

Human Influences on Forest Ecosystems

The Southern Wildland-Urban Interface Assessment
Summary Report



U.S. Department of Agriculture
Southern Research Station
General Technical Report SRS-64

Edward A. Macie
L. Annie Hermansen

April 2003
Southern Research Station
P.O. Box 2680
Asheville, NC 28802

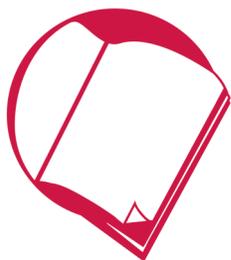
Human Influences on Forest Ecosystems

The Southern Wildland-Urban Interface Assessment Summary Report

Authors

Edward A. Macie, Regional Urban Forester, USDA Forest Service, Southern Region, 1720 Peachtree Road, NW, Atlanta, GA 30367-9102, emacie@fs.fed.us

L. Annie Hermansen, Technology Transfer Coordinator, USDA Forest Service, Southern Research Station, 408 W. University Ave., Suite 101, Gainesville, FL 32601, ahermansen@fs.fed.us



Summary Report

Human Influences on Forest Ecosystems

The Southern Wildland-Urban Interface Assessment

THE WILDLAND-URBAN INTERFACE

The South is experiencing unprecedented growth in human population, resulting in rapid land use change and profound effects on forest ecosystems. As a result, the goods, services, and management of its forests are changing. Such areas of rapid change commonly are referred to as the wildland-urban interface. Although the interface has been variously defined, perhaps the most common definition is that of an area of urban sprawl where homes and other development press against the boundaries of public or private wildlands or rural areas (fig. 1). From a natural resource perspective, the interface is an area where increased human influence and land use conversion are changing natural resource benefits and management. ▶

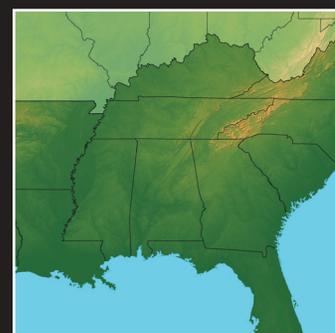


Figure 1

The wildland-urban interface is commonly defined as an area of urban sprawl where homes and other development press against the boundaries of public or private wildlands or rural areas.

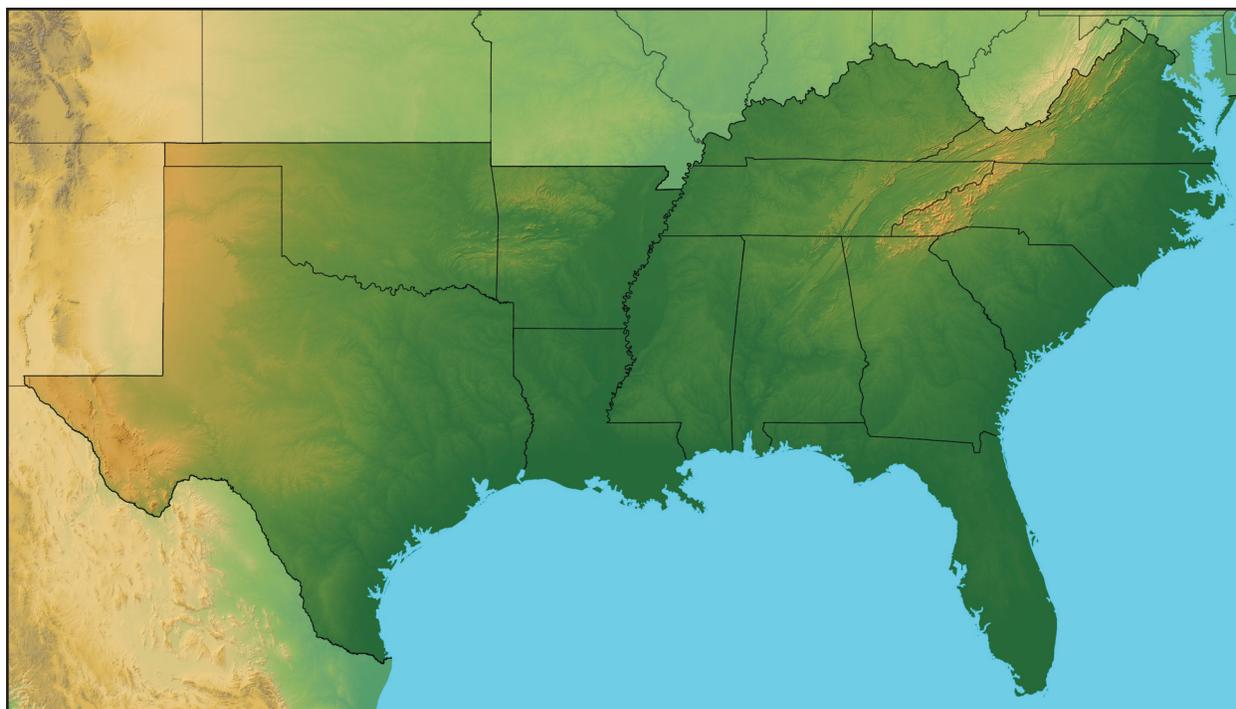


Wildland fires that threaten lives and property are perhaps the most obvious problem facing residents in the wildland-urban interface, although there are other equally important issues. For example, as the number of private forest landowners in the South increases, ownership tract size decreases. As a result, managing small-scale tracts for a variety of management objectives becomes problematic. Other examples include watershed management and protection, nonnative species proliferation, forest health concerns, wildlife management and conservation, and increased recreation demand. Natural resource professionals currently have limited skills, information, and tools necessary to address the challenges of managing resources in the wildland-urban interface. Local policymakers, planners, and homeowners need scientific information packaged in user-friendly, easily accessible formats for informed decisionmaking.

In response to the growing need for such information, the Southern Research Station of the USDA Forest Service has established the Southern Center for Wildland-Urban Interface Research and Information in Gainesville, FL. The purpose of the Center is to provide new interface research, technologies, outreach programs, and educational material for managers, landowners, local governments, and others.

A Southern Assessment

The Southern Research Station and the Southern Region of the USDA Forest Service, in cooperation with the Southern Group of State Foresters, conducted an assessment to identify and better understand factors driving social and ecological changes within the wildland-urban interface, as well as the consequences of such changes. The Assessment considers a geographical area that includes 13 southern States from Virginia to Texas (fig. 2). Although the South differs in many ways from other regions—in climate, vegetation, land ownership, and culture—most of the broad findings of this Assessment will be applicable to other regions of the United States and around the world. It examines currently available tools, research findings, and information on wildland-urban interface topics. It also presents suggestions for new research, education, and management options.



The primary contributors to this Assessment are recognized authorities from Federal agencies and university faculties. Before compiling the Assessment, the Assessment team held 12 focus groups in 6 southern communities that are experiencing rapid growth. The groups helped identify important issues and needs common to the wildland-urban interface and validated the overall findings of the Assessment.

Figure 2
The scope of this Assessment covers the 13 Southern States.

Factors Driving Change

Major factors influencing the rapid growth of the wildland-urban interface in the South include population growth and changing demographics, economic and tax issues, and land use planning and policy issues.

Population and Demographic Trends

Between 1990 and 2000, the South's population increased by almost 14 percent, and the region's share of the Nation's population also increased. Reasons for the disproportionate increase in southern populations include immigration from other countries, migration from other parts of the United States, and increased life expectancy. Those trends are expected to continue. Between 2000 and 2020, the region's population is expected to increase another 26 percent to almost 114 million people (fig. 3).

An aging population and increases in ethnic and cultural diversity will also have profound effects in the wildland-urban interface. A highly significant result of population aging will be an unprecedented increase in the number of retirees, who bring additional demands for retirement, second-home, and recreation destinations. In addition, research has shown that different age and ethnic groups differ

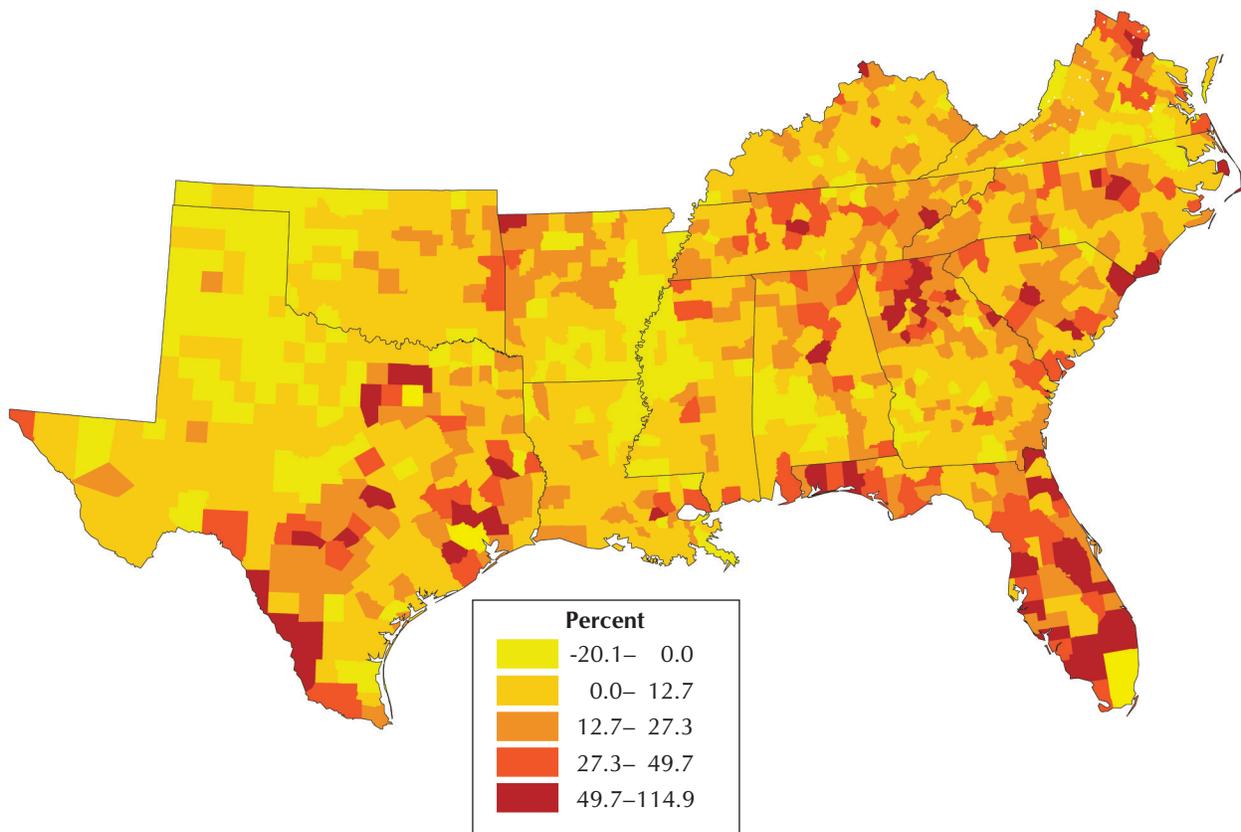


Figure 3
Distribution of projected change in the South's population, 2000-20.

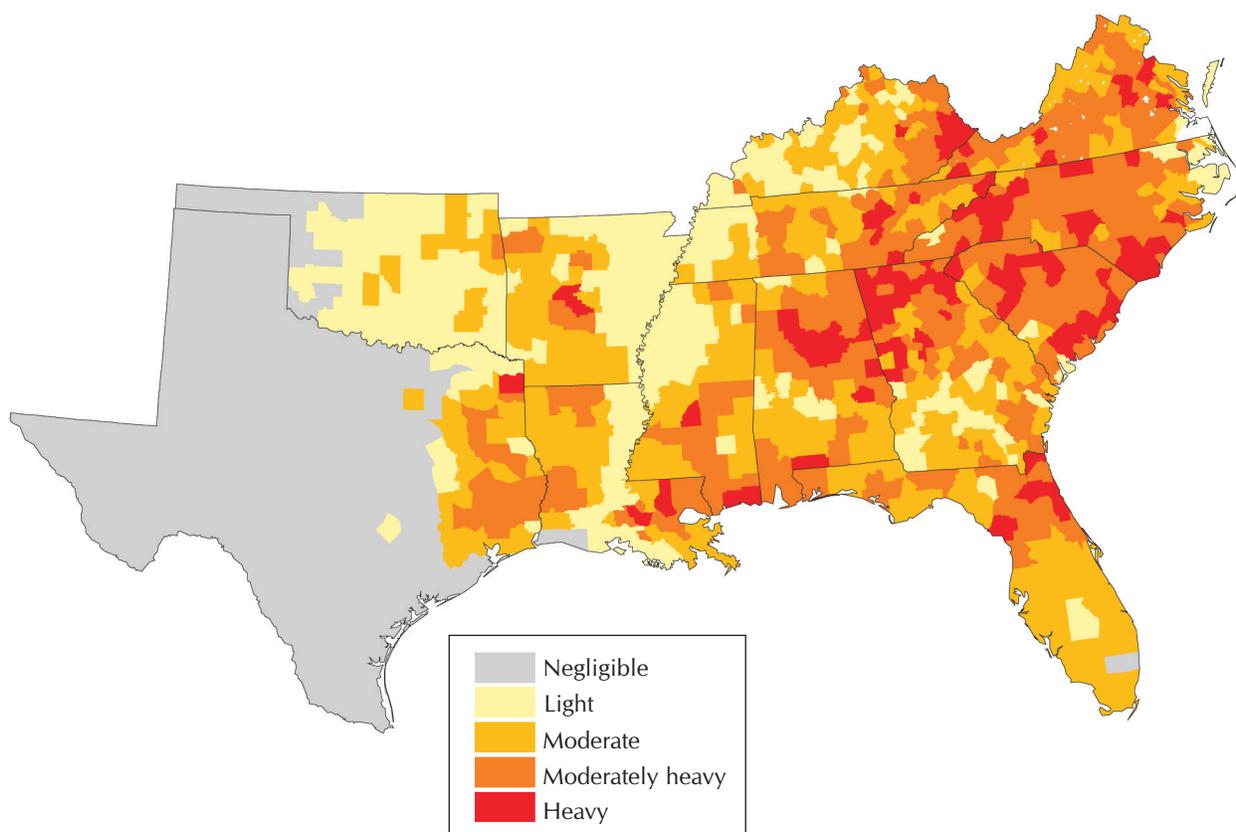
in how they use and value forests and other natural resources. Changing public attitudes and opinions about natural resource management and protection likely will be the social trend with the greatest impact on how forests are valued—and used.

As the region's population grows, the rate at which rural land is converted to urban uses will continue to increase. Right now, more rural acreage in the South is being converted to urban land uses than in any other region of the country. Between 1992 and 1997, of the top 10 States nationwide with the greatest total acreage of rural land converted to urban uses, 6 were in the South, and much of the region's projected population growth and urban expansion is expected to be in counties where forest land is still relatively abundant (fig. 4).

Population and demographic trends are key factors affecting urbanization in the South. Understanding these trends and projections of change is important when identifying where human pressures will have the greatest effects on natural resources and their management.

Economic and Tax Issues

Until about 1900, the South had few major metropolitan areas, and its economy was dominated by agriculture. After World War I, southern governors and mayors began to lure northern industries to the region by offering modest tax rates and inexpensive labor, as well as relocation subsidies. Although the incentives have changed somewhat, efforts to attract industry from other regions and coun-



tries continue. For example, the Greenville/Spartanburg area in South Carolina is home to more than 90 international companies, which were attracted to the area by its relatively low cost and abundant blue- and white-collar workforce, proximity to universities, and easy access to the Interstate Highway transportation system. Employment opportunities have risen steadily, so that since 1978, of every 10 new jobs in the Nation, 4 were in the South.

Such changes have helped foster migration and unprecedented growth in cities both large and small. As cities grow, the interface becomes a more attractive area to develop. Rural landowners often find it financially attractive to subdivide farm and forest lands. In fact, rising land values and property taxes make it necessary for some of them to subdivide, if they are to keep any land at all. As traffic congestion and other factors associated with urban development increase, the rural environment that early residents sought can disappear entirely, motivating residents to seek home sites in even more remote locations.

A major issue associated with land development is the amount municipal governments must spend in providing services to interface residents. Studies have shown that municipalities spend between 15 and 80 cents in providing services for every dollar of tax revenue generated by farms and forests, and between 15 and 47 cents for every dollar generated by commercial development. By contrast, spending on services for residential development ranges from \$1.04 to \$1.55 per dollar of revenue collected (fig. 5). Had consideration been given to the nonmonetary value provided to municipal governments by forests, such as reduced stormwater storage requirements, the costs presented in those studies would have been even higher.

Figure 4
Projected ambient population pressures on forest, 2020. Population hot spots are where pressures on forests are expected to be heaviest.

Figure 5
Municipalities spend far less to provide services for farms and forestlands than they do for residential development.



Federal and State taxes also affect land use. The Federal income tax code has provisions that can both benefit and burden farmers and forest landowners. Generally, income from the sale of timber can qualify as a long-term capital gain, on which an individual will pay a maximum rate of 20 percent, while ordinary income is taxed at rates that may be as high as 40 percent. However, because the Federal income tax is higher than most other tax rates, it often can increase the cost of owning or managing rural land, thereby encouraging sale and development. Similarly, heirs sometimes are forced to sell or subdivide rural tracts in order to pay estate taxes. There are many strategies for reducing or eliminating the effects of estate taxes, but those effects will be greatest for those who have not planned well for the transfer of their estates.

Economic research can help determine the effects of various types of taxes on land use change and management activities while enabling conservation and responsible use of natural resources. Such research also can help identify the monetary and nonmonetary costs of changes in environmental quality resulting from urbanization.

Land Use Planning and Policy Issues

Land use change in the wildland-urban interface is greatly affected by current land-related public policies at the Federal, State, and local levels. For example, the Federal Government subsidized creation of the State-numbered route system, as well as the national Interstate Highway system. Road expansion opened up to development many previously isolated lands. On the other hand, many Federal policies and programs are designed to protect and conserve natural resources on public and private ownership. For example, pollution control laws such as the Clean Water Act and the Clean Air Act were created to decrease air and water pollution.

Authority to guide land use decisions lies mainly with the States, although they generally delegate this control to local governments. Local governments use zoning ordinances as the primary tool when making land use decisions. There are many examples, however, of how local zoning policies indirectly promote growth. In seeking to increase property tax revenue, a local government may overzone the amount of development that can be expected in the future. For example, in

Loudoun County, VA, current zoning allows approximately 50,000 new housing units to be built, while current demand is for only about 3,000 units per year. Local governments also may try to reduce housing density by increasing lot size, which may have the effect of increasing land consumption, resulting in further sprawl and increased effects on natural resources.

Local officials and planners have tried a number of programs and policies to guide and control growth. Ongoing research can help identify which combinations of policies and practices have been successful and help facilitate the development of practical land use options. Research also provides an opportunity to better define the relationship between natural resource issues and land use policies and to help resource managers and planning officials better understand their roles in protecting natural resources within the interface.

Consequences of Change

In the wildland-urban interface, natural resource professionals face difficult challenges in their attempts to manage southern forest ecosystems and to lessen the resulting impacts to natural resources. To remain effective in this changing landscape, resource professionals must understand the ecological, managerial, and social changes taking place.

Urban Influences on Forests

In addition to providing food, wood, medicine, and recreation, forest ecosystems provide humans with many benefits. They serve to:

- ◆ Maintain hydrologic cycles
- ◆ Regulate climate
- ◆ Cleanse water and air
- ◆ Take up carbon dioxide and give off oxygen
- ◆ Maintain soil productivity
- ◆ Store and cycle nutrients
- ◆ Absorb and detoxify pollutants
- ◆ Provide beauty and inspiration.

Urbanization directly changes forest ecosystems by fragmenting or removing forest cover. It indirectly changes forest ecosystems by modifying hydrology, altering nutrient cycling, introducing nonnative species, modifying disturbance regimes, and changing atmospheric conditions.

As development proceeds in the interface, construction of roads, buildings, and parking lots divide forest stands into smaller parcels. Deforestation, fragmentation, and other human disturbance affect the biological diversity of native plants and animals by reducing habitat size or, in some cases, causing local extinctions. Over time, urbanization even may affect forest ecosystems that have not been disturbed by development. Mere proximity to urban land uses may cause changes.

Urbanization alters water flow by creating impervious surfaces, which reduce infiltration of water, increase surface runoff, and alter flooding regimes. It also

drains wetlands, alters stream channels, and increases the amounts of sediments, nutrients, and pesticides entering streams.

Just as hurricanes, floods, and other natural disturbances alter a landscape's features, urbanization alters the composition, structure, and spatial arrangement of ecosystems within a landscape. Unlike natural disturbances, however, urban effects last much longer. One example is wildfire suppression, which in the South has altered the diversity of landscapes and increased the frequency and severity of insect outbreaks and other disturbances.

With increased urbanization also comes an increase in air pollutants, such as nitrogen oxide, sulfur oxide, and ground-level ozone. Although these gases occur naturally, human activities are increasing atmospheric concentrations of them. At high concentrations, they can change ecosystem processes, damage plant tissue, and compound the effects of other environmental stresses on forests.

When plants are weakened by changes associated with urbanization, they become more susceptible to damaging insects and diseases (fig. 6). When an ecological system is unable to recover naturally from stresses, it is said to have distress syndrome. Urbanization predisposes forest ecosystems to distress syndrome. The composition, structure, and function of a forest change within urbanizing landscapes. Over time, new forests will develop from native and exotic species that have adapted to the stresses created by the urban landscape.

We are just beginning to understand the long-term ecological effects that urbanization has on forest ecosystems. Research on ecosystem structure, function, and composition will help us to predict how forests and other natural habitats will respond to various levels of development, altered disturbance regimes, and atmospheric pollution.



Figure 6
Southern pine beetle outbreaks occur after major stress events, such as droughts, hurricanes, and urbanization.

Challenges to Forest Resource Management and Conservation

As the demographics of the South's population change, southern forests and the benefits people expect from them also are changing. In and near the wildland-urban interface, forests increasingly are valued more for noncommodity benefits, such as wildlife viewing and esthetics. The character of private land ownership is changing quickly, too; over 40 percent of the South's landowners have retired, and their lands will soon pass into other hands. Such lands commonly are subdivided. As the average tract size decreases and forest management priorities shift, new skills and approaches will be necessary. Adaptive forest management will be key to the continued successful management of our shared natural resources.

Public-forest managers are dealing with greater demands for recreation, increased pressure from adjacent landowners, development along forest boundaries, heightened concerns about esthetics, and the need for more complex planning and decisionmaking.

Although the changes and challenges associated with natural resource management are many, five main elements are of particular concern: water resources, traditional forest products, fire management, recreation, and wildlife.

Water resources

Urbanization is the most pressing land use issue affecting water quantity and quality (fig. 7). Water quality is threatened by increased development in the upland watersheds that supply water for many of the South's urban residents. Municipal waste facilities in rapidly developing areas face difficulties with handling and treating increased waste loads, and sewage overflows may occur after heavy rainfalls. Septic tanks are often placed at high densities in the interface and are extremely vulnerable to failures. Nonpoint-source pollution, such as farm and stormwater runoff, is difficult to trace and is one of the leading causes of current water pollution problems in the United States. Allocating high-quality, abundant flows of water and managing forest ecosystems at large watershed scales remain key challenges.

Traditional forest products

About 40 percent of U.S. timberland is in the South, supplying about half of the Nation's traditional forest products. A large proportion of southern forests, however, are within the wildland-urban interface, and decisions about whether and when to harvest trees are more complex there. Although much remains unknown, urbanization appears to reduce timber supply, increase harvesting costs, and decrease the profitability of timber production. Many industry and nonindustrial private forest (NIPF) landowners are selling land in these areas, both due to rising costs of producing timber and increased public concern over forest management practices. The increased public contact with forest management practices often results in regulatory local ordinances. Local governments, industry, and NIPF owners, and the public increasingly are challenged to develop cooperative, innovative solutions that meet everybody's needs.

For traditional forest management to maintain relevance in the interface, adaptive management techniques are needed. New models for managing forests across multiple ownerships and on much smaller scales are required, as well as new technologies that will help address a variety of management objectives.



Figure 7
Urbanization is the most pressing land use issue affecting water quantity and quality.

Figure 8

Prescribed fire is a fuel reduction option that can be used in the wildland-urban interface to reduce the risk of wildland fire, but interface residents may oppose its use.



Fire

Fire is perhaps the most challenging management issue in the wildland-urban interface. Demographics, economics, public policy, ecology, and social dimensions all influence efforts to manage and protect people and natural resources from wildland fire.

Many forest ecosystems in the South require periodic fires to regenerate trees and other vegetation. Decades of fuel accumulation and human settlement have increased the challenges of preventing and suppressing fire while reducing our ability to use fire to maintain and enhance ecological processes. Prescribed fire is one method for reducing fuel loads, but often it is opposed by interface residents due to public health and safety concerns (fig. 8). Other means of fuel reduction, such as chemical or mechanical methods, may be better received, but they do not mimic the effect that fire has on ecosystem processes.

Many homes and landscapes within the wildland-urban interface are designed without regard for fire risk or protection. With more people living there, the risk of both accidental fire and arson increases. The priorities and strategies of firefighting agencies, therefore, focus first on the protection of human life and property and then on natural resources. Most forest-fire suppression personnel are inadequately trained or prepared to fight structural fires, and municipal fire departments often are not trained to fight wildland fires. These factors make wildfire protection and suppression within the interface increasingly problematic and dangerous.

Recreation

Most outdoor recreation activities have been growing steadily over the last several years. At the same time, an increasing number of private landowners have been posting their properties, effectively limiting outdoor recreation access and use. As a result, recreation pressure on public land has increased dramatically. Because the demand for recreation opportunities is expected to continue growing, recreation planners and managers face the compound challenge of providing high-quality experiences while sustaining the quality of natural resources. Managers increasingly need the skills to communicate with people from a wide range of cultures, ages, and value systems about the responsible use and management of public lands.

Wildlife

The combined effect of deforestation, fragmentation, and urbanization threatens wildlife resources. The most significant wildlife challenge in the interface is conserving, managing, and restoring habitat. Urbanization not only fragments habitat, but also severs wildlife migration routes. Maintaining migration routes, corridors, and quality habitats will be necessary for many species' survival. One successful strategy has been to establish core habitat reserves where human influences are reduced.

Urbanization creates “edge” habitats while removing the interior forest habitat necessary for many wildlife species. Because of this, some wildlife species populations are increasing and others are decreasing. White-tailed deer, for example, have been shown to thrive in edge habitats, posing serious management challenges, such as responding to complaints of deer browse in gardens and on ornamental landscapes. Wildlife managers must be aware of such concerns, adapt appropriate management strategies, and keep abreast of local attitudes towards wildlife conservation and management.

Social Issues

As an area is transformed from rural to urban, the economics, politics, structure, and quality of life of a community change. If resource professionals are to be effective in managing the wildland-urban interface, they must understand such changes and their human effects.

Urbanization alters the economics of land management. Trees become more valued for nonconsumptive social and ecological benefits than as commodities (fig. 9). Return on investment comes more from a property's commercial or residential potential than for its standing timber. Closeness to urban markets permits many landowners to profit from nontimber products such as fruits and medicinal herbs. Income from such crops may make it feasible for landowners to productively manage forest or agricultural lands that might otherwise be subdivided or sold.

The costs of infrastructure—roads, schools, water, and related services—are higher in urbanizing areas than in either urban or rural areas, and serious questions often arise about who should pay for necessary construction and



Figure 9

In an urbanizing environment, the costs of planting and maintaining trees increases, as well as do the perceived benefits of these trees.

maintenance. Increased development in rural and interface areas may provide greater access to health care, education, and jobs. Although many residents cite the benefits of being closer to nature and away from urban stressors, increased population density can generate the very stressors they thought they left behind. Higher population densities also increase the potential for neighbors to directly affect one another's quality of life. One example of this is that regulation of forest and land management practices tends to increase with urbanization. The challenge is to find an acceptable balance of social costs and benefits.

To be effective in the wildland-urban interface, resource professionals must develop new methods of communicating with landowners and distributing advice and assistance. New partners and constituents, particularly such nontraditional ones as tax accountants, media representatives, and local agents of economic development, will be essential. Mechanisms that enable and encourage cooperative and cross-boundary management also are needed.

Themes and Research Needs

Through careful examination of Assessment results, four major themes emerged:

- 1. Wildland-urban interface issues are about people** and their relationship with and effect on natural resources. Public perceptions, values, and attitudes affect land use and ultimately determine future forest management strategies and policies.
- 2. Public policy plays an important role in creating and solving interface problems.** Some public policies serve to protect and conserve natural resources, while others provide incentives for urban development. The objectives of some policies may even conflict with one another. Increasingly, resource professionals are recognizing a critical need to understand a variety of policies and become involved in decisionmaking processes that are unique to the wildland-urban interface. Resource professionals can help by providing policymakers with the best scientific information available.
- 3. Interface issues are interdisciplinary.** This Assessment demonstrates the crosscutting nature of interface issues and the need to take interdisciplinary approaches when addressing their inherent complexity. Building relationships across various disciplines and professions will improve opportunities for addressing interface issues.
- 4. Interface issues involve multiple ownerships, jurisdictions, and scales,** which complicate management and conservation of natural resources within the wildland-urban interface. Subdivision of forest tracts results in a diversity of landowners and management objectives. Multiple jurisdictions in a region may implement conflicting policies, a phenomenon that often complicates land use and management of forest resources. Harmful ecological effects may occur at the landscape or watershed scale, but may only be addressed at a much smaller scale. These challenges are addressed most effectively when efforts are coordinated across the landscape and multiple stakeholder involvement is sought.

Assessment results suggested four major areas of necessary research:

1. Explaining and adapting to human influences on forest ecosystems:

The ecological effects of urbanization can be profound. Forests have been fragmented, natural disturbance regimes altered, pollution increased, and nonnative plant species spread. Ongoing and future research will explore the effects of change on ecosystem structure, function, composition, and processes; develop models for predicting change; and establish long-term monitoring to test model accuracy. Applied research is needed to develop adaptive management practices, such as small-scale forest management techniques, to help management agencies address the challenges presented by urbanization and multiple small-scale land ownerships.

2. Identifying the influences of public policy on forest ecosystems and their management: This research area describes the need to better understand relationships among policy, land use changes, and affected forest ecosystems, as well as the roles, strengths, and weaknesses of various policies that address natural resource management and conservation in the wildland-urban interface. Effective and appropriate decisionmaking at a variety of scales requires a program of basic discovery, reliable interdisciplinary models, and technology and information exchange.

3. Identifying and reducing risks to ecosystems and people in the wildland-urban interface: Human and forest communities within the interface are threatened by the risk of fire, floods, invasive species, groundwater contamination, and other environmental changes. Controlled experiments, historical studies, modeling, and long-term monitoring will help managers, landowners, and residents better understand, predict, and avert such risks.

4. Understanding and communicating public attitudes, values, and perceptions: The focus of this area is the knowledge, attitudes, and preferences of homeowners and others regarding the management and conservation of natural resources. Differences in ethnicity, age, and cultural backgrounds influence policy, resource uses, and management practices (fig. 10). Widely disseminated demographic and social science information will enable natural resource managers and the public to develop and engage in effective communication strategies, outreach, educational opportunity, and conflict resolution.



Figure 10
With unprecedented increases in ethnic, racial, and age diversity in the South, recreation managers must consider the needs and expectations of the different groups using interface recreation sites.

Conclusion

Population and demographic trends, economic and tax issues, and land use planning and policy issues all play a part in influencing change in the interface. As a result, the ecological structure, function, and composition of forests in the South are changing, as are forest resource management and conservation practices and strategies. Additional skills, tools, and information are necessary for natural resource professionals, policymakers, planners, and others to address the unique conditions, challenges, and needs associated with the wildland-urban interface. The Southern Center for Wildland-Urban Interface Research and Information in Gainesville, FL, will address these needs through a comprehensive program of research, information, and technology transfer and exchange.



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

The USDA prohibits discrimination in all its programs and activities on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, sexual orientation, or marital or family status. (Not all prohibited bases apply to all programs). Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact the USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326—W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250–9410 or call (202) 720-5964 (voice or TDD). USDA is an equal opportunity provider and employer.

Macie, Edward A.; Hermansen, L. Annie. 2003. Human influences on forest ecosystems: the southern wildland-urban interface assessment: summary report. Gen. Tech. Rep. SRS–64. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 13 p.

This summary report synthesizes the findings contained in the Southern Wildland-Urban Interface Assessment (General Technical Report SRS-55). The Assessment provides a review of critical wildland-urban interface issues, challenges, and needs for the Southern United States. Topics include population and demographic trends, economic and tax issues, land use planning and policy issues, urban influences on forest ecosystems, challenges for forest resource management and conservation, social issues, and themes and research needs for the wildland-urban interface.

Keywords: Demographics, economics, fire, forest ecology, land-use planning, natural resource management, public policy, taxation, urbanization, wildland-urban interface.

