Successes–

Our Major Accomplishments

2002

Southern Pine Ecosystems

Reforestation Technology

Nursery and reforestation research at the Even-Aged Southern Pine Forests research work unit in Pineville, LA, has been focusing on major problems in the restoration of the southern pine ecosystem. It also has national responsibility for providing technology to Federal, State, and private nurseries. Producing high quality seed is the primary limitation in increasing the production of container seedlings. A scientist in Pineville has been providing seed, seedling, and nursery production technology for restoration of the longleaf pine ecosystem. In FY02, that scientist provided information relevant to the long-recognized problem of obtaining good longleaf pine seeds.

Another scientist continues to provide technology to Federal, State, and private nursery producers across the country, and serves as research liaison for Forest Service Research and Development, State and Private Forestry, and the National Forest System. This important program has national support because it is almost the last program in Forest Service research that provides technical expertise on conifer issues. One significant accomplishment was to provide a guide to seedling selection for major northern conifer and windbreak species.

Program implementation has resulted not only in major increases in longleaf pine seedling production and acres planted, but also in the dissemination of scientific information widely used by small, private nursery producers and landowners. Research results in this important field provide critical information on seedling standards for longleaf pine container stock; and research of northern conifers and seedling-selection information is of great benefit to land managers and owners trying to protect dry, windborne lands from soil loss.

Reforestation studies are conducted at different locations.

B. Lea

Southern Pine Ecosystems

In 1982, the Disturbance of Southern Forest Ecosystems research work unit began a study of the benefits of six site-preparation treatments on survival and growth of loblolly pine in the Piedmont of Georgia. The treatments to prepare sites for loblolly pines plantations vary widely in cost, completeness of competing vegetation control, and site disturbance. Twenty-year measurements were taken in FY02 and the data are being evaluated. Growth and yield information was published at years 3, 5, 8, and 10. Since 1982, 9 more studies have focused on wildlife benefits, stand dynamics, economics of forest management, soil relationships, and early succession/vegetation responses after silvicultural practices.

Plots with the most intensive site preparation had the best survival after 10 years, but all treatments improved survival. Height growth and volume production was best for the most intensive treatments. We will not know the full effects of the imposed treatments until the plantings reach full rotation, but results of the recent 20-year measurements will provide significant insight about treatment effects and benefits.

This study represents a wide range of site-preparation methods that offer information based on intensity of site preparation treatment, which in turn relates directly to economics of cost and profits from the investment. Therefore, a private landowner who owns a small acreage and can invest only minimal capital in reforestation can evaluate the choices and apply them accordingly. The same is true for an industrial forest manager who has capital and wants to use it to maximize the return on reforestation investment. ▲

Longleaf Pine Silviculture

SRS scientists and University of Florida researchers met with managers from the Florida Division of Forestry and the National Forests in Florida to discuss how best to apply uneven-aged management to longleaf pine. While uneven-aged management is one way to mimic some of the natural stand-replacement dynamics that occur in longleaf forests, these forests traditionally have been managed using even-aged methods. Thus, managers have virtually no experience or a sound scientific understanding of long-term costs and benefits to support the wide-scale use of uneven-aged methods for longleaf pine. To meet the needs revealed in this process, scientists in Auburn, AL, and Athens, GA, developed a comprehensive multisite study plan. The study is an operational-scale research and demonstration plan that will examine five silvicultural methods for effectively regenerating and sustaining longleaf pine forests. Single-tree selection, group selection, irregular shelterwood, classic (uniform) shelterwood, and naturalistic management (i.e. no timber management) will being tested on upland, sandhill, and flatwood sites. ▲

Several species of pine flourish throughout the South.
USDA Forest Service

Southern Pine Products

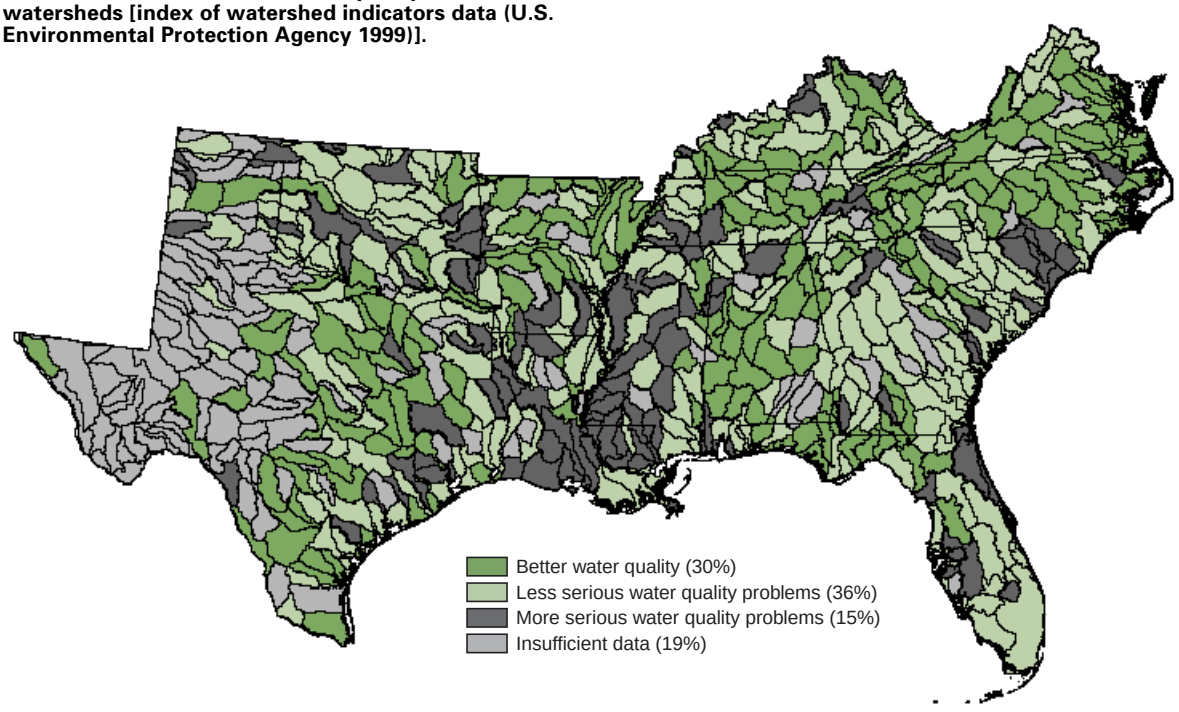
The South's pine wood industry is now using intensive cultural treatments such as vegetation control, fertilization, and planting of genetically improved seedlings to increase fiber production. The impact of treatments on increased growth is positive and significant, but their effects on lumber strength, stiffness and dimensional stability, pulp yields, and paper properties are not very well known. Intensively managed pines grow rapidly early in the rotation, are younger when they reach merchantable size, and may contain a significantly higher proportion of juvenile wood, raising concerns for the use of new wood in traditional products. The stiffness and strength of structural lumber containing juvenile wood is significantly lower than that of mature wood and may not meet design specifications. Pulp chips containing large volumes of juvenile wood yield less pulp per ton of green chips.

The Disturbance of Southern Forest Ecosystem research work unit in Athens, GA, together with the University of Georgia and forest industry participants, established the Wood Quality Consortium in 1999. The Consortium is now conducting a baseline study and an intensive management study. The baseline study will develop comprehensive baseline data for conventionally managed planted pine to determine the effects of environmental factors and stand variables on specific gravity, tracheid length, microfibril angle and their relationship with stiffness, strength and dimensional stability of wood. Data for the baseline study are being collected on operational, industrial plantations 20 to 25 years of age from Virginia to Texas. The intensive management study will quantify effects of intensive forest management, soils, and geographic location on basic wood properties. ▲

Streamside Management Zones

In order to ensure compliance with a variety of statutes and regulations implemented under Federal laws such as the National Environmental Policy Act, the Clean Water Act, and the Endangered Species Act, most States have implemented voluntary Best Management Practices (BMPs), which specify the design and placement of Streamside Management Zones (SMZs). In countries around the world, SMZs are used to protect water quality and quantity, as well as the habitat of forest wildlife and plant species.

Overall characterization of water quality in southern watersheds [index of watershed indicators data (U.S. Environmental Protection Agency 1999)].



Scientists are looking to strengthen the scientific basis for the application and the specifications of SMZs. In Auburn, AL, the Vegetation Management and Longleaf Pine research work unit continues its research on the use and efficacy of SMZs to protect water quality from the off-site movement of herbicides and sediment. The Auburn team has repeatedly demonstrated the effectiveness of SMZs in keeping both herbicides and sediment out of streams, especially the ephemeral and intermittent streams that feed perennial streams during local storm events. While SMZs are typically installed on perennial streams, they are used less often on intermittent streams and rarely on ephemeral streams.

On a national and global scale, forest management practices contribute a small amount of sediment and chemicals to water bodies relative to agriculture and urbanization. Still, the public demands that forest managers quantify such effects and use practices that reduce environmental and ecological impacts. SMZ designs, especially specifications for length and width, must be improved and provide a stronger scientific basis for increasing voluntary compliance. All forest vegetation management tools need to be readily available and optimized for the forest manager to properly select BMPs for specific site conditions and objectives. ▲

Soil Productivity

As part of the international Long-Term Soil Productivity program, the Pineville research work unit is evaluating how soil productivity is affected by intensive site preparation and timber harvesting. Installations in Louisiana, Texas, and Mississippi are being used to measure the effects of compaction and organic matter removal on sustainability of forest sites. The concept has been extended to industrial forest sites by a partnership with forest industry and universities. Related studies now are being installed in a number of other countries. For example, under the leadership of the Center for International Forestry Research (CIFOR), scientists are evaluating the sustainability of management practices in tropical plantation forests.

Scientists at the Pineville lab used two long-term studies to evaluate the response of loblolly and slash pine during a second-rotation. Growth was significantly lower during the second rotation, probably as a result of nutrient depletion. Bedding on West Gulf Coastal Plain soils is questionable, and scientists have found that beds should be leveled or recreated and fertilized.

At the Biological Foundations of Sustainability research work unit in Research Triangle Park, NC, Forest Service scientists collaborated with their peers in industry and academia to assess the use of ground-penetrating radar (GPR) for measuring root biomass. Forest productivity and sustainability depend on biological and physical processes reflected in the rates of above- and belowground tree growth. Because it is so expensive and time-intensive, measuring root biomass has been practically impossible. They found it to be an extremely powerful quantification tool in forest ecosystems, especially in well-drained soils. Future modifications for collecting and processing images show promise that GPR will be useful in other soil types also. Use of this tool makes it possible to collect as much data in 4 hours as would be collected from 10,000 root cores. The research results produced will likely lead to commercial development and ready access to forest biologists around the world. It will permit root assessment at spatial scales previously impossible, such as at the watershed level. It will foster and enhance studies on diverse topics such as optimizing buffer strips along streams, tree improvement, and intensive silviculture. ▲

Forest Pests and Invasive Species

The USDA Forest Service strategy for noxious and nonnative invasive plant management announced in September 1999 was entitled "Stemming the Invasive Tide." Scientists in the Vegetation Management and Longleaf Pine research work unit in Auburn, AL, recognized that a fundamental first step was to develop the plant identification skills of researchers, managers, and other user groups. To address this crucial need in the Southeastern United States, a list of the worst 33 invasive plants was developed from State and Forest Service invasive species lists. Then, in cooperation with the SRS Forest Inventory and Analysis (FIA) unit, a true color in-house guidebook and training manual, ***Exotic Pest Plants of Southeastern Forests***, was developed to facilitate survey crew training and to implement the first region-wide survey of exotic pest plants in cooperation with State forestry agencies. Six additional States were added to the survey in FY02 and their crews were provided manuals and trained in invasive plant identification. An additional section on integrated vegetation management treatments to control each species has been added. This in-house manual is available to other users through the SRS FIA Web site (http://srsfia1.fia.srs.fs.fed.us), as well as the nationally recognized exotic species Web site at the University of Georgia ("the bugwood network" — http://www.bugwood.org/). A follow-up printing with multiagency funding is now underway with release projected for early in FY03. The working title is ***Nonnative Plants Invading Forests of the Southern United States: a field guide for identification and control***.

At the Insects and Diseases research work unit in Athens, GA, scientists are grappling with the full complement of phenomena that adversely affect forest sustainability and productivity. Kudzu is a perennial, woody vine related to soybeans, which was introduced into the United States as an ornamental plant at the 1876 Philadelphia Centennial Exposition. In the 1930s and '40s, it was promoted for erosion control, and in a government landowner-assistance program over 73 million seedlings were produced and planted across the South, where erosion and soil loss were

Kudzu crowds out native species in many southern locations.

R. Kindlund

major problems. The range of kudzu is expanding, and now extends from Illinois to Connecticut, and Oklahoma to Florida.

Dissatisfaction with current kudzu-control methods is universal. Utility companies spend enormous amounts to prevent it from shorting-out transformers. Many forest landowners are finding that it costs about $350/acre to apply herbicides to kill kudzu, and they cannot afford the treatment. The most effective herbicides are not selective and cannot be used near waterways. More selective herbicides are available, but cost even more.

In China, over 50 different insect species have been observed feeding on kudzu, and representative samples have been collected for identification by collaborators at the Chinese Academy of Science, and several Chinese universities. These include stem and root borers, defoliators, shoot-clipping weevils, and seed predators. The Insects and Disease research work unit has begun preliminary host testing on a small group of these insects in China. They also have identified several fungal diseases, the most promising of which is called "imitation rust." Scientists also are conducting studies of insect life, with a goal of developing suitable rearing techniques. They are looking to develop colonies of test insects before conducting quarantine tests to ensure host specificity. ▲

Other Significant Accomplishments

Obtained a grant to evaluate new fungicides for controlling pathogens on pine seeds.

Determined a strong linear relationship between the infection of slash pine stems with fusiform rust at age 5 and a decline in stand stumpage values, which will permit land managers to estimate the value of slash pine stands at harvest at early ages and then decide among management alternatives.

Served on the National Regeneration Committee which collects input from the field related to equipment development needs that support nurseries and reforestation practices and makes recommendations for funding the Missoula Technology and Development Center.

Led workshops in Chile and Argentina on seedling physiology and nursery production, thereby helping those countries' nursery practices and seedling production.

Prepared the keynote presentation for the International Union of Forestry Research Organizations (IUFRO) Continuous Cover Forestry Conference in Germany describing the American experience with continuous cover forestry in southern pines. ▲

Awards

Chung-Yun Hse received a Friendship Award from the State Administration of Foreign Experts Affairs of People's Republic of China for his work in the international science community in China.

Richard Conner, **D. Craig Rudolph**, and **Jeff Walters** received the "Outstanding Book Award" from the Texas Chapter of The Wildlife Society for ***The Red-cockaded Woodpecker; surviving in a fire-maintained ecosystem.***

John Stanturf received an IUFRO award in appreciation of his efforts in organizing the international Conference on Restoration of Boreal and Temperate Forests, Denmark, spring 2002.

Wetlands, Bottomlands, and Streams

Forested Wetlands: An Important Component of Terrestrial Carbon Cycling

Wetlands contain 20 to 30 percent of the terrestrial soil carbon, the largest amount among ecosystem types. Within the continental United States, forested wetlands contain as much soil carbon as upland forests, although they only occupy about 20 percent of the resource. Recognizing the importance of forested wetlands to the terrestrial carbon cycle, several research work units have initiated studies to: (1) consider distribution of the resource; (2) study the processes controlling the carbon balance; and (3) develop a soil carbon model that can be used for large-scale assessments.

The current paradigm is that disturbance regimes (e.g., silvicultural practices) cause a reduction in the soil carbon balance. The loss of carbon is typically associated with changes in temperature, aeration regime, and substrate. Recent findings by the Center for Forested Wetlands research work unit, and Michigan Technological University show that by sustaining site productivity, soil carbon pools can recover. Coupled with recent reports from Europe, this work suggests fundamental changes in our understanding of the effects of forest management on soil carbon pools.

The forest landscape in the Southeastern United States is a complex mosaic of upland and wetlands, so developing a model that accurately considers the carbon cycle is critical. Researchers at the Center for Forested Wetlands unit compared the most commonly used models and found that they were not applicable to forested wetlands. Since the Southern Global Change Program in Raleigh, NC, is concerned with developing models for large-scale carbon cycling assessments, scientists there worked with the Center for Forested Wetlands to develop a soil carbon model that could be used across forested landscapes. Through cooperation with scientists from the University of New Hampshire, a new model has been developed and tested. This model signifies an important advancement because it accurately portrays the biogeochemistry of carbon in wetland forests, and it considers forests during an entire rotation. To augment the data required for modeling the carbon cycle, scientists are also conducting field investigations to better quantify evapotranspiration in bottomland hardwood forests. ▲

Characterizing and Measuring Southern Forested Wetlands

Definitions of forested wetlands can vary considerably. Measuring carbon storage below ground requires a different model from those

Tupelo-baldcypress swamp in Mississippi.
B. Lea

used in other forested areas. *Forested Wetlands of the Southern United States: A Bibliography* describes forested wetland as a variety of habitat types ranging from bottomland hardwood forests to alluvial swamp forests that occur on river floodplains. This comprehensive list of references to varied studies conducted in these forest types could benefit researchers, students, managers, and other interested people. Citations date from 1923 to 2001. *Wetland Forest Statistics for the South Atlantic States* presents information about timberland with hydric vegetation, hydric soil, and a wetland hydrology. Scientists present findings about area, distribution, and ownership; stand size and age structure; forest management types and detailed forest types; physiography; volume, growth, removals, and mortality; and disturbances, condition, and opportunities. ▲

Wetland Carbon and Nitrogen Cycling

Wetlands serve many important functions, including wildlife habitat, quality purification, and as a sink for atmospheric carbon. The Southern Global Change Program is collaborating with other SRS research work units to better understand the processes that control carbon gain and water flow from wetland ecosystems. This research interests forest managers evaluating the hydrologic consequences of wetland management in the Southeastern United States. Research continues on developing a wetland hydrologic model that incorporates carbon and nitrogen cycling for studying the effects of climate change on carbon sequestration. A new wetland carbon model is being published in the journal ***Global Biogeochemical Cycles,*** and a multisite synthesis paper on contrasting wetland and upland hydrology was coauthored and published in the *Journal of Hydrology* by scientists in the Southern Global Change Program, university collaborators, and paper industry scientists.

Through collaboration with other SRS units, scientists from the Southern Global Change Program modified the FLATWOODS model to simulate groundwater and surface water interactions in the Carolina Bays, an isolated wetland system. Researchers acquired another integrated hydrologic model, MIKE-SHE, and are evaluating it for modeling hydrologic processes of forested wetlands in the Coastal Plain. ▲

Flatwoods ecosystem.

B. Simon

The Carolina Bay Restoration Project

Restoration of wetlands and riparian zones requires both new technologies and indicators of ecosystem health. Carolina bays are an abundant wetland type found throughout the Atlantic Coastal Plain of the United States. It has been estimated that there are over 300 Carolina bays or bay-like depression wetlands on the Savannah River Site, SC, of which an estimated two-thirds were ditched or disturbed prior to Federal occupation. These isolated wetlands range from small ephemeral depressions to large permanent ponds of several hectares in size. They provide habitat to support a wide range of rare plant and animal species. Historical impacts to the Carolina bays at the Savannah River Site were primarily associated with agricultural activities. Bays were often drained, tilled, and planted to crops. The consequence was a loss in the wetland hydrologic cycle, the native wetland vegetation, and associated wildlife.

A large factorial experiment to evaluate strategies for restoring 16 Carolina bays was implemented in 2001. Drainage ditches were plugged to reestablish earlier hydrological conditions, and interior trees were harvested in the degraded bays. Restoration of these sites to herbaceous communities was evaluated in eight bays by stimulating remnant seed banks through soil scarification during the timber harvest. In addition, wetland grasses (*Panicum hemitomon* and *Leersia hexandra)* were planted on a portion (10 percent) of the interiors at these sites. The other eight bays were restored to a forested community by planting swamp tupelo (*Nyssa sylvatica*) and baldcypress (*Taxodium distichum*) throughout the wetland interior. In an effort to gain a better understanding of the relationship between buffer-zone management and wetland properties, bay margin treatments were applied to a 100-m margin from the edge of a bay into the upland. Fire-managed, open-canopy pine forest savannas, and relatively unmanaged closed canopy mixed pine-hardwood represent the two upland management treatments. Whether restored systems and their accompanying buffers are moving toward planned endpoints is being assessed through a monitoring program established to evaluate the change in biotic (vegetation, invertebrates, bats, avifauna, herpetofauna) and abiotic (soil, geochemistry, hydrology) metrics. Undisturbed reference bays and drained control bays are being monitored for comparison.

Patsy Pond Complex, Croatan National Forest, North Carolina.

B. Lea

The monitoring program will record the progress of the restoration for five years after the treatment manipulations (2002 to 2006), and will be used as criteria for determining the final net improvement displayed for each individual wetland. Scientists and cooperators anticipate that the comprehensive nature of this study will provide the opportunity to establish guidelines for restoring degraded bays and for managing these unique ecosystems. ▲

Afforestation of the Mississippi River Alluvial Valley

The complexity of ecological processes and restoration of bottomland hardwoods involves a network of researchers, land managers, and landowners. The U.S. Geological Survey and the Southern Research Station jointly published *A Guide to Bottomland Hardwood Restoration*. The report provides information for the reestablishment of bottomland hardwood forest vegetation, especially trees, on lands where they formerly occurred. Hydrology is recognized as the driving force of wetland ecosystems. The authors state the hope that the book's audience will work toward restoration of all functions and values associated with these forests—storage of floodwaters, water quality improvement, provision of wildlife habitat. Since national forest silviculturalists, land managers, and landowners are adopting *A Guide to Bottomland Hardwood Restoration* as a manual, the authors' goal to transfer knowledge into restored ecosystems appears to be on track. ▲

Reduction of Ecological Impacts of Forest Operations

Two studies published by the Forest Operations research work unit in Auburn, AL, relate to erosion control from the forest road prism on the National Forests of Alabama. The scientist examined alternative turnout ditch designs and road sideslope stabilization. The effectiveness of vegetative stabilization on forest road sideslopes in mitigating sediment production was reported based on four year results. Erosion control techniques were found to reduce sediment losses by as much as 98 percent compared to no control during study years. Native species vegetation was as effective as exotic species vegetation or a wood excelsior erosion mat in controlling erosion losses. Alternative road turn-out erosion control techniques were compared on the basis of runoff concentrations and sediment export from forest roads. Runoff concentration reductions were as much as 85 percent from the sediment basin control treatment. Alternative sediment control treatments show promise in reducing runoff concentrations and sediment transport distances downslope from roads.

The findings reported from these road erosion control studies provide valuable information on the applicability of alternative methods to reduce the environmental impact of forest roads. Alternative sediment control practices can reduce sediment export from forest road prisms by increasing detention time of storm runoff. Controlling the quantity of sediment leaving the forest road will likely reduce sediment travel distances downslope of road systems and sediment delivery to streams.

Scientists with the Forest Operations unit collaborated with a university colleague to study the efficacy of a global positioning system (GPS) to map disturbance patterns of forest harvesting machinery. They investigated the GPS-transformation system and found it could be used to make estimates of total site disturbance and to identify regions of higher or lower disturbance. The study also found that the system was less effective when applied in defining number of passes at a given point in a stand.

Results of using ground-penetrating radar to study tree roots in the Southeastern United States were published by the Biological Foundations unit in Research Triangle Park, NC. Study sites included the southern Piedmont, Carolina Sandhills, and Atlantic Coast Flatwoods. Results indicated that the utility of ground-penetrating radar for estimating root biomass is site specific. The technology is least successful in soils with high clay or water content and at sites with rough terrain. However, under particular soil and site conditions, ground-penetrating radar appears useful to augment traditional biomass sampling. ▲

Station Scientists Contribute to International Conferences

Scientists from several SRS research work units participated in the International Union of Forest Research Organizations conference on restoration boreal and temperate ecosystems in Vejle, Denmark. The objective of the conference was to document forest restoration knowledge and practice. They presented research findings relative to restoration and afforestation of the Mississippi River Alluvial Valley, served as session moderators and compiled the proceedings.

The SRS collaborated with the National Wetlands Center of the U.S. Geological Survey, the Chinese Academy of Sciences, and Nanjing University of Forestry to support the international conference on wetland restoration. The conference provided an opportunity for Chinese scientists and students to learn about the state of knowledge of western forested wetlands. Interaction among American, European, and Asian researchers set the stage for future international collaboration. There is rapidly growing interest in environmental sciences in China. An increasing focus on the significance of clean water and air to a healthy society resonates in cultural, economic, and environmental areas. A boat tour along the Yangtze helped crystallize the complexity of these issues. The world's largest hydroelectric dam is being built at the Three Gorges area of the Yangtze River. ▲

Focus on Low-Income Minority Communities of Upper Charleston County

The Center for Forested Wetlands received a $10,000 grant from the Forest Service for a collaborative project in the public schools of upper McClellanville, the largest town in upper Charleston County. The project will help start a new environmental sciences program in the county's public schools. Researchers will also conduct a study of community perceptions and needs in relation to the national forests and future land use within the rural coastal community. Upper Charleston County, which lies north of the city of Charleston in the Coastal Plain between the Sewee and Santee Rivers, is increasingly threatened by urban sprawl and coastal development. Once covered with rice plantations, the area is still mostly rural and its residents predominantly African American. Though a large part of the county lies within the Francis Marion National Forest, African American residents rarely use this resource, nor do they tend to be involved in decisions about future land uses in their area.

The project will support new environmental science curricula in McClellanville schools by providing equipment, supplies, a network of volunteers, and the technical help of a wide array of partners. A social scientist from the SRS Recreation, Wilderness, Urban Forest, and Demographics Trends research work unit in Athens, GA, will coordinate the second component of the program, a study of community needs and perceptions that will focus specifically on minority participation in decisions about both private and public lands in upper Charleston County.

For the curriculum on wetland ecology, students are constructing a small model wetland for study just outside their classroom, and will explore the role of land use on the health of wetlands systems and how these systems in turn influence deepwater marine life and fisheries. This topic is particularly important to people in the area, since fishing is still one of the most important industries in McClellanville. ▲

Fundamental Biotic and Abiotic Processes and Functions in Forested Wetland Landscapes

The goal of developing a reference bottomland hardwood forest system has been accomplished with the maturation and publication of numerous studies on the long-term Coosawhatchie Bottomland Ecosystem Study. During the first phase of the study, a 50-year flooding history was developed using hydrologic models created on

Alligator in cypress swamp.
B. Lea

the site and long-term stage data from a gauge upstream. Results showed that historically the site flooded more frequently and more deeply than in recent years. Results suggest that developmental pressure on aquifers and surface water have contributed to hydrologic changes. Scientists identified relationships between plant community variation and differences in hydroperiod and soil characteristics, and characterized five main plant communities on the site. Differences among communities also have been quantified for above- and below-ground primary productivity, mycorrhizae, soil microorganisms, litter decomposition, nutrient cycling, and sedimentation rates.

Studies that have been completed on the site include those of bird, invertebrate, and fish community compositions; water quality; coarse woody debris dynamics; and forest gap dynamics. Phase 2 will entail continuing long-term studies of hydroperiods, above- and below-ground net primary production, and tree regeneration. Regeneration of bottomland hardwood species is a fundamental although poorly understood ecosystem process that influences other ecosystem functions. A field experiment was installed to contrast tree regeneration success and seedling physiology under continuous canopies, in canopy gaps, and under clearcut and partially cut conditions. Artificial canopy gaps were created by girdling canopy trees. Artificial root gaps were created by trenching soil around subplots and installing a barrier to prevent roots regrowing into the subplots. Results suggested the most effective way to regenerate ecologically and economically desirable tree species in bottomlands is by allowing regeneration to occur in canopy gaps or by partially cutting stands. Apparently, clearcutting large areas can increase soil resource availability to the extent where nondesirable plants are stimulated and ultimately out-compete desirable tree species. ▲

Other Significant Accomplishments

Presented information on ecological impacts of forest herbicides, with particular emphasis on aquatic systems, at the 4th International Forest Vegetation Management Conference.

Hosted visiting scientists from Mexico and Turkey for training and consultation in watershed analysis and management.

Distributed publications to international collaborators in many countries on methods for hazard assessment and water quality criteria for selenium and TMDLs (Total Maximum Daily Loads).

Collaborated on field research studying riparian zone carbon dynamics in Canada.

Provided knowledge base and technical assistance in the initial stages of developing a restoration plan for the Nariva Swamp in Trinidad and Tobago, West Indies. ▲

Awards

Dennis Lemly received two international commendations this year. He was recognized by the International Academy of Environmental Safety in London for innovations in the field of selenium ecotoxicology that have led to major advances in environmental safety, and by the International Academy of Biomedical and Environmental Sciences in Beijing for his professional service to the Chinese Academy of Preventive Medicine by developing a public health education program for selenium contamination in Hebi Province.

Margaret Burke received a certificate of appreciation from the Charleston County School District for giving invaluable support in furthering the education of the students.

Susie Adams received a certificate of appreciation from the Mississippi Department of Environmental Quality for outstanding service and support to the sixth annual Aqua Fair Event.

Mountain and Highland Ecosystems

Reintroduction of the American Chestnut

The woods of the Southern Appalachian region were once crowded with American chestnut, the tree's white flowers filling the forest canopy in early summer. Chestnuts supported a wide range of wildlife and played an important part in rural economies. In 1904, chestnut blight was discovered in New York City; by 1950, the great American tree had all but disappeared from eastern forests.

Plant breeders have been working for decades to create a blight-resistant chestnut by crossing the American species with Chinese and other blight-resistant Asian species. The American Chestnut Foundation is developing blight-resistant seedlings, but little is known about how propagation, transport and planting methods affect survival and growth when the seedlings are reintroduced into hardwood forests.

In a cooperative study between the Southern Appalachian Ecology and Management unit at the Bent Creek Experimental Forest near Asheville, NC, the University of Kentucky, and the Daniel Boone National Forest, SRS scientists are developing procedures for large-scale reintroduction of American chestnut into the mixed hardwood forests of the Southern Appalachians and the Cumberland Plateau.

Research forester with chestnut seedlings and saplings.

USDA Forest Service

Fall oak leaves.
USDA Forest Service

In a multisite study on Kentucky's Cumberland Plateau, the Station and its cooperators are also comparing the growth and survival of planted chestnut seedlings in openings created by overstory removal with that of seedlings planted in stands where light has been increased by the removal of understory. Results from the study will be used to develop more effective strategies for reintroducing American chestnut in the Southern Appalachians. ▲

Prescribed Burning in Oak Forests

Prescribed burning involves deliberately setting fires in forest stands to reduce undergrowth and promote the growth of trees and other fire-dependent forest plants. For years, prescribed burning has been used successfully for vegetation management in native and plantation pine forests. Periodic low-intensity fire promotes seed germination in pine species and reduces the fuel that can feed wildfires. Without periodic fire, many pine ecosystems would revert to hardwoods.

Even though some managers have started using fire in hardwood-dominated stands, the effects of fire on oak systems are still poorly understood. The few studies that have tested the hypothesis that oak stands could be perpetuated by fire have produced mixed results. Scientists from the Southern Appalachian Ecology and Management research work unit and the University of Kentucky recently began a large study in cooperation with the Daniel Boone National Forest in eastern Kentucky to examine the ecological response of oak-dominated communities to prescribed fire.

Funded by a grant from the Joint Fire Sciences Program, the research focuses on how fire affects oaks, their competitors, and forest structure. SRS scientists will also study the effect of fire on the insects that feed on acorns and the relationship of bird nesting success to prescribed fire. Knowledge developed from these studies will guide efforts to apply prescribed fire to oak stands. ▲

Silvicultural study, Bent Creek Experimental Forest.
B. Lea

A Simpler Method to Predict Site Quality

Forest managers and consultants often base their recommendations for silvicultural treatments on site quality. Conventional methods for determining site quality—usually based on tree height—are labor intensive, prone to error, and not readily understood by the average landowner. Researchers are developing an alternative method that uses tree indicator species—species that are usually found on sites with particular physical characteristics—as an easier and more reliable way to estimate site quality.

Preliminary results suggest that the tree indicator species method can be used effectively to classify site quality as low, medium, or high. These three classes are all that forest managers need to plan many silvicultural treatments. Bent Creek researchers found that, for the Southern Appalachians, they could combine elevation measurements with the presence or absence of 6 tree species to group forest sites into low, medium, and high classes. The tree indicator species identified were mostly trees adapted to dry environments such as chestnut and scarlet oaks, hickory, or sourwood. Anyone who can identify trees can use the method, and it will be particularly useful to consultants working with private landowners. ▲

The Response of Forested Watersheds to Disturbance

Understanding how forested ecosystems respond to disturbance requires a long-term approach because forest ecosystems are always changing in both structure and function as they age over decades and even centuries. To understand functions of the forest, scientists at the Coweeta Hydrologic Laboratory study the interactions among water, carbon, and nutrient cycling. These functions determine the aspects of structure—such as tree size and vigor, species composition, and suitability as wildlife habitat—that forest managers are concerned about.

In one long-term study, scientists examined changes in vegetation and nutrient cycling on a clear-cut watershed site 20 years ago. They found that, even though the effects on soil carbon from logging slash—the treetops, limbs, and logs remaining on the site—persisted for several years, vegetation in the clear-cut watershed grew back rapidly, preventing nutrients from being washed out into the streamwater. This and other long-term studies suggest that forest ecosystems of the Southern Appalachians are generally resistant and resilient to disturbances, with significant short-term changes in some nutrient cycling occurring as the stand redevelops. ▲

Respiration Research Contributes to Better Models of Climate

In the metabolic process of respiration, plants use oxygen to break down complex sugars in their own tissues to create energy, releasing carbon dioxide as a byproduct. Respiration is an important indicator of how forests are responding to changes in the environment. Developing accurate models of forest response to climate change depends on a more precise understanding of how functions such are respiration are affected by changes in temperature and atmospheric levels of carbon dioxide and nitrogen.

Coweeta scientists conduct basic research on the relationship between temperature, nitrogen, and respiration in specific parts of the tree—leaves, branches, stems, coarse roots, and fine roots. In addition to the importance of temperature and nitrogen, the results show that accurate estimates of respiration need to take into account variations in the respiration rates in individual tissues rather than relying on whole-tree data. Refining this information is critical for improving the accuracy of the computer models used to simulate future climate changes due to air pollution and global warming. ▲

Coweeta Basin, view from the east.
USDA Forest Service

Nitrogen Deposition Impacts on Forest Health

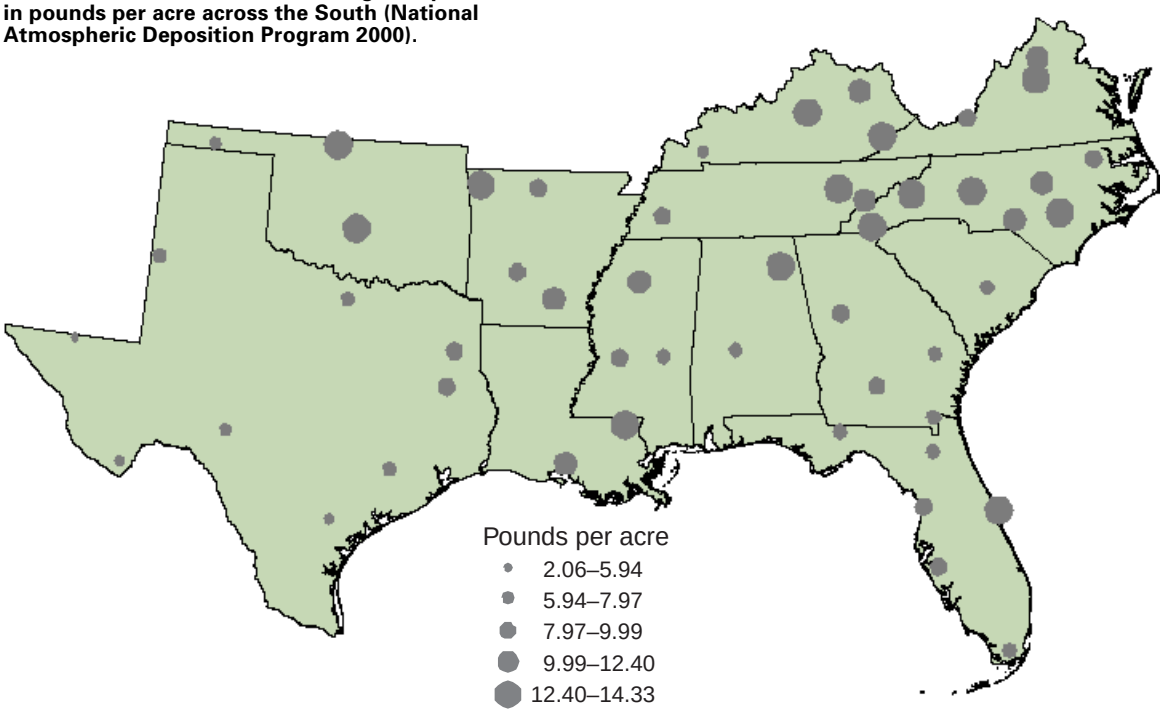
Historically, nitrogen has limited forest growth across the United States. During the last century, the burning of fossil fuels such as coal and gasoline, raised the amount of nitrogen in the atmosphere, with total nitrogen deposition in some parts of the country increasing as much as 10 times over the global background over the last century.

Eventually the nitrogen falls out of the atmosphere in rain and dust. Over 95 percent of forests actually benefit from the fertilizer effects of the nitrogen deposition; however, the forest can become nitrogen saturated when nitrogen deposition exceeds the nitrogen demand of plants and microorganisms. Nitrogen saturation can adversely affect forest health and productivity, and can lead to nitrate leaching into drinking water.

Nitrogen saturation effects have been observed in the northeast in high elevation spruce-fir forests. Recent studies suggest that nitrogen saturation is also beginning in lower elevation sugar maple forests across New England, and in high elevation forests of the Southern Appalachian region. Forest health and sustainability could be severely impacted during the coming decades if nitrogen saturation occurs in conjunction with climate change and increasing ozone episodes.

The Southern Global Change Program located in Raleigh, NC, is examining tree ring growth and nutrient concentrations in tree foliage and soils to determine if the early stages of nitrogen saturation can be detected in the forests of New England and the Southern Appalachians. The program is also conducting the world's longest high elevation, nitrogen saturation experiment, established in 1988. Results of this research continue to provide new insights on how nitrogen saturation impacts forest health, and show that high elevation forests are already experiencing the early stages of nitrogen saturation. ▲

Current (1999) distribution of nitrogen deposition in pounds per acre across the South (National Atmospheric Deposition Program 2000).



Shortleaf pine on rock outcrop.
B. Lea

Effects of Forest Management on Soil Quality in the Ouachita Highlands

The Ouachita Highlands in Arkansas and Oklahoma have been the site of numerous research projects on the effects of forest management on the soil environment of shortleaf pine (*Pinus echinata* Mill.), the most ecologically and economically important native pine species of the Interior Highlands. In FY02, scientists from the Upland Forest Ecology and Management unit in Monticello, AR and the Ouachita National Forest—with cooperators from the University of Arkansas and Oklahoma State University—summarized the results of years of soil research.

The research evaluated the effect of management practices such as harvesting and prescribed burning on the forest soils of the region in four fundamental areas—soil compaction, soil loss, organic matter, and nutrients. Findings showed that:

- when harvesting took place during wet weather, soils with less than 15 percent rock content or sandy loam textures might become compacted;

- harvesting by single tree or group selection methods reduced soil disturbance in the stand, but increased soil compaction on the primary skid trails used to move timber to levels that could reduce seedling growth or regeneration success;

- both harvesting and prescribed burning significantly altered the amounts of organic matter and nutrients on the forest floor and in the soil; however,

- these same nutrient and organic pools recovered rapidly after harvesting or prescribed burning.

The release of the summary led to immediate changes in forest management procedures on the Ouachita National Forest, to better minimize adverse effects of harvesting and prescribed burning on forest soils. ▲

Monitoring the Status of Sensitive Forest Bat Species

Mostly hidden from human view, bats play many important roles in the forest ecosystem. The number and diversity of bat species present is one indicator of the overall health of a forest system. Bat habitat requirements can be complex: many species winter in caves and then roost and

Eastern pipistrelle (*Pipistrellus subflavus*), banded male.
USDA Forest Service

reproduce in trees in the summer. Bats are particularly sensitive to human disturbance, and many species have declined rapidly over the last few decades.

In 2000, the Threatened and Endangered Wildlife and Plants research work unit in Clemson, SC, started collecting information on the distribution and habitat requirements of endangered and sensitive forest bat species. Sensitive species are those that are of special concern, but have not been designated as endangered or threatened. Four species of bats in the South are considered sensitive: Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), the southeastern bat (*Myotis austroriparius*), the small-footed bat (*M. leibii*), and the Florida mastiff bat (*Eumops glaucinus*).

The status of Rafinesque's big-eared bat is the most controversial of the four and in need of resolution. The species is listed as endangered in South Carolina. Many biologists believe it should be protected under the Federal Endangered Species Act, but there is not enough data on the species' distribution and population trends to take this action. In FY02, the scientists began collecting data on the distribution and status of Rafinesque's big-eared bat in South Carolina.

Though Rafinesque's big-eared bat is found throughout the South, the species is rare and sparsely distributed throughout its range. Big-eared bats are slow but agile flyers, feeding mainly on moths and other nocturnal insects. Big-eared bats along the Coastal Plain of South Carolina seem to rely mostly on large hollow trees and old buildings for roosting; both of these resources are disappearing, and Rafinesque's big-eared bats are now often found roosting beneath bridges.

This summer, working cooperatively with Clemson University's Department of Environmental Toxicology and the South Carolina Department of Natural Resources (DNR), scientists conducted a statewide survey of bridges and other roost structures, counting the number of Rafinesque's big-eared bats present and assessing whether pesticides or other toxicants are affecting them negatively. Since they feed on insects, big-eared bats may be impacted by the pesticides used to control gypsy moths and other pests.

The team surveyed over 1,100 bridges in all 46 counties of South Carolina, finding Rafinesque's big-eared bats under 55 bridges; most of these were tee-beam bridges in bottomland hardwood habitats. Fifteen of the 55 sites included maternity colonies, where female bats were raising young. Guano was collected from the colonies and is being analyzed for various contaminants.

The South Carolina DNR has agreed to work with the State's Department of Transportation to conserve and manage the bridges identified by the study as roosts. Clemson scientists will use the roosts identified in the survey as the basis for a long-term monitoring program on the status and distribution of Rafinesque's big-eared bat. ▲

Tracking Bats in the Ouachita Mountains

Bats make up a quarter of the 70 mammal species found in the three national forests in Arkansas. In the eastern United States, bats are generally classified as either cave or tree bats. Cave bats inhabit caves all or part of the year, while tree bats roost in trees during the summer and spend the winter in hollow trees.

Bats use four types of roosts—day roosts, night roosts, maternity roosts, and hibernating roosts (hibernacula)—with some species using all four types within a given year. In 2000, the Wildlife Habitat and Timber Resource Integration unit in Nacogdoches, TX, in collaboration with the Ouachita National Forest and the Arkansas Game and Fish Commission, began collecting data on bats that roost in trees during the summer to determine the effect of different timber harvesting decisions on the availability and quality of roosting habitat for tree bats. Bats captured with mist nets were fitted with tags and tiny transmitters, and then tracked to their roost sites using radiotelemetry equipment. Biologists measured each roost tree and the condition of the surrounding habitat.

Wildlife biologist using radiotelemetry equipment to locate bats carrying tiny transmitters.

Sixty-nine bats of 8 different species—red, hoary, northern long-eared, evening, and big brown among them—were caught and tagged in the first two summers of the project; 43 of these were fitted with transmitters and tracked to their roosts. Preliminary data on this first group of bats showed that they were captured within 0.6 mile of their roosts. Most of the captured red and hoary bats roosted in unharvested forest stands. Although pine plantations made up a large part of the habitat near several of the trapping sites, the data suggest that these species of bats tended to avoid pine plantations.

Two-thirds of the bats netted were red bats, which roost on the foliage of deciduous or evergreen trees. Suspended by one foot from a twig or limb, the red bat can easily be mistaken for a pinecone or a dead leaf. Red bats are mostly solitary, only coming together to mate or migrate; very little is known about their winter habitat or behavior. About two-thirds of the roost sites for red and hoary bats were located in unharvested forests, and almost half of the cavities or crevices used as roosts by the northern long-eared, evening, and big brown bats were located in unharvested stands. These stands, unlike the pine plantations, consist of the large overstory hardwoods typically favored by foliage-roosting bats and the snags used by cavity and crevice-roosting bats.

In FY02, over 350 bats were captured and banded, 50 were radio-tracked, and over 70 new roosts were located and measurements taken of trees and surrounding habitat. The collaborators plan to continue the study for several years; sample sizes for several of the less common species are still small, and information about their roosting habitat particularly important. ▲

Bluestems and Butterflies

The Ouachita National Forest is restoring 153,000 acres of shortleaf pine-bluestem communities in the Ouachita Mountains by thinning overstory trees, removing most of the midstory, and using an aggressive program of prescribed fire. While the main purpose of the restoration is to provide habitat for the red-cockaded woodpecker, the shortleaf pine-bluestem ecosystem also provides habitat for an increased abundance and diversity of butterfly and moth species. Scientists from the Nacogdoches unit have been conducting surveys of butterflies and moths to learn about the response of these species to the habitat restoration efforts.

In the growing season following prescribed burning, these habitats explode with flowers. The researchers have found that butterfly numbers are highest during the first growing season after prescribed burns and decline in each successive year. Without prescribed burning to stimulate the growth of nectar-producing flowers, butterflies are restricted to roadsides, disturbed sites, and limited natural openings in the forests.

The restored habitats clearly support greater numbers and a higher diversity of butterflies than the areas that have not been restored. Two butterfly species of special concern—the monarch and the Diana fritillary—occurred more frequently in the restored sites. The Diana fritillary (*Speyeria diana*), which has disappeared from most of its traditional range, still occurs in the Ouachita Mountains of Arkansas. Surveys indicate that restored sites support much higher populations of this rare species. Migrating monarch butterflies, which are also on the decline in some areas, also make heavy use of the fall flowers in these restored habitats. ▲

Restored shortleaf pine-bluestem habitat on Ouachita National Forest.

Inset: Diana fritillary (*Speyeria diana*) still occurs in the restored shortleaf pine-bluestem habitat.

Inset: C. Rudolph

American Eels in Decline

Since the mid-1970s, the numbers of American eels have been declining in Canada and the United States, prompting concern over the status of this species. Although eels have historically occupied all of the Atlantic watersheds, little is known about their seasonal behavior or distribution patterns in the headwaters of Virginia. Barriers to headwater habitats may be a factor in eel decline.

The Coldwater Streams and Trout Habitat unit in Blacksburg, VA is working with the Virginia Department of Game and Inland Fisheries and the George Washington and Jefferson National Forests to learn more about the American eel in its freshwater habitat. In FY02, the collaborators and a Virginia Tech graduate student studied the abundance, habitat use, growth, and daily and seasonal movements of American eels in the headwater tributaries of the James River in Virginia. Researchers also used radiotelemetry to monitor the seasonal movements and habitat use of individual eels along a stream network. Preliminary results show that the daily activity of eels is strongly influenced by seasonal changes.

Attaching transmitter to monitor winter movements of the American eel.

During the summer, eels were most active during the 3 to 5 hours just after sunset; during the fall, activity was much more sporadic. Although researchers expected that eels would move out of the smaller streams into larger, deeper streams for the winter, radiotelemetry studies showed that the eels actually spent most of their time underneath the boulders and undercut banks of the headwater streams, moving little.

The results of the study have important implications for how streams that provide habitat for American eels are managed. High sediment loads from flooding or erosion could fill in the cracks and undercut banks used by the eels during the winter. The findings will also be used to protect eel habitat and migration corridors and to develop restoration plans for eels and other migratory fish species.

Information on the Availability of Wildlife Foods

Fleshy fruit and the hard mast (mostly nuts) from trees are both important wildlife foods. Since 1994, scientists from the Southern

Acorn "trap" used in long-term studies on fruit and mast production.

Inset: Hard mast, such as these acorns, are important wildlife foods.

B. Lea
Inset: USDA Forest Service

Appalachian Ecology and Management unit have conducted a cooperative study on variations in fleshy fruit and mast production among five types of habitat at the Savannah River Site in South Carolina.

In 1999, the unit began a companion study in the Southern Appalachians that compares fleshy fruit production in mature and recently harvested hardwood forests. With both sets of sites monitored monthly, these long-term studies capture information on differences in production between types and ages of forests, variations in the availability of fruit over seasons and years, and changes in fleshy fruit production as a forest moves from one successional stage to the next. Unit scientists plan to develop fruit yield tables so that wildlife and forest managers can estimate how much fruit will be produced based on the number of key plant species in a forest stand.

In FY02, scientists began a study with Clemson University to identify and count birds on the same stands where fruit data is being collected. The additional data will allow scientists to look at the relationship between the availability of fruit and the composition and abundance of bird communities. ▲

Other Significant Accomplishments

Tested the second version of the NED Ecosystem Management Decision Support System. Designed to provide landowners, public land managers, and forestry consultants with powerful, integrated forest management tools, NED-2 was tested by program developers and resource professionals. NED-2 writes silvicultural prescriptions, projects tree growth, and can be adapted to changes in landowner goals.

Evaluated the initial version of the hypertext ***Encyclopedia of Southern Appalachian Forest Ecosystem,*** written in Web language, with about 50 percent of the content finished. The initial version was evaluated by natural resource managers and the public to determine the usefulness of both the content and the hypertext format.

Published ***Wildlife of Southern Forests*** — compiled by SRS scientist emeritus James Dickson, this book traces the history of southern forests and associated wildlife, details the biology and habitat requirements of species and communities, and offers practical guidelines for habitat management on a broad scale. The book is a collaborative effort of the Southern Research Station, the National Wild Turkey Federation, Wildlife Forever, and Louisiana Tech University; chapters were written by leading wildlife experts from universities, wildlife agencies, and conservation organizations.

Hosted Chinese scientists at Bent Creek Experimental Forest to increase understanding of hardwood ecology. ▲

Awards

The Southern Appalachian Ecology and Management research work unit received the Forest Service New Century of Service award for exemplary leadership skills in developing an outreach program that demonstrates the value of forest management in upland hardwood forests.

Thomas Kubisiak received a certificate of appreciation from the American Chestnut Foundation for presenting research results pertinent to breeding disease resistant American chestnut.

James Guldin received a Forest Service certificate of merit for exceptional leadership in the development of the USDA Forest Service's Science Consistency Review Guidelines.

Callie Schweitzer received a certificate of appreciation from the USDA Cooperative Extension System for dedicated support of the Alabama Cooperative Extension System.

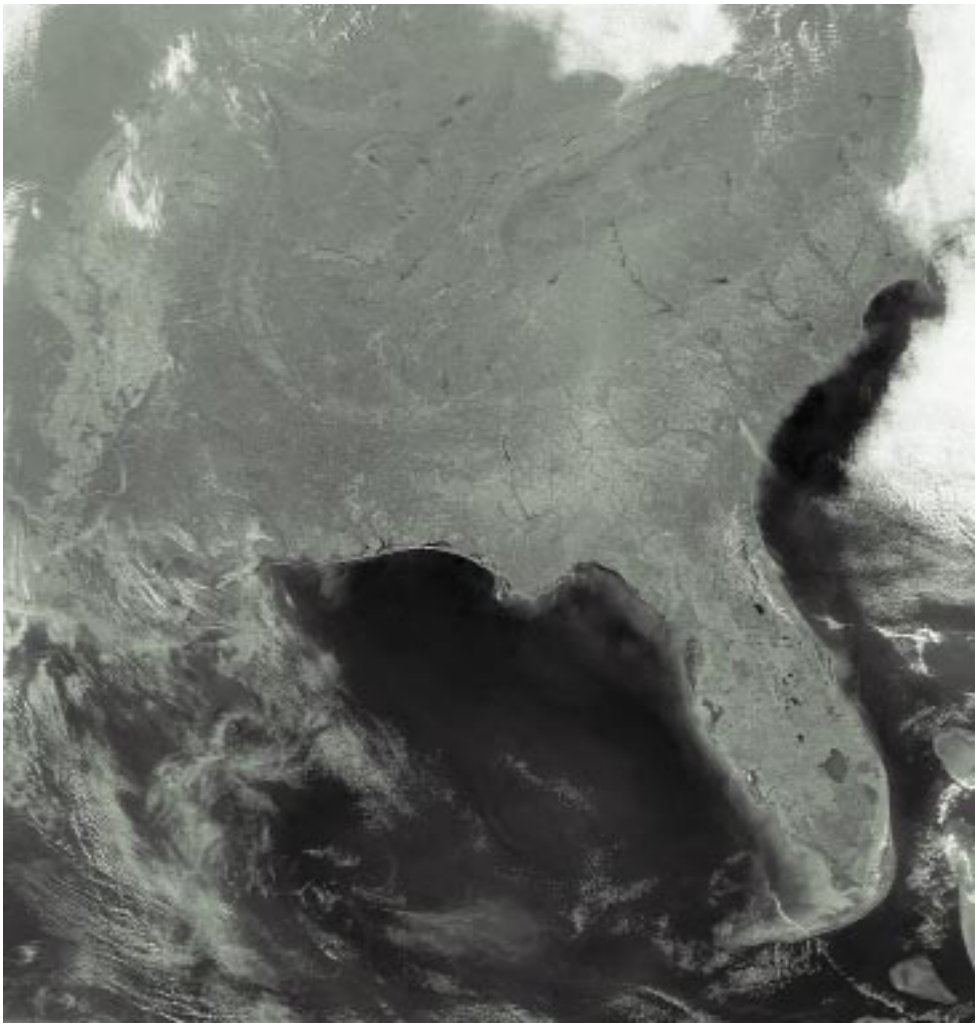
Large-Scale Assessment and Modeling

U.S. Department of Agriculture
Forest Service
Southern Research Station

Southern Forest Resource Assessment Completed

The Southern Forest Resource Assessment was initiated in 1999 as a result of concerns raised by natural resource managers, the science community, and the public regarding the sustainability of forests in the South. These included changes to the region's forests brought about by rapid urbanization, increasing timber demand, increasing numbers of satellite chip mills, forest pests, and changing air quality. In response to these issues, leaders of four natural resource agencies agreed to work together to provide a careful evaluation of the overall condition and ongoing changes of southern forests. State forestry and fish and wildlife agencies were invited to take part and have actively contributed to the effort.

The Assessment was a question-driven effort, with the questions defined through a lengthy public involvement process. Ten public meetings in five locations were convened to develop input for forming the questions. More than 750 individuals participated. Input at this stage and at all others was also gathered through an



A beautiful spring day in the southeastern United States is seen in this SeaWiFS image.

Photo courtesy of SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE.

innovative, interactive Web site. The Assessment, for the first time, provided a platform for a pubic dialogue on concerns regarding the forests of the entire South. Web-based techniques allowed the public to have access to all documentation of Assessment activities except peer reviews.

Twenty-five chapter managers from the Forest Service, Environmental Protection Agency, and Fish and Wildlife Service completed drafts and more than a hundred anonymous technical experts were enlisted to provide peer reviews. Following a 90-day public comment period, the 600-page technical report was printed in September. It was scheduled for release at the national Society of American Foresters meeting in October 2002. A 100-page summary report was also produced.

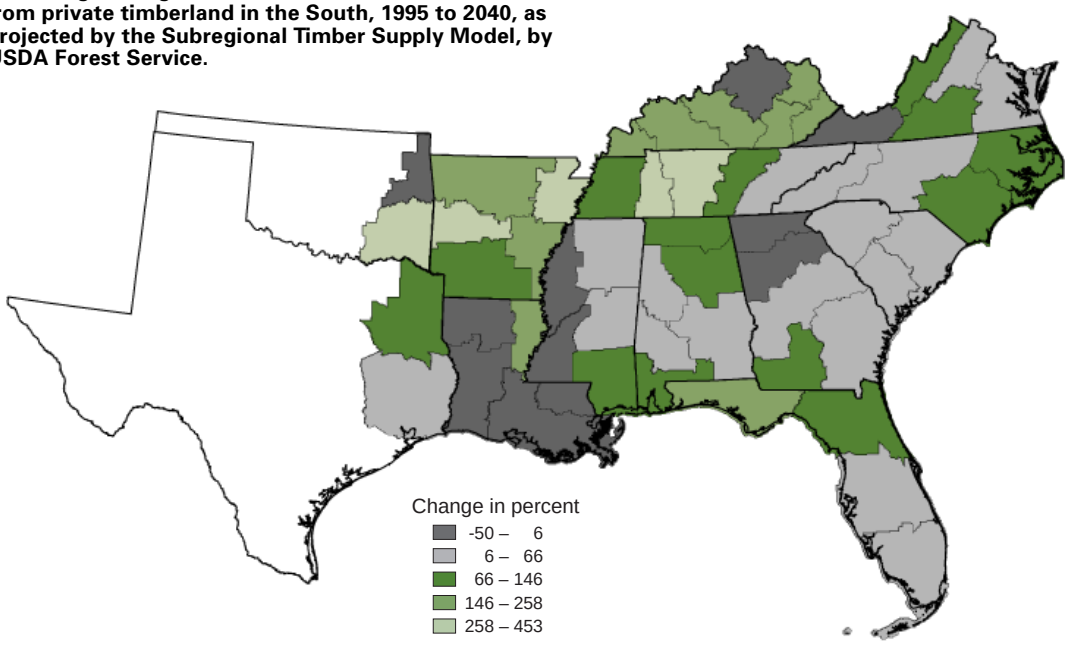
The regional coverage and comprehensive nature of the Assessment are unique and make it a valuable resource for anyone seeking information about the current status of and potential threats to southern forests. Information contained in this document addresses forces of change (timber and land markets, social institutions, biological factors, and physical factors) and current conditions (forest area and ownership, landscape structure, effects of land use changes, and water quality) as well as providing a synopsis of scientific uncertainties and knowledge gaps.

The Assessment has achieved broad public support. The Society of American Foresters dedicated the entire September issue of the Journal of Forestry to explore the implications of Assessment findings. Endorsement has come from both ends of the natural resource spectrum, with The Nature Conservancy chapters in the Southeast expressing high praise. "This assessment can be the foundation for rational and careful public and private decisions that will shape the future of our forests," said Bob Bendick, director of the Conservancy's Southeast Division. "The Forest Service and the other participating agencies and stakeholders deserve our thanks for undertaking a hard and objective look at the forests of the South." ▲

Private Timber Supply

In cooperation with North Carolina State University and the Research Triangle Institute, SRS scientists completed studies of the structure and operation of private timber markets in the South. One study investigated the linkages among geographic regions in determining timber prices. Results on how local disasters such as widespread fire or hurricanes affect local and regional markets are essential for defining the full costs of these events.

Percentage changes in annual softwood harvest levels from private timberland in the South, 1995 to 2040, as projected by the Subregional Timber Supply Model, by USDA Forest Service.

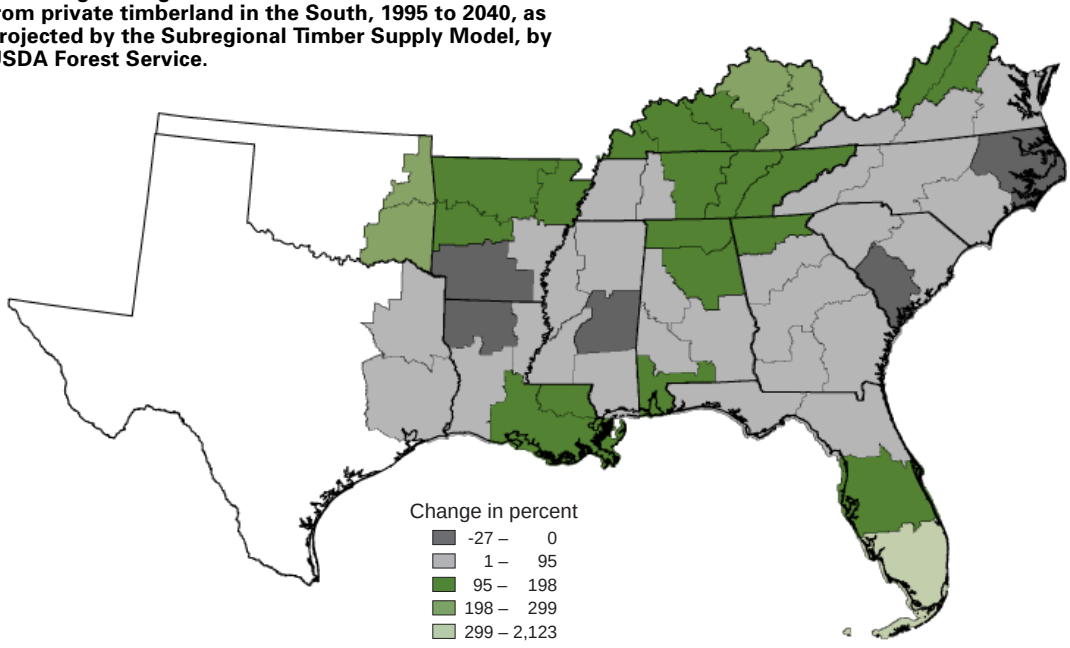


Hurricane damage could intensify with carbon dioxide-induced climate change.

B. Lea

Another set of studies has led to improved timber market forecasts for the South by linking together forecasts of timber markets, forest investments, and land use changes. SRS scientists evaluated the history and status of timber production and investment in the South and provided forecasts of future timber harvesting, timber inventory dynamics, and changes in forest types. They examined historical data on land use and forecast where and how land use could change in the future, examined the direct contribution of forests to local economies in terms of jobs and income returned from timber management and recreational activities, and studied the overall contribution of southern forests to quality of life in the region and examined potential changes resulting from land use and timber management. These forecasts were a key component of the Southern Forest Resource Assessment. ▲

Percentage changes in annual hardwood harvest levels from private timberland in the South, 1995 to 2040, as projected by the Subregional Timber Supply Model, by USDA Forest Service.



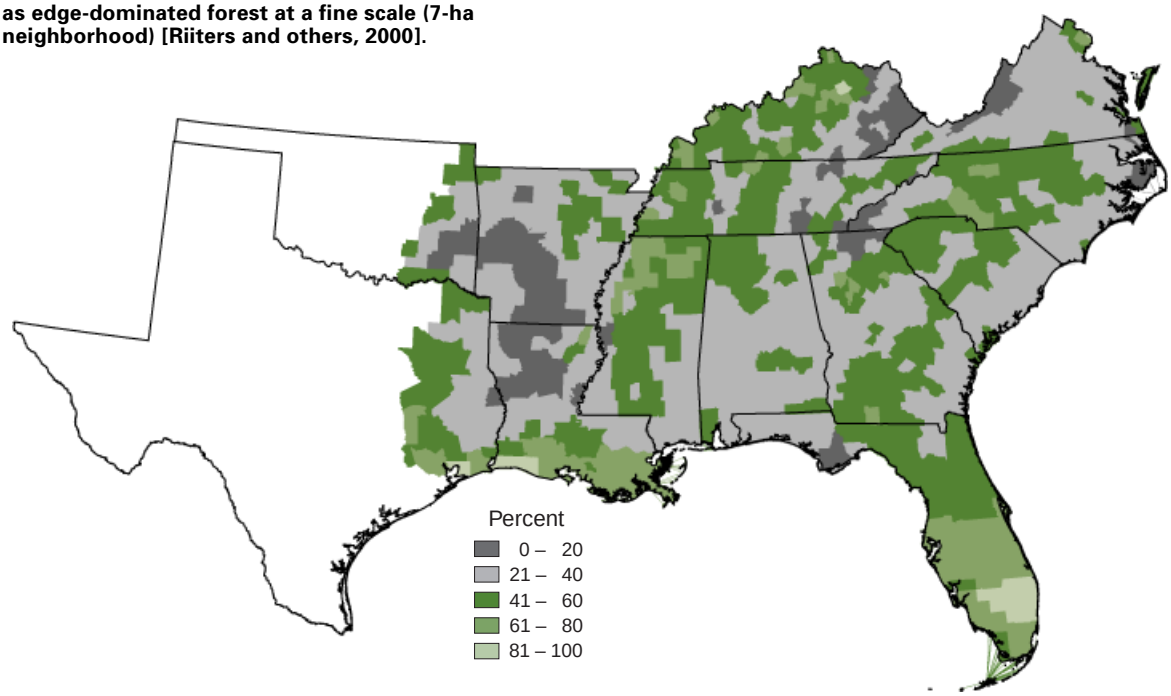
Assessing Forest Fragmentation from Satellite Imagery

The U.S. Government has adopted the Montréal Process framework for strategic forest planning and national assessments of forest sustainability. Seven criteria and 67 indicators address environmental and socioeconomic values that forests provide, and the policies and institutions that enable efforts to achieve them. The SRS contributes to the Montréal Process by providing national analyses and assessments of forest land fragmentation for use in Forest Service and International planning and policy arenas.

Scientists completed two national assessments of forest land fragmentation, one for the 2003 U.S. Report on Sustainable Forests (part of the Montréal Process) and one to demonstrate an alternate approach at national scale. They also contributed national fragmentation statistics to the H.J. Heinz Center's "Environmental Report Card." All of the research and subsequent applications are based on national land-cover maps derived from Landsat Thematic Mapper imagery for the United States. All of the results and maps generated by this research have been made available to other researchers and the public via the SRS Web site. The research has produced fundamental insights about U.S. forest land patterns and represents a cutting edge achievement because it is the first time that anyone has successfully conducted an analysis of forest fragmentation at national scale with such high-resolution land cover maps.

To facilitate analyses of such large databases, SRS scientists have constructed a computer infrastructure known as the "supercomputing headhouse." They developed protocols for efficiently processing land cover maps with tens of billions of pixels, which if attempted with commercial software, would have required at least ten times the hours than were actually needed. Their databases have been used by the Environmental Protection Agency's Regional Vulnerability Program and by the U.S. Geological Service, which is developing large-area habitat models to evaluate reintroduction strategies for Florida panthers and black bear. In addition, they have responded to requests for analyses of the CORINE land cover map for Europe (part of a NATO project), watershed-scale land-cover maps in Italy (with researchers at the University of Lecce). ▲

Shares of areas in southern counties classified as edge-dominated forest at a fine scale (7-ha neighborhood) [Riiters and others, 2000].



Soil data are useful in predicting changes in carbon sequestration.

R. Kindlund

Productive pine plantations will contribute to forest sustainability in the South, but the effects of climate change on productivity will vary over time and across geographic areas.

USDA Forest Service

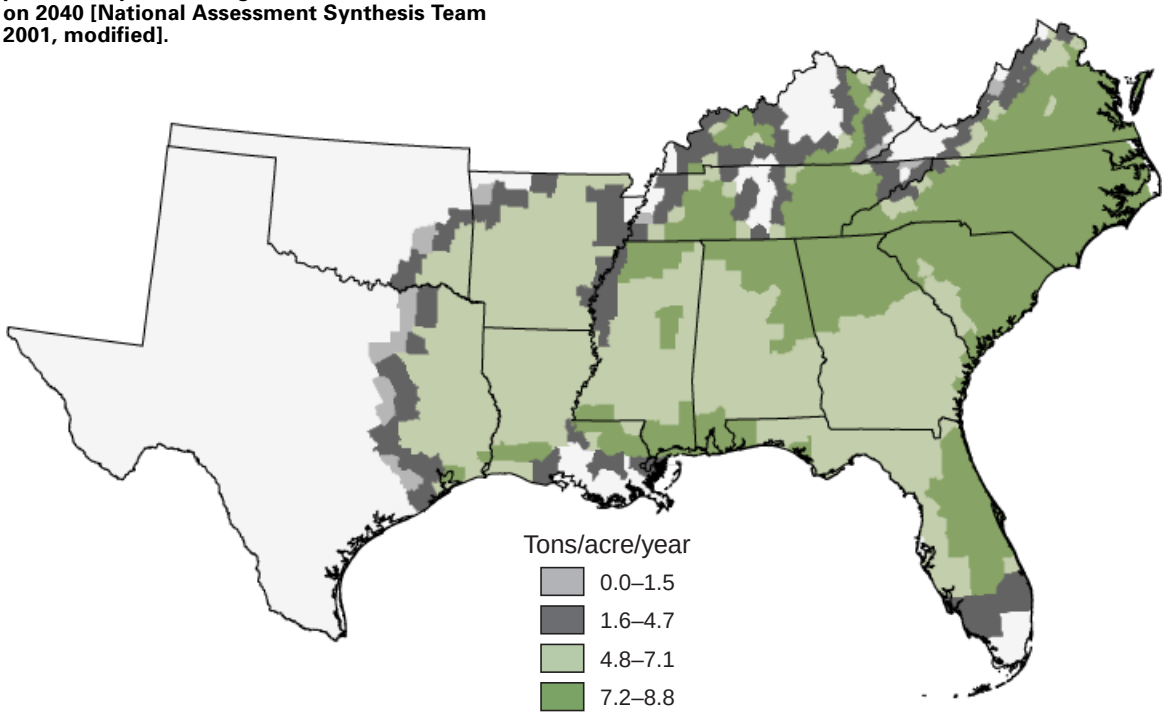
Using Soil Data to Predict Carbon Sequestration

Since 1990, the national Forest Health Monitoring (FHM) program has established several thousand plots on a statistically based grid network across the United States. Recent interest in the potential of forests to sequester atmospheric carbon dioxide that is contributing to global climate changes has prompted researchers to ask whether FHM soil data can be used to monitor changes in above ground and below ground forest carbon. In collaboration with North Carolina State University and the University of Nevada, scientists used FHM data with published carbon sequestration models to compare the predicted changes to measured changes. Results indicate that there is a greater than 80 percent probability that FHM predictions of a change in carbon content will be correct when the rate of change is 20 percent over 10 years. ▲

Global Change and Forest Productivity

With over 214 million acres, southern forests make up 29 percent of U.S. forest land. Only 11 percent is publicly owned, with 154 million acres held by nonindustrial private forest landowners and 36 million acres held by forest industry. Southern forest productivity is affected by many factors including global change. The relationship between forest productivity and global change is an important, complex issue that adds to the uncertainty of southern forest sustainability. Changes in land use, atmospheric nitrogen deposition, carbon dioxide concentration, and ozone will occur over time in conjunction with increased air temperature and shifting precipitation patterns. To manage forests to adapt to these environmental changes, land managers and biologists, conservation groups, and policy makers need to predict how forest growth will be affected and the role that forests will play in sequestering carbon from the atmosphere and

PnET-II model predictions of total potential annual southern forest growth, represented as net primary productivity and averaged for the decade centered on 2040 [National Assessment Synthesis Team 2001, modified].



mitigating the effects of a changing climate. Because forest, agricultural, rangeland, wetland, and urban landscapes have different rates of carbon sequestration, these ecosystems may go from being a carbon sink to a carbon source or vice versa. Quantifying terrestrial carbon fluxes due to change in land use and land cover is essential in understanding and mitigating the impacts of global change on U.S. forest productivity and sustainability.

Satellite image analysis gives timely and accurate measurement of spatially explicit land use change and is well suited for use in inventory and monitoring of terrestrial carbon. Accurate information on land cover types, spatial distribution, rates of change of forest characteristics, and forest inventory data are required to estimate the carbon emission and sequestration potential of forestry-related land use activities. High-resolution satellite imagery, forest inventory data, and forest modeling techniques provide an opportunity to optimize the available, regional-scale information on forest growth, soils, and climate to measure and model net primary productivity over spatial and temporal dimensions.

Changes in forest productivity are variable among forest types, across physiographic regions, and among differing climate change scenarios. Moderate increases in temperature and atmospheric carbon dioxide are likely to result in increased productivity. This may in turn result in reduced timber prices and shifts in land area away from forests and toward alternative land uses such as agriculture and development. More severe changes in temperatures and carbon dioxide concentrations could have negative impacts on forest growth and area, especially if precipitation increases are not sufficient to balance increased water demands. From 1953 to 1997, aboveground forest carbon stocks accumulated steadily in forest ecosystems for all Southern States and many also sequestered carbon in products, either in use or in landfills, and in wood burned for energy.

Large-Scale Assessment and Modeling

The future composition of forest ecosystems resulting from global climate change and socioeconomic responses to that change can only be estimated using predictive climate change, forest-process, and socioeconomic models. Scientists conducted an analysis to estimate southern forest productivity in 2000, 2050, and 2100 using a forest growth model of forest carbon balance under a warmer and wetter climate as projected under the Hadley2Sul climate change scenario and forest land cover from Landsat TM data. Their analysis showed steady carbon accumulation for the northern portion of the region and decreased carbon accumulation for the southern portion until 2050, followed by decreasing carbon stocks throughout the region. Future trends in climate suggest increasing air temperature will affect woody tissue respiration, evapotranspiration, and the development of seasonal water stress. Air temperature will likely be a contributing factor in lowering future forest productivity, especially along the Gulf Coastal Plains. ▲

Effects of Global Change and Land Use on Water

Water quantity and quality are critical land use management and policy issues for the South. Forests, agriculture, wetland, and urban land uses retain and discharge precipitation at differing rates. Scientists developed and validated a regional evapotranspiration model for mixed land-use watersheds to predict the effects of land-use and climate changes on water quality and abundance. Using a regional forest hydrology database, they compared six potential evapotranspiration models, ranking them in terms of ease of use for regional hydrologic applications.

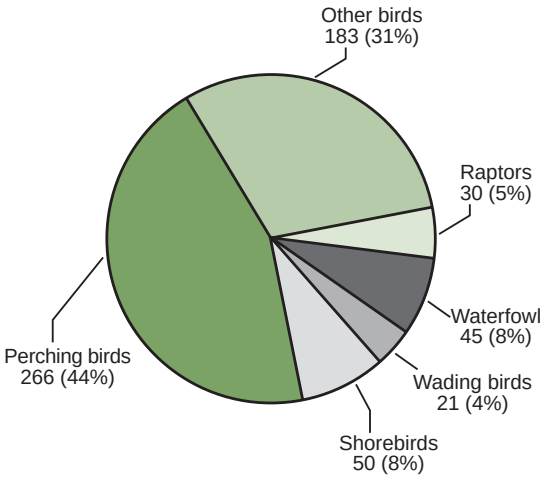
SRS scientists also assembled hydrologic databases for more than 40 watersheds across the South to establish statistical relationships among evapotranspiration, land cover, and watershed characteristics. Results were presented at the Second Federal Interagency Hydrologic Modeling Conference. This work will clarify the role of forest evapotranspiration rates in water yield and the response of watersheds to global climate and land use change.

Climate change may cause a decrease in water availability across the South.

B. Lea

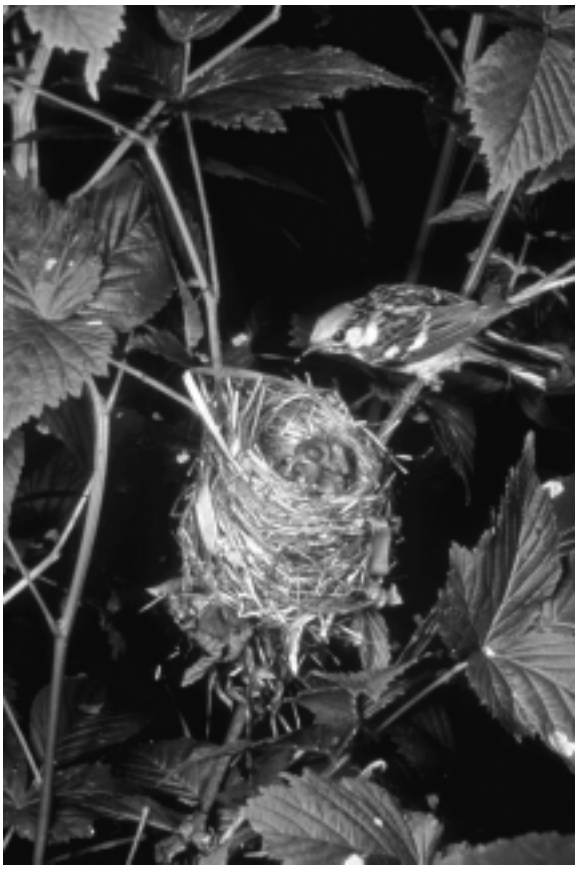
In addition, they integrated an annual time-step hydrologic model with spatial datasets of climate change and human population dynamics to study potential water stress over the next 100 years. The study showed that water availability may decrease across the South, with problematic areas concentrated east of the Mississippi River in Florida, Georgia, Tennessee, and Virginia. ▲

Species richness by major subgroups of avian taxa occurring within the South (NatureServe 2000).



Effects of Global Change on Bird Populations

Because birds occupy a wide variety of environmental conditions and forest types and are sensitive to a variety of environmental stressors at multiple scales, they are valuable ecological indicators. In collaboration with the University of Tennessee and Mississippi State University, SRS scientists developed a suite of GIS-based avian habitat-models for birds in the Southern Appalachians using a combination of statistical procedures, remotely sensed landscape-level and site-specific parameters, and empirical bird data collected on several national forests. Habitat models are now available for 10 species that are of management concern and whose needs are thought to be reflective of larger groups of species (such as area-sensitive species and late-successional species). These models have been used to facilitate the incorporation of bird conservation objectives into national forest management plans.



Neotropical migratory bird habitats may be disturbed by climate change.

K. Franzreb

Another application of the models is in examining the relationship between habitat quality and landscape attributes for some Neotropical migratory songbirds in the Southern Appalachians. They can also be used to assess the relative impact of human or natural disturbances on a population or community and will be extrapolated onto private lands. ▲

Risks of Wildfire to Human Populations and Water Supplies

The wildfires that burned 2.8 million hectares in 2000 showed that fuel loads resulting from past fire exclusion policies and practices have become a hazard to life, property, and ecosystem health. The President's National Fire Plan cautions that fuel loads are reaching hazardous levels and can lead to widespread catastrophic wildfires, both in forest ecosystems and at the wildland-urban interface. The potential for wildfires at any given location results from complex interactions among

Large-Scale Assessment and Modeling

forest fuels, topography, ignitions, and weather. To minimize the potential for catastrophic fire and protect the American public with limited resources, land managers need tools to for monitoring fuel loading and predicting wildfire risk and behavior based on inputs of fuel, weather, and topography for a specific location.

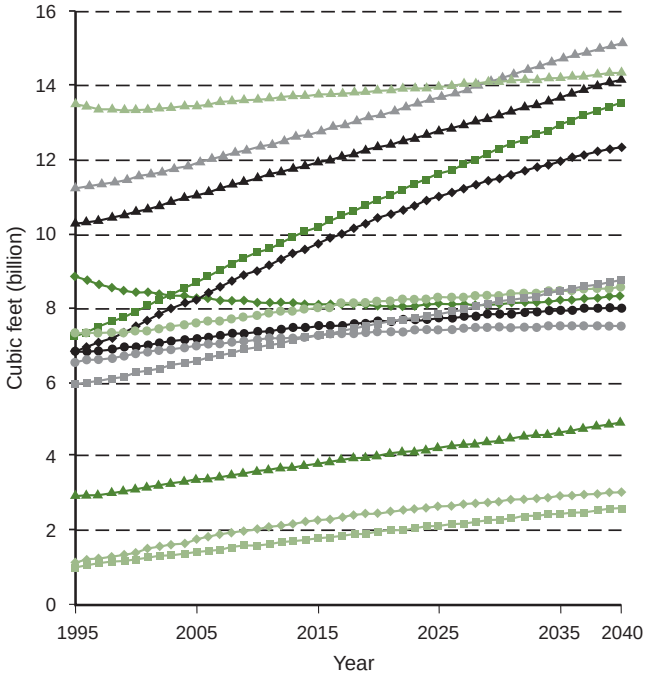
SRS scientists have developed county-level estimates of live tree biomass in the Forest Inventory and Analysis east-wide database. The resulting database and associated maps allow land managers and communities to manage fuels at county to regional scales by estimating the live tree component of wildfire and prescribed burning fuels.

Annual estimates of net primary forest production from 1990 to 2100 at a 30 m^2 resolution are now available for the eastern U.S. These spatial data and maps allow predictions and displays of areas of increasing and decreasing forest productivity. Working with land-use change and forest-patch characteristic datasets, SRS scientists also mapped wildfire risk to humans at the wildland-urban interface for the 1990s. This map provides an index of forest wildfire risk to humans based on the size and characteristics of the contiguous forest patch being developed and identifies heavily forested areas that are most likely to witness increased wildfire ignitions due to human encroachment.

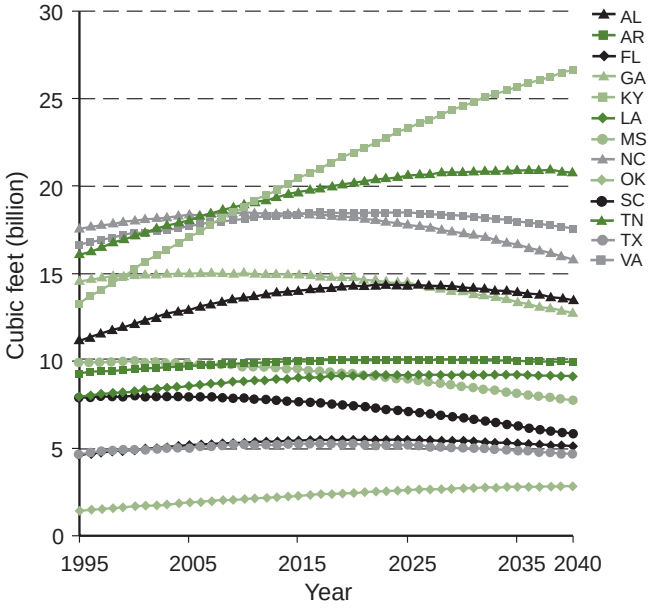
Studies of wildfire effects on nutrient and sediment loads have generated a distributed watershed scale hydrologic/water quality model to estimate impacts on downstream communities and natural resources, and an evaluation of risks from added nitrate, sediment, and other contaminants.

These preliminary research estimates show the potential for linking forest inventory data, satellite imagery, and forest process models to improve wildland fire fuel load estimation. A physically-based, distributed, watershed scale hydrologic water quality model will be developed for fire impacted ecosystems for use as a wildland fire and prescribed burning management planning tool. This research will enable the characterization of flooding, soil erosion, and nutrient contamination risk and the interaction with site characteristics and forest management for use as a fire management tool for reducing risk to extreme water, sediment, and nutrient flow following fire. ▲

Softwood inventory by State, 1995 to 2040.



Hardwood inventory by State, 1995 to 2040.



Fire Severity and Risk

ENSO (El Niño-Southern Oscillation) is a strong driver of North American climate, shifting the jet streams across the continent and dramatically changing temperature and precipitation. Previous research has linked ENSO and wildfire activity in Florida and throughout the South. Most studies that directly related climatic conditions to the number of fires or acres burned had limited usefulness, because data were skewed by fire prevention and suppression, fuels management, and arson.

Many indices of fire danger have been developed using recent weather and fuel conditions. An advantage of a fire danger index in long-range forecasting is their cumulative nature. Although many indices rely on more than temperature and precipitation, the Keetch-Byram Drought Index is attractive because it uses readily available weather information.

SRS scientists analyzed fire and climate data, quantified the relationship between ENSO and wildfire activity, and forecast the probable range of Keetch-Byram values down to the county level. The Florida Climate Center used this technique to produce forecasts for February-June of 2002. Few counties had values outside the most predicted range. A rigorous evaluation of the forecasts is currently underway.

The established relationships between fire danger indices and climatic variability has been used to develop forecasting tools that will aid land managers in assessing future changes in wildfire potential, as well as assessing whether conditions will be conducive to prescribed burning activities. This ability to forecast the severity of the upcoming fire season can be used in decisions about resource allocations.

SRS scientists completed a study of the linkages between vegetation management, land use, and climatic factors and wildfire risk at a landscape level in Florida. Results suggest reduced risk in areas that have been subjected past wildfires and recent site preparation burning. These results provide a framework for designing optimal risk reduction strategies and policies. They may also prove useful in targeting important areas for treatments.

New models incorporate climate variations into county-level assessments of wildfire risk.

USDA Forest Service, Insert: USDA Forest Service

Researchers also developed a methodology for determining publicly optimal levels of prescribed burning. Based on research into the effects of various treatments on wildfire risk, this analysis approach provides a tool for estimating total costs and potential benefits of the fire program. Ongoing research is refining these techniques for application to specific landscapes. ▲

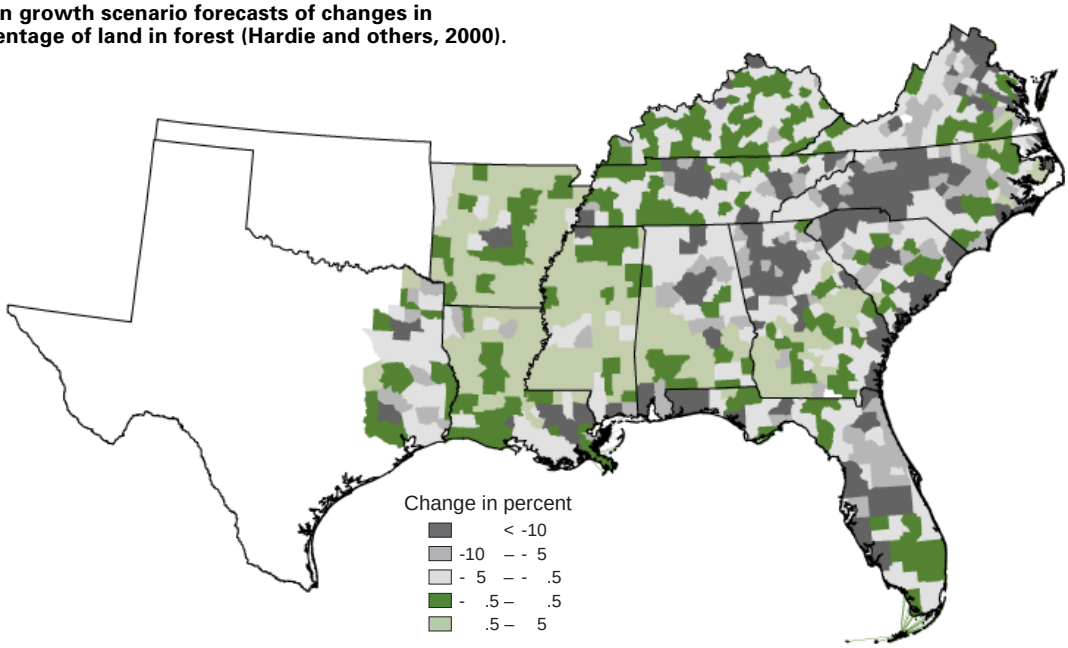
Tax Considerations for Forest Management, Investment, and Policy

The tax laws affecting forest management are complex and constantly changing. For many forest owners and investors, taxes are a critical factor in determining the feasibility of resource management options, the level of stewardship practiced, and the types of forest outputs produced. When judging the potential effects of income and tax provisions on nonindustrial private land, the forestry community and other participants in the policymaking process need unbiased estimates.

In cooperation with Clemson University, scientists collected and analyzed data for a regional survey that measured nonindustrial forest owner understanding and use of beneficial federal income tax provisions. They also cooperated with researchers at Mississippi State University to conduct a national survey of the effects of the federal estate tax on nonindustrial private forests. The survey results suggest that some 84,000 forest estates, with an estimated 86 million forest acres, are transferred each year after the death of their owners. In about 5 perecnt of these transfers, timber or land must be sold to pay the estate tax. Roughly a quarter of the acres sold are converted to other, more developed uses. Changes to the estate tax enacted in the Economic Growth and Tax Relief Reconciliation Act of 2001 will moderate these effects in future years.

A valuable component of this research has been to develop materials for maintaining the estates of limited-resource forest owners, to enhance the national timber tax information Web site (www.timbertax.org); and to revise taxation and estate planning workshop materials delivered by the Forest Service Timber Tax Team. These technology transfer efforts alert the forestry community to the need to reexamine their resource management and estate transfer plans. They contribute significantly to legislators and other participants in the policymaking process and to nonindustrial private forest owners. Forest owners estimate that the taxation and estate planning workshops save them tens of thousands of dollars. ▲

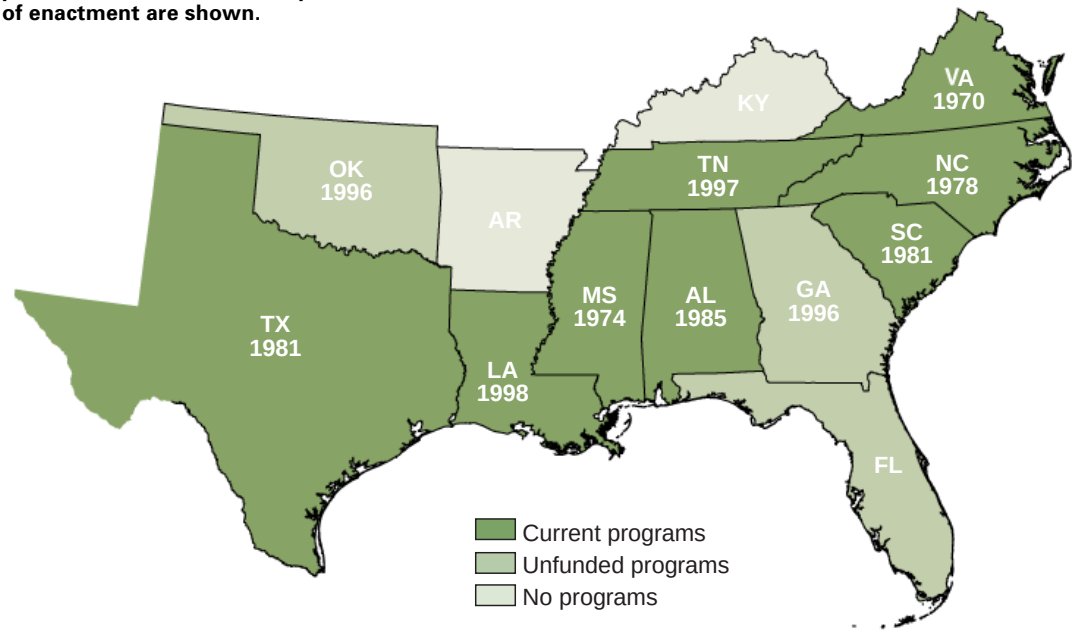
Urban growth scenario forecasts of changes in percentage of land in forest (Hardie and others, 2000).



The high cost of site preparation is a barrier to reforestation for many landowners.

USDA Forest Service

State level cost-sharing programs to improve timber production on nonindustrial private forest lands. Dates of enactment are shown.



Large-Scale Assessment and Modeling

Impacts of Forestry Incentive Programs

Timber availability has become a concern across the South in recent years as supplies from other regions are constrained and as the long-term demand for timber continues to grow. In some States and local areas, inventories of softwood timber have declined. A failure by nonindustrial private forest landowners to adequately regenerate pine stands after harvest has contributed to declines in softwood inventories. Failure to reforest is often caused by lack of immediate funding and absence of long-term credit. In cooperation with Mississippi State University, SRS scientists developed a new approach in which the State of Mississippi sells long-term, zero-coupon municipal bonds and uses the proceeds to finance reforestation investments on suitable nonindustrial private lands.

The proposed Mississippi Reforestation Investment Program is another tool that can be used to support rural communities and the sustainable management of forests. With minimal modification, the model could be implemented nationally, in other States, and possibly at more local levels. ▲

Other Significant Accomplishments

Developed prescribed burning guidelines for fire intensity to achieve successful regeneration of ridgetop pine communities.

Continued collaboration on climate change and soil erosion with the People's Republic of China. Four scientists presented papers at the International Soil Conservation Organization's 12th Meeting in Beijing, at Beijing Forestry University, and at several Institutes of the Chinese Academy of Sciences.

Participated in the IPCC Expert Group Meeting on Factoring Out Direct Human-Induced Changes in Carbon Stocks and GHG Emissions from Those Due to Indirect Human Induced and Natural Effects in Geneva, Switzerland, September 16-18, 2002.

Detailed a Chinese scientist to the SRS global change unit for a year, to study soil erosion in forested ecosystems and the potential impacts of global change with funding from the Chinese government via the China State Scholarship Fund, a highly competitive program that fosters international study and advanced training for promising Chinese scientists.

Represented the Department of Agriculture at the World Summit on Sustainable Development in Johannesburg.

Collaborated with representatives from 19 countries to complete the ***Tropical Tree Seed Manual***.

Contributed update of data and synthesis to the Global Database on Invasive Species.

Attended and presented papers at the Conference on Restoration of Boreal and Temperate Forests sponsored by IUFRO in Denmark.

Presented paper on "Fire effects on pines and their management using fire," at the Caribbean Fire Management Workshop in Belize. ▲

Awards

David Wear was recognized by the Southern Group of State Foresters for outstanding leadership and dedicated service in the development of the Southern Forest Resource Assessment.

Dale Wade received the "Best Management Involvement" award from the Joint Fire Sciences Program in recognition of efforts to involve managers his research on the ecological and economic consequences of the 1998 Florida wildfires.

Inventory and Monitoring

Forest Inventory and Analysis

The research results and inventory information from Forest Inventory and Analysis (FIA) are used to assess resource sustainability by forest industry, State forestry agencies, consultants, national forests, and other Forest Service units. The results are critical for policy formulation and management of resources because of the importance of the resources to State, regional, and national economies, and sustaining quality of life in the South. The new inventory system measures a systematic sample comprising approximately 20 percent of all plots in the State each year. The 20-percent systematic sample is referred to as one panel of inventory data.

In FY02, FIA collected data in 11 of the 13 Southern States and Puerto Rico. Annual inventory work was conducted in 10 States, and the periodic inventory work continued in North Carolina. Specific accomplishments include:

• Annual inventory data were compiled and sent to State Foresters for review in Virginia (3 panels), Georgia (3 panels), Arkansas (1 panel), South Carolina (5 panels), and Tennessee (1 panel).

• Annual inventory data were compiled, reviewed, and released for 3 annual panels in South Carolina and for the second panel in Georgia. Data are available at the FIA Web site: http://srsfia1.fia.srs.fs.fed.us.

• New forest inventory data for Alabama were compiled and reported through published resource bulletins and a State statistical report.

• Comprehensive analyses of the forest resources of Arkansas and Georgia were published.

Measuring individual trees on a forest plot.
USDA Forest Service

• FIA implemented a new data recorder program for national manual plots ("NaTally") for the P2 and P3 data entry program providing technical expertise and the framework for the National Information Management System (NIMS), and Internet access to data was developed for stakeholders.

• A comprehensive assessment of the forested wetlands resource for a 5-State region in the South was published.

Scientists and other FIA personnel led or provided support to ongoing regional and national efforts, such as the Southern Forest

Inventory and Monitoring

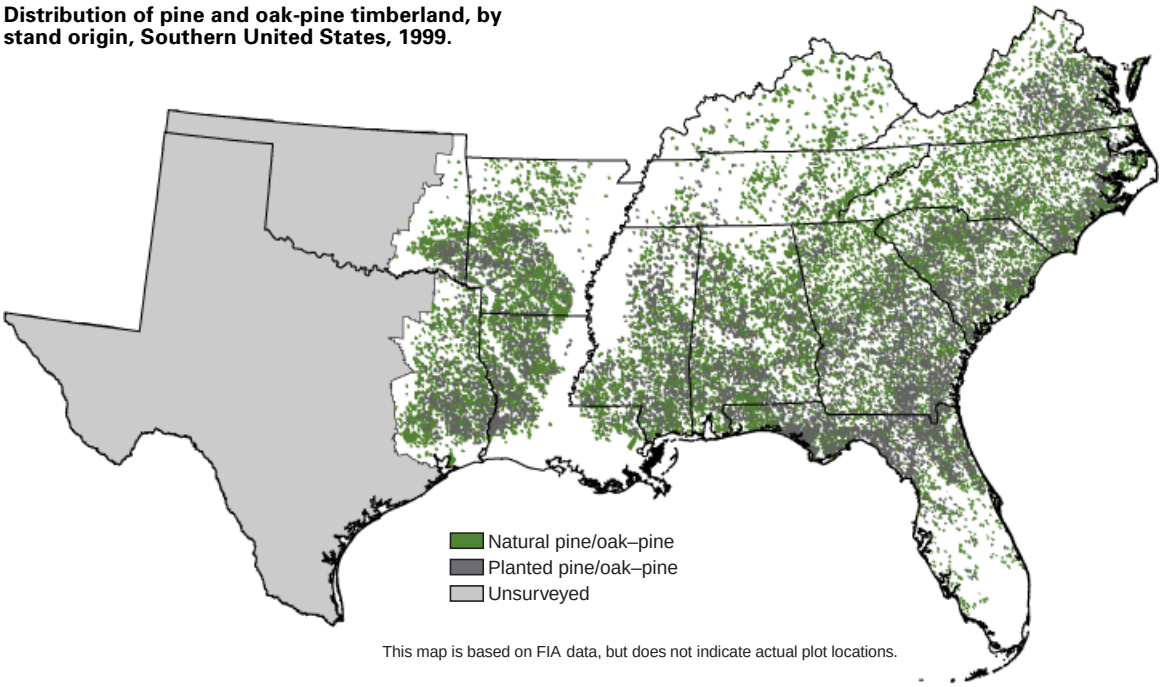
Recording plot information.
USDA Forest Service

Resource Assessment, the Geospatial Training Advisory Committee, and regional and national management and technical coordinator groups. Collaboration with State foresters resulted in 8 cooperative agreements exceeding $3 million in Federal funds, with 25 percent in matching State funds, and continuing representation by State Forester staff on national executive and management teams. Programmers developed Web-based plot lists for State coordinators' review, including a plot tracking system. A Web page was developed to provide updated inventory information to state coordinators and crews: (http://www.srs.fs.fed.us/fia/data_acquisition).

Scientists and cooperating research work units developed components and devised new and improved techniques for implementing a total southern annual forest inventory system, which included: (1) developing methodologies for predicting forest area for large-area research monitoring based on multi-spectral satellite data; (2) developing statistical methods and estimators for the annual inventory system applicable for measured and modeled data; (3) continuing cooperative ventures with university scientists and other research stations,

The ongoing integration of the FIA and Forest Health Monitoring (FHM) programs continued by assigning a new Phase 3 (P3) FHM coordinator with the responsibility for development, integration, and implementation of all P3 activities within the 13 Southern States. FIA is cooperating with the University of Tennessee, to provide staff and research assistance to conduct data collection for the vegetation diversity and structure variable of the P3 program, under a pilot study being implemented on P3 plots in South Carolina. Research work unit personnel participated in the National FHM workshop to develop processes to integrate the FIA and FHM programs. ▲

Distribution of pine and oak-pine timberland, by stand origin, Southern United States, 1999.



Forest Health Monitoring Program

Since 2000 the Forest Health Monitoring and Forest Inventory and Analysis programs have merged ground-plot sampling networks and modified the sampling protocols to attain a nationally consistent sampling design across the United States. In FY02, FHM collaborated with FIA statisticians to develop nationally consistent estimation procedures. The resulting research paper, Forest Inventory and Analysis National Sample Design and Estimation Procedures," has been released for external review. FHM authored or coauthored 3 of the 5 chapters and is editing and publishing the document. This information will enable FIA and FHM specialists to develop a National Information Management System (NIMS) based on the specified estimation procedures.

In FY02, FHM devised methods to synthesize crown parameters into a single measure for crown condition, and adjust them for the effect of stand conditions. A research paper "Crown condition as an indicator of forest health" was submitted for review to the Journal of Ecological Indicators. Because a method to synthesize FHM tree crown data into a meaningful indicator of forest health is now available, trees can be examined at the population level for outliers and pockets where poor crown conditions are evident. Scientists produced a Forest Health Indicators publication that defines indicators, explains why they are important to the Montréal process of tracking and reporting sustainability, discusses how indicators are measured, and how the data are used.

Intensive Site Monitoring (ISM) is an important component of the FHM program. It provides a critical link between large scale

Severe ozone injury on yellow poplar, *(Liriodendron tulipifera).*

USDA Forest Service

monitoring indicators in FHM and FIA and key ecosystem processes such as nutrient cycling and carbon fixation. This in turn improves the capability to monitor key ecosystem processes at various spatial scales. Working with scientists from other agencies and disciplines can link forest ecosystem information and processes with aquatic systems, agricultural systems and urban systems. The FHM research work unit is currently implementing an ISM project in the Delaware River Basin that involves multiple cooperators of various disciplines and partner agencies: U.S. Geological Survey, National Park Service, and National Aeronautics and Space Administration.

Using the ISM concept, FHM has improved methods for linking forest ecosystem health with the condition of associated aquatic ecosystems, for example, sampling first order aquatic systems with associated FIA or FHM plots, and urban and agricultural systems through relationships with forest fragmentation. FHM is providing proof of the Council on Environment and Natural Resources concept, by demonstrating the efficiency of sampling at multiple spatial scales and cooperation of multiple disciplines and agencies to address multiple environmental issues in a focused and efficient manner.

Developing quantitative relationships between macroindicators is needed to interpret the data currently being collected by FIA and FHM monitoring programs; the information will be used by groups striving to address forest health and sustainability issues. The monitoring system technology will be exportable to other forest ecosystems in the United States and other countries, especially those currently using the FHM technology to monitor forest health (central Europe countries and Indonesia). This new monitoring system will improve our ability to address specific forest health issues in diverse forests by anchoring the inventory, or monitoring at the larger spatial scales with the process-level research and monitoring occurring at smaller spatial scales. The new system will serve as a template for cross-resource inventory and monitoring by multidisciplinary teams from different groups within the Forest Service and partner agencies.

Scientists produced the first national spatial estimates of forest fragmentation. Fragmentation of forest types is an indicator of biodiversity for national assessments. Fragmentation refers to the spatial arrangement of forest and the degree to which continuous forest cover has been broken up into smaller pieces. Together with other indicators of the total area and protected status of forests, it describes habitat capacity, of interest because habitat capacity change is considered a leading indicator of biodiversity change. Unit scientists are working on localizing the national statistics to help develop forest plans, implement management regimes, and inform national policy.

A national risk-based sampling design was developed to detect the pathogen *Phytophtora ramorum*, the causal agent of sudden oak death disease. The risk-based sampling process includes determining the distribution of known and suspected host species, identifying pathways of introduction to new areas, identifying climatic conditions that favor or limit the development of the pathogen, defining the risk strata, and evaluating the veracity of the risk strata. A sudden oak death risk map has been produced for the nation.

Monitoring programs in FIA and FHM develop and use quantitative relationships between large regional indicators and associated processes that enable them to better interpret existing monitoring data and to make better risk analyses of future condition. These relationships and models provide information for the Resources Planning Act and sustainability reports. In addition, global change researchers generate current status and trends over time and space of carbon for the United States by combining information from the FIA and FHM data, and other data sources. ▲

Other Significant Accomplishments

Began applying aerial technologies as a pilot test to Phase 1 estimations with successful completion of West Texas aerial inventory project. Using digital-ortho photography, an FIA employee flew an aerial survey of 312 plots in Texas, identifying 60 percent of the plots as nonforest, thus eliminating them from ground visits.

Continued a cooperative research venture with the Tree Quality, Processing, and Recycling research work unit in Blacksburg, VA to conduct research studies on nonforest timber products.

Cooperated with the National Council for Air and Stream Improvement (NCASI), which distributed Request for Proposals titled Habitat Modeling for the USDA Forest Service's Forest Inventory and Analysis Program. FIA received eight proposals and two have been selected for funding.

Shared southern techniques for felled tree utilization studies with the University of Montana. After visiting five logging operations in one week, felled tree measurements were demonstrated and data editing and compilation were discussed showing that the southern methods and techniques for measuring felled trees in the South could produce valid data for western species as well. ▲

Awards

Andy Edwards received the Forest Service Director's Award for Excellence in FIA for excellence in customer service in performance of Quality Assurance duties in the State of Texas.

U.S. Department
of Agriculture
Forest Service
**Southern
Research
Station**

Urban Forestry/ Wildland-Urban Interface

Urban Forestry/Wildland-Urban Interface Cross-Cutting Theme Established

Rapidly increasing human populations and spreading cities and suburbs throughout the South are creating both opportunities and challenges in urban forests and on nearby forested lands in the path of urban expansion. The Southern Forest Resource Assessment found that urbanization will have the "most direct, immediate, and permanent effects on the extent, condition, and health of forests." This Cross-Cutting Theme (CCT) will provide a framework for addressing the issues of sustaining healthy and productive urban and wildland-urban interface forests in the South. These issues are complex, involving multiple biotic, abiotic, and socioeconomic factors. This CCT will help organize and focus SRS expertise and resources, with the depth and breadth needed to be effective. This CCT will be a direct response to findings and stated "unknowns" in the Southern Forest Resource Assessment, and it also complements ongoing national initiatives, such as the Urban Forestry Health Monitoring Program. The Southern Center for Urban Forestry Information and Research, in Athens, GA and the Wildland-Urban Interface (WUI) Center, in Gainesville, FL will play key roles by facilitating technology transfer of research products. The Centers' will help identify priority information and research needs, and facilitate the sharing of information between researchers, practitioners, and others. The Forest Service Southern Region, Urban and Community Forestry Program, is a vital partner in this CCT, providing technical expertise and financial resources for technology transfer. ▲

Wildland-Urban Interface – where the houses meet the trees.

B. Lea

Wildland-Urban Interface Center

In January 2002, the WUI Center became a reality; initial staffing included a Technology Transfer Coordinator and an Administrative Assistant. Additionally a project intern and a Web support specialist were hired under a cooperative agreement with the University of Florida and a Research Forester is doing a one-year detail with the Center. Early activities included completing the publication, ***Human Influences on Forest Ecosystems: The Southern Wildland-Urban Interface Assessment,*** which was printed in the fall of 2002. The draft report was a springboard for a November 2001 conference titled, "The Wildland-Urban Interface: Sustaining Forests in a Changing Landscape." There were 162 participants — planners, land managers, educators, consultants, researchers, and all kinds of natural resource professionals — from over 26 States. This conference and the assessment report were the first step in a multiyear technology development and transfer strategy to assist State, local, and Federal policy makers who deal with the problems brought on the by expanding interface.

Enhancement of the Interface South Web site (http://www.interfacesouth.org/) is in process–creating a fire section, and expanding current literature, contact directory, Web links, and other existing databases. The assessment is also posted on the Web site. The Center sends out wildland-urban interface information each week through the Center listserve (SWUINET) and provides technical assistance to State forestry and natural resource agencies, universities, and nongovernment organizations (NGOs) upon request.

Through the Cooperative Agreement with the University of Florida, Center associates have:

- Completed sampling in 7 of the 10 study sites for the flammability study.

- Provided technical assistance to County Commissioners in Pinellas County, FL on the use of prescribed fire and other fuel reductions options in the wildland-urban interface.

- Visited community in Bonita Springs, FL where the Red Robin Fire threatened 5 homes and collected data for post-fire study and met with homeowners to discuss reducing fire risk.

- Held workshop for landowners on "Managing Risk in Florida's Forests."

- Established study plots and completed pretreatment vegetation sampling for study on fuel management options.

- Initiated field sampling for study on the flammability of southern fuels.

- Protocol for interviewing participants in the post-fire assessment study was accepted by the University of Florida Institutional Review Board.

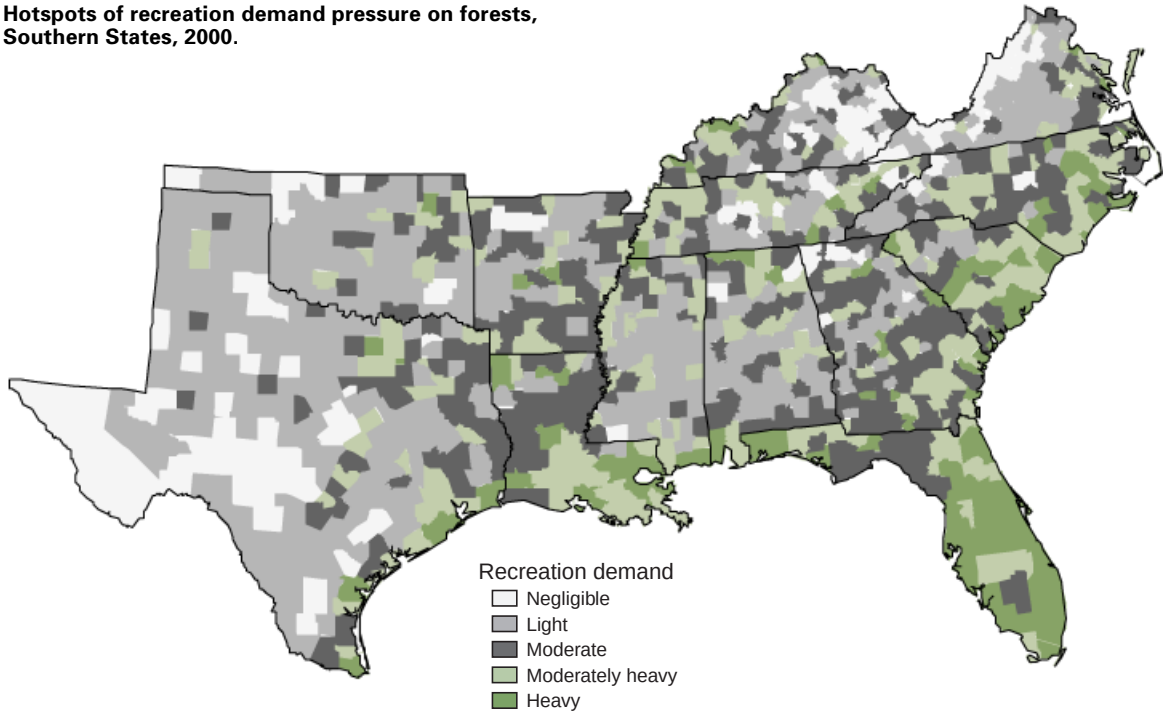
- Reviewed the research methods for the post-fire study and established partnerships with both agencies for site selection and data collection. ▲

Outdoor Recreation Trends

Scientists at the Recreation, Urban Forests, and Human Dimensions research work unit initiated studies to identify and describe trends in demand, preferences, and markets for outdoor recreation on forest and rangelands throughout the United States. For the most part, this research will serve as the basis for the 2005 Resources Planning Act (RPA) assessment of outdoor recreation in America. In addition, this research is being used by private industry, other Federal agencies, and State planners.

The core data collection instrument is the National Survey on Recreation and the Environment. Included in the survey are related topics including equitable access to public lands, public access to private lands, preferences for national forest management options, public knowledge and perceptions of Congressionally-designated recreation areas, wilderness values, and changing conditions at the wildland-urban interface. In addition to this population-wide survey, work is underway to improve and operate the National Visitor Use Monitoring system, the means by which recreational use is measured

Hotspots of recreation demand pressure on forests, Southern States, 2000.



on National Forests and other public lands across the country.

Work has been initiated on improving measures of recreation use and opportunities on forest lands nationwide for the 2003 Nation's Report on Sustainable Forest Management in response to the international agreement through the Montréal Process. Research was begun to better understand public perceptions of wildfires and managed fires on forest and range lands nationwide and regionally. ▲

National Wilderness Preservation System

Scientists and cooperators are conducting research on the National Wilderness Preservation System (NWPS) and its recognition or value to the American public. As part of this work, cooperators survey American households to characterize their use of wilderness, values, NWPS awareness, attitudes towards protection alternatives, and levels of involvement with the NWPS.

A nationwide assessment of the social, economic, ethical, and intrinsic values derived from the National Wilderness Preservation System

Backpacking is a popular Wilderness activity.
H. Riekerk

has been initiated collaboratively with the Federal wilderness management agencies, nongovernment organizations and other research units. A national workshop entitled "The Multiple Values of Wilderness" was held in Athens, Georgia in April 2002.

As part of the National Visitor Use Monitoring project, national forest wilderness use is being estimated. The information gathered by these studies will be used for the 2003 Nation's Report on Sustainable Forest Management and in preparation of the Forest Service's RPA assessment on outdoor recreation. FY02 was the second year of this national survey effort. One-fourth of the national forests are surveyed each year.

Work was also begun on spatial models describing the wilderness visitation in the United States as explained by demographic and biophysical factors. These models will yield improved estimates of economic values for wilderness use. ▲

Benefits from Urban Forests

Scientists and cooperators initiated several new studies on urban forestry and the wildland-urban interface. We have initiated studies on: (1) the economic benefits of trees in suburban settings; (2) the demand for and socioeconomic benefits of abandoned railways, power line rights-of-way, waterways, and integrated urban trails; and (3) difference in the urban/nonurban recreation behavior, preferences, and values as determined by the National Visitor Use Monitoring data.

Results from the completion of research indicate that: (1) forest management plans that provide the most benefits to Southern Appalachian mountain bikers may not be best to stimulate local economies; (2) people living in wildland-urban interfaces are unwilling to pay amounts sufficient to fund white-tail deer control-by-contraception programs; and (3) race and rural residence are less likely than gender to serve as constraints to participation in outdoor recreation activities. ▲

Recreation Visitation

A major hurdle to examining the role of recreation and related amenities on southern rural communities lies in obtaining accurate measures of recreation visitation. Through the National Visitors Use Monitoring Program, this gap in data is being filled.

During FY02, data on recreation visitation was collected for the Cherokee National Forest (NF), Francis Marion-Sumter NF, and National Forests in Mississippi. These data will be readied for analysis during FY03. Visitation estimates were obtained for National Forests in North Carolina, Kisatchie NF, and Ozark-St. Francis NF. Characterization of the visitation nodes and expected visitation levels was accomplished for

Recreation visitation includes off-road vehicle use.
B. Lea

the Chattahoochee-Oconee NF, National Forests in Alabama, and National Forests in Texas. In cooperation with the Human Dimensions module of the National Resource Information System, GIS coordinates for sample points are being identified. Models of visitation and visitor spending have begun to be developed by cooperators. Estimates of the number of people who view scenery on national forests from non-Forest Service roads will be available for the first time.

Improved measures of recreation visitation on national forests in the South will be available for all forests within the next 18 months. Recreation planners and managers have reliable, scientifically valid estimates of recreation use and viewing scenery visitation.

Resource planners and economists will have more complete and accurate information on the contribution of national forest recreation to local economies. Recreation managers will have unprecedented levels of information about dispersed recreation in the national forests. This improved information also redirects the reporting and managerial units of visitation into units that are more compatible with economic theory, and thus are more easily and accurately measured. ▲

Alabama Consortium on Forestry Education and Research

In the early 1990s, the Alabama Consortium on Forestry Education and Research was formed to promote communication and collaboration among diverse institutions involved in forestry in the State of Alabama. It was organized to advance forestry education and research in ways that could not be accomplished by individual members alone. The organizational effort is notable because it reached across institutional and racial boundaries that historically have often proved divisive. A report was prepared by the Legal, Tax, and Socioeconomics research work unit that describes the Consortium's history and accomplishments through 1999. It offers useful information about the Consortium to people and organizations in other States and regions seeking to open creative dialog and promote collaborative relationships among diverse forestry institutions. It also documents research efforts in two main areas: socioeconomic relationships between forests and people; and forest operations for ecosystem management.

One accomplishment this past year was an evaluation of participation behavior of limited-resource farmers in cost-share programs in Alabama. Landowner assistance programs are a public policy instrument used to encourage conservation on private land. Several different federal programs provide technical and cost-share assistance to landowners, many of which have the goal of conversion of marginal agricultural lands to conservation uses. This study identified and analyzed the socioeconomic factors that affected participation in cost-share programs. The results indicate that age, college education, total acres, and membership in conservation organizations were correlated with participation in cost-share programs. The study also explored the ethnic/racial dimensions of limited resource landowner participation, learning that Caucasian and minority landowners were equally likely to participate in the programs. However, compared to Caucasians, more minorities were dissatisfied with program participation and were not able to afford the cost share. They also preferred different ways to receive program information. The differences for program participation by the two groups show the need for different approaches to encourage minority participation in these programs, and the specific information on minority landowners provides the information needed to tailor program delivery to meet their interests and needs. ▲

Bark Beetles and Invasive Insects

The southern pine beetle (SPB) is the most destructive insect pest in southern forests. SPB, especially when considered with other bark beetles such as the small pine engraver, causes great economic damage and disruption of resource management practices. The identification of new control tactics, both in forest and wildland-urban interface settings, is critical to the protection of southern pines.

The Bark Beetles and Invasive Insects research work unit has, in cooperation with the University of Georgia, been testing new insecticides for the efficacy as tree protectants against bark beetles. In these tests, we have identified one (possibly more) compounds that show good efficacy in the field. We have used laboratory tests to determine the minimum dose required to kill bark beetles. We have identified a more effective aggregation pheromone combination for trapping the small southern pine engraver. This important bark beetle may now be more effectively monitored and managed.

Currently we have no effective licensed insecticides for southern pine beetle control. This work will identify compounds that should be licensed and made available for use in forests and the wildland-urban interface. Findings from our research will be shared through scientific and lay publications, Web sites, and our biyearly extension publication, ***The Southern Pine Beetle Update***, as well as through direct interaction with clientele.

The compounds identified in the work described above will benefit sustainable forestry by enabling effective tree protection and forest management. National, State, industrial, and private forests in Alabama, Tennessee, Florida, South Carolina, and other Southern States have recently been heavily impacted by SPB. In addition, wildland-urban interface areas in Florida have been heavily impacted by SPB. New compounds will aid managers and owners of these lands. ▲

New Termite Control Products

The cost of controlling native subterranean termites and repairing their damage is estimated at more than one billion dollars annually in the United States. These losses do not include those incurred by the U.S. military or the growing impact from the invasive Formosan subterranean termite. Of all urban pest problems, termite control carries the highest risk for the pest control industry, and increasing restrictions on and cancellations of insecticides increasingly make termite control less reliable and more costly. For these reasons, research on termite control is a high priority.

Termite control study site.

The Wood Products Insect research work unit has been testing chemicals for termite control since 1939, and today this work is internationally recognized for providing unbiased efficacy data for product registration using standardized tests, sites, and evaluation procedures. Virtually all termite control products undergo Forest Service testing before being evaluated and registered by Federal and State regulators. Tests are performed on repellent and nonrepellent termiticides, chemically impregnated and physical barriers, and treated wood products. New products undergo 18-24 months of laboratory screening to prevent unnecessary field testing on ineffective chemicals. Termiticides are considered effective in the field at the lowest concentration(s) that prevent termite penetration through the treated soil in test plots on four national sites for at least five years. Test sites are located in Arizona, Mississippi, Florida, and South Carolina.

This research will continue to produce efficient, cost-effective, and safe termite control products and practices that reduce environmental contamination, help protect wood products from damage, and prolong the life of wood in use. During FY02, laboratory screening was conducted on three termiticides, and field tests were conducted on 18 termiticides and five impregnated barriers. These tests were administered through 26 agreements with product manufacturers (registrants). Data also were collected on seven termiticides and one physical barrier from past (expired) agreements. ▲

Termites in Forest Ecosystems

Conditions regulating native subterranean termites in natural habitats are poorly understood, and research was initiated to investigate the biological, ecological, and physical parameters associated with the diversity, distribution, and role of these organisms in forest ecosystems. The research will provide an understanding of the habitat requirements supporting and promoting each species. It will provide insights required to initiate more complex studies on colony dynamics and will lead to the improvement and development of more efficient termite control products and practices that reduce costs and environmental contamination and help protect and conserve wood products from damage. The studies will also provide critical baseline data needed to assess the potential impact of the exotic Formosan subterranean termite on southern forests. The ongoing research on native termites will: (1) provide the foundation to study the distribution and abundance of the Formosan termite in southern forests; (2) evaluate the biological, ecological, and physical habitat criteria supporting its expansion into these forests; (3) evaluate the potential of this invasive species to disrupt or displace the native subterranean termites in the forest; (4) assess the potential impact of the Formosan termite on forest health and on recycling of woody debris. A GIS database will be developed from the research and then a risk assessment tool of potential new invasion sites and interactions with the native species will follow.

Termites have been collected and mapped from more than 465 locations. Scientists are also collecting, isolating, and identifying decay fungi associated with rotting wood that contains, and is devoid of, termites from diverse forest habitats. This research will promote an understanding of the relationships and interactions among decay microorganisms and individual termite species, specifically to identify microorganisms that act as behavioral attractants/repellents, or feeding stimulants/inhibitors, to termites. If successful, additional research will identify the underlying modes of action causing the altered termite behavior. This work will support the development of improved control strategies and protection techniques directed against termites. ▲

Other Significant Accomplishments

Implemented a recreation demand analysis process in support of a regionwide recreation initiative and produced of a series of reports on research investigating public perceptions and values in support of forest plan revisions in the Southern Appalachians.

Completed literature reviews on the following research topics: (1) structural survival in wildland-urban interface fires; (2) southern interface landscape patterns and their associated fire risk; (3) characteristics of vegetation that contribute to flammability and fire hazard.

Presented paper on "Some considerations when prescribed burning at the Wildland-Urban Interface," at the 22nd Tall Timbers Fire Ecology Conference in Canada.

Hosted a tour of the termiticide product-testing plots at the Harrison Experimental Forest for representatives from Australia.

Consulted with Chinese foresters for development of an urban forest management plan for the city of Shanghai.

Consulted with Brazilian and Chinese students on ecosystem management in urban landscapes. ▲