICKR



PHOTO: UNANIMOUSGRAPHICS, FLICKR

Top: A coal mine using mountaintop removal practices in Appalachia.

Bottom: A reclaimed mountaintop removal mine site in Harlan, Kentucky.

Box 4.1 A Fungus Fells a Forest Giant

The American chestnut was once a dominant tree species of the forests of the South, Mid-Atlantic region, and Northeast. At its peak, an estimated four billion American chestnuts—up to one-fourth of the hardwood tree population—grew within its range. The tree was so prevalent that a chronicler of the De Soto expedition around 1540 wrote, “Where there are mountains there are chestnuts” (Davis 2003).

The American chestnut provided a variety of ecosystem services to people living within its range. For example, its decay-resistant wood was used for fence posts, utility poles, homes, barn beams, furniture, and musical instruments. The nut was an important crop for livestock and many families gathered chestnuts to sell in nearby towns. The leather industry used tannins from the tannic acid that could be found in the bark and wood of the tree.

During the first half of the 20th century, however, the species succumbed to chestnut blight, an Asian fungus to which the tree had little resistance. The fungus disperses via spores in the air, raindrops, or animals and enters a tree through wounds in its bark. As the fungus spreads through the tree's cambium and wood, nutrient flow to and from sections of the tree above the infection ceases. The tree eventually dies.

Imported on plant material from Asia in the late 19th century and first observed in 1904 in New York City, the blight spread rapidly through American forests. By 1950, nearly all mature American chestnut trees were dead. Today, eastern U.S. forests host some small trees and root sprouts, but these typically become infected within a few decades.

In 2009, the American Chestnut Foundation announced that a successful batch of blight-resistant saplings survived their first growing season in three national forests in North Carolina, Tennessee, and Virginia. Although more time is needed to determine whether the trees will ultimately survive, scientists are one step closer to reintroducing this important species to its native range (Taylor 2009).

Source: The American Chestnut Foundation. More information can be found at <http://acf.org/index.php>.



bedrock, called “overburden,” to expose underlying seams of coal. Forests on the slopes are lost in the process. Additional forest acreage and freshwater streams are buried when the rock, soil, and other debris are deposited into adjacent valleys (USEPA 2009).

In the South, mountaintop removal coal mining is concentrated in western Virginia, eastern Kentucky, and some parts of eastern Tennessee (Figure 4.6). The practice occurs in West Virginia, as well, although the state lies outside the South. The practice is estimated to have impacted approximately 1.17 million acres of land, most of it forest, in these four states by the early 2000s (USEPA 2005). The U.S. Environmental Protection Agency estimates that by 2010, 1.4 million acres

of Appalachian forests will have been disturbed or cleared by mountaintop removal (USEPA 2003). By law, disturbed areas are to be restored to vegetation by mining operations.⁶

5. Pest and pathogen outbreaks

Pests (insects and other invertebrates that are detrimental to human concerns) and pathogens (organisms such as fungi and bacteria that cause disease) can affect the health of forest ecosystems in positive and negative ways. In some circumstances, a pest or pathogen can speed up decomposition and ecological succession in a forest (Ward and Mistretta 2002). In other circumstances, a pest or pathogen can kill trees of susceptible species, stunt tree growth, change forest species mix, reduce



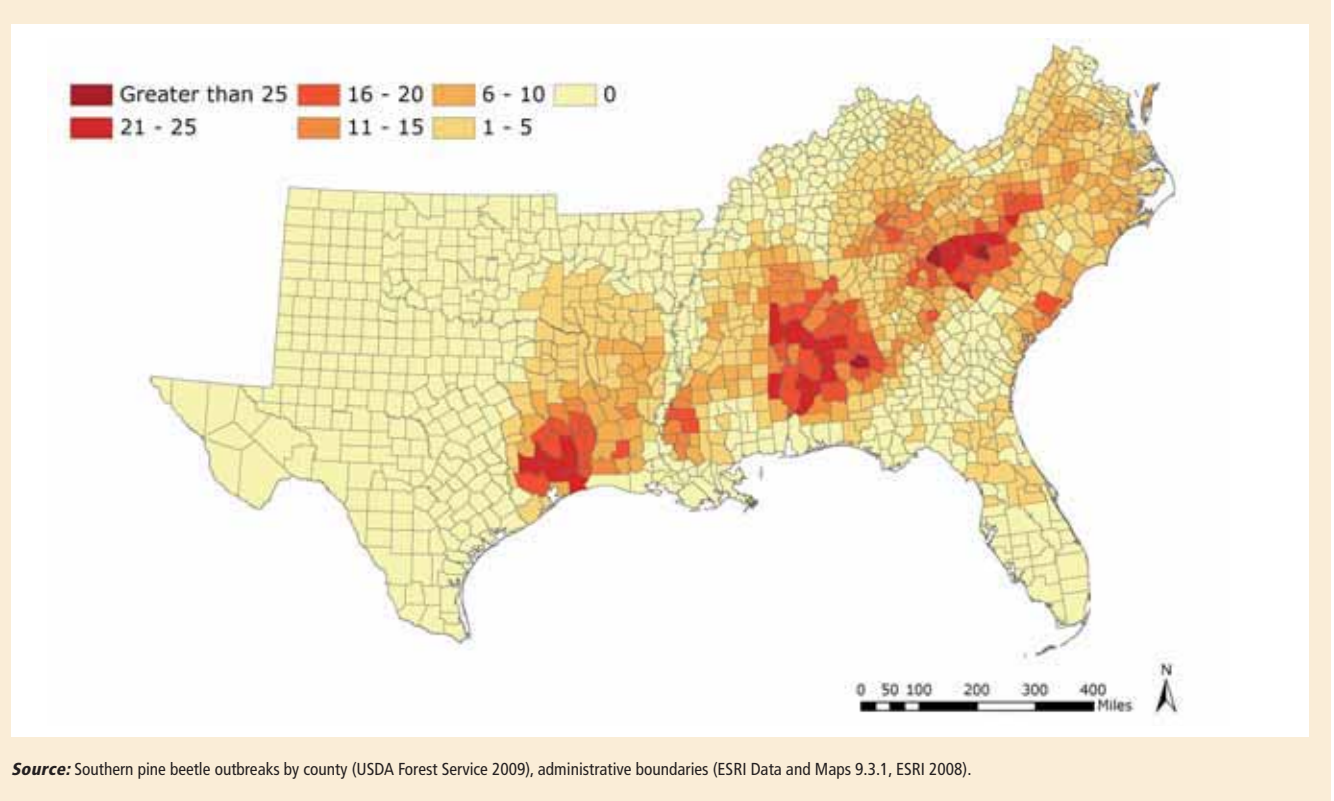
Far left: A southern pine beetle infestation killed the 20-year-old loblolly pine trees on this plantation one year before the photo was taken. With the canopy gone, hardwood trees are growing rapidly.

Immediate left: A gypsy moth caterpillar feeds on a white oak leaf in Shenandoah National Park.

PHOTO: DAVID J. MOORHEAD, UNIVERSITY OF GEORGIA, BUGWOOD.ORG

PHOTO: JOHN H. GHENT, USDA FOREST SERVICE, BUGWOOD.ORG

Figure 4.7 Number of Years of Southern Pine Beetle Outbreaks by County (1960-2008)



biological diversity, and/or increase the risk of wildfires, among other effects (Ward and Mistretta 2002). In some cases, a pest or pathogen can effectively eliminate a dominant tree species from the ecosystem, as the chestnut blight did to the American chestnut during the 20th century (Box 4.1).

Some pests and pathogens are native to the region. The southern pine beetle, for example, is expected to continue affecting pines in many parts of the South. Its impact has already been felt. Beetle infestations have occurred throughout the region over decades (Figure 4.7), with widespread outbreaks in some years and smaller ones in others. According to the U.S. Forest Service, the southern pine beetle is the most destructive forest pest in the South, and 8.4 million acres of southern pine forests are at risk of southern pine beetle-related mortality from 2007-2022. (Nowak et al. 2008).

Other pests and pathogens are non-native, having been introduced from other regions or continents into the South, primarily through human activity. The gypsy moth, for example, is a Eurasian species whose caterpillar defoliates basswood, oak, sweetgum, and other hardwoods. Currently affecting forests in Virginia and northward, the pest is expected to continue spreading further into the South. The siren wood wasp is a recent arrival from Eurasia and is emerging as a new pest threat to pines, having caused 80 percent mortality in productive planted loblolly pine forests in other countries (Haugen and Hoebeke 2005). The hemlock woolly adelgid is projected to

cause mortality of most eastern hemlocks in southern forests (Ward and Mistretta 2002). First observed in Georgia in 2002, laurel wilt of redbay—a fungal disease spread by the ambrosia beetle—threatens to decimate native red bay trees (Culbert 2008). In general, non-native pests and pathogens have greater potential than do native ones to restructure forest ecosystems or otherwise impact forest health because non-native species often lack natural predators or pathogens (Ward and Mistretta 2002).

The dynamics of pest and pathogen outbreaks are influenced by the availability and condition of host plants or pathogen targets. For example, the growing prevalence of productive planted pine forests in the South has contributed to outbreaks of southern pine beetle and fusiform rust, since both target pine species. Such risks can be mitigated to some degree, however, by appropriate forest management practices such as wider tree spacing and better matching of species to sites.⁷

6. Invasive species

Invasive species are expected to continue to impact southern forest quality over the coming decades (Ward and Mistretta 2002). An invasive species is a non-native organism whose introduction to an area causes, or is likely to cause, damage to ecosystems or ecological processes.⁸ For instance, invasives can cause populations of native species that have little resistance to a non-native pathogen or predator to dwindle. They also can out-compete native species for food, habitat, water, or light.

PHOTO: CHARLES T. BRYSON, USDA AGRICULTURAL RESEARCH SERVICE, BUGWOOD.ORG



Cogon grass is a non-native, invasive plant that has spread across millions of acres of southern forest landscapes.



PHOTO: CHRIS EVANS, RIVER TO RIVER CWMA, BUGWOOD.ORG

Left: Japanese honeysuckle is a non-native, invasive plant.



PHOTO: BARRY RICE, SARRACENIA.COM, BUGWOOD.ORG

Kudzu drapes the edge of a forest near Montgomery, Alabama.

Invasive species may include non-native plants, insects, mammals, birds, reptiles, amphibians, fish, mollusks, crustaceans, or fungi. For centuries, invasives have become established by humans through deliberate introduction, unintentional release, and accidental importation.

Southern forests contain numerous invasive species. For example:⁹

- Mimosa trees and Japanese honeysuckle were introduced into urban landscapes for aesthetic reasons and subsequently spread into the wild.
- Accidentally imported, the balsam woolly adelgid is an insect that currently threatens the future of the South's remnant Fraser fir forests (Ward and Mistretta 2002).
- Introduced as a means of controlling erosion and as a potential food for livestock, kudzu has spread to occupy more than 7 million acres in the South (Wear and Greis 2002b). Kudzu—or “the vine that ate the South”—forms dense mats of vegetation over the shrub layer and edges of many forests.
- Cogon grass, introduced to reduce soil erosion, has spread across millions of acres of southern forest landscapes. Considered one of the “top 10 worst weeds in the world,” cogon grass affects pine productivity and survival, wildlife habitat, recreation, native plants, and fire behavior. Flammable oils in cogon grass blades raise the temperature and severity of fires, increasing the risk of converting low-intensity, fuel-reducing fires into high-intensity, crown fires (Florida Department of Agriculture and Consumer Services 2004).
- First observed in Tennessee in 1919, Japanese stiltgrass has spread to other states, including Georgia, North Carolina, and Virginia. Well-adapted to low-light conditions, this Asian grass spreads to form extensive patches that displace native species incapable of competing with it (Plant Conservation Alliance's Plant Working Group 2008).

7. Fire

Some forest ecosystems in the South adapted over millennia to coexist with fire of both natural and human origin. Often caused by lightning strikes during the region's frequent thunderstorms, fire is a natural part of these ecosystems and can be an important, beneficial direct driver of forest health. For instance, frequent low-intensity fires are critical for maintaining the flowering plant diversity of longleaf pine forests (Stanturf et al. 2002) and for ensuring successful oak regeneration.

Starting around the 1930s, however, fire suppression emerged as an objective of public forestry programs across the United States. Fire was considered a waste of timber resources and a threat to human life and property (Macie and Hermanen 2002). Forest fires in the South and elsewhere thereafter declined (Houghton, Hackler, and Lawrence 2009).

Fire suppression has had at least two major effects on forest health. First, it has altered forest density and species composition. For example, when natural fires are suppressed, stands of longleaf pine grow thicker, hardwoods encroach, and the understory plant diversity—and dependent faunal diversity—diminishes (Stanturf

et al. 2002). One consequence is that longleaf pine seedling recruitment declines, making it more difficult for the longleaf ecosystem to regenerate itself. Second, fire suppression has increased the probability of high-intensity wildfires that burn large areas of forest, burning even the crowns of mature trees of fire-adapted species. This occurs because understory vegetation such as shrubs and woody debris accumulate, creating fuel loads for wildfires.

Although forest management policy is shifting toward the use of managed or controlled fire as an approach to reduce excess fuel loads and restore natural forest ecosystems, fire management may be an ongoing challenge in the South. Willingness to use prescribed burns as a forest management tool is constrained by several factors. Air quality and smoke regulations, particularly in forests near population centers and residential development, can result in burning restrictions. Moreover, some landowners are concerned about legal liability and local public opinion if one of their prescribed burns were to encroach upon a neighbor's property.¹⁰

At the same time, several factors may contribute to the continued buildup of fuel. For instance, pests and pathogens that kill trees in the region leave flammable debris in the landscape. Changes in climate and the drought cycle may increase the probability of longer and more intense fire seasons in several regions of the United States, with the South predicted to be an area of special vulnerability (National Interagency Fire Center 2008). In fact, the South is already a major center of wildfire in the United States. Between 2003 and 2007, approximately 1.17 million acres burned each year in the region (National Interagency Fire Center 2008). This is the highest average number of forest acres burned due to wildfires of any region in the United States besides Alaska (National Interagency Fire Center 2008).

8. Climate change

Climate has played a major role in shaping the extent, distribution, and composition of southern forests for millennia (see Chapter III), and many forest species have adapted to specific climatic conditions. Therefore, as Earth's climate changes during the 21st century (Solomon et al. 2007), southern forests will change as well. Although implications for specific locations over time are difficult to predict, climate change may have a variety of impacts on southern forests, including:

- The natural range of certain plant and animal species may shift. Species conditioned to cooler climates, such as spruces, may retreat northward and/or to higher altitudes. Species conditioned to warmer climates, such as sweetgum and longleaf pine, may expand their range northward along portions of their ranges (Hoyle 2008). The area of suitable conditions for other species, such as yellow poplar, may decline (Figure 4.8). As species ranges shift, the ability of parks and protected areas to serve as refuges for some types of plant and animal species may decline. For example, Great Smoky Mountains National Park may lose more than 16 percent of its current mammalian diversity as the park's ecosystems adjust to climate change (Burns, Johnston, and Schmitz 2003).

PHOTO: DAVID J. MOORHEAD, UNIVERSITY OF GEORGIA, BUGWOOD.ORG

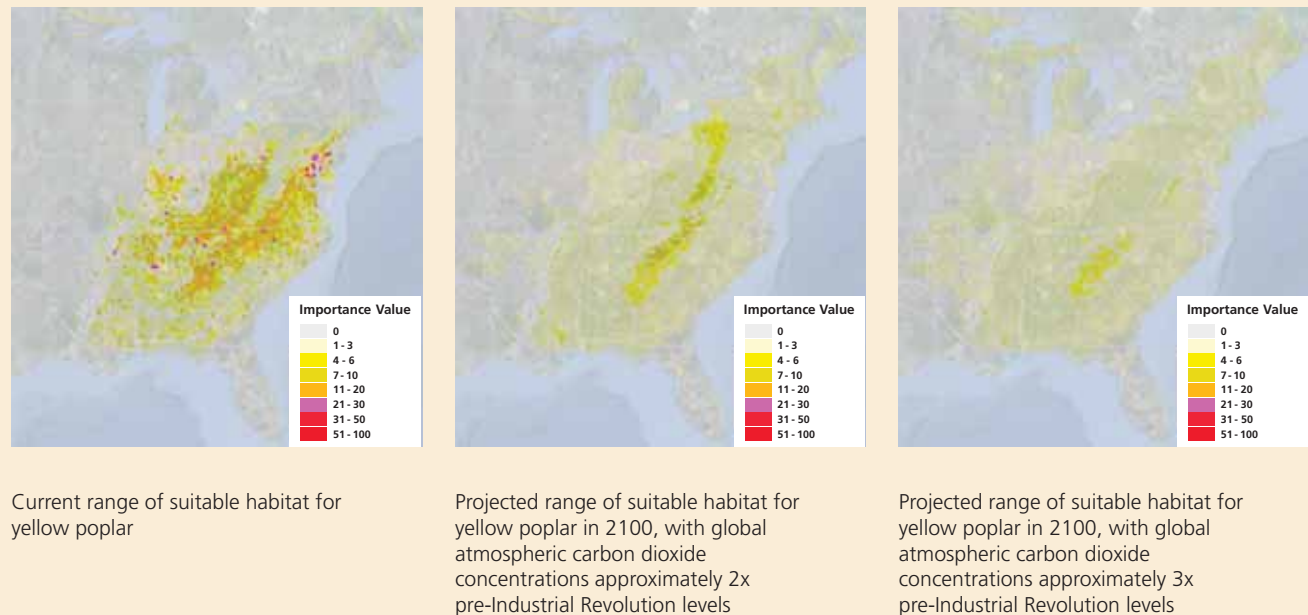


PHOTO: NATIONAL INTERAGENCY FIRE CENTER ARCHIVE, BUGWOOD.ORG

A prescribed burn simmers in Georgia. For fire-dependent ecosystems, such as this longleaf pine forest, low-intensity fires are important for maintaining forest health and species diversity.

A wildfire spreads in Georgia in 2007. Wildfires can be caused by natural extreme conditions, but their intensity and distribution is often exacerbated by the buildup of fuels resulting from human suppression of natural fires.

Figure 4.8 Shifts in Suitable Yellow Poplar Habitat Due to Projected Climate Change



Source: Prasad et al. 2007-ongoing.

- Some coastal forests, such as low-lying cypress swamps, may decline in extent and health due to an increase in inundation and saltwater intrusion as sea levels rise (Hoyle 2008).
- Changing precipitation patterns may increase the frequency and intensity of wildfires (National Interagency Fire Center 2008).
- Forest species composition may change if drought-sensitive species decline in number or become more susceptible to pests and pathogens (Winnet 1998).
- Large tracts of coastal forest may be impacted by extreme weather events, including hurricanes. For instance, Hurricane Katrina felled an estimated 320 million trees along the coast of Louisiana and Mississippi in 2005. Rising sea temperatures associated with climate change are projected to increase the intensity of tropical storms and hurricanes (Solomon et al. 2007).
- As atmospheric carbon dioxide concentrations increase and growing seasons lengthen, some species of trees may increase their rate of growth, with hardwood productivity likely to increase more than softwood productivity (Alvarez 2007). This “fertilization effect” may be limited, however, if trees face constraining growth factors such as too little available nitrogen (Norby 2005).

POSSIBLE IMPLICATIONS

Changes in southern forest quantity and/or quality due to these drivers of change may have implications for southern forest ecosystem services. For example:

- In those areas where suburban encroachment is prevalent, where disease/pathogen outbreaks occur, or where wildfires emerge, the supply of timber and/or pulpwood may decline. Suburban encroachment corresponds with lower rates of forest management for timber and other wood products (specifically due to smaller management parcels and increased land values). According to the U.S. Forest Service, at approximately 45 people per square mile, there is a 50 percent chance a forest owner will practice forestry. At 150 people per square mile, the likelihood approaches zero percent (Wear 1999).
- Production of biomass energy from southern forests will likely increase if policies stimulating demand for biomass-to-energy emerge.
- Where forests are converted to alternative land uses, the carbon storage potential of the landscape will decrease, since forests have a higher carbon storage potential than any other land use in the South.
- Where agricultural land reverts to forest, the carbon storage potential of the landscape will increase.
- In areas where forests are converted to development, forest-based recreation and tourism opportunities will decline. As a result, hiking, camping, wildlife viewing, and other recreational activities may become concentrated on fewer forest acres (Tarrant and Cordell, 2002).

Table 4.2 Species of Concern* and Critically Imperiled Species in the South**

Class	Total number of species	Species of concern		Critically imperiled species	
		Number	Share of total	Number	Share of total
Amphibians	170	54	32%	19	11%
Reptiles	197	40	20%	3	2%
Mammals	246	18	7%	2	1%
Birds	595	20	3%	4	1%
Total	1208	132	11%	28	2%

*Species of concern = critically imperiled (observed at 5 or fewer locations or fewer than 1,000 animals or otherwise vulnerable to extinction), imperiled (observed in 6 to 20 locations or fewer than 2,000 animals), or vulnerable (observed at 21 to 100 locations or 3,000 to 10,000 animals or found locally in a restricted area).

**Critically imperiled = observed at 5 or fewer locations or fewer than 1,000 animals or otherwise vulnerable to extinction.

Source: Wear and Greis 2002a.

In general, less forest area—or less healthy forests—means fewer forest-based ecosystem services. It is important to note, however, several caveats:

- The precise implications for particular services will vary by location. In some geographic areas of the South, the quantity or quality of an ecosystem service may increase, while in other areas it may decrease.
- The precise implications for particular services will depend in part on the capacity of southern forests to adapt to pressures such as disease, drought, and climate change. This capacity is determined by multiple factors, including levels of biodiversity, forest intactness, and number of stressors.
- Likewise, the precise implications for particular services will depend in part on forest management practices people take in response to the drivers of change. For example, if the number of private landowners that allow public recreation or hunting opportunities in their forests were to increase sufficiently in response to declining forest extent around suburban areas, then the supply of these cultural services may remain stable or actually increase over time.
- Practices, natural processes, and other factors may diminish some of these projected trends in ecosystem services. For instance, to the degree that foresters, farmers, and developers implement forest buffers or streamside management zones, the ability of the landscape to control erosion may in part be retained. Likewise, as suburbs age, landscape trees develop into a canopy that can provide ecosystem services such as local climate and air quality regulation, as well as habitat for wildlife.
- Quantitative information about a forest's supply of—or ability to supply—many regulating services and some cultural services is often sparse or nonexistent. Therefore, measuring, monitoring, and forecasting changes in these ecosystem services can be difficult. This feature, however, is not unique to southern forests; it is a challenge for ecosystem assessments worldwide (Layke, 2009).

- Further quantitative research on the interaction among southern forest-based ecosystem services and ecosystem service production functions is needed. For example, modeling and other assessments would help answer increasingly pertinent questions, such as: What are the biophysical and ecosystem service trade-offs among managing southern forests for timber, pulpwood, biomass energy, and carbon? To what degree may there be supply constraints between the ecosystem services of timber, pulpwood, and biomass energy in southern forests over coming decades? What approaches are available for a landowner to optimize the supply of a suite of ecosystem services?

Changes in southern forest quantity and quality will have implications for the region's biodiversity, as well. For example:

- Suburban encroachment threatens to increasingly fragment the southern forest landscape into smaller, isolated patches. For species that prefer large tracts of undisturbed forest, fragmentation can diminish available habitat and create barriers to movement, thereby decreasing connectedness among individuals and populations, increasing roadside mortality, and decreasing access to food. Affected species in the South include bobcat, black bear, and neotropical migratory birds such as certain species of warblers and tanagers (Aldrich 2003; Matthews et al. 2007-ongoing). On the other hand, forest fragmentation can increase available habitat for species such as white tail deer that prefer "edges" between forest and non-forest ecosystems.
- Habitat loss and fragmentation have been a leading factor in plant and animal species becoming rare around the world. The same is true in the southern United States. The South already has more than 130 "species of conservation concern" (Table 4.2). Further declines in forest quantity and quality will make it difficult to remove species from this list and could add more.

- The survival of some tree species in the wild will be threatened by expected pest and pathogen outbreaks. For example, the hemlock woolly adelgid is projected to decimate eastern hemlock (Ward and Mistretta 2002). Butternut canker is expected to eliminate butternut trees from the South (Ward and Mistretta 2002).
- Climate change is projected to shrink the range of red spruce and other species adapted to higher-elevation, cooler climates (Wear and Greis 2002a).

In summary, a number of drivers of change will likely impact the extent, distribution, health, and composition of southern forests over coming decades. How private landowners, businesses, conservation organizations, governments, and citizens respond to these drivers of change will shape the future of southern forests.

Right: Cypress forest killed by saltwater intrusion in Terrebonne Parish, Louisiana.



PHOTO: PAUL GOYETTE, FLICKR

Below: In 2005, Hurricane Katrina felled an estimated 320 million trees in Louisiana and Mississippi, such as these near New Orleans.



PHOTO: BOB MCMILLAN/FEDERAL EMERGENCY MANAGEMENT ADMINISTRATION

³ Forest Encyclopedia Network. Online at: www.forestencyclopedia.net

⁴ Data on plantation extent in the eastern United States is based on classifications of stand origin made at Forest Inventory and Analysis plots, which denote natural and planted status.

⁵ Some of the converted natural forests include “naturally regenerated pines.” Since loblolly pine is an early successional species, some of the converted forest may have been naturally regenerated loblolly. Prestemon and Abt 2002.

⁶ Reclamation efforts are required by law on mountaintop removal sites under the 1977 Surface Mining Control and Reclamation Act. For the most part, reclamation has traditionally focused on stabilizing rock formations and controlling for erosion. Some reclamation efforts have planted fast-growing, non-native grasses such as sericea lespedeza, which compete with tree seedlings. In addition, seedlings may have difficulty establishing root systems in compacted soil. Waivers are also often granted by state agencies that regulate mining. Some efforts are underway to improve restoration efforts. For example, the Appalachian Regional Reforestation Initiative is a broad-based coalition of citizens, industry, and government agencies working to encourage planting of productive hardwood trees on reclaimed coal mine lands and abandoned mine lands. USEPA 2005. “Biology: Plants, Animals, & Habitats - We live in a hot spot of biodiversity.” Apalachicola Region Resources on the Web. Florida Natural Areas Inventory. Online at: http://www.fnai.org/ARROW/almanac/biology/biology_index.cfm. Retrieved September 18, 2006. <http://arri.osmre.gov/FRA.htm>.

⁷ Bill Stuart, personal communication, October 14, 2009. Matching species to appropriate sites is an important strategy for reducing the threat of pests and pathogens. The areas of highest southern pine beetle infestations have been in the piedmont and upper coastal plain regions (Figure 4.7). Traditionally, these regions supported shortleaf pine, but loblolly was planted there because of its faster growth rate and concern over little-leaf disease, which affects shortleaf pine. Loblolly grows well in these regions, but is subject to drought and other environmental stress such as ice storm damage that weakens the species, making stands susceptible to beetle infestations.

⁸ Federal Register 64(25): 8 Feb. 1999. Executive Order 13112. 3 Feb. 1999. Online at: <http://www.invasivespeciesinfo.gov/laws/execorder.shtml>.

⁹ See www.SeeSouthernForests.org for more examples.

¹⁰ Tom Martin, American Forest Foundation, personal communication, September 8, 2009.

Notes

¹ Although there are many drivers of change, the ones discussed in this chapter were the predominant ones identified via literature review and expert interviews.

² The U.S. Forest Service has convened a multi-stakeholder process to model projected scenarios for southern forests, a project called “Southern Forest Futures.” This modeling will include projected impacts of bioenergy on southern forests. Results are expected to be released in late 2010.

Solutions



CHAPTER

V

Over the coming decades, several direct drivers of change are expected to affect southern forests and their ability to provide ecosystem services. These direct drivers include suburban encroachment, climate change, reversion of agricultural land, forest management practices, surface mining, pest and pathogen outbreaks, invasive species, and fire. Going forward, what types of incentives, markets, and practices—collectively called “measures”—can help ensure that southern forests continue to supply needed ecosystem services and the native biodiversity that supports them? This chapter explores this question and outlines a number of measures, albeit not an exhaustive list. Although public policies have an important role to play in sustaining southern forests, this chapter primarily concentrates on non-policy measures.

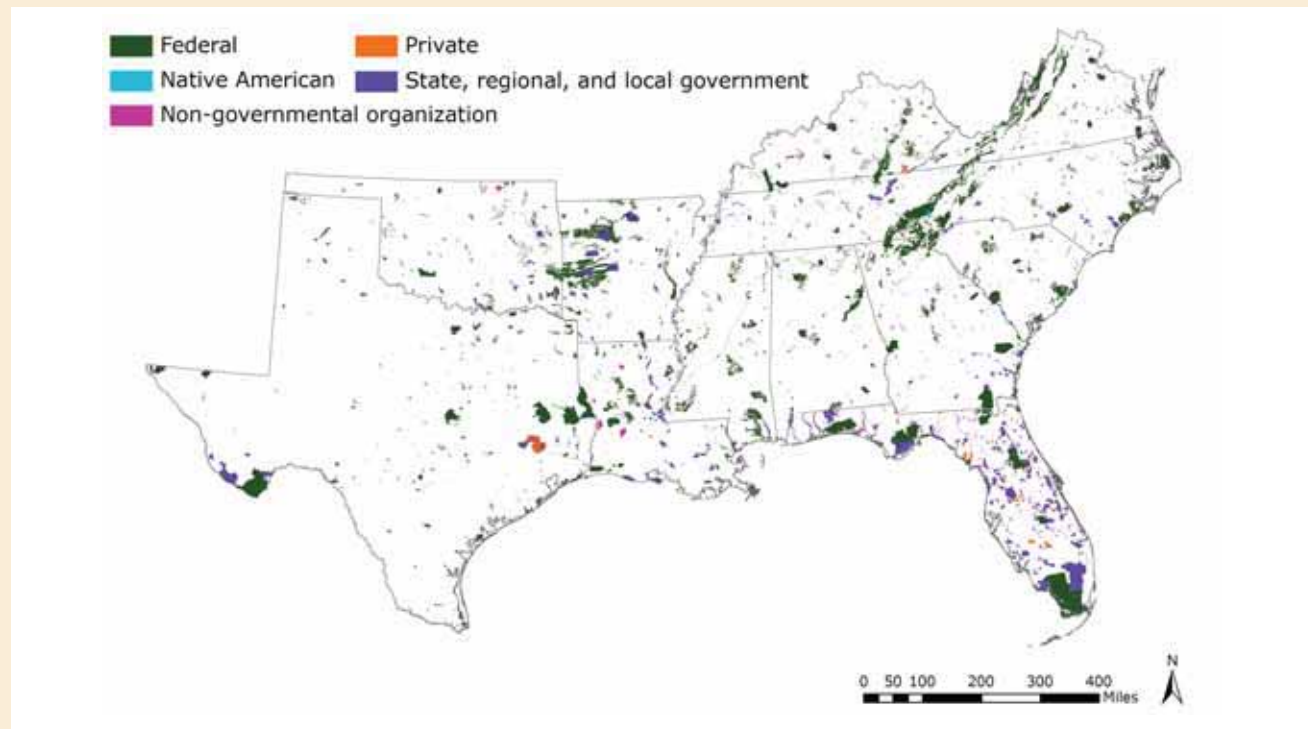
PROTECTED AREAS

A traditional measure for maintaining the ability of forests to provide a range of ecosystem services, particularly regulating and cultural services, has been to establish protected areas. Protected areas are clearly defined geographical regions that are recognized, dedicated, and managed by legal or other effective means to achieve the long-term conservation of nature and associated ecosystem services (Dudley 2008). Protected areas have some form of permanent designation, preventing the conversion of a natural ecosystem and prescribing the types of use of the ecosystem. The southern United States currently contains approximately 39.5 million acres of protected areas—many of them forested—distributed throughout the region (Figure 5.1).

The majority of protected areas in the South are federally owned, while the rest are owned by state and local governments, non-governmental organizations, or private citizens. For example, the federal government owns approximately 29.8 million acres, including 12.9 million acres in national forests, 5.4 million acres in national parks, and 3.8 million acres in wildlife refuges. The 13 southern states combined own approximately 3.6 million acres of state forests and 1.7 million acres of state parks.

Not all protected areas, however, confer the same degree of ecosystem protection. The Gap Analysis Program (GAP) defines several levels of protection (Box 5.1). For instance, “status 1” confers permanent protection from land conversion and precludes extractive activities, while “status 3” confers permanent protection from conversion but allows extractive activities such as logging and mining. The network of protected areas in the South includes all three classifications (Figure 5.2). Approximately 12.8 percent of southern forests are currently located within these protected areas (Figure 5.3), with 1.1 percent under status 1 protection, 3.8 percent under status 2, and 7.9 percent under status 3.

Figure 5.1 Protected Areas in the South (2009)



Source: Protected areas (PAD-US, U.S. Geological Survey National GAP Analysis Program, 2009), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Box 5.1 Protected Area Status

Coordinated by the U.S. Geological Survey's Biological Resources Division, the Gap Analysis Program (GAP) provides regional assessments of the conservation status of native vertebrate species, natural land cover types, protected areas, and other related information. GAP is a cooperative effort among regional, state, tribal, and federal agencies, academic and nongovernmental institutions, and other private groups, as well as the divisions of the U.S. Geological Survey.

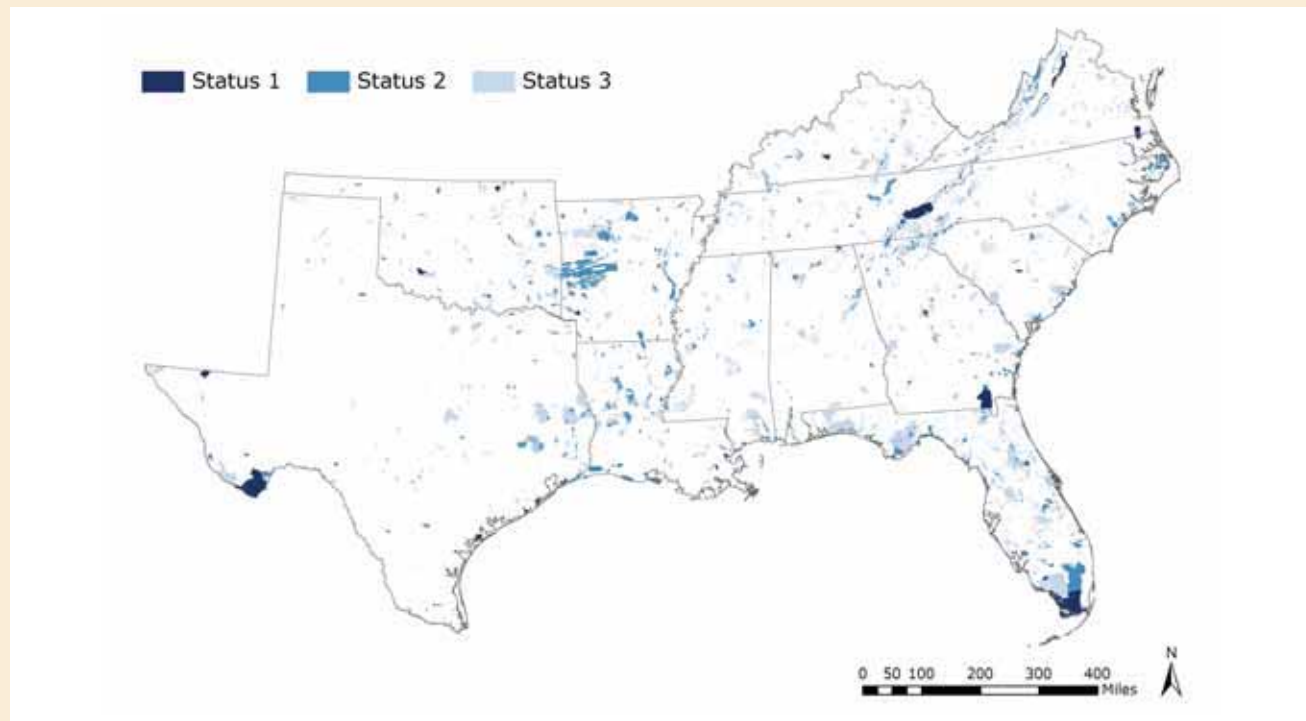
GAP categorizes protected areas into several states or levels:

- **Status 1.** An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management. This class includes federal designations such as national parks, national monuments, wilderness areas, nature reserves, preserves, and research natural areas.
- **Status 2.** An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may permit uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance. This class includes state parks, state recreation areas, national wildlife refuges, national recreation areas, areas of critical environmental concern, wilderness study areas, conservation easements, private conservation lands, and national seashores.
- **Status 3.** An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type such as logging or a localized, intense type such as mining. It also confers protection to federally listed endangered and threatened species throughout the area. This class includes national forests, most Bureau of Land Management property, wildlife management areas, military reservations, state forests, game and fish preserves, fish hatcheries, state commemorative areas, access areas, national grasslands, and Army Corps of Engineers holdings.
- **Status 4.** An area with no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. These areas generally allow conversion to unnatural land cover throughout.

Adapted from: Crist 2000

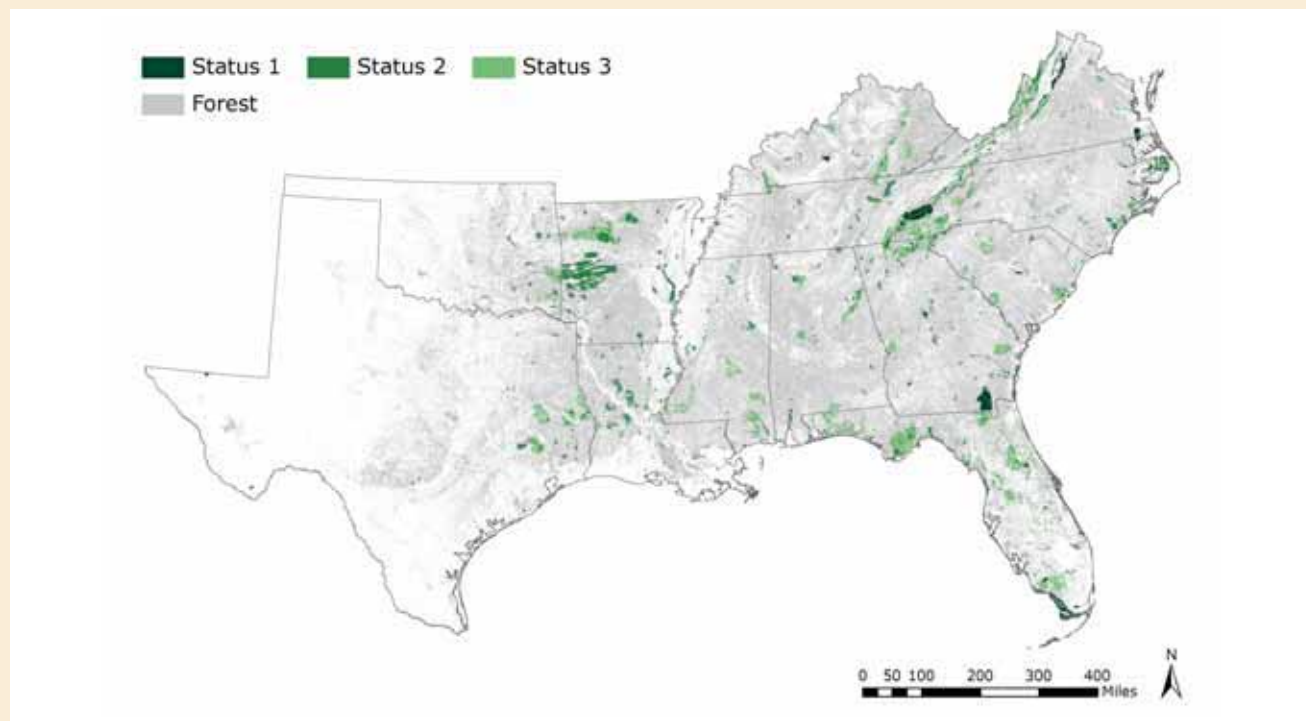
Note: Some lands in "status 3" may not be technically zoned as "protected" but are managed to conserve biodiversity.

Figure 5.2 Protected Areas in the South: Degrees of Protection (2009)



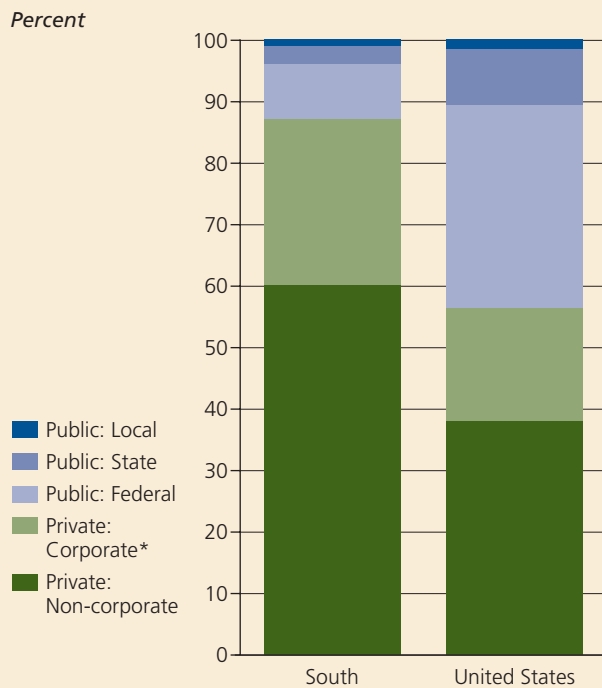
Source: Protected areas (PAD-US, U.S. Geological Survey National GAP Analysis Program, 2009), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Figure 5.3 Southern Forests Located in Protected Areas (2009)



Source: WRI analysis based on protected areas (PAD-US, U.S. Geological Survey National GAP Analysis Program, 2009), forest cover (U.S. Geological Survey 2007), and administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).

Figure 5.4 Profile of Forest Ownership (2007)



*Includes forests owned by industrial forest product companies, timberland investment management organizations (TIMOs), and real estate investment trusts (REITs).

Source: Smith et al. 2009.

Protected areas typically entail land uses that reduce the potential for revenue. Protected areas therefore need to be financed, which can be done through a variety of approaches. For instance, governments utilize funds from annual appropriations or from dedicated government revenue streams. An example of the latter is the U.S. Land and Water Conservation Fund, which finances the creation and expansion of parks, open spaces, wildlife refuges, and other natural areas via a royalty on offshore oil and gas extraction. Another approach that has proven popular across the United States is the ballot initiative, in which citizens vote on and approve conservation-oriented bonds or taxes at the local or state level. Between 2000 and mid-2009, voters across the United States approved more than \$36 billion in conservation funds to finance the protection of forests and other open spaces (Trust for Public Land 2009).

SOUTHERN FOREST OWNERSHIP

Protected areas are an important foundation for sustaining southern forest ecosystem services. Expanding protected areas and increasing their protected status will be an important strategy going forward, particularly given that some ecosystems such as bottomland hardwood forests and coastal wetland forests are underrepresented within the current network.¹ In light of forest ownership in the region, however, the government-owned, protected areas strategy will need to be complemented by other measures. Approximately 87 percent of southern forest acreage is currently privately held, an ownership pattern quite different from that of U.S. forests as a whole (Figure 5.4). To a large degree, the future of southern forests thus rests in the hands of private landowners.

Twenty-seven percent of the region's forest acreage is owned by private companies. In the past, these companies were primarily integrated industrial forest product firms, but increasingly corporate forest ownership has become dominated by real estate investment trusts and timber investment management organizations (Box 5.2). Corporate ownership is particularly concentrated along the Atlantic Coast, the Gulf Coast, and in forested areas west of the Mississippi River (Figure 5.5).

Private non-corporate entities, often called "non-industrial private forest" (NIPF) owners, own 60 percent of southern forests. This category of owner includes individuals, families, and nongovernmental organizations. Family forests comprise most of this land, about 57 percent of total southern forest acreage (Butler 2008). Most family forests are small tracts, with nearly 3 million owners each holding 9 acres or less in 2006 (Figure 5.6).²

Private, non-corporate forests are typically considered part of personal or family wealth and, according to a recent survey, confer a variety of benefits to their owners (Figure 5.7). Cultural services such as aesthetic enjoyment, the rewards of conserving biodiversity, and various forms of recreation were commonly noted by surveyed family forest owners. Provisioning services such as the generation of timber, pulpwood, and biomass fuel were also noted. Going forward, a significant majority of family forest owners surveyed aspire to maintain their forests with no

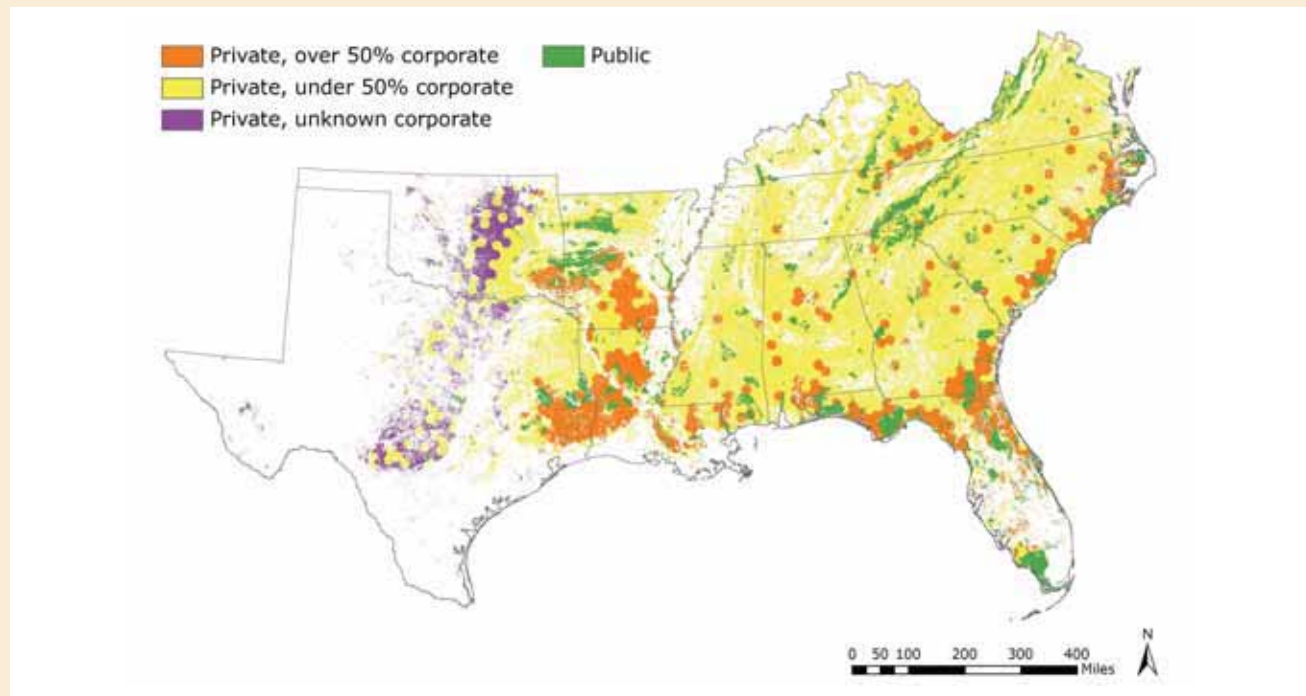
Box 5.2 REITs and TIMOs

In 1995, large-scale commercial forests in the United States were primarily owned by integrated industrial forest product companies, firms that not only owned forest assets but also owned diverse other business lines, including building products and paper. Since that time, specialization has become a dominant trend within the forest products industry, with firms restructuring to concentrate on timber, building products, or paper.

Timber "specialists" have evolved that are both publicly traded and privately held. Public firms are commonly structured and referred to as real estate investment trusts (REITs), a particular form of corporation unique to real estate investments. Publicly traded timber firms can also be organized as traditional c-corporations. Private firms engaged in the timberland management business are often referred to as timberland investment management organizations (TIMOs), and their investors may be institutions or individuals.

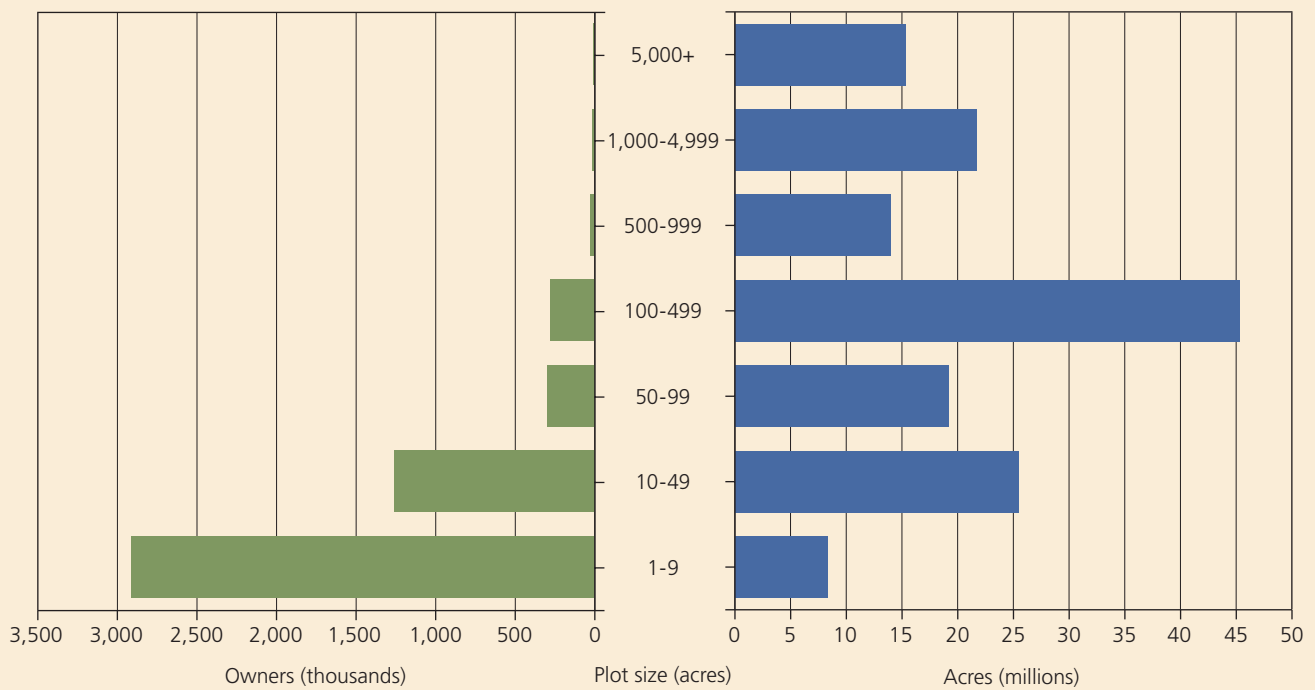
Both REITs and TIMOs manage large-scale commercial forests on behalf of investors seeking "pure" forest investments, as opposed to the former structure for investments in integrated companies which included forest assets, lumber and plywood operations, and pulp/paper divisions. Pure forest investment vehicles reflect end-use markets for building products and paper, but also incorporate strong interests in pursuing other opportunities including real estate, conservation easements, recreation, and other ecosystem services. With this historic shift in forest ownership comes changes in forest management practices, land use and forest policies, and generally greater ownership turnover—trends expected to continue and perhaps accelerate in the years to come.

Figure 5.5 Geographic Distribution of Southern Forest Ownership (2009)



Source: Forest ownership (USDA Forest Service FIA, 2009), administrative boundaries (ESRI Data and Maps 9.3.1, ESRI 2008).
Note: Private, unknown corporate are the areas where data for percent corporate are not available.

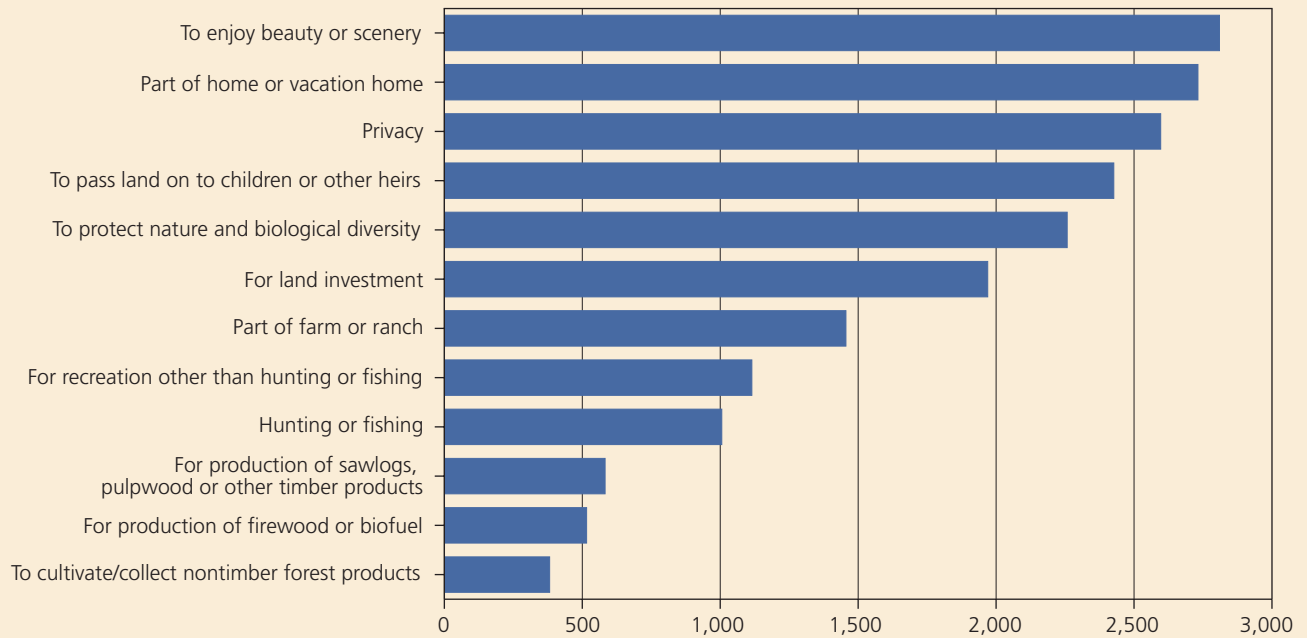
Figure 5.6 Non-industrial Private Forest Ownership by Plot Size in the South (2006)



Source: Butler 2008.
Note: Categories are not exclusive. Data do not display non-respondents.

Figure 5.7 Reasons for Owning Family Forest Land in the South (2006)

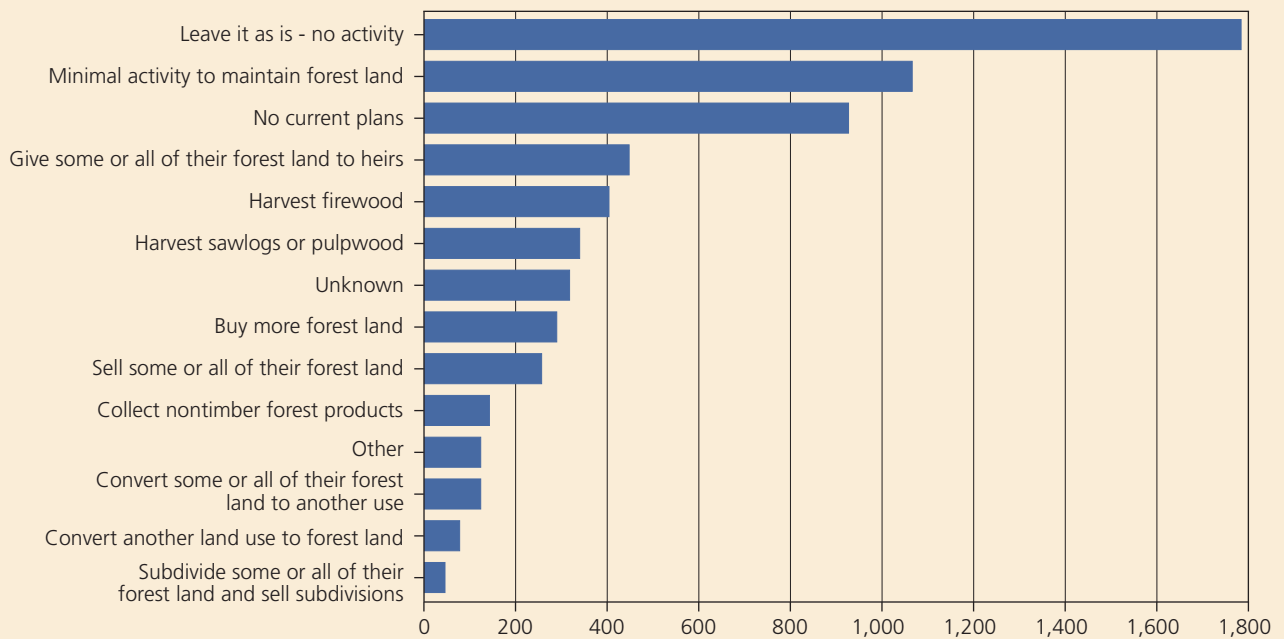
Owners listing reasons as "important" or "very important," thousands*



*Categories are not exclusive. Does not display non-respondents.
Source: Butler 2008.

Figure 5.8 Family Forest Owners' Future Plans for Forest Land (2006)

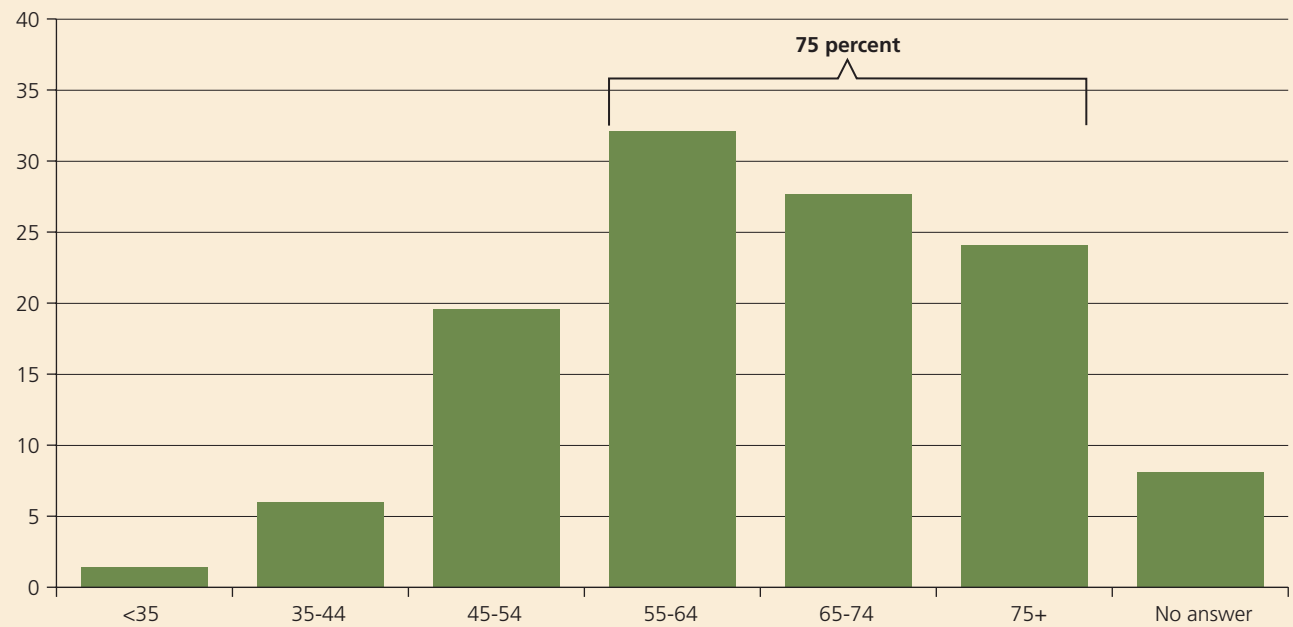
Owners' plans for next 5 years, thousands of owners*



*Categories are not exclusive. Data do not display non-respondents.
Source: Butler 2008.

Figure 5.9 Area of Family Forest Land in the South by Age of Owner (2006)

Forest acres (millions)



Source: Butler 2008.

or minimal change—these were the top three responses—while some seek to maintain their forests while harvesting firewood, sawlogs, or pulpwood—the fifth and sixth responses (Figure 5.8). A much smaller share of respondents wish to convert their forests to other uses or to subdivide their land.

Most family forest owners are older, with approximately 75 percent of southern forest acreage owned by people of 55+ years of age (Figure 5.9). A large generational transfer of southern forest tracts thus appears to be coming over the next decade or two. Passing on their forests to heirs is an important aspiration (Figures 5.7 and 5.8). Consequently, having available a portfolio of measures that can help private landowners maintain their forests during this transition is critical to the future of southern forests.

BEYOND PROTECTED AREAS

Simply creating protected areas out of their forests is not a viable option for many private landowners, given the entailed forgone revenue. A number of measures exist, however, that could create incentives for private southern forest owners to maintain the quantity and quality of their forests. These measures include land use instruments, fiscal incentives, liability limitations, market incentives, and increased education and capacity building.



PHOTO: APPALACHIAN TRAIL CONSERVANCY

A man teaching kids about the importance of forests.

Land use instruments

Protected areas are a delineation of eligible uses for a tract of land. Other forms of delineation, many of them voluntary, are also available or are beginning to emerge (Table 5.1). For instance, companies, nongovernmental organizations, or private

citizens can establish conservation easements on forest land or other ecosystems. Easements have been increasingly utilized in the United States over the past two decades, growing from approximately 500,000 acres in 1990 to more than 6 million acres across the country in 2005 (Land Trust Alliance 2006). Just under 1 million of these acres were in the South.

Table 5.1 Examples of Land Use Instruments

<i>Not Exhaustive</i>		
Measure	Definition	Example from the South
Conservation easements	A legally enforceable land preservation agreement between a landowner and a government agency (municipal, county, state, or federal) or between a landowner and a qualified land protection organization (such as a land trust) for the purposes of conservation. It restricts certain activities on the property, such as real estate development and resource extraction, to a mutually agreed upon level. The decision to place a conservation easement on a property is voluntary and the property remains the private property of the landowner. The restrictions of the easement, once set in place, are binding on all future owners of the property. Landowners sometimes sell conservation easements to willing buyers, such as land trusts, or donate them.	<ul style="list-style-type: none"> In 2006, The Nature Conservancy, Potlatch Forest Holdings, Inc. and several Arkansas state agencies agreed to a 16,000-acre "Working Forest" easement which allows for sustainable timber extraction and hunting.*
Voluntary development offsets	A voluntary program in which land developers or businesses finance the permanent conservation of one or more acres of natural landscape for every acre they convert and develop. The offsets are legally binding, designed akin to or utilizing conservation easements.	<ul style="list-style-type: none"> In 2005, Wal-Mart committed to purchase and permanently conserve at least one acre of high conservation value land for every acre occupied by current and future Wal-Mart stores in the United States through 2015.
Transferable development rights	Voluntary programs in which municipalities can avoid growth in sensitive areas and encourage higher density in others. Owners of sites targeted for preservation can receive transferable development rights (TDR) credits to sell in exchange for permanent restrictions on certain uses of their property. Developers can buy the generated TDR credits to gain permission to build more profitable, higher density units in areas targeted for development.	<ul style="list-style-type: none"> Since 2005, Marion County, Florida, has preserved over 3,000 acres of ecologically sensitive land through its TDR program at no cost to taxpayers.**
<p>Notes:</p> <p>* The conservation easement involved The Nature Conservancy, Potlatch Forest Holdings, Inc., the Arkansas Game and Fish Commission, the Arkansas Natural Heritage Commission, and the Arkansas Forestry Commission. "16,000-acre 'Working Forest' Easement to Become Wildlife Management Area." The Nature Conservancy. Online at: http://www.nature.org/success/art19782.html</p> <p>** Thompson, Bill. "County adds 1,958 acres to land-conservation program." <i>Ocala (Florida) Star-Banner</i>, 5 May 2009. Online at http://www.ocala.com/article/20090505/articles/905059977?Title=County-adds-1-958-acres-to-land-conservation-program</p>		

Table 5.2 Examples of Fiscal Incentives

<i>Not Exhaustive</i>		
Measure	Definition	Example from the South
Subsidies (cost-share programs)	Federal and state subsidies that provide funding for reforestation and sustainable management practices on private forest land.	<ul style="list-style-type: none"> Conservation Reserve Program Forest Land Enhancement Program Landowner Incentive Program
Tax incentives	Provisions in federal or state tax codes that encourage improved management and stewardship of private forest land.	<ul style="list-style-type: none"> Immediate deduction of reforestation expenses Enhanced amortization of timber stocks Special tax provisions for forests under conservation management plans "Current use" taxation that allows land to be appraised for tax purposes according to its current use (e.g., forestry, wildlife habitat) instead of its highest potential use (e.g., commercial development)

Fiscal incentives

Fiscal incentives can influence private sector land use decisions and practices (Table 5.2). For instance, a number of cost-share programs are available that help finance the expenses associated with reforestation, conservation, and sustainable forest management on private lands (Box 5.2). Likewise, tax deductions or credits are available to lower the cost of planting trees or instituting sustainable forestry practices. Such tax policies—or the lack thereof—can have a significant impact on both corporate and non-corporate forest owner decisions regarding the status, extent, and management of their forests.

Liability limitations

Liability limitations are designed to reduce liability risk to landowners for taking voluntary, proactive steps to protect or restore forests or other ecosystems (Table 5.3). For example, safe harbor agreements encourage private landowners to voluntarily maintain and/or restore habitat for a particular endangered or threatened species. In return, the U.S. Fish & Wildlife Service absolves the landowner of any increased restrictions should the landowner's management actions increase the number of a listed species on his or her land or bring a listed species to that land. Under candidate conservation

Box 5.2 Selected Government Cost-Share Programs

The U.S. federal government offers a number of subsidies and cost-share programs to landowners to fund reforestation, forest conservation, and other sustainable forest management practices on private land. Examples include, but are not limited to:

- **Conservation Reserve Program.** Provides technical and cost-share assistance to eligible ranchers and farmers to address various natural resource concerns in a way that is both environmentally beneficial and cost-effective. The program encourages farmers to convert highly erodible cropland or other environmentally sensitive land to vegetative cover such as trees or grass. The landowner receives some financial help to purchase and plant the vegetation as well as an annual rental payment for the term of their multiyear contract.
- **Forest Land Enhancement Program.** Provides financial assistance to nonindustrial private forest owners in the form of a cost share of up to 75 percent of the costs incurred by the landowner, not in excess of \$100,000, and technical assistance to implement management practices that promote sustainable forest management.
- **Healthy Forest Reserve Program.** Provides financial incentives to conserve and restore endangered species habitat on privately owned forest lands, improve biodiversity, and enhance carbon sequestration. The program is designed for private landowners of either forest lands or historical forest land converted to cropland.
- **Landowner Incentive Program.** Provides funding from the U.S. Fish & Wildlife Service to state wildlife agencies to staff and finance their own individual programs to help private landowners create and improve habitat for endangered, threatened, candidate, and other at-risk species. Once state wildlife agencies receive funding to operate a program, they are able to provide grants to private landowners to restore, enhance, or manage rare species habitat on private land.
- **Stewardship Incentives Program.** Provides technical and financial assistance to encourage non-industrial private forest landowners to keep their lands and natural resources productive and healthy. Qualifying land includes rural lands with existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Native American tribe, or other legal private entity. Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land—exceptions for landowners with up to 5,000 acres may be obtained.
- **Wetlands Reserve Program.** Offers landowners the opportunity to protect, restore, and enhance wetlands on their property. Offers technical and financial support to help private landowners protect, restore, and enhance wetlands, including forested wetlands.
- **Wildlife Habitat Development Plans.** Gives technical assistance and cost-sharing opportunities to landowners to improve wildlife habitat on nonfederal lands. The plans describe the landowner's goals for improving wildlife habitat, include a list of practices and a schedule for installing them, and detail the steps necessary to maintain the habitat for the life of the agreement, which lasts five to ten years. Fifteen percent of program funding has historically been used to develop wildlife habitat for federally endangered and threatened species. Many of these critical habitats exist on forest land.
- **Wildlife Habitat Incentives Program.** Provides technical assistance and cost-share funds of up to 75 percent to landowners who want to develop and improve wildlife habitat on nonindustrial private forest land, agricultural land, and Native American land.

In addition, many southern states provide funding for reforestation and timber stand improvement projects through state cost-share programs. Examples include:³

- **North Carolina Forest Development Program.** Encourages private landowners to reforest after harvesting and to place idle or underproductive forest land into full timber production. The program is funded primarily by the forest industry through a special assessment paid on all timber harvested in the state. Some funds also come from the state legislature.
- **Florida Forest Land Recovery Program.** Provides financial assistance to nonindustrial private forest landowners who suffer losses as a result of a tropical storm, hurricane, or related event. The program finances 75 percent of the costs associated with debris removal, timber replanting, and other related purposes.
- **Virginia's Reforestation of Timberlands Program.** Provides funding to private landowners to plant pine seedlings in response to the overharvesting of pine timber. Funds come from the forest industry, the Commonwealth of Virginia, and private landowners.

Table 5.3 Examples of Liability Limitations

<i>Not Exhaustive</i>		
Measure	Definition	Example from the South
Legal assurances	Laws that assure private landowners that steps they take voluntarily to improve ecosystem health will not lead to future regulatory restrictions on their land.	<ul style="list-style-type: none"> • Safe Harbor Agreements • Candidate Conservation Agreements with Assurances
“Right to prescribed burn” laws or “right to practice forestry” laws	Laws that recognize prescribed burning as a legal and ecologically beneficial operation, establish burner training/certification programs, protect landowners from nuisance claims for prescribed burning activity, and limit burner liability for damages and injuries.	<ul style="list-style-type: none"> • Prescribed burn laws enacted in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, and Virginia

Table 5.4 Examples of Market Incentives

<i>Not Exhaustive</i>		
Measure	Definition	Example from the South
Provisioning services		
Timber, paper, and biomass energy markets	Private markets for products such as timber, paper, and biomass energy. The private market for timber, paper, and biomass energy encourages landowners to keep forests as forest. If managed sustainably, these forests may also provide a multitude of other ecosystem services over the long term.	<ul style="list-style-type: none"> • Global market for lumber • Global market for paper • Global market for veneer • Global market for biomass energy
Markets for non-timber forest products	Private markets for forest products such as wild foods, natural medicines, and ornamental plant species.	<ul style="list-style-type: none"> • Pine needles for mulch and bedding • Ginseng • Walnuts
Regulating services		
Payments for climate regulation (carbon sequestration)	Payments made to landowners for the carbon sequestered in their forests. The buyer—typically a company or other institution—receives carbon credits (sometimes called “offsets”) that it can apply to either a voluntary or regulatory greenhouse gas emissions reduction target.	<ul style="list-style-type: none"> • In Mississippi’s Tensas River Basin, the Nature Conservancy replanted floodplain forests, measured the carbon to be sequestered through reforestation, and generated carbon credits to sell to willing buyers.*
Wetland mitigation banking	A system in which a landowner who restores, enhances, establishes, or preserves wetlands—including forested wetlands—generates credits that compensate for unavoidable impacts to wetlands occurring elsewhere. A mitigation bank may be created when a government agency, corporation, nonprofit organization, or other entity undertakes these activities under a formal agreement with a regulatory agency. Landowners receive payment when they make “deposits” into a “wetland bank.” Mitigation banks are form of “third-party” compensatory mitigation, in which the responsibility for compensating for wetland damages is assumed by a party other than the developer. Wetland mitigation banking is permitted under Section 404 of the U.S. Clean Water Act and similar state or local wetland regulations.	<ul style="list-style-type: none"> • The Obion Wetland Mitigation Bank in Tennessee is a 367-acre tract of farmland that was purchased in 2003 and restored as a bottomland hardwood forest. • The Mud Creek Wetland Mitigation Site in Tennessee is an 8-acre site purchased in 1996 and restored into an oxbow lake surrounded by woods of oak, cypress, and tupelo.**
Payments for watershed protection	Payments to private landowners for the role their forests play in improving water quality—preventing erosion, absorbing excess nutrients—or regulating the timing of water flows within a watershed. These payments may occur in purely voluntary transactions or as part of regulated water quality markets.	<ul style="list-style-type: none"> • Neuse River water quality trading program (North Carolina) • Florida Ranchlands program • Tar-Pamlico water quality trading program (North Carolina)
Cultural services		
Payments for recreation, hunting, and/or fishing	Fees that landowners charge people for utilizing forests for camping, hiking, hunting, fishing, or other related activities.	<ul style="list-style-type: none"> • Plum Creek, a company with significant forest holdings in the South, sells hunting leases and seasonal camping options in its forests to recreational enthusiasts.*** • Many family forest owners sell hunting leases

agreements with assurances, a nonfederal landowner voluntarily implements land management practices to benefit candidate species that are declining, but which are not yet listed as endangered or threatened. In return, the landowner has no legal obligations beyond what was committed to in the agreement if the species is later listed as endangered or threatened. In return, the landowner receives regulatory assurances.⁴

Market incentives

Market incentives are another measure for encouraging sustainable forest management. A range of markets exist, often tied to specific types of ecosystem services (Table 5.4). For

example, markets already exist for many of the provisioning ecosystem services such as timber and non-timber forest products. Revenue from sustainably harvesting timber has provided and can continue to provide southern landowners an incentive to maintain their lands as forests. In fact, recognition of this fact is leading some conservationists to increasingly collaborate with timber companies and private landowners in an effort to keep forest as forest and stave off development.⁵

Markets and payment systems also are emerging for some of the regulating and cultural ecosystem services, such as carbon sequestration, watershed protection, and recreation. For instance, payments to landowners for carbon offsets have occurred in the

Table 5.4 Examples of Market Incentives (continued)

<i>Not Exhaustive</i>		
Measure	Definition	Example from the South
Other		
Biodiversity banking (conservation banking)	A system in which a landowner who restores, enhances, establishes, or preserves habitat of an endangered species generates credits that compensate for the loss of habitat of the same species. Landowners receive payment when they make "deposits" into a "conservation bank." These deposits are purchased as "credits" by developers or other landowners who are converting or otherwise reducing the quality of habitat of the endangered species. Landowners can apply credits to their own properties.	<ul style="list-style-type: none"> • In 2000, International Paper created a red-cockaded woodpecker conservation bank near Bainbridge, Georgia by expanding habitat for the endangered bird from 1,500 acres to more than 5,000 acres. The credits generated allowed the company to harvest timber in woodpecker habitat in other sites. • In 2009, Westervelt Ecological Services established the Chickasawhay Conservation Bank, a 1,223-acre site in Greene County, Mississippi that provides gopher tortoise conservation credits for sale for compensatory mitigation within approved areas of Mississippi and Alabama. It also provides restoration of longleaf pine habitat.****
Forest certification and eco-labeling	<p>A forest product labeling system designed to recognize and promote environmentally responsible forestry and sustainability of forest resources. The certification process involves an evaluation of management planning and forestry practices by a third party according to an agreed-upon set of standards. Certification standards address social and economic welfare as well as environmental protection. Forest products that meet these standards can be labeled as meeting the respective certification requirements.</p> <p>As of mid-2009, acreage of southern forest certified by program was approximately:*****</p> <ul style="list-style-type: none"> • American Tree Farm System: 13 million • Forest Stewardship Council: 3 million • Green Tag, approved by the National Forestry Association: 5,000 • Sustainable Forestry Initiative: 20 million <p>Since the early 1990s, certification and eco-labeling of timber and paper products have grown as important private initiatives to encourage forest management practices that maintain a forest's ability to provide a spectrum of ecosystem services. Certification can help forest product suppliers with market access and, in some cases, pricing.</p>	<ul style="list-style-type: none"> • American Tree Farm System, a program of the American Forest Foundation designed for small landholdings • Forest Stewardship Council (FSC), developed by environmental nongovernmental organizations • Green Tag, a program of the National Woodland Owners Association • Sustainable Forestry Initiative (SFI), developed by the American Forest & Paper Association, and now an independent 501c3 and stakeholder standard
Notes:		
*The Nature Conservancy. "Climate Change: The Tensas River Basin Project." Online at: http://www.nature.org/initiatives/climatechange/work/art24028.html		
**Ecology Section Wetland Mitigation and Wetland Banking Program, Tennessee Department of Transportation. Online at: http://www.tdot.state.tn.us/environment/ecology/mitigation.htm		
***"Hunting Programs." Plum Creek. Online at: http://www.plumcreek.com/Recreation/HuntingPrograms/tabid/142/Default.aspx		
****"The Chickasawhay Conservation Bank." Online at: http://www.westerveltecologicalservices.com/pdf/chickasawhay-flyer.pdf . Westervelt Ecological Services.		
*****American Tree Farm System. Online at: http://www.treefarmssystem.org/cms/pages/20_5.html . 2007; Green Tag. Online at: http://www.greentag.org/primary_pages/greentag_register.asp ;		
"FSC in the South." Forest Stewardship Council: United States. Online at: http://www.fscus.org/images/documents/international_fact_sheets_2007/fs_south.pdf ; "SFI Program Participants that have Completed 3rd Party Certification." Sustainable Forestry Initiative. Online at: http://www.sfiiprogram.org/files/pdf/SFI2005-2009Certificates.pdf . 2009.		

Table 5.5 Drivers of Change Addressed by Measures

Not Exhaustive

Category	Measure	Drivers of change addressed							
		Suburban encroachment	Reversion of agricultural land	Forest management practices	Surface mining	Pest and pathogen outbreaks	Invasive species	Fire	Climate change
Land use instruments	Conservation easements	X			X				
	Voluntary development offsets	X							
	Transferable development rights	X							
Fiscal incentives	Subsidies (cost-share programs)*		X	X		X	X	X	
	Tax incentives	X	X	X					
Liability limitations	Legal assurances		X	X					
	“Right to prescribed burn” laws or “right to practice forestry” laws			X				X	
Market incentives	Timber, paper, and biomass energy markets	X	X	X		X	X	X	X
	Markets for non-timber forest products			X					
	Payments for climate regulation (carbon sequestration)	X	X	X					X
	Wetland mitigation banking	X	X	X					
	Payments for watershed protection	X	X	X					
	Payments for recreation, hunting, and/or fishing			X					
	Biodiversity banking (conservation banking)	X	X	X	X				
	Forest certification and eco-labeling			X		X	X	X	
Education and capacity building		X	X		X	X	X		

* Driver of change addressed varies by cost-share program.



PHOTO: APPALACHIAN TRAIL CONSERVANCY

Education and outreach to southern forest landowners are important for maintaining healthy forests.

United States. These new revenue streams might be able to provide forest owners with additional income to finance sustainable forest management practices, fund forest conservation, or pay taxes or other expenses associated with keeping land as forest.

Education and capacity building

Extension services are another means of informing and influencing forest management decisions. Extension services are avenues for exchanging ideas, knowledge, and techniques designed to change attitudes, practices, knowledge, and/or behavior such that forest and tree management improves (Anderson and Farrington 1996). State divisions of forest resources and federal extension services, for example, can inform landowners about prescribed burns, reforestation techniques, deer fences, and harvesting practices that mimic natural canopy openings, among other practices.⁶ Some forest product companies offer landowner assistance programs to private forest owners for the same purpose. Likewise, consulting foresters offer forest management advice to landowners. State forest services can provide lists of consulting foresters by region or county.

Such technical assistance programs have been successful in encouraging the application of sustainable forest management practices on private lands (Greene et al. 2005). Research suggests that education and capacity building are still in high demand. A recent nationwide study of family forest owners found that the most frequently cited request or demand was for one-on-one access to a forester or other natural resource professional to “walk the land” with them and discuss best management practices and options (Kilgore et al. 2007).

ENSURING SOUTHERN FORESTS FOR THE FUTURE

As this profile suggests, a number of measures exist that could help ensure that southern forests continue to provide a myriad of ecosystem services going forward. These measures could help landowners address and respond to many of the drivers of change affecting southern forests (Table 5.5).

To date, however, the performance of many of these measures has been mixed. For instance:

- Despite being already available, some of these measures are currently undersubscribed in the region. For example, although the South constitutes approximately 28 percent of the land area of the United States (excluding Alaska and Hawaii), it has only 16 percent of the country’s conservation easement lands (Alvarez 2007). Similarly, according to a southern family forest owner survey from 2006, only 5 percent of owners surveyed were currently participating in cost-share programs.
- Some measures have been insufficient to outweigh the incentive to convert forest land to non-forest uses.
- Awareness of some measures is low. For example, less than 15 percent of southern family forest owners surveyed had “heard of” sustainable forest certification programs (Butler 2008).

- Some of the market incentives, especially payments for ecosystem services such as carbon sequestration and watershed protection, are just emerging and therefore are relatively novel for most forest owners. The region lacks a sufficient number of pilot projects utilizing these incentives to raise awareness, stimulate adoption, and facilitate continuous improvement of incentive design.
- Some measures, such as development offsets or transferable development rights, have been piloted in a few locations, but have yet to be scaled up.

These observations lead to a number of questions, including:

- Which of these incentives and measures show the greatest promise for sustaining southern forests and their ecosystem services?
- What are the barriers southern forest owners face that limit utilization of these measures and how can these barriers be addressed?
- How can emerging, novel incentives be piloted in the region to demonstrate effectiveness and refine incentive design?
- How can incentives that have successfully been piloted in a few instances in the region be scaled up?
- What other innovative incentives for sustaining forest ecosystem services are being pioneered elsewhere that could be replicated in the South?
- How can awareness of these incentives and outreach be improved?

Now is the time for stakeholders to address these and related questions. Southern forests are too important to do otherwise. As this publication has shown, the forests of the southern United States are a national and global treasure. They provide people, communities, and businesses with a wide range of ecosystem services, including timber, pulpwood, energy, carbon sequestration, erosion control, recreation, hunting, and aesthetic pleasure.

They are forests of diversity, being among the most biologically diverse temperate forests in the world. They are forests of change, as well. The southern forests of today were shaped by humankind and natural disturbances over many centuries and millennia. The southern forests of tomorrow will be shaped by a number of drivers of change, including suburban encroachment, climate change, reversion of agricultural land, forest management practices, fire, and outbreaks of pests and pathogens.

How stakeholders involved with forest stewardship—such as conservation organizations, concerned citizens, landowners, academic institutions, the private sector, and agencies—respond to these drivers of change is today’s challenge and opportunity. For its part, WRI will engage a number of regional organizations over the coming years to evaluate a portfolio of options that align economic incentives with forest stewardship, pilot the most promising ones, and assist with scale up. As do others in the region, WRI seeks to realize a world in which economic incentives align with ecosystem stewardship. In so doing, we hope to ensure southern forests for the future.

Notes

¹ WRI analysis based on the Protected Areas Database for the United States (PAD-US) (USGS National Gap Analysis Program, 2009) overlaid on National Land Cover Data (NLCD 2001) (U.S. Geological Survey, 2007).

² Commercial timber harvesting is typically not a viable management option for tracts of forest as small as 9 acres or less. Susan Moore, North Carolina State University, personal communication, October 16, 2009.

³ Forest Incentive Programs Available from State Sources. Online at: <http://www.srs.fs.usda.gov/econ/data/forestincentives/state.htm>

⁴ Environmental Defense Fund. “Candidate Conservation Agreements With Assurances.” Center for Conservation Incentives. Online at: <http://www.edf.org/page.cfm?tagID=15>

⁵ For instance, see Mapes, Lynda V. “New strategy to save forests: logging,” *The Seattle Times*, August 3, 2009.

⁶ Official state extension services are located in universities and counties. They are a partnership among federal, state, and county governments. William G. Hubbard, Southern Regional Extension Forester, University of Georgia, personal communication, November 11, 2009.

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