Ecosystems provide a range of services that benefit people, communities, and businesses and contribute to our well-being. Forest ecosystems, in particular, are important providers of these services; for example, southern forests provide timber for construction, reduce soil erosion, store carbon, and provide for recreation opportunities. Southern forests are among the most diverse forests in the world, ranging from naturally regenerated old growth pine to intensively managed pine plantations and from high elevation spruce-fir to coastal mangrove and live oak forests (Wear and Greis 2011).

This fact sheet begins by describing some of the key ecosystem services provided by southern forests using the first three categories identified in the Millennium Ecosystem Assessment: provisioning, regulating, and cultural services. Supporting services, the fourth category in the assessment, are underlying ecosystem processes necessary to maintain and allow production of the other three categories of services, such as nutrient cycling and soil formation. Since people benefit from supporting services by way of the other categories of ecosystem services, this fact sheet will only focus on the first three categories (Box 1). It then considers different aspects of ecosystem services to keep in mind. Finally, it discusses ecosystem services and disservices in the context of the wildland-urban interface.

**Box 1. Categories of Ecosystem Services**

The Millennium Ecosystem Assessment defined ecosystem services as the benefits that people obtain from ecosystems and classified them into four broad categories:

**Provisioning services** are the goods or products people get from ecosystems, such as food, fresh water, timber, and fiber. These services are often directly used by humans and are typically goods included in our market economy.

**Regulating services** are the benefits that come from an ecosystem’s effect on natural processes, such as pollination of crops, storm damage mitigation, and climate stabilization.

**Cultural services** are nonmaterial benefits people get from ecosystems, such as recreation, aesthetic and intellectual enjoyment, and spiritual renewal.

**Supporting services** are the underlying ecosystem processes necessary to maintain and allow production of the previously mentioned services, such as nutrient cycling and soil formation.

*Source: Millennium Ecosystem Assessment 2005.*
Ecosystem Services of Southern Forests

Provisioning Services

Timber. Timber is a primary ecosystem service provided by forests and is integral to market economies. Timber is used to create a variety of products for human use, including pulpwood for paper and cardboard and lumber for the construction of homes and furniture. The South is called the nation’s “wood basket” because its productive forests produce approximately 60 percent of the nation’s timber products and more timber than any other single country in the world (Wear and Greis 2002). Wood supplied by southern forests generates significant economic benefits in the region during both the harvesting and manufacturing stages (Hanson et al. 2010). In 2007, the value of sawtimber, veneer logs, poles, and pulpwood harvested from southern forests was nearly $12 billion (Hanson et al. 2010). Nearly 600,000 jobs were generated by harvest activities combined with the indirect and associated spending by businesses and households (Hanson et al. 2010).

Bioenergy. Woody biomass, organic matter that is renewable over time, can be used to produce heat, power, electricity, transportation fuels, and a variety of products, such as chemicals and adhesives (Ashton et al. 2009). The wildland-urban interface in the South contains a variety of woody biomass sources, including forest residues from commercial harvests, non-merchantable biomass from silvicultural activities, waste wood (bark, sawdust, wood chips, and wood scrap), and urban wood residue from sources such as yard waste, tree care activities, utility line clearing, and more. Woody biomass resulting from habitat restoration, from land clearing and conversion, and from short-rotation and intensively managed forests are also potential sources of energy. While many southern households burn wood in fireplaces or stoves to generate heat, larger scale power generation uses the most wood (Staudhammer et al. 2011). In the Southeast, for every 1,000 tons of wood energy consumed 1.39 jobs and about $24,000 in income are produced (Gan 2006). This industry is still developing, however. Using wood for energy can decrease wildfire risk in the interface, improve forest health, decrease U.S. dependence on imported fossil fuels, introduce new markets for forestry, and create local jobs.

Nontimber forest products. Humans benefit from many products that originate from the forest but that are not timber-based. These nontimber forest products (NTFPs) fall into five product categories that have important social, cultural, and economic values (Smith et al. 2009). Below are the categories and a few examples of NTFPs from southern forests.

Edible and culinary food products include blackberries, maple syrup, paw paw fruit, muscadine grapes, wild onions (ramps), and edible fungi, such as morel and wood ear mushrooms (Hanson et al. 2010, Smith et al. 2009).

Arts and crafts product examples include sassafras stems used as walking sticks and grapevines used to make wreaths and baskets.

Medicine and dietary supplements are harvested from over 125 plant species in southern
forests (Smith et al. 2009). Some examples include saw palmetto berries, black cohosh, and ginseng. More than 80% of the forest-harvested ginseng comes from Virginia, Kentucky, Tennessee, and North Carolina.

Floral and decorative sources include grape-vine, galax, and species of moss and lichen harvested for the floral industry.

Landscape products are abundant in the southern region. More than 200 species of trees, shrubs, herbs, and vines used in landscaping are native to the southern United States, including magnolia, rhododendron, and azalea.

Nontimber forest products contribute more than $1 billion annually to the South’s economy (Harper 2005) and continue to be important benefits we receive from forestlands.

Clean water. Freshwater is one of the most valuable ecosystem services provided by forests. Two-thirds of the clean water supply in the United States is stream water from precipitation filtered by forests (Smail and Lewis 2009). Clean water is also important for agricultural production and industrial uses and the other ecosystem services such as recreation opportunities and wildlife habitat. Trees, microbes, and soils each play a role in improving water quality. Plants slow the flow of water and trap sediments, and their roots keep soils porous, which allows water to sink into the ground more easily. As water filters through layers of soil, microbes break down pollutants, wastes, and nutrients, and soil particles attract contaminants.

Clean water has value. One city launched a revolutionary project to protect its drinking water by protecting the ecosystem services of its watershed. By investing $1.4 billion in watershed protection thus far, the city has avoided spending $6 billion on the construction of new water filtration facilities plus annual maintenance costs in the hundreds of millions a year (Kenny 2006).

Regulating Services

Reduced flooding and erosion. Forests also play a critical role in reducing flooding. Forest vegetation, leaf litter, and soils play roles in absorbing, storing, and then slowly releasing water into surface waters and groundwater. These processes regulate water flow, reduce flooding, maintain infiltration capacity, recharge aquifers, and allow moisture to return to the atmosphere. The ability of forests to absorb and store water runoff can be approximately 20 times greater than that of an impervious parking lot and nearly 6 times greater than a residential lawn (Hanson et al. 2010).

Forests also play an important role in keeping soil in place and preventing it from eroding...
and causing sedimentation of nearby waterways (Hansen et al. 2010). The tree canopy intercepts rainfall, and leaves and other debris on the forest floor soften the impact of rain on forest soils. Leaf debris on the forest floor can slow water runoff, absorb water, and trap soil. Tree roots also hold soil in place, stabilize stream banks and coastlines, and help to prevent landslides. Forests reduce soil erosion and prevent soil loss and sedimentation.

**Air quality.** Forests play a role in improving air quality by absorbing or trapping pollutants that affect environmental quality and human health, including particulate matter (soot), nitrogen oxides, and other pollutants. Cars, planes, power plants, factories, or any other human activities that require the burning of fossil fuels release these pollutants into the environment. In one study of 55 U.S. cities, urban trees removed tons of air pollutants annually, which improved the average air quality typically less than 1 percent. Nonetheless, the estimated value of that service is $3.8 billion annually (Nowak, Crane, and Stevens 2006). Forests may also improve air quality by reducing summertime air temperatures through shading and transpiration, which can decrease the energy used for cooling buildings (Escobedo, Seitz, and Zipperer 2009). Lower energy use means fewer greenhouse gases emitted from power plants.

**Climate regulation.** Forests are important in regulating climate because of their key role in the global carbon cycle. Atmospheric carbon dioxide (CO₂) is a greenhouse gas created by the burning of fossil fuels. Rising carbon dioxide concentration in our atmosphere is changing its composition and tending to warm the planet. Trees absorb CO₂ when they photosynthesize, and they store carbon in their branches, trunks, and roots as they grow, as well as in soils when leaves and other tree parts decay (Hansen et al. 2010). In these ways, forests are key to removing CO₂ from the atmosphere and usually serve as a “sink” of carbon. Carbon removed from the atmosphere by forest growth or stored in harvested wood products is equal to 12–19 percent of fossil fuel emissions nationwide (Malmsheimer et al. 2011). One study reported that forests in the southeast and south-central United States currently sink 13 percent of the region’s annual greenhouse gas emissions and that could increase to 23 percent with implementation of proper policies and land management practices (Han et al. 2007).

**Cultural Services**

**Aesthetic, spiritual, and religious benefits.** Biodiversity and natural landscapes have long been a source of inspiration for art and culture. People often find beauty or aesthetic value in forested lands. Parks and trees can provide a “sense of place” and aesthetic enjoyment for the people who live adjacent to them. The presence of street trees and larger trees in yards can add 3–15 percent to home values throughout neighborhoods (Wolf 2010). The spiritual benefits gained from an ecosystem can affect a person’s health and well-being. For example, a certain ceremonial or spiritual site can affect a person’s sense of security or of social belonging (Ghermandi et al. 2010). These ecosystem services are valued for their effects on social relations in the community, perceptions of freedoms and choice, and other components of human well-being.

**Recreation.** Forests are an ideal environment for recreation and they provide a wide range of outdoor opportunities that contribute to human well-being. Recreation activities in which Southerners typically participate include walking for pleasure, attending family gatherings, visiting nature centers, sightseeing, driving for pleasure, picnicking, viewing or photographing natural scenery, and visiting historic sites (Wear and Greis 2002). Other forest-based activities gaining popularity include kayaking, jet skiing, hiking, and backpacking. Outdoor opportunities offer an
avenue for active recreation that can improve human health and contribute to the emotional value of a quality environment. Additionally, forests provide habitat for game species and can be popular for hunting and fishing (Hanson et al. 2010). Expenditures on hunting, fishing, and wildlife-watching activities in the South were an estimated $41.6 billion in 2006, accounting for 34 percent of total U.S. expenditures on wildlife-associated recreation (U.S. Fish and Wildlife Service and U.S. Census Bureau 2006).

### Aspects to Keep in Mind

Ecosystem services are dynamic and multifaceted and so it can be helpful to look at ecosystem services from different perspectives, especially in resource management and decision-making processes. Ecosystem services exist at different scales, are interrelated, can overlap, may not be equally valued, can have different monetary and non-monetary values, and can either enhance or detract from the provision of other ecosystem services. The following are a few aspects to think about when assessing ecosystem services:

- **Scale.** Ecosystem services are generated at all ecological scales and used by people at different scales. For example, fish can come from a small pond, the Mississippi River, or the Gulf of Mexico (Hein et al. 2006). Also a single ecosystem can meet human needs at different scales. For example, southern forests can provide a single person with a hunting opportunity at the individual scale, a city with water filtration services at the municipal scale, and an international population with carbon sequestration at the global scale.

- **Interrelationships.** Ecosystem services can also be interrelated. For example, clean water is essential for other ecosystem services, such as food production, recreation opportunities, and wildlife habitat.

- **Double counting.** There are differing definitions and categories of ecosystem services, and as a result there can be overlap in the way people think about, measure, and value them. For example, one person may consider clean water as a provisioning ecosystem service. Another person may believe the water purification that results in clean water is actually a key ecosystem service and categorize this as a regulating service. This example demonstrates that there is often overlap in how people define and categorize related ecosystem services. Valuing both of these as ecosystem services (clean water and water purification) in an assessment would result in “double counting” because water purification as an ecosystem function is already accounted for in the value of the clean water (Boyd and Banzhaf 2006).

- **Economic value.** Ecosystem services can have different economic values. For example, a forest stand can provide timber production and aesthetic enjoyment for the people who live adjacent to the stand. Markets exist for some services like timber and so the monetary value of that timber can be easily determined. However, for services like aesthetic enjoyment that are not bought and sold in a marketplace, it is challenging to determine their monetary value. When markets exist for two services, for example, timber and carbon sequestration, the economic value of those services
may differ. In this example, the economic value of timber generated from a stand may be greater than the economic value of the carbon storage.

- **Different types of values.** In the previous example, economic value was used to compare two ecosystem services. Other values can be used to compare services. For example, a forested stand may contain monumental trees that have cultural value deemed more important than the value of the stand’s merchantable timber.

- **Trade-offs.** The enhancement of one ecosystem service can result in the loss of another ecosystem service; this is a “trade-off.” Forests provide a variety of ecosystem services, but if a forest cannot be managed for multiple services, then one service may be preferred over another service. For example, if a forest stand is managed for timber production, then its value for the service of carbon sequestration is lost. In this example the trade-off may be made by choice, but often trade-offs arise unexpectedly when the interaction between ecosystem services is not well understood.

- **Co-benefits.** The enhancement of one ecosystem service can result in the gain of another ecosystem service, making this the opposite of a trade-off. The most common examples involve efforts to reduce greenhouse gas emissions. For example, trees are planted to enhance carbon storage. In addition to the service of storing carbon, those trees may also improve air quality or may be enjoyed for recreational opportunities, resulting in co-benefits (Kamayana 2009).

### Ecosystem Services and Disservices in the Wildland-Urban Interface

The expansion of towns and cities increases the area of urban forests and enhances both their importance and that of the surrounding rural forests in providing the critical ecosystem services to sustain health and environmental quality in and around urban areas (Nowak and Walton 2005). With greater than 80 percent of the U.S. population living in urban areas, ecosystem services provided by urban trees and forests are significant and valued in the billions of dollars annually. Urban and interface ecosystems offer many opportunities for cultural services, such as recreation and leisure activities. These cultural services are perhaps the most valued ecosystem services provided by ecosystems in the wildland-urban interface.

For example, the aesthetic benefits of parks can raise the property value of homes, and individual trees can be highly valued by homeowners. After the construction of Centennial Olympic Park in Atlanta, Georgia, adjacent condominium prices rose from $115 to $250 a square foot (Lewis 2002). A study of the effect of 14 neighborhood parks on suburban areas of the Dallas-Fort Worth metroplex found that homes adjacent to parks received an approximate price premium of 22 percent relative to properties half a mile away (Miller 2001). Forests in urban and urbanizing areas can provide other ecosystem services, such as removal of air pollution, interception and retention of storm water, storage of carbon, and shading of homes.

There are also ecosystem functions that have costs, which negatively affect or reduce human well-being, referred to as ecosystem disservices (Escobedo, Kroeger, and Wagner 2011). The same park in the interface that provides recreational activities and therefore positively affects human well-being can also provide disservices such as

- an increased risk of fire,
- a greater number of hazardous trees,
- a greater number of wild animals that may damage property, injure pets, or carry disease,
• an increase in leaf and fruit drop,
• an increase in the production of pollen, which can be a human allergen, and
• a fear for one’s safety (whether rational or not) in city parks.

As land-use change occurs in the wildland-urban interface, there is an opportunity to design forests proactively and plan cities to maximize the ecosystem services valued and required by residents and minimize the disservices (Box 2). Cooperation between regional planning and natural resources managers is needed to understand, adapt to, and direct the changing landscape to sustain forest health and productivity, as well as human health and well-being, in an urbanizing landscape (Nowak and Walton 2005) (Box 3). As a first step, natural resource management professionals could engage in outreach and education targeting urban planners, city arborists, landscape architects, and homeowners; this could help guide land-use decision-making processes and urban forestry management.

It is important to recognize that people assign relative value to ecosystem services based on their individual socio-cultural and economic background and perspective. Thus, what is a service to one person could be a disservice to another. For example, a tree canopy provides shade around a person’s home. One individual may consider this a service because the shading has the potential to lower ambient air temperatures and associated cooling costs. Another person may consider the shading a disservice, instead preferring an open and sunny yard in which to grow fruit trees or a garden.

\[ \text{Box 2. Minimizing Disservices in the Interface} \]

Ecosystem disservices negatively affect or reduce human well-being. Citizens, city officials, and planning and natural resource professionals in urbanizing areas can collaborate to guide interface development to minimize ecosystem disservices. The following are a few steps to minimize such disservices.

• Planting trees that are not susceptible to damage and have a strong safety record could minimize effects on infrastructure and threats to human well-being.
• Planting trees that survive well in urban areas could minimize removal and replacement costs.

• Providing information about proper tree species selection and planting distances for yards could increase the human sense of safety and satisfaction.
• Building clustered neighborhoods that encourage high-density development and conservation of adjoining intact forest could increase aesthetic, recreation, and property values for residents.
• Maintaining a healthy and intact tree canopy could increase the capture of air pollutants and result in lower temperatures.

\[ \text{Source: Escobedo, Kroeger, and Wagner 2011.} \]
In general, public awareness of the importance of ecosystems for human well-being changes with technological advances and an increasingly urban landscape, making us seem removed from nature. In the United States today, we can easily turn on a faucet for clean water and buy an array of fruits, vegetables, and meats from the grocery store without thinking about the ecosystem functions that provide those services or how our actions affect ecosystems and their ability to provide these ecosystem services. Residents in urban and interface areas may not

**Box 3. A Focus on Ecosystem Services in City Decision Making**

When working in urbanizing areas and with different audiences, resource professionals must consider the language they use to communicate their messages about ecosystem services as well as the values of their audience, including what is important and meaningful to them. By encouraging decision makers to consider the connections between natural systems and human well-being in the context of policy and management processes, it becomes easier for them to see interrelationships between city operations, such as planning, budget allocations, infrastructure, and ecosystem services provisioning.

Consider the following three talking points, which highlight how a focus on ecosystem services can support the work of cities.

1. **A focus on ecosystem services** soon demonstrates the benefits, at the local level, derived from properly functioning ecosystems, and their relation to municipal service delivery becomes clearer. For example, cities are responsible for providing clean water to citizens. Focusing on ecosystem services relevant to water provision can help decision makers identify the water purification value of nearby forests. The preservation of forests can then become a part of the strategy to provide clean water to residents.

2. **A focus on ecosystem services** allows decision makers to anticipate the consequences of different decisions or policies. Ecosystems generate multiple services. It is possible to use an ecosystem services framework to consider the costs and benefits of different choices. For example, if a forested area valued by residents and decision makers for the full range of services it provides is threatened by a new development, then the scenario can be evaluated in terms of the benefits that would be gained and lost.

3. **A focus on ecosystem services** allows more effective communication between government operations and the general public about the environmental, social, and economic implications of a decision. The broad range of ecosystem services can provide a context to view the gain or loss of natural resources and associated benefits. If this is communicated to all stakeholders, then hopefully more desirable outcomes can be achieved through effective decision making.

By considering ecosystem services, cities have the opportunity to make positive changes, save on municipal costs, boost local economies, enhance quality of life, and secure livelihoods. If ecosystems stop supplying the services interface or urban residents rely on, then it can be extremely expensive, time consuming, or sometimes impossible to restore the ecosystems and/or find an alternative solution. Thus, ecosystem services can be factored into city planning, management, and budget to outline the costs and benefits of different policy options, and therefore help officials make better-informed decisions to create more sustainable cities.

*Source: Mader et al. 2011.*
know where the ecosystem services they enjoy are provided. Yet, these residents are the most influential decision makers affecting the continued provision of those ecosystem services. Natural resource management professionals could target outreach and education programs to the public to equip them with the knowledge to make decisions that ensure continued provision of ecosystem services.

Summary

Forests provide multiple ecosystem services, such as timber, bioenergy, nontimber forest products, clean water, reduced flooding and erosion, improved air quality, climate regulation, recreation, and aesthetic, spiritual, and religious services. In urban and interface areas, forests can, however, also provide disservices, which negatively affect or reduce human well-being. As urbanization occurs, natural resource professionals can work with residents, local leaders, and land-use planners to increase awareness of ecosystem services and plan and manage the interface to maximize the provision of ecosystem services and avoid disservices to improve overall human well-being.

Suggested Resources

*Artificial Intelligence for Ecosystem Services (ARIES)* is a web-based decision support system used for the assessment and valuation of ecosystem services. This system assesses the flow of valuable services between ecosystems and human beneficiaries in a selected area and then links the flows to potential and realized economic values. The purpose of ARIES is to make environmental decision making easier and more effective. The program services are open and free for users.

http://ariesonline.org/

*New Business Decision-Making Aids in an Era of Complexity, Scrutiny, and Uncertainty* is a report that emerged from a round table discussion sponsored by the Business for Social Responsibility’s Ecosystem Services, Tools, and Markets Working Group. The discussion included industry, tool developers, and government, and it focused on preliminary findings from a comparative assessment of emerging ecosystem services tools. The motivation behind this report is that, in the future, ecosystem services may become a metric by which to track and analyze environmental and social performance. The effort was aimed at helping corporate decision makers, tool developers, government officials, and others interested to understand better how to apply these tools.


*Community on Ecosystem Services* brings together government, non-governmental organizations, academia, tribal, and private sector leaders to advance the use of ecosystem services and related science in conservation, restoration, resource management, and development decisions.

http://ecosystemcommons.org/group/aces-community-ecosystem-services

*The Ecosystem Marketplace* is a website that is a leading source of news, data, and analytics on markets and payments for ecosystem services (such as water quality, carbon sequestration, and biodiversity). It provides information on policy, finance, regulation, science, business, and other market-relevant factors with the goal that one day markets for ecosystem services will become a fundamental part of our economic system, helping give value to environmental services.

www.ecosystemmarketplace.com

*The Environmental Valuation Reference Inventory (EVRI)* is a searchable storehouse of empirical studies on the economic value of environmental benefits and human health effects. It has been
developed as a tool to help policy analysts use the benefits transfer approach. Using the EVRI to do a benefits transfer is an alternative to doing new valuation research. This resource is available on a subscription basis.

www.evri.ca/Global/HomeAnonymous.aspx

The Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) is a publicly available, ArcGIS-based tool for quantifying the values of ecosystem services. It employs a scientific approach to quantifying and forecasting the returns that investments in nature claim to deliver. InVEST enables decision makers to quantify the importance of natural capital, to assess the trade-offs associated with alternative choices, and to integrate conservation and human development.

www.naturalcapitalproject.org/InVEST.html

iTree is a software suite, available at no cost, from the USDA Forest Service and other cooperators that provides urban forestry analysis and benefits assessment tools. The iTree Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

www.itreetools.org/

References


