



## KEEPING FOREST AS FOREST: Incentives for the U.S. South

LOGAN YONAVJAK, CRAIG HANSON, JOHN TALBERTH, AND TODD GARTNER

### SUMMARY

- Forests of the southern United States provide a wide variety of benefits—collectively known as “ecosystem services”—to people, communities, and businesses. For example, they provide timber, help purify water, control soil erosion, help regulate climate by sequestering carbon, and offer outdoor recreation, hunting, and fishing opportunities.
- Over the coming decades, several direct drivers of change are expected to negatively affect the quantity and quality of southern forests and thus their ability to provide ecosystem services. These direct drivers include suburban encroachment, unsustainable forest management practices, climate change, surface mining, pest and pathogen outbreaks, invasive species, and wildfire.
- A number of incentives, markets, and practices—collectively called “measures”—could help address these drivers of change and promote southern forest conservation and sustainable management. These measures fall into five major categories: land use instruments, fiscal incentives, liability limitations, market incentives, and education/capacity building. With such measures in place, these forests could continue to supply needed ecosystem services and the native biodiversity that underpins these benefits.
- The South has experience with many of these measures. A few have been around for awhile, such as parks and protected areas, while many are relatively new, such as payments for watershed protection. However, adoption of even some of the most traditional measures is still relatively low in the South. Why is this the case? What can be done to increase adoption of these measures? Are there other innovative ideas that hold promise for more widespread application?
- This issue brief sets the stage for these questions and introduces subsequent installments of the *Southern Forests for the Future Incentives Series*, which will answer these and related questions. This brief is designed for conservation and land use professionals, decision makers, and concerned citizens.

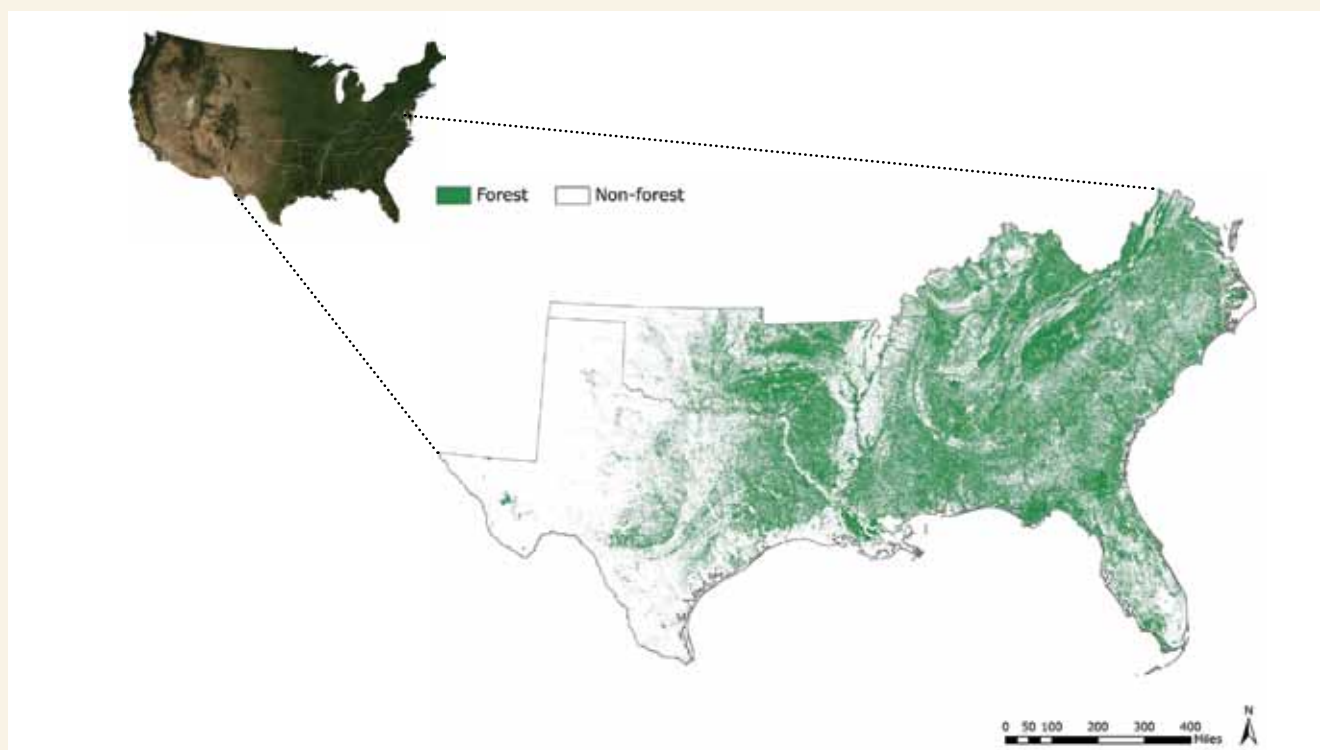
### SOUTHERN U.S. FORESTS PROVIDE NUMEROUS BENEFITS

The forests of the southern United States span approximately 214 million acres (Smith et al. 2009) and stretch across 13 states, from Texas to Virginia and from Kentucky to Florida (Figure 1).<sup>1</sup> These forests are among the most biologically diverse temperate forests in the world (Trani 2002) and contain the highest concentration of tree species in the United States (Hansen et al. 2002). Southern forest landscapes support 3,000 species of plants, 595 species of birds, and 246 species of mammals (Miller 2001; Trani 2002). Home to 170 amphibian and 197 reptile species, these ecosystems are also a center of amphibian and reptile diversity in North America (Trani 2002).

In addition to these biological values, southern forests are natural economic assets that generate a suite of ecosystem services—sometimes called “nature’s benefits” or “environmental services”—critical to human health and well-being at multiple scales (Box 1). For instance, at the local level, southern forests provide people with fuelwood and hunting and fishing opportunities. Regionally, they filter water and offer recreational opportunities for urban and rural dwellers. At a global scale, they sequester carbon—helping to regulate greenhouse gas concentrations in the atmosphere—and provide wood for the forest products industry. Many of the non-timber benefits are often provided at low or no cost to society, and are often overlooked in management decisions.

FIGURE 1

## Extent of Southern U.S. Forests



**Source:** Satellite imagery (ESRI Data and Maps 9.3.1; ESRI, i-cubed, and GeoEye 2009), forest cover (NLCD 2001 Land Cover, USGS, 2007), and administrative boundaries (ESRI Data and Maps 9.3.1, ESRI, 2008).

## Box 1

## Ecosystem Services and 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 of 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 in 95 countries. The assessment 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. Southern forests provide a wide range of provisioning services, including timber for furniture, pulpwood for paper, biomass fuel, and non-timber forest products such as blackberries, mushrooms, and ginseng.

**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.\* Southern

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

**Cultural services** are the nonmaterial benefits obtained from an ecosystem such as recreation, aesthetic enjoyment, and spiritual renewal. Southern forests provide several cultural ecosystem services, including outdoor recreation, tourism, hunting and fishing.

**Supporting services** are natural processes—such as nutrient cycling, primary production, and water cycling—that maintain the other ecosystem services.

For more information about the Millennium Ecosystem Assessment, visit [www.maweb.org](http://www.maweb.org). For more information on forest-related ecosystem services provided by the forests of the southern United States, refer to [www.SeeSouthernForests.org](http://www.SeeSouthernForests.org) and *Southern Forests for the Future* (Hanson et al. 2010).

\* Government cost-share programs such as the Environmental Quality Incentives Program (EQIP) are an exception.

**Source:** Millennium Ecosystem Assessment 2005.

## YET SOUTHERN FORESTS FACE MANY CHALLENGES

Despite their tremendous economic, environmental, and social value, southern forests continue to be lost and degraded. Over the coming decades, a number of factors or “drivers of change” are expected to affect southern forests and their ability to provide ecosystem services. “Direct drivers” are factors—of natural or human origin—that cause changes in an ecosystem and thereby either increase or decrease its ability to provide certain ecosystem services.<sup>2</sup> Those affecting southern forests include suburban encroachment, climate change, the reversion of agricultural land to forestland, unsustainable forest management practices, surface mining, pest and pathogen outbreaks, invasive species, and wildfire (see Hanson et al. 2010)—*Southern Forests for the Future*—for more information about these drivers of change). Table 1 outlines potential negative impacts of some of these direct drivers.

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 are projected to impact southern forest quantity and quality over the next few decades.

Going forward, changes in southern forest quantity and/or quality due to these drivers of change will have implications for southern forest ecosystem services (Hanson et al. 2010). For example:

- 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. According to the Environmental Protection Agency, in 2008<sup>3</sup> U.S. forests absorbed an estimated 792 million metric tons of carbon dioxide equivalent, an amount equal to approximately 11 percent of the country’s gross greenhouse gas emissions from industrial and other sources (EPA 2010). For the South, it is estimated that the carbon sequestered by managed forests accounts for a third of the carbon storage capacity of continental U.S. forests (Jose 2007).
- Carbon storage and sequestration potential can be diminished by the conversion of natural forests to industrial tree plantations. According to Gower (2008), overall, “the industrial forest carbon cycle—and its associated manufacturing, transportation, and disposal of timber products—releases large amounts of carbon and is a net carbon source” (White et al. 2005; Gower et al. 2006; Ahl et al. 2007, qtd. in Gower, 2008).

- In areas where forests are converted to development, forest-based recreation and tourism opportunities will decline, despite increasing demand. As a result, hiking, camping, wildlife viewing, hunting, fishing, and other recreational activities may become concentrated on fewer forest acres.
- High-intensity wildfires, because of the intensity and duration of burning, can deteriorate watershed function because of the severity of soil and hydrologic effects. After moderate or high-severity forest fires, for example, major precipitation events can lead to increased runoff, peak flows, and sediment delivery to streams, impacting fish populations and habitat as well as impacting downstream water quantity and quality (Ice et al. 2004).
- Invasive species<sup>4</sup>—such as Japanese honeysuckle, Cogon grass, and the balsam woolly adelgid—can decrease biological diversity by out-competing native species for food, habitat, water, or light. Biological diversity underpins the supply of many ecosystem services (Millennium Ecosystem Assessment 2005).
- In those areas where suburban encroachment is prevalent, where disease/pathogen outbreaks occur, or where wildfires emerge, the supply of timber and/or pulpwood from southern forests will likely decline.

In general, less forest area—or less healthy forests—means fewer forest-based ecosystem services and negative implications for forest-dependent biodiversity.

## MEASURES EXIST FOR INCREASING FOREST CONSERVATION AND SUSTAINABLE MANAGEMENT

A number of incentives, markets, and practices—collectively referred to here as “measures”—exist that could help address these drivers of change and ensure that southern forests continue to supply needed ecosystem services and the native biodiversity on which they depend. These measures fall into five categories: land use instruments, fiscal incentives, liability limitations, market incentives, and increased education/capacity building.

- **Land use instruments** delineate eligible uses for a tract of land. Designated protected areas are one type of land use instrument. Other instruments include zoning, development offsets, and transferable development rights. Companies, nongovernmental organizations, or private citizens are increasingly establishing conservation easements on forestland and other ecosystems, as well.

Table 1

## Impact of Selected Direct Drivers on the Quantity and Quality of Southern Forests

Driver of change	Example of impact	Potential scale of impact
Suburban encroachment	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.  At 31 million acres, approximately 14 percent of 2010 southern forest area would be lost to development by 2040.
Forest management practices	In 2006, industrial tree plantations covered roughly 43 million acres, or 20 percent of the southern forest landscape (Smith et al. 2009). By 2040, this area is expected to climb to 54 million acres (Wear and Greis 2002; Prestemon and Abt 2002). 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 (Prestemon and Abt 2002). <sup>a</sup> Productive planted pine forests disturb and alter the native species mix of natural forests and are often a net source of carbon. However, due to their high productivity, they can help reduce pressure to extract timber from other forests and thereby increase those forests' ability to provide non-timber ecosystem services. <sup>b</sup>	By 2040, the area of industrial tree plantations is expected to increase to approximately 25 percent of the entire southern forestland area.
Surface mining	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). Over 2,000 permits for new valley fills have been granted since 2000 (GAO 2010).	An area of 1.4 million acres is less than 1 percent of the overall forest area in the South. However, mountaintop removal clears native forests and causes a number of other environmental problems, such as freshwater pollution and the permanent rechanneling of streams.
Pest and pathogen outbreaks	Pest and pathogen outbreaks cause immense forest damage every year in the South by killing trees over extensive areas. From 1999 to 2003 alone, the southern pine beetle affected more than 1 million acres of land at an economic cost exceeding \$1.5 billion (Nowak et al. 2008).	The southern pine beetle threatens to affect 8.4 million acres or 4 percent of southern pine forests between 2007 and 2022 (Nowak et al. 2008).
Invasive species	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).  Kudzu has spread to occupy more than 7 million acres in the South (Wear and Greis 2002).	The area affected by kudzu alone covers more than 3 percent of southern U.S. forests.

- *Fiscal incentives* refer to taxes, subsidies, and fees that influence land use decisions and practices. For instance, a number of cost-share programs are available that help finance the expenses associated with reforestation, conservation, and sustainable forest management<sup>5</sup> on private lands. 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 owners regarding the status, extent, and management of their forests.
- *Liability limitations* are designed to reduce liability risk to landowners for taking voluntary, proactive steps to protect or restore forests or other ecosystems. For example, safe harbor agreements encourage private landowners to voluntarily maintain and/or restore and maintain habitat for a particular endangered or threatened species. In return, the U.S. Fish & Wildlife Service absolves the landowner of any increased

Table 1

*continued*

Driver of change	Example of impact	Potential scale of impact
Wildfires	Between 2002 and 2010, approximately 10 million acres burned due to wildfires <sup>c</sup> alone in the southern United States, with an average of 1.12 million acres per year (note: 2010 data only goes through August 1) (National Interagency Fire Center, ongoing analysis). Not all fires have negative impacts; some forest ecosystems in the South adapted over millennia to coexist with fire of both natural and human origin. Thus, fire is a natural part of some forest ecosystems, such as longleaf pine, 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.	Between 2002 and 2010, almost 5 percent of southern forests were burned by wildfires.
Climate change	<p>Some forest ecosystems—such as southern spruce-fir forests, which are comprised primarily of red spruce and Fraser fir—may retreat northward and/or to higher altitudes. The ability to retreat is contingent upon the availability of land for them to migrate through and to; urban areas and agricultural land can preclude movement.</p> <p>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 (Prasad et al. 2007).</p> <p>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).</p> <p>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).</p>	Depending on the species range, these projected changes could affect millions of acres of southern U.S. forests and the natural range of certain plant and animal species that are forest-dependent.

**Notes:**

“Reversion of agricultural land to forest” is one of the direct drivers of change affecting southern U.S. forests. However, this driver of change on average is having a positive impact on southern forest extent and therefore is not included in Table 1, which focuses on direct drivers having negative impacts on southern forest quantity and/or quality.

- a. 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).
- b. 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).
- c. Wildfire in the context of this statistic refers to “an unplanned, unwanted wildland fire including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out” (National Interagency Fire Center glossary 2008).

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 agreements with assurances, a nonfederal landowner voluntarily implements land management practices to benefit species that are declining but not yet listed as endangered or threatened. In return, the landowner has no legal obliga-

tions beyond what was committed to in the agreement if the species is later listed as endangered or threatened. Thus, the landowner receives regulatory assurances.<sup>6</sup>

- *Market incentives* are another measure for encouraging sustainable forest management. A range of markets exist, often tied to specific types of ecosystem services. For example, markets already exist for many provisioning ecosystem

services, such as timber and non-timber forest products. Revenue from sustainably harvested timber has provided and can continue to provide southern landowners an incentive to maintain their lands as forests. Recognition of this fact is leading conservationists to increasingly collaborate with timber companies and private landowners in an effort to keep forest as forest and stave off development across the country.<sup>7</sup>

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 already occurred in the United States. These new revenue streams can 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* are another means of informing and influencing forest management decisions and can help landowners access the aforementioned incentives. Extension services, for instance, 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 Farington 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.<sup>8</sup> 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.

Table 2 summarizes some of these measures. Each of these measures addresses or responds to at least one of the drivers of change affecting southern forests (Hansen et al. 2010). However, none of these is a silver bullet. Ensuring southern forests for the future will require a portfolio of these measures; the most effective combination will likely vary by ownership, state, and other features.

As Table 2 shows, the South has experience with many of these measures. A few have been around for some time, such as parks and protected areas, while many are relatively new, such as payments for watershed protection. In the South, however, these measures—including even some of the most traditional measures—have not been widely adopted.

Take, for example, parks and protected areas. Currently, only 7 percent of total land area and 13 percent of forest area in the South is under any kind of formal protection<sup>9</sup> (Hanson et al. 2010), whereas approximately 34 percent of the rest of the country (excluding Alaska and Hawaii) is under some form of protected status. The same is true for conservation easements. Although the South constitutes approximately 37 percent of the private land area in the continental United States, it only has 23 percent of the country's total conservation easement lands (Aldrich and Wyerman 2006; Land Trust Alliance 2010).<sup>10</sup> Forest certification and eco-labeling have low penetration, as well. Just 17 percent, or 37 million acres, of southern forests are enrolled in some form of sustainable forest management certification system.<sup>11</sup>

Why is this relatively low penetration of measures the case? What can be done to increase adoption of these measures? What other measures hold promise for more widespread application?

Table 2

## Measures for Ensuring Southern Forests for the Future

NOT EXHAUSTIVE

Category	Measure	Definition	Examples from the South
<i>Land use instruments</i>			
	Parks and protected areas	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. Protected areas have some form of permanent designation, preventing the conversion of a natural ecosystem and prescribing the types of use of the ecosystem.	<ul style="list-style-type: none"> <li>• Great Smoky Mountain National Park, North Carolina</li> <li>• Angelina National Forest, Texas</li> <li>• Blackwater River State Forest, Florida</li> </ul>
	Zoning	Zoning is a tool for implementing the policies and goals established in a community's plan as they relate to land use. It specifies activities allowed on each parcel of land in a specified area, as well as any associated standards or exceptions. Most cities and towns are composed of regions that are zoned for residential, commercial, or industrial development, and often these zones are subdivided by additional use restrictions.	<ul style="list-style-type: none"> <li>• In Lancaster County, Virginia, sliding scale zoning is used to decrease the density of development by limiting the number of times a parcel of land can be split based on its size. Once the lots are subdivided, no new divisions may take place.</li> <li>• In Atlanta, Georgia, incentive zoning allows developers to increase the number of lots by a factor (such as 25 percent or more) in exchange for clustering the development and preserving the balance of undeveloped land.</li> </ul>
	Conservation easements	A conservation easement is 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 easement's restrictions, once set in place, are binding on all future owners of the property. Landowners sometimes donate conservation easements or sell them to willing buyers such as land trusts.	<ul style="list-style-type: none"> <li>• 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.<sup>a</sup></li> </ul>
	Development offsets	A voluntary or regulatory program in which land developers, extraction industries, or other 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"> <li>• 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.</li> </ul>
	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 that may be at a higher density than ordinarily permitted by the base zoning. These programs are not intended to control the amount of growth in a community, but rather to direct where and at what density development occurs.	<ul style="list-style-type: none"> <li>• Since 2005, Marion County, Florida, has preserved more than 3,000 acres of ecologically sensitive land through its TDR program at no cost to taxpayers.<sup>b</sup></li> <li>• In 2003, the state of Georgia allowed municipalities and county governments to adopt ordinances to provide for the transfer of development rights.</li> </ul>
	Density transfer credit ordinance	A specialized and simplified variation of transferable development rights. This variation requires the establishment of sending zones and receiving zones, which relies on an active real estate market with sufficient growth to stimulate the sale and transfer of development rights. Sending zones are the lands protected from development, and receiving zones are the areas designated for growth. With density transfer credit ordinances, the community can accept a fee in place of an actual conservation easement. This fee is used to then purchase easements, either at the point of sale or at a later time, resulting in a more flexible method for the developer and the community.	<ul style="list-style-type: none"> <li>• Charlotte County, Florida transfer of density units ordinance</li> <li>• Virginia Model Transfer of Development Rights Ordinance for Virginia Localities</li> </ul>

Table 2

*continued*

Category	Measure	Definition	Examples from the South
<i>Fiscal incentives</i>			
	Subsidies (cost-share programs)	Federal and state subsidies that provide funding for reforestation, sustainable management practices, ecological restoration, and habitat protection on private forest land.	<ul style="list-style-type: none"> <li>• Environmental Quality Incentives Program</li> <li>• Conservation Reserve Program</li> <li>• Forest Land Enhancement Program</li> </ul>
	Tax incentives	Provisions in the federal tax code (e.g., income tax or estate tax credit or deduction) or state tax codes (e.g., income or property tax deductions or exemptions) that encourage improved management, conservation, and/or stewardship of private forest land. Some of these tax incentives could be tradable, wherein an entity that earns a tax incentive (e.g., credit) but cannot exercise it is allowed to sell the incentive to another entity that can exercise it.	<ul style="list-style-type: none"> <li>• Immediate deduction of reforestation expenses</li> <li>• Enhanced amortization of timber stocks</li> <li>• Special tax provisions for forests under conservation management plans</li> <li>• “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)</li> <li>• Virginia’s conservation easement tax credit trading provisions</li> </ul>
	Tax disincentives	Provisions in the federal tax code (e.g., income tax or estate tax increases) or state tax codes (e.g., income or property tax increases) that discourage low-density development while promoting development patterns that follow smart-growth principles that are environmentally friendly, fiscally and economically “smart,” and include land-use planning, mixed-use development, open-space preservation, and so forth.	<ul style="list-style-type: none"> <li>• A tax on capital gains realized on the sale of land held for less than a specified number of years aimed at protecting rural land from short-term land speculations, controlling land prices, and also promoting more efficient use of land.</li> <li>• The land value taxation (LVT) approach (also called the split-rate tax) views property as having two distinct tax bases: one on land and one on buildings. LVT levies a lower rate on the value of buildings and improvements, and a higher rate on land. LVT generally raises the tax burden on low-intensity users of land located in highly valued areas. This encourages more development on already developed land, as opposed to on open space, and promotes more efficient use of urban infrastructure.</li> </ul>
	Fees	Fees that governments can impose to pay for public services, incentivize land conservation, and promote more compact growth.	<ul style="list-style-type: none"> <li>• City of Durham, NC impact fee ordinance</li> <li>• City of Conway, Arkansas impact fee for new residential development based on square footage of housing</li> </ul>
<i>Liability limitations</i>			
	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"> <li>• Safe Harbor Agreements</li> <li>• Candidate Conservation Agreements with Assurances</li> </ul>
	“Right to prescribed burn” laws and “right to practice forestry” laws	Right to prescribed burn laws 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. Right to practice forestry laws, depending on the degree of protection, can either provide a defense against nuisance lawsuits or prohibit local ordinances from unreasonably restricting forestry operations.	<ul style="list-style-type: none"> <li>• Prescribed burn laws enacted in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, and Virginia</li> <li>• Virginia “Right to Practice Forestry Law”</li> </ul>

Table 2

*continued*

Category	Measure	Definition	Examples from the South
<i>Market incentives</i>			
<i>Provisioning services</i>			
	Timber, paper, and biomass energy markets	Private markets for products such as timber, paper, and biomass energy. These private markets encourage landowners to keep forests as forest. If managed sustainably, these forests may provide a multitude of other ecosystem services as well over the long term.	<ul style="list-style-type: none"> <li>• Global market for lumber</li> <li>• Global market for paper</li> <li>• Global market for veneer</li> <li>• Global market for biomass energy</li> </ul>
	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"> <li>• Pine needles for mulch and bedding</li> <li>• Ginseng</li> <li>• Walnuts</li> </ul>
<i>Regulating services</i>			
	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"> <li>• 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.<sup>c</sup></li> </ul>
	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 create saleable “credits” when they create “deposits” into a “wetland bank” by restoring and protecting wetlands. Developers, or others converting or otherwise impacting wetlands, then purchase credits from these landowners to fulfill permit requirements. Mitigation banks are a 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"> <li>• 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.</li> <li>• 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.<sup>d</sup></li> </ul>
	Payments for watershed protection	Payments to private landowners for the role their forests play in improving water quality—preventing erosion or 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"> <li>• Neuse River water quality trading program (North Carolina)</li> <li>• Florida Ranchlands Environmental Services project</li> <li>• Tar-Pamlico water quality trading program (North Carolina)</li> </ul>
<i>Cultural services</i>			
	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"> <li>• Plum Creek, a company with significant forest holdings in the South, sells hunting leases and seasonal camping options in its forests to recreational enthusiasts.<sup>e</sup></li> <li>• Many family forest owners sell hunting leases.</li> </ul>

Table 2

*continued*

Category	Measure	Definition	Examples from the South
<i>Other</i>			
	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 create saleable “credits” when they create “deposits” in their “conservation bank” by restoring and protecting habitat. To fulfill permit requirements, these credits are purchased 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"> <li>• 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.</li> <li>• 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.<sup>f</sup></li> </ul>
	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-2010, acreage of southern forest certified by program was approximately:<sup>g</sup></p> <ul style="list-style-type: none"> <li>• American Tree Farm System: 14 million</li> <li>• Forest Stewardship Council: 3 million</li> <li>• Green Tag, approved by the National Forestry Association: 5,000</li> <li>• Sustainable Forestry Initiative: 20 million</li> </ul> <p>Since the early 1990s, certification and eco-labeling of timber and paper products have become important private sector initiatives to encourage forest management practices that maintain a forest’s ability to provide the full 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"> <li>• American Tree Farm System, a program of the American Forest Foundation, designed for small landholdings</li> <li>• Forest Stewardship Council (FSC), developed by environmental nongovernmental organizations</li> <li>• Green Tag, a program of the National Woodland Owners Association<sup>h</sup></li> <li>• Sustainable Forestry Initiative (SFI), developed by the American Forest &amp; Paper Association, and now an independent 501c3 and stakeholder standard</li> </ul>
<b>Education and capacity building</b>			
	Extension services	Avenues for exchanging ideas, knowledge, and techniques designed to change attitudes, practices, knowledge, and/or behavior such that forest and tree management improves.	<ul style="list-style-type: none"> <li>• State divisions of forest resources</li> <li>• Private sector-sponsored landowner assistance programs</li> <li>• Consulting foresters</li> </ul>
<b>Notes:</b>			
<p>a. 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. See The Nature Conservancy: “16,000-acre ‘Working Forest’ Easement to Become Wildlife Management Area.” Online at: &lt;&lt;<a href="http://www.nature.org/success/art19782.html">http://www.nature.org/success/art19782.html</a>&gt;&gt;.</p> <p>b. Thompson, Bill. “County adds 1,958 acres to land-conservation program.” Ocala (Florida) Star-Banner, May 5, 2009. Online at: &lt;&lt;<a href="http://www.ocala.com/article/20090505/articles/905059977?Title=County-adds-1-958-acres-to-land-conservation-program">http://www.ocala.com/article/20090505/articles/905059977?Title=County-adds-1-958-acres-to-land-conservation-program</a>&gt;&gt;.</p> <p>c. The Nature Conservancy. “Climate Change: The Tensas River Basin Project.” Online at: &lt;&lt;<a href="http://www.nature.org/initiatives/climatechange/work/art24028.html">http://www.nature.org/initiatives/climatechange/work/art24028.html</a>&gt;&gt;.</p> <p>d. Ecology Section Wetland Mitigation and Wetland Banking Program, Tennessee Department of Transportation. Online at: &lt;&lt;<a href="http://www.tdot.state.tn.us/environment/ecology/mitigation.htm">http://www.tdot.state.tn.us/environment/ecology/mitigation.htm</a>&gt;&gt;.</p> <p>e. “Hunting Programs.” Plum Creek. Online at: &lt;&lt;<a href="http://www.plumcreek.com/Recreation/HuntingPrograms/tabid/142/Default.aspx">http://www.plumcreek.com/Recreation/HuntingPrograms/tabid/142/Default.aspx</a>&gt;&gt;.</p> <p>f. “The Chickasawhay Conservation Bank” <a href="http://www.westerveltecologicalservices.com/pdf/chickasawhay-flyer.pdf">http://www.westerveltecologicalservices.com/pdf/chickasawhay-flyer.pdf</a>. Westervelt Ecological Services.</p> <p>g. American Tree Farm System. Online at: &lt;&lt;<a href="http://www.treefarmssystem.org/cms/pages/20_5.html">http://www.treefarmssystem.org/cms/pages/20_5.html</a>. 2007&gt;&gt;. Green Tag. Online at: &lt;&lt;<a href="http://www.greentag.org/primary_pages/greentag_register.asp">http://www.greentag.org/primary_pages/greentag_register.asp</a>&gt;&gt;. “FSC in the South” Forest Stewardship Council: United States. Online at: &lt;&lt;<a href="http://www.fscus.org/images/documents/international_fact_sheets_2007/fs_south.pdf">http://www.fscus.org/images/documents/international_fact_sheets_2007/fs_south.pdf</a>&gt;&gt;. “SFI Program Participants that have Completed 3<sup>rd</sup> Party Certification.” Sustainable Forestry Initiative. Online at: &lt;&lt;<a href="http://www.sfiprogram.org/files/pdf/SFI2005-2009Certificates.pdf">http://www.sfiprogram.org/files/pdf/SFI2005-2009Certificates.pdf</a>. 2009&gt;&gt;.</p> <p>h. Data only available through November 2006.</p>			

## ABOUT THIS SERIES

Subsequent issues in the *Southern Forests for the Future Incentives Series* explore these and related questions for a number of measures in more detail. Each brief in the series describes a measure, outlines how it works, profiles key design parameters, and addresses challenges regarding adoption.

The measures covered in the series were identified as those holding significant promise by a set of experts from the private sector, nonprofit organizations, and governmental agencies convened by the World Resources Institute (WRI) in March 2010. Subsequent issues address a number of measures and key questions in more detail, including but not limited to:

- *Conservation easements.* Over the past several decades, conservation easements have become an increasingly popular method for conserving forests and other ecosystems across the United States. However, the use of conservation easements in the South lags behind other regions of the country. What strategies could be employed to increase adoption of easements to conserve and sustain southern forests?
- *Large scale financing for conservation.* A large amount of funding will be required to conserve significant portions of the more than 200 million acres of southern U.S. forests through economic incentives. How can such large-scale funding be generated? Are there some more traditional approaches to generating conservation funds that can be scaled up simultaneously as other economic incentives, such as payments for ecosystem services, are explored?
- *Payments for carbon sequestration.* Voluntary and mandatory (or “compliance”) markets for forest-based carbon sequestration are much discussed. What issues need to be addressed before these markets can become more robust? What steps can southern forest landowners take to prepare for these markets?
- *Payments for watershed services.* Examples of downstream water users paying upstream forest owners to maintain forests and thereby protect water quality, quantity, and flow are starting to emerge in the United States and elsewhere. Who are prospective payers and what is their business case for entering into a payment for watershed service agreement? What steps can southern forest landowners take to participate in such payments?
- *Working forest acquisitions.* Despite support indicated in surveys, publicly owned protected areas and public financing for them are disproportionately low in the South relative to the entire United States. One approach for addressing this underrepresentation is for public entities to purchase forests—or conservation easements on forests—and subsequently “put the forest to work,” earning revenue from sustainable timber production, recreation and hunting fees, and other payments for ecosystem services. How do such “working forest acquisitions” overcome traditional obstacles to public forest ownership? What are the economic benefits of working forests relative to more traditional forms of acquiring protected areas?

This series follows and builds upon *Southern Forests for the Future*, a publication that profiles the forests of the southern United States, providing data, maps, and other information about southern forest distribution and make-up, condition, and trends. *Southern Forests for the Future* explores questions such as: What are the physical features of southern forests? Why are southern forests important? What is their history? What factors are likely to impact the quantity and quality of these forests going forward?

For additional information about southern U.S. forests, visit [www.SeeSouthernForests.org](http://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.

We hope that this *Incentives Series* and [www.SeeSouthernForests.org](http://www.SeeSouthernForests.org) will help spur wider adoption of measures to conserve and sustainably manage southern forests for the future.

## NOTES

1. This brief 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. Southern forests comprise 40 percent of the land area of these states and 29 percent of the total forest land in the United States (Conner and Hartsell 2002).
2. “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 quantity or quality. Some direct drivers such as climate change affect other drivers, and thereby can have a magnified impact on forests.
3. The rate of carbon absorption by terrestrial systems in the United States peaked around 1960 and has been falling since (Stavins and Richards 2005).
4. 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 (Office of the President 1999). For instance, invasive species can cause populations of native species that have little resistance to a non-native pathogen or predator to dwindle.
5. Sustainable forest management, for the purposes of this series, can be defined as “managing forests for their ecological, economic, and social benefits such that those benefits do not diminish in quantity or quality over time” (Jacobson et al. 2009). Sustainable management of southern forests includes integrated management practices such as reforestation of denuded lands with native tree species, harvesting less volume than annual growth, retention of snags and downed wood, mixed-species management, and forest management that provides for integrated habitat connectivity at the landscape scale and allows for wildlife migration (Oliver and Deal 2007).
6. Environmental Defense Fund. “Candidate Conservation Agreements With Assurances.” Center for Conservation Incentives. Online at: <<<http://www.edf.org/page.cfm?tagID=15>>>.
7. For instance, see Mapes, Lynda V. “New strategy to save forests: logging.” *The Seattle Times*, August 3, 2009.
8. Official state extension services are located at 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.
9. 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 four states or levels. For more information, see Crist (2000).
10. Data for southern U.S. states (not including Texas and Oklahoma) was provided by the April 2010 Southeastern U.S. Land Trust Survey Report. Data for Texas and Oklahoma was provided separately through personal communication with Andrew Weaver at the Land Trust Alliance in January 2011.
11. FSC: 3.3 million acres, SFI: 19.8 million acres, American Tree Farm Program: 14 million acres, Green Tag: 5,000 acres as of mid-2010.

## REFERENCES

- Aldrich, Rob and James Wyerman. 2006. *2005 National Land Trust Census*. Washington, DC: Land Trust Alliance. Online at: <<<http://www.landtrustalliance.org/about-us/land-trust-census/2005-report.pdf>>>.
- Anderson, Jon, and John Farrington. 1996. “Forestry extension: facing the challenges of today and tomorrow.” FAO Corporate Document Repository. *Unasylva* (41)184: 3–12. Online at: <<<http://www.fao.org/docrep/v9122e/v9122e02.htm>>>.
- Baker, James C., and William C. Hunter. 2002. “Effects of Forest Management on Terrestrial Ecosystems.” In David N. Wear and John G. Greis, eds. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.
- Conner, Roger C., and Andrew J. Hartsell. 2002. “Forest Area and Conditions.” In Wear, David N., and John G. Greis, eds. *Southern Forest Resource Assessment* (2002). Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Southern Research Station.
- Crist, Patrick J. 2000. “Mapping and Categorizing Land Stewardship.” In eds. *A Handbook for Gap Analysis*. Version 2.1.0. Online at: <<<http://www.gap.uidaho.edu/handbook/CompleteHandbook.pdf>>>.
- ESRI. 2008. “ESRI Data and Maps 9.3.1” [DVD]. Redlands, CA: Environmental Systems Research Institute.
- ESRI, i-cubed, and GeoEye. 2009. “ESRI Data and Maps 9.3.1” [DVD]. Redlands, CA: Environmental Systems Research Institute.
- General Accounting Office (GAO). 2010. *Surface Coal Mining: Financial Assurances for, and Long-Term Oversight of, Mines with Valley Fills in Four Appalachian States*. GAO Report GAO-10-206. Washington, DC: GAO.
- Gower, Stith T. 2008. “Coupling Biological and Industrial Forest Ecosystem Carbon Cycle Models to Enhance Carbon Management: A Decision Support Tool. USDA North American Carbon Program.” Madison, WI: Forest Ecosystem Ecology at the University of Wisconsin-Madison. Online at: <<[http://forestecology.forest.wisc.edu/Research\\_Details.html?Carbon\\_Model](http://forestecology.forest.wisc.edu/Research_Details.html?Carbon_Model)>>.
- Hansen, Mark, et al. 1992. “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>>>.
- Hanson, Craig, et al. 2010. *Southern Forests for the Future*. Washington, DC: World Resources Institute. Online at: <<[www.SeeSouthernForests.org](http://www.SeeSouthernForests.org)>>.
- Hoyle, Zoe. 2008. “That Carbon Dance.” *Compass: Perspectives and Tools to Benefit Southern Forest Resources from the Southern Research Station* 10: 7–14. Online at: <<<http://www.srs.fs.usda.gov/compass/issue10/issue10.pdf>>>.

- Ice, George G., Daniel G. Neary, and Paul W. Williams. 2004. "Effects of Wildfire on Soils and Watershed Processes." *Journal of Forestry* September 2004: 16-20. Online at: << [http://www.wildfire-economics.org/Library/Ice\\_et\\_al\\_2004.pdf](http://www.wildfire-economics.org/Library/Ice_et_al_2004.pdf)>>
- Jacobson, Michael G., John L. Greene, Thomas J. Straka, Steven E. Daniels, and Michael A. Kilgore. 2009. "Influence and Effectiveness of Financial Incentive Programs in Promoting Sustainable Forestry in the South." *Southern Journal of Applied Forestry* 33(1) 35-41.
- Jose, S. 2007. "Carbon Sequestration and Intensive Silviculture: The Southern U.S. Experience." Paper presented to the American Geophysical Union, Fall Meeting 2007 (abstract #B53A-03). Online at: <<<http://adsabs.harvard.edu/abs/2006AGUSM.B53A..03J>>>.
- Land Trust Alliance. 2010. *2010 Southeastern Land Trust Survey Report*. Land Trust Alliance Southeast Regional Program. Online at: <<<http://www.landtrustalliance.org/about/regional-programs/se/documents/2010%20Southeastern%20U.S.%20Land%20Trusts%20Survey%20Report.pdf>>>.
- Millennium Ecosystem Assessment 2005. *Ecosystems and Human Well-Being: Synthesis*. Washington, DC: Island Press.
- Miller, James H. 2001. "Pine plantation communities: how do we begin to manage for plant diversity?" In eds. *New Century: New Opportunities*. Proceedings, 54<sup>th</sup> Annual Southern Weed Science Society, January 22-24, 2001, Biloxi, Mississippi. Champaign, IL: Southern Weed Science Society. Online at: <<<http://www.treearch.fs.fed.us/pubs/6084>>>.
- National Interagency Fire Center. 2008. *2009 Quadrennial Fire Review*. Online at: <<<http://www.nifc.gov/QFR/QFR2009Final.pdf>>>.
- National Interagency Fire Center. National Year-to-Date Report on Fires and Acres Burned by State. "Fire Information-Wildland Fire Statistics." Online at: <<[http://www.nifc.gov/fire\\_info/fire\\_stats.htm](http://www.nifc.gov/fire_info/fire_stats.htm)>>.
- National Wildfire Coordinating Group. 2008. "Glossary of Wildland Fire Terminology." Online at: << <http://www.nwcg.gov/pms/pubs/glossary/pms205.pdf> >>.
- Nowak, John, Christopher Asaro, Kier Klepzig, and Ronald Billings. 2008. "The Southern Pine Beetle Prevention Initiative: Working for Healthier Forests." *Journal of Forestry* July/August 2008: 261-267.
- Office of the President. 1999. "Executive Order 13112." *Federal Register* 64, no. 25 (February 3, 1999). Online at: <<<http://www.invasivespeciesinfo.gov/laws/execorder.shtml>>>
- Oliver, C. D., and R. L. Deal. 2007. "A working definition of sustainable forestry and means of achieving it at different spatial scales." *Journal of Sustainable Forestry* 24:141-163.
- Prasad, A.M., L.R. Iverson., S. Matthews., and M. Peters. 2007-ongoing. "A Climate Change Atlas for 134 Forest Tree Species of the Eastern United States." (database) Newtown Square, PA: Northern Research Station, USDA Forest Service. Online at: <<<http://www.nrs.fs.fed.us/atlas/tree>>>.
- Prestemon, Jeffrey P., and Robert C. Abt. 2002. "Timber Products Supply and Demand." In David N. Wear and John G. Greis, eds. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.
- Smith, W. Brad, Patrick D. Miles, Charles H. Perry, and Scott A. Pugh. 2009. *Forest Resources of the United States, 2007*. Gen. Tech. Rep. WO-78. Washington, DC: U.S. Department of Agriculture, Forest Service.
- Stanturf, John A., Dale D. Wade, Thomas A. Waldrop, Deborah K. Kennard, and Gary L. Achtemeier. 2002. "Background Paper: Fire in Southern Forest Landscapes." In David N. Wear and John G. Greis, eds. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-3. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.
- Stavins, Robert N. and Kenneth R. Richards. 2005. *The Cost of U.S. Forest-Based Carbon Sequestration*. Arlington, VA: Pew Center on Global Climate Change. Online at: << [http://www.pewclimate.org/docUploads/Sequest\\_Final.pdf](http://www.pewclimate.org/docUploads/Sequest_Final.pdf)>>
- Trani, Margaret K. 2002. "Maintaining Species in the South." In David N. Wear and John G. Greis, eds. 2002. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.
- U.S. Environmental Protection Agency (EPA). 2003. "Draft Programmatic Environmental Impact Statement – Draft 2003." Washington, DC: U.S. Environmental Protection Agency. Online at: <<<http://www.epa.gov/region03/mntnptop/pdf/executivesummary.pdf>>>.
- U.S. Environmental Protection Agency (EPA). 2010. "Executive Summary: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008." Online at: <<<http://www.epa.gov/climatechange/emissions/usinventoryreport.html>>>.
- U.S. Geological Survey. 2007. "NLCD 2001 Land Cover" [computer file]. Sioux Falls, SD: U.S. Geological Survey: Online at: <<<http://www.mrlc.gov>>>.
- Ward, James D., and Paul A. Mistretta. 2002. "Impact of Pests on Forest Health." In David N. Wear and John G. Greis, eds. 2002. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.
- Wear, David N. 2002. "Land Use." In David N. Wear and John G. Greis, eds. 2002. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.
- Wear, David N., and John G. Greis, eds. 2002. *Southern Forest Resource Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

## ABOUT THE AUTHORS

**Logan Yonavjak** is a Research Analyst with WRI's People & Ecosystems Program. Email: Lyonavjak@wri.org.

**Craig Hanson** is the Director of WRI's People & Ecosystems Program. Email: Chanson@wri.org.

**John Talberth** is a Senior Economist with WRI's People & Ecosystems Program. Email: Jtalberth@wri.org.

**Todd Gartner** is a Senior Associate, Conservation Finance and Markets, with WRI's People & Ecosystems Program. Email: Tgartner@wri.org.

## ACKNOWLEDGMENTS

The authors are grateful to the following colleagues and peers who provided critical reviews and other valuable contributions to this publication: Andrew Goldberg (Dogwood Alliance), Adam Grant (WRI), Charles Iceland (WRI), Becca Madsen (Ecosystem Marketplace), Susan Minnemeyer (WRI), Jack Nelson (WRI), Thomas Ostertag (Florida Fish and Wildlife Conservation Commission), Dr. Tom Straka (Department of Forestry and Natural Resources, Clemson University), and Lauren Withey (WRI).

The publication process was helped along by WRI's experienced publications team, particularly Hyacinth Billings, David Tomberlin, and Ashleigh Rich. We thank Bob Livernash for editing and proofreading. We also thank Maggie Powell for the publication design. Colors for publication maps are from [www.ColorBrewer.org](http://www.ColorBrewer.org) by Cynthia A. Brewer at Pennsylvania State University.

We are indebted to Toyota for its generous financial support for this brief.

This report is released in the name of the World Resources Institute (WRI) and represents the perspectives and research of its authors alone. It does not necessarily represent the views of WRI, Toyota, the publication's reviewers, or their affiliated organizations and agencies.

## ABOUT THE WORLD RESOURCES INSTITUTE

The World Resources Institute (WRI) is an environmental think tank that goes beyond research to find practical ways to protect the earth and improve people's lives. Our mission is to move human society to live in ways that protect Earth's environment and its capacity to provide for the needs and aspirations of current and future generations.

Because people are inspired by ideas, empowered by knowledge, and moved to change by greater understanding, WRI provides—and helps other institutions provide—objective information and practical proposals for policy and institutional change that will foster environmentally sound, socially equitable development.

WRI organizes its work around four key goals:

- **People & Ecosystems:** Reverse rapid degradation of ecosystems and assure their capacity to provide humans with needed goods and services.
- **Governance:** Empower people and strengthen institutions to foster environmentally sound and socially equitable decision-making.
- **Climate Protection:** Protect the global climate system from further harm due to emissions of greenhouse gases and help humanity and the natural world adapt to unavoidable climate change.
- **Markets & Enterprise:** Harness markets and enterprise to expand economic opportunity and protect the environment.

In all its policy research and work with institutions, WRI tries to build bridges between ideas and action, meshing the insights of scientific research, economic and institutional analyses, and practical experience with the need for open and participatory decision making.

*With support from*  
**TOYOTA**

---

Each World Resources Institute brief presents a timely, scholarly treatment of a subject of public concern. WRI takes responsibility for choosing the study topics and guaranteeing its authors and researchers freedom of inquiry. It also solicits and responds to the guidance of advisory panels and expert reviewers. Unless otherwise stated, however, all the interpretation and findings set forth in WRI publications are those of the authors.

Copyright 2011 World Resources Institute. 

This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivative Works 3.0 License. To view a copy of the license, visit <http://creativecommons.org/licenses/by-nc-nd/3.0/>

ISBN: 978-1-56973-761-3