Human Influences on Forest Ecosystems

The Southern Wildland-Urban Interface Assessment

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Edited by
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Edited by

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Table of Contents

	Page
Foreward *Peter J. Roussopoulos*	v
Contributors to this Report	vi
Authors	vi
Editorial Team	vii
Acknowledgments	vii
Chapter 1: Introduction *L. Annie Hermansen and Edward A. Macie*	1
Introduction	1
Defining the Wildland-Urban Interface	2
Purpose and Objectives of the Assessment	5
Scope and Sources of Information	5
Organization of the Assessment	6
Literature Cited	7
Section I: Factors Driving Change	
Chapter 2: Population and Demographic Trends *H. Ken Cordell and Edward A. Macie*	11
Introduction	11
Population and Other Social Trends	12
The Emerging Wildland-Urban Interface	26
Needs	32
Conclusion	34
Literature Cited	34
Chapter 3: Economic and Tax Issues *Steverson O. Moffat and John L. Greene*	37
Introduction	37
Economic Trends and the Wildland-Urban Interface	38
Tax Issues Driving Change	42
Existing Economic and Tax Tools	47
Needs	49
Conclusion	49
Literature Cited	50
Chapter 4: Land Use Planning and Policy Issues *James E. Kundell, Margaret Myszewski, and Terry A. DeMeo*	53
Introduction	53
Current Public Policies and Programs Affecting the Wildland-Urban Interface	54
Public Attitudes and Involvement in Growth Management Policies	60
Future Trends of Current Land-Related Policies	61
Tools for Protecting Natural Resources Within the Interface	62
Needs	64
Conclusion	67
Literature Cited	67

Section II: Consequences of Change

Chapter 5: Urban Influences on Forests 73
Wayne C. Zipperer

Introduction 73
Urban Effects on Forest Ecosystems 74
Needs 86
Conclusion 87
Literature Cited 88

Chapter 6: Challenges to Forest Resource Management and Conservation 93
Mary L. Duryea and L. Annie Hermansen

Introduction 93
Managing Forests under Change 94
Conclusion 109
Literature Cited 110

Chapter 7: Social Consequences of Change 115
R. Bruce Hull and Susan I. Stewart

Introduction 115
Consequences of Economic Change 116
Consequences of Political and Regulatory Changes 118
Consequences of Community and Landowner Changes 121
Needs 124
Conclusion 127
Literature Cited 127

Section III: Major Themes and Needs

Chapter 8: Fire 133
Martha C. Monroe

Introduction 134
The Way It Was 134
The Way It Is 135
Integrating Interface Issues 136
Meeting the Challenge 145
Needs 146
Conclusion 148
Literature Cited 148

Chapter 9: Themes, Research, and Information Needs 151
Edward A. Macie and L. Annie Hermansen

Introduction 151
Major Themes 153
Research Areas 157
Conclusion 159
Literature Cited 160

Foreword

In 1998, Florida wildfires demonstrated the complexities of natural resource management in the wildland-urban interface. Shortly after these fires, the Chief of the USDA Forest Service identified the wildland-urban interface as one of the main challenges for the Forest Service in the South.

While many studies have addressed various interface issues, few have been conducted with an interdisciplinary perspective in the South. As this Assessment demonstrates, the South is facing dramatic change. The future sustainability of southern forests and the ability to manage for forest benefits, goods, and services are challenged. This Assessment is a first step toward addressing these challenges and validates the need to establish a wildland-urban interface center that addresses the many research and information needs identified.

The Southern Wildland-Urban Interface Council, an interagency team with representatives from the Forest Service; Southern Group of State Foresters; universities; the Cooperative Extension Service, Southern Region; and nonprofit organizations provided direction for the Assessment. Council members were principal advisors and planners for this project and identified key interface issues, which were then refined and validated by a series of focus groups held in six Southern States.

This Assessment is closely linked to the Southern Forest Resource Assessment (SFRA), which has comprehensively examined challenges to forest sustainability in the South. We focus here specifically on urbanization, changing land use patterns, and issues related to the wildland-urban interface. Readers of this Assessment, however, will find valuable supporting information in the SFRA report.

A comprehensive wildland-urban interface literature database and other supporting resources can be found on the Web site, Interface South (www.interfacesouth.usda.gov). This Web site was developed to meet the growing demands for wildland-urban interface information and resources.

As you read this Assessment, remember that issues in the wildland-urban interface are too complex to be bound to a single topic or perspective. Furthermore, this Assessment was not meant to cover every possible issue related to the wildland-urban interface; space and other limitations made this impossible. Rather, our goal has been to start a dialogue. We hope that dialogue will lead us toward a more complete understanding of interface issues, challenges, and needs for the Southern United States.

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Chapter 1

INTRODUCTION

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Introduction

Large areas of once primarily contiguous forest land in the South are increasingly influenced by humans and surrounded by or intermixed with urban development. These areas of increased human influence and land use conversion make up the wildland-urban interface. Severe wildfires in Florida in 1998 demonstrated the complex challenges that the wildland-urban interface presents for a diverse group of people that live and work there. These fires also brought the wildland-urban interface to the forefront for the U.S. Department of Agriculture Forest Service (USDA Forest Service) and other natural resource agencies across the South, spurring the development of this Assessment. ▶

"In a word, the interface is a façade—the illusion that you are in the forest." Texas

Photos courtesy of Florida Division of Forestry

Figure 1.1
The intensity of the 1998 wildfires in Florida was enough to kill large, mature trees.

Due to these wildfires, over $600 million were lost through reduced tourism, fire suppression efforts, and damaged timber, businesses, and homes. Public health and safety were threatened; in some cases entire counties had to be evacuated and many elderly people and those afflicted with asthma needed medical treatment. Forest ecosystems were endangered. Although fire is a common occurrence in most southern forest ecosystems, the intensity of these fires was enough to kill large, mature trees (**fig. 1.1**). Firefighting agencies fought first to prevent loss of life and structures and second to protect natural resources. They also struggled to combine responsibilities of structural and wildfire firefighting, a necessity in the wildland-urban interface.

Though fire is a critical issue in the wildland-urban interface, it is but one of the many issues affecting the condition, health, and management of forest resources. Demographics, economics and taxation, and land use planning and policy are major forces driving change in the wildland-urban interface. Urbanization is influencing forest ecosystems by changing their structure, function, and composition, as well as the benefits derived from them. Management of water resources, recreation, traditional forest products, wildlife, and other natural resources is changing to meet the challenges in the interface. There are also many social consequences produced by this changing landscape.

Resource professionals need new management practices, skills, and tools to address the new and changing environment of the wildland-urban interface. New research is needed to place the best scientific information into the hands of decisionmakers. This Assessment is a first step towards addressing wildland-urban interface challenges, opportunities, and needs in the South.

We begin this chapter by defining the wildland-urban interface. Then we present the Assessment's purpose, objectives, scope, and information sources. We conclude by describing the organization of the Assessment and a brief overview of each chapter.

Defining the Wildland-Urban Interface

For this Assessment, we defined the wildland-urban interface as an area where increased human influence and land use conversion are changing natural resource goods, services, and management. Our definition was written from a natural resource perspective. Other common definitions are based on geographical, sociopolitical, biophysical, and fire perspectives.

The term wildland-urban interface most often brings to mind a definition based on geography. There are many types of interface that vary by spatial configuration. Spatial differences among these interface types are significant because they result in different conditions and challenges for natural resource managers, policymakers, and landowners.

The classic wildland-urban interface is characterized by areas of urban sprawl where homes, especially new subdivisions, press against public and private wildlands, such as private nonindustrial or commercial forest land, or land under public ownership and management (Hughes 1987) (**fig. 1.2**).

Photo by Hans Riekerk, University of Florida

Figure 1.2
The classic wildland-urban interface is characterized by areas of urban sprawl where homes and other human-made structures press against public and private wildlands.

The wildland-urban intermix refers to areas going through transition from agriculture and forest uses to urban land uses on the leading edge of development. Such areas are characterized by a mixing of urban, forest, and agricultural land uses in advance of where the urban fringe is moving into the rural countryside.

The isolated wildland-urban interface is made up of remote structures, typically second or summer and recreation homes, ranches, and farms, surrounded by large areas of vegetation (**fig. 1.3**).

Photo courtesy of Virginia Department of Forestry

Figure 1.3
The isolated wildland-urban interface is made up of remote structures surrounded by large areas of vegetation.

Photo courtesy of USDA Forest Service

Figure 1.4
Islands of undeveloped lands, such as public parks, are left when cities grow together. This creates wildland-urban interface islands.

Finally, wildland-urban interface islands are areas of wildland within predominantly urban areas. As cities grow together, islands of undeveloped land are left, creating remnant forests. Sometimes these remnants exist as public or publicly protected openspace, or as land that is not developable or too expensive to develop due to site limitations, such as topography, wetlands, or rocky outcrops (**fig. 1.4**).

The interface can also be thought of in a sociopolitical context as a place of interaction between different political forces and potentially competing interests (Vaux 1982). It is a place of interaction between people with different beliefs and perceptions about how natural resources should be managed or between institutions with competing visions. One example is the opposing views within a community over the value of a local watershed. Some may see managing forests in a watershed to protect water quality as an important value while others may see more value in large expanses of parking lots within the same watershed.

Photo courtesy of USDA Forest Service

Figure 1.5
The wildland-urban interface can also be defined as an area where physical changes to forest ecosystems, such as this spot created by a southern pine beetle outbreak, are occurring as a result of increased urbanization.

From a biophysical perspective, the interface can be defined as an area where physical changes to forest ecosystems are occurring because of increased urbanization. Examples of these changes include habitat fragmentation, reductions in connectivity, changes in biodiversity, encroachment of invasive species, changes in stormwater runoff and quality, and increased soil erosion (**fig. 1.5**).

Fire managers in the wildland-urban interface are concerned with protecting people and built structures as well as natural areas. Their definition of the interface is an area where residential or commercial development is in or adjacent to areas prone to wildfire (Davis and Marker 1987, Tokle 1987).

Purpose and Objectives of the Assessment

The main purpose of this Assessment is to provide a foundation for developing an integrated USDA Forest Service program of research, application, and development that addresses the issues, challenges, and opportunities of the wildland-urban interface. The five main objectives were to:

1. Explore the wildland-urban interface from an interdisciplinary perspective in order to understand the complexity and connectivity of interface issues.
2. Examine factors driving change in the interface, including population and demographic trends, economic and taxation issues, and land use planning and policy.
3. Explore consequences of this change on forest ecosystems, resource management, and social systems.
4. Identify gaps in our knowledge of interface issues to help us identify research and information needs.
5. Promote dialogue about and heighten awareness of interface issues among practitioners, researchers, and the public.

Scope and Sources of Information

This Assessment covers the 13 Southern States shown in **figure 1.6**. Challenges in the wildland-urban interface in the South differ somewhat from those of other U.S. regions due to differences in the number of private landholdings, topography, climate, vegetation type, and culture. Although Assessment findings are for the South, many of the main themes and recommendations are applicable to other areas of the United States and abroad.

" . . . . The interface is sometimes very abrupt. You'll have agricultural fields right next to shopping centers. There's no transition zone there." Virginia

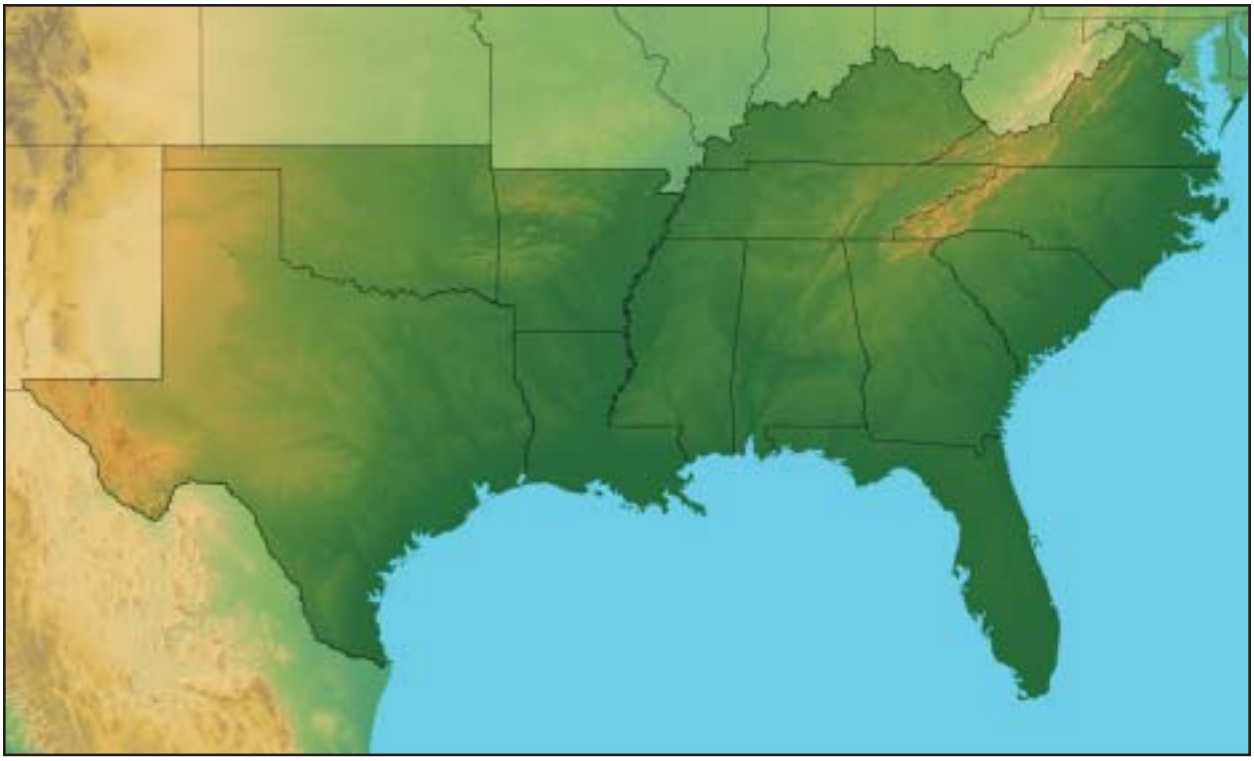

Figure 1.6
The scope of this Assessment covers the 13 Southern States.

Several sources of information were utilized for this Assessment. Scientific literature was searched to identify the current state of knowledge on interface issues. Also, a total of 12 Assessment focus groups were convened in 6 communities experiencing rapid growth across the Southern United States. The States in which these focus groups took place are Texas, Georgia, Florida, Alabama, Virginia, and Mississippi. Findings of focus groups are reported in the USDA Forest Service General Technical Report "The Moving Edge: Perspectives about the Southern Interface" (Monroe and others, in press). These focus groups helped to refine and validate interface issues that are presented in this Assessment and demonstrated that interface challenges are complex, compelling, and shared commonly among a diverse group of people who live and work in the interface. Quotations from these focus groups are presented in each chapter.

"The interface is a mosaic of incompatible land uses, a zone of increased conflict." Texas

Organization of the Assessment

This publication is divided into three major sections. Within each section are several chapters, each beginning by exploring major issues, changes, and challenges in the wildland-urban interface. Then current programs, tools, research, and information that help address interface challenges are examined. Chapters conclude with suggestions for research, education, and development of management options and tools.

Section I (chapters 2 through 4) provides a foundation for subsequent chapters by overviewing factors driving the rapid change and expansion of the wildland-urban interface in the South. Chapter 2 begins with a discussion about population and demographic trends and projections in the South and predicts where forest resources are likely to face the greatest pressures from human influences. Chapter 3 follows with a look at economic conditions and tax policies that influence land use decisions and the rate of change in the wildland-urban interface. Chapter 4 then examines the role of land-related public policy at the Federal, State, and local levels and explores how natural resource management and conservation in the interface is complicated by current land-related public policies.

While the authors in the first section explore factors driving change in the interface, contributors to section II (chapters 5 through 7) assess some of the consequences of this change. Chapter 5 focuses on urban influences on forest ecosystems in the South. The author explores how urbanization is changing forest health and modifying the goods and services provided by forest ecosystems. The changing condition of forest ecosystems has a direct effect on the management of forest resources in the wildland-urban interface. Chapter 6 considers important changes and challenges that forest resource managers face when managing water resources, traditional forest products, fire, recreation, and wildlife in interface forests and gives some examples of innovative management and conservation alternatives. Chapter 7 reviews social consequences of change in the interface. It includes effects on communities and landowners as a result of changes in economics, policies, community structure, and quality of life in the interface. The authors conclude with a discussion of what natural resource professionals need to be effective in the changing social climate of the interface.

Section III (chapters 8 and 9) summarizes the Assessment by presenting a case study and addressing major themes and research and information areas. Chapter 8 uses fire in the wildland–urban interface as a case study to emphasize many of the questions and issues raised in the previous sections of the Assessment. Wildland fire perhaps best demonstrates how demography, economics and taxation issues, land use planning and policy, ecosystem structure and function, forest resource management, and social dimensions all affect efforts to manage resources and protect human communities in the wildland-urban interface. Chapter 9 concludes the Assessment by highlighting major themes that cross all of the chapters and by listing research and information needed to promote better understanding and provide solutions for wildland-urban interface challenges.

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SECTION 1:
FACTORS DRIVING CHANGE

Photo courtesy of USDA Forest Service

Photo by James Kundell, University of Georgia

Photo courtesy of Virginia Department of Forestry

Photo by Nick Cowie

Chapter 2

POPULATION AND DEMOGRAPHIC TRENDS

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Introduction

This chapter reports significant population, demographic, and other social trends and predicts where in the South these factors are likely to drive further urban expansion. We first examine the primary causes of population growth, which are relative birth and death rates and immigration. Next, we outline the changing social composition of the South, including age trends and evolving racial and ethnic composition. We look at growth of urban areas and its flip side, rural transition, which indeed is occurring. As an indicator of some of the economic changes occurring, we examine employment trends that are related to urban expansion. Finally, we examine various dimensions describing southerners, including rural land ownership, lifestyles, and outdoor recreational activities. ▶

To illustrate the significance of the previous social demands and trends, a number of maps are presented. These maps overlay the distribution of forecast social conditions onto the locations of forest, water, wetland, and wildlife habitat resources throughout the region. These maps identify where human pressures are likely to have the greatest effects on natural resources by 2020. Data sources used to describe demands and trends include the Census of Population (U.S. Department of Commerce, Bureau of the Census 2000b), Forest Service Renewable Resources Planning Act assessment data (Cordell and others 1999), rural landowner surveys (Teasley and others 1999), Natural Resources Conservation Service data describing rural lands (U.S. Department of Agriculture, Natural Resources Conservation Service 2000), and the National Survey on Recreation and the Environment [Cordell and others, in press (b)].

Population and Other Social Trends

The Drivers of Population Growth

Of the social changes underway, population growth will undoubtedly be the most significant in shaping the future of the South's wildland-urban interface. In April 2000, the population of the United States was estimated to be 281,421,906. Of that number, 91,486,129 lived in the 13-State region from Virginia to Texas (**table 2.1**) (U.S. Department of Commerce, Bureau of the Census 2000c). Between April 1, 1990, and April 1, 2000, this region's population grew 13.9 percent and now accounts for 32.5 percent of the national total. The South's share is increasing relative to shares of other regions.

Table 2.1—Population of most heavily populated Southern States, the South, and the United States, 2000

Census unit	Population
	Million
Texas	20.9
Florida	16.0
Georgia	8.2
North Carolina	8.0
Virginia	7.1
South	91.5
United States	281.4

Source: U.S. Department of Commerce, Bureau of the Census 2000c.

The three fundamental drivers of population change are births, deaths, and net immigration rates. The current birth rate in the South is 16.5 per 1,000-population per year, which is just below the national average for the 48 contiguous States. Across a wide band of counties stretching across the South from coastal and Piedmont North Carolina to Louisiana and coastal Texas, however, birth rates are well above the region-wide and national rates. Some rates reach 30 to 40 per 1,000 per year. The death rate across the South, at 10.2 per 1,000 per year, is just at the national average. In Florida and in parts of Mississippi and Arkansas, death rates exceed this region-wide average, reaching 15 to 25 deaths per 1,000 per year in many counties. The South's birth rate of 16.5, being substantially higher than its death rate of 10.2, results in a net population gain (called a "natural increase") of 6.3 people per 1,000-population per year. At this rate, around 600,000 people are added to the South's resident population per year through natural increases, adding tremendous pressures for urban expansion and development to accommodate needs for new housing, retail outlets, and transportation.

Immigration from other countries and migration from other regions to the South are additional sources of population growth. They exceed the natural increases from net birth rate. Between 1981 and 1990, 7.3 million immigrants moved into the United States from other parts of the world. Exiting emigrants during this same period numbered 1.6 million. Thus, net immigration was just over 5.7 million. The statistics account only for legal immigration (U.S. Department of Commerce, Bureau of the Census 1992). Illegal immigration is believed to be much larger—over 1 million per year by some estimates. As in the Nation as a whole, net immigration to the South has continued to rise dramatically decade by decade.

"One of the things that concerns me is the changing demographics . . . . Let's talk about the Houston area. By the year 2030, the population is supposed to double." Texas

Migration to the South from other regions of this country is highly significant. In 1981, 1.47 million people moved into this region from other parts of the United States, while approximately 1 million moved out. The net increase was 470,000 (U.S. Department of Commerce, Bureau of the Census 2000a). People moving into the South from abroad that year totaled 401,000 making a legal net gain of 871,000. In 1998, net internal migration totaled 271,000, while movers from abroad totaled 544,000. The South's net gain, excluding illegal immigration, was 815,000. That total was greater than the totals across all other U.S. regions combined. With migration pressures of this magnitude, mostly to already burgeoning metropolitan areas like Houston, TX, Atlanta, GA, and Miami, FL, former rural areas and forests are being converted to urban interface zones at unprecedented rates.

Social Composition, Age, and Ethnicity

Like population growth, aging is a major component of social change in the United States and in the South. Aging is likely to have profound effects on future recreation, development, and agricultural demands on our forests and other rural lands, especially those in attractive retirement destinations (**fig. 2.1**). The median age of the U.S. population has been rising steadily from 18.9 years in 1850 to 32.8 years in 1990. In the South, median ages among the States range from a low of just under 34.5 in Texas to a high of over 42 in Florida. In all the States, median age is expected to rise, with Virginia, Alabama, Mississippi, and Arkansas leading in this increase. A dominant reason for the rising median age of the region's population is rising life expectancy due to better diets and medical care. For people born in 1950, average life expectancy is just under 70 years (Barrick and Zayatz 1996). For people born in 2000, life expectancy is around 74 for males and just over 80 for females.

Photo courtesy of Virginia Department of Forestry

Figure 2.1
Forested areas in the wildland-urban interface are attractive as retirement destinations across the South.

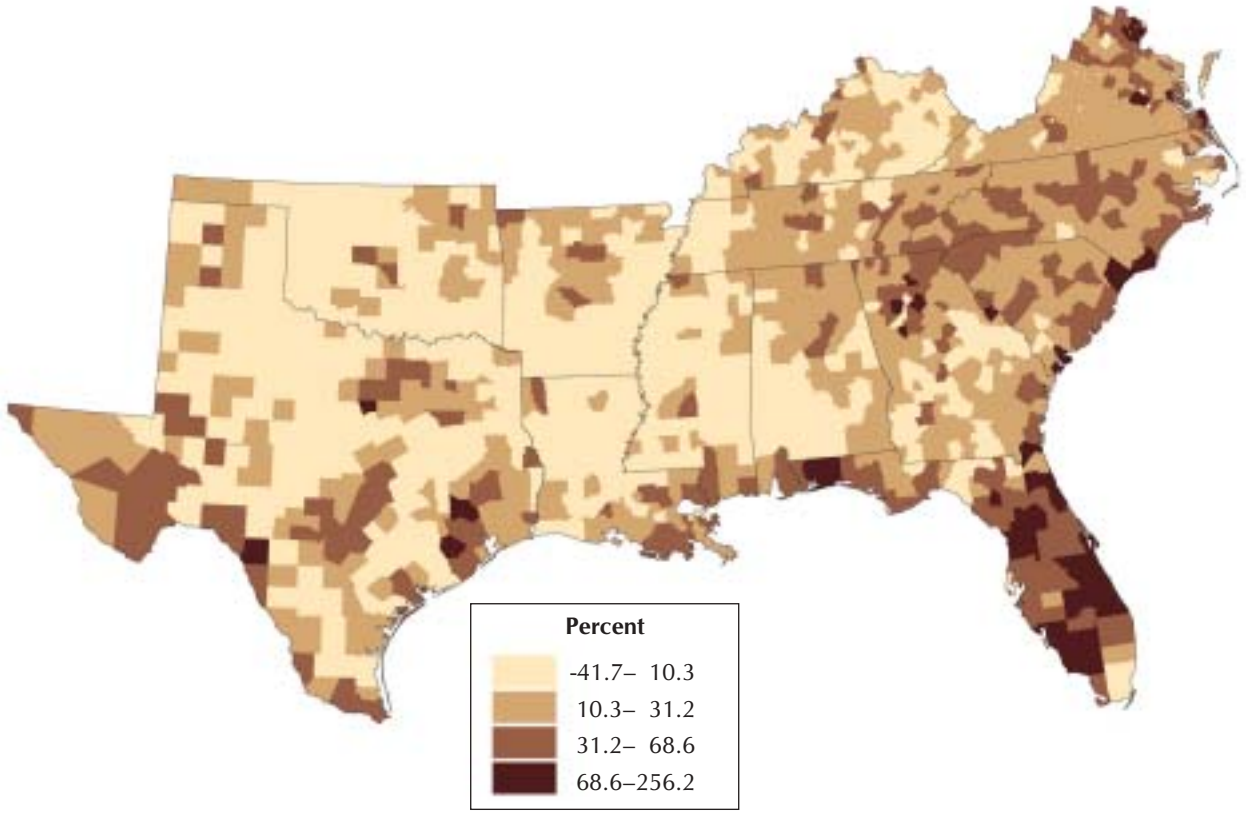


Figure 2.2
Distribution among counties of change in U.S. population 65 and older, 1980-90. (Source: Woods and Poole Economics, Incorporated 1997.)

A highly significant outcome of population aging is the unprecedented increase in number of retirees. **Figure 2.2** shows changes in numbers of residents over 65 years old between 1980 and 1990 across the counties of the South. The overall regional increase was 25.7 percent. The most rapid increases were in most of Florida, along the Atlantic coast, down the Southern Appalachians to Atlanta, along the gulf coast, and in eastern Texas. Over the region, the percentage of the population age 65 and over is projected to continue to rise from about 12.5 percent in 2000 to over 17 percent by 2020 (Woods and Poole Economics, Incorporated 1997). This increase is likely to have profound effects on forest ecosystems. It means continued development of retirement communities, second homes, and recreation facilities like golf courses, all of which lead to the creation of new interface areas. It also means more potential for interactions between interface residents and forest management practices, such as fire, recreation, and timber management (Marcin 1993).

"A lot of our population growth is part-time or seasonal, but their impact is felt all year round." Florida

Increasing ethnic diversity is another primary component of social change in the South. The makeup of the population is shifting rapidly. In the 1990s, non-Hispanic Whites made up approximately 72.4 percent of the region-wide population. Of minority populations, Hispanic residents made up 8.9 percent, Blacks

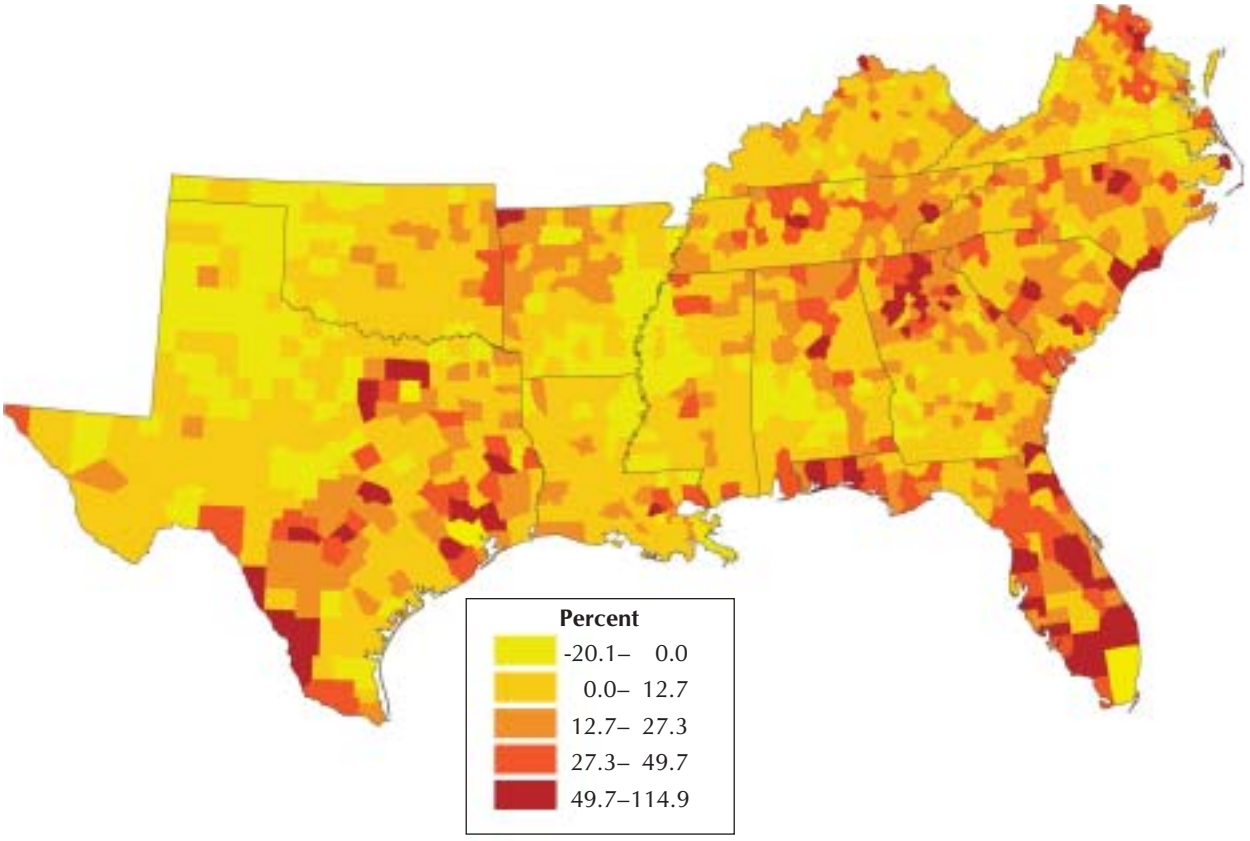


Figure 2.3
Distribution of projected change in the South's population, 2000-20. (Source: Woods and Poole Economics, Incorporated 1997.)

made up 16.7 percent, and Asian and other races made up just over 2 percent. The trends now are similar in the South to those in the rest of the United States. Non-Hispanic Whites are steadily becoming a smaller percentage of the total population. Research has shown that Whites, Blacks, Hispanics, Asians, and others differ in how each uses and values southern forests and other natural resources [Cordell and others, in press (a)]. Resulting changes in collective public positions on natural resource management and protection will likely end up being the social trend with the greatest impact on how we collectively view and use forests.

Population Projections

Between 2000 and 2020, the South's population is projected to increase another 23.8 million, reaching almost 114 million people by the close of those two decades. **Figure 2.3** shows projected distribution of percentage population growth over counties of the South between 2000 and 2020. Over the region, the percentage of the population age 65 and over is projected to increase from about 12.5 percent in 2000 to over 17 percent by 2020 (Woods and Poole Economics, Incorporated 1997). Ethnic composition is shifting rapidly in this region. By 2020, Hispanics are expected to account for about 16.2 percent of the population, Blacks 19.5 percent, and Asians and others around 3 percent (Woods and Poole Economics, Incorporated 1997). Non-Hispanic Whites, as a proportion of the population, will drop to about 61 percent by 2020 and just over 50 percent by 2050.

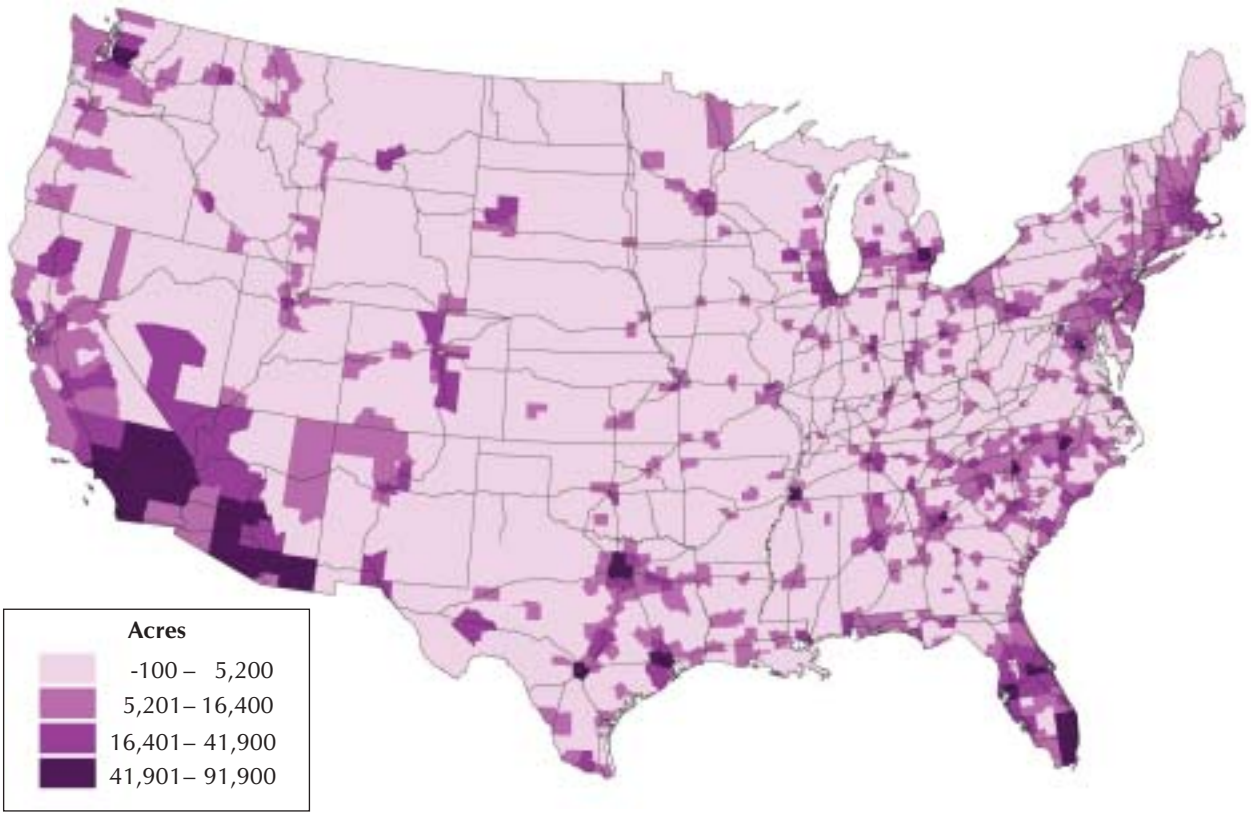


Figure 2.4
Change in acreage from rural to urban across the United States, 1982–92. (Source: Woods and Poole Economics, Incorporated 1997.)

Urban Growth

In the South and the Nation, population growth is primarily in urban areas. In 1790 when the first U.S. census of population was done, only 5 percent of the country's population lived in the few large cities of that time. By 1920, the population balance between rural and urban had shifted, and the population became predominantly an urban one. By 1990, 75 percent of the people in the United States lived in urban areas. Since then, metropolitan counties have accounted for about 82 percent of all growth, even though they make up only 18 percent of the total land base (U.S. Department of Commerce, Bureau of the Census 1997). Today, over 80 percent of the U.S. population is urban, and well over 2 million more urban residents are added each year.

"Landscapes just change almost overnight before you can even react to anything . . ." Mississippi

The burgeoning urban population drives new development, constantly expanding the wildland-urban interface. Urban and related development is occurring at unprecedented rates in the United States and the South. Between 1992 and 1997, nearly 16 million acres of formerly rural land across the Nation were converted to developed urban land uses. At this rate, over 3 million acres of urban development are being added annually. Notable among southern counties facing

Table 2.2—Changes and projections in urban population and population density in the six largest metropolitan areas and the South, 1995–2020

Region	Population			Population density		Change
	1995	2020	1995–2020	1995	2020	
				Per square mile		*Percent*
Dallas-Ft. Worth	4,449,877	6,625,820	2,175,943	488.75	727.74	48.9
Atlanta	3,431,987	5,254,118	1,822,131	560.21	857.65	53.1
Houston	3,710,847	5,494,718	1,783,871	626.72	927.99	48.1
Tampa-St. Petersburg	2,180,484	3,339,119	1,158,635	853.59	1,307.15	53.1
Miami	2,031,337	2,403,171	371,834	1,044.55	1,235.75	18.3
Memphis	1,068,895	1,341,475	272,580	355.40	446.03	25.5
South	60,750,243	83,968,681	23,218,438	283.14	391.35	38.2

Source: Woods and Poole Economics, Incorporated 1997.

high rates of urbanization between 1982 and 1992 were those along the coast of South Carolina, Georgia, and Florida; counties in the highlands of Virginia and nearby West Virginia; counties in eastern Kentucky and eastern Tennessee; and counties in southern Texas (**fig. 2.4**). A sizeable number of counties in the South were adding urban development at rates of 21 to almost 62 percent during this 10-year period. Of the 20 counties in the country with the greatest number of acres converted to urban uses between 1982 and 1992, 4 were in Texas, 5 were in Florida, 2 were in North Carolina, and 1 was in Georgia. Thus, 12 of the top 20 were in the South. By 1997, when the latest National Resources Inventory (NRI) was completed, the annual rate of urban land development had doubled (U.S. Department of Agriculture 1994). Nationally, total acreage of land developed for urban uses between 1992 and 1997 was greatest in 10 States. Six of those States were in the South, and in each of those Southern States, more than 500,000 acres had been converted to urban development. Topping the list nationally was Texas with 1.2 million acres. Other States on this list were Georgia with 1 million, Florida with 945,000, North Carolina with 782,000, Tennessee with 612,000, and South Carolina with 540,000.

Urban Population Projections

The urban population of the United States is predicted to grow by 18.8 percent between 2000 and 2020, compared to 12.4 percent growth in rural counties. **Table 2.2** provides projections for the South and its six largest metropolitan areas. The predicted growth of 23.2 million new southern urban residents between 1995 and 2020 will exceed the combined growth of the North and Pacific coast regions during this period. While the urban areas of the North will continue to be the most densely populated among U.S. regions, at over 540 people per square mile, population density will be rising faster in the South, reaching 391 persons per square mile by 2020. Except for cities in Florida, population growth in southern cities is driven less by natural and cultural amenities than it is by economic opportunities and employment. Florida cities are growing largely because they are high-amenity retirement destinations and because of massive Hispanic immigration. As

urban expansion accelerates and urban population growth continues, the region is likely to see a moderate shift in public attitude away from protection of forested interface lands. There are also likely to be shifts in the way the future population uses forests and other natural lands.

Rural Transition

Seventy-six percent of the Nation's counties (2,305) are classified by the Federal Government as rural. While rural counties account for 83 percent of the Nation's land, they account for < 20 percent of its population (Rural Policy Research Institute 1999). Between 1980 and 1990, a number of counties in the South experienced population losses. Included were counties in northern Texas and parts of Arkansas, Mississippi, Alabama, Georgia, West Virginia, and Kentucky.

In most rural counties, however, population grew in the 1980s, particularly in parts of Texas and Florida. During this decade, the South experienced a 3.1-percent rate of rural population growth. In the 1990s, however, the population of rural counties in the South grew 7.5 percent. In some, growth exceeded 100 percent. Such rapid growth is expected to continue along sections of the Atlantic and gulf coasts. On average, populations of southern rural counties are expected to grow by 11.5 percent. Over the same period, population growth rates in rural counties are expected to be 23.3 percent in Pacific Coast States and 8.0 percent in the North. In terms of population density, the rural South will gain more than any other region of the country (4.2 people per square mile). Many of these rapidly growing rural areas are connected one to the other, or to nearby metropolitan areas, by interstate highways. This interstate linkage demonstrates the influence that Federal policies, such as the creation of the National Interstate Highway System, can have in opening land previously in agriculture and forests to growth and development. Such development, of course, will further expand the wildland-urban interface (see chapter 4).

Nationally, between 1982 and 1992, around 13.3 million acres of rural land were converted to urban and other built-up uses. This total included 6.5 million acres in the South, where more rural acreage was converted than in any other region. Expressed as a percentage change rate, this 33-percent, 10-year pace of land conversion indicates a greater-than-national rate of expansion of the South's wildland-urban interface. The NRI data for 1992–97 showed that loss of rural land had accelerated in every State in the Nation. The highest acreage losses between 1992 and 1997 occurred in Texas (1.14 million), Georgia (1.05 million), Florida (0.92 million), and North Carolina (0.75 million). Large-scale conversion to urban development also occurred in Virginia, Kentucky, and Georgia. Of the top 20 counties in rural land area converted, 3 were in Virginia, 2 in Kentucky, and 2 in Texas. Comparing the ratio of rural area converted to growth of population among regions revealed that the South had the highest annual ratio at 3.2 converted acres per added rural resident. This ratio indicates the considerable impact that new residents have on land development and, subsequently, forest ecosystems (see chapter 5).

The Shifting Economy

Shifts in employment among sectors of the economy help to identify changing demand pressures on natural resources, changes in industry makeup, and transitions in the ways people make their living and conduct their lives. Many of the

Photo courtesy of USDA Forest Service

Figure 2.5
Greater employment in construction indicates greater pressures to expand the wildland-urban interface.

employment shifts are closely linked to the transition of the South from a rural to an urban region. People working in urban services, retail stores, or other urban jobs usually view the role and importance of forests and other natural resources differently from their rural neighbors.

Many of the significant shifts that have been occurring over the past 20 years among sectors of the South's economy have been driven by a continuing transition from a rural to an urban society. For more than 20 years, employment in farming, as a share of total employment, has been in decline. In large part, this decline has been due to increased large-scale corporate farming and associated upscaling of technology, mechanization, and use of chemicals. Unable to compete, small farms have all but disappeared. Along with them have gone many of the low-technology, labor-intensive farming practices of the past. From 1975 to 1995, the percentage of people employed in farming in the South dropped by about 7 percent. By the late 1990s, farming was an even smaller proportion of the region's workforce, and by 2020, only 12 to 13 percent of the South's workers are expected to be employed in farming. While employment in farming has been declining, employment in the agricultural service industry, which distributes such commodities as fertilizers, insecticides, and farm equipment, has been increasing. Between 1975 and 1995, the percentage of southern workers employed in agricultural services had roughly doubled. Unlike the growth in agricultural services, jobs in the mining, forestry, and fisheries industries are expected to remain somewhat stable through to 2020.

Greater employment in construction indicates greater pressures to expand the wildland-urban interface (**fig. 2.5**). There was a significant increase in the region's construction employment during the late 1970s, from around 5 percent of the labor force in 1975 to over 5.5 percent in 1980. Since then, construction has accounted for between 5.5 and 5.7 percent of workers. In 1975, about 13 percent of workers were employed in retail trades. Since then, the region-wide proportion has risen significantly. In southern metropolitan areas, such as Atlanta, Charlotte, Houston, Dallas, and Miami, growth in retail employment has been especially significant. As urban population has grown in these and other cities, so too has the need for retail trade workers in stores, shopping malls, and associated manufacturing plants. In 1995, retail trade employment accounted for between 15 and 18 percent of all employment. The service sector is another of the South's economic sectors with direct linkages to urban expansion. By 1995, service workers, mostly

working in urban settings, made up just over 20 percent of the region's labor force.

Percentage of workers employed in farming is projected to continue to decline through 2020. This trend will hold not only in the South, but also for the Nation as a whole (Woods and Poole Economics, Incorporated 1997). Percentages of employment in agricultural services and construction should remain stable at their 1995 levels. Percentages of jobs in services and retail trade, however, will continue to rise. By 2020, a 1- to 3-percent increase in the service sector workforce is expected. Overall, with rapid urban expansion, persistent population growth, and rising numbers of high-income retirees, the South's economy is forecast to continue its vigorous growth and further transition from farming and manufacturing to service, retail, technology, and other urban industries. That growth will mean more development of forest land in the wildland-urban interface, and this development in turn will stimulate even more economic growth.

As economic growth continues, incomes will be driven higher. Projections indicate an average increase for both the Nation and the South of about 27 percent in real per capita income (after adjusting for expected cost-of-living inflation) during the first 20 years of the 21st century. Counties whose per capita income is predicted to grow at more than 30 percent from 2000 to 2020 are scattered across the South, but most are concentrated in northern North Carolina, central Georgia and Alabama, Florida, and central Texas. Growing per capita income will result in more households being in the highest income brackets. Nationally in 1995, just over 2 percent of all households had an income of over $100,000 per year. In the South, the areas where people earning this much per year are likely to increase most rapidly include coastal South Carolina and south Florida. These are among the areas of the South where the greatest levels of urban expansion also are occurring.

Rural Land Ownership

Across Southern States, approximately 432 million acres of rural land is in corporate and individual private tracts, about 78 percent of the region's total area. Texas, by far, has the greatest private total—almost 147 million acres. South Carolina has the least, about 15 million acres. Private land area in the rest of the Southern States ranges from 19 million acres in Virginia to 38 million acres in Oklahoma (U.S. Department of Agriculture, Natural Resources Conservation Service 2000). Among the different categories of ownership in this region, individual ownership is the primary type (**figs. 2.6A, 2.6B**).

The characteristics of rural landowners are important to the status and future of the rural landscape and the character and effects of the advancing wildland-urban interface. Population growth, changes in ethnic diversity, conversion of rural land to urban uses, shifts in the economy and sectors in which people are employed, and many other social changes occurring in the South influence rural land ownership. Increasingly, rural land is being converted from small farms to urban worker and retiree residences. This conversion usually results in tract subdivision and greater fragmentation of the rural landscape. At the same time, the number of absentee versus resident landowners is increasing. Leading motivations for absentee owners are recreation and speculation. Residential development and tract fragmentation are associated with urban expansion. However, absentee owners motivated by the desire to have a rural retreat can act as a buffer to such development. It is unclear what the land ownership patterns of the future will be. The majority of current owners are in their fifties or older, and their land will pass into other hands in the not-too-distant future (Sampson and DeCoster 2000). Important

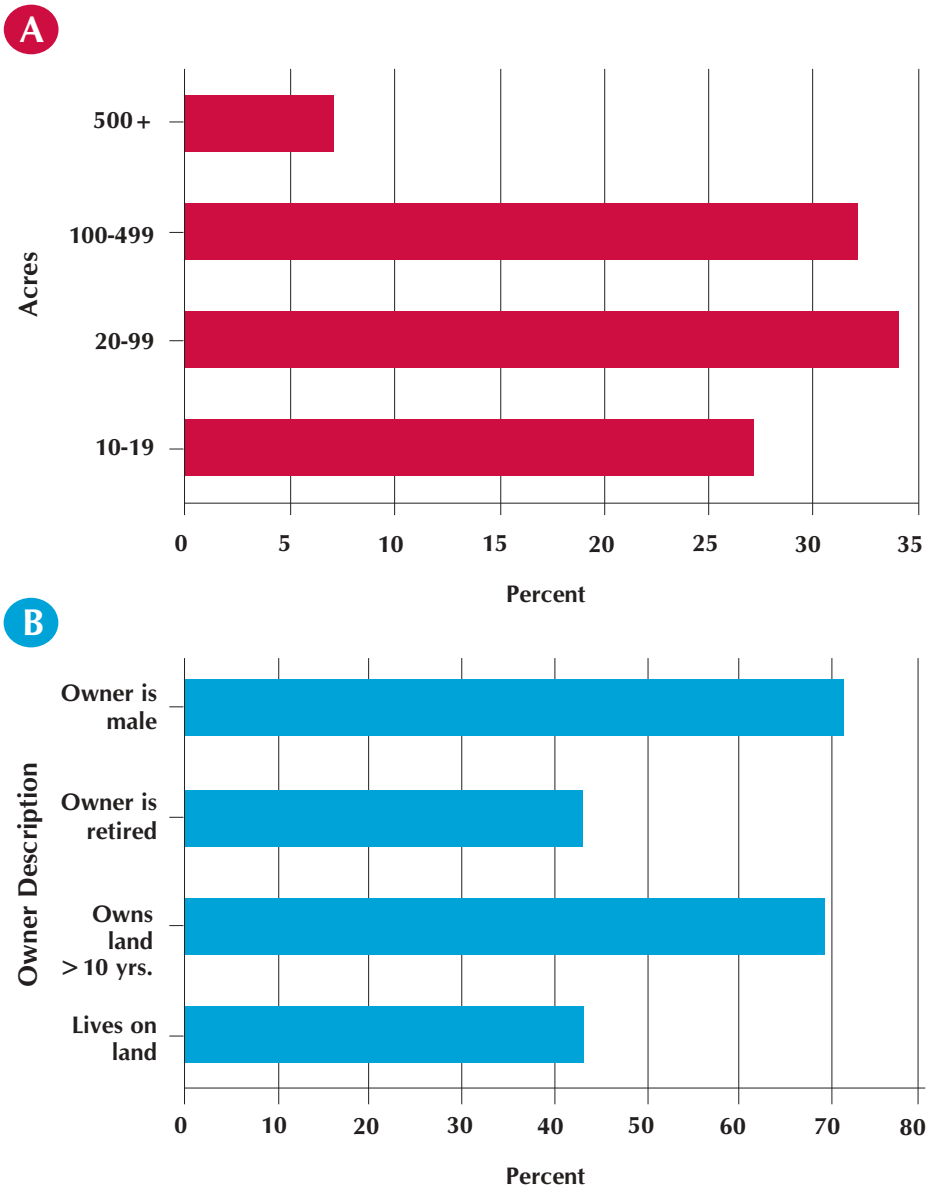


Figure 2.6
(A) Percentage of individual owners by size of tract owned and (B) percentage of landowners by owner description.

changes will likely result from these property transfers. The implications of ownership changes and other trends on public policy, forest ecology, forest management, and social systems are discussed in more depth throughout this Assessment.

The estimated 4 to 5 million individual private owners in the South have a variety of reasons for possessing rural land. Knowing these reasons provides critical insights into more effectively working with owners. Some prominent reasons for owning land are: living in a rural environment, enjoying personal green space, building an estate for heirs, and providing wildlife habitat (Teasley and others 1999). Predicting trends in the interface requires an understanding of what owners want to emphasize in the use of their land (**fig. 2.7**). Study results indicate that owners care about the natural condition of their land. Management practices employed to improve the natural condition varied among owners from no efforts to a number of purposeful practices. The more prominent purposeful practices included prescribed burning, improving wildlife habitat, planting trees, harvesting

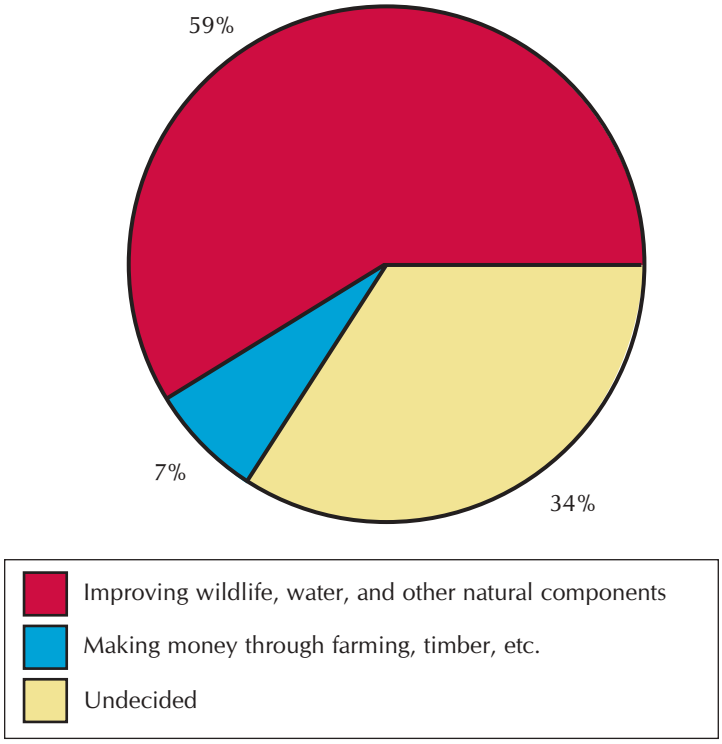


Figure 2.7
Percentage of owners by land management emphasis.

timber, and developing ponds or lakes. Just over 30 percent of owners have undertaken some sort of wetland conservation measure.

Such findings suggest a significant conservation ethic among most of the South's private landowners. But there is also potential for a great deal of conflict between this conservation ethic and more traditional views that emphasize economic utility. Increasing fragmentation of tracts suggests a need for neighbors to plan together and set common objectives. Working together, landowners can address issues like the buildup of forest fuel, which can lead to catastrophic interface fires. There is obviously a significant opportunity for State forestry agencies and others to focus more on education and providing incentives for better management of private forest land.

With accelerating urban expansion, private owners increasingly are faced with public use problems, such as littering, illegal hunting, dumping, and property damage. Landowners often post their properties (41 percent of landowners do) to limit these unwanted problems (**fig. 2.8**). Posting reduces use of private land and puts greater recreation and wildlife management pressures on public land.

Twenty percent of owners have definite plans to sell all or part of their land in the future. Thirteen percent plan to add acreage. Fifty-one percent have no definite plans. As urbanization continues across the South, owner plans may shift from their former, historical patterns. Sixteen percent of southern owners report that their land is now next to or only a short walk from a residential subdivision. Thus, a vast proportion of the southern landscape is subject to increasing human influences and interface expansion. Pressures such as rising property taxes, encroaching development, and others will surely continue to grow.

Photo courtesy of USDA Forest Service

Figure 2.8
Increasingly, southern landowners are posting their properties as a way of limiting problems, such as littering and illegal hunting.

Table 2.3—Percentage of residents 16 years or older in 5 regions of the United States who regularly participate in 20 lifestyle activities, 2000

Activity	South	North	Great Plains	Rocky Mtns.	Pacific coast
			Percent		
Belong to environmental group	9.0	7.3	8.6	8.9	8.0
Have a vacation home	15.1	15.1	11.3	15.3	15.5
Commute > 45 minutes	16.6	16.1	12.6	11.8	14.9
Run own business	17.5	14.5	15.4	23.6	21.0
Youth volunteer	20.4	19.9	20.2	19.8	17.3
Play stock market	23.0	24.2	20.1	20.4	21.8
Creative arts	23.9	27.2	23.9	25.6	29.0
Read nature magazines	27.1	25.1	27.6	23.6	26.1
Crafts	27.3	27.2	27.8	32.3	30.4
Collect things	29.8	26.1	26.7	24.3	25.6
Grow a garden	30.6	32.8	34.5	30.4	33.6
Exercise	41.2	40.6	39.4	45.4	46.7
Raise kids	47.0	44.6	46.2	42.2	44.3
Follow sports	48.9	44.3	43.5	43.5	45.3
Eat out	50.6	37.9	43.0	44.7	44.6
Use computer at home	51.8	56.0	50.5	55.6	58.7
Recycle	52.4	75.9	64.7	54.3	77.1
Attend church	57.3	46.5	49.7	44.1	36.0
Care for pets	59.5	56.7	60.3	62.0	60.3
Cook at home	76.9	79.9	80.4	84.0	84.5

Source: Cordell and others, in press (b).

Lifestyles

Demographics, economics, and land ownership information tell only a part of the story of our lives. The ways in which we conduct our lives—our lifestyles—are equally telling. Knowing lifestyles, recreation activities, and choices people make provides insights into what people consider important. Knowing what is important in people's lives translates directly into a better understanding of how they perceive natural areas. More importantly, that knowledge suggests pathways for interface education, outreach, and involvement programs.

Our research shows that southerners are not a great deal different from people in the rest of the country. Our analysis of the lifestyles of southerners indicates that they are more like, than unlike, people who live in other regions. **Table 2.3** reports percentages of residents 16 years or older in 5 regions of the country who regularly participate in 20 lifestyle activities. The source of data is the National Survey on Recreation and the Environment [Cordell and others, in press (b)]. These

activities (not including outdoor recreation, which is presented later) are ordered from the least to the most frequently pursued. Least frequently mentioned were belonging to an environmental group, running one's own business, owning a vacation home, and daily commuting to work more than 45 minutes one way. Most frequently mentioned lifestyle activities include using the Internet and the computer at home, recycling home waste materials, attending church, and caring for pets.

Outdoor Recreation Activities

A highly significant aspect of southerners' lifestyles and how they relate to forested lands is participation in outdoor recreation (Cordell and others 1999). For many, the only direct contact with the South's forests and wildlands is through outdoor recreation. As with other lifestyle activities, knowing which recreation activities people choose gives great insight into their interests, whereabouts, and paths for communication. Recreation and leisure are among the drivers of contemporary rural land settlement and development patterns. Living in the country, having land to recreate on, having a vacation home, and taking trips to tourist destinations are among the reasons people move and travel to rural areas. Examples of tourist destinations include ski resorts in the Southern Appalachians, golf resorts in coastal South Carolina, and camping and lodge resorts in highland areas throughout the region. Over time, these tourism destinations become the leading edge of the wildland-urban interface.

More than 95 percent of southerners participate to some extent in one or more outdoor recreation activities at some time during a typical year. **Table 2.4** displays percentages of the South's and of the United States' populations that participate in the listed recreation activities. By far the most popular activities are those that are relatively easy to do, require little monetary outlay or skill, and are readily accessible. These most popular activities include walking, going to outdoor family gatherings, visiting nature centers, sightseeing, and driving for pleasure. Activities with an emphasis on seeing and learning are prominent among the top one-third of activities in table 2.4. Trail activities, such as hiking, backpacking, and horseback riding, are among those in the middle one-third. More specialized, physically demanding, and skill- or equipment-intensive activities are among those with the lowest participation rates by southerners. In this group are activities occurring in snow and ice settings, which are prominent only at high elevations in the South.

Table 2.4—Recreation activity participation in the South and the United States, 2000

Activity	South	United States
	Percent of population	
Walk for pleasure	83.08	84.85
Family gathering outdoors	71.91	73.85
Visit nature centers	53.69	59.27
Sightseeing	53.04	53.98
Drive for pleasure	52.77	53.66
Picnic	49.73	57.34
View/photograph natural scenery	46.56	55.09
Visit historic sites	43.83	48.71
Swim in streams and lakes	42.35	44.38
View/photograph wildlife	36.83	41.05
View/photograph flowers, etc.	36.68	41.19
Visit the beach	36.45	39.96
All nature viewing/photography	35.92	41.68
Bicycling	35.03	41.63
Freshwater fishing	33.40	27.80
Visit a wilderness	31.11	35.45
View or photograph birds	27.47	30.07
Day hiking	27.43	36.48
Visit waterside besides beach	27.07	27.09
Gather mushrooms, berries, etc.	25.54	27.97
Motorboating	24.86	23.90
View or photograph fish	21.39	21.68
Outdoor team sports	21.33	22.51
Developed camping	20.70	26.83
Visit prehistoric sites	19.53	21.30
Drive off-road	17.81	17.01
Mountain biking	16.15	23.39
Saltwater fishing	13.82	7.90
Primitive camping	13.05	16.18
Hunting	12.77	10.54
Horseback riding	10.59	9.99
Jet skiing	10.03	8.85
Rafting	9.16	9.95
Water-skiing	8.72	7.92
Backpacking	8.61	12.15
Canoeing	7.51	10.23
Snorkeling	6.13	6.95
Downhill skiing	4.37	10.26
Sailing	3.99	5.43
Rowing	3.31	4.99
Scuba diving	2.14	1.77
Snowboarding	2.02	5.83
Kayaking	1.82	3.51
Surfing	1.48	1.52
Snowmobiling	1.36	7.06
Cross-country skiing	1.22	5.03
Windsurfing	.75	.85

Source: Cordell and others, in press (b).

Photo by Larry Korhnack, University of Florida

Figure 2.9
Birdwatching is one of the fastest growing outdoor recreation activities in the South with a growth rate of 13 percent per year.

Approximately 69 million people 16 years old or older across the region participate in outdoor recreation to some extent. With this population growing at a rate of 1.3 to 1.4 percent per year, growth of outdoor recreation demand is virtually assured well into the future. What is most interesting, however, is that the growth rate among some activities is much higher than the population growth rate. Activities that are growing fastest are birdwatching (13.1 percent per year) (**fig. 2.9**), hiking on trails (10.9 percent), backpacking (9.2 percent), walking for pleasure (5.1 percent), off-road driving (5.0 percent), primitive camping (4.6 percent), developed camping (4.2 percent), and swimming in rivers, lakes, or the ocean (3.6 percent). Many of these activities occur in mostly rural, forested environments. Urban encroachment on rural forested environments, therefore, can have dramatic effects on opportunities for such activities. Availability of outdoor opportunities is an important lead indicator of demand pressures leading to growth of the wildland-urban interface in future years. This also results in direct pressures on natural resources and how they are managed (see chapters 5 and 6).

Recreation Demand Projections

Using three common outdoor activities as indicators—fishing, hiking, and camping—we examine projections developed to predict growth in number of days of participation for the South to 2020 (Bowker and others 1999). By 2020, days people spend are projected to rise 19 percent for fishing, 48 percent for hiking, and 68 percent for developed camping. Days of participation are forecast to grow faster than the population for about 60 percent of all activities tracked. Recreation demand growth, therefore, will add to urban expansion and to tourist development in rural parts of the region.

The Emerging Wildland-Urban Interface

This section presents the results of a geospatial analysis of land cover characteristics, population growth, and nonagricultural economic development. Cover characteristics include existing forest, public land, water and wetland, and wildlife habitat in southern counties. Projected population growth is in persons per square mile. Nonagricultural employment is used as an indicator of economic development. Conditions are projected to the year 2020. Details of data sources and data treatment can be found in Cordell and Overdevest (2001). The results of this analysis are summarized in six maps as follows: (1) forests and population growth, (2) forests and economic development, (3) forests and recreation demand growth, (4) public land and population growth, (5) water and wetlands and population growth, and (6) wildlife habitat and population growth. These maps collectively reflect the interdisciplinary nature of wildland-urban interface issues discussed throughout this Assessment.

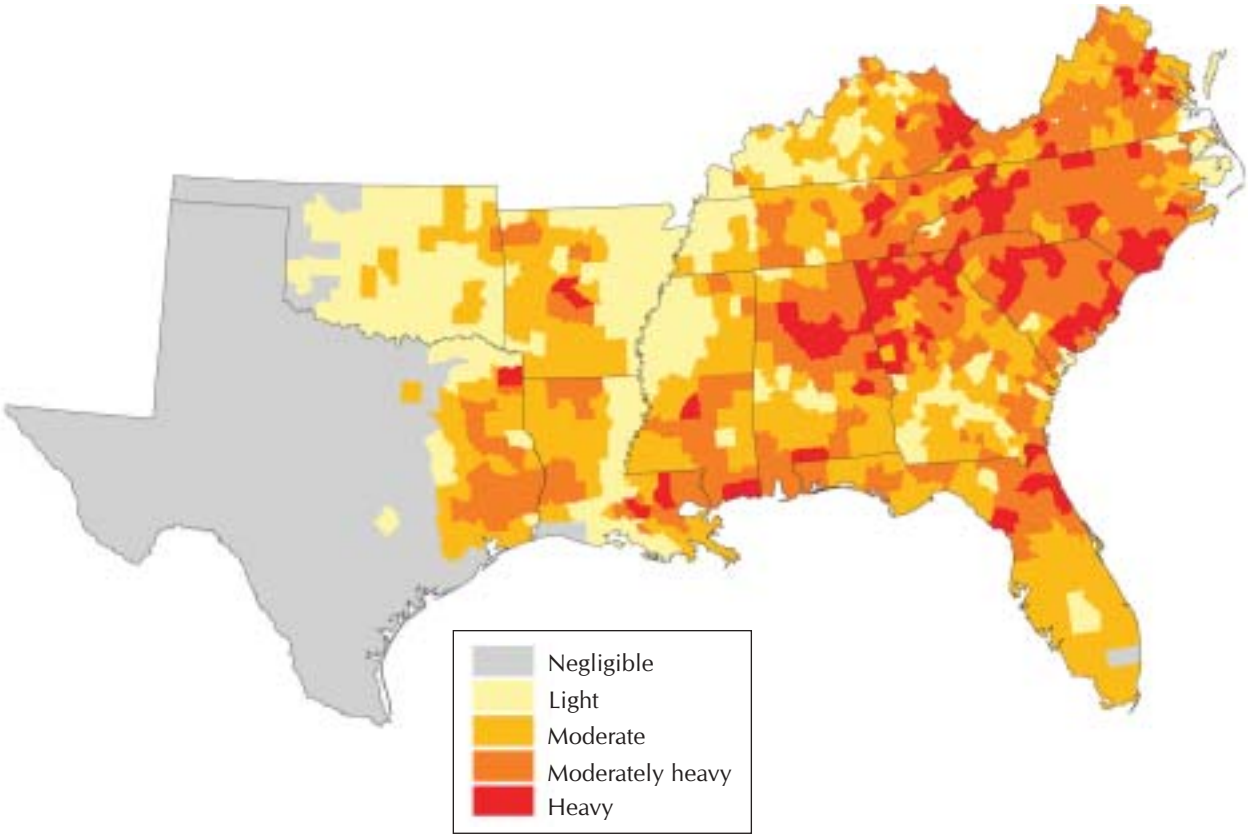


Figure 2.10
Projected ambient population pressures on forest, 2020. Population hot spots are where pressures on forests are expected to be heaviest.

Forests and Population Growth

Population is projected to grow across most counties of the South to 2020 and beyond. Growth will occur in many of the South's counties where forest land is still relatively abundant. Future growth in population will create a variety of pressures on forests, including demands for development, forest gathering, timber harvesting, recreation, and road building. In **figure 2.10**, the clusters of counties where these population pressures will be greatest are highlighted as "population hot spots." They include the Southern Appalachians, northcentral Alabama, the Piedmont of North and South Carolina, and coastal North and South Carolina. Other scattered hot spots of population pressure include northeastern Virginia and coastal Florida, Alabama, and Louisiana.

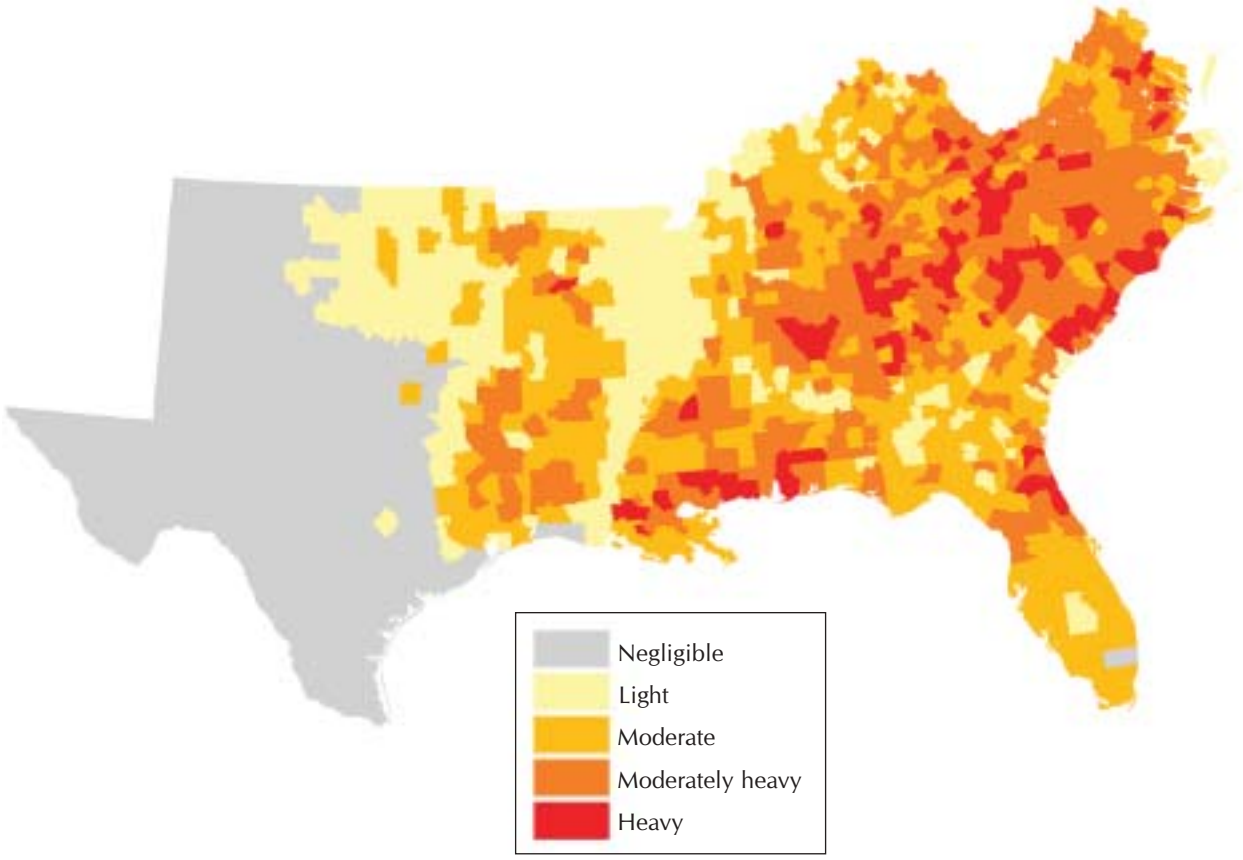


Figure 2.11
Projected ambient nonagricultural pressures on forest, 2020.

Forests and Economic Development

Figure 2.11 displays projected nonagricultural economic development in relation to locations with relatively abundant forest cover. The spatial pattern of coincidence between likely future economic development and forest cover is very similar to population growth and is spatially dependent on location of major highways, especially interstate highways. Differences include more pressure along the gulf coast of southern Mississippi and Louisiana.

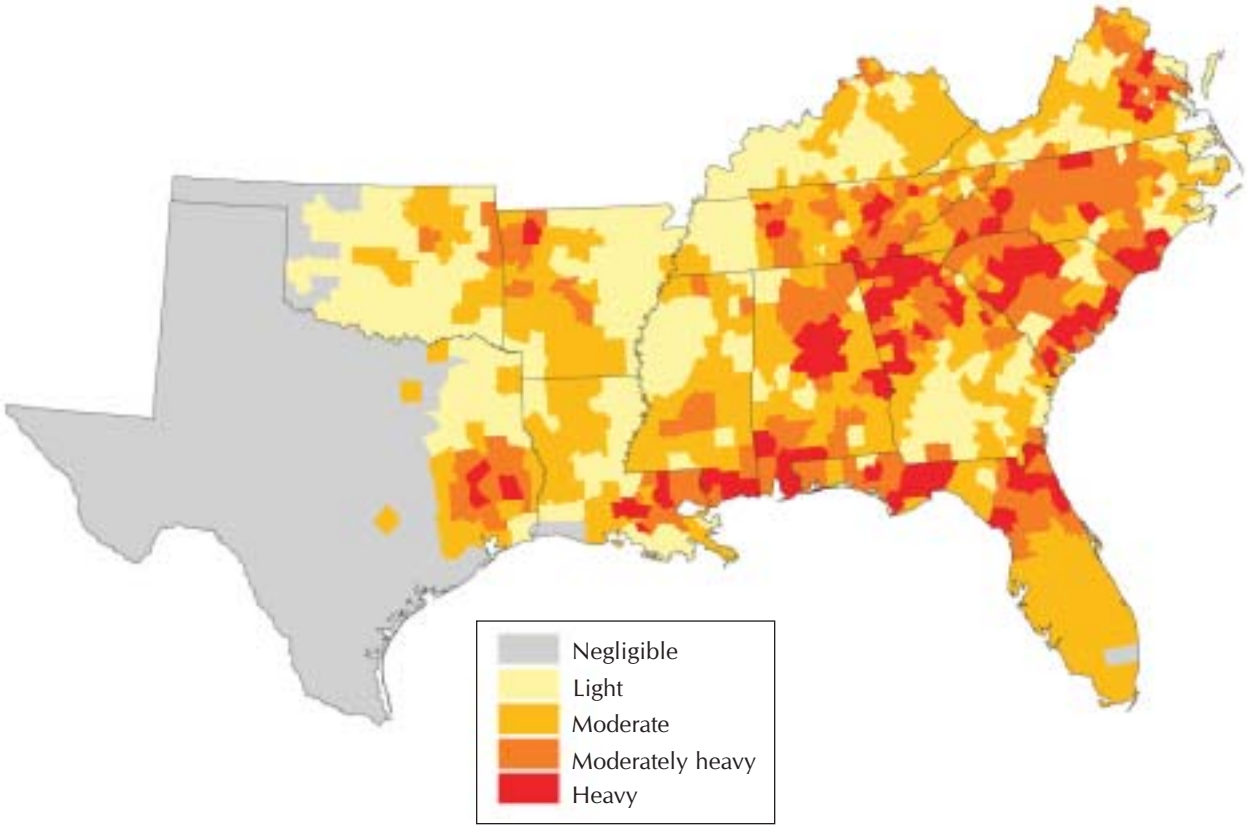


Figure 2.12
Projected ambient recreation pressures on forest, 2020.

Forests and Recreation Demand Growth

Growth in recreation demand puts direct pressures on forest land in the South (**fig. 2.12**) (Cordell and Tarrant, in press). Among those recreation activities considered are off-road vehicle use, camping, hiking, backpacking, fishing, and sightseeing. Hot spots of future recreation demand pressures include gulf coastal Florida, Alabama, Mississippi, and Louisiana; central Alabama; north Georgia; coastal South Carolina; and east Texas. Areas that experience high recreation demands typically end up being developed for tourism, and then ultimately into urban interface areas.

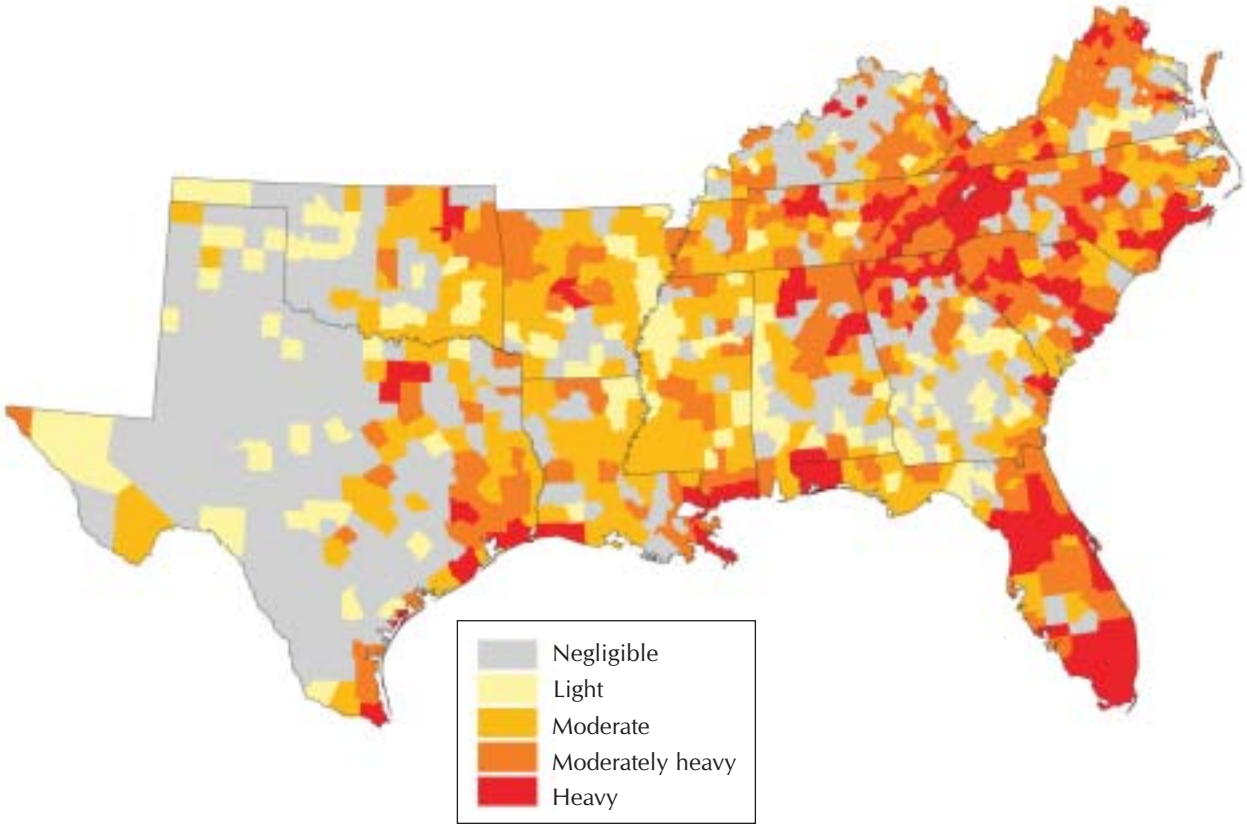
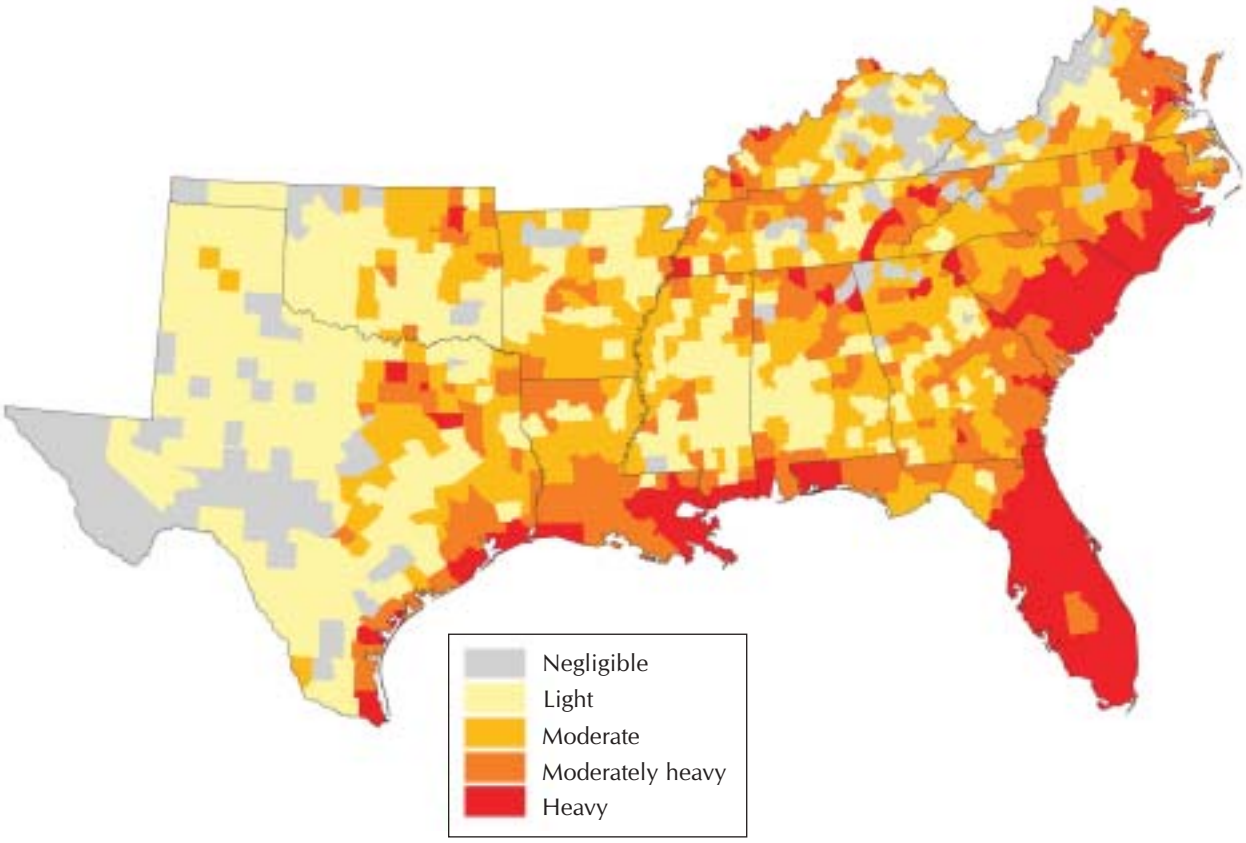


Figure 2.13
Projected ambient population pressures on public land, 2020.

Public Land and Population Growth

Most of the public land in the South is forested and makes major contributions to the amenity character of southern landscapes. Public land includes national forests, national parks, wildlife refuges, Federal reservoirs, and State parks and forests. Migration to high-amenity areas where these public lands are located is putting unprecedented pressures on public land managers. Hot spots where future population growth pressures are likely to be most pronounced can be seen in **figure 2.13**. Especially highlighted are south and central Florida, coastal Alabama, the Southern Appalachians, Cumberland Plateau area of Tennessee, northern Virginia, and coastal North Carolina.

"It seems like every woodlot is for sale, and everybody's looking for that piece of property that's close to public property. They develop and build around it." Florida



Water and Wetlands and Population Growth

Water may become the most critical limiting natural resource anywhere in the region. Water shortages, which used to be associated only with the dry Western States, increasingly are a reality for the South. In **figure 2.14**, massive areas of future population pressure on aboveground water and wetland resources can be seen. Hot spots include eastern Virginia; the Coastal Plain of North and South Carolina; almost all of the Florida peninsula; coastal Texas, Louisiana, Mississippi, and Alabama; and a string of counties on the Cumberland Plateau in Tennessee.

Figure 2.14
Projected ambient population pressures on water and wetlands, 2020.

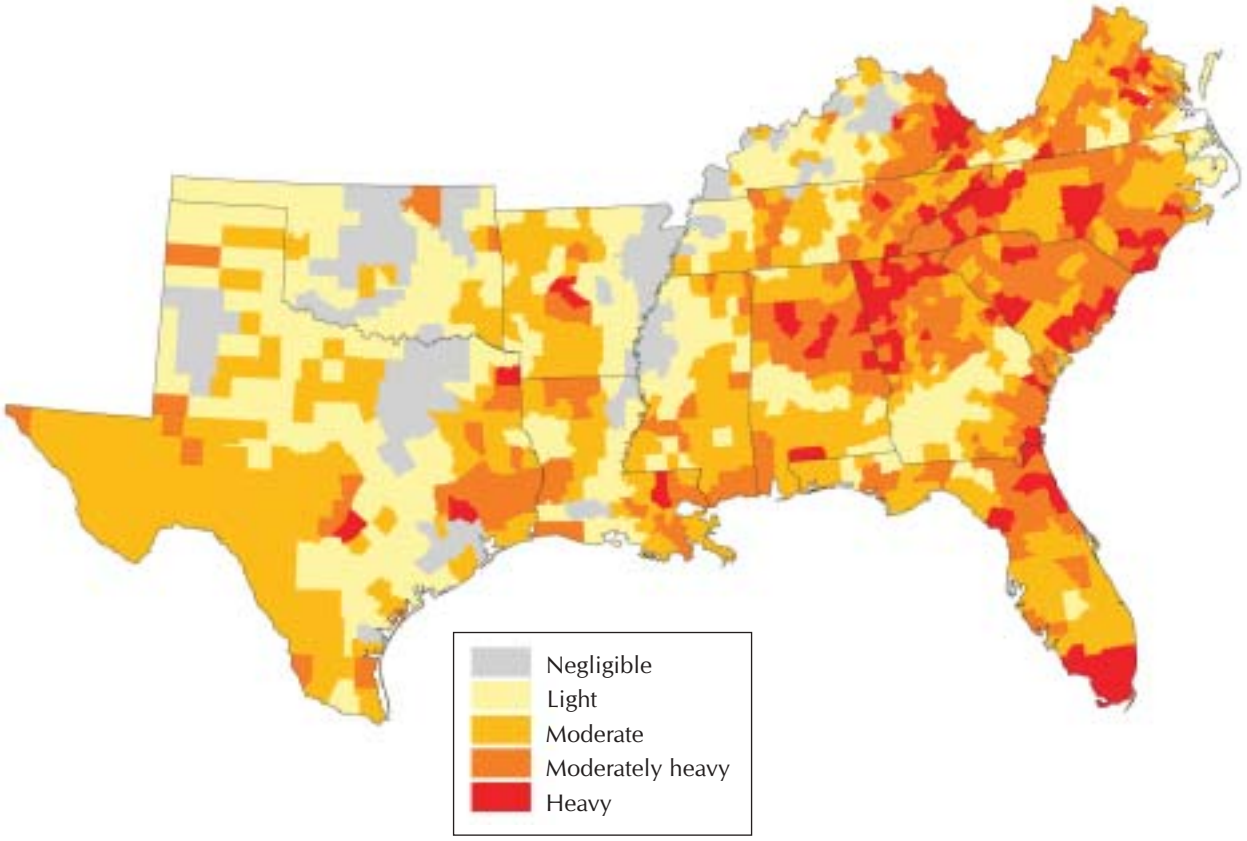


Figure 2.15
Projected ambient population pressures on wildlife habitat, 2020.

Wildlife Habitat and Population Growth

Figure 2.15 shows the distribution of projected population growth overlaid onto the relative abundance of wildlife habitat in the South. Wildlife habitat occurs where there is public land, a large stretch of forest or other undisturbed natural land, and wetlands. Of all the attributes of natural land in the South, wildlife habitat may be the most endangered by human growth pressures. Hot spots most noticeable include south Florida, coastal South Carolina, the Piedmont of North and South Carolina, and the Southern Appalachians.

Needs

Research

There is a critical need to know much more about the rapidly expanding sphere of human influence on the South's rural land and water. Specific areas of need include:

- An efficient system for accessing current data and information on changing population, demographics, economics, recreation demands, and other social trends affecting land uses and urbanization in the South.

- A way to identify the recreational importance and primary users of public land and other open spaces near urban areas in the South.
- Studies of urban residents' attitudes toward land uses and management.
- Data, Geographical Information Systems (GIS) capacity, indexing systems, and other tools for monitoring and forecasting urban expansion, economic development, recreation demands, and other human pressures that cause land use changes.
- Approaches and models for predicting the effects of urbanization and other land use changes in the South on the size, condition, and benefits flowing from urban, rural, and wildland-urban interface forests.

Education

Education will be one of the keys to sustaining forests and other natural land and water in the South. Rapid social, economic, and land use changes point to an urgent need for effective conservation education. To support education initiatives, information is needed about:

- Patterns and trends in urban and rural residents' knowledge, perceptions, and opinions about urban expansion and other southern land use issues, especially the effects of urban expansion on rural land, water, and wildlife as well as human communities.
- The knowledge, opinions, demographics, lifestyles, and other differentiating characteristics for segmenting urban and rural publics, including private landowners.
- Paths for communication across the broad spectrum of people making up the South's population and design of education modules specific to the paths and population segments identified.

Management

Management is interpreted here to mean the broad array of land use policies, incentives, regulations, and practices on public and private land and water in the South. The most critical management initiatives needed include:

- An array of policy approaches and incentives to influence land use decisions to favor sustainable management and conservation of natural land, water, wildlife habitat, open space, and forests.
- Timely guidelines for urban expansion that emphasize minimal land development, ecosystem disturbance, water consumption, and forest fragmentation.
- Effective and lasting coalitions of public and private interests, including developers and urban and rural landowners.
- Giving emphasis to areas of the South identified as hot spots, a system for continuously monitoring attitudes and values and using the results to develop mutually acceptable strategies for accommodating growth while sustaining natural ecosystems.

Tools

Tools for addressing wildland-urban interface research, education, and management must be developed jointly with the wide array of research, conservation education, and management organizations and agencies in the South. Generally, tools would include:

- A consortium of Federal, State, and university research institutions and agencies that would help strengthen and focus resources and expertise in areas such as urban forestry, demography, recreation, wildland protection, ecosystem monitoring, GIS development, land use, wetlands, wildlife, and economics.
- Linking with existing population survey efforts and developing dissemination approaches for keeping researchers, educators, decisionmakers, legislators, and managers current on trends in people's values, opinions, demands, and movements.
- Models for forecasting change scenarios and interactions among population, ethnic makeup, economic growth, recreation/tourism demand, land development, natural cover, and land uses.

Conclusion

Population, demographics, recreation demands, and other social trends are key factors affecting land use and urbanization in the South. Understanding these trends and projections of change is important for identifying where human pressures will have the greatest effects on natural resources and their management in the future.

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Chapter 3

ECONOMIC AND TAX ISSUES

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Introduction

Economic conditions and tax policies affect land use decisions everywhere, but their effects on the rate of change in land use are particularly large in the wildland-urban interface. We begin this chapter with a brief economic history of the South and a description of the macroeconomic trends and conditions that affect microeconomics at the wildland-urban interface. Next comes a description of the many Federal and State taxes that affect nonindustrial private landowners. This is followed by a summary of historical trends in rural land taxation and a discussion of how taxes affect land use change at the wildland-urban interface. The chapter concludes with discussion of existing economic and tax tools and of challenges and opportunities in research, education, and policy. ▶

Economic Trends and the Wildland-Urban Interface

Historical Trends in the South

From its earliest settlement through the end of the 19th century, the South's economy was based on agriculture and natural resource extraction. The population was dispersed throughout the region, and very few major metropolitan areas developed. Around the turn of the century, southern governors and mayors sought to attract northern industries to the area by touting the region's modest tax rates and inexpensive labor, and by offering relocation subsidies. Because subsidies often included substantial tax incentives, industries contributed little to the generation of tax revenue. With modest tax revenues, local governments could not increase school spending, so the low-skilled labor pool remained that way, and wages remained low. Furthermore, many of the industries that came south were declining in competitiveness, and their move south was a temporary stop on their way overseas.

Changes in these trends came gradually, but their influence throughout the South lasted until the 1970s and continues to affect parts of the region today (Autry and others 1998, Cobb 1990). Since 1978, nearly 4 of every 10 jobs gained in the United States were in the South. During the same period, the number of jobs increased by 54 percent in the South and by 38 percent in the rest of the Nation. While the South has narrowed the gap, it still trails the Nation in per capita income. A generation ago the South depended on tobacco, textiles, other low-skilled blue-collar manufacturing processes, and northern capital. While portions of the South still depend on these economic sectors, today southern industry draws on global capital to fuel a diversified economy that includes automotive, chemical, computer manufacturing, and blue- and white-collar service sectors (Bishop and others 2000). The South is also attracting new residents. Between April 1, 1990, and April 1, 2000, the South's population grew by 13.9 percent, mostly attributed to immigration from other countries and migration to the South from other regions of the United States. A more detailed description of demographic changes in the South is provided in chapter 2.

For much of the 20th century, industrialization of the South occurred without significant urbanization (Schulman 1994). Today, however, the majority of job and population growth occurs in and around large cities, and 7 out of 10 southerners live in metropolitan areas (**fig. 3.1**). On average, the South's major metropolitan areas grew faster than 3 percent per year since 1970 (Autry and others 1998) (refer to chapter 2 for details on urban growth and rural transition). Unlike urban areas in the Northeast and Midwest, southern cities have adopted a sprawling growth pattern with urban centers surrounded by successive rings of suburban neighborhoods and bedroom communities. For example, in Charleston, SC, for each 1-percent increase in population since 1973, urban land use increased by 6 percent (Allen and Lu 1999). During the same time period, the population of Mobile, AL, grew 25 percent while its urban footprint doubled (Southern Environmental Law Center 1999). Woodstock, GA, has over 66,000 residents, but it and surrounding areas in southern Cherokee County host fewer than 14,000 jobs. The vast majority of these residents commute to Atlanta to work (Brookings Institution 2000). Further discussion related to land use patterns and public policy is presented in chapter 4.

Photo courtesy of USDA Forest Service

Figure 3.1
In the South, the majority of job and population growth occurs in and around large cities.

Macroeconomic Trends

Economic factors involving areas larger than one or two counties fit the term "macroeconomics." Macroeconomic trends contributing to change at the wildland-urban interface are, by and large, related to efforts to improve the southern economy as a whole. As chapter 4 indicates, local governments receive most of their funding from property and sales taxes. This creates an incentive to promote economic development at the local level. For example, in the early 1990s South Carolina successfully lobbied German automaker BMW to locate its American

"We don't have any sources of income in local government other than property tax, so that tends to drive an awful lot of these issues. If your only money is coming from the land, you have some self-interest in seeing it developed." Virginia

automobile assembly plant on Interstate 85 near the city of Spartanburg. Initially drawn to the area by its relatively low cost and abundant blue- and white-collar labor, by the close proximity of a land-grant university with a strong engineering program, and by easy access to the interstate highway transportation system, BMW finalized its decision when the State provided special tax incentives and agreed to make substantial improvements to the Greenville, SC, airport. Anchored by BMW, BASF, and Michelin, more than 90 international companies are located in the area. South Carolina's portion of Interstate 85 is referred to as "America's autobahn" (Bishop and others 2000). Pioneered in North Carolina's Research Triangle Park, this exploitation of available labor, interstate highways, universities, and incentives has been a powerful force in the modern southern economy. Urban areas throughout the region have been best positioned to utilize this multifaceted approach and have grown, while rural areas dependent primarily on blue-collar manufacturing industries and agriculture have declined. Chapter 2 provides additional information on shifts in employment within the southern economy.

Photo by Annie Hermansen, USDA Forest Service

Figure 3.2
Roads are often widened to accommodate increased development in the interface.

Photo courtesy of USDA Forest Service

Figure 3.3
An increase in development in the wildland-urban interface can cause some residents to seek new development on a new interface.

As these cities grow, interface areas become more attractive to develop and to live in. Rural landowners find it financially attractive to subdivide farms and forests. In fact, rising land values and property taxes force some landowners to subdivide to keep any land at all. New residences and business parks require sewer, water, garbage, fire, emergency medical services, and schools, but especially, they require bigger roads to facilitate increased automobile traffic (**fig. 3.2**). Bigger roads bring additional interface areas within reasonable commuting time from city centers, begetting more residential development. Lower home prices in these new developments draw families out of more expensive and congested areas. Congestion and other negative factors increase in developed, former interface areas, and eventually reach levels that spark some residents to seek a new development on a new interface, repeating the cycle (**fig. 3.3**).

A reluctance to utilize zoning restrictions, land use planning, and other growth management strategies is the final macroeconomic factor in the southern interface (see chapter 4). The result is that developers for the most part pay only a fraction, if any, of the costs borne by governments to extend services to new developments (Pae 1997).

The pace of urban development in the South is sobering. In Atlanta, over 350 acres of open space are converted each week, and in northern Virginia, on average, 28 acres are converted each day. Whereas the United States lost 6 percent of its farmland between 1982 and 1997, the South lost 10 million acres, or 14 percent (Southern Environmental Law Center 1999).

Unknowns include the costs related to regional declines in environmental quality resulting from urbanization, such as reduced air and water quality, increased energy costs, increased storm runoff and sewer infiltration, and loss of recreation opportunities. Also not known is the increased monetary and nonmonetary value of rural land to an urbanizing society. All of these costs can be associated with human influences to forest ecosystems (see chapter 5).

"I'd take you to several places across north Georgia that have very intense commercial development, shopping centers, factory malls, and that type of thing. Then you go a mile down the road and look at the small farms and the 'for sale' signs on those properties." Georgia

Microeconomic Trends

The term "microeconomics" describes localized conditions such as changes in prices, the amount collected in tax revenues, expenditures to provide services, and other situations that might be faced by an individual family, county, or municipality. Microeconomic conditions can be divided into two categories: monetary and nonmonetary. Monetary costs are measured in dollars, whereas nonmonetary, or "quality-of-life," costs are expressed in other terms. Governments, private individuals, farmers, and forest land owners are among the many who pay these microeconomic costs.

Land development in the wildland-urban interface generates less revenue than municipal governments spend to provide services to the area. Numerous studies have shown that municipalities spend between 15 and 80 cents in services for every dollar of tax revenue generated by farms and forests, and between 15 and

Photo by Annie Hermansen, USDA Forest Service

Figure 3.4
Municipalities spend far less to provide services for farms and forest lands than they do for residential development.

47 cents for every dollar of revenue generated by commercial development (**fig. 3.4**). In contrast, spending on services for residential development ranges from $1.04 to $1.55 per dollar of revenue collected (Esseks and others 1999). These costs would have been even larger had the nonmonetary value provided to municipal governments by forests been considered. For example, the trees lost to development in the Puget Sound region since 1973 would have reduced stormwater storage requirements by 1.2 billion cubic feet—the equivalent of a $2.4 billion stormwater management system (Smith 1999).

Many southern examples illustrate the revenue problem. Prince William County, VA, spent $3,838 to provide services to the average single family home, while the same home generated $2,150 in revenue (Lipton and Perez-Rivas 1996). Fairfax County, VA, had only $700 million of the estimated $1 billion needed to provide schools, fire stations, libraries, and other infrastructure to growing interface areas. Nearby Loudon County anticipates the need to build 22 new schools in the next 6 years (Frankel and Fehr 1997, Katz and Liu 2000). An additional cost factor is damage to road and bridge infrastructure as increased traffic exceeds original design standards. Additional discussion on infrastructure costs is provided in chapter 4.

While this arrangement appears to favor private individuals in residential settings who receive more in services than they pay in taxes, a look at some of the monetary and nonmonetary costs they face presents a different picture. They face lower quality, overcrowded schools that expend a significant portion of their budgets on busing and less efficient fire, police, and ambulance services. Emergency units have increased response times as they attempt to cover larger territories and longer distances (Esseks and others 1999). The numbers of miles driven by interface residents and the time they lose to traffic delays have increased in most large- and medium-sized cities (**fig. 3.5**). Between 1987 and 1997, Virginia's population increased by 16 percent while the number of miles per driver increased by over 60 percent. Atlanta, GA, area residents drive the most miles per person per day (34 miles) of any city in the United States (Southern Environmental Law Center 1999). Average household transportation expenditures by Houston, TX, and Atlanta, GA, residents in 1997–98 were $8,840 and $8,513, respectively, or slightly more than 20 percent of total household expenditures (McCann 2000). Finally, there is a social cost that is often overlooked: resources diverted to providing services and infrastructure to interface areas reduce the amount available for similar actions in city centers. Businesses migrate outward from these areas, isolating poorer and less-educated residents in stagnating or declining metropolitan zones. In some instances, low-skilled, blue-collar workers cannot afford to commute to suitable jobs available in interface areas (Katz and Liu 2000).

Rural landowners in the interface also bear their share of costs. In a 1999 study, researchers at the Southern Rural Development Center found that highest rural land prices were exclusively in counties adjoining metropolitan areas.

Photo by Nick Cowie

Figure 3.5
The number of miles that interface residents commute is increasing for many medium- and large-sized cities.

Furthermore, they estimated that row-crop agriculture in high-value areas throughout the South would not generate a 4-percent rate of return to a landowner (Hite and others 1999). The implicit costs of rural land management in the wildland-urban interface are further increased by the amount owners forgo in returns they could have gained by selling the land and investing the proceeds in other venues (Hite and others 1999).

"I work with landowners trying to encourage them to manage their timber, and they're getting offered $10,000 per acre for the land. I'm trying to tell them to plant trees on it, and in thirty years they might see a profit." Georgia

Economic returns to owners of forests and wildlands are more difficult to calculate. Investors consider not only the productive capacity of the land, but interest rates, fluctuating stumpage values, and irregularly timed returns on management treatments, as well as a long time horizon between revenue-generating events. In a Mississippi example looking at three time periods, three different rates of return were calculated (Hartsell and Bullard 2000). Forestry-based returns were noticeably higher than the rates of return for row-crop agriculture identified by Hite and others (1999). This work looked at mature, undisturbed timberland and not at forest land at the urban interface, where high land prices (as much as $5,000 per acre in the case of northern Virginia) raise real and implicit forest land management costs and lower returns to timber investments (Hite and others 1999).

Tax Issues Driving Change

Throughout the United States, Federal and State taxes affect every aspect of rural land ownership. The land itself is taxed annually, income derived from the land is taxed, the transfer of land and other assets from one generation to another is taxed, and, in several States, the act of removing timber or minerals from the land is taxed. Depending upon how they are structured, taxes can accelerate development at the wildland-urban interface or help shape development to meet the needs of a growing population while retaining as much land as possible in a rural condition.

Individuals and families own 97 percent of farm acres (National Agricultural Statistics Service 1999) and 70 percent of private forest acres (Birch 1996) in the South. Except where otherwise noted, we focus here on the effect of Federal and State taxes on these nonindustrial private landowners. Individuals and families hold land for a variety of reasons, many of which are unrelated to financial returns, and few people respond solely to economic pressures. At the same time, however, an understanding of the economic pressures that Federal and State taxes place on rural landowners can provide insight into the reasons behind land use changes occurring at the wildland-urban interface.

Federal Taxes

Income tax—Since its institution in 1913, provisions have been added to the Federal income tax to encourage improved management and stewardship of farm and forest land. These provisions help owners retain their land in rural uses. Some examples are:

- Farmers can average their income over 3 years, a provision that is not available to other taxpayers (Internal Revenue Service 2000).
- Farmers also can immediately deduct part or all of the cost of qualifying expenditures for soil and water conservation, expenditures that other taxpayers must capitalize (Internal Revenue Service 2000).
- Farmers and forest owners can exclude from their gross income part or all of qualifying payments they receive from cost-sharing programs such as the Environmental Quality Incentives Program, the Forestry Incentives Program, the Stewardship Incentives Program, the Wetlands Reserve Program, or the Wildlife Habitat Incentives Program (Haney and others 2001).
- Forest owners can take a 10-percent investment tax credit on and amortize (write off) over 8 tax years up to $10,000 per year of reforestation expenses (Haney and others 2001).
- Landowners who sell natural resources, such as timber or minerals, can recover their investment in the resource by taking a depletion deduction (Haney and others 2001, Siegel 1978).

Income from the sale of timber generally can qualify as a "long-term capital gain," which is taxed to individuals at a maximum rate of 20 percent (Haney and others 2001). Most other income from rural land is "ordinary income," which is taxed at rates that range as high as 39.6 percent. This is true whether the income is farm related from the sale of field crops or livestock (Internal Revenue Service 2000) or forest related from the sale of products like pulpwood or firewood made from harvested trees, pine straw, mushrooms or medicinal plants gathered from the forest, or from hunting leases (Haney and others 2001) (**fig. 3.6**).

The Federal income tax has the greatest economic effect of any tax on working land in the South (Greene 1995, 1998), because it applies uniformly across the region and because the tax rates are high compared to most other taxes. The economic effect of the tax is to increase the variable cost of owning or managing rural land. The tax, therefore, influences production decisions (Gregory 1972).

Particularly if the opportunity cost of keeping land in its present use is increasing, the Federal income tax places pressure on rural owners to sell or convert their land. At the wildland-urban interface, an area undergoing slow development might see a gradual shift from less intensive to more intensive uses over time, with

Photo by Robert L. Anderson, USDA Forest Service

Figure 3.6
Income from the sale of nontimber forest products, such as shitake mushrooms, is taxed at rates that range as high as 39.6 percent.

Photo by Hans Riekerk, University of Florida

Figure 3.7
In the wildland-urban interface, an area undergoing slow development may see a gradual shift from rural to developed uses; an area undergoing rapid development may see a sudden conversion, with little or no intermediate shift in uses.

individual holdings at the edge of the interface being converted from rural to developed uses. An area undergoing rapid development might see a sudden conversion from rural to developed uses, with little or no intermediate shift in uses (**fig. 3.7**).

Estate and gift taxes—The Federal Government has taxed transfers of estates since 1916 and lifetime gifts since 1932 (Haney and Siegel 1993). Congress combined the estate and gift taxes into a single structure in 1977. As society in general has become wealthier, Congress has redefined what constitutes a taxable transfer. At present, gifts up to $10,000 per recipient per year plus other lifetime gifts and estate values below the amount shielded by the "unified credit effective exemption" are not taxed. The Economic Growth and Tax Relief Reconciliation Act of 2001 increases the unified credit effective exemption from $675,000 to $1 million beginning in 2002 and gradually reduces the top rate for Federal estate and gift taxes from 55 to 45 percent by 2009. The act eliminates the estate tax entirely and sets the top tax rate for gifts equal to the top individual income tax rate beginning in 2010. The act itself, however, is scheduled to "sunset" at the end of that year, returning estate and gift taxes to current law (Manning and Windish 2001).

Many strategies exist to reduce or eliminate the impact of the estate tax, so the brunt of the tax is borne by the estates of people who fail to plan or who do not realize the value of their assets. Sharp increases in timber and land values over the past two decades (Morrow and Fritschi 1997, Peters and others 1998) have put many rural landowners into the second group.

"Part of what's driving all the loss of our farmland is taxes. When the older generation dies, the younger generation that now has this large farm can't afford to pay the estate taxes on that property and has no choice but to at least sell part of it, if not all of it, in order just to pay the taxes." Virginia

The economic effect of estate, inheritance, and gift taxes is difficult to quantify, because they occur at irregular intervals. They do, however, increase risk and place a premium on keeping management options open. For rural landowners, the consequences of inadequate estate planning can be severe, requiring the premature sale of timber or the conversion or sale of land if other family assets are not adequate to pay the estate tax. A study undertaken to quantify the effect of the Federal estate tax on forest owners found that rural landowners in general are many times more likely than the U.S. population as a whole to be affected by the estate tax. The study estimates that, nationwide, on the order of 2.6 million acres

of forest must be harvested and 1.3 million acres must be sold each year to pay the Federal estate tax (Greene and others, in press).

The cost of minimizing the estate tax also is high, both in terms of the fees paid to estate planning professionals and the personal cost of following tax-minimization strategies. Virtually all of the strategies involve transferring ownership or surrendering control of assets through the use of gifting, trusts, or ownership structures like family-limited partnerships and limited-liability corporations. Rural landowners' inability or unwillingness to sustain the dollar cost, loss of control, and management changes required to minimize the Federal estate tax is another reason an inordinately high proportion of rural estates incur the tax.

State Taxes

Income taxes—The Southern States vary widely in the way they tax personal income. The tax codes of seven States correspond closely to the Federal income tax. Of the five remaining States, Alabama, Arkansas, and Tennessee have their own definitions of taxable income, while Florida and Texas do not tax income at all (Bettinger and others 1989). State income taxes have a smaller impact on rural landowners than the Federal income tax, because their rates are a fraction of the comparable Federal rates (Bailey and others 1999). In terms of their economic effects, State income taxes generally mirror those of the Federal income tax (Holley 1988): they influence production decisions and contribute to the development of land in areas that are undergoing development.

Estate, inheritance, and gift taxes—Southern States also vary widely in the way they tax the transfer of estates and gifts. Like the Federal Government, Mississippi and South Carolina levy an estate tax on the right of a decedent's estate to transfer property. Kentucky, Louisiana, North Carolina, and Tennessee, on the other hand, levy an inheritance tax on the right of heirs to receive property. The remaining States impose a "piggyback" tax, equal to the credit for State death transfer taxes allowed on the Federal estate tax return. Four States—Louisiana, North Carolina, South Carolina, and Tennessee—also tax gifts made during the donor's lifetime (Walden and others 1987). As with Federal estate and gift taxes, most of the cost of State transfer taxes falls on families that fail to plan, and tax minimization strategies entail giving up ownership or control of the land. Researchers have noted that the tax burden in States that have a piggyback tax is somewhat lower than in States that use other types of transfer taxes (Walden and others 1987).

Property and yield taxes—As in other regions of the United States, rural land in the South originally was assessed and taxed based on its "highest and best use," using an unmodified ad valorem property tax. Highest and best use typically is interpreted as the use that would generate the greatest economic return to the owner, given the overall level of development in the area. By this method, farm or forest land in an area undergoing conversion to commercial use would be assessed and taxed as commercial rather than agricultural land, increasing the property tax burden and placing economic pressure on the owner to convert or sell. Such an occurrence was rare through the early decades of the 20th century, when the South was predominantly rural. As the region developed, however, it became clear that an unmodified ad valorem property tax encourages too-rapid conversion of rural land. The approaches the Southern States have taken to address the problem of taxing rural property appropriately fall into three categories: modified assessment laws, yield tax laws, and exemption laws (Siegel and Hickman 1989).

"... Involved with that are the taxation issues for farmlands and agriculture where the farmer wants to keep his one hundred acres and thirty head of cattle. Even with the preferential tax assessment we have in Georgia, which helps some, to me it doesn't seem to go far enough." Georgia

Under a modified assessment law, rural land is appraised differently from other forms of property. The assessed value of the land may be fixed, calculated using a reduced assessment rate, or calculated based on the land's actual use instead of its highest and best use. All Southern States have modified assessment provisions for rural land (Siegel and Hickman 1989).

Yield tax laws and exemption laws apply only to forest land. Under a yield tax law, the forest is divided into land and timber components for property tax purposes. The land is taxed annually, but the timber is not taxed until it is harvested. The deferred property tax on the timber most often is based on the amount, or yield, of the harvest. Alabama, Louisiana, and Mississippi have yield tax laws (Siegel and Hickman 1989). Exemption laws remove forest land, timber, or both from the property tax rolls, either permanently or for a specified number of years. Alabama, North Carolina, and Tennessee have exemption laws; in all three States, the exemption applies to essentially all standing timber (Siegel and Hickman 1989).

Two Southern States have helped pioneer a policy under which landowners can opt to apply for a special assessment that further reduces their property tax in exchange for accepting certain use restrictions. Tennessee's Greenbelt Program was one of the first of this type in the United States. Georgia also passed a version of this policy—the Conservation Use Valuation Assessment program—in 1991. The Georgia law, however, limits the program to ownerships under 2,000 acres. Larger ownerships, including all forest industry firms, remain under an ad valorem property tax. The results of Georgia's approach have been mixed. In the counties surrounding expanding urban areas, rising ad valorem property taxes often reduce the returns to agriculture and forestry below a level that is acceptable to owners who cannot participate in the program. Forest industry firms in north Georgia, for example, are finding they make the most profit by performing what they term a "residential cut," then subdividing and selling their interface holdings for development (Newman and others 2000).

Because they occur annually, property taxes have a greater potential than other State taxes to influence owners' land use decisions (Greene 1995). The economic effect of property taxes is to increase the fixed cost of owning or managing rural land. Thus, property taxes influence owners' decisions about whether or not to continue to hold land (Gregory 1972). As shown above, an ad valorem property tax promotes fragmentation, conversion, and development of rural land. In contrast, a modified assessment law should result in enclaves of land remaining in rural uses as the area around them develops. The stable property tax rate would enable families dedicated to a rural lifestyle to resist pressures to convert or sell—at least until the later stages of development.

Severance taxes—Seven Southern States—Alabama, Arkansas, Louisiana, Mississippi, North Carolina, South Carolina, and Virginia—levy a severance tax when timber is harvested or minerals are removed from the land. All of these

States with the exception of Louisiana use part or all of their timber severance tax receipts to support a forestry incentive program or another forest-related purpose (Haines 1995). The economic effect of a severance tax is minor (Greene 1995); taken alone, it would have little effect on a landowner's management or land ownership decisions.

Existing Economic and Tax Tools

So far, this work has focused on traditional economic, tax, and policy models that generally treat profit maximization (and loss minimization) as primary goals of human economic behavior. A challenge that remains is moving toward an approach that incorporates intrinsic, nonmonetary values of wildlands along with their monetary values. Ecological economics is a new discipline that has made strides toward this goal. Mitigation banks for carbon sequestration and wetlands protection are examples of the ecological economics approach. Under existing and proposed programs, forest land owners whose properties qualify are able to capture normally unrealized revenues from the intrinsic values of their lands by expanding their management efforts to include wetland restoration and carbon sequestration in living trees. These revenues may make it more profitable for landowners to continue rural land uses in interface areas, thereby slowing sprawl and land conversion.

Conservation easements represent another popular and effective method of incorporating social values and property rights with tax and other land valuation methods (Bick and Haney 2001) (see chapter 4). Underutilized opportunities for preserving forests at the interface include landowner cooperatives and forest banks (see chapter 6). These two conservation vehicles convert the normally irregular returns to forest investments into smaller annual payments. They can also keep rural land uses in interface areas economically competitive. However, these have proved largely ineffective up to now in most U.S. applications. One challenge to conservation easements and other approaches to reducing the rural landowner's tax burden and improving profitability is the lack of policy support at the municipal, county, State, and Federal levels. Tax incentives alone cannot prevent the conversion of rural land at the wildland-urban interface, nor can financial agreements that depend on group consensus. With a population that is growing, that is increasingly wealthy, and that is increasingly concerned with its quality of life, economic pressure will yield continued urban expansion. The best that may be accomplished is to eliminate tax and other policy incentives for urban sprawl.

Although there has been some policy action at the State and local levels to improve the economic and tax situation in the interface, these approaches are limited in their effectiveness or are too new to have a track record. State programs include Georgia's regional transportation authority in Atlanta, which has jurisdiction over transportation and air quality in the metropolitan area, and Tennessee's Annexation Reform Act of 1998, which directs counties to adopt comprehensive land use plans or risk losing eligibility for State infrastructure funds. Local and

"I would like to see the State legislature start looking at tax incentives for conservation easements and for the purchase of development rights by the State—ways to try to help keep these areas in green space despite the fact that development around them is causing the taxes on those properties to go up." Georgia

county-level programs are primarily limited to tree protection ordinances and road protection ordinances, but some counties and municipalities are moving toward programs that hold developers accountable for meeting a greater percentage of the costs of extending services to new interface subdivisions. Tree protection ordinances are effective at maintaining vegetation, but ordinances restricting mud from roads and limiting the weight of vehicles allowed to drive them will make timber management, at least, less cost-effective in certain jurisdictions (see chapters 6 and 7).

There currently is considerable interest in strategies to further reduce the property tax burden on forested and other rural land near the wildland-urban interface. Many strategies involve use of conservation easements (Beauvais 2000, Best 2000) (refer to chapter 4 for more policy-related tools). Other strategies involve governmental action to encourage the transfer of riparian land and forested buffers around new developments from private to public ownership, which concentrates owners' property tax liability on land that is economically operable (Honeczy 2000).

Income tax incentives that have been under discussion during the past several years and that would reduce the Federal income tax burden on forested land include:

- Income averaging.
- Reducing the tax rates for long-term capital gains, either across-the-board or according to the number of years a capital investment is held.
- Enhancing the amortization provisions for reforestation.
- Permitting the immediate deduction of reforestation expenses.
- Extending the tax incentives available to owners who manage their forest holdings for a profit to owners who manage primarily for environmental or social purposes.

In addition to reducing the Federal income tax burden, the third and fourth of the above incentives have the potential to improve the management and stewardship of rural land because they are linked to reforestation of harvested areas (Greene 1998). The fifth incentive would encourage owners in all timber types to make environmentally beneficial investments in forest stewardship (Wear and Greis, in press).

With the percentage of estates subject to the Federal estate tax increasing yearly, there is active interest in additional ways to reduce the estate tax burden (Herman 2001). The methods under discussion include eliminating the estate tax altogether, reducing the rates, increasing the exemption, increasing the exclusion for interest in a family-owned business, and adding an exclusion for farmers and other rural landowners.

Needs

Research clearly has a role in:

- Determining which methods are most economically effective and socially acceptable for improving social and environmental conditions in the wildland-urban interface.
- Determining what factors lead to southern sprawl. Lessons can be learned from American cities outside the South that have successfully concentrated population growth on fewer acres.
- Identifying the monetary and nonmonetary costs related to changes in environmental quality resulting from urbanization, as well as the monetary and nonmonetary values associated with wildland and rural land to urbanizing areas.
- Identifying methods that encourage reclaiming of abandoned urban industrial sites and discourage unnecessary "green space" development.
- Examining the microeconomic factors affecting forest land investment in interface areas. This approach should include timber production as a management objective, but should also be targeted for landowners who are primarily motivated by the nonmarket attributes of their forest land.
- Determining the impact of various types of property, income, and transfer taxes on land use change, as well as the impact of tax-related landowner incentives programs.
- Demonstrating the most effective linkages of public policy with tax reform.

Educational needs include:

- Programs to alert potential new interface residents to the microeconomic conditions they will experience. This role necessitates new extension and other technology transfer agents. A comprehensive program must include outreach to county executives, county councils, city planners, and other local officials.
- Programs that target policymakers. Positive changes in economic and tax issues at the interface depend almost entirely on policymakers. Efforts by individuals to minimize their tax burden or maintain the profitability of their undeveloped land are not likely to succeed in the absence of a committed vision for land use.

Conclusion

The economic and tax conditions facing rural landowners at the wildland-urban interface are numerous and complex. Some economic issues have tangible and easily quantified monetary costs associated with them; others that are just as important, such as quality of life, are harder to link to a price tag. Property, income, and transfer taxes, in combination with high land prices, make it difficult for some owners to keep their land in rural uses or to transfer their land to the next generation. Often, these economic and tax relationships and their contribution to

land use change at the urban-wildland interface are poorly understood. Some tools to help landowners maintain their land in a rural condition exist, but are either underutilized or of limited effectiveness without a concerted effort by policymakers to integrate and coordinate Federal and State tax codes and landowner assistance programs.

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Chapter 4

LAND USE PLANNING AND POLICY ISSUES

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Introduction

How can land be used, and who makes that determination? These are among the most contentious questions faced by any community. When that community is in the wildland-urban interface, conflicts can arise between newcomers and long-term residents; between private and public land management needs; and between Federal, State, and local governments. Current land-related public policies at all levels of government are contributing to the severity of these conflicts by failing to provide a way for communities to direct and control the increasing demand for land development that results when large numbers of people move into the interface. As long as people have the ability and desire to live in rural and undeveloped areas, land use policies should be designed to minimize the negative impacts such movement has on natural resources in the interface. ▶

Table 4.1—Southern State rankings by acreage and rate of non-Federal land developed for 1992–97 and 1982–92 [a]

State	1992–97			1982–92		
	Rank	Change in total land developed	Avg. annual conversion rate	Rank	Change in total land developed	Avg. annual conversion rate
		- - - - - - - - *Acres* - - - - - - - -			- - - - - - - - *Acres* - - - - - - - -	
Texas	1	893,500	178,700	1	1,387,000	138,700
Georgia	2	851,900	170,380	5	738,400	73,840
Florida	3	825,200	165,040	2	1,088,200	108,820
North Carolina	6	506,600	101,320	3	933,100	93,310
Tennessee	7	401,900	80,380	7	464,000	46,400
South Carolina	10	362,000	72,400	11	386,400	38,640
Virginia	11	343,500	68,700	10	441,000	44,100
Alabama	13	315,300	63,060	13	320,400	32,040
Kentucky	16	237,100	47,420	12	355,100	35,510
Mississippi	22	206,400	41,280	29	147,400	14,740
Oklahoma	26	176,700	35,340	27	156,100	15,610
Arkansas	28	168,900	33,780	36	96,800	9,680
Louisiana	29	133,600	26,720	18	256,300	25,630

[a] Out of 49 States. Alaska data not yet available.

Source: Natural Resources Conservation Service 2000.

Natural resource management and conservation in the interface are complicated by current land-related public policies. These challenges are related to both the amount of land being developed in the interface and the speed with which this development is taking place (**table 4.1**). The health and condition of natural resources are also related to the manner in which land is developed. It often appears that land use decisions are made without regard to the sensitivity of the landscape or its suitability for development. Land development too often inhibits natural ecosystem functions, such as flood mitigation and natural habitat. The migration of large numbers of people into the wildland-urban interface, however, creates increasing demand for land development, public services and infrastructure, and places greater strains on existing natural resources (**fig. 4.1**).

Current Public Policies and Programs Affecting the Wildland-Urban Interface

Federal Policies and Programs

Various Federal laws and programs have created incentives for development within the interface. For example, the Federal Government subsidized the creation of the State numbered route system and the National Interstate Highway System. This road expansion has opened up previously isolated land to development. Development has been further encouraged by the availability of federally backed mortgages through the Federal Housing Administration and the Veterans Administration (Rylander 2000).

Photo by James Kundell, University of Georgia

Figure 4.1
Development for housing has allowed erosion and sedimentation to occur which can affect the quality of nearby water.

While the net result of such Federal policies has been to facilitate population movement into the interface, other Federal policies and programs are designed to protect and conserve the natural resources of public and private land. For example, pollution control laws such as the Clean Air Act (CAA) and the Clean Water Act (CWA) were created to decrease air and water pollution. To do so, the laws limit certain land use practices. The CWA, for instance, contains provisions for area-wide land use planning to address pollution from nonpoint sources. In addition, under the CAA, States create air-quality control regions and prepare State Implementation Plans (SIP) that are designed to enable each region to attain federally set numerical limits for ambient concentrations of specific pollutants. If a region fails to meet its SIP obligations or fails to prepare an adequate SIP, Federal highway funds can be jeopardized and new construction can be halted. In contrast, the Coastal Zone Management Act attempts to minimize adverse impacts of development in coastal areas by providing Federal funding and guidelines for States to develop coastal management plans tailored to fit their specific needs. The Endangered Species Act (ESA) is another example of a Federal law whose purpose is to conserve and protect natural resources. The ESA prohibits both public and private individuals from "taking" any species that has been listed as threatened or endangered. Under the takings provision, a habitat modification that indirectly kills members of a listed species can be prohibited, even if this habitat is privately owned.

State Policies and Programs

Authority to guide land use decisions lies mainly with the States, which may choose to delegate this power to local governments at the county or municipal level. State and local governments have authority to regulate land uses and forest practices based on police powers that can be invoked to protect the public health, safety, morals, and welfare.

Forest management practices play an important role in land management in the interface. Actions by private forest landowners that might pollute or damage roads may be regulated by the State directly through forest practice ordinances and indirectly through tree conservation, water quality, wetlands, and open-burning laws (**figs. 4.2A, 4.2B**). In the South, forest regulatory ordinances are usually adopted by counties (or parishes in Louisiana) and tend to be concerned with protecting

Figure 4.2
(A) Regulation of private forest land addresses a number of management activities including clearcutting; (B) some Southern States have relied on nonregulatory use of forestry best management practices to ensure that forest practices provide adequate protection to the environment, especially water quality.

Photo by James Kundell, University of Georgia

(A)

Photo by James Kundell, University of Georgia

(B)

local government investments in roads, bridges, and highway infrastructures. However, State government environmental policies can be an important stimulus for the creation of local forest laws. For example, Virginia requires localities to regulate forestry activities adjacent to the Chesapeake Bay (Martus and others 1995). Tree protection ordinances generally apply to the removal of trees associated with land clearing and development. Often enacted in response to changes from rapid land development, tree ordinances range in complexity from simple tree replacement standards to more comprehensive ordinances addressing natural resource issues (U.S. Department of Agriculture, Forest Service 2001). Nonregulatory best management practices (BMPs) are another way Southern States have attempted to ensure that forest practices provide adequate protection to the environment, especially water quality. These BMP programs are usually not mandatory in the South. The Florida Division of Forestry, for instance, has developed voluntary BMPs for silvicultural operations near streams, rivers, lakes, and wetlands (Cubbage 1991). However, BMP programs are not always completely voluntary. A North Carolina regulation requiring landowners to prepare an erosion and sediment control plan for activities that disturb more than one contiguous acre exempts forestry operations, provided that forest owners and operators adhere to performance standards established by the forest practices guidelines on water quality. State forestry BMPs are recommended as a way to achieve compliance with these water-quality standards (Cubbage 1995).

While the States generally delegate their authority over land use to local governments, State legislatures can review or supersede local zoning where statewide interests are at stake. The State's police powers are usually delegated through enabling statutes, frequently patterned after the Standard State Zoning Enabling Act (SSZEA) of 1924. The SSZEA was intended to provide a common statutory zoning scheme for municipalities engaged in controlling land uses. This model act was eventually adopted by all 50 States and is still relied on by many States today (Nicholas 1999). A 1997 survey conducted by the American Planning Association as part of its Growing Smart Project revealed that many Southern States lack modernized planning statutes (American Planning Association 1999) (**tables 4.2, 4.3, 4.4**). This deficiency makes it more difficult for these States to effectively manage growth and change in the interface.

Table 4.2—The status of land use planning statutes (extent of updates to State legislation governing local planning) in the Southern States, 1997

State	Extent updated			
	Substantially	Moderately	Slightly	None
Alabama				X
Arkansas			X	
Florida	X			
Georgia	X			
Kentucky		X		
Louisiana				X
Mississippi			X	
North Carolina				X
Oklahoma				X
South Carolina		X		
Tennessee				X
Texas				X
Virginia				X

Source: American Planning Association 1999.

Nationally, several States have adopted comprehensive growth management plans. In general, these plans establish statewide goals and policies, create regional agencies charged with reviewing and coordinating local plans, and require local governments to prepare plans that implement State goals. While statewide planning systems are designed to provide intergovernmental coordination, all too often, lack of local government cooperation prevents achievement of the goals of the State plan. Florida's attempt at implementing its comprehensive growth management plan is a case in point. While Florida's comprehensive planning statute requires local governments to adopt local land-development regulations that implement and are consistent with the State comprehensive plan, sprawling development remains rampant, and local zoning decisions still favor low-density and large-scale forms of development (Nelson and others 1995, Porter 1999).

State infrastructure policies have also contributed to problems with land-development patterns in the interface. Under the SSZEA, States are confined to regulating only narrow areas of State interest, such as highway systems. As a result, State departments of transportation are answerable only to the Governor and State legislature, and can build roads without regard for local plans or land use consequences (Buzbee 1999, Lindstrom 1997). State funding programs for basic community infrastructure also tend to promote development in the interface by emphasizing funding of new facilities rather than rehabilitation or replacement of older systems. State water and sewer system financing programs likewise are mostly concerned with adding capacity (Porter 1999). The consequences of such policies are expensive both environmentally and financially. For example, it has been estimated that South Carolina will pay more than $56 billion in infrastructure costs between 1995 and 2015 if current development trends remain unchecked.

Table 4.3—The status of land use planning statutes (State with legislation mandating local land use planning) in the Southern States, 1997

State	Planning mandated?		
	Yes	Conditionally [a]	No
Alabama		X	
Arkansas			X
Florida	X		
Georgia	X		
Kentucky	X		
Louisiana		X	
Mississippi		X	
North Carolina			X
Oklahoma		X	
South Carolina		X	
Tennessee		X	
Texas			X
Virginia		X	

[a] The statute requires a local government to develop a plan only if it chooses to first create a planning commission.

Source: American Planning Association 1999.

This total amounts to $750 per citizen per year for the next 20 years (Burchell and Shad 1998) (see chapter 3 for more discussion on infrastructure costs).

Local Policies and Programs

Traditionally, the authority to guide and restrict land use has been the prerogative of local governments. The scope of local authority to make land use decisions is determined by whether the locality exists in a State with the Dillon rule or home rule. Under the Dillon rule, local governments may obtain power to govern only through a clear and expressed delegation of power by the State. In contrast, under home rule, State legislatures may give local governments the power to legislate with respect to local matters. State legislatures may limit, expand, or withdraw the locality's authority at their discretion. The extent to which home rule operates to limit the scope of State power varies from State to State. However, even in States where the scope of home rule is broad, State law supersedes local law except to the extent that it is prevented from doing so by the State constitution or by statute (Weiland 2000). Today, nearly every State has some type of home rule provision enabling municipalities to exercise some degree of self-governance.

Local governments exercise their authority over land use decisively through zoning ordinances. By geographically separating and organizing different land uses, zoning laws prevent incompatible uses from interfering with one another

Table 4.4—The status of land use planning statutes (strength of State role in local land use planning) in the Southern States, 1997

State	Description of State role		
	Strong	Significant	Weak
Alabama			X
Arkansas		X	
Florida	X		
Georgia	X		
Kentucky		X	
Louisiana			X
Mississippi		X	
North Carolina			X
Oklahoma			X
South Carolina		X	
Tennessee			X
Texas			X
Virginia			X

Source: American Planning Association 1999.

(Bernstein 1995). Local zoning codes divide the community into land use districts and establish building restrictions limiting the height, lot area coverage, and other dimensions of structures that are permitted to be built within each district depending on the degree of zoning authority granted to the local government. For example, counties with populations over 500,000 in Oklahoma are authorized to regulate building restrictions (height, number of stories, size of yards, and open spaces), population density, and location and use of buildings. Similarly, municipalities and counties in Mississippi are allowed to regulate the height of buildings and structures, the percentage of lots that may be occupied, open space, density of population, and the location and use of buildings.

Local governments have traditionally held the authority to make land use decisions because, in addition to being seen as more sensitive and responsive to local concerns, they are perceived as having more expertise in implementing fair and efficient land use policy. These local land use policies, however, often have the effect of increasing development and expanding the wildland-urban interface. Local governments receive most of their funding from property and sales taxes. They, therefore, have little reason to attempt to limit land development in their jurisdictions (see chapter 3). The desire to maximize property tax revenue sometimes results in overzoning for development by local governments. Many developing areas are highly overzoned for the amount of development they can expect in the foreseeable future. For instance, in Loudoun County, VA, current zoning allows between 50,000 and 53,000 new housing units to be built, even though current demand is running at about 3,000 units per year (Lindstrom 1997). Even when local governments attempt to limit growth, the policies they implement can have the indirect effect of increasing development in the interface. For example,

when local governments become alarmed about potential development impacts on available infrastructure, they often reduce allowable densities to levels supportable by private wells, septic tanks, and roads. The effect is to spread out settlement, causing more land to be developed. In Maryland, more than half of the development capacity allowed by local plans in 1996 was outside current or planned sewer service areas (Porter 1999). In another attempt to control growth, local governments sometimes implement restrictive zoning practices. However, by raising the entry costs for new residents and businesses and limiting undesirable land uses, localities direct would-be newcomers into undeveloped areas at the perimeter of the urban area (Lockard 2000). It is not yet fully understood what impact these developments may have on forest ecosystems and the goods and services they provide.

Public Attitudes and Involvement in Growth Management Policies

Property owners can contribute to natural resource problems in the interface because they do not always take into account the consequences their land use decisions may have on their neighbors. In addition, actions that are harmless in isolation can create serious problems when large numbers of people act in the same way (Freyfogle 1997). These two ideas came up repeatedly in the Assessment focus groups. Many participants saw private property rights as an important challenge for managing growth and conserving and managing natural resources. Others wanted to ensure that private property rights were respected and saw growth management tools, such as zoning, as a threat to these rights (Monroe and others, in press). Despite the emphasis many landowners place on property rights, public attitudes towards land ownership are beginning to reflect a concern for natural resource protection. For example, a strong majority of private forest owners in the Tennessee Valley (all of Tennessee and portions of Mississippi, Alabama, Georgia, North Carolina, Virginia, and Kentucky) agreed with the statement that while private property rights are important, they are secondary to environmental protection and should be limited where necessary to protect the environment (Bliss and others 1997). The results of this survey signify that the public is becoming increasingly aware that the actions of individual landowners can significantly impact neighbors and the entire community.

"I have the first place on the water that comes off of Piney Mountain, and I'm always so conscious of anything that I do impacting everyone else downstream, and I think there's not enough of that. People need to be aware that what you do impacts so many other people." Georgia

Public attitudes also impact natural resource issues in the interface by influencing how these resources will be used. For example, individuals moving into the interface frequently are unfamiliar with forest management needs and often are intolerant of certain harvesting practices and changes in the appearance of the forest. Such new interface residents are more likely than their long-term, forest-production-oriented neighbors to favor zoning and logging regulations that place

limits on forestry operations, such as clearcutting, herbicide use, and prescribed fire (Bliss and others 1997). However, this dichotomy may be changing. A recent study on the environmental attitudes of forest owners in the Midsouth revealed that, to a large extent, the views of forest owners on key forestry and environmental issues were no different from those of nonowners. Both groups supported regulating forest-harvesting practices, even on private land, where necessary to protect the environment (Bliss and others 1997). These results suggest that in order to be responsive to the needs of forest owners in the interface, natural resource managers will require more environmentally sensitive approaches to forest management (see chapter 6).

Photo by James Kundell, University of Georgia

Figure 4.3
Rapid development leads to the fragmentation and loss of forest land in growing areas.

Future Trends of Current Land-Related Policies

To a large extent, current land use policies have been ineffective in altering land use patterns and slowing the influx of people into the interface. Part of the reason why traditional land use control programs have had limited impact on interface development is that they were not designed for that purpose. The purpose of traditional zoning ordinances, for example, was to protect private property values and public investment in infrastructure by restricting neighboring landowners from using their land in a way that reduced property values or added cost to the community. In a survey of the most sprawl-threatened cities in the United States, 9 of the top 15 cities were in the South (Sierra Club 1998). A rapidly increasing human population in the South (see chapter 2) will result in further movement on to land in the interface as well as continued degradation of environmental resources (**fig. 4.3**). Increased human activity in the interface will also place greater stress on water supplies (see chapters 5 and 6). Water shortages in the South have already resulted in conflicts between several States, and total water withdrawals in the South are expected to increase by 40 percent between the years 2000 and 2045 (Kundell and Tetens 1998, Pringle 2000).

Current land use policies also have been unable to prevent the overlap of multiple Federal, State, and local jurisdictions over land use. As a result, various levels of government are making land use decisions independently of each other. Often these decisions are made without any common understanding of what long-range growth management goals separate government levels want to achieve and without an approach for addressing environmental issues that cross jurisdictional boundaries. Assessment focus group participants in Virginia suggested that current policy is "crying out for vision and clear direction and that there needs to be cooperation among agencies involved in the management of the interface" (Monroe and others, in press). The current system encourages private landowners to make land use decisions that are in their own short-term best interest without regard for whether these decisions will be beneficial to the broader community.

"There is no empowerment of regional planning because there are so many local municipal governments. There is fragmentation, an imbalance of power, and a lack of coordination." Texas

Tools for Protecting Natural Resources Within the Interface

Technologies

Increasingly, innovative ways are being found to use Geographic Information Systems (GIS) to aid in land use planning in the interface. For instance, CITYgreen is a GIS application developed by the nonprofit organization, American Forests. It allows users to calculate the environmental and economic benefits of forests and trees. CITYgreen is used by planners and policymakers to map and measure tree-cover changes (see chapter 5) and to calculate the benefits urban trees and forests provide, including reduced stormwater runoff, energy savings, carbon sequestration, and the removal of pollutants. CITYgreen is part of a method of land assessment used by American Forests called Regional Ecosystem Analysis (REA). Regional Ecosystem Analysis measures a region's or city's tree canopy and calculates its economic worth. For example, an REA conducted in Austin, TX, found that if canopy coverage in the city was increased to match that of the best canopied sample site, annual carbon sequestration would increase from 5,700 to 10,000 tons, and the annual value of that sequestration would increase from $5.3 million to $9.2 million (American Forests 2000) (see chapter 6).

Geographic Information System technology can also be used to analyze land use trends. The Georgia Land Use Trend Project (GLUT) was instituted to produce landcover maps based on satellite data for Georgia from 1973–98, and to analyze rates of change in landcover during this 25-year period. The GLUT provides information on the impact of changing land use on the State's natural resources as well as the relationship between land use activities and water quality. This information allows resource managers, planners, local officials, developers, nonprofit organizations, and other stakeholders to incorporate the needs of resource management into their land use decisions (Wexler 2000).

Local governments can also benefit from computer technology when making land management decisions. The Land Capacity Model is an example of a computer program designed to allow the user to forecast the effects of a continuation of recent development trends or to project the effect of possible changes in existing trends (Dahlstrom 1997). Likewise, the California Urban Futures Model (CUF Model) uses GIS for data integration and spatial analysis to examine the environmental impacts associated with different potential development policies (Landis 1995). In this way, land use models can provide local government planners with the information they need to determine where growth can be accommodated without sacrificing environmentally sensitive land.

Land-Related Policies

Local governments are using a number of programs and policies to guide and control growth in the interface. These growth management measures include such policies as:

> **Smart growth programs**—This term includes a range of approaches to contain development by using more efficient and compact urban development patterns, such as urban growth boundaries that preserve open space and protect environmentally sensitive areas.

Alternative zoning ordinances—These can be used to protect forests, wetlands, floodplains, or environmentally sensitive land (**fig. 4.4**). There are several different forms of alternative zoning ordinances:

- **Floating zones**—A floating zone is a specialized use district that floats over an entire jurisdiction until it attaches to a specific property upon the request of the owner who must demonstrate that a variety of impacts will be properly handled, such as the project's effect on natural resources and preservation of open space.
- **Overlay zones**—An overlay zone supplements the underlying zoning standards with additional requirements that can be designed to protect the natural features in an important environmental area.
- **Cluster development**—A cluster development is a subdivision in which the applicable zoning ordinance allows or requires development to be placed on a portion of the parcel and the rest to remain undeveloped open space.
- **Incentive zones**—Incentive zones are significant waivers of zoning requirements offered to developers as a method of directing larger scale development into designated growth areas.
- **Impact fees**—In order to pay for development and not impact current residents, local governments have implemented impact fees as a mechanism for assigning a share of the new required public service infrastructure to new owners of developed property.

Transferable development rights (TDR)—Under a TDR program, a landowner is assigned rights to develop which cannot be used on sensitive land but can be transferred to other land or sold to other developers.

Purchase of development rights (PDR)—Under a PDR program, landowners can volunteer to sell the development rights to their land to the Federal, State, or local government or a nonprofit group while retaining ownership of the land. The current and future owners of the land are restricted from development activities.

Conservation easements—Conservation easements that permanently restrict the use of a particular tract of land can be purchased by Federal, State, or local agencies or by private groups.

Priority funding areas (PFA)—PFAs control growth by limiting State support for growth-related projects such as sewer and water systems to locally designated growth areas. Maryland has implemented PFAs since 1998 (American Planning Association 1999).

Open-space preservation—Open, or green, space is defined as agricultural and forestry land in a natural state or land developed only to the extent consistent with the protection of the environment (Urban Land Institute 1999) (**fig. 4.5**). Many State conservation programs include open-space preservation as part of the State's overall policy to preserve land. For example, Georgia recently created a Greenspace Trust Fund with the goal of ultimately preserving 20 percent of Georgia's land area as open space (Griffith 2000).

Land trusts–In addition to Federal and State land conservation programs and policies, there are over 1,000 land trusts currently operating at the local and regional levels in the United States, protecting over 4 million acres of land through voluntary land transactions (Wiebe and others 1997).

Map by Steve MacAuley

Figure 4.4
Alternative zoning techniques provide greater flexibility than traditional zoning and allow planners to design developments that better fit the land and to set aside more green space.

Photo by Annie Hermansen, USDA Forest Service

Figure 4.5
Many local governments are acquiring green space as part of their conservation programs.

Examples include The Nature Conservancy, which currently protects more than 11 million acres in the United States, and The Trust for Public Land, which protects more than 1.2 million acres in 45 States (The Nature Conservancy 1999, The Trust for Public Land 2000).

The following tabulation shows Southern State acreage that is protected by The Nature Conservancy:

State	Area protected *Acres*
Alabama	101,000
Arkansas	230,000
Florida	920,000
Georgia	200,000
Louisiana	205,000
Mississippi	106,578
North Carolina	457,154
Oklahoma	84,000
South Carolina	165,198
Tennessee	93,000
Texas	473,000
Virginia	200,000
Total	**3,234,930**

Needs

Research needs to be conducted to better define natural resource management issues in the interface and their relationship to land use policies. Analysis should focus on the following areas:

- Public policies toward land use and the influence of subsequent land uses on natural resources.
- The role land use policies play in managing growth in both rural areas, which may lack many land use policies, and more suburban areas where land use policies are in place but may or may not be effective in controlling growth in the interface.
- Weaknesses in land use policies as well as options that are available to better address natural resource management and conservation issues in the interface.
- Public support for land protection and how much people are willing to pay for land protection. For example, one recent survey of Chicago suburbanites revealed that residents were willing to pay $484 per year for 5 years to permanently protect about 20,000 acres of farmland in their county from development (American Farmland Trust Center for Agriculture in the Environment 1997).
- The value of strategically using forests to offset some of the negative environmental consequences of urbanization and changing land use patterns in interface and urban areas.

- Approaches to planning that have worked in other areas.

Natural resource managers and local planning officials need to understand the role each plays in protecting natural resources in the interface. In particular, natural resource managers need to better understand and influence public policies related to natural resources. Natural resource managers can do the following:

- Help adjacent communities and private landowners understand ecological systems so that they can make their planning and development decisions in an informed, science-based manner.
- Initiate communication with planners and developers by responding to requests for comments or participation by local communities and by paying closer attention to the goals and effects of the local planning process.
- Conduct environmental outreach by communicating with key audiences at the local, regional, State, and national levels. Natural resource managers need to make messages easily understood by the public.
- Engage the public to establish mutual understanding, promote involvement, and influence attitudes and actions in order to foster joint stewardship of natural resources.

To best address natural resource and conservation issues in the interface, the appropriate level of government needs to have the authority to deal with issues on the most suitable scale. Scaling requires an awareness of individual changes, an understanding of what the changes mean in terms of natural resources and environmental quality, and an ability to determine whether the rate of change is acceptable. Each level of government has a role to play in controlling the rate of change in the interface.

The Federal Government can provide:

- Research,
- Technical assistance, and
- Management of public lands and natural resources.

State governments can provide:

- Research;
- Monitoring, compliance, and enforcement;
- Oversight of local programs (including funding);
- Training and technical assistance to local governments; and
- Management of State land and natural resources.

Local governments can provide:

- Infrastructure and program funding,
- Land use planning and regulation, and
- Management of lands of local interest.

There is also a need to encourage cooperation and collaboration when dealing with multijurisdictional natural resource issues (see chapter 7). As long as cities and counties differ in their visions of how development should proceed, developers will be able to shop for lenient forums and make decisions that yield the highest profits. Growth management issues are often best addressed at a regional level, especially around large metropolitan areas with multiple local governments. In some cases, regional cooperation can be encouraged by State policies.

The current lack of reliable natural resource information on critical wildlife habitats, aquifers, and other environmental quality indicators also needs to be addressed. In the absence of relevant scientific and technical data, environmental needs cannot be prioritized and long-term threats may not be identified. The technology to conduct this research, such as GIS, satellite imaging, and computer systems, is currently available. However, it is not presently being used enough for these purposes. In order to address this information deficit, natural resource managers need to:

- Correlate natural resource information with demographic and land use change data;
- Collect more GIS data from more communities;
- Project growth and estimate the impact of that growth on natural resources; and
- Establish sound, interdisciplinary research to serve the needs of policymakers.

"I think we need a lot more information about the transition, how you protect your environment and forests in a transition from rural to urban." Virginia

The land use policies discussed above, such as TDRs, conservation easements, and alternative zoning, when implemented at the State and local levels, can improve natural resource management and conservation in the interface. Natural resource managers and the public, as well as State and local officials, need to become both more aware that these land use policies exist and be more willing to put them into practice.

One of the most important roles natural resource managers can play in affecting policy change is in educating the public about the value of natural resources and conservation in the interface. Natural resource managers can:

- Encourage those who live in the interface to become aware of their connection to the forest and of their responsibility to assist with its stewardship. For example, many people do not understand the importance that watersheds have in supplying clean water to communities. Consequently, they do not actively assist managers in ensuring that watersheds are sustainably managed.
- Conduct educational programs to increase the perceived legitimacy of specific natural resource measures.

- Distribute information over the Internet through use of Web sites aimed at the general public.
- Help stakeholders develop a consensus about what the interface community should look like in the future. Such visions should, in turn, be reflected in local ordinances.
- Integrate stakeholders into natural resource decisionmaking. Land and resource planning must provide mechanisms for dialogues that are open to any person. Ideas should be expressed in nontechnical terms that are readily understandable to the general public. The participation of citizens should be encouraged from the beginning and be maintained throughout the planning process.

"There is a huge lack of understanding, knowledge, and appreciation of the valuable rural and forest assets that are here. They're just taken for granted, both rivers and forests." Mississippi

It is important for natural resource managers to remember that without broad-based public understanding and support, land use policies cannot conserve and protect natural resources in the interface.

Conclusion

Risks to natural resources and conflicting interests of stakeholders make urban development in the interface a most difficult problem for natural resource managers. The underlying policy issues need to be addressed by the public as well as elected officials if natural resources in the interface are to be preserved. Natural resource managers can play an important role in raising public awareness of the natural resource and conservation issues in the interface. Too often communities wait until development has begun before attempting to revise their land development plans. By then, emotions are often running high, and anger, divisiveness, and resentment preclude rational discussion about the long-term goals of the community. Because these issues are multifaceted, proactive and flexible land use policies are needed to deal with them. Fortunately, such policies exist, and communities across the South are implementing them. However, much more still needs to be done to assure natural resource protection in the interface.

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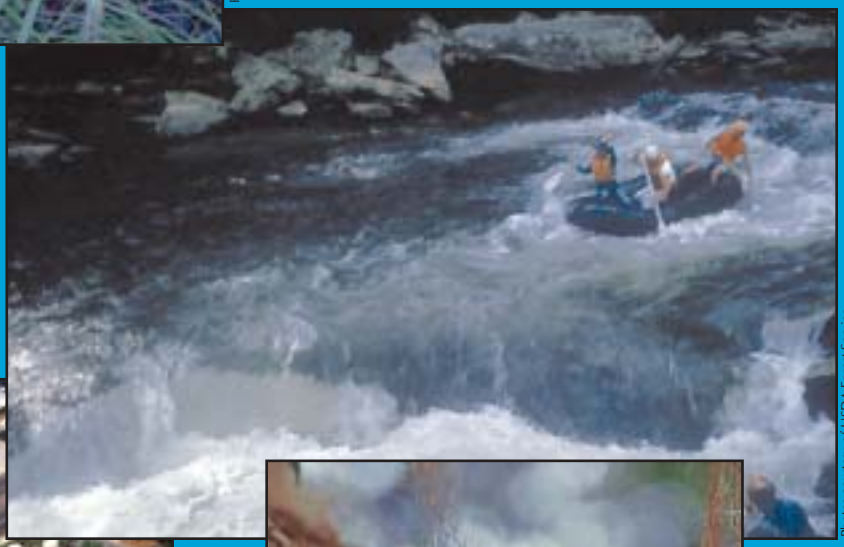
SECTION II:
CONSEQUENCES OF CHANGE

Photo by Hallie Dozier, Louisiana State University

Photo by Larry Korhnack, University of Florida



Photos courtesy of USDA Forest Service

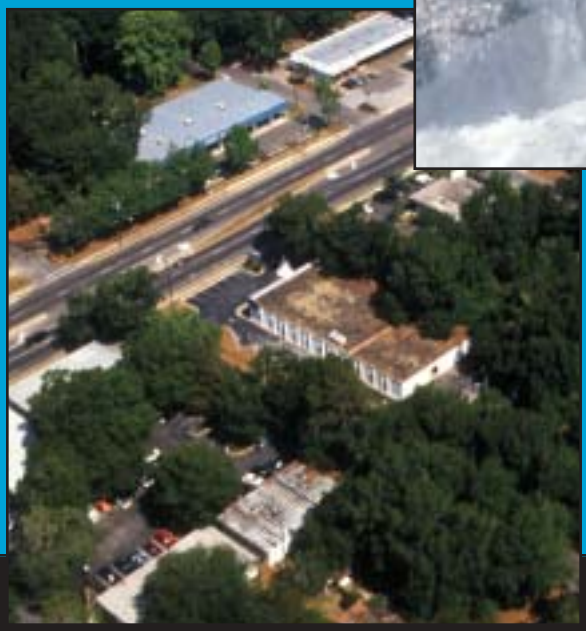


Photo by Hans Riekerk, University of Florida

Photo by Larry Korhnack, University of Florida

Chapter 5

URBAN INFLUENCES ON FORESTS

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Introduction

A common concern voiced in each Assessment focus group was the loss of agricultural sites and natural habitats to urban use. As children, group members fondly recalled playing in fields and forests. Today, those open spaces are gone, covered by shopping centers, housing subdivisions, or other urban land uses. The conversion of open lands to urban uses is not new. What is different today is the rapid rate of conversion (Boyce and Martin 1993).

Since the 1970s, the South's population has increased dramatically causing extensive urbanization across the region. A strong economy, new telecommunication technology, new transportation systems, and land use planning policies have stimulated development from the edges of cities to formerly remote rural areas. This chapter assesses some of the key urban effects on forest ecosystems and identifies future research and educational needs to address these effects. ▶

Urban Effects on Forest Ecosystems

Urbanization directly alters forest ecosystems by removing or fragmenting forest cover. Urbanization also indirectly alters forest ecosystems by modifying hydrology, altering nutrient cycling, introducing nonnative species, modifying disturbance regimes, and changing atmospheric conditions. Collectively, these changes significantly affect forest health and modify the goods and services provided by forest ecosystems. A list of selected ecosystem goods and services, where goods are valued as items with monetary value in the market place and services are valued economically but rarely bought or sold (Christensen and others 1996), follows.

Ecosystem "goods" include

- Food products,
- Decorative products,
- Wood products,
- Medicinal plants,
- Wild genes for domestic plants and animals, and
- Tourism and recreation.

Ecosystem "services" include

- Maintaining hydrologic cycles,
- Regulating climate,
- Cleansing water and air,
- Maintaining the gaseous composition of the atmosphere,
- Pollinating crops and other important plants,
- Generating and maintaining soils,
- Storing and cycling essential nutrients,
- Absorbing and detoxifying pollutants, and
- Providing beauty, inspiration, and research.

Most ecosystem research has not examined urban effects on ecosystems in the wildland-urban interface. In this section, I draw upon ancillary research in urban and rural landscapes to illustrate the direct and indirect effects of urbanization on forest ecosystems in the interface.

"There is no general recognition of natural capital. That land with weeds on it is worth something—for absorption, filtration, habitat, and oxygen." Mississippi

Photo by Alice Cohen, USDA Forest Service

Figure 5.1
The Appalachian Highlands are greatly impacted by urbanization due to the sensitive ecosystems found there.

Deforestation and Fragmentation

The most obvious landscape effects of human activities are the reduction of total forest area and the fragmentation of remaining forests into smaller, isolated patches. Agriculture is the primary cause for deforestation (Alig and others 2000). However, forest losses to urban uses have increased since the 1970s (Boyce and Martin 1993). In addition, urbanization of agricultural land has caused conversion of forests to agriculture in other places to offset losses (Alig and Healy 1987). In the South, the Piedmont has the greatest rate of forest land conversion to urban uses, but the greatest impact of urbanization may be in the Appalachian Highlands and Coastal Plain because of the sensitive ecosystems found in those regions (Boyce and Martin 1993) (**fig. 5.1**).

Table 5.1—Tree canopy losses[a] in selected areas in the South

Location	Forested area[b]	Time period	Tree canopy loss[b]
	M acres	*Year*	*Percent*
Atlanta *metropolitan area*	1,747	1974-96	26
Chattanooga, TN	110	1974-96	21
Houston *metropolitan area*	692	1972-99	8
Roanoke, VA	313	1973-77	9
Fairfax County, VA	125	1973-97	20

[a] Because measuring canopy losses and fragmentation are scale dependent, a comparison across different studies is difficult. The author uses analyses by American Forests because the same protocol is employed to analyze each region. This use, however, does not imply an endorsement of techniques or models developed to obtain these values.

[b] This value represents area and the loss of canopy cover as classified by a 30-meter Landsat pixel as having at least 50 percent tree cover.

Source: American Forests 2002.

Photo by Hans Riekerk, University of Florida

Figure 5.2
Forest fragmentation is accelerated by the construction of buildings, roads, and parking lots.

Rapid urban expansion occurs not only around major metropolitan areas but also around small towns and villages (see chapter 2). Forest losses to urbanization have not been analyzed comprehensively. Although forest losses in specific places have been studied, findings often are not comparable because of different techniques and scales to measure change and different definitions of forest cover and losses. Analyses conducted by American Forests (2002) show that forest cover for four metropolitan areas—Atlanta, Chattanooga, Houston, and Roanoke—and Fairfax County, a county near Washington, DC, declined by over 585,000 acres over a 24-year period (**table 5.1**).

Regional conversion rates, however, provide little ecological information on site content and landscape context. For example, the data presented in table 5.1 convey no information about losses of critical and threatened ecosystems, rates of fragmentation, size distribution of existing forest cover by particular forest types, or the location and nature of affected watersheds. Such information is critical to understanding the direct and indirect effects of urbanization on ecosystem components and processes and ultimately on goods and services provided by ecosystems. An analysis of the effects of fragmentation has not yet been conducted for the entire South, but some regional studies have been done (Rudis 1995; Turner 1990; Turner and others 1996; Wear and Greis, in press; Wear and others 1998). In general, rates of forest loss are fastest along major communication corridors, near major urban centers, and near recreational areas such as national forests and parks; they are slowest in areas with slow economic development (Boyce and Martin 1993).

Fragmentation, one of the most significant negative effects of human activities on biodiversity (Noss 1987), is accelerated in the interface because of the construction of buildings, roads, and parking lots (Zipperer 1993) (**fig. 5.2**). Fragmentation affects native biodiversity by reducing habitat size, reducing the amount of forest interior habitat, isolating existing populations, and modifying microclimates (Noss and Csuti 1994, Saunders and others 1991). Isolation is increased further by the loss of corridors connecting natural habitats and by natural habitats being embedded in urban landscapes that inhibit organism movement. With restricted organism movement, genetic flow among populations is drastically reduced, leading potentially to inbreeding and local extinctions. For example, the Florida panther (*Felis concolor*) suffers from a high frequency of inbreeding and may be on the verge of extinction (White and Wilds 1998).

Photo by Joseph Schaefer, University of Florida

Figure 5.3
In urbanizing landscapes, edges become dominant features.

In the interface, development creates new edge habitat and alters habitat shape from irregular to highly regular and linear (Godron and Forman 1983, Zipperer 1993). By increasing edge habitat, development increases the number of edge species but decreases the number of interior species (Nilon and others 1994). Edges occur naturally and contribute to the habitat heterogeneity of a landscape. In urbanizing landscapes, however, edges become dominant features principally because of new roads (**fig. 5.3**). Roads also have numerous other ecological effects. A listing of known road effects on species, communities, and landscapes (Baker and Knight 2000) follows:

- Species (fine scale)
  - Direct effects
    - Direct habitat loss/gain to roads and adjoining built area
    - Direct mortality on roads
  - Road-effect zone
    - Habitat loss/gain due to avoidance areas surrounding roads and built area
    - Increased access
      - Increased mortality from hunting
      - Increased harassment of wildlife near roads
      - Increased woodcutting and trampling along roads
      - Increased human-set fires/other disturbances
      - Increased dumping
    - Potential indirect effects of landscape changes
      - Increased edge species/decreased interior species
      - Perils to small populations
      - Loss/gain of important natural disturbance patches
    - Pollution effects
      - Increased lighting
      - Increased dust and fumes
      - Increased noise
  - Connectivity effects
    - Barrier/deterrent to movement
    - Conduit effects
      - Spread of nonnative species
      - Enhanced/decreased movement of native species
- Community and landscape (broad scale)
  - Preferential loss of ecologically valuable communities
  - Fragmentation and isolation of patches
  - Increase in edge area
  - Decrease in interior area
  - Ratios of edge area or interior area to total patch area
  - Decreasing complexity of patch shape
  - Decreasing variation in patch area, edge area, and interior area
  - Fewer large patches and more small patches
  - Landscape texture (local diversity) higher
  - Expansion of other fragmenting land uses from road network
  - Changes in natural disturbance regimes.

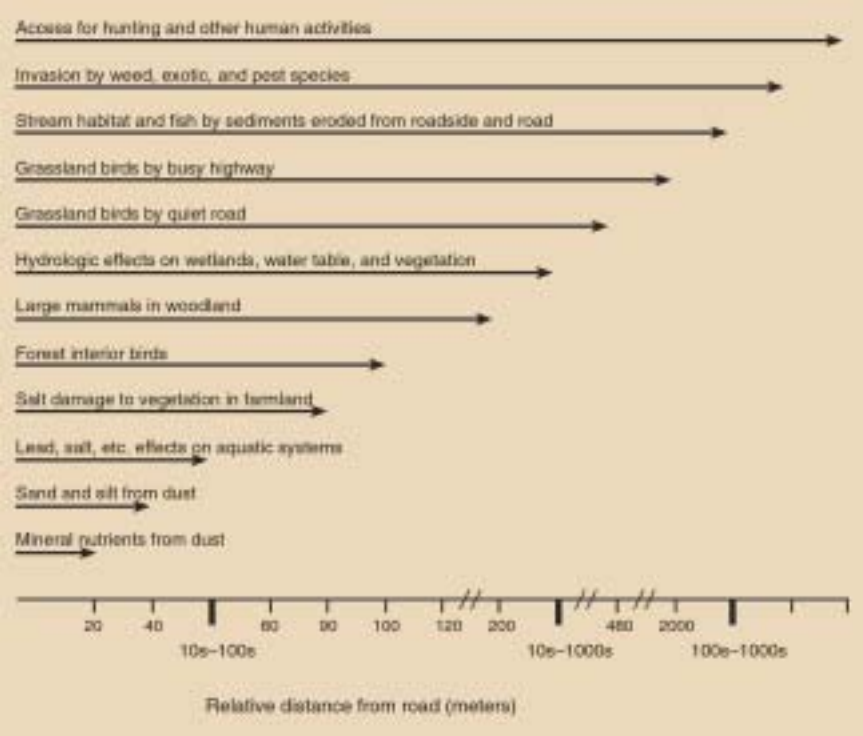


Figure 5.4
The effect of roads on the adjacent land cover. The horizontal axis is not linear but illustrative to show ranges of effects (Forman 1995).

At the forest edge, the physical environment and biotic community are altered, a phenomenon called the edge effect [see Forman (1995) for a discussion of edges and boundaries]. Physical changes include greater wind turbulence, greater temperature fluctuation, increased lateral light penetration, and drier site conditions. Biotic changes include a proliferation of nonnative species, an increase in plant and animal generalists, an increase in parasitism and predation, and an alteration of ecological processes such as nutrient cycling. These effects vary across a range of spatial and temporal scales for different forest types and species (**fig. 5.4**).

" . . . . If you drive by some parts [of north Georgia] you will see a ridgetop covered with houses or a stream bank that used to be a pastoral setting that now has houses every 50 feet sitting right on top of the streambank." Georgia

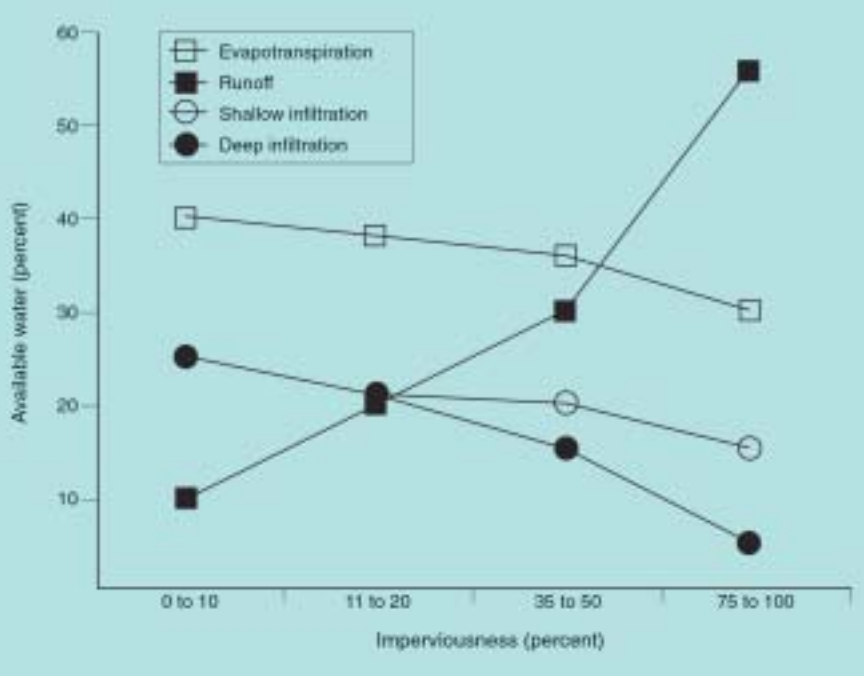


Figure 5.5
Changes in evapotranspiration, runoff, and shallow and deep infiltration with increasing impervious surface cover in a watershed (Arnold and Gibbons 1996, Paul and Meyer 2001).

Hydrology

Urbanization alters water flow in the interface (**fig. 5.5**). Changes include increased amount of impervious surfaces, decreased infiltration, increased surface runoff, and altered flooding regimes (**fig. 5.6**). Impervious surfaces include rooftops, driveways, roads, and parking lots. In low-density residential development (<1 house per acre), the roads may account for more than 60 percent of the impervious surface and exert a greater affect on aquatic systems than rooftops (Schueler 1994). Storm runoff from roads and parking lots often flows directly into streams. Runoff from rooftops often flows out over yards with pervious surfaces. An increase of just 10 percent in impervious surfaces significantly changes streambank stability, water quality and quantity, and biodiversity of aquatic systems (Schueler 1994) (**table 5.2**).

Besides increasing the amount of impervious surfaces, urbanization drains wetlands, channelizes streams, and increases the amounts of sediments, nutrients, and biocides entering the aquatic system. Erosion and sedimentation occur not only from constructing new roads and buildings but also from eroding beds and banks of streams. Sediment loads from inadequately controlled construction sites typically are 10 to 20 times greater per unit of land area than those from agricultural land and 1,000 to 2,000 times those from forests (Weiss 1995). Streambank stability decreases rapidly above a level of 10 percent impervious cover because of increased stream velocity and volume from storm runoff (Schueler 1994). Recent analyses of watersheds by the U.S. Geological Survey (1999) show that urban and urbanizing landscapes have a defining pollution signature for insecticides and herbicides. Conductivity, suspended soils, and concentrations of ammonium, hydrocarbons, and metals in surface and subsurface waters increase with urbanization (U.S. Geological Survey 1999).

Photo by Larry Korhnack, University of Florida

Figure 5.6
Increased impervious surfaces lead to decreased infiltration, increased surface runoff, and altered flooding regimes.

Table 5.2—The effect of different percentages of impervious surface on stream attributes

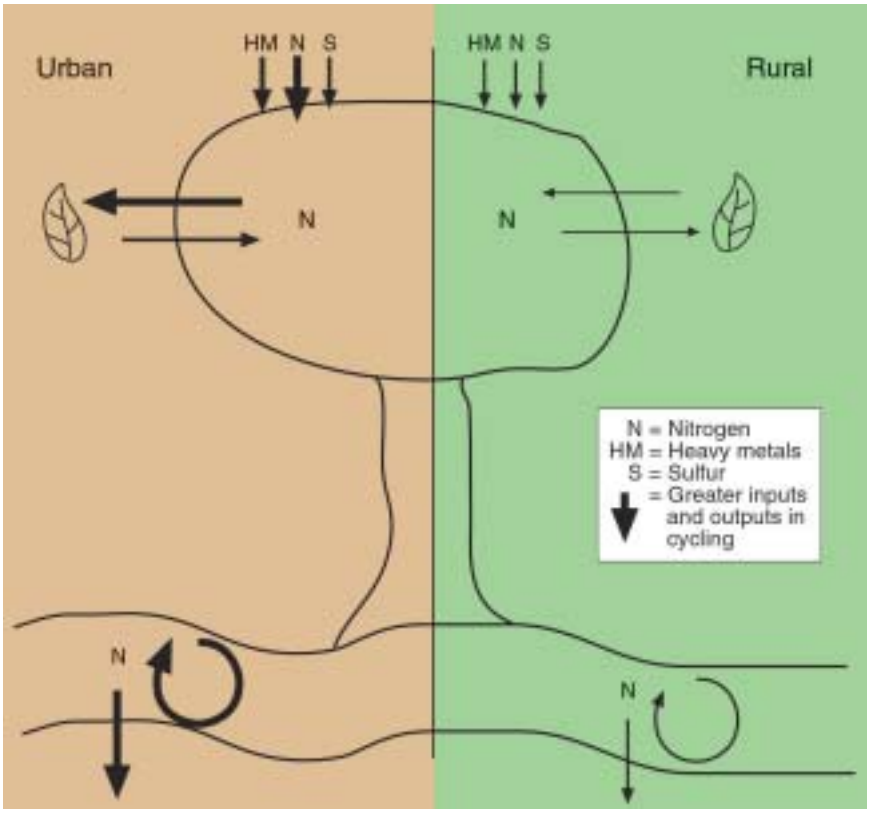
	Impervious surface (percent)		
Stream attribute	**0-10**	**11-25**	**25-100**
Stream stability	Stable	Unstable	Highly unstable
Water quality	Good	Fair	Fair-poor
Stream biodiversity	Good-excellent	Fair-good	Poor

Source: Schueler 1994.

Development in the wildland-urban interface often occurs in the headwaters of many streams and rivers. These very small creeks and streams are home to many endemic species that are extremely sensitive to environmental changes and pollution. Urbanization alters headwaters by covering or ditching them, removing riparian vegetation, increasing water temperature, and altering water quality (Marsh and Marsh 1995, Pluhowski 1970). Research is needed not only to document the extent of land use changes caused by urbanization at headwaters but also to measure biotic and abiotic effects downstream.

Nutrient Cycling

Urban landscapes are a mosaic of different human population densities, building densities, and amounts of impervious and pervious surfaces (Stearns and Montag 1974). Embedded in these urban landscapes are native forest stands. When compared to rural forest ecosystems of similar composition, structure, and geology, forests in urban landscapes differ environmentally, compositionally, and structurally and have different rates for certain ecosystem processes (McDonnell and others 1997) (**fig. 5.7**). Over time, urbanization affects forest ecosystems even if the forests have not been disturbed by development. Mere proximity to urban land use can cause changes. Work needs to be conducted to determine at what level of urbanization shifts in ecosystem species composition, structure, and processes occur, and the corresponding lag times between the respective responses.



Urban		Rural
+	Soil temperature	–
+	Soil hydrophobicity	–
–	Microinvertebrates	+
+	Earthworms	–
–	Fungal hyphae	+
+	Nonindigenous plants	–
–	Stem density	+
–	Leaf letter depth	–
+	Decomposition	–
+	Nitrogen-mineralization	–
+	Nitrification rates	–

Figure 5.7
Generalized illustration depicting structural and functional differences of forests in urban and rural landscapes having similar physical environments and species composition and structure (Kostel-Hughes 1995; McDonnell and others 1997; Pouyat and others 1994, 1996; Rudnicky and McDonnell 1989).

Biodiversity

Biodiversity is an integrator of environmental changes and land transformation on a landscape. Urbanization alters the composition of plant and animal species in both terrestrial and aquatic systems. In general, as one moves from the rural to urban landscape, plant species richness increases, but decreases for amphibians, reptiles, mammals, and birds (Kowarik 1990). Along this urban continuum, the number of native species decreases whereas the number of exotic species increases. Native species are missing from urban landscapes because their habitats may be absent or too small to maintain a viable population. Species also may be unable to adapt physiologically or behaviorally to an urban environment. A study of avian species in the Lake of the Ozarks region revealed that as development increases, habitat specialists decline. Other species, such as those that inhabit edges and are habitat generalists, increase with development (Nilon and others 1994).

Urbanization is not the only human activity that has altered biodiversity locally and regionally. Past and current agricultural and natural resource management practices significantly affect biodiversity (White and Wilds 1998). Five large mammals—bison (*Bison bison*), elk (*Cervus* e. *canadensis*), gray wolf (*Canis lupus*), jaguar (*Felis onca*), and ocelot (*Felis pardalis*)—have been extirpated from the South because of past agricultural and natural resource management practices (Echternacht and Harris 1993) (**table 5.3**). Collectively, agriculture, forestry practices, and urbanization significantly reduce the extent of ecosystems in the South. A listing of critically endangered and endangered ecosystems (85-percent loss) in the South (Noss and others 1995, White and Wilds 1998) follows:

Table 5.3—The number of native, endemic, extinct, extirpated, and federally listed vertebrates in the South

Vertebrate group	Species				
	Native	Endemic	Extinct	Extirpated	Listed endemics
Fishes	535	257	3	2	23
Amphibians and reptiles	242	83	0	0	8
Birds	237	0	2	3	4
Mammals	101	7	0	5	13

Source: Echternacht and Harris 1993, White and Wilds 1998.

Geographic area	Ecosystem type
	> 98-percent loss: critically endangered
Southeast	Old-growth deciduous forests
Tennessee, North Carolina, Virginia	Southern Appalachian spruce-fir
Coastal Plain	Longleaf pine
Florida	Rockland slash pine
West Gulf Coastal Plain	Loblolly-shortleaf pine
Southeast	Canebrakes
Kentucky	Bluegrass-savannah-woodland
Alabama, Mississippi	Blackbelt prairie, Jackson prairie
Florida	Dry prairie
Louisiana	Wet and mesic coastal prairies
Virginia, North Carolina	Atlantic white-cedar
Kentucky	Native prairies
Cumberland Plateau, Tennessee	High-quality oak-hickory
	85- to 98-percent loss: endangered
Central Appalachians	Red spruce
Coastal Plain, Tennessee	Upland hardwoods
Tennessee	Old-growth oak-hickory
Tennessee	Cedar glades
Texas, Louisiana	Longleaf pine
Louisiana	Mississippi terrace prairies, calcareous prairie, Fleming glades
Louisiana	Live oak, live-oak hackberry
Louisiana	Prairie terrace-loess oak forest
Louisiana	Shortleaf pine-oak-hickory
Louisiana	Mixed hardwood-loblolly pine
Louisiana	Xeric sandhill
Louisiana	Stream terrace, sandy woodland savannah
Coastal Plain	Gulf coast pitcher-plant bogs
Virginia	Pocosins
North Carolina	Mountain bogs
Blue Ridge, Tennessee	Appalachian bogs
Highland Rim, Tennessee	Upland wetlands
Tennessee	Aquatic mussel beds
Virginia	Ultramafic glades

For example, agriculture and forestry practices initially reduced the longleaf pine (*Pinus palustris* Mill.) and wiregrass (*Aristida stricta* L.) ecosystems in the Coastal Plain from over 24 million acres to <2 million acres (Noss 1989). Urbanization further reduces the extent of these ecosystems. This change significantly affects the biodiversity of the region. Decline in the population of the gopher tortoise (*Gopherus polyphemus*), a keystone species, was especially damaging. Over 350 species depend on the tortoise and its burrows. As the tortoise is locally extirpated, many of the species depending on it may also disappear.

Likewise, major problems involving nonnative species in the South are not just the result of urbanization but also the consequence of past agricultural, forestry, and wildlife practices (Williams and Meffe 1998). Examples include balsam wooly adelgid (*Adelges picea*), kudzu [*Pueraria montana* (Lour.) Merr.] (**fig. 5.8**), and the wild boar (*Sus scrofa*). Urbanization may increase the susceptibility of a forest to colonization by nonnative species. Forest communities with modified soils, low native biodiversity, absences of predator species, simple food webs, and a high frequency of human disturbances are more vulnerable to invasion by nonnative species than intact communities (Lodge 1993, Meffe and Carroll 1994, Williams and Meffe 1998). These traits often characterize forest communities in urban and urbanizing landscapes (McDonnell and others 1997). We are only beginning to understand how nonnative species alter ecosystem composition, structure, processes, goods, and services. Research needs to consider the positive as well as the negative effects of nonnative species in an ecosystem.

Photo by Hallie Dozier, Louisiana State University

Figure 5.8
Kudzu (*Pueraria montana*) is an invasive nonnative species that is altering ecosystems throughout the South.

"Very often when you're developing a forested environment, that kind of disturbance promotes exotic species that may not compete well in a forested environment but do very well when the area is disturbed." Georgia

Over 6,500 nonnative species occur in the United States (Williams and Meffe 1998). In the South the number of introduced plant species ranges from 362 in Oklahoma to 1,017 in Florida; most States have between 500 to 700 introductions (Williams and Meffe 1998). Fish, amphibians, reptiles, and mammals have also been introduced into the South. Some of these introductions—especially the fish, amphibians, and reptiles—resulted from pets being released into the wild (Williams and Meffe 1998). Since humans are the primary cause for introductions of nonnative species, the potential for additional introductions increases as human population density increases.

High population densities of native species also affect ecosystem composition and structure. Examples include the Canada goose (*Branta canadensis*), raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*) (**figs. 5.9A, 5.9B**). High populations of Canada geese pollute water bodies and contribute significantly to the eutrophication of small ponds and lakes. Population densities of raccoons have increased dramatically in some parts of the South (Southern Appalachian Man and the Biosphere 1996). For example, only 43 percent of the counties in the Appalachian Mountains and Shenandoah Valley (135 counties) had moderate densities of raccoons (5 to 10 individuals per square mile) in 1970. By 1995, nearly 96 percent of those counties had moderate to high densities of raccoons (>10 per square mile). Because the raccoon is a vector for rabies and a predator of ground-nesting animals, this increase, caused by human development, has significant implications for human health and species diversity in the region.

Photo by Larry Korhnack, University of Florida

(A)

Photo courtesy of Virginia Department of Forestry

(B)

Figure 5.9
High population densities of native species, such as (A) raccoons and (B) white-tailed deer, can affect ecosystem structure and function.

A similar increase in white-tailed deer population has occurred. For example, in the Southern Appalachians, only 30 percent of the counties had moderate deer densities (15 to 30 individuals per square mile) in 1970. By 1995, nearly 70 percent of the counties had moderate to high densities (>30 individuals per square mile) (Southern Appalachian Man and the Biosphere 1996). This increase resulted from changes in landscape configuration, lack of predators, and increased food supplies. At moderate to high population density, white-tailed deer can reduce agricultural production, damage urban plants, and denude understory vegetation in forest stands. The loss of understory vegetation significantly affects breeding success of ground-nesting species. The increased number of homes in the interface also contributes to increased white-tailed deer densities by reducing hunter access. Similarly, with the increase in human population in the interface, population densities of domestic dogs and cats are expected to increase. Domestic pets also can significantly affect ground-nesting species (Churcher and Lawton 1987).

Disturbance Regime

Ecosystems are dynamic. Changes occur because ecological, physical, and social components change through time and because of natural and human disturbances. Urbanization is a disturbance agent. Like natural disturbances, urbanization alters composition, structure, and spatial arrangement of ecosystems on the landscape. Unlike natural disturbances, however, changes caused by urbanization often are longer lasting. For example, intensive lawn and horticultural management systems inhibit natural succession. In addition, as the interface is developed, landscape heterogeneity changes. Urbanization decreases the number of native habitat types and increases the number of human structures and habitats (Pickett 1998).

Suppressing disturbances alters landscape heterogeneity (Turner and others 1998). In the South, one of the single most disruptive changes in the natural disturbance regime has been fire suppression (see chapters 6 and 8). The policy decision to suppress fires has endangered the existence of fire-dependent communities and species, enabled xeric communities to become more mesic in species composition, increased the size and severity of forest fires, and reduced landscape heterogeneity (Buckner and Turrill 1998, Stuart 1998) (**fig. 5.10**). Fire suppression also alters the frequency and severity of other disturbances, such as those caused by insects and pathogens (Covington and others 1994).

In human-dominated systems, fires often are suppressed to minimize the losses of personal property and structural damage. To minimize fuel buildup around structures, prescribed burns are conducted. These fires, conducted in late winter or early spring, burn cooler and have different ecological effects than hot fires occurring during the hotter and drier periods (Buckner and Turrill 1998). For example, cool fires may lack the heat and intensity to open serotinous cones of Table Mountain pine (*P. pungens* Lamb.). Cool fires also may create a landscape that is more homogeneous than a landscape with both cool and hot fires.

Fire creates new habitat. Both native and nonnative species quickly colonize this habitat (Stuart 1998). Cool burns and high population densities of nonnative species in urbanizing landscapes may create a more favorable condition for colonization and growth of nonnative species. The effect of cooler, prescribed burns on native and nonnative species needs to be assessed. Changes should be measured at different spatial and temporal scales.

Atmospheric Effects

Air pollutants of concern in southern forest ecosystems include oxides of nitrogen (NO_x) and sulfur (SO_x) and tropospheric or ground-level ozone (O_3). Each of these pollutants occurs naturally, but human activities increase their concentrations in the atmosphere. At high concentrations, these pollutants injure plant tissues, alter ecosystem processes, and predispose forests to other environmental stresses (Berish and others 1998).

Automobiles are the major sources of NO_x (Berish and others 1998). These compounds can react with volatile organic compounds to form O_3 or they can be deposited directly on forests. When deposited, they may alter productivity rates, and increase nitrification and nitrate leaching in terrestrial systems (Aber and others 1989). Although NO_x deposition is greatest in urban landscapes (Lovett and others 2000), increased vehicle travel throughout the interface may enhance NO_x deposition in rural areas.

Utility companies burning fossil fuels are the major sources for SO_x, a precursor to acidic deposition (Berish and others 1998). Long-term exposure to acidic deposition alters soil pH, leaches base cations from the soil, and causes surface water acidification (Berish and others 1998, Likens and others 1996). The greatest cumulative deposition rate of SO_x in the United States was measured in a spruce-fir forest in the Appalachian Highlands (Johnson and Lindberg 1992, Peine and others 1998). The SO_x originated from an adjacent State when the Tennessee Valley Authority increased electricity production to supply new and existing developments and the tourist industry during the summer. Climate patterns carried the pollution over the spruce-fir forest, demonstrating the regional impacts of pollution. New Federal regulations limiting SO_x emissions may reduce the effect of SO_x on forest ecosystems.

Like NO_x and SO_x, O_3 increases with urbanization. Typical summertime daily maximum O_3 concentration in urban and suburban landscapes ranges from 100 to 400 parts per billion (ppb) as compared to 50 to 120 ppb for rural landscapes (National Research Council 1992). Short-term exposure to relatively high concentrations (>150 ppb) can cause acute visible foliar injury in sensitive plants (Krupa and others 1998). Because O_3 enters a plant through leaf stomata, which close when soil moisture is limiting, soil moisture is an important variable affecting uptake and subsequent tissue damage. Greater rainfall at higher elevations may make forests there more susceptible to O_3 damage than forests at lower elevations (Berish and others 1998). Pollution damage to sensitive ecosystems in the Appalachian Highlands may increase as regional and local NO_x and O_3 concentrations increase.

Forest Health

In each of the previous sections, urbanization effects were discussed as independent events. These effects, however, act together. For example, atmospheric deposition alters nutrient availability in the soil and injuries plant tissue. These effects subsequently predispose the forest to pests and pathogens.

How do we know if a forest is healthy? This question was the focus of a workshop attended by scientists, philosophers, managers, environmentalists, and industrial representatives (Constanza and others 1992). They developed the following definition: "an ecological system is healthy and free from 'distress syndrome' if it is stable and sustainable—that is, it is active and maintains its organization and

Photo courtesy of Florida Division of Forestry

Figure 5.10
Many southern ecosystems are dependent on fire for maintaining ecological processes.

Broad and Fine Scales

In the wildland-urban interface, natural habitats are rapidly transformed into urban land uses with significant ecological consequences. Land use planners must reconcile economic development with environmental protection. To understand the ecological effects of urbanization, we need to look at entire landscapes (broad scale) as well as affected sites (fine scale). Traditionally, effects on soils, vegetation, species composition, and hydrology have been analyzed only on a fine scale.

autonomy over time and is resilient to stress" (Haskell and others 1992). Distress syndrome refers to the inability of an ecological system to recover naturally. Urbanization ultimately predisposes a forest ecosystem to a distress syndrome because of a suite of direct and indirect effects including land use conversion, fragmentation, pollution, loss of keystone species, introduction of nonnative species, and altered disturbance regime. With time, the original composition, structure, and function of the forest ecosystem will change in urban and urbanizing landscapes (Zipperer and Pouyat 1995). These new forests will be composed of native and nonnative species that have adapted to the stresses created by the urban landscape. The quality and quantity of ecosystem goods and services provided by these forests have yet to be determined.

" I think we have taken the wrong focus when saving a tree or patch of woods. Rather we need to take a systems approach. We need to look at the natural system and all the components . . ." Virginia

To address urban effects on forest health, an integrative and interdisciplinary approach is necessary. The approach must include terrestrial and aquatic systems and account for ecological processes operating at different spatial and temporal scales. Likewise, the approach must account for the complexity of interactions among the social, ecological, and physical components of an ecosystem.

An Ecosystem Approach

Land use decisions often are based principally on socioeconomic elements of an ecosystem. Biological and physical elements should also be considered in a holistic or ecosystem approach to land use decisions. Since humans derive benefits from all the elements in ecosystems, anything less than an ecosystem approach may yield the wrong conclusions.

An ecosystem approach acknowledges the biophysical and social complexities of ecosystems and the importance of maintaining those complexities to meet human needs. Energy, organisms, and materials flow into and out of ecosystems and are not confined by political or management boundaries. A broad scale or landscape perspective is needed to assess how development alters these flows. A broad perspective also helps planners to see cumulative changes across the landscape.

Needs

Forests will always exist in the South. Their composition, structure, and function will continue to change because of environmental and human effects. During the urbanization process, we need to maintain forest health to provide the goods and services enjoyed and used by humans. To accomplish that objective, we need to sustain ecological and social integrity through an ecosystem approach to management (McCormick 1998). To meet these goals, new research should be conducted and educational tools should be developed.

Research is needed to:

- Quantify population distributions of native and nonnative species.
- Assess the synergistic effects of various land conversions, altered disturbance regimes, and atmospheric pollution on natural habitats and the establishment, growth, and maturity of native and nonnative species.
- Assess how nonnative species are altering the composition, structure, and function of the numerous ecosystems of the South.
- Understand how current fire management policies influence native and nonnative species colonization and growth.
- Monitor urban effects on ecosystem processes such as nutrient and carbon cycling, hydrology, and productivity over the long term. Monitoring is needed across the entire South rather than just at a few localities.

- Develop protocols for restoring or rehabilitating ecosystems affected by urbanization.
- Move beyond smart growth models and start to predict the impacts of land use changes on landscape heterogeneity as well as ecosystem composition, structure, and function. Wear and others (1998) are modeling land use changes in an urban and urbanizing context. This work needs to be expanded to landscapes throughout the region, and results need to be applied to land use decisions.
- Identify the linkages among ecological, social, and physical components of the ecosystem and how social policies and socioeconomic conditions alter those linkages at different spatial and temporal scales.

Education needs are to:

- Establish a center or clearinghouse for research information so that results can be synthesized and packaged for various user groups-natural resource managers, land use planners, and landowners. The center must not only provide information; it also must provide a focus for education. Satellite learning centers also may need to be established to effectively transfer information to different user groups. Currently, scientific information exists to make sound land management decisions, but the information is not being used (McCormick 1998).
- Develop information vehicles to enhance traditional approaches for groups and individuals without Internet connections. The Internet provides a new avenue for dissemination, but access needs to be enhanced, and information needs to be packaged according to user group.
- Develop workshops and short courses not only for natural resource managers but also for mayors, county planning commissioners, and staffers from Governors' and legislators' offices on the importance of a holistic approach to land use planning. These workshops should also provide protocols for land use decisions.
- Update management procedures to reflect current techniques being applied by the management community and evaluated by the research community. Users—researchers and managers—need to be linked through the center so that new needs are identified and new information is disseminated.

Conclusion

Fire blackens the earth temporarily, but asphalt blackens it permanently. While this Assessment acknowledges that fire is an important wildland-urban interface issue, it also recognizes the long-term consequence of losing basic ecosystem goods and services to urbanization. Even if all development stopped today, forests would continue to be affected by urban uses through indirect stresses such as air pollution, global climate change, altered disturbance regimes, and introduction of exotic species. We are just beginning to understand the long-term ecological consequences of these indirect effects on forest ecosystems.

The question is not whether we should develop, but rather how best to use the land to maintain or enhance the goods and services provided by ecosystems (Turner and others 1998). Since the greatest threat to species, habitats, and cul-

tures of the South is the increase in human population, land management decisions need to incorporate the principles of an ecosystem approach to decisionmaking (Dale and others 2000, Flores and others 1998, Zipperer and others 2000). Without ecological planning and collaboration, we are faced with continual urban sprawl and the loss of the ecological uniqueness and cultural diversity that define the South.

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Chapter 6

CHALLENGES TO FOREST RESOURCE MANAGEMENT AND CONSERVATION

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Introduction

Southern forests produce many ecosystem goods and services, such as clean water, timber, recreation, and wildlife. However, these forests—particularly those in the interface—are changing. Forest tract size is decreasing, and the number of forest owners is increasing. These new forest owners may have different management objectives than long-term residents, emphasizing noncommodity goods and services. At the same time, society's demands on forest resources are expanding. These changes set the stage for innovative management and conservation alternatives. This chapter begins by addressing some of the main issues affecting the management of interface forests. It then addresses the changes and challenges, new approaches and trends, and needs for five major aspects of forest resource management in the interface. Finally, we conclude with a summary of overall management needs. ▶

The Forest Stewardship Program

Private individuals own most of the South's forest lands, many of which need financial and technical assistance to actively manage their forests. To address these needs, Congress enacted the Forest Stewardship Program in 1990. This program has integrated multiple landowner objectives into management planning. The Forest Stewardship Program helps private landowners develop plans designed to increase the economic value of their forests while maintaining their environmental integrity for future generations. In addition, the Stewardship Incentives Program was established to provide financial assistance for conservation practices. This program could be adapted to interface forests.

Managing Forests under Change

As rural land is converted to urban uses, the ways in which nearby private and public forests are valued and managed change a great deal. As one moves along the spectrum from rural to urban, forests become more valued for their non-commodity benefits, such as wildlife viewing and aesthetics. Managers of interface forests must be more prepared than their rural counterparts to deal with human influences and interactions.

Interface forests are changing hands. Sampson and DeCoster (2000) found that there are roughly 150,000 new landowners every year across the United States. In the South, a 12-percent increase in forest landowners was observed from 1978 to 1993 (Wear and Greis, in press). These new owners often have different management objectives than their predecessors or may not know where to go for forestry information (DeCoster 1998). Fifty-nine percent of the approximately 5 million individual nonindustrial private forest (NIPF) landowners in the South emphasize improving wildlife, water, aesthetics, and other natural components on their land as their primary or secondary objective. Only 7 percent of landowners list making money as their primary goal (see chapter 2, fig. 2.7).

Additionally, tract sizes are decreasing. Out of the approximately 5 million landowners in the South, 4.1 million own <50 acres (Wear and Greis, in press). Traditional forest management is seldom applicable to the smaller tracts in the interface; new management options for these forests are thus required.

Managers of public forests and other large forest tracts lying close to cities are also faced with many challenges. Some of the major issues confronting managers of urban national forests (Dwyer and others 2000) are:

- Greater use of the forest;
- Pressures from adjacent owners;
- Development along their boundaries;
- Concerns over landscape views, trash, fire, invasive plants and animals;
- Higher degree of visibility to a greater population; and
- More complex planning and decisionmaking.

The composition, structure, and function of forest ecosystems in the interface are changing due to stresses such as pollution, land use conversion, and introduction of invasive exotic species (**fig. 6.1**) (see chapter 5). An example of a southern landscape-level stress is the current outbreak of the southern pine beetle (*Dendroctonus frontalis* Zimmermann). These beetles increase their populations after natural and human-caused stress events, such as droughts, hurricanes, and

"Two thirds of the state is in forest cover. The trend is an increasing amount of forest cover. But if we could see property lines out there, we'd see many, many more forest landowners owning smaller and smaller parcels of forestland." Virginia

urban development (Personal communication. 2001. James Meeker, Forest Entomologist, Florida Division of Forestry, Forest Health Section, 1911 SW 34th St., Gainesville, FL 32608). Two recent outbreaks in Florida originated in urban areas and spread outward to forests in the interface (**fig. 6.2**). Management to reduce these imposed stressors on forest ecosystems will involve a landscape perspective, which includes the management of adjacent ecosystems. Most management recommendations to sustain healthy forests emphasize minimizing stress due to altered energy, species, and materials flowing into and out of ecosystems. Landscape-level management that incorporates ecological, social, and physical components of several ecosystems is necessary to solve these complex challenges to forest health (see chapter 5).

Management and conservation of forest resources in the interface are further challenged by scale. Federal laws, such as the Endangered Species Act or the Clean Water Act, may impact the whole southern region. State laws and growth management planning may affect forest ecosystems at a State level (see chapter 4). Counties also are seeking to influence their surrounding forests. In 1999, out of 102 local initiatives voted on in the United States to devote public funding to protect open space, 90 percent won approval, committing $7.3 billion (Land Trust Alliance 2001). At local levels, developers are often seeing the benefit of green space and clustered housing, and local governments are adopting ordinances to foster forest and water resource conservation (see chapter 4). All these levels of government, citizenry, and private enterprise affect forest management at all scales from backyards to large forested tracts.

Photo by Hans Riekerk, University of Florida

Figure 6.1
The interface has many new inputs, such as invasive species and pollution.

Photos courtesy of USDA Forest Service

Figure 6.2
Southern pine beetle outbreaks occur after major stress events, such as droughts, hurricanes, and urbanization.

Photos courtesy of USDA Forest Service

Figure 6.3
As demands for water-based recreational activities increase, there are also concerns with assuring that there are adequate water supplies for wildlife and aquatic species habitat.

Managing Water Resources

Changes and challenges—Forests play a critical role in the earth's water cycle. About 80 percent of the Nation's fresh water originates in forests. Forests absorb water, refilling underground aquifers. They cool and cleanse the water, slow storm runoff, reduce flooding, sustain watershed stability and resilience, and provide critical habitat for fish and wildlife (U.S. Department of Agriculture, Forest Service 2000). These benefits are threatened, however, when forests are converted to other uses (see chapter 2, fig. 2.14).

Traditionally, water-quality concerns in the South have revolved around activities such as mining, livestock operations, agriculture, and some forestry activities. The loss of forest land to urban land uses, however, has a far greater affect on water quality (Minahan 2000). Today urbanization is the most pressing land use issue affecting water quality and quantity. The growing population of the South is demanding ever-larger water supplies. Large metropolitan areas, such as Atlanta, GA, rely on upland watersheds to supply their water. In addition, increasing numbers of people are settling and recreating on the primary watersheds for large cities (Minahan 2000). Demand for water-based recreation is also increasing, and there are concerns with assuring adequate water supplies for wildlife and aquatic species habitat (**fig. 6.3**).

Reducing Runoff

Some new approaches for reducing runoff are initiated at the planning and design phases of development and include incorporating less impervious surfaces and cluster development, which results in more green space. Austin, TX, for example, has developed environmental protection and management plans for 11,000 acres of greenbelt to preserve such unique water bodies as Barton Springs, a park with a natural limestone pool in the center of Austin.

". . . . Whatever happens upstream impacts the downstream area. So if you have a fellow that builds a pond on the headwaters and it warms the water, then the folks downstream don't have trout in their stream." Georgia

With demands for water increasing, allocation issues present significant challenges for resource managers, scientists, and citizens. Serious conflicts are emerging over allocation of high-quality, abundant flows of water for many purposes (U.S. Department of Agriculture, Forest Service 2000). Increased demands for water also place increased pressure on public lands, such as national forests, to protect water supplies while at the same time providing recreation opportunities.

When forests at the interface are replaced by impervious surfaces, such as buildings, paved streets, and parking lots, the water cycle is interrupted with some of the following consequences:

- Infiltration of water into soil decreases;
- Stormwater runoff increases, and it must be managed and accommodated in sewers, canals, or other structures;
- Water quality decreases as pesticides, fertilizers, trace metals, and other pollutants are concentrated in the runoff;
- Shallow and deep infiltration decreases;
- Erosion of unprotected soils increases, leading to sedimentation in streams and rivers; and
- Evaporation of water decreases as does its associated cooling effect.

Other concerns from urbanization are the increased need for wastewater treatment and the effects of septic system failures on water quality. To delay the need for sewer system extensions and improvements in interface areas, many residential areas install densely placed septic tanks that are highly susceptible to failures and are the chief contributor of fecal coliform contamination (Minahan 2000). This contamination can result in economic and human health concerns. Nonpoint-source pollution is also a major concern. Sources are widely dispersed across the landscape and are difficult to pinpoint or regulate. Thus, the challenge is to balance population growth and economic needs with the protection of human health and water resources. There is also the challenge of educating those upstream about the "downstream effect"—helping people to realize that what they do on their land affects those who use water downstream.

Managing forest ecosystems at a watershed scale is a pressing challenge for resource managers. Previous land management decisions often were made independent of other human activities on watersheds. Consequently, the cumulative effect of incremental changes in land cover was never assessed, and water quality and quantity declined. To effectively manage water resources, a watershed approach is mandatory. A watershed approach provides a framework to design the optimal mix of land covers, minimize the effects on water resources, and coordinate management priorities across land ownerships. The challenges of managing on a watershed scale, however, are many. Most management strategies are not on a scale commensurate with issues at the watershed scale. Local control or management for system components often takes precedence over systemwide needs. Data are not collected and analyzed on watershed scales. Similarly, the scale of monitoring is too small. There is also a lack of long-term commitment to assess cumulative effects, and it often is not economically feasible to study, manage, and restore at such large scales (Naiman 1992).

Needs—Research is needed to discover:

- Accurate information on how much water comes off forested lands (including national forests), where it flows, and how it is used;
- Long-term hydrological impacts and changes to water at the interface [efforts like the Baltimore Ecosystem Study are needed (Doheny 1999)];
- The role that urban forests play in improving water quality and quantity;

Naturescaping for Clean Rivers

The program "Naturescaping for Clean Rivers" seeks to improve the quality and reduce the quantity of water reaching storm drains and eventually the aquatic systems in Portland, OR. Workshops teach homeowners how to establish and manage their landscape with native plants that require much less water, fertilizers, chemicals, and mowing.

Watershed Protection and Flood Prevention Program

The U.S. Department of Agriculture, Natural Resources Conservation Service, Watershed Protection and Flood Prevention Program works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres (Minahan 2000).

- Interactions among multiple land uses and cumulative effects over time across large landscapes;
- Information to relate water-quality standards to the effectiveness of individual control measures;
- The connections between water-quality standards and specific nonpoint-pollution sources;
- New strategies for managing mixed-ownership watersheds;
- Methods for large-scale watershed restoration;
- Methods of developing land with water conservation in mind;
- Ways to retain natural attributes such as streams, springs, ponds, wetlands, and lakes;
- New conservation practices and methods for reusing wastewater; and
- Information about the use of riparian buffers around streams in interface and urban situations.

Educational efforts and collaborative approaches should center on:

- Improved public awareness and general understanding of watershed issues, how their everyday actions affect water quality and quantity, and the value of reducing water consumption and improving conservation efforts;
- Long-term stewardship programs that include identification of impact sources, monitoring, annual clean-up outings, streamside and lakeshore vegetation maintenance, and restoration projects;
- Programs for developers that demonstrate new designs, plans, and cost savings associated with less impervious surfaces and better stormwater management;
- Wetland and riparian buffer protection programs;
- Demonstration cost-sharing projects that encourage landowners to minimize nonpoint-source pollution by using best management practices; and
- Collaborative partnerships among potential and existing water users at watershed scales to achieve long-term, sustainable watershed health (U.S. Environmental Protection Agency 1998).

Managing for Traditional Forest Products

Changes and challenges—Southern forests make up 40 percent of U.S. timberland, and the forest industry employs more than 660,000 people in the South. Indirectly, the industry accounts for another 1.7 million jobs in the region (Faulkner and others 1998) (**fig. 6.4**). Projections show that the South will continue to be the Nation's leading source of timber, and there are great opportunities to increase timber production on private forests (Cubbage and others 1999). While they are providing traditional forest products, such as timber and fiber, these forests also help maintain areas in green space and provide many other ecosystem goods and services. However, when these lands are within the interface, their management and conservation become increasingly difficult.

The South has a high portion of forests near metropolitan areas where many interface forests are located. Dwyer and others (2000) found that the South had the most cities with forests within 50 miles than any other part of the United States. The highest rural land prices are found in these metropolitan counties, which bring about a corresponding increase in the costs of producing timber there. Because of this, selling interface forests for real estate can be more profitable for both industry and NIPF owners than timber production (see chapter 3). The perceived impermanence of land use in the interface can discourage landowners from making long-term forestry investments in metropolitan counties (Wear and others 1999).

For these reasons, it is not surprising that studies are indicating that timber production decreases the closer forests are to urban areas. Wear and others (1999) report that there is little opportunity for practicing forestry for timber production near population densities of 150 people per square mile or more. Another study in Mississippi and Alabama also illustrated that proximity to urban land uses, higher population densities, and proximity to urban centers all lead to lowered timber-harvesting rates (Barlow and others 1998). For timber production to remain relevant in the interface, private landowners must be able to afford to retain and manage these forests for both timber and the noncommodity goods and services that they provide.

As more people are in close contact with traditional forest management practices, there is more potential for conflict between people who hold different sets of perceptions and values over how or if forests should be managed (Vaux 1982). Public concerns over forest management practices range from environmental concerns over erosion, herbicide use, and maintaining an adequate tree cover to complaints about noise and dust from forestry operations. Increasingly these public concerns are translating into the development of local ordinances that regulate forestry practices (see chapters 4 and 7). This can impact the amount of timber available and the cost of transporting it. Recent studies have shown, however, that a majority of both the general public and NIPF owners support environmental protection and even regulation if necessary (Bliss and others 1993, 1997).

The challenge is for local governments, industry and NIPF owners, and the public to work together to develop innovative solutions that meet the needs of all of the involved stakeholders. Working with the public to demonstrate how sound forest management protects environmental values is critical. The collaboration of forest industry with local units of government can lead to productive relationships that benefit both industry and public interests. These relationships can help increase awareness of the benefits of retaining land in working forests while assuring that citizens' concerns are taken into account.

Because of the changing economic and sociopolitical environment in the interface, traditional forest management may need to be adapted to these special conditions to maintain relevance. Modified practices may include changes in harvest size and location and the use of shelterwood and partial cuts. The use of fire and herbicides for removing understory may also be limited (Bradley 1984). The challenge is to adapt forestry practices to the changing conditions and transitioning values in the interface while maintaining the cost effectiveness of management. Otherwise, the landowner may be forced to consider more profitable options (Bradley 1984).

Where timber production is not an option, nontimber commodity products may be viable alternatives for landowners. Examples of such products include pine straw, firewood, nuts, and medicinal plants. These products may have more relevance for owners of small tracts (see chapter 7). However, much still needs to be known about their management and market potential.[1] Managing forests for carbon sequestration also has potential in the interface. The challenge for foresters

Photo by Tim White, University of Florida

Figure 6.4
Forest industry in the South produces commodities valued in excess of $90 billion, employs more than 660,000 people, and indirectly accounts for another 1.7 million jobs (Faulkner and others 1998). However, challenges for managing forest lands for traditional forest products in the interface are growing.

The Forest Legacy Program

The Forest Legacy Program works in partnership with States to protect environmentally sensitive forest land from conversion to nonforest uses through acquisition and conservation easements (Beauvais 2000). States develop plans that identify environmentally important private forests facing urbanization. These targeted private forests are then eligible for matching funds from Federal and non-Federal sources of up to 75 percent for the acquisition of conservation easements (see chapter 4). Most of the Forest Legacy Acquisition Projects to date have been in the Northeastern and Western United States; but North Carolina, South Carolina, Tennessee, Virginia, Georgia, and Alabama are participating, and Kentucky is beginning the planning process.

"Issue one for me that deals with forestry is the issue of gypsy moths and the problem of spraying for gypsy moths. I was almost sued for spray going onto someone else's property, which is almost impossible to prevent when you're spraying by air. You're trying to save your own investment, yet you run the risk of legal problems from the public at large." Virginia

is to adapt to these diverse management needs and scales. Adapting will require new skills, knowledge, and tools.

Small parcels, multiple owners, and conflicting objectives complicate coordinated management on larger ecosystem scales, such as watersheds. Management across ownerships can ensure healthy ecosystem function while providing the desired goods and services of forests. Partnerships among private landowners and private organizations can help overcome the challenges of managing on a landscape scale.

Needs—Research is needed to develop:

- Models for managing across multiple ownerships and technologies that address a wider variety of management objectives;
- Effective options for maintaining working forests in the interface (see chapter 4);
- Workable solutions for managing the increasing number of small NIPF parcels;
- Ways to market forestry information and services for small tracts;
- Techniques for incorporating new neighbors into forestry decisionmaking;
- Management and market potential of nontimber forest products;
- Alternatives to public policies that discourage forest management (see chapters 3 and 4);
- Technologies for identifying critical forest lands for conservation efforts; and
- Costs and benefits of different forest management schemes in the interface.

Tools, incentives, collaboration, and education needs include:

- Adoption of the National Coalition for Sustaining America's Nonfederal Forests' (2000) Report recommendations proposing education, research, extension, and outreach for stewardship of private forests;
- Landscape- or community-level partnerships and cooperatives for forest management;

Carbon Sequestration

Carbon dioxide (CO_2) in the atmosphere is increasing globally and is the principal contributor to global warming. The two main sources of CO_2 are the burning of fossil fuels and deforestation (Houghton and others 1996). Catastrophic fires in the interface, caused by large fuel buildups, rapidly release large amounts of CO_2. Forest ecosystems store carbon, and exchanging them for asphalt and concrete lowers carbon (C) sequestration. Urban trees often are less healthy and are slower growing than those in natural forests, contributing very little to C sequestration (Rowntree and Nowak 1991). Young, fast-growing forests accumulate C at a greater rate than old forests (Clausen and Gholz 1999). If healthy, fast-growing interface forests can be sustained, C sequestration can be one of their global contributions. Forests at the interface also cool and shade structures in the summer, reducing fossil fuel consumption.

[1]Virginia Polytechnic Institute and State University, Center for Forest Products Marketing and Management. 2001. Non-timber forest products. http://www.sfp.forprod.vt.edu[Homepage].

- Economic incentives and compensation to forest landowners for providing public values, such as riparian buffers or protection of endangered species as well as timber production;
- Targeting forestry programs addressing a range of management objectives for all sizes of tracts; and
- Educating the citizens in the interface about the importance of forests and the benefits accrued from conserving and managing them.

Managing Fire

Changes and challenges—Fire is one of the most visible and demanding issues facing the wildland-urban interface. Recent wildfires in the West and South have caused millions of dollars of property damage to homes, forests, and rangeland. With decades of fuel buildup and the increasing numbers of people moving to the interface, the challenges of preventing and suppressing fires have increased, and the ability to use fire to maintain and enhance ecological processes has decreased. Temporarily successful fire suppression efforts have led to hazardous fuel buildups across the country. Fire exclusion has also produced a range of forest health and wildlife problems, such as critical epidemic insect and disease conditions and species extinctions (Wade and others 1998).

Prescribed fire is one method for removing combustible fuels and reducing the risk of uncontrolled wildfire. It also can maintain, enhance, and restore processes in fire-dependent ecosystems (Wade and others 1989) (**fig. 6.5**). The use of prescribed fire in the interface may be limited, however, due to the perceptions and attitudes of the public. Many people may not understand its benefits or may decide that the benefits are not worth the risks involved with its application. Many public health and safety issues are associated with burning. Fires can get out of control. They can reduce visibility on highways. Ash may drift into swimming pools, and smoke from fire may reduce air quality (see chapter 8). Another challenge regarding the potential use of fire is that many landowners of tracts in the interface do not want to manage their forests at all (see chapter 2). Community development standards may also encourage unsafe fire conditions.

"The ecosystems we have here are dependent on fire. If you don't control the density and the fuel loads with prescribed fire, when they do burn, we are not going to stop them." Florida

The Forest Bank™

The Nature Conservancy's Center for Compatible Economic Development was created in 1995 to develop new businesses, land uses, and products that help achieve conservation goals (Gilges 2000). One of its programs, The Forest Bank$_{TM}$, aims to form partnerships with private landowners to protect the ecological health and natural diversity of working forests while ensuring long-term economic productivity (Dedrick and others 2000). Landowners who deposit or transfer their right to grow, manage, and harvest trees are ensured a sustainably managed working forest, a dividend payment, and the right to withdraw the value of their timber in cash. The Virginia pilot study has deposits of over 650 acres of forest at a value of $750,000.

Photo by Larry Korhnack, University of Florida

Figure 6.5
Prescribed fire is one tool that fire managers can use to remove combustible fuels and reduce the risk of uncontrolled wildfire.

Florida Wildfire Mitigation Program

After the 1998 wildfires, the Florida Division of Forestry developed a Wildfire Mitigation Program, which includes four Wildfire Management Teams and public information officers to address hazard fuel reduction in the wildland-urban interface. Each regional team is responsible for reducing fuel accumulations in and around communities with subdivisions. They also help to suppress wildfires. The public information officers contact individuals and homeowner associations to describe the benefits of the program and discuss aspects of making their homes "FireWise." They also help identify potential areas for hazardous fuel reduction. Public awareness and education is a key factor in this program (Rhea 2000).

Because of these issues, fire management cannot be the same in the interface as in rural areas. In the South, a vast majority of land is privately owned. A dense road network in the interface provides many firebreaks; but it also brings people into forests. In the West, on the other hand, the Federal Government owns most of the undeveloped land, and the network of roads is not as well developed (Achtemeier, in press). Weather and fuel characteristics that may be optimal for burning hazardous fuel loads or for restoring wildlife habitat in rural areas may not be practical in the interface. For example, prescriptions for achieving optimal fire intensities, fuel consumption, and completeness of burn may need to be compromised to avoid excessive smoke production that could enter neighboring communities or cross highways. Different firing techniques and ignition patterns may also be needed in the interface. Although objectives for rural and interface prescribed burning may be similar, priorities shift in the interface due to human health, safety, and liability concerns. Because of this, smoke management becomes a major priority in the interface.

Where prescribed fire is not a viable option, mechanical, biological, and chemical fuel reduction methods may be needed. Although these methods may effectively reduce hazardous fuels, evidence suggests that only prescribed fire can mimic historical ecosystem processes, such as lightning (Heinselman 1973) (see chapters 5 and 8). Other methods, particularly herbicide use, may face stiffer public opposition than the use of fire or may need to be used in combination with fire to be effective (Brennan and others 1998). With any method, regular retreatment is needed to prevent hazardous fuel buildup.

Many of the homes that have sprung up in the interface are built with little consideration for fire risk or protection. Roofing and siding materials are flammable, addresses are poorly marked, access to water supplies is limited, and access for fire emergency vehicles is poor (Perry 1985). Vegetation may be allowed to grow right up to the sides of homes, with little thought for the associated risks of the building fuel loads. Fuel buildups near structures are particularly troublesome where vacation and second homes lacking year-round maintenance predominate.

The risk of fire increases as more forested and rural areas are opened up to human influences (Rice 1987). Some of these ignitions may be accidental, while many are due to arson. In either case, the frequency and risk of catastrophic wildfires grows. Firefighting agencies must have a higher degree of readiness to respond to fires in the interface due to these factors and the increased values at risk that come with urbanization (Rice 1987). All of these factors have made wildfire protection and suppression increasingly dangerous and difficult.

Fire suppression priorities and strategies also change in the wildland-urban interface. The policy of Federal and State agencies has been to first protect life and structures and then natural resources (Cortner and Lorensen 1997). The problem is that most forest fire suppression personnel are inadequately prepared for fighting structural fires, whereas municipal fire departments are not always fully trained or equipped for wildland fire suppression (Davis 1986). The challenge is to combine structural and wildland fire expertise on interface fires and provide cross-training opportunities and effective cooperation across firefighting agencies (see chapter 8).

Needs—Research is needed to (also see chapter 8):

- Determine public perceptions about prescribed fire and wildland fire, including the barriers to actions that can reduce the risk of wildland fire;
- Develop effective strategies for delivering fire prevention messages;

- Understand the role and influence of local public policy in creating or preventing interface fire-related conflicts;
- Develop effective fire ordinances, land use planning policies, and incentives for reducing fire risks to residences;
- Improve prediction of air quality and visibility impacts from smoke;
- Develop models that incorporate weather and elevation data to better predict and monitor smoke;
- Determine the extent and frequency of traffic problems created by smoke from prescribed fire and wildland fire;
- Improve and validate fire weather and fire behavior prediction models;
- Evaluate firing and ignition techniques for prescribed burning in the interface;
- Develop effective fuel reduction burning parameters including mechanical, chemical, and biological treatments and fuel reduction combinations;
- Improve understanding of the costs, benefits, and tradeoffs of different fuel reduction methods;
- Determine the effectiveness of firewise landscaping designs/structures, including plant and mulch flammability, and structure ignitability characteristics; and
- Develop guidelines for southern land and homeowners for assessing and mitigating fire risk around their homes.

Education, tools, and skills needed include:

- Expansion of fire education programs for homeowners;
- Cross training and enhanced collaboration among wildland and structural firefighting agencies;
- Education and outreach messages about fire for the media and local politicians;
- Collaborative efforts and stronger planning partnerships between stakeholders involved in fire prevention and suppression;
- Fire education at the grade school level region wide, emphasizing differences between wildland fire and prescribed fire;
- Education programs at the college level that emphasize wildfire and prescribed fire, communication skills, conflict resolution, political science, and land use planning in the wildland-urban interface;
- Awareness of and involvement in community-based land use planning and policy issues that affect the wildland-urban interface; and
- Hazard rating systems for interface conditions.

Urban-Wildland Interface Advisory Board

The Urban-Wildland Interface Advisory Board in Birmingham, AL, has been dealing with interface fire issues for over 8 years. Members represent a variety of agencies, including those involved in firefighting, local policymaking, and planning. This advisory board has worked to provide training and activities for professionals and private citizens in interface areas in Alabama. They provide an annual award called "Fire-Safe in the Interface" to individuals or groups that have promoted fire safety in the interface.

Table 6.1—Participation in recreational activities in the South in 1995 and projected increases for 2010, 2030, and 2050

Recreational activity	Number of participants 1995	Projected increase		
		2010	2030	2050
	Million	*Percent*		
Water based				
Canoeing	4.20	79	16	34
Motorboating	15.50	13	33	59
Nonpool swimming	23.30	15	37	64
Rafting/floating	4.90	1	4	18
Visiting a beach	37.70	20	48	76
Wildlife related				
Fishing	20.20	11	24	38
Hunting	6.50	82	68	64
Wildlife viewing	34.20	22	54	86
Land related				
Backpacking	3.60	8	23	42
Hiking	11.30	17	45	78
Biking	15.20	22	55	95
Picnicking	27.40	21	52	80
Sightseeing	33.90	25	61	96

Source: Bowker and others 1999.

GREENWAYS

One way to meet increased recreation demand on public land is through creative mechanisms for acquiring greenways in and near cities, such as local acquisition of open space by local units of government and through land trusts (see chapter 4). With over 5,000 active greenways in the United States, these open-space corridors may be the most significant recreation management change and trend in outdoor recreation in the last 10 years (Betz and others 1999, McMahon 1999). These corridors originate from grassroots efforts by citizens to have green space close to where they live (Betz and others 1999). Some unique characteristics of greenways are their local management and leadership and the partnerships that must be formed to create them (Betz and others 1999). Greenways may be created and managed as connections between natural areas (with an ecological objective), as purely recreation areas, or both.

Managing Recreation

Changes and challenges—Most outdoor recreation activities have been growing steadily in the South over the last few years, and recreation has become a significant part of southern lifestyles (Cordell and Tarrant, in press). A national assessment of demand and supply trends concludes that participation in outdoor recreation will continue to increase nationally, with the greatest percentage increases in the South (Cordell and others 1999a). Southern recreation activities, such as wildlife viewing, hiking, and biking, are expected to increase between 18 and 96 percent by the year 2050 (**table 6.1**) (see chapter 2).

While recreation demand is growing, the opportunities for recreation on nonindustrial private forests are decreasing. As a result, pressure will increase to accommodate recreation demands on public lands, which already have significant budget and capacity constraints (Cordell and Tarrant, in press). The challenge for recreation planners and managers is to provide high-quality recreation experiences while sustaining the quality of natural resources. The soil, for example, must be managed to avoid erosion, compaction, and other degradation under heavy recreation pressures (**fig. 6.6**). The interface land is especially under pressure due to its proximity to large urban populations and declining recreation opportunities in cities.

Photo courtesy of USDA Forest Service

Figure 6.6
Increased demand on public recreational facilities in the wildland-urban interface can lead to overuse of trails and camping sites, resulting in erosion and compaction of the soil.

Providing high-quality recreation opportunities for inner-city residents is another challenge. As recreation opportunities decline in inner cities and force people to look beyond the city limits, many inner-city residents with limited resources or disabilities may be left without access to recreation facilities and services (Cordell and others 1999b) (**fig. 6.7**).

With the unprecedented increases in ethnic, racial, and age diversity in the South (see chapter 2), recreation managers must consider the needs and expectations of the different groups using wildland-urban interface recreation sites. For example, Gramann and Floyd (1991) found that Mexican-Americans rated "doing something with your family" and "doing something with your children" significantly higher than non-Hispanic Whites as favorite outdoor activities.

"We're moving into a multicultural society, and I don't think we [natural resource professionals] have changed to reflect that." Mississippi

Managers must also possess skills to communicate not only with people of different cultures (Magill and Chavez 1993), but also for communicating with people that hold diverse values and perceptions about how the land should be used and managed. As forest recreation demand grows, there is more potential for conflict between different recreation user groups utilizing the same areas. Four-wheel drive enthusiasts, for example, are likely to clash with hikers over how backcountry areas should be used (Cordell and Tarrant, in press) (see chapter 7). The challenge is to plan and facilitate diverse recreation experiences for the variety of user groups by including them in decisionmaking processes and helping them to find ways to share access opportunities.

Photo courtesy of USDA Forest Service

Figure 6.7
Programs, such as the Atlanta-based community project, the Urban Tree House, provide outdoor recreational opportunities for inner-city residents.

Needs—Research is needed to:

- Continually assess and track recreation markets, cultural preference trends, and opportunities for recreation on urban, interface, and rural land;
- Determine the importance of private lands, greenways, and urban forests for recreation, especially to serve the urban public and take the pressures off other natural areas outside the city;
- Identify and monitor forested areas in the South where recreation participation is likely to place increased pressures on forest resources;
- Assess impacts of recreation on natural resources, such as vegetation, soils, and wildlife;
- Identify critical areas in need of rehabilitation and protocols for effective rehabilitation in interface situations;
- Identify the diversity of recreation experiences desired by user groups and how user perceptions influence the quality of their experiences; and
- Identify factors that limit effective communication between recreation managers and the diversity of user groups.

Educational needs are:

- Training courses for future recreation managers that prepare them for the social and political dimensions of their work;
- Continuing education opportunities for current managers; and
- Involvement of diverse user groups in the development of education programs, planning, and management objectives, emphasizing their role in managing and protecting resources.

Managing and Conserving Wildlife

Changes and challenges—Southern forests boast an abundance of wildlife, and wildlife-associated recreation is becoming increasingly popular, with 34 million people participating each year (Faulkner and others 1999). Popular wildlife recreation activities in the South include viewing and photographing wildlife, as well as fishing and hunting (see chapter 2, table 2.4). Urbanization and other human influences often destroy, degrade, or fragment wildlife habitat (see chapter 2, fig. 2.15). These changes are the major contributors to declines in wildlife populations and biodiversity worldwide (Swisher and others 2000) (see chapter 5). The consensus among conservation biologists is that direct habitat destruction is the greatest threat to biodiversity at both the species and ecosystem levels, and is the major factor threatening 80 percent or more of the species listed under the Federal Endangered Species Act (Noss and Peters 1995). As the wildland-urban interface expands, managers must address many new wildlife conservation and management challenges.

The most significant wildlife challenge in the wildland-urban interface is conserving, managing, and restoring wildlife habitat. The interface contains patches that can range from backyards, to small pocket parks, to larger forested tracts. The size, shape, and spatial relationships of patches in the landscape affect the structure and function of ecosystems (Dale and others 2000). For example, many

Habitat Restoration

Ecological restoration and management of wildlife habitat is essential for the health of natural communities and the conservation of biodiversity. Many species depend on particular stages of succession and their related disturbances. The Florida scrub-jay (*Aphelocoma coerulescens*), for example, inhabits pine/oak scrub ecosystems in central Florida. This bird requires a low shrub layer, bare ground, and a few scattered trees, avoiding canopied areas. To manage habitat for this rare bird, conservation groups such as The Nature Conservancy have reintroduced periodic fires that maintain the stage of succession needed by scrub-jays.

"The wildlife is being squeezed into smaller and smaller areas or into areas where there is little space . . ." Virginia

studies have shown that the larger the habitat patch, the greater the number of wildlife species present (Adams 1994). Connecting small forest patches to larger reserves with corridors is especially valuable for wildlife. In one urban wildlife habitat conservation strategy, core habitat reserves with minimal human influences are established. To prevent isolation of these reserved areas, corridors are maintained to link core reserves to each other. The result is an integrated network of habitats. Surrounding the core areas are buffers in which resource management and recreation activities occur (Adams 1994).

Another important wildlife conservation strategy is to preserve all the processes that affect wildlife populations and communities, not just site size and connectivity. The site history, the types of adjacent land uses, and current influences should be taken into account when developing wildlife conservation plans (Nilon and Pais 1997).

Urban interface areas have a large proportion of edge habitats—transitions between two ecosystems (see chapter 5). Soft edges with different layers of vegetation are more favorable to wildlife than hard edges in which forest and grass are adjacent. With the increase of forest/development edges, there is a corresponding increase in edge-adapted species, such as deer and quail, and predator species, such as skunks and raccoons. Forest interior species decline (Nilon and others 1995). Increases in predator species and parasitism can result in higher rates of predation of some species (Andren and Angelstam 1988). Also, as more people move to interface areas, there is an increase in domestic animals, such as cats, which can have devastating effects on many native species, particularly on small birds and mammals (Clifton 1992).

While populations of some species are decreasing in the interface, others are rapidly increasing, causing serious challenges for wildlife managers. White-tailed deer (*Odocoileus virginianus*) populations, for example, have exploded in some parts of the South (see chapter 5), leaving many communities searching for solutions. Citizen complaints have ranged from annoyance about damage to ornamental shrubs and property, to safety concerns about deer-vehicle collisions, and health concerns about the transmission of Lyme disease to humans by deer ticks (Fitzwater 1989, Franklin 1997). At the same time, many interface residents enjoy observing deer and other wildlife near their homes (**fig. 6.8**). Balancing local residents' desires to increase their wildlife contact with their concerns about nuisance and human health problems is a major challenge for wildlife managers in the interface. They must be able to deal not only with people-wildlife conflicts but also people-people conflicts.

The proportion of the U.S. population that hunts and supports traditional game management activities is dropping, while more people are watching, hearing, seeing, and otherwise enjoying wildlife (Cordell and others 1999a). While hunting can help control burgeoning wildlife populations, it may not be accepted by local interface residents. Additionally, safety concerns or laws and regulations administered by State and local governments may prevent hunting (Stout and others 1997). Other methods of control, such as contraceptives, may be one answer but can be expensive and may be opposed by local animal activist groups (Fosgate 2001, Warren and others 1995).

Photo by Linda Robinson

Figure 6.8
The program Landscaping for Wildlife, developed by the Florida Cooperative Extension Service, gives homeowners guides for managing and landscaping their backyards for wildlife.

Landscaping for Wildlife

Some new programs are encouraging landscaping of backyards and neighborhoods to recreate habitats for wildlife in urban and interface communities. One program developed by the Florida Cooperative Extension Service gives homeowners guides for managing and "landscaping forwildlife" (fig. 6.8). The National Wildlife Federation Backyard Wildlife program is a national certification program that encourages everyone from homeowners to teachers and community leaders to consider wildlife needs when planning their landscapes.

Wildlife managers must be able to adapt management to include both consumptive and nonconsumptive uses (Curtis 1978) and be aware of local public attitudes towards wildlife conservation and management. They must also take steps to actively involve stakeholders from a diversity of backgrounds into policy and management decisionmaking processes and programs (Decker and Chase 1997).

Needs—Research is needed to:

- Develop models that identify and evaluate valuable wildlife habitats for local planning, design, and management;
- Identify management options for trails and linear greenways (corridors) for multiple uses including wildlife;
- Improve techniques and guidelines for ecological restoration and adaptive wildlife management;
- Identify relationships between patch habitat history and plant species composition and structure, and determine how these relationships influence wildlife populations;
- Identify mechanisms by which adjacent land use practices and human activities influence patch habitats and animal populations;
- Determine how wildlife species use habitats in urban areas and the range of wildlife habitats in which species reside;
- Develop models for joint action by local, State, and Federal Governments working with private and grass-roots organizations to plan and establish landscape-level initiatives;
- Discover how to lessen people-wildlife and people-people conflicts at the interface and incorporate stakeholders into decisionmaking; and
- Survey public attitudes and perceptions about wildlife management and conservation strategies.

Education needs include:

- Information to educate new interface residents about the environment that they are moving into, about minimizing negative human-wildlife interactions, and about greater tolerance for living with wildlife;
- Programs to show neighborhoods and communities how to enhance and support their wildlife populations;
- Programs for planners and developers to illustrate how to sustain and manage ecosystems and incorporate ecological principles when faced with growth and development; and
- Outreach programs for the many stakeholders involved in conserving and managing wildlife resources to encourage cooperation and collaboration.

Tools and skills needed by wildlife managers include:

- The ability to work closely with community members, landscape architects, planners, engineers, developers, and the public;
- Knowledge of how to use public meetings, surveys, and advisory groups for assessing public opinion on local wildlife issues (this

information can be used in public education efforts and future management decisionmaking); and

- The ability to reconcile the competing interests that different stakeholders have regarding wildlife resources.

Conclusion

Forests in the South are changing in their ownership, tract size, and many ecological qualities, making new adaptive management strategies essential. These forests are influenced by a large number of stakeholders with diverse interests who must be involved in management decisions. The major ecological goods and services that these forests provide are in peril as are many rare forest ecosystems, which are becoming part of the interface. Adaptive management regimes must be applied across the landscape. Government agencies, industry, nonprofit organizations, and citizenry need to be involved and to find alternatives to many of our current customs and approaches. There are some promising new approaches and solutions, but more scientific knowledge is needed to find practical solutions to local problems. Some of the major themes for sustaining and managing these forests are to promote and support:

- Sound stewardship,
- New policies,
- New market-based solutions,
- Landscape-level management solutions,
- Incentives for management,
- Research,
- Dissemination of existing research findings,
- Technical assistance, and
- Improved and expanded education efforts.

Some additional overall needs are:

- Landscape-level management plans for forest ecosystems;
- Collaborative partnerships between private and public managers for conducting landscape-level management;
- Ways to grow without degrading and fragmenting our forested landscape and ways to link ecological principles to land use planning, decisionmaking, and management;
- Identification of the most important, imperiled ecosystems to conserve and manage;
- Improved scientific knowledge and information about forest ecosystems in fragmented landscapes;
- Identification of human perceptions, uses, and values related to urban and interface forests;

- Recognition that intensive forest management is necessary in rural areas to meet our future timber supply and to take the pressure off natural areas and other open spaces;
- Packaging technical information for various stakeholders; and
- Education of and collaboration among multiple stakeholders including developers, forest landowners, policymakers, citizens, and natural resource professionals.

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Chapter 7

SOCIAL CONSEQUENCES OF CHANGE

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Introduction

The natural resource professionals are only one voice in the chorus of the social forces shaping the wildland-urban interface. Other voices include powerful and long-time favorites of the American body politic: the American dream of a single-family home produces an endless demand for forested lots; multinational industries strive to generate the profits and materials that fuel America's economic engine; retail stores insist on space to advertise and market their wares; economic development agencies struggle to spread prosperity, growth, and progress; and environmental preservationists seek to protect wild nature for the spiritual, aesthetic, and moral benefits of current and future generations. To be relevant and effective at influencing the form and function of this emerging landscape, natural resource professionals must recognize and influence the social consequences of landscape change. ▶

This chapter begins by reviewing three types of social consequences produced by this emerging landscape: (1) economic, (2) political and regulatory, and (3) community and landowner. We also discuss the challenges and opportunities natural resource professionals face if they are to remain relevant in the wildland-urban interface.

Consequences of Economic Change

The urbanization of forested areas alters the economics of land management. For example, trees become valued more as amenities than as commodities; return from investment comes more from a property's commercial or residential potential than from its soil productivity. Slowing stormwater discharge becomes as valued as recharging water supply; and mitigating urban heat-island effects overshadows habitat needs of wildlife.

Forest Industry

Forest industries provide economic vitality to local economies. Urbanization clearly changes that economy, but it is not clear whether the net change is positive or negative. Some industries and land uses, such as forestry, are constrained by increased regulation and decreased supply. Other new enterprises, such as retail sales, services, and land development, emerge and create new sources of wealth and new values for forests (see chapter 3).

Conventional wisdom suggests that urbanization shrinks the timber supply. Data are sparse. Some estimates suggest that urbanization reduces commercial inventories between 30 and 49 percent (Wear and others 1999); other estimates are less pessimistic (Barlow and others 1998). We do not have a good understanding of the reasoning owners use to decide whether and when to harvest timber or invest in forest management. But we do know that these decisions become more complex in the interface forest because of additional concerns about neighbor and community perceptions, about amenity and environmental consequences of logging practices, and about increased attention given to fire hazard reduction, wildlife habitat creation, and control over visual access (see chapter 6).

"The inhabitants of areas surrounding the forests are not willing to allow silvicultural practices to occur in those forests adjacent to their property." Florida

Similarly, conventional wisdom suggests that parcelization increases harvesting costs and decreases the profitability of timber production. Supposedly, parcelization leads to more regulation, more onerous negotiations among multiple landowners for access, and a greater emphasis on protecting environmental and amenity resources. However, the actual data are still somewhat inconclusive (for example, Kittredge and others 1999). Another common concern is that wood-processing plants might relocate to find cheaper and more reliable timber supplies. The resulting decrease in timber processing capability hurts local forest owners because they face higher costs for transporting timber to mills. As real estate and amenity values exceed income available from timber harvest, further parcelization may be encouraged. There is limited study about any of these issues. The complex factors that influence the supply of and demand for timber make simple conclusions hard to find. It appears, however, that traditional, rural forestry practices of buying, sell-

Photo courtesy of USDA Forest Service

Figure 7.1
Many employers migrate to the interface following or trying to attract qualified workers.

ing, harvesting, transporting, and processing timber will increasingly struggle for relevance in interface forests (Barlow and others 1998) (see chapter 6).

Nontimber Industry

Nontimber commodity production on interface land is increasingly popular as a means for landowners to supplement their incomes. Because of easy access to markets, "metro farms" generate more revenue per acre than rural land and they "specialize in high-value crops, producing more than two-thirds of vegetable and fruit sales and more than three-fourths of nursery and greenhouse crop sales" (Heimlich and Brooks 1989). Many of these holdings have woodlots that can provide timber for additional revenue. Subdividing and selling small land parcels also generates income. The supplemental income from these and other interface economies can make feasible the continued management of marginally productive forest and agriculture land.

Resource-Dependent Communities

New economies emerge in the interface bringing growth, diversifying employment, and expanding the tax base. Interface residents can commute to employment along surface roads or information highways, bringing their paychecks back to spend at local retail and service businesses. Employers migrate to the interface following or in search of a qualified workforce (Garreau 1991, Johnson and Rasker 1995) (**fig. 7.1**). Taxes on residential properties, merchandise sales, and services, as well as taxes on new information and service industries, supplement tax revenues lost from relocated commodity-producing industries. While urbanization may cause pain by disrupting employment patterns and social networks, many rural communities aggressively seek development opportunities that offer economic growth, improve the quality of life, and provide young people reason to stay in their hometowns (Riebsame and others 1996, Voth and others 1999). Additional information about economic and taxation issues can be found in chapter 3.

Photo courtesy of USDA Forest Service

Figure 7.2
As the urbanizing forest transitions to an urban forest, the costs of planting and maintaining these trees increases, as well as do the perceived benefits of these trees.

Infrastructure Costs and Benefits

The costs of providing roads, schools, water, and related services are higher in urbanizing areas than in either urban or rural landscapes. They are highest in the dispersed development pattern associated with the wildland-urban interface. Parcelization of forested landscapes, therefore, raises an equity question: Who should be taxed or otherwise finance expanding the physical and social infrastructure?

The role of the forest as an environmental infrastructure also changes. The urbanizing forest becomes more valuable because it reduces heat islands and air conditioning needs, slows and absorbs stormwater, and improves air and water quality. Individually, every tree provides benefits and, cumulatively, the forest provides enormous services that can reduce the need for regional power generation stations and equally costly water treatment and processing facilities. As urbanization continues and the interface forest transitions into an urban forest, the perceived benefits from trees change and perhaps increase, as do the costs of planting and maintaining these trees (Dwyer and others 2000) (**fig. 7.2**).

Consequences of Political and Regulatory Changes

Interface forests also differ from their rural cousins in the number and complexity of political issues affecting them.

Multiple Jurisdictions

As human communities grow, they impose more of their structure onto natural communities. With every new jurisdiction comes another planning process and additional stakeholders. Urbanizing forests have overlapping jurisdictional boundaries created by local and State planning entities; fire, water, and soil conservation districts; county and local planning boards; and homeowners associations (see chapter 4).

"No one has a vision for the future. There is fragmentation of everything." Florida

Land management practices and policies often change at property and jurisdictional boundaries, disrupting ecosystem processes and complicating forestry operations that might otherwise cross those boundaries for ecological or economic reasons (Grimm and others 2000). For example, control of insects and fire often requires practices that cross political boundaries.

Photo by Larry Korhnack, University of Florida

Figure 7.3
New owners and neighbors of interface forests are often motivated and organized to influence natural resource policies and management.

Increased Regulation

Higher population density increases the potential for neighbors to directly affect one another's quality of life. As a result, regulation of forest and land management practices increases with urbanization. By most accounts, the increased regulation decreases the short-term profit of harvesting timber; estimates vary from several to many percentage points of profit (Kittredge and others 1999). Regulations also may reduce the amount of timber available by restricting how much forest cover must remain after silvicultural operations (see chapters 4 and 6). Enforcing compliance with these regulations requires the public to commit substantial resources (Ellefson and Cheng 1994). A new class of professionals—public regulatory and planning officials as well as consultants to advise private landowners—is created to provide this value-added service. The uncertainty surrounding the future regulatory environment is sometimes blamed for encouraging landowners to harvest sooner, before potentially costly regulation occurs (Johnson and others 1997). Though they are not yet well documented, potential long-term benefits from increased regulation include prolonged and improved environmental conditions. For example, soil productivity is maintained and water pollution is decreased.

Participation in Land Use Planning

Land use decisions in interface areas generate more controversy and attention than in rural areas, and involve more plentiful and more diverse public participation. There is considerable debate about whether and how newer residents affect public participation in local governance (Lee and others 1990, Smith and Krannich 2000). Typically, newer residents give environmental concerns a stronger voice, at least relative to commodity production concerns. However, research suggests that new and long-time residents differ little in their environmental concerns (see chapter 4). What may differ are the power and ability each group has to express their concerns. New residents tend to have more resources and be less dependent upon local means of production, freeing them to be more critical of the local situation. Some new residents also possess greater skills for manipulating political and media systems (**fig. 7.3**). Consequently, the involvement of new residents sometimes helps long-time residents voice previously muted environmental concerns. Regardless of the cause, the concerns heard by land use planners and managers do change (Voth and others 1999).

Because of urbanization, the decisionmaking process changes. It tends to become increasingly formal as a community grows. The personal contacts of long-time residents may not be available to newcomers as a means to influence land use decisions. To neutralize this advantage, newcomers are more likely to use alliances with national and regional organizations, and to insist on more formal procedures of participation and decisionmaking, such as hearings and impact statements.

New residents may have different needs and preferences for recreation and community services. Community growth increases the amount of land developed and the demand for community resources. New development is often

Photo by Larry Korhnack, University of Florida

Figure 7.4
New interface residents may object to traditional land uses such as forestry or agriculture due to reasons such as increased traffic and mud on roads.

concentrated near sensitive and publicly owned amenities, such as water edges and ridge lines, further increasing the pressure on these amenities and the number of people concerned about them. Some studies find that newcomers are more likely to object to traditional land uses such as forestry and agriculture because they find them offensive or dangerous, or because these uses compete for land with other, preferred uses. Forestry practices produce odor, noise, traffic, pesticide drift and mud on the road, and compete with housing developments and retail stores for the same land (**fig. 7.4**). Traditional, or long-term residents, sometimes object to newcomers because of concerns about trespass, vandalism, and increased regulation brought on by the pressures of population growth. Research findings tend to be case-specific because no two communities are alike (Lee and others 1990).

Property Rights

Growth in interface communities has a profound effect on property rights, on how they are formally defined and enforced, on how they are informally understood and used, on what rights are most important and to whom, and on who has the power to change them. As land use changes, so do practices and understandings associated with that use. What is appropriate and reasonable in a subdivision can seriously conflict with what is appropriate and reasonable where commodity production dominates. For example, running the four-wheeler or "mudder" through the best wetland near one's home may be considered harmless fun in a rural setting, but a punishable violation of both wetland regulations and trespass laws in an urbanized area. Putting a bird feeder in one's yard is something a rural or suburban homeowner might do, but in some suburbs the homeowner would be well advised to check the zoning covenants first. Interface forests tend to see an increase in formal postings, boundary delineation, zoning code enforcement, and remedies to property disputes via legal rather than informal means. Both the rights and the obligations associated with property ownership are treated more formally. Further discussion on private property rights and public attitudes is provided in chapter 4.

"We have a very strong sense that if you have a piece of land you can do whatever you want with it, regardless of how it impacts your neighbor. It is your sacred right." Texas

Landowner Assistance Programs

Some programs attempt to stimulate forest management and reforestation through subsidies of advice, money, and materials to increase acres covered with forest and the supply of timber (see chapter 6). There is evidence that some timber-producing landowners would actively manage for timber even without the subsidy, while nontimber-producing landowners will not harvest timber even with a subsidy. Both types of landowners take the landowner assistance subsidy, but the result does not increase the timber supply (Kluender and others 1999). Whether an assistance program is designed to increase timber output or improve environmental quality, it may not reach many new landowners because program eligibility often requires too large a parcel or too specific a resource output, such as pine timber or a stream buffer. Moreover, the increasing number of new landowners overwhelms the capacity of traditional landowner assistance personnel and programs. New methods are needed to reach these landowners.

Consequences of Community and Landowner Changes

Urbanization brings with it new landowners, as well as changes in community structure and quality of life. As with economics and policy, there are both positive and negative consequences of settling in interface forests.

Changing Management Preferences and Practices

Development of the interface changes the mixture of forest owners, whose preferences and practices may or may not be the same as their predecessors'. For example, private forest landowners increasingly value amenities such as scenery, wildlife viewing, privacy, and recreation (**fig. 7.5**). Of decreasing importance are the income-related values of forests, such as timber, real estate investment, grazing, and hunting leases (Birch 1997). When harvesting does occur, it is often done under more restrictive conditions than in the past. There are fewer verbal agreements and more written contracts, more independent or third-party estimates of volume and stumpage price, more restrictions on what and how trees are harvested, and increasingly specific site restoration requirements. Moreover, landowners are more willing to sacrifice profit from timber production in exchange for improved environmental quality and higher amenity values (Hickman 1983). It seems, however, that parcel size matters. Owners of large tracts of forested land are more concerned with the income-generating potential of their forests. These large-tract landowners still own most private forests in the South, which bodes well for a continued supply of traditional forest products.

Many new forest landowners do not feel membership in the forestry community or a connection to those who manage and harvest timber (Bliss and others 1994, Kuhns and others 1998). Social science surveys show marked similarity between owners of nonindustrial forest land and the general public in their concerns about environmental quality and forest practices, such as being against large-scale clearcutting (Jones and others 1995). Consequently, landowners in the interface may perceive the forestry profession as less relevant and less trustworthy. Professional gardeners and landscape architects may become the primary contacts and sources of information about forest and land management. The rapid turnover of landowners, whose average tenure is just 7 years in some Southern States (Birch 1997), combined with absenteeism, suggest that many may know little about their land and have limited contact with the professionals who traditionally offer management advice. Very few forest owners (only 5 percent by some estimates) have written plans for the management of their forests. Traditionally, forestry advice has been distributed primarily in forest management plans, but these new landowners may not need or want such formal plans.

Photo by Larry Korhnack, University of Florida

Figure 7.5
Private forest landowners increasingly value amenities, such as birdwatching, over income-related values of forests.

"A lot of the people moving into our area are leaving a metropolitan setting. They can sell one acre in the city and come up here and buy ten acres and think they got a bargain price. Locals could not do that." Georgia

Photo courtesy of USDA Forest Service

Figure 7.6
More frequent contact with nature and less exposure to urban stressors are presumed benefits of moving to the wildland-urban interface.

Social Capital and Turbulence

A community's networks, expertise, and shared mutual aid are its social capital. Communities use this capital to solve problems and improve quality of life. New settlers impact this capital. They are often wealthier, better educated, and more politically astute. They may bring resources such as knowledge and money to the local community. They are less concerned about alienating the local institutions on which many long-time residents depend for livelihood. New residents often insist on more formal decisionmaking processes, as previously mentioned. Long-time residents may feel disenfranchised and threatened by these changes, although those who did not share in the previous power structure may support the new methods and directions of community governance (Smith and Krannich 2000). Interface communities can be destabilized by the relatively high percentage of transitory and absentee landowners. Many landowners in high-amenity areas have dual residencies and migrate with the seasons; some may be absentee inheritors or investors with little local loyalty and no regular contact with their neighbors or the landscape. However, long-term residents can be just as transitory (McHugh and others 1995).

"I think the quality of life up here is what they're after. They [urbanites] want to get away from Atlanta–the stress, the traffic, etc." Georgia

Community Infrastructure

Urbanization changes the economy, diversifies employment opportunities, improves access to and quality of health care, creates a better funded and more diverse educational system, and improves the transportation network. Many rural communities seek these changes and offer them as a rationale for rural economic development (see chapter 3). They directly improve residents' quality of life and create incentives and opportunities to keep talented, young adults from moving to more economically thriving locations.

Physical and Psychological Well-Being

The pollution, crime, and stress of urbanized, industrial, and congested areas can create health risks. A persistent explanation for the migration out of urban areas has been the pursuit of cleaner, healthier, saner, and safer lifestyles (Jacobs 1997, Schmitt 1969). Having more frequent contact with nature and less exposure to urban stressors are presumed benefits of settling in the wildland-urban interface, one that society might wish to encourage by facilitating further settlement (**fig. 7.6**). However, increasing population density in interface forests generates urban-like congestion and decreases open green space, degrading the very qualities that motivated migration and, perhaps, encouraging migration to yet more remote areas. Thus, settling forested landscapes increases both the social benefits and the social costs. Finding an acceptable balance between these costs and benefits is an ongoing challenge, and one that does not readily lend itself to scientific analysis because it involves political tradeoffs and because changes in the environment and how it is valued are often unpredictable. Science may help decisionmakers, however, by monitoring these changes and making the consequences of change more obvious.

Visual Amenities

The once unbroken forested horizon is now dotted with houses and streetlights. Perhaps the most obvious consequence of interface development is the mixing of humans with nature and the consequent visible transformation into housing developments of open spaces, agricultural fields, and forested ridges (**fig. 7.7**). Scenic vistas and visually appealing landscapes are valued resources that increasingly dominate management concerns on public and private forests. Federal and State laws, local ordinances, and other mechanisms have multiplied in recent decades to protect scenic views and create scenic easements (Smardon and Karp 1993). Again, research fails to indicate which policy direction is best. Land development increases the aesthetic resource by clearing forests, creating vistas and open spaces, and increasing access to scenery. Land development creates roads, recreation settings, and houses with picture windows from which to view the scenery. Too much development, though, degrades the resource by blocking or altering vistas so that the views are no longer attractive.

Recreation Demand and Supply

Settlement of interface forests impacts the supply of recreation resources. More tracts of smaller size make it more difficult to contact landowners and negotiate use of private land for recreation. Settlement generally decreases access by nonowners to forested locations (see chapters 2 and 6). Increased posting of private land, by contrast, may increase recreational access if it produces formal leases for recreational activities such as hunting (Cordell and others 1993). The increasing parcelization of land means that new owners, and their acquaintances, will have greater access to their land for nature-based recreation activities; however, most Americans do not own land and, thus, do not enjoy this access. Back-country recreation opportunities, such as hunting and enjoyment of solitude, require vast areas over which to disperse people. These opportunities are likely to decrease where ownership density is increasing. By contrast, front-country activities such as bird watching, picnicking, day walks, and drives may increase as access becomes easier. Finally, the increased demand on public and private recreation resources can produce conflict. If newcomers prefer the same recreation activities as longtime residents, then crowding may result. If they prefer different activities, scarce

Photo courtesy of Virginia Department of Forestry

Figure 7.7
One obvious consequence of interface development is the mixing of humans with nature.

Photo by Larry Korhnack, University of Florida

Figure 7.8
Recreational opportunities are needed for diverse users.

resources are likely to be redirected to provide and maintain these new activities, potentially sacrificing the quality of the traditional activities.

Lifestyle changes associated with interface forests also impact the demand for recreation resources. The 2-week summer vacation to distant locations is becoming less popular. It is being replaced by single-day and long-weekend holidays to local attractions (Hornback 1991). Meanwhile, participation in many nature-based recreation activities continues to increase faster than population growth, with wildlife viewing leading the way (see chapter 2). The result is a rather dramatic change in the staffing and management needs of recreation settings. Visitation tends to be distributed year-round rather than seasonally. Because visitors will come from within the region, they are more familiar with specific areas and more discerning. Recreation destinations with lower quality facilities and services lose popularity. In addition to experiencing a different pattern of visitation, recreation sites attract more diverse users (**fig. 7.8**). This trend is not unique to interface areas. The American population is aging and becoming more ethnically diverse, suggesting that future users will prefer a different mix of recreation activities than was demanded by the white, young, middle-class visitors that dominated demand during most of the 20th century, and for whom many of the existing parks and recreation programs were designed (Cordell and others 1999) (see chapter 6).

Needs

Lee's (1984, p. 131) challenge to natural resource professionals almost 20 years ago remains relevant today:

> . . . the problems of managing forests and wild lands on the urban fringe require specialized knowledge and skill that do not currently exist. The manipulation of natural ecosystems to produce a multitude of benefits requires not only scientific knowledge but also the skill to resolve conflicts between competing uses and to integrate a variety of management techniques to achieve special purposes. Foresters are perhaps the most suitable professionals for these tasks. Their general education and training in specialized techniques have enabled them to address complex problems in wild-land management. These same capabilities also suit them for solving problems of converting forest from wood production to residential environments and for continued residential use. The greatest challenge to foresters who seek to solve problems on the urban fringe will be to learn how to become effective agents for local residents, planners, developers, and environmentalist. This challenge will force foresters to rethink the purposes for which lands are managed and to reintegrate those purposes with emerging forms of technology and socioeconomic organization.

New Content and Methods for Outreach

In general, landowners are placing higher value on soil, amenities, wildlife, and other nontimber forest resources. Natural resource advice must change to reflect these new needs. However, new landowners are less trusting and have had less contact with the professionals who traditionally offer forest management advice. The traditional outreach mechanism—the forest plan—is neither familiar nor appealing to the new clientele. Clearly, new methods for communicating with landowners and distributing forestry advice and assistance are needed. The American Nursery and Landscape Association estimates that American households

spend $15 billion or more annually for professional help with their gardens and trees. DeCoster (2000) estimates that this translates into $648 million per year spent on forested homesites. That is more than 12 times the average annual amount of all U.S. Department of Agriculture forest incentive programs. Little of this business presently goes to forest professionals because they generally have not effectively marketed their services to these new forest owners. Forestry professionals need to supply:

- brochures, fact sheets, and personal assistance, which may be more effective with this audience than workshops, forest plans, and demonstration projects (DeCoster 2000, Kuhns and others 1998); and
- "how to" pamphlets or training sessions. Making these available through home improvement stores may reach more interface forest landowners.

New Skills

Managing the parcelized forest, with its environmental constraints and diverse landowner objectives, requires knowledge and skills that either do not yet exist or are not widely available. Harvesting remains one of the most affordable ways to manipulate vegetation, even if its primary goal is enhancing amenity values such as scenic views, hiking trails, and wildlife grazing areas. In addition, management of wildlife for nuisance control can be as important as management for wildlife viewing and hunting. Bears, deer, and geese destroy vegetation, become disease vectors, interfere with traffic, damage property, and generate fear. Needs include:

- small-scale, less-capital intensive, amenity-enhancing forest harvesting technology; and
- techniques to manage wildlife pests and amenities as well as fire and disease on small tracts of land.

In addition, natural resource professionals must work effectively with diverse groups. An important and defining characteristic of interface forestry is the large number of stakeholders with diverse interests who involve themselves in management decisions. Forestry practices are now evaluated by multiple parties and subject to the jurisdiction of multiple institutions. Hence, new skills to handle the more complicated contracts and project implementation are needed. Natural resource professionals need:

- tools and skills to work with land use planning processes, zoning appeals, public meetings, fire departments, insurance agents, and other public institutions.

New Partners

Natural resource professionals must seek new partners and constituents. If they wish to stem the rising tide of forest fragmentation, natural resource professionals must work with the institutions that create interface forests and have influence over their management. Tax accountants and estate planners should be recruited to influence owners of large forested tracts from which fragmented forests are created. Media that influence migration, such as country living magazines and retirement community promoters, could be targeted with messages about the concerns and practices of natural resource management in interface forests. Similar messages could be shared with State and local agents of economic

development, such as chambers of commerce, Governors' offices, industrial parks, and other groups that try to attract industry and qualified workers into communities. Natural resource professionals should:

- target messages for social institutions driving land use change, and
- form partnerships with these institutions.

Partnerships might be formed with the professionals who increasingly are primary sources of land management advice for landowners. Examples include the lawn and garden care industry, home and garden stores, landscape architects, land use planners, and suburban homeowner associations. Insurance companies might be persuaded to offer financial incentives for forest treatments that reduce the risk of fire. Water utilities can explain water demands of landscaping. Power utilities can explain benefits of shading. Local municipalities can promote the benefits of retaining tree cover for stormwater management. Distribution of advice, incentives, and best management practices through these conduits may be more effective in reaching the increasing number of landowners. Many new landowners fail to see how traditional natural resource professionals can help them. Natural resource professionals should:

- form partnerships with professions and organizations that currently serve interface landowners such as the lawn and garden care industry.

Cooperative and Cross-Boundary Management

Property parcelization need not lead to increased ecosystem fragmentation. A forest ecosystem becomes fragmented when landowners implement different and uncoordinated management objectives. Natural resource professionals need mechanisms that enable and encourage cross-boundary ecosystem management. Several such mechanisms are currently available, but more are needed. Cooperative programs, for example, use funding from public or nongovernment institutions to bring together landowners within a geographic region, such as a watershed, to structure management goals and practices. Typical goals of a cooperative are preservation of wildlife habitat and water storage, which require coordination across vast areas. Partnerships permit economies of scale and solve access problems so that management practices such as burning, spraying, and harvesting become viable (Campbell and Kittredge 1996). Natural resource professionals need:

- mechanisms that enable and encourage cross-boundary management.

Setting New Goals and Developing a New Language

Natural resource professionals should resist the urge to declare that all fragmentation and development threaten the "health" and "sustainability" of forests. Many landscape architects and environmental planners believe they are creating healthy and sustainable residential developments. The whole idea of sustainable development and smart growth is built on that premise. The forest means different things to different stakeholders. Similarly, health and sustainability mean different things to different people.

Contemporary forest planning and management involve a large number of stakeholders who think and speak differently about forests and forestry. As a result, the practice of forestry, now more than ever, requires knowledge about the languages, values, and beliefs of these stakeholders. This is particularly true for inter-

face forestry. Controversy about how to manage interface forests is due, in part, to stakeholders' differing ideas about ecology, about the appropriate role of human technology in nature, and about what goods and services forests should provide. People vary in their beliefs about how nature works, about whether nature or humans know best, and about whether management should emphasize timber or biodiversity. These diverse understandings limit the ability of natural resource professionals and State and Federal agencies to manage landscape change and forest productivity. Forestry's language, motivations, sciences, and practices were not developed to address the undertakings and concerns of interface residents. Foresters need:

- a new language and conception of forestry; and
- new ways to describe the goals of forest management—goals such as sustainable development and residential quality of life.

Conclusion

The social consequences of managing interface forests are considerable in scope and magnitude and certainly comparable in importance to the environmental consequences. There are no clear policy implications, however, because fragmentation produces benefits and costs, winners and losers. While the timber supply may shrink, other economic opportunities emerge and noncommodity values of forests increase. While the amount of fragmented land may increase, many people gain from the improved access to green spaces, employment opportunities, and social services. While planning may become more difficult because of increased interest in and jurisdiction over forest land, the quality of input and the quality of the plans may also improve. One thing is certain: the owners and neighbors of forests are changing, and natural resource professionals need to change if they are to remain effective and relevant.

Social issues, including demographics, migration, economics, and policy, are the primary forces behind the creation of interface forests. Social institutions, including education, regulation, cooperative management, and tax incentives, are the primary mechanisms to manage these forests. Natural resource professionals can work toward three broad goals in interface areas: (1) they can seek to slow fragmentation and preserve contiguous forested areas, (2) they can guide development and fragmentation to maximize benefits and minimize costs, and, perhaps most importantly, (3) they can adapt to the changed landscape and develop new techniques that allow them to practice their crafts. Growth controls and tax incentives slow and direct fragmentation and development of interface forests. However, they are seldom permanent solutions. Demand for housing sites, fueled by the allure of living near nature, enriches landowners who divide and sell real estate. The challenge is to influence how development occurs and to find ways to work in a fragmented forest.

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SECTION III:
MAJOR THEMES AND NEEDS

Photo courtesy of Florida Division of Forestry

Photo courtesy of USDA Forest Service

Photo courtesy of Florida Fish & Wildlife Conservation Commission

Photo courtesy of USDA Forest Service

Chapter 8

FIRE

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Geoff Babb, a Florida wildland fire manager, was asked to be a spotter for a fire detection flight one morning in June 1998. Fires had been burning in the State since May, but central Florida had not yet seen widespread fire activity. The summer thunderstorms were beginning, bringing the threat of lightning strikes to the dry forests. As the plane became airborne that day, the horizon filled with streams of smoke rising in the morning sun. At only 500 feet in the air, individual 5- to 10-acre fires were easy to see; orange flames licked at each perimeter, and smoke coalesced above the canopy. Geoff jotted down latitudes and longitudes for every fire they passed, quickly filling a steno notepad page and missing as many as he noted. The local forestry office had reported 88 lightning-started fires from the previous night's storm, and many were still burning. ▶

Photo courtesy of Florida Division of Forestry

Figure 8.1
Wildland fire helps to maintain fire-dependent ecosystems in the South.

At the southern Volusia County line, the plane turned around and headed north. By then, the sea breeze had picked up, intensifying every fire and lifting smoke columns higher into the air. It was an impressive sight. A mile-wide swath of fire and smoke, approximately 10 miles from the ocean, stretching as far as he could see, and one that Geoff won't forget. "If left to burn, those fires would scorch a million acres from Cape Canaveral to St. Augustine, stopped only by the St. Johns River to the west and the Atlantic Ocean on the east."

It had probably happened many times in Florida's prehistory, but it would not happen again. Below them, a power line to Miami, timber plantations, ranches, homes, towns, highways, and cities like Daytona Beach represented human lives and resources that would be protected from fire.

Introduction

Perhaps more than any other wildland-urban interface challenge, the interface makes wildland fire an issue. Some lightning-started wildland fires might be left to burn and maintain natural ecosystems if human lives and structures were not threatened, but they are threatened. Second homes and villages dot the region. Nearly every major fire threatens human establishments, requires suppression efforts, causes heartache among evacuees, and grabs newspaper headlines. Every State forestry agency has a wildland fire suppression division. Communication efforts abound to educate the citizenry about reducing risk, preparing for fire, and managing the emergency.

Any number of issues could be used to illustrate the complexity of managing natural resources and people in the wildland-urban interface, but for the sake of simplicity this report uses one: wildland fire. This term refers to fires that occur in natural areas that are not purposefully set for land management activity. They are usually started by human carelessness, though many are sparked by lightning or arson. Wildland fires also include prescribed fires that run out of control for any reason. This chapter reinforces the concepts presented throughout this Assessment. It demonstrates how demography, public attitudes, political and economic conditions, ecology, and resource management techniques influence our efforts to manage and protect both people and natural resources from wildland fire in the interface.

The Way It Was

Across the South, different forest ecosystems experience different natural wildland fire regimes (**fig. 8.1**). Swamps, marshes, bottomland hardwoods, and Appalachian forests tend to burn infrequently after a windstorm or drought increases the amount of combustible vegetation (Pyne and others 1996). Sandy, flat, or hilly regions dominated by pine trees may burn as often as every 3 years. An oak (*Quercus* spp.) and grass (*Gramineae* spp.) savanna in Texas may burn every 7 to 10 years. These relatively short cycles are possible in much of the South because relatively high rainfall and long growing seasons favor rapid vegetation growth. Some understory plant species contain oils and resins that fuel fire. The southern landscape evolved with lightning-induced fires during dry seasons; the ecosystems burn readily and recover quickly. Soon after a fire, roots send up new shoots, seeds germinate and establish roots in the newly exposed mineral soil, and wildflowers proliferate (Myers and Ewel 1990).

Some areas of the South experience more cloud-to-ground lightning than elsewhere on the continent, and most of the South was experiencing a great deal of human-induced fire when Europeans arrived. Without a layer of snow, southern forests and grasslands could burn during any month of the year. Native Americans frequently used fire to protect themselves from wildfires, improve wildlife habitat, and clear land for cultivation. Seasons and burning intensities were selected for each chore (Pyne and others 1996, Wade and others 2000). Fires helped to fell trees and smoke out raccoons; burned patches launched new cycles of berry and tuber production; light surface fires exposed and singed chestnuts; rolling grass fires drove deer to a river. European settlers adopted these practices as well, maintaining a relatively open landscape.

From the earliest European settlement to the early 1900s, industrial logging, gum tapping for turpentine, cotton plantations, railroads, and livestock transformed the southern pine forest into an agrarian region that flourished, then collapsed with economic change. Fire suppression programs were developed in the 1930s to stop the deeply held practices of woodsburning to protect the regenerating forest. As forestry agencies began to replant cutover land, fire protection activities eventually halted the widespread use of fire in landscape management.

The Way It Is

The exclusion of purposeful fire from the South, however, created an enormous fuel load for the eventual wildland fires. Whether it is sparked by lightning, arson, or human carelessness, wildfire cannot be excluded forever. The increasing population and the expanding wildland-urban interface both create and complicate the issue of wildland fire. Fires no longer regularly sweep great expanses and maintain the southern forests because human development necessitates that fires be suppressed. Lack of regular fire increases the chances of catastrophic wildland fire, and greater numbers of people in the wildland-urban interface increase the chances that such fires will be ignited (Irwin 1987).

Prescribed fires reduce fuel buildups, making wildfires smaller and less damaging[1] if used repeatedly every 5 years (Davis and Cooper 1963) (**fig. 8.2**). Yet, as fragments of forest habitat more urgently need fire to reduce fire hazards and restore or maintain endangered species populations, citizens have been known to shun the use of prescribed fire (Myers and Ewel 1990, Wade 1993). Policies to enable managers to use prescribed fire to manage their land must first win the support of the public, which has been predisposed to believe that forest fires are dangerous. Secondly, these policies must resolve the conflict with competing policies that protect air quality.

Complicating the issue is the obvious fact that even prescribed fires can be dangerous and destructive. Changes in weather or human error may cause prescribed fires to escape human control. It would seem that at least in the southern fire-dependent ecosystems, we couldn't live without fire; we will either have to learn to live with fire, or forfeit having these ecosystems in the wildland-urban interface.

There are no simple answers to the issue of fire in the wildland-urban interface, but by teasing out the tangled threads, it may be easier to understand why some programs have begun to see some success and what other solutions may be needed.

Photo by Larry Korhnack, University of Florida

Figure 8.2
Prescribed fire is a fuel reduction option that can be used in the wildland-urban interface to reduce the risk of wildland fire.

[1] Koehler, J.T. 1991. The use of prescribed burning as a wildfire prevention tool. 28 p. Unpublished report submitted to the National Fire Academy from the Florida Division of Forestry. On file with: Annie Hermansen, Southern Center for Wildland-Urban Interface Research & Information, U.S. Department of Agriculture, Forest Service, Southern Research Station, 408 W. University Ave, Gainesville, FL 32601.

Photo by Ken Outcalt, USDA Forest Service

Figure 8.3
Longleaf pine seedlings in the grass stage can withstand a low-intensity fire that singes needles but does not harm the growing bud.

Integrating Interface Issues

Ecological Structure and Function

Fire plays an important role in the ecology of southern forest ecosystems. Some 90 million acres of the South's Coastal Plain were once covered with longleaf pine (*Pinus palustris* Mill.) forests. It has been called "the forest that fire made." From the mineral soil required for seedling establishment to the thick bark of scaly plates that insulates and dissipates heat, every stage of the longleaf pine life cycle relates to fire (Myers and Ewel 1990). Unlike most pines, the longleaf seedling spends an undetermined number of years in the "grass stage," which affords the young tree protection from fire by surrounding the terminal bud with a tuft of long needles (**fig. 8.3**). A substantial root system is developed during this stage, enabling the sapling to bolt above the most lethal fire zone in two to three growing seasons. Despite the many adaptations, a wildland fire can kill even large, mature trees, particularly if it burns dry duff. During drought, a low-intensity ground fire can burn into this duff layer and damage tree roots to the point of mortality.

Other southern pine ecosystems have different fire regimes. A vigorous, intense, stand-replacement fire, for example, is the normal regime for sand pine [*P. clausa* (Chapm. ex Engelm.) Vasey ex Sarg.] forests. A fire every 10 to 100 years typically reduces the trees to cinders, from which a new sand pine forest grows (Myers and Ewell 1990).

The appearance of pine in the overstory of many southern forests indicates a potential for wildland fire, but even forests with an oak-hickory (*Carya* spp.) canopy are susceptible. Estimates for fire return intervals in these forests are complicated by the use of fire by Native Americans and settlers, but could range from 15 to several hundred years (Harmon 1982 as cited in Wade and others 2000). Oaks and hickories succeed in areas with periodic fire, protected by their thick bark. Sprouting from a large seed, these trees develop a substantial root system and are able to resprout (Wade and others 2000). In the mountainous region of the South, when a lack of rain dries out the leaf litter layer and vegetation has not yet leafed out in the spring or just dropped leaves in the fall, exposed southern slopes are at considerable risk of fire. Plants such as mountain laurel (*Kalmia latifolia* L.) and rhododendron (*Rhododendron* L.) can burn with surprising intensity, nearly exploding into flame (Wade and others 2000).

Fire consumes aboveground litter, mineralizing phosphorus and other nutrients and making them available to plants. Fires can also volatize nitrogen, causing a reduction in this nutrient. On balance, however, it appears that frequent light fires result in the release of small pulses of nutrients (Myers and Ewel 1990). These nutrients are used by sprouting vegetation, and then consumed by wandering herbivores. Removal of leaf litter increases soil movement during rains, but in the South where vegetation regrowth is quite fast, this increase in soil erosion is generally not significant.

The balance of pine and oak in the forests of the South has changed over the last 20,000 years so much that it is impossible to know the composition of the "original" forest (Myers and Ewel 1990). Soil types, moisture levels, climate, and fire at different frequencies and seasons worked in concert to shape and reshape the forest ecosystem. Some might see the recent resurgence of oak in fire-excluded pine forests, and of maple (*Acer* spp.) in oak forests, as merely additional steps in the natural system of change. While this change might dampen or reduce the

incidence of wildland fire in a protected forest, it is not likely to affect the intensity of the occasional catastrophic fire that follows a drought. A forest without fire is likely to have a great deal of understory fuel. Ground cover, shrubs, and ladder fuels sustain and drive wildland fires. However, regardless of the overstory composition, the real question is how do we best manage the existing forests to maintain species diversity, enhance ecosystem goods and services, and still protect interface dwellers?

Forest Resource Management

Managing forest resources in the interface is a challenging game of balance. Certain activities are important to maintaining healthy ecosystems, but these activities might be difficult for nearby neighbors to accept. Efforts to reduce deer herds to viable levels by opening a hunting season has generated conflict in a variety of States, leaving managers with a frustrated "I can't implement the management strategy I believe is best" feeling. Fire is no different.

"The risk of using prescribed fire has just grown exponentially. You can be totally within the prescription, do everything 100 percent right, and then 12 hours later have a smoke-related incident because we have an increase in traffic we didn't have 10 or 20 years ago. " Mississippi

Managing for forest health often means using fire in the landscape. The ability of managers to use prescribed fire is limited by weather and by public opinion. Managers across the South have worked to educate the public about the benefits of prescribed fire in reducing the hazards from wildfires.

In areas where prescribed fire is not an acceptable treatment, the alternatives of mechanical fuel reduction and herbicide application have been explored. Thinning with tree removal or chipping helps reduce the remnant woody material and speed decomposition (Kalabokidis and Omi 1998). A herd of goats is used at a Florida 4–H Camp because of the risk of smoke on a nearby interstate highway. Herbicides are often used in managed plantations to reduce competition from nondesired species. Where decomposition occurs quickly and where rainfall reduces the threat of drought, herbicide application might be a reasonable alternative. Herbicide treatment, however, may be even less acceptable to the public than fire.

"The interface is overgrown—overgrown due to lack of fire." Mississippi

A recent study on the public's willingness to pay for various alternatives rated herbicide the least popular treatment.[2] In a comparison of different fuel reduction techniques, Brose and Wade (2001) suggested that combinations of thinning, herbicide application, and prescribed fire could reduce the short-term and long-term risks from wildland fires.

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[2] Loomis, J.B.; Bair, L.S.; Gonzales-Caban, Armando [and others]. 2000. A survey of Florida residents regarding three alternative fuel treatment programs. Fort Collins, CO: Colorado State University. 89 p. Unpublished study. In cooperation with: University of Georgia, Survey Research Center, Athens, GA. On file with: John Loomis, Department of Agriculture and Resource Economics, Colorado State University, Fort Collins, CO 80523.

Photo courtesy of Florida Fish & Wildlife Conservation Commission

Figure 8.4
Wildlife may return rather quickly to burned forests in order to nibble on the new vegetation.

In Assessment focus group discussions, resource managers in most States mentioned the problems of using prescribed fire in the interface. They spoke of common experiences and challenges in managing forests near residents who did not understand the use of fire. They feared liability if a prescribed fire led to vehicle accidents or property damage. Managers seemed caught in a tightening vise of growing vegetation, unyielding attitudes, and increasing population. They were concerned for both the resource and the impending danger to residents, and they did not have ideas for solutions (Monroe and others, in press).

"One of the reasons we have wildfires is a direct result of the litigiousness of society. If a private landowner is doing a controlled burn and somebody down the road has a car accident, regardless of whether or not smoke actually caused the problem, if they can smell smoke, they're going to sue and that stops controlled burning." Florida

Invasive exotic plant species are often quick to colonize a recently burned area and many, such as Old World climbing fern [*Lygodium microphyllum* (Cav.) R. Brown], magnify the fire hazard. In the interface, managers may have to reduce invasive plant seed sources before a prescribed fire, or physically remove vegetation to reduce the threat of wildland fire. For threatened and endangered plants that inhabit fire-dependent ecosystems, the use of prescribed fire is imperative to restore critical habitat.

Wildlife represents another complication for interface managers. Some wildlife populations respond favorably to frequent, low-intensity fires, though not all individuals survive (Main and Tanner 1999) (**fig. 8.4**). Most endangered species in the South require periodic fire; herbicide and mechanical methods of reducing vegetation do not provide the same benefits as fire for wildlife habitat (Brennan and others 1998). The public, however, believes that harming wildlife is one of the greatest risks in prescribed burning even though newspaper reports generally do not reinforce this misperception. In an analysis of 272 newspaper articles on fire in Florida printed in summer 1998, only one of the 44 articles that discussed prescribed fire mentioned a risk to wildlife (Jacobson and others 2001).

Demographics

Across the Nation, the increasing human population in the wildland-urban interface has exacerbated the issue of wildland fire. Though relatively few lives

Photo courtesy of Virginia Department of Forestry

Figure 8.5
Homes in the woods are at risk of wildland fire.

have been lost, damage to homes and businesses is a significant risk of living in the interface, and one that new residents are not likely to realize at the time they move (Gardner and others 1987) (**fig. 8.5**). While leaving one set of problems in the urban areas, such as smog, congestion, crime, and noise, some migrants merely exchange them for other problems, like the lack of public services, questionable water quality, trash along roadsides, and wildland fire. **Table 8.1** represents a partial history of interface fires, indicating the scope and breadth of the problems.

The expanding interface represents different challenges as it grows. The first homes there are at substantial risk because of limited fire protection services in

Table 8.1—A selected history of wildland-urban interface fires in the United States

Location	Year	Structures lost	Area burned
		– – Number – –	*– – Acres – –*
Pine Barrens, NJ	1963	383	183,000
Laguna, CA	1970	382	175,425
Sycamore, CA	1977	234	805
Panorama, CA	1980	325	23,600
Palm Coast, FL	1985	99	13,000
Burke County, NC	1985	76	2,000
Onslow County, NC	1986	0	73,000
Monterey County, CA	1987	31	160
Nevada County, CA	1988	90	33,500
Sisters, OR	1990	22	3,300
Paint Cave, CA	1990	641	4,900
Oakland Hills, CA	1991	2,900	1,500
Chelan Cty, WA	1992	32	2,400
Craven County, NC	1994	0	24,600
Millers Reach, AK	1996	344	37,336
Poolville, TX	1996	141	16,000
Florida	1998	330	500,000
Juniper, CA	1998	44	6,000
St Lucie, FL	1999	43	759
Los Alamos, NM	2000	235	47,650
Russell County, AL	2000	6	4
Chambers County, AL	2001	2	30
Talledega County, AL	2001	1	347

Photo courtesy of Virginia Department of Forestry

Figure 8.6
Steep, winding, narrow roads to residences may not be accessible by large fire engines or may become blocked with debris during a wildland fire.

Table 8.2—Recent fire history in Texas[a]

Year	Fires	Area Burned	Structures Saved	Value	Structures Lost	Value
	No.	*Acres*	*No.*	*M $*	*No.*	*M $*
1996	2,800	236,000	3,170	158,500	165	3,000
1997	650	8,400	105	5,300	9	400
1998	2,793	198,000	4,087	238,000	147	2,700
1999	2,313	172,000	2,739	129,500	52	3,400

[a] Forest resource protection department fire database. On file with: Texas Interagency Coordination Center, Route 5, Box 3650, Lufkin, TX 75904 [936.875.4786].

sparsely populated areas and limited access on winding, narrow roads not built for heavy equipment (**fig. 8.6**). A scattering of summer homes, mobile homes, or secluded mansions is difficult to protect because of the large area involved. In 1988, Texas Forest Service officials were concerned that while 80 percent of the population lived on 3 percent of the land, an increasing number of people lived in areas without full-time fire protection (Miles 1988). Over 1,400 communities of <10,000 people had no fire department serving the town. **Table 8.2** provides a recent fire history in Texas and indicates the value of the homes and other structures that are found in this risk-laden interface.

As the interface becomes more populated, zoning codes may require water sources, road clearances, and emergency services. Where existing communities are expanded or infilled, however, the additional homes may be approved under the old regulations that governed the less-dense development (Rice and Davis 1991). In other regions, planning for increased growth is woefully inadequate, and the people who are selling new homes or building schools may not have even considered fire services. Even if new developments are zoned more appropriately with forethought for fire, they are still at enormous risk if a fire from an adjacent wildland approaches. During fire suppression, the demand for water, access, equipment, and firefighters may overwhelm the available system (Davis 1990).

Residents of the South represent a diverse and changing mixture of ethnic and cultural groups. A recent study of English- and Spanish-speaking residents who lived in areas exposed to recent large-scale Florida wildland fires reveals that knowledge and perception of risk varies between these groups, but not their willingness to pay for fuel reduction strategies (see footnote 2). Efforts to educate the public must take into account the variety of groups and their potentially different values and perceptions.

In some parts of the South, retirees dominate interface communities. People who are new to the fire regimes of southern forests may not be aware of the fire risk, or may not understand the use of prescribed fire. Furthermore, the elderly are more likely to suffer from lung disease and, therefore, are at greater risk of medical complications from the particulate matter in smoke. More people, more kinds of people, and more people with different needs in the wildland-urban interface help shape the strategies used to manage fire.

Economics

Wildland-urban interface fire is costly. There are replacement costs for lost structures, opportunity costs of reduced tourism or cancelled events, and the costs of suppression. In California alone, the average annual losses to wildland fires between 1985 and 1989 amounted to $41,678,800, including 79 destroyed structures (Anderson and others 1991). Suppression costs for only one complex of fires in Florida, which burned from June 29 to July 16, 1998, near Orlando, totaled $5,211,500.[3] Of this total, 28 percent was spent on bulldozers, water tenders, and fire engines; 23.4 percent on food, lodging, communications, transportation, and toilets; 18.5 percent on personnel; and 15 percent on air support (see footnote 3). Fifty-one fires in five counties broke out during that period, destroying 40 homes (see footnote 3). In 2000, wildland fires in the South destroyed more structures than wildland fires in the rest of the country, even though the acreage burned was relatively small.[4] The housing density in the wildland-urban interface of the South explains this substantial loss.

Because of high housing density, any wildland fire in the South is likely to put interface homes at risk. Protecting these homes usually comes at a cost to other resources. In recent years, the largest loser has been the forest industry. An economic study estimates at least $620 million were lost in the 1998 wildland fires in Florida (Mercer and others 2000). Timber revenues increased for landowners who had to salvage their burned timber. Salvaged trees have less value than unburned logs, and with the large amount of salvaged timber on the market, prices dropped even further. Total pine losses were estimated between $354 and $605 million, with hardwood losses presumed to be $100 million (Mercer and others 2000). Sales tax receipts increased for the months during the wildland fires, perhaps due to supporting firefighters; they dropped immediately after the fires, perhaps due to the drought or media exposure. The net change in tourist and sales tax revenue was a loss of $138 million (Mercer and others 2000). Suppression and disaster relief efforts cost the government more than $120 million (Mercer and others 2000). A study of medical treatment noted an increase in emergency room visits for asthma, bronchitis, and other respiratory ailments, but no increase in hospital admissions during the months of wildland fire (Mercer and others 2000). Finally, the loss of insured property totaled $10 to $12 million (Mercer and others 2000).

There are costs to prevention, as well. In Arizona, the national forests have identified 237,000 acres in their wildland-urban interface in need of vegetation reduction to reduce the risk of wildfire to nearby residents. In 1998, 5,016 acres were treated with thinning, chipping, fuel breaks, prescribed fire, and timber sales at a cost of $1,213,720 (U.S. Department of Agriculture Forest Service 1997). This treatment is not a permanent remedy, of course. Some ecosystems require additional burns to reduce fuel loads within 5 years (Davis and Cooper 1963).

The economic cost of using prescribed fire in the interface is greater than the cost of using fire in wildlands. While burning costs are $3 per acre in wildlands, they rise to $50 per acre in the wildland-urban interface because more preparation and public contact are needed.[5]

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[3] Birch, K.; Brown, M. 1998. Orlando complex fire narrative summary and discussion of incident management operations. 25 p. Unpublished report. On file with: Annie Hermansen, USDA Forest Service, Southern Research Station, Southern Center for Wildland-Urban Interface Research and Information, 408 W. University Ave. Suite 101, Gainesville, FL 32601.

[4] Personal communication. 2001. William R. Sweet, Program Manager, U.S. Department of Agriculture, Forest Service, Southern Region, Fire Prevention and Wildland-Urban Interface, 1720 Peachtree Rd., NW, Atlanta, GA 30309.

[5] Greenlee, J.M.; McGarrahan, F.; Namlick, T. [N.d.]. Wildfire mitigation in the 1998 Florida wildfires. FEMA-1223-DR-FL. Federal Emergency Management Agency. 9 p. [After action report]. On file with: Annie Hermansen, U.S. Department of Agriculture, Forest Service, Southern Research Station, Southern Center for Wildland-Urban Interface Research and Information, 408 W. University Ave. Suite 101, Gainesville, FL 32601.

Insurance rate structures have been used to encourage improved health, better driving habits, and hurricane preparedness; similar strategies could be employed to encourage wildland fire prevention, such as the cost of retrofitting homes with fire-resistant materials. Unfortunately, there is some indication that disaster loans and low premiums subsidize inappropriate and high-risk construction (Davis 1990). Homeowner insurance premiums do not currently compensate homeowners for the cost of all the firewise improvements they might make to their home. Unlike improvements to reduce the risk of hurricane or earthquake damage, damage from wildland fire has not been a large enough cost to the insurance companies to encourage changes in the premium structure in most States.

Land Use Planning and Policy

Policies and recommendations about wildland fire suppression, the use of prescribed fire, zoning, and building construction abound. For example, because of the predominance of a fire-prone ecosystem, high fire risk, and large population, Florida's Division of Forestry aggressively uses prescribed fire to manage natural areas. They also use a full complement of policies and regulations to guide who can burn, when burns occur, when burners are liable, how burners are trained, and how burns are authorized. This proactive wildland-urban interface fire program is certainly a model for other States.

"Traditional forest management practices, like prescribed burning, have to be changed because of conflicts between management and people." Texas

Councils

Building awareness for using prescribed fire to reduce wildfire hazards starts with increased communication among the agencies and organizations that manage wildlands and joint efforts on publicity. Prescribed Fire Councils have been successful avenues for maintaining contact among those interested in using prescribed fire and for coordinating media efforts. By creating posters and brochures, speaking to civic groups and schools, conducting workshops and field trips, obtaining press coverage, and maintaining a presence at the State capital with exhibits during Prescribed Fire Awareness Week, the councils in Florida perform an important service in public education (Wade and Brenner 1995). Periodic regional meetings in Florida have attracted nearly 300 participants.

It is the policy of land management agencies to protect human life and structures before natural resources during a wildland fire (Cortner and Lorensen 1997). In the interface, this policy often means that Federal and State forest agency firefighting personnel and equipment must work with structural fire crews to protect homes rather than focusing on suppression of the spreading fire. The differences between these two groups of firefighters, in firefighting procedures, clothing, tools, and equipment, mean that communication is essential. Some structural fire departments with repeated experience in interface fire have obtained wildland fire equipment and training, making the job of fighting fires together much more successful.[6]

At the institutional level, wildland-urban interface firefighting requires communication and cooperation among a broad array of agencies. In most States, the responsibilities for forest fires, structural fires, firefighting training and certification, emergency management, transportation and highway safety, smoke and air quality, insurance rates, building codes and development regulations, and growth management fall within several different agencies. They may also be addressed at different levels of government. In Texas, for example, local fire departments are the primary initial response force for fighting wildland fires; the State forestry agency is called when the conditions exceed the capabilities of the local resources.

Such a wide variety of disciplines, interests, and perspectives on fire create challenges for communication and joint policy initiatives, particularly in the heat of a crisis. Many fires in the wildland-urban interface are approached through a multiagency incident command system, which requires each agency to operate under a common set of guidelines.

[6] Personal communication. 2000. Will May, Chief of Emergency Management, Alachua County Fire and Rescue, P.O. Box 548, Gainesville, FL 32602.

Photo courtesy of Florida Division of Forestry

Figure 8.7
People in both rural and urban areas are exposed to smoke from prescribed fire. Concerns about air quality and traffic hazards are very real.

The State of Florida recognized the value of prescribed fire for ecological and resource management purposes and charged the division of forestry with the responsibility to develop rules to regulate its use (Wade and Brenner 1995). Also known as the "right to burn" law, it requires written prescriptions for each burn and protects the burner from liability unless negligence is proven. A well-constructed lobbying effort of industry, conservation organizations, and State agencies helped to pass this groundbreaking legislation.

Local governments also have the power to establish ordinances that address wildland-urban interface fire. Flagler County, FL, the site of a countywide evacuation during the 1998 fires and where over 200 homes have been destroyed by interface fires, recently enacted an ordinance requiring brush mowing and selective thinning of mature pine trees (Flagler County Ordinance No. 98-14). Property owners of "nuisance brush and pine trees" are required to clear the property or reimburse the division of forestry for the service. A similar effort at the State level, the Hawkins Bill, was passed in 1977 to allow the Florida Division of Forestry to use prescribed fire to reduce fuel loads on properties owned by absentee owners (Wade and Brenner 1995). To alert new residents to the probability of nearby smoke, several Florida counties use an ordinance requiring that prospective homebuyers be notified about the use of prescribed fire to manage State-owned natural areas (Wade and Brenner 1995). The ongoing challenge is in balancing private property rights and public safety.

Prescribed fire is necessary and valuable, but it raises liability questions if property is damaged or vehicle accidents can be blamed on smoke (**fig. 8.7**). The State of Florida has wrestled with these issues for several years and currently offers legal protection to individuals who have completed a training course in prescribed fire, become certified prescribed burn managers, and are conducting a prescribed burn within prescription and in accordance with appropriate regulations (Long 1999, Wade and Brenner 1995).

Smoke from prescribed fire generates significant public concern, particularly when it drifts into urban areas where residents have little appreciation for the benefits of prescribed fire. Smoke from wildland fire also contains particulate matter that is a pollutant regulated by the U.S. Environmental Protection Agency (EPA) (**fig. 8.8**). If a region is approaching the maximum allowable standard for particulate matter, prescribed burning activities could cause the area to exceed the daily limits on air quality (Monroe 1999). Violation of daily limits would trigger a required implementation plan under the Clean Air Act with activities to reduce particulate matter. Under an agreement between the EPA and the Federal land management agencies, however, in these cases State smoke management plans may be reviewed for appropriate parameters to reduce smoke problems (U.S. Environmental Protection Agency 1998). If a city is already a nonattainment zone, prescribed fire may be banned during seasons of peak ozone production.

TECHNOLOGY

Technology can help protect structures from wildland fire. Foams and gels can be sprayed over a home several hours before a fire approaches to protect the structure. Siding made from a concrete mixture (Hardiplank®) is virtually inflammable, and even wooden shingles can be treated with chemicals to render them as fire resistant as asphalt shingles.

Photo courtesy of Florida Division of Forestry

Figure 8.8
Smoke plumes signal a growing wildland fire in the wildland-urban interface.

Photo courtesy of Florida Division of Forestry

Figure 8.9
Vinyl soffits and siding are quick to melt in the heat of a wildland fire. In Florida, one identifiable cause of destroyed homes was sparks entering the attic through exposed soffit vents.

TOOLKIT

The cooperative extension service is a likely partner in a communication effort with interface residents. Extension agents conduct programs throughout rural counties across the South. In Florida, the extension service teamed up with the Florida Division of Forestry and The Nature Conservancy to prepare extension agents and forestry staff to develop public programs, work with the media, and establish prescribed fire demonstration areas in high-risk communities. The Wildland Fire Education Toolkit was developed to provide agents with programming tools such as videos, fact sheets, brochures, press kits, and slides. Within the first 4 months of the program, county agents and forestry staff reached over 2,000 residents in direct programs, contacted 23,000 people at county fairs and displays, and used the local media to reach over 2.1 million citizens with messages about wildland fire mitigation activities (Monroe, M.C. 2000. Increasing public awareness and knowledge of wildland fire through county programs. 41 p. Unpublished final report. On file with: Martha Monroe, School of Forest Resources and Conservation, University of Florida, P.O. Box 110410, Gainesville, FL 32611-0410).

Preventing the loss of life and the loss of structures in wildland-urban interface fires may begin with changes in land use planning, zoning, structural codes, and development design. An improved connection between land use planning and ecosystem dynamics may begin to resolve a variety of wildland-urban interface challenges. Many Western States have used all of these tools to manage interface fire, with varying degrees of success (Davis 1990, Irwin 1987, Pumphrey 1993, Rice and Davis 1991). The most common guidelines represent a common sense approach to prevention: create firebreaks from retention ponds or golf courses around subdivisions, assure access roads and water supplies, use fire-resistant building materials, and avoid steep slopes (Monroe and Marynowski 1999, Smith 1987) (**fig. 8.9**). Unfortunately, few of these recommendations are easy to implement after homes are built, and few seem to be heeded during the planning phase.

A series of recommendations, known as NFPA 299: Standard for the Protection of Life and Property, was developed by the National Fire Protection Association (NFPA) to guide developers, builders, planners, and decisionmakers who approve developments in the wildland-urban interface. The recommendations include dimensions for roads, distances to water, and building materials that can improve homeowners' abilities to protect themselves from fire. Some of these building materials, such as aluminum soffits, are not widely available; others are usually more expensive than the traditional materials. Neither case makes it likely that homeowners will seek out these materials.

Finally, successful policies will be those that the public supports. In a study of attitudes held by interface residents in 2 California communities, respondents rated 16 public policies that would help reduce their risk of wildland-urban interface fire. Policies that regulate industries and agencies (building material restrictions and prescribed burning program) tended to be more favored. Policies that restrict homeowner choice (density requirements and fire insurance) were ranked low (Cortner and others 1990). A policy to encourage homeowners to clear vegetation on their property was ranked high, though few of the respondents had done so.

Social Dimensions

Public reactions to wildland fire have become more sophisticated over the last 20 years, evolving from a "fire is bad" perspective to a more rich understanding that fire plays an important role in many forest ecosystems (Cortner and others 1990). Despite growing support for the use of prescribed fire in a wilderness, however, there is mixed reaction to the use of prescribed fire in the interface. Florida residents may have expressed this "not in my backyard" sentiment when 79 percent responded that people who live near natural areas should tolerate some smoke from wildland fire and 53 percent agreed that protecting air quality is more important than burning natural areas (Jacobson and others 2001). The respondents (sample excluded urban dwellers) lived an average of 7 miles from the nearest natural area.

The attitudes and preferences that support migration to the wildland-urban interface also support particular choices about the homesite, construction, and landscaping that directly oppose firewise recommendations. In the Assessment focus groups, resource managers commented that these homeowner choices also put firefighters in jeopardy (Monroe and others, in press). A study of homes that burned in Florida's Palm Coast fire of 1985 revealed that one of three significant factors was clearing the brush near the house. Homes within 10 feet of brush burned more often than homes with 30 feet of brush clearance (Abt and others 1987).

"We've got steep, dead-end roads that go up hillsides to homes. Firefighters are at risk trying to reach these people's homes." Georgia

If new migrants situate their home on a high ridge to enjoy a scenic view or behind a screen of vegetation to insure privacy, they have increased their risk of a wildland fire consuming their home. If they wish to design a home that blends in with the surroundings and use wooden siding, unrated wooden shingles, and wooden decks, they also increase the risk. Narrow, winding driveways, while appealing to the homeowner, discourage emergency vehicles from approaching a home (Davis 1990). Native plants that attract wildlife, thick shrubbery that shelters birds, windbreaks and shade-providing trees that overhang the home, and little lawn to maintain are all landscape elements preferred by environmentally concerned interface residents. All of these elements increase their risk of wildland fire. In fact, many agencies lend to the confusion by recommending these elements in home landscapes. Subdivision ordinances may require homeowners to maintain privacy screens of vegetation. The risks of fire are rarely obvious when residents move to the interface (Gardner and others 1987), but must be communicated in a manner that is sensitive to the homeowners' preferences and values.

Reactions to messages about wildland fire portray some of the same responses as other risks involving personal behavior, like smoking and drinking alcohol. Convinced that fire won't strike twice in the same place, recent survivors tend to discount their risk, even if their ecosystem burns at a regular and frequent interval (Gardner and others 1987). A basic ignorance of wildland fire leads many residents to underestimate their fire risk. Residents who believe that forest fires are, basically, random events that no one can control may be less likely to support protective measures or take actions to reduce their risk (Winter and Fried 2000).

Education programs have increased awareness and knowledge about wildland fire in several different ecosystems (Marynowski and Jacobson 1999, Taylor and Daniel 1984). In the wildland-urban interface, residents have increased their knowledge and developed attitudes that are more positive about prescribed fire, because of educational activities (Monroe and others 1999a). Residents with an increased awareness and understanding of fire and risk are often willing to take some actions to protect their homes and property (Cook 1997). A recent Florida survey found that 42 percent of those surveyed had already taken precautionary actions, such as removing shrubs and branches from near the home and moving flammable objects like woodpiles away from the house (**fig. 8.10**) (Monroe and others 1999b). Another survey in Florida found that the more respondents believe in the effectiveness of prescribed fire to reduce wildland fire risk, the less concerned they are with the cost of the mitigation effort (see footnote 2).

Meeting the Challenge

Increasing communication with the public is part of nearly every recommendation from any report on wildland fire written in the last 20 years. Fire in the wildland-urban interface cannot be managed by government agencies alone; homeowners must become responsible partners. A more knowledgeable public can contribute to improved policies, zoning and building regulations, home maintenance, and landscaping. Fortunately, some programs have begun to make a dif-

FIRECAP

In Texas, the program Fire-Citizen's Advisory Panel (FireCAP) helps involve local residents in efforts to raise awareness of fire and emergency-related issues, support the fire departments, improve emergency response networks, and engage citizens in wildfire mitigation activities. The program began in Bastrop County, where a partially built subdivision (600 homes on 4,000 acres) in a steeply sloped, pine/juniper forest with narrow, unimproved roads appeared to be a disaster in the making. Local fire officials and citizens worked together to better communicate the challenges of interface fire and promote fire prevention and mitigation. An outgrowth of FireCAP was the Tahitian Village Wildfire Mitigation Project, which aggressively promoted the use of defensible space around homes. Several homeowners volunteered their properties to become demonstration areas to help alert other neighbors to the feasibility of the recommendations. They also organized a MulchFest, giving residents a chance to learn about wildland fire and defensible space, order 911 numbers, and dispose of brush, leaves, and needles while enjoying the camaraderie of their neighbors. One goal of the program is to enable residents to safely dispose of the slash they create from their mitigation efforts. The program has expanded to explore permanent ways to deal with brush, pine needles, and leaves and has spread to encompass the 80,000-person county.

Photo courtesy of Virginia Department of Forestry

Figure 8.10
Homeowners can create firewise landscapes to reduce their risk of wildland fire.

ference by improving agency partnerships, raising public awareness, developing demonstration yards, and putting interface fire protection in the news. Examples include FireCAP, Firewise, fire councils, and the Wildland Fire Toolkit. Additional staff, additional training, interagency training, cooperative programs, and new publications are also employed to help educate citizens and managers working in the interface.

Positive results from some efforts might be copied by other agencies and States. Some of the more creative ideas that have been well received and shared with other locations are:

- training sessions for local media including attendance at a prescribed fire (**fig. 8.11**);
- trained fire prevention education teams that share key wildland-urban interface fire messages with high-risk communities and homeowner associations;
- courses for special audiences, like cattlemen, native plant society members, or natural area managers;
- regular newspaper columns;
- educational materials for students, distributed through workshops with teachers;
- demonstration areas next to public hiking trails with interpretive signs on the role of fire;
- prescribed fires around golf courses to expose interface residents to the value of fire; and
- billboards, pencils, mugs, T-shirts, and caps advertising the benefits of prescribed fire.

Firewise

At the national level, the Firewise program has created a set of materials, an interactive Web site (www.firewise.org), and a model workshop for local agencies to use to build support for fire mitigation activities. The program recognizes that builders, mortgage lenders, utility agencies, firefighters, elected representatives, educators, planning commissions, and land managers must be involved in preventative planning in the interface. The workshop engages this diversity of participants in discussions about rating and reducing fire hazards in existing and proposed developments. Several States have adapted the national recommendations to their own situations and organized their own series of workshops.

Needs

Some land managers are very enthusiastic about prescribed fire to mitigate wildland fire effects in the interface, but it cannot be the only solution. Weather patterns often make it difficult to safely conduct prescribed fires in the South, and there will be schools, hospitals, retirement villages, highways, and airports in the airshed of natural areas that make smoke management difficult. There is an urgent need to better understand fuel management in the South. Some specific needs are to:

- monitor urban expansion into hazardous fuels, rating fuel loads, and prioritizing reduction efforts;
- develop cost-effective and environmentally benign combinations of fire, grazing, mowing, thinning, and herbicide application to reduce vegetation over time in the interface and enhance the ecosystem;
- improve prediction of smoke movement;
- improve communication strategies to inform all fire, safety, and transportation personnel about smoke movements; and
- improve predictability of fire behavior in the southern wildland-urban interface so that vegetation removal and housing design can reduce the need for firefighters.

Photo by Martha Monroe, University of Florida

Figure 8.11
Allowing television crews to cover a prescribed fire in a residential area for the evening news allows the public to become more accustomed to this land management tool.

Similarly, more work needs to be done on the defensible space guidelines. Research needs are to:

- explore flammability and develop a rating system for landscape plants and types of mulch in the South;
- develop guidelines for appropriate density of trees (particularly pines) in a wooded housing development and appropriate distance of vertical and horizontal separation of landscape vegetation to reduce ignition potential of structures while providing shade and other benefits (**fig. 8.12**);
- better understand residents' values that determine landscape priorities, so their desires for wildlife, energy conservation, privacy, and reduced lawn maintenance can be accommodated while maintaining defensible space; and
- identify segments of the wildland-urban interface publics that are more likely to perceive a realistic risk of wildland fire and take actions to reduce their risk.

Reducing the risk of damage from wildland fires in the interface may be best accomplished by communities, homeowner associations, community-based fire department auxiliaries, and groups of landowners. More research is needed to understand:

- the most effective strategy to engage groups of people in fire-mitigating activities;
- how agency partners can nurture and support community leaders;
- how the social capital in a community of neighbors can be used to support land management activities;
- which tasks can be expected of citizens, and which fuel reduction activities they would find most acceptable;

Photo courtesy of Florida Division of Forestry

Figure 8.12
Increasing the vertical and horizontal space between plants and branches will help reduce the risk of wildland fire.

- the roles of policy, tax, and insurance incentives in motivating citizens;
- the most useful educational assignments, materials, or activities that help students take wildland fire messages home to parents;
- the design characteristics of interface structures and developments that will make them more survivable in a wildland fire and safer for prescribed fire; and
- the key characteristics of a successful homeowner education program—one that engages individuals to work in concert with their neighbors to reduce wildland fire risk.

Public agencies can work to improve communication, coordination, and organization during wildland fire preparation activities. Agency staffers are important links to information and resources. We need to better understand:

- the best ways for agencies to support communities and communicate the urgency of the message in a manner that will be heard by residents;
- how agencies can better work with companion agencies on overlapping turf, like water management, transportation, and energy conservation;
- how agency staffers can become integral components of community planning and development decisions that affect the risk of wildland fire in the wildland-urban interface; and
- how agency staffers can better integrate community leaders in the planning and design of prescribed fire activities and incorporate their expertise as residents into management activities.

Conclusion

Fire is only one issue in the wildland-urban interface, but it attracts attention. The challenges associated with managing wildland fire in the interface—interagency communication, growth management, fire-dependent ecological systems, Federal-State-local cooperation, public education, behavior change, and organizational development—are not unique to fire. They are challenges for every interface issue.

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Chapter 9

THEMES, RESEARCH, AND INFORMATION NEEDS

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...to accept certain kinds of change is not to accept all kinds of change. Moreover, we must focus our attention on the rate at which changes occur, understanding that certain rates of change are natural, desirable, and acceptable, while others are not (Botkin 1992).

Introduction

Driven by social forces discussed in this Assessment, change is sweeping across the southern landscape unlike anywhere else in the United States. These changes are affecting forest ecosystems and creating challenges for managers of natural resources. Current knowledge, skills, and approaches are insufficient to meet these challenges. There is little doubt that research could contribute much to the solution of natural resource concerns in the interface. ▶

Photo courtesy of USDA Forest Service

Figure 9.1
Wildland-urban interface issues are about people and their relationship with and effect on natural resources.

In the South, where the wildland-urban interface is expanding most rapidly, ecological and sociological effects are readily apparent. In the foregoing chapters, where these effects were examined, four major themes emerged:

1. Wildland-urban interface issues are about people.
2. Public policy plays an important role in creating and solving interface problems.
3. Interface issues are interdisciplinary.
4. Issues involve multiple ownerships, jurisdictions, and scales.

Results of the Assessment suggest four major areas for research:

1. Explaining and adapting to human influences on forest ecosystems.
2. Identifying the influences of public policies on forest ecosystems and their management.
3. Identifying and reducing risk to ecosystems and people in the wildland-urban interface.
4. Understanding and communicating public attitudes, perceptions, and values.

The remainder of this chapter addresses the major themes that were found and the research areas that were identified.

Major Themes

Wildland-Urban Interface Issues are About People

The first major theme of the Assessment is that wildland-urban interface issues are about people and their relationship with and effect on natural resources (**fig. 9.1**). This theme first emerges in chapter 2 (Population and Demographic Trends in the South), which demonstrates how significant population and demographic trends, shifts in land ownership, and the dramatic transformation of the landscape alter forest ecosystems in the South. Alterations are caused not only by population increases, but also by changes in attitudes, perceptions, and priorities of this population with respect to land use. These new values can be attributed to a populace that is moving, aging, and becoming more culturally and ethnically diverse.

Changing perceptions, attitudes, and values affect the way in which forests are perceived and managed in the transition from rural to interface, and eventually, to urban use. Along this gradient, predominant forest values change from traditional forest products, such as wood and fiber, to noncommodity benefits such as improvement of air and water quality and conservation of energy. Multiple ownerships and jurisdictions, increased recreation demand, and pressures from adjacent homeowners and landowners complicate forest management. As a result, forest management objectives change. These human influences ultimately determine future forest management strategies in the wildland-urban interface.

With increases in the South's population come even more dramatic increases in the conversion of rural and forest land to urban uses. Six of the ten U.S. States with the highest rates of rural-to-urban conversion are in the South. Chapter 5 (Urban Influences on Forests) shows that urbanization directly alters forest ecosystems by removing or fragmenting forest cover. The rate and scale of change that is occurring in the South significantly affect forest health and the goods and services that people rely on from forest ecosystems. Consequently, human health and quality of life are affected.

Relationships between people and natural resources are intricate and complex. Research can help us to better understand and predict these relationships. Education plays a key role in helping people to understand these relationships and the consequences of their actions.

Public Policy Plays an Important Role in Creating and Solving Interface Problems

The second major theme of this Assessment is the important role of public policy in the wildland-urban interface. This theme closely links with the first because public policy is driven and shaped by people's attitudes, values, and perceptions. Policy issues in the wildland-urban interface are complicated by the diversity of landowner objectives, by property rights issues, and by land use impacts across property boundaries. Some public policies help to protect and conserve natural resources, while others create incentives for urban development (**figs. 9.2A, 9.2B**). Thus, public policies can create problems as well as provide solutions in the interface.

One way that public policies affect the interface is by influencing land use change. Chapter 4 (Land Use Planning and Policy Issues) shows that Federal

Photo by Larry Korhnack, University of Florida

(A)

Photo courtesy of USDA Forest Service

(B)

Figure 9.2
(A) Some public policies help to protect and conserve natural resources; (B) other policies create incentives for urban development.

"Natural resources accounting is needed to point out to people what is being lost. We need a whole new way of taking into account the value of the resources that is potentially being lost to urbanization." Virginia

policies provide incentives for migration to and subdivision of land in the interface. Often, however, the greatest effects on land use decisions come from local public policies, especially land use planning. It is at this local level where public values and perceptions have the greatest effect on policy. For example, citizens opposed to activities that could result in deforestation, such as land development for urban uses, may push for conservation regulations that may inadvertently interfere with traditional forest management practices.

Conflicting policies at various levels can set up complex situations. Chapter 8 (Fire) discusses one such situation. Local and State governments can establish ordinances to reduce the risk of wildland fire by lessening fuel loads. Prescribed fire is the least expensive way of reducing fuel loads, but the particulate matter in the smoke can create health problems. Fuel reduction policies, therefore, may conflict with Federal clean air policies (**fig. 9.3**).

Because public values and perceptions ultimately dictate policy, accepted policies will be those that an informed public supports. Chapter 2 points out that population growth is greatest in urban areas. Urban constituencies, therefore, will have the greatest impact on national and State policies affecting natural resources and the management of public land. Though natural resource information and technology transfer programs must be targeted to a variety of audiences, those that focus on urban constituents and policymakers may well have the greatest influence on the creation of policies that support natural resource management and conservation, and begin to address complex interface-related issues.

In the changing political environment of the interface, it is critical that natural resource professionals understand the various policies and decisionmaking processes unique to the interface. The most important role of resource professionals in this decisionmaking is to provide the best available natural and social scientific information. This information should come from an aggressive program of research and technology transfer.

Photo by Cotton Randall, University of Florida

Figure 9.3
Prescribed fire offers a management tool that temporarily reduces fuel loads, but particulate matter found in smoke can create air quality and health concerns. Fuel reduction policies, therefore, may conflict with Federal clean air policies.

Interface Issues are Interdisciplinary

The third major theme of the Assessment addresses the interdisciplinary nature of wildland-urban interface issues. Any one wildland-urban interface issue cannot be addressed in isolation. Chapter 8, for example, shows us that fire concerns in the interface cannot be resolved solely from a resource management perspective. Land use planning and policy, economics, social dimensions, and demographics must also be taken into account. Building relationships across multiple disciplines enhances opportunities for addressing interface issues.

Many other examples throughout the Assessment could be used to illustrate the interdisciplinary nature of interface issues. The push to diversify the southern economy (chapter 3) helped create a climate conducive to the migration to the South. As more diverse employment opportunities have increased in both urban and rural areas, there has been a corresponding increase in urban sprawl. Local policy (chapter 4) has helped to fuel this migration by providing incentives for economic development and exploitation of the interstate highway system.

As land uses change in the interface, property values and taxes often increase. Consequently, the sale of subdivided land can become more profitable for the landowner than continuing to practice forestry. Upfront costs for improving infrastructure and providing public services are extremely high. Often, these costs exceed the tax revenues for local government generated by conversion of forest land (chapter 3).

Urbanization has many direct and indirect effects on forest ecosystems (chapter 5). Changes significantly affect forest health and modify the goods and services provided by forest ecosystems. These changes also create environmental risks. While human modification of forest ecosystems is not unique to the South, the current rates, patterns, and permanence of modifications are.

As cities grow and the wildland-urban interface expands, interactions between new and traditional landowners increase. These two types of landowners may have different attitudes about how forests should be used and if they should be managed. As a result, forest management practices may be regulated and must be adapted (chapter 6). Chapter 8 uses fire management to show the kinds of issues that can arise. For example, negative public perceptions about smoke production can influence the ability of managers to use prescribed fire in the interface.

Settlement of the interface raises quality-of-life issues (chapter 7) (**fig. 9.4**). Obvious benefits of settling the wildland-urban interface include cleaner,

Photo courtesy of USDA Forest Service

Figure 9.4
Settlers of the wildland-urban interface may seek an improved quality of life.

healthier, and safer lifestyles. As the density of settlement increases, however, benefits that early settlers sought will change. Some may move farther from the city to a new interface. Those who stay may influence local public policies affecting natural resource management.

Interface issues, therefore, must be addressed simultaneously by a variety of disciplines. The resource professional must take an interdisciplinary view of interface issues and work with a diverse group of professions including biologists, planners, economists, policymakers, and many others that influence interface forests.

Issues Involve Multiple Ownerships, Jurisdictions, and Scales

The fourth theme addresses challenges associated with multiple ownerships, jurisdictions, and issues related to scale. Subdivision of interface tracts results in a diversity of owners and management objectives. Urbanization and the resulting changes to forest ecosystems extend over large regions and cross multiple jurisdictional boundaries. Multiple ownerships, jurisdictions, and scales create pressures on forest resources and complicate efforts to manage them.

Chapter 6 shows that as tract size decreases and the number of landowners increases, landowner objectives become increasingly diverse and the need for small-scale management techniques becomes more critical. Many new landowners prefer noncommodity values to timber harvests. Conflicts may result when adjacent landowners implement practices for different management objectives. Techniques for small-scale management do not yet exist or are not cost effective. These complexities underscore the importance of developing adaptive management techniques, new technologies, and education techniques to address the changing conditions and increased human influence characteristic of the interface.

Management and conservation of forest resources in the interface is further complicated by scale. For an individual landowner, the scale may be 1 to 10 acres. However, ecological concerns, such as invasive exotics or wildland fire risk, often exist at the landscape or even the watershed scale. Policy and regulatory units also cover large scales, but rarely match the problems that are being addressed. For addressing air and water pollution concerns, for example, the appropriate scale may be regional, but regulations may exist only at the county level. A typical landscape comprises many distinct yet interconnected ecosystems that cross ownership and jurisdictional boundaries. Forest ecosystems become fragmented when adjacent landowners implement varied and uncoordinated management practices. Local, State, and Federal Governments can impose different and often conflicting policies that complicate land use and management of forest resources.

These challenges are addressed most effectively when efforts are coordinated across the landscape. Landscape-scale management requires collaboration among public and private landowners and public participation in planning processes. Cooperative programs are needed to bring together landowners in a geographic region and establish common goals and practices. This approach could make possible some practices, such as harvesting and burning, which would otherwise be socially unacceptable or economically infeasible. Involvement of multiple stakeholders is important for effective forest resource management that meets diverse objectives across multiple ownerships and jurisdictions. Landscape level management must also incorporate ecological, social, and physical components of several ecosystems to solve the complex challenges of managing forests in the interface.

Research Areas

This Assessment describes the changes that are occurring in the South's wildland-urban interface. It lists factors driving these changes, as well as the influences on forest ecosystems, the challenges to forest management, and the social consequences of the changes. Forest resource professionals must adapt existing management techniques and develop new ones to positively influence ecological and social changes occurring in the wildland-urban interface. Part of this challenge is met outside of the forest through participation in community land use planning, collaboration with new partners, management through cooperatives, work across boundaries, and education. Natural resource professionals must also understand the complexity of interface issues, such as complications presented by multiple scales and jurisdictions.

Do we in the forestry community fully understand the complex array of issues in the wildland-urban interface? Do current programs, tools, and resources meet our needs? Are we adequately educating and training resource professionals to meet these challenges? Does research address identified needs, and are practical applications of research findings being built? At present, the answer to each of these questions is "No." This Assessment, therefore, must conclude with a call for a new and fully integrated program of basic and applied research, the development of new technologies, and a comprehensive approach to information dissemination. Resolution of wildland-urban interface issues requires information based on the best available research, communicated in an understandable way to decisionmakers, practitioners, and the public.

The Assessment has identified critical research and information needs. Those needs fall into four cross-cutting areas.

Photo by Charles Fryling

Figure 9.5
There is a need to better understand the effects of nonnative species, such as common privet (*Ligustrum vulgare L.*), on ecosystem structure, function, composition, and processes.

Explaining and Adapting to Human Influences on Forest Ecosystems

This research area addresses the need to understand the effects of land conversions, forest fragmentation, altered disturbance regimes, pollution, and nonnative species on ecosystem structure, function, composition, and processes (**fig. 9.5**). Applied research in this area must also develop adaptive management practices, such as small-scale forest management techniques. It must develop the tools necessary for management agencies to address challenges presented by urbanization and multiple small-scale land ownerships.

"Is it possible to develop alternatives to the current development schemes where you can still maximize the economic benefits while protecting the environmental values?" Georgia

Modeling and long-term monitoring that assess urban effects on forest ecosystems are also needed. Models are needed to predict the impacts of land use changes on landscape heterogeneity, and ecosystem composition, structure, and function. Monitoring that includes remote sensing and computer-mapping technology is essential to address the issues presented by multiple scales, landownerships, and jurisdictions. Through map overlays, it is also possible to integrate contributions from different disciplines. The measurement of change at various scales and

Photo by Cotton Randall, University of Florida

Figure 9.6
More needs to be known about the use of prescribed fire for reducing fuel accumulations in the wildland-urban interface.

across multiple disciplines, and the development of indexing systems and forecasts will allow us to put the best available science behind decisionmaking.

Identifying the Influences of Public Policy on Forest Ecosystems and Their Management

This problem area addresses the need to better understand the relationships among policy, land use change, and the resulting effects on forest ecosystems. Policies influence natural resources in many ways. They set standards for air and water quality. They limit land management practices. They affect the economics of land use. They affect taxation, land use planning, and transportation. There is also a need to understand the roles, strengths, and weaknesses of various policies that address natural resource management and conservation issues in the wildland-urban interface.

Reliable interdisciplinary models are needed for land use and natural resource decisionmaking at various scales. There is also a lack of reliable natural resource information about critical wildlife habitats, aquifers, and other environmental quality indicators for interface policy analysis. In the absence of relevant scientific and technical data, environmental needs cannot be prioritized and long-term threats may not be identified.

The most important contributions of science to resolution of interface issues may be in the policymaking arena. Needs include basic discovery, modeling, and an aggressive program of information and technology transfer.

"We need to listen to the public and understand what they want and then translate that into something that is going to work." Texas

Identifying and Reducing Risk to Ecosystems and People in the Wildland-Urban Interface

In the interface, important risks associated with urbanization include fire, invasive species, groundwater contamination, forest health, and environmental changes. Such factors create risks for both forest and human communities. Controlled experiments and historical studies are needed to assess the synergistic effects of various land conversions, altered disturbance regimes, atmospheric pollution, and nonindigenous species on environmental quality, forest health, and the

establishment and growth of native and nonindigenous species. This work should include assessing how nonindigenous species are altering composition, structure, and function in the numerous ecosystems of the South.

Some specific research needs related to fire include: (1) using prescribed fire to maintain and enhance ecological process and reduce accumulations of fuels (**fig. 9.6**); (2) studying alternative hazardous fuel reduction techniques; (3) validating and improving smoke and fire behavior prediction models; (4) determining the flammability of exotic species and landscape products; (5) developing defensible space models; and (6) determining the effectiveness of various landscape and structural characteristics that protect homes from fire.

Two important research needs in this problem area cross into other problem areas. The first is the role of public policy in altering wildfire risk in the interface. The second issue is how public values, attitudes, and perceptions influence policies related to wildland fire prevention and mitigation activities.

Technology also plays an important role in this problem area. It could help us to predict land use impacts on ecosystems, forest health, and the environment. It could also help us to determine thresholds of responses in the form of resource management and public policy. Long-term monitoring is needed to assess urban effects on ecosystem processes, such as nutrient and carbon cycling, hydrology, and productivity, as well as effects on air and water quality and forest health.

Understanding and Communicating Public Attitudes, Values, and Perceptions

An important element of this problem area is to ascertain the knowledge, attitudes, and preferences of urban and interface residents related to the management and conservation of natural resources. It is also important to understand how differences in ethnicity, age, and cultural backgrounds influence public use and management of forests, as well as how these characteristics influence public policy (**fig. 9.7**).

This information must be communicated to natural resource managers and the public for development of effective communication strategies, outreach messages, educational programs and activities, and conflict resolution. New methods for communicating with landowners and distributing forestry advice and assistance are needed, as well as new ways of describing the goals of forest management to homeowners and landowners. Strategies for communicating wildfire risk, for example, that are sensitive to homeowner preferences and values will likely be more effective in changing homeowner behavior.

Demographic research also falls into this problem area. Such research could develop data and models, indexing systems, and other tools for monitoring and forecasting urban expansion, economic development, and resulting human influences on land use change.

Photo courtesy of USDA Forest Service

Figure 9.7
Research is needed to better understand how differences in ethnicity, age, and cultural backgrounds influence public use and management of forests.

Conclusion

The products of interface research will include data, information, models, tools, communication and public participation strategies, educational programs, and adaptive management practices. The research will lead to a greater understanding of changing demographics and resulting influences on natural resources and their management. It will improve public understanding of relationships

between people and natural resources. Studies at various scales and across multiple jurisdictions will help resource managers and policymakers determine what actions are most economically effective and socially acceptable in improving social and environmental conditions in the wildland-urban interface. Putting usable information into the hands of decisionmakers will require comprehensive information and technology transfer. The needs of various groups of customers will have to be identified and addressed. Throughout the research and research application processes, the views of important stakeholders will have to be incorporated. Important stakeholders include natural resource professionals, various types of landowners, and those with control and decisionmaking authority over the land. The responsibility to integrate stakeholders into the decisionmaking process requires open dialogue conducted in nontechnical terms.

Wildland-urban interface issues are about people and their relationships with and effects on natural resources. A main goal of this proposed program of integrated research, information, and technology transfer is to help people understand and influence change in the wildland-urban interface. Armed with this knowledge, people can address interface challenges and make decisions based on the best available information.

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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.

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This publication provides a review of critical wildland-urban interface issues, challenges, and needs for the Southern United States. Chapter topics include population and demographic trends; economic and tax issues; land use planning and policy; urban effects on forest ecosystems; challenges for forest resource management and conservation; social consequences of change; fire; and themes, research, and information 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.