Forest Science in the South

United States
Department of
Agriculture

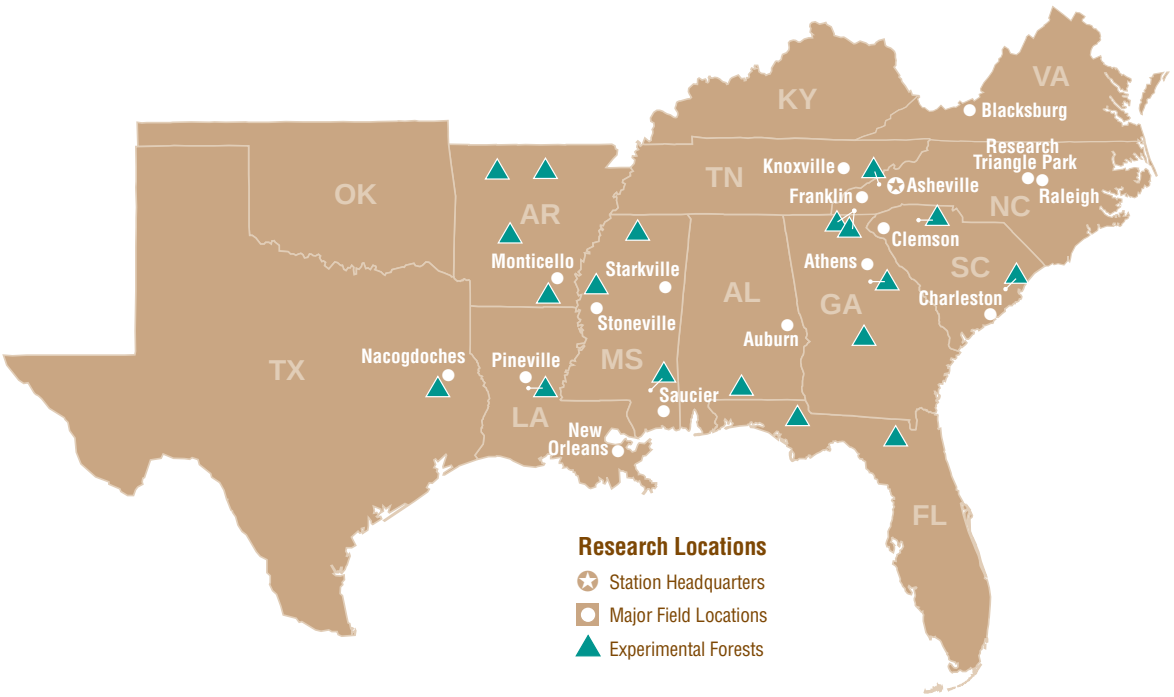
Forest Service

**Southern
Research Station**

Science Update
SRS-002

Southern Research Station

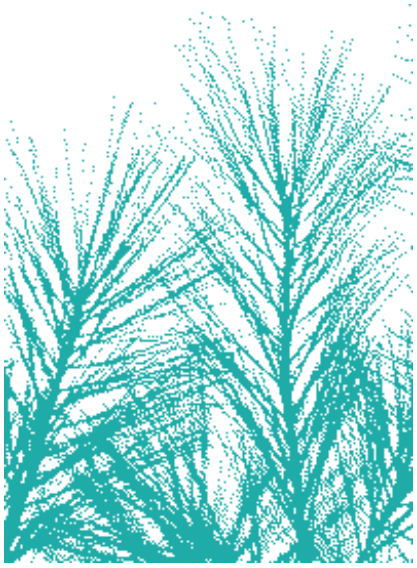
Our mission is to create the science and technology needed to sustain and enhance southern forest ecosystems and the benefits they provide.



Cover Photo, left: Experiments conducted at the USDA Forest Service's Southeast Tree Research and Education Site and Duke Forest near Raleigh about the relationship of elevated carbon dioxide and tree growth were reported in the prestigious research journal, *Nature*, in May, 2001; top: young screech owl, © Ralph W. Scott.

2001

Forest Science in the South



Southern Research Station

USDA Forest Service
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March 2002

Caring for the Land and Serving People

FY01 Accomplishment Summary

October 2000 – September 2001

Research work units. 25

Publications. 667

Web sites (Research work units). 22

Web sites (other SRS). 7

Publication requests filled
- Hard copy. 21,000
- Electronic. 500,000

Site tours. 259

Presentations –
- To scientific societies. 166
- To lay organizations. 167
- To other science groups. 256

International activities. 58

Conservation Education Outreach Program contacts (2 teams). 4,027

Total employees. 442
- Scientists. 127

Budget (research funds only). ..... $ 42,098,000

Awards/Grants to States, universities, and other Federal agencies (all funds). $12,653,585

External funding received from non-Federal Sources and other Federal agencies. $2,703,878

Collaborating organizations. 108

Table of Contents

From the Director

The Southern Research Station (SRS) is part of USDA Forest Service Research and Development, which is the Nation's largest forestry research organization. We contribute to quality of life in the South by providing the knowledge and technology needed to sustain and enjoy the benefits of the region's forests and waterways. Forest Service scientists in the South have excelled in natural resource and socio-economic studies in temperate and tropical forest ecosystems – providing a wealth of long-term data sets and conclusions about those ecosystems and their products and services.

Working with partners at Federal laboratories, experimental forests, and universities, SRS scientists produce research results that are useful to forest landowners, commodity and industry associations, conservation groups, educators, legislative bodies, and managers of local, State, and Federal agencies. Our scientific workforce is divided into research work units that are headquartered at 19 locations throughout the South; we are responsible for forestland research, technology transfer, and inventory and monitoring for 13 Southern States. Our annual budget from Federal funds supports an extensive program, and provides for collaborative grants. We also receive some collaborative funding from other Federal and external sources.

This report highlights many accomplishments from this past fiscal year, October 2000 through September 2001 (FY01), and describes some of our current and emerging research priorities. In FY01, we began several new research efforts under the National Fire Plan. We completed the research and data collection for the Southern Forest Resource Assessment, which will set the framework for determining future priorities for research and development. The Assessment also sets the stage for public and private land managers to revise or develop management plans for the sustainability of forests throughout the South.

Among the recognition for our employees was the Chief of the Forest Service Honor Award for Distinguished Science awarded to Dr. H. Ken Cordell of Athens. He was recognized for his outstanding research and assessment contributions to the study of long-term trends in outdoor recreation and wilderness.

We encourage you to contact us with any questions you may have about the work we do.

Web site: http://www.srs.fs.fed.us

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PETER J. ROUSSOPOULOS
Director

Successes–

Our Major Accomplishments

2001

2001

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

Southern Pine Ecosystems

Studies of Prescribed Fire Impacts and Effectiveness Expanded

The Disturbance of Southern Pines Ecosystem RWU has added additional sites to the nationwide Fire and Fire Surrogate Study with funding from the National Fire Plan. The study is primarily funded by the Joint Fire Sciences Program to compare the effects of prescribed fire with mechanical and herbicide methods of fuel reduction. Data on the effects of the treatments on a full range of ecosystem components will be collected. Sites in four different southern ecosystems are included in the nationwide study — Florida (pine flatwoods), South Carolina (southeastern Piedmont), North Carolina (southern Appalachian), and Alabama (Coastal Plains longleaf pine).

The role of stand replacement fires in providing habitat for ridgetop pine communities in the Southern Appalachian Mountains has been examined by the Disturbance of Southern Pines RWU. Work completed this year shows that single fires of moderate intensity, or multiple low-intensity fires provide better regeneration of Table Mountain pine habitat than crown fires. Seedbed habitat becomes too dry after crown fires; viable seed are abundant in all trees over 10 years old throughout the year; mycorrhizal abundance can be reduced by soil heating. Existing stands of Table Mountain pine are uneven-aged, suggesting they became established through multiple low-intensity fires. A test of multiple low-intensity burns showed that more than 4 burns are necessary to eliminate hardwood and shrub sprouting and to reduce duff depth enough for seedlings to survive. This knowledge will allow a wider burning window and increase worker safety because severe weather conditions are not required for low-intensity fires. Public land managers throughout the southern Appalachians can use these results.

Southern Appalachian mixed forest

Scientists in Nacogdoches, TX conducted two years of field research to quantify the abundance and diversity of butterflies in the major forest types in eastern Texas under frequent and infrequent prescribed fire regimes. Butterfly census results were analyzed in relation to additional data on the abundance of flowers that provide nectar for food. Lepidoptera (butterflies and moths) are a significant group that play an important role in forested ecosystems; they are primary consumers of vegetation and serve as pollinators of many plant species. As prescribed fire is more widely used to restore and maintain natural ecosystems and to reduce wildfire risk, it is imperative to understand impacts on their habitat.

Bottomland hardwood forests in eastern Texas, which typically do not experience fire, supported a butterfly community of low diversity but relatively high abundance. The two pine-dominated communities supported a more diverse array of species, especially in longleaf pine forests. Overall

Diana fritillary butterfly on butterfly weed, Pisgah National Forest

abundance of butterflies was dependent on the fire regime. Forests subjected to frequent prescribed fire (2-3 times per decade) supported average butterfly abundances over two times as great as in similar forests subject to only infrequent prescribed fire. The abundance of butterflies was related to the abundance of nectar resources (flowers) present. Frequent prescribed fire reduced competing woody vegetation (shrubs and midstory trees) and allowed the development of an abundant and diverse herbaceous layer that produced an abundance of flowers.

The Threatened, Endangered, and Sensitive Species RWU has been investigating the pollination and breeding systems of rare plants, specifically White Birds-in-a-nest and Harper's Beauty. They have found that these two species have different reproductive strategies and different relationships to prescribed fire. Since prescribed fire is a common management tool in longleaf pine ecosystems, where these plants are found, it is important to understand fire's effects on their seed production and their animal pollinators, in order to maintain populations of these rare species. The information gained from this work will provide basic ecological information about both plants and insects, and can be used in planning the spatial extent and timing of prescribed fires. Informed fire planning is central to sustaining the diversity of life of fire-dependent longleaf pine communities. ▲

Prescribed burn near Pineville, Louisiana

Wildfire

Southern Pine Ecosystems

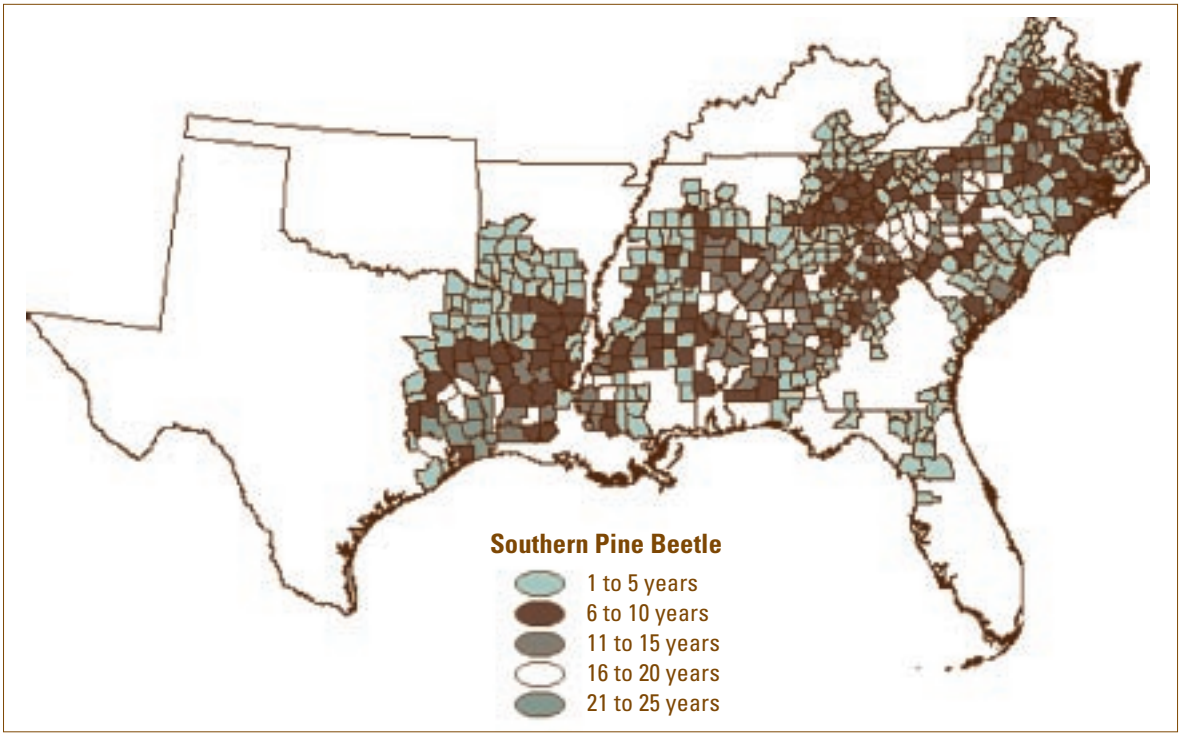
Understanding and Managing Bark Beetles

At epidemic levels, bark beetles pose serious threats to forest ecosystem health. Acting as invasive agents, bark beetles seriously affect the function and sustainability of forest ecosystems. The southern pine beetle (SPB) is the most destructive insect pest in southern forests. SPB, especially when considered with other bark beetles, causes great economic loss and disruption of resource management practices. A thorough, basic understanding of the biology and ecology of these important pests is necessary to improve control methods to protect individual trees and pine forests from bark beetles.

Research by the Bark Beetle and Invasive Insect RWU has revealed a series of complex interactions among trees, beetles, fungi, mites, parasitoids, and predators. SPB is greatly affected by the abundance of mites that ride from tree to tree on the beetles. The mites carry bluestain fungi which can reduce the ability of the beetles to feed and develop within pine bark.

This team of researchers at Pineville, LA has identified compounds that promise protection of trees from bark beetle attack. Research on the ability of bark beetles to locate host trees has led to the development of strategies to interfere with visual cues used by the beetles. Coating trees with white paint used in conjunction with naturally occurring tree defensive compounds helps protect trees from attack. A strategy using a large, dark profile trap has also shown promise in being able to "trap out" beetles from infestations. The RWU has also identified genetic lines of trees that appear to have a high level of defense against SPB and found that trees which have been subject to a nonfatal, simulated SPB attack are more resistant to a subsequent beetle attack. ▲

Southern pine beetles in flight (top). Southern pine beetle larvae in pine bark (middle). What we learned from the Southern Forest Resource Assessment: counties in outbreak status for southern pine beetle; a 40 year summary (bottom).



Southern Pine Ecosystems

Pine seedling

Regeneration of Pines

Regeneration is the bridge between the harvest of mature trees and the establishment of their successors. Successful and prompt regeneration is critical for sustaining timber production on forestlands. Planning and executing forestry practices that provide favorable conditions for natural or planted regeneration will facilitate success.

Scientists in the Upland Forest Ecosystems RWU monitored pine seed production in natural stands on the Crossett Experimental Forest in southern Arkansas. They summarized 20 years of monitoring seed crops of the commercially important loblolly and shortleaf pines. Pine seed crops were found to vary greatly, from bumper crops with over 1 million seeds per acre to complete failures. The finding that is important to land managers, however, was that there were never back-to-back failures. Even though poor seed crops occurred in 5 of the 20 years, ample seeds were produced during subsequent years to successfully regenerate stands. Knowledge of the year-to-year variation in seed production will help managers in planning for successful natural regeneration.

The Southern Institute of Forest Genetics led a committee to update the "Southern Pine Seed Sources" manual. Choosing the proper seed source is crucial for survival and subsequent growth of southern pines. The new guide is based on more recent analyses that include long-term results from seed source studies and progeny tests. These studies show continuous geographic variation in economic traits. Most importantly, performance is related to one parameter — matching the average yearly minimum temperature at the seed source to the planting site. The manual includes guidelines for seed source selection for loblolly, slash, longleaf, Virginia, shortleaf, and sand pines. Everyone who plants southern pines will benefit from the guidelines for seed source selection in this manual.

The late Dr. Richard Tinus, who was a plant physiologist with the Even-aged Southern Pine Ecosystems RWU, invented the "Beamflicker" greenhouse illuminating device to provide cost-efficient lighting for an entire greenhouse using a single stationary light fixture. The device is an oscillating parabolic mirror behind a sodium arc lamp that flicks beams of light from one end of a greenhouse to the other, providing intermittent light. Plants need light at night to maintain vegetative growth, prevent bud dormancy, induce flowering in long-day plants, and to prevent flowering in short-day plants. The Beamflicker meets those needs with one easily installed fixture at a lower cost than other systems. The patent for the Beamflicker was licensed to Hydrofarm, Inc., of Petaluma, CA in FY01. ▲

Pine nursery

Maintaining Red-cockaded Woodpecker Populations

The RWU at Clemson, SC has conducted research on the biology, ecology, and recovery of the endangered red-cockaded woodpecker for over 25 years. One aspect of that research included studies of the red-cockaded woodpeckers' interactions with other species in the community, particularly species that commonly uses their cavities and may negatively impact them. Research has shown that the southern flying squirrel is one of the most important cavity users (or kleptoparasites) and that removal of southern flying squirrels from red-cockaded woodpecker cluster sites during the breeding season can significantly increase reproductive success of the bird. Analysis shows important seasonal changes in the nest site selection of southern flying squirrels. Red-cockaded woodpecker cavities were only used from March through November and received their highest use during April – the beginning of red-cockaded woodpecker nesting season. These results suggest that if flying squirrel removal is deemed necessary, it should be concentrated from March through May. Using nest boxes to divert flying squirrels from red-cockaded woodpecker cavities may only be effective during fall, winter, and early spring. Optimal habitat for flying squirrels will have a high number of cavities and leaf nests so that varying seasonal requirements can be met.

Scientists in Nacogdoches, TX have determined that the presence of artificial cavities decreases red-cockaded woodpecker natural cavity excavation rates. Cavities are a rare resource because they take a long time to excavate and pines suitable for excavation are often in limited availability. In 1990, artificial cavity technology became available and artificial cavities were installed to augment the numbers of suitable cavities in woodpecker clusters where they were in short supply. Researchers compared cavity excavation rates during an 8-year period prior to the use of artificial cavities with an 8-year period when artificial cavities were provided in all active woodpecker clusters. New cavity excavation was significantly higher in longleaf pine habitat during the first 8 years when artificial cavities were not available than it was during the subsequent 8 years.

The Insects and Diseases RWU used automatic cameras to record adult red-cockaded woodpecker nest visits with food for nestlings. Diet of nestlings on or near an old-growth longleaf pine remnant in southern Georgia was compared to that in longleaf pine stands established on old farm fields in western South Carolina. Roaches were the most common arthropod fed to nestlings; other common prey were spiders, centipedes, and caterpillars, primarily coneworms. Research showed that old trees on relatively undisturbed sites provide the same prey as younger trees growing on old farm fields and the relative importance of the different prey was similar for both habitats. ▲

Red-cockaded woodpecker feeding young

Southern Pine Ecosystems

Other Significant Accomplishments

Conducted research that indicates that composite manufacturers will be able to produce high performance medium-density fiberboard from low quality and low cost materials.

Summarized 53 years of dynamics in the "Methods of Cut Study" in Arkansas showing that over time there is little difference in the productivity of even-aged and uneven-aged stands – a finding that will help landowners decide which cutting system best meets their management objectives.

Revitalized long-term databases by setting up new plots in young stands, which will enable tracking of effects of newer silvicultural practices during establishment and ensure that historical data is relevant to current practices.

Developed guidelines to help landowners make choices after damaging storms about whether trees should be cut and replaced by replanting, or left to grow to rotation age.

Determined that managers could detect stem sinuosity in the first 1-3 years after planting and should remove bent trees in the first thinning in order to eliminate reductions in the value of the stand.

Provided information to Mexico and Guatemala on southern pine beetle biology and management and gained knowledge about Mexican and Central American populations of southern pine beetles which may pose a threat to American forests or provide strategies for control.

Developed cooperative research project with The Biocomposites Center, Bangor, Wales to explore pressure-refining of loblolly pine.

Consulted on utilization of plantation timber for the Taiwan Forestry Bureau, Taipei, China.

Demonstrated feasibility of alternative logging methods in tropical areas by cost-benefit analysis of sustainable timber harvests.

Hosted Chinese scientists to share information and provide technology to improve conifer reforestation programs in China. ▲

James A. Miller received the "Maintaining and Enhancing the Nation's Natural Resources and Environment" USDA Secretary's Honor Award for leading research and outreach to further native plant conservation and nonnative plant management for sustaining regional biodiversity and productivity in the forests of the Southeastern United States.

William Boyer, emeritus scientist, received the Chief of the Forest Service Retiree Volunteer Service Award for research and management support for sustaining longleaf pine ecosystems.

John C. Moser, emeritus scientist, received the Chief of the Forest Service Retiree Volunteer Service Award for his continuing research and information dissemination in basic research in forest health and southern pine beetle biology and management.

Wetlands, Bottomlands, and Streams

Restoring the Savannah River Site

The Savannah River Swamp is a 3,020-hectare wetland located in the floodplain of the Savannah River on the U.S. Department of Energy (DOE) site near Aiken, SC. Ninety percent of the swamp was once covered with bottomland hardwoods.

In the early 1950s, nuclear reactors were built on the site, resulting in the almost total devastation of the wetlands. Water to supply reactor processes was pumped from the Savannah River, cycled through secondary heat exchangers, and discharged into streams that flowed into the swamp. From 1954 to 1988, water heated to over 150 degrees Fahrenheit ran into Pen Branch—one of the swamp's tributary streams—at rates 20 to 40 times higher than normal flow. This hot water overflowed stream banks, eroded the original stream corridor, and formed a new river delta where it deposited a deep layer of silt. Most of the vegetation along the river and portions of the floodplain died.

The pumping of heated water ended in the mid-1980s. Vegetation along the Pen Branch began to grow back, but almost no volunteer seedlings from the bottomland hardwoods could be found. The Center for Forested Wetlands RWU began working with the Savannah River Institute and the Savannah River Technology Center to find the best methods for reintroducing wetland tree species into the area. From 1993 to 1995, the Forest Service planted approximately 75 percent of the affected area in bottomland hardwoods that included overcup oak, swamp chestnut oak, nuttall oak, willow oak, cherry bark oak, water hickory, persimmon, green ash, sycamore, swamp black gum, water tupelo, and bald cypress. The remaining 25 percent of the land was kept unplanted for experimental purposes. Three site preparation approaches were used in relation to the differing conditions of the floodplain—no preparation, herbicides combined with burning, or herbicides alone.

South Carolina swamp

Wetlands, Bottomlands, and Streams

Predicting the effectiveness of different approaches within the first few years is essential to the success of restoration projects. The Center for Forested Wetlands RWU not only conducts experiments, but also develops the techniques needed to assess the effectiveness of restoration efforts. This involves extensive collaborative research in areas such as hydrology, soils, vegetation, carbon and nutrient cycling, and animal communities. For the Pen Branch project, the work has focused on exploring the linkages between wetlands and streams, and is designed to develop indicators to use in assessing the functions of restored wetlands.

In FY01, a special issue of *Ecological Engineering*, published in book format as *Restoration of a Severely Impacted Riparian Wetland System—The Pen Branch Project*, presented 16 interdisciplinary papers outlining the restoration ecology of the system. Evaluation and monitoring information reveal that Pen Branch—an area denuded of vegetation less than a decade ago—is currently functioning as a viable wetland. Information from Pen Branch has been used to develop a quantitative assessment method for evaluating the success of future wetland restoration. ▲

The Next Step – the Carolina Bays

Carolina bays—shallow natural depressions found along the Coastal Plain from Maryland to Florida—have been greatly altered by human activity, mostly draining and ditching for agricultural purposes. At one time, there were 194 Carolina bays within the 78,000-hectare Savannah River Institute (SRI). Ranging in size from 0.1 to 50 hectares, the bays have been estimated to contain one-third of the rare plant species found at SRI. Despite the ecological significance of the Carolina bays, few studies have been conducted on the restoration of these wetland areas.

Researchers from the Center for Forested Wetlands RWU, established a large-scale Carolina bay restoration experiment on the Savannah River site. Similar to the bottomland hardwood restoration project, the Carolina bay project will focus on ecosystem-level processes that occur as vegetation grows back and the system is restored. Different alternatives to restoration will be explored to determine how to best provide suitable habitat for key animal and plant species and communities. The results will not only further the restoration of the Carolina bays at SRI, but will provide needed information to other individuals and agencies interested in restoring these unique coastal ecosystems on their own lands. ▲

Carolina bay

Dances With Fishes

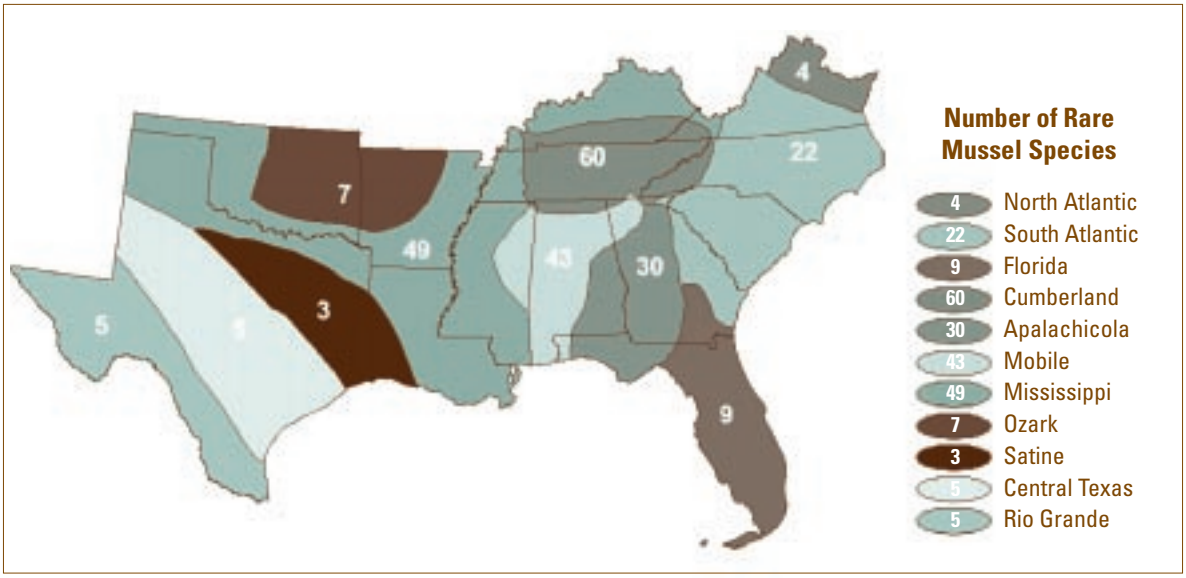
Scientists at the Center for Bottomland Hardwoods RWU's subunit in Oxford, MS, recently uncovered a previously unknown aspect of the reproductive cycle of two species of freshwater mussels. The research, published in 2001 in the prestigious journal *Animal Behavior*, describes a fascinating dance of survival between mussels and their fish hosts.

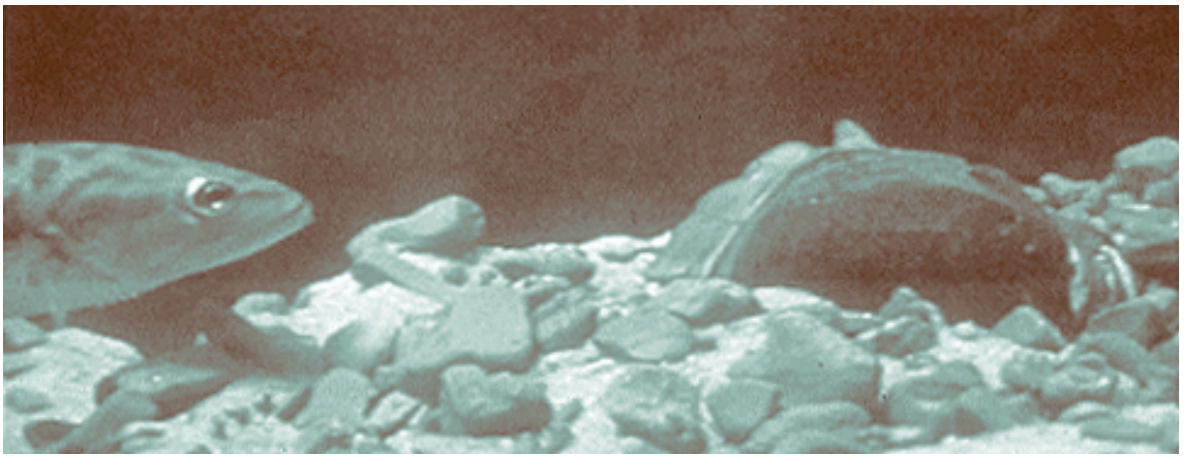
Native freshwater mussels in the southeastern United States are at risk—many species considered threatened, endangered, or sensitive—due to loss of habitat and invasions of exotic species. Some of the most important remaining populations of freshwater mussels occur in streams that drain from public and private forestlands. The reproductive cycles of mussels are complex, requiring the presence of a specific fish species which serves as host for the mussels' parasitic larvae. Understanding the reproduction cycles of native mussels is essential for developing effective management strategies for these imperiled animals.

Freshwater mussels vary widely in their choices for host fish. Some mussels are generalists—able to parasitize a wide variety of fishes—while others are specialists, tied to only a few closely related fish species. Two mussel species that occur on National Forests in Alabama and Tennessee—*Villosa nebulosa* and *V. vibex*—rely on bass and sunfish as hosts for their larvae. In the recent work, the researchers discovered that females of the two mussel species display "lures"—modifications of the mantle that resemble small fish or large worms—to attract the interest of fish. When a bass or sunfish attacks the phony prey item, the mussel releases a "cloud" of larvae that attach to the fish gills, forming cystlike "cocoons" in which shell and internal organs develop. After a few weeks, the larvae emerge from the cysts as tiny mussels that drop off and make their way to the bottom of the stream. Because bass and sunfish are the primary top predators in headwater streams inhabited by these mussels, few other fish species are enticed to attack the large prey items mimicked by the mussels. Thus, this strategy not only increases the chances of larvae encountering a bass or sunfish, but it also decreases the chances of larvae winding up on a nonsuitable host species. As a counterbalance to their complicated reproductive cycle, freshwater mussels tend to have long lives—decades to over a century in some cases.

The details of larvae transmission in freshwater mussels discovered this year by SRS researchers have important implications for managing the streams these mussels inhabit. Because larvae

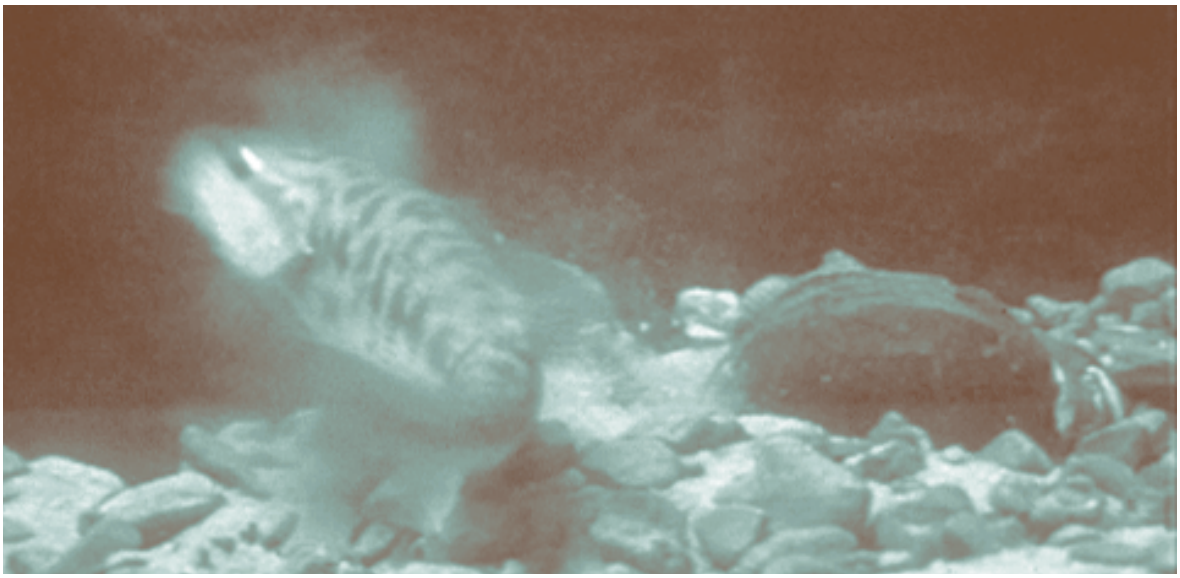
What we learned from the Southern Forest Assessment: Distribution of mussel species by aquatic fauna provinces





transmission depends on the host fish seeing the lures, disturbances in the stream that reduce visibility during the reproductive season could be a contributing factor to the decline of freshwater mussel populations observed across the country. Declines in populations of host fishes due to habitat disruption could also contribute to diminishing mussel populations. ▲

Host fish lured by mussel (top). Mussel displays "lures" to bring host fish closer (middle). Mussel releases a cloud of larvae that attach to fish gills (bottom).



Live oak

An Added Line of Defense Against Oak Wilt

Oak wilt, a disease caused by the fungus *Ceratocystis fagacaereum,* has damaged and killed live oaks (*Quercus virginiana* and *Q. fusiformis*), red oaks (*Q. Texana*) and other oak species in central Texas for over 30 years. The fungus infects the water-conducting vessels in the oak, producing a toxin that causes the tree to wilt and then die—often within a year after being infected. Austin, TX is the most heavily infected city in the United States; over 10,000 of the city's oaks have died over the last 20 years. This massive loss of oaks from public and private property has led to combined economic losses to the State of Texas exceeding $1 billion from increased utility bills, decreased property values, and reduced landscape aesthetics.

With funding and technical assistance from the USDA Forest Service, the State of Texas Forest Service maintains the Texas Oak Wilt Suppression Project (TOWSP). TOWSP coordinates the combined efforts of local government and private citizens to detect and control oak wilt infection. The project's goals are to educate the public, locate the disease, provide technical and cost-share assistance in eradicating the fungus, and monitor suppression treatments to control the spread of the fungus.

Oak wilt has been found in over 55 counties in central Texas and a growing number of counties in west Texas. The disease spreads through interconnected root systems at rates of up to 100 feet per year. To stop the advance of infection, cooperators in the oak wilt project have dug hundreds of miles of barrier trenches to sever root connections in advance of the fungus. Approximately 70 percent of the trenches have been successful in stopping the spread of encircled infection centers. Trench breakouts—infection spreading due to root grafting across trenches—occur in the remaining 30 percent of cases. Many of these occur within the first three years of trench installation due to improper placement or insufficient trench depth to sever preexisting root grafts. Other breakouts occur three or more years after trenches are installed and are due to the formation of new root grafts from roots severed by trenching.

Wetlands, Bottomlands, and Streams

Over the last seven years, researchers at the Center for Bottomland Hardwoods RWU in Stoneville, Mississippi, have conducted studies on the effectiveness of using different materials as inserts to prevent trench breakouts. Results indicate that trench inserts in general did not significantly improve trenches as barriers the first three years after installation. However, water permeable insert materials did significantly improve trench effectiveness three years after trenching and beyond.

Researchers found that water permeable inserts were more effective root barriers because they did not redirect root growth up or down the face of the trench inserts themselves. Impermeable materials, by redirecting root growth, actually promoted root graft connections and the transmission of oak wilt fungus across the trench. Permeable inserts could extend the effectiveness of trenches indefinitely, saving landowners with oak wilt on their property the expense of installing backup trenches when original trenches begin to fail. Inserts can also provide extra security in high-risk areas—such as in urban areas, rural parks, and homestead sites — where tree value is particularly high. If implemented by TOWSP, this improved cultural method for oak wilt suppression is expected to save hundreds of millions of dollars in tree removal costs and property value depreciations for Texas landowners alone. ▲

Prothonotary warbler

Artificial Nest Boxes for Prothonotary Warblers

The prothonotary warbler is the only species of wood warbler (Parulinae) in the eastern United States that regularly nests in the cavities of trees. While still relatively common in some areas, prothonotary warblers are declining over most of their range due to the loss of their preferred breeding habitat of swamps and bottomland hardwood forests. This loss of habitat is especially evident in the Lower Mississippi Valley, where nearly 80 percent of the original bottomland hardwood forests have disappeared. The warblers' winter roosts in the mangrove forests of the Neotropics have also been destroyed, leaving this once abundant songbird imperiled.

The Wildlife Habitat and Timber Resource Integration RWU collaborated with the Texas Parks and Wildlife Department to study the breeding ecology of the prothonotary warbler, and to determine whether artificial nesting boxes can provide a viable substitute for tree cavities during breeding season.

Texas Parks and Wildlife mounted four different types of nesting boxes. Two types of wood boxes, originally designed for wood ducks, were modified to include either vertical or horizontal interior lofts. These wood boxes were compared with smaller artificial cavities made from wax-covered milk cartons and plastic liter bottles. Researchers observed that the prothonotary warblers preferred the two smaller artificial nest boxes. Of the two, the plastic design proved more durable and required less maintenance. If the smaller artificial cavities were not available, the warblers preferred the wood boxes with vertically oriented nesting lofts. ▲

Mountain stream

Determining Safe Levels of Selenium in Water

Over 40 percent of waters assessed in the United States do not meet water quality standards. These impaired waters include approximately 300,000 miles of rivers and shorelines and approximately 5 million acres of lakes polluted mostly by sediments, excess nutrients, and harmful organisms.

Under the 1972 Clean Water Act, States are required to develop action plans to determine Total Maximum Daily Loads (TMDLs) on all impaired waters within their borders. The TMDL is a calculation of the maximum amount of a particular pollutant a body of water can receive from all point and nonpoint sources and still meet water quality standards. Although required by law, very few TMDLs have actually been developed. The U.S. Environmental Protection Agency recently requested the input of State and Federal biologists on procedures to identify and track materials that could have an adverse effect on aquatic life. The agency may soon require TMDLs on substances ranging from nutrients and sediments to pesticides and trace elements such as selenium.

Establishing a specific TMDL procedure for selenium is particularly important. Selenium accumulates in biological tissues, is known to cause reproductive impairment in fish and wildlife, and persists in the environment. Scientists at the Coldwater Streams and Trout Habitat RWU developed a TMDL procedure for selenium structured to answer two questions: 1) based on biological criteria, is selenium impairing the body of water under study, and 2) if so, how much must the selenium load be reduced to correct the problem? They constructed a seven-step procedure that links EPA's TMDL process to the contaminant-specific information required for selenium. The underlying principle for the process is to keep selenium concentrations below levels

that threaten the reproductive capacity of fish and aquatic birds. The resulting procedure can be applied to any aquatic habitat needing assessment or to any situation where TMDLs are adopted as a means of improving water quality. In addition to the USDA Forest Service, U.S. Fish and Wildlife Service, and U.S. Geological Survey, the procedure has been introduced to users in North America, South America, Europe, Asia, Africa, and Australia. ▲

Other Significant Accomplishments

Published GTR-SRS-038, The Coosawhatchie Bottomland Ecosystem Study: A Report on the Development of Reference Wetland– this report stemmed from the Ecosystem Management Initiative to provide forest managers with reference ecosystems as a basis for developing sustainable management strategies and effective ecosystem restoration.

Published the results of a study in willow oak that shows that the economic importance of minimizing the production of epicormic branches along the boles of high-value hardwood sawtimber trees.

Consulted with the Chinese Academy of Sciences, Nanjing Forestry University, and the Northeastern Forestry University, China to develop an international symposium on wetland ecology, management, and restoration.

Assisted in the evaluation of research capabilities and study sites in Vietnam and the Congo for possible installation of sites in CIFOR's (Center for International Forestry Research) Tropical Plantation Sustainability Program.

Hosted a visiting scientist from the National University of Mexico to develop collaborative research and training opportunities between Coweeta Hydrologic Lab and long-term ecological research programs and watershed scale studies in Mexico. ▲

Wendell Haag and **Melvin L. Warren, Jr.** received a Chief of the Forest Service award for outstanding contributions to the conservation of threatened, endangered, and sensitive species on the national forests and grasslands.

Emile Gardiner was named Outstanding Young Forester by the Mississippi Society of American Foresters, in recognition of contributions to the field of forestry in 2000.

Margaret S. Devall received the Forest Service Research Natural Area Monitoring Award for long-term commitment to monitoring species of interest and establishing and maintaining RNAs in the Southern Research Station.

DeSoto National Forest

Mountain and Highland Ecosystems

Long-Term Stream Response to Clearcut Cable Logging

Understanding how water, soil and other forest resources respond to management practices, natural disturbances, and atmospheric changes is the long-term mission of the Watershed Responses to Disturbance RWU at the Coweeta Hydrologic Laboratory, located near Franklin, NC. Coweeta, established in 1934, is one of 24 sites selected for the Long-Term Ecological Research (LTER) program funded by the National Science Foundation (NSF). Situated in the Nantahala Mountains, the site contains several distinct and carefully instrumented watersheds, providing a unique opportunity to study watershed ecosystem responses to a variety of disturbances over long periods of time.

Coweeta researchers published results from an interdisciplinary study of ecosystem response to clearcut cable logging. Two decades of research on this practice found little long-term effect on water, soil, and ecosystem sustainability and health. Though streamflow, stream nutrients, and sediment increased slightly in the first years after cutting, these variables returned to baseline conditions within the first decade. In the second decade, there were noticeable increases in both streamflow and levels of nitrogen in the stream, primarily in response to changes in vegetation dynamics and nutrient cycling processes. Researchers concluded that when best management practices (BMPs) for harvesting and logging road location and design are followed, clearcut cable logging has little impact on long-term watershed health and sustainability. ▲

Weir at Coweeta Hydrologic Lab

Forest Regeneration Under Varying Levels of Overstory Retention

The forests of the Cumberland Plateau region—an area that stretches northeast to southwest from Kentucky through the middle of Tennessee into northern Alabama—have been the site of accelerated timber harvesting by private and industrial landowners. Little research has been done to determine how these southern Appalachian forest systems respond to disturbance.

Bent Creek researchers with Mead Corporation managers

In late 2000, the Southern Appalachian Forests RWU began to study the effects of different harvesting regimes on forest regeneration and composition in the Cumberland Plateau area. For the study, researchers will remove various levels of the overstory and midstory levels of the forest to examine how various removal methods affect forest structure. Researchers will try to determine what effect these different regimes have on species composition, the regeneration of trees and other plants, and the development of remaining trees. The study will also examine how the different regimes affect habitat and food availability for bird and bat species.

The study site, located on property recently acquired by the Mead Corporation in Jackson County, AL, has been selectively harvested for over 60 years with little management planning. Mead recently received Sustainable Forest Initiative (SFI) certification; managers are committed to incorporating science into forest management practices and to identifying and documenting the biodiversity of their forests.

For this study, the status of individual trees and stands will be documented over time in response to the five different harvesting regimes. The study area is designed for use as a demonstration forest; plans for communicating findings and models to landowners in nearby northern Alabama and other Cumberland Plateau areas have been built into the study. ▲

Indiana Bats

The Indiana bat (*Myotis sodalis*) was one of the first bat species recognized as endangered by the U.S. Fish and Wildlife Service. Early efforts to recover the species focused on protecting hibernation caves, since 85 percent of the known populations hibernated in just nine caves in Kentucky, Indiana, and Missouri. Yet even when the entrances of blocked caves were reopened and disturbed caves gated, bat populations continued to decline—from approximately 590,000 individuals in 1980 to 350,000 in 1997. Biologists began to suspect that the decline might be linked to the loss of the summer maternity habitat where the young are born.

Although mating occurs in the fall, female Indiana bats do not become pregnant until after they emerge from migration in the spring. Soon after emergence, females migrate to their summer roost sites where they form maternity colonies of 20 to 100 members. Most maternity roosts are under the shedding bark of live or dead trees. In late June or early July, each female gives birth to a single young.

Prior to 1999, Indiana bat maternity roosts had only been found in the Midwest and the Northeast areas of the United States. In 1999, researchers from Tennessee Technological University (TTU) discovered a roost in a large eastern hemlock tree in the Nantahala National Forest in western North Carolina. This was also the first report of Indiana bats using conifers as maternity roosts; before the find, it was assumed that they only roosted in hardwoods.

Since 2000, researchers from TTU and the Threatened and Endangered Species RWU in Clemson, SC, have been studying the roosting behavior of Indiana bats in the southern Appalachians. In the summers of 2000 and 2001, they captured and radio-tagged several male and female Indiana bats in the Great Smoky Mountains National Park in eastern Tennessee. The adult females led them to two main maternity roosts, both in pine snags. The team also found five alternate roost trees, three of them in pine snags and two in red oak snags. The maternity roost found in 2000 had already fallen when checked in May 2001. Researchers suspect that the turnover of primary roost sites may be high, and that a steady supply of new roost trees must be available for Indiana bats to successfully reproduce.

Information gained from this ongoing research is important to the recovery of this species. Researchers will use the data they collect on the characteristics of individual roost trees and the landscapes surrounding the trees to develop models of suitable habitat and to predict other sites for maternity roosts. ▲

Trout and Debris

Trout are notoriously sensitive creatures, and have disappeared from some southern Appalachian streams for a variety of reasons—changes in stream temperature due to human activities, competition among species, and changes in water quality. Scientists at the Coldwater Streams and Trout Habitat RWU identify stream characteristics that limit the abundance of trout and other fish populations in the southern Appalachians. They have explored the relationship between the presence of large woody debris in a stream and the number and quality of trout the stream supports.

Over the last few years, researchers have experimented with adding large woody debris to restore trout populations and habitat in Wine Spring Creek in North Carolina. Like many watersheds in the southern Appalachians, the area around Wine Spring Creek was logged in the early 1900s. The stream was cleared as recently as 1976 of the fallen trees, logs, and stumps that shaped the water flow and provided habitat for trout.

Trout habitat improvement study stream

Data collection for trout habitat study

To understand more clearly the relationship between large woody debris and trout populations, researchers identified two 200-meter sections of Wine Spring Creek where rainbow trout (*Oncyrhynchus mykiss*) live, and a 100-meter section of a tributary where brook trout (*Salvelinus fontinalis*) live. In 1997, employees of the Nantahala National Forest used hand-held tools to add logs and large branches to the stream sections under study. All three sites included control sections where large woody debris was not added.

Over the last four years, the added debris has remained stable through floods without being artificially anchored to the streamsides. The habitat of the treated sections has become more complex as water diverted by debris has scoured out pools and small debris and gravel sediment have collected around the larger debris—increasing spawning sites for trout.

This is the only study conducted in the southern Appalachians to assess trout movement, growth, and population dynamics in response to large woody debris. The effect of adding debris on trout populations has proved difficult to determine, more subtle than simple changes in the number of fish or their size. Trout in Wine Spring Creek and its tributary grow more slowly and live longer than previously thought for streams in the region. Trout also move seasonally, some for distances of hundreds of meters. Further research is necessary before specific conclusions can be drawn; however, the study has demonstrated that "low-tech" methods are highly effective for restoring streams in environments too rugged—or ecosystems too delicate—for heavy equipment. ▲

Storm Damage Recovery

In June 1995, a catastrophic flood washed down the Staunton River, a second-level stream located on the eastern slope of the Blue Ridge Mountains in Virginia. The flow of debris scoured the streambed, depositing new materials, knocking out trees, and eliminating fish from a 1.9-kilometer stretch of the stream. Researchers in Blacksburg, VA saw the flood as an opportunity to study how native brook trout (*Salvelinus fontinalis*) respond to the severe disturbance of their habitat.

They used mark-recapture and radio telemetry techniques to track the movement of brook trout in disturbed and undisturbed sections of the Staunton River. They found that differences in trout activity in affected and unaffected areas were actually minimal when compared to the differences in activity from season to season. Population density appeared to limit fish growth for a short period of time: the researchers suspect this may help brook trout populations recover quickly from catastrophic events. Most of the affected habitat reverted to previous conditions just four years after the flood. This research demonstrates that immediate management actions such as stocking or habit modification may not always be necessary after major floods. ▲

Migratory Birds in the Southern Appalachians

The southern Appalachian region plays an important role in the survival of Neotropical migratory birds—species that nest in North America and winter in Mexico, Central America, or South America. Analyses from the last 35 years of breeding bird surveys indicate that many species of Neotropical migratory birds in the southern Appalachians are declining as fragmentation and urbanization accelerate on both breeding and nesting grounds.

Mountain and Highland Ecosystems

Researchers from the Wildlife Habitat and Timber Resource Integration RWU, are working with university scientists from Tennessee and North Carolina to explore how habitat modifications due to forest management affect bird communities.

To help understand how forest management affects migratory songbirds on a landscape-scale level, researchers counted birds by species at 1,177 sampling points during the period between 1997 and 1999. Located in two national forests in North Carolina and Tennessee, the study area consisted mostly of deciduous hardwood forest, though there were some sites located in dry, mixed pine-hardwood forests. Bird count numbers were correlated with vegetation data that included canopy height, tree density, and the percent of coverage from five vegetation layers that ranged from ground to canopy levels.

Neotropical migratory birds

Researchers found that the landscape effects of large-scale forest management played a relatively small part in explaining differences in the abundance of birds. Most species seemed to respond mostly to elevation, and to local habitat factors such as stand-level forest disturbance and the stage of restoration. For example, several birds (black-throated blue warbler, Acadian flycatcher, northern parula, and blue-headed vireo) were found more in areas with older forest, implying a negative effect of landscape disturbance. Red-eyed vireos, on the other hand, were related to landscapes with dense edges due to disturbance. Other species—including the chestnut-sided warbler, eastern towhee, rose-breasted grosbeak and indigo bunting—were associated with earlier stages of forest restoration where disturbance had occurred relatively recently. ▲

Recreation

Forest-based recreation adds greatly to the quality of life for southerners, both socially and economically. Southern forests provide the setting for an increasingly wide range of recreational activities, most taking place on relatively small areas of public land. Only 4.6 percent of Federal land and 12 percent of State park and forestlands are in the South, and only 7 percent of privately owned land is accessible to the public. Recreation pressures on public land in the South are high and expected to increase: population in the South—already home to a third of the nation's population—is growing at a faster rate than in the rest of the country.

The Recreation, Urban Forests and Human Dimensions RWU develops effective approaches, data, and delivery systems for tracking population, demographic, land development, and resource demand changes. Basic research on the theoretical and conceptual basis of human values, preferences, and recreation behavior is complemented by applied, site-based research to identify the factors that affect recreation behavior on public land.

The RWU completed surveys for the 2000 National Survey on Recreation and the Environment (NSRE), the continuation of

the ongoing National Recreation Survey (NRS) series begun in 1960. Although similar to the previous six NRS surveys, NSRE 2000 explores more extensively the outdoor recreational needs and environmental interests of the American public. New survey questions target activities, opinions, attitudes, and plans for private public lands. The results provide broader descriptions of who people are, what they believe about recreation and the environment, and what they are doing for recreation. The survey continues to evolve as new needs arise. Results from the NSRE are slated for publication in book form in early 2002, with current summaries and updates available online at the Southern Research Station website at http://www.srs.fs.fed.us/trends.

In July 2001, the RWU started a new project to identify the effects of rapidly expanding urban populations on urban forests and the wildland-urban interfaces of the South. Research areas include the economic benefits of trees in suburban settings, the economic benefits of converting abandoned railways to recreation corridors, and comparisons of urban and nonurban recreation preferences and values.

Researchers are also using data from the NSRE to examine interactions between forest management and nearby rural communities, especially minority communities and communities in the wildland-urban interface. Studies are underway to explore the role wilderness resources play in the quality of life in southern rural communities, to estimate recreation in national forests by minorities and underserved populations, to evaluate the effects of wildfire on recreational use, and to compare perceptions and recreational uses of various subpopulations of national forest visitors.

Natural water slide

Since 1994, researchers have completed a number of studies on the economic effects of outdoor recreation activities on communities located near public lands. New methods for estimating economic impacts have been developed, and have become part of standard practice in evaluating the relationship between recreation and rural economics. Related research has improved understanding of the dependence of rural communities on nature-based tourism and how rural economic growth is directly enhanced by natural resources. Sites researched have included white-water rafting venues, wildlands and coastal sites in Florida and South Carolina, and mountain biking sites in the Appalachians. Findings from recent site-based studies include:

- Mountain biking and guided whitewater rafting are among the most highly valued outdoor pursuits in the U.S.

Backpacking in North Carolina

- Race and gender influence the demand for wildland recreation trips.
- User fees can influence the number of visits made members of some ethnic groups.
- The economic values for many outdoor recreation activities are increasing faster than the rate of inflation.
- Most Americans support user fees for public land.

Footprints on the Land: Demographic Trends and the Future of Natural Resources in the United States, published in 2001, presents the results of a national assessment the RWU conducted to identify where the greatest impacts from demographic change are likely to occur over the next decade. The book represents the first time these trends have been interpreted in relation to forest and natural resources management.

Included in the book are chapters on natural lands and the America mindset, trends in population and urban growth, changes in the social composition and economic trends in the United States, rural communities in transition, and trends in leisure and outdoor recreation. The book identifies "hotspots"—wildland areas pressured by rising population, urbanization, and increased demand for recreation—to provide information for developing the strategies needed for sustaining increasingly scarce natural lands. ▲

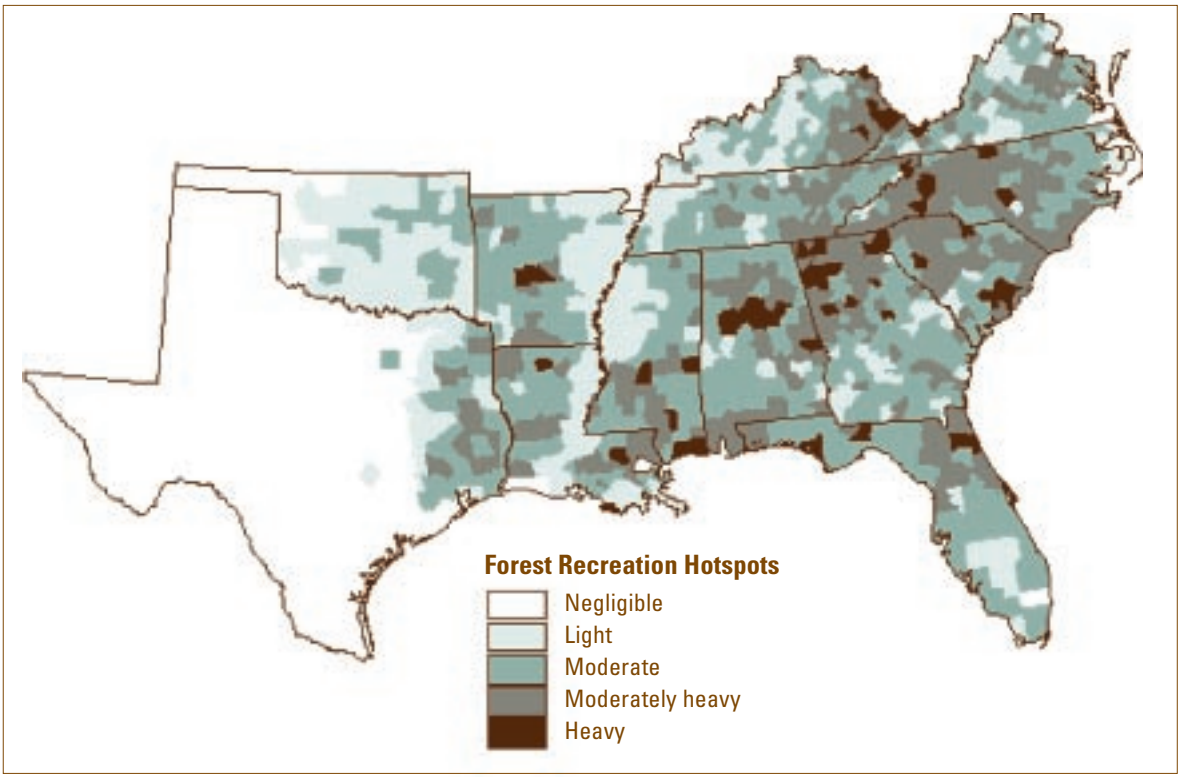
Other Significant Accomplishments

Established a southern Appalachian study area as part of a nationwide interdisciplinary study to assess the impacts of fuel reduction techniques such as prescribed fire and mechanical thinning on breeding birds, reptiles, and small mammals.

Continued a cooperative study with the University of Florida on the production of fleshy fruit and hard mast in five types of habitat on the DOE-operated site near the Savannah River in South Carolina.

Published the results of a study on the response of small mammals, reptiles, and amphibians to forest canopy gaps cared by wind and other natural disturbances.

What we learned from the Southern Forest Resource Assessment: Hotspots of recreation demand pressure on forests, 2000



Mountain and Highland Ecosystems

National forest urban interface

Worked with a wide range of agencies to identify the ecoregions of North Carolina based on a system that combines the terrestrial and aquatic schemes; produced a draft map of 27 distinct ecoregions within North Carolina.

Presented the "NED" Decision Support Process to a group of French forest managers and researchers.

Consulted with Jewish National Fund to develop a tree improvement strategy for the country of Israel.

Collaborated with the Institute of Ecology, Xalapa, Mexico, on plant ecology studies.

Hosted a visiting scientist from the National University of Mexico to develop collaborative research and training opportunities between Coweeta Hydrologic Lab and long-term ecological research programs and watershed scale studies in Mexico.

Consulted on utilization of plantation timber for the Taiwan Forestry Bureau, Taipei, China.

Continued research in Costa Rica to improve protected area buffer zone management by analyzing results of a landowner survey.

Demonstrated feasibility of alternative logging methods in tropical areas by cost-benefit analysis of sustainable timber harvests. ▲

H. Ken Cordell was the recipient of the 2001 Chief of the Forest Service Honor Award for Distinguished Science. He was recognized for his outstanding research and assessment contributions to the study of long-term trends in outdoor recreation and wilderness.

Wayne Swank, emeritus scientist, has been designated as SAF Fellow by the Society of American Foresters (SAF) in recognition for outstanding service to forestry and SAF.

Large-Scale Assessment and Modeling

Southern Forest Resource Assessment

The draft report of the Southern Forest Resource Assessment was completed. The Assessment was initiated in May 1999 to examine the status, trends, and potential future of southern forests and their various benefits. The SRS and Southern Region of the USDA Forest Service led the effort in cooperation with the U.S. Fish and Wildlife Service, Environmental Protection Agency, Tennessee Valley Authority, and Southern States represented by their forestry and fish and wildlife agencies. The intent was to develop a thorough description of forest conditions and trends in the South to help the public understand complex natural resource management topics. The Assessment addresses topics regarding the sustainability of southern forests in light of increasing urbanization and timber harvests, changing technologies such as chip mills, forest pests, climatic changes, and other factors that influence the region's forests.

The co-leader of the project was David Wear, Project Leader of the Economics of Forest Resources RWU in Research Triangle Park, NC. The Economics RWU scientists contributed several technical analyses in support of the Assessment. They examined historical data on land use, forecast where and how land use could change in the future, and analyzed the direct contribution of forests to local economies in terms of jobs and income returned from timber management and recreational activities. They 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.

The findings of the Assessment have led to some broad observations about the status and future of southern forests:

- Urbanization presents a substantial threat to the extent, condition, and health of forests.
- Total forest area will remain stable, but subregional and compositional changes will continue.
- Timber production is forecast to expand but will not deplete forest inventories below current levels.
- Investment in pine plantations is forecast to expand to meet increased softwood demand; this has implications for the ecological characteristics of southern forests.
- Changing land use and harvest patterns will have important impacts on people.

The recreational use of forests was an important component of the draft report of the Southern Forest Resource Assessment. Findings from the National Survey on Recreation and the Environment provided needed information about the values people hold for forest resources. In rating a group of 12 forest values, subjects from the general public gave the highest rankings to

Kayaking in Georgia

Bank fishing

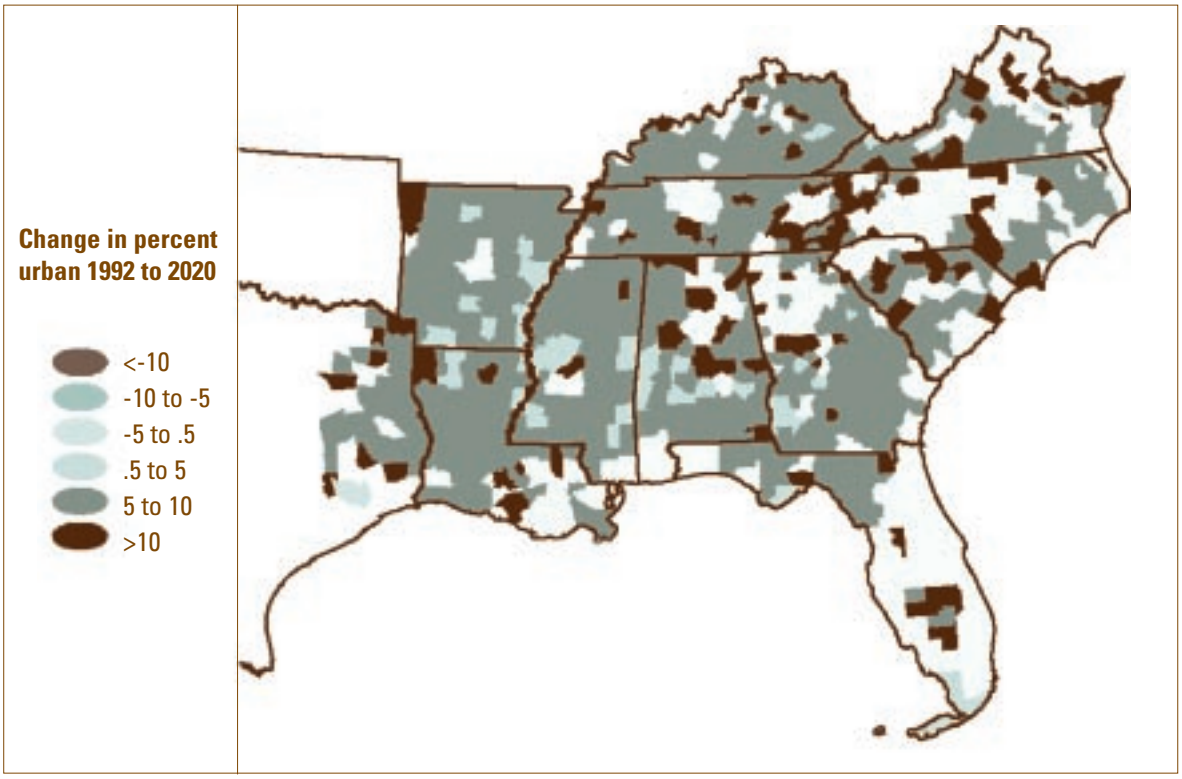
clean air and water and protecting habitat, and the lowest rankings to timber management for commodity purposes. In terms of attitude, 80 percent agreed that "the earth is fragile and humans are upsetting the balance." These findings have definite implications for how decisions will be made for managing relatively scarce public land resources in the South.

The Assessment was released on Web site http://www.srs.fs.fed.us/sustain/ in November 2001, with a public comment period ending at the beginning of February, 2002. The final reports are expected to be printed later in 2002. ▲

Understanding the Relationship Between Soil Components and Carbon Sequestration

Experiments conducted at two sites in central North Carolina, one at Duke Forest near Raleigh and one at the USDA Forest Service's Southeast Tree Research and Education Site in Scotland County, NC, indicate that elevated levels of atmospheric carbon dioxide may have more limited effect on forest growth than previously expected. While many short-term studies have shown atmospheric carbon dioxide (a "greenhouse" gas) increases tree growth, the experiments, which were discussed in an article in the May 24 research journal *Nature*, showed that without additional nutrients, initial growth increases of mature loblolly pine trees leveled off after the first three years of exposure. In addition to nutrient limitations, growth responses were also sensitive to the availability of soil moisture. The presence of elevated levels of carbon dioxide alone, which is occurring due to global industrialization and land use changes, may not result in a long-term increase in the rate of tree growth. However, the results also suggest that

What we learned from the Southern Forest Resource Assessment: Forecast change in share of land that is urban for counties in the South, 1992 to 2020



forest fertilization, already a practice in southern pine plantations, might become even more beneficial in a high carbon dioxide world.

The study is part of the effort to understand the relationship between forests that often are limited to sites with low nutrient soils, and carbon sequestration, in order to estimate current and future global carbon budgets. Researchers from the Biological Foundations of Sustainability RWU and the Southern Global Change Program are working on the cooperative study. They determined that along a gradient of decreasing site fertility, nutrient amendments (nitrogen) would become increasingly necessary if forested ecosystems are to help reduce the rate at which atmospheric carbon dioxide concentrations increase. The study was collaboratively funded by the USDA Forest Service; the U.S. Department of Energy Office of Health and Environmental Research; the National Institute for Global Environmental Change, Southeast Regional Center at the University of Alabama; and the National Science Foundation's Multi-User Instrument Program.

The Forest Operations RWU is working to develop a better understanding of the effect of forest operations systems on the ecological processes of forest ecosystems. One study investigated the potential for enhancing soil carbon storage by mechanically mulching woody debris and stirring it into the upper soil layer. Incorporation of the shredded wood led to a larger amount of carbon held in the soil. This suggests that the development of new tools to efficiently mulch forest debris could be beneficial in addressing greenhouse gases.

The results of this research will be used to improve management of forests. Through a better understanding of preexisting soil properties and the expected impacts of forest operations, managers will be able to develop treatments that are best suited for a particular forest site. In addition, new technologies in site preparation and carbon sequestration may be able to effectively improve forest soil condition and enhance ecological benefits from forest management. ▲

Southern High-Resolution Modeling Consortium (SHRMC)

Significant new funding under the National Fire Plan was provided to the Disturbance of Southern Pine Ecosystems RWU in Athens, GA to initiate a modeling consortium to develop smoke models and air quality models that require high-resolution weather data and predictive weather models using such data. It is one of four Forest Service high-resolution modeling consortia being established nationwide to provide national forests, State forestry agencies, air quality regulators, and researchers with products derived from high-resolution forecast weather data. The four consortia will collaborate to share products that have national application. Most effort during FY01 was directed to the start-up of SHRMC, including forming partnerships with other agencies to develop products that meet their needs. Researchers are attempting to provide high-resolution forecast weather data on the Internet to users of the models. Key accomplishments are: 1) establishing a cooperative agreement with the Department of Geography, University of Georgia, to develop modeling capability and develop new models using the data, as well as transfer this technology to users; 2) installing a NOAA port satellite downlink for the high resolution weather data; 3) designing and purchasing components to assemble two super computers to run SHRMC programs.

SHRMC will make available data and models for predicting fire weather, fire severity, smoke movement, air quality, and other products as users specify needs. The models will be useful for long-range fire resource allocations, air quality regulations, and decreasing the hazards from smoke reducing visibility on roadways, which will be valuable for improving public health and safety. Cooperators identified to date include the University of Georgia, the Southern Region of the USDA Forest Service, Georgia Forestry Commission, Georgia Department of Transportation, Environmental Protection Agency, and the modeling consortia in other research stations. ▲

Large-Scale Assessment and Modeling

Other Significant Accomplishments

Improved the decision-support tool LEEMATH (Landscape Evaluation of Effects of Management Activities on Timber and Habitat) by incorporating state-of-the-art knowledge into models and databases. LEEMATH permits timely evaluation of effects of alternative forest management strategies on both timber production and wildlife habitat quality at large spatial scales.

Identified important differences in the valuations that result from using different contemporary survey techniques, and examined how people place value on combinations of various resource qualities contained in a forest.

Developed a National Integrated Environmental Modeling Project (NIEMP) with the northern and western Forest Service Global Change programs to better collaborate research methods and findings across the nation.

Developed a process-based forest soil carbon model and successfully validated it in boreal and subtropical soils.

Invited by Inner Mongolia Forestry Academy, People's Republic of China, to visit the arid grassland in the Mongolia steppes and discuss local land degradation and desertification issues; presented seminars on global change and watershed management. ▲

The "Operating an Efficient, Effective, and Discrimination-Free Organization" USDA Secretary's Honor Award was received by the Climate Change Negotiations Analytic Support Team, Office of the Chief Economist; **Hermann Gucinski**, was one of the Forest Service members of the group.

Inventory and Monitoring

Forest Inventory and Analysis

The Forest Service has collected data for the Forest Inventory and Analysis (FIA)—the census of the Nation's forests—for over 70 years. An invaluable source of consistent, long-term information on forestland, FIA relies on numerous partners at the national, State and private levels. Over the last few years, the Forest Service has reoriented the FIA program by implementing annual inventories and by expanding the scope of the inventory itself. FIA has traditionally collected information on forest area and location: the species and size of trees, total tree growth, health and mortality, wood production and use rates, and forest landownership. The enhancements include data on tree crown condition, lichen community composition, soil, coarse woody debris, understory vegetation, and ozone indicator plants. Previously, the Forest Health Monitoring (FHM) program took these measurements; all FHM plot measurements have now been integrated into the FIA survey.

Measuring individual trees on forest plot

Recording plot information

FIA is the only program providing long-term forest resource data on both public and private lands. The inventory includes information on how much forested land exists, whether forest areas are increasing or decreasing, what species a forest includes and how this is changing, how quickly trees are growing and dying, and how the forest ecosystem is changing in terms of soil and vegetation. Users of this information include policymakers, land managers, researchers, constituency groups, and the general public. Historically, FIA conducted periodic inventories—usually ranging from eight to 12 years—for each of the States. With the passage of the Agricultural Research, Extension, and Educational Reform Act of 1998, annual inventories became the norm for the entire FIA program.

FIA data are collected in three phases. First, and is classified as forest or nonforest and spatial measurements are taken of urbanization and fragmentation. Aerial photography traditionally provided the data for this phase; research continues on the use of satellite imagery to replace the use of aerial photos. In phase two, locations for field sampling are selected, with one FIA plot chosen for every 6,000 acres. Field crews collect a variety of data from these sample

Inventory and Monitoring

locations. Federal funding provides resources for 15 percent of the remeasurement, with participating State Foresters adding resources to bring the rate up to 20 percent annually. For phase three, a subset of phase two plots (approximately 1 for every 96,000 acres) are sampled during the growing season to provide the additional data needed for the enhanced survey, and then at 20 percent annually.

The FIA program applies a consistent sampling method across the entire nation; the southern FIA covers 13 Southern States, as well as Puerto Rico and the U.S. Virgin Islands. The area includes 213 million acres of forest that shelters wildlife, ensures water quality, and provides recreational and economic benefits to the region. By the end of FY01, the FIA program had established annual surveys for 10 states (AL, AR, FL, GA, KY, LA, SC, VA, TN, and TX), and had collected phase three data in Puerto Rico. In 2001, cooperative agreements with the Southern States to implement annual inventories totaled $4.3 million with over 8,300 plots measured during the year.

FIA data are used to assess resource sustainability by forest industry, State forestry agencies, consultants, and other Forest Service units. In the last year, FIA scientists also led or provided support to numerous other ongoing efforts, including the Southern Forest Resource Assessment (SFRA). During FY01, the southern FIA program also completed the National Timber Products Output (TPO) Report for the nationally mandated Resources Planning Act (RPA) 2003 database. The program also published comprehensive analyses of the forest resources of Texas, Oklahoma and Mississippi. In addition, the first compilation of annual inventory data for Georgia was made available to the public on the SRS Web site.

Southern FIA scientists continued to develop techniques to more fully implement the annual forest inventory system. They completed research on using remote sensing to assess forest damage from catastrophic events. First used after the Mississippi ice storm of 1994, the two-step sampling method allows scientists to quickly assess forest damage. Researchers fly over the area, recording imagery on a video camera. Global Positioning System coordinates are encoded onto the video images during flight and used to map out zones of similar forest damage using a Geographic Information System. Then researchers link the damage zone data to the latest FIA inventory data to estimate resource damage. The FIA airborne video system—easy to transport and install—provides a way to quickly assess forest damage when there is a need for rapid response.

FIA scientists also developed tree crown diameter models from the FIA database to provide a framework for classifying forest area based on satellite data. Cooperating scientists from the U.S. Geological Survey and other Forest Service FIA programs used the data from the models to create a new generation of forest area classifications.

Collecting forest inventory data

Inventory and Monitoring

Forest Health Monitoring Program

The national Forest Health Monitoring (FHM) program was designed to monitor, assess, and report on long-term trends in forest ecosystems. FHM analyzes data from a range of sources for a variety of forest ecosystem indicators. FHM also researches and evaluates new methods to collect and interpret data and to facilitate assessment on specific regional issues such as air pollution, exotic pests, and tree decline.

The FHM program conducts research to improve forest health monitoring methods and technologies. In FY01, the FHM RWU located in Research Triangle Park, North Carolina, focused on developing new indicators, monitoring systems, and analytical techniques for the health monitoring of urban forests and riparian areas. Specific projects included:

- research on street trees and nature reserves in urban areas,
- a revision of the ozone biomonitoring national system,
- a national analysis of forest fragmentation,
- indicators of biodiversity and national health for the 2003 Sustainability Report, and
- the review of soil carbon monitoring.

The RWU researched new indicators (salamanders, earthworms, and tree crown closure), developed methods to detect regional "hotspots," and constructed a systems model for FIA phase two and three indicators.

Until recently, FHM collected measurement data from different plots than those set up for the Forest Inventory Assessment (FIA) program. Over the last decade, the two programs have worked together to integrate their methods and plot locations. In 2000, FIA took on full responsibility for taking FHM plot measurements, freeing FHM to focus on research, evaluation, and assessment topics. By the end of 2001, FIA and FHM detection monitoring programs at SRS were almost fully integrated. The integrated programs will continue to provide essential information on forest ecosystems over the next decades of certain change due to increasing carbon dioxide concentrations, changing climate, and extreme weather events. ▲

Other Significant Accomplishments

New methods have been developed to provide a way to directly measure timber supply effects from FIA surveys, which will enhance the usefulness of these surveys as we move from periodic to continuous sampling methods.

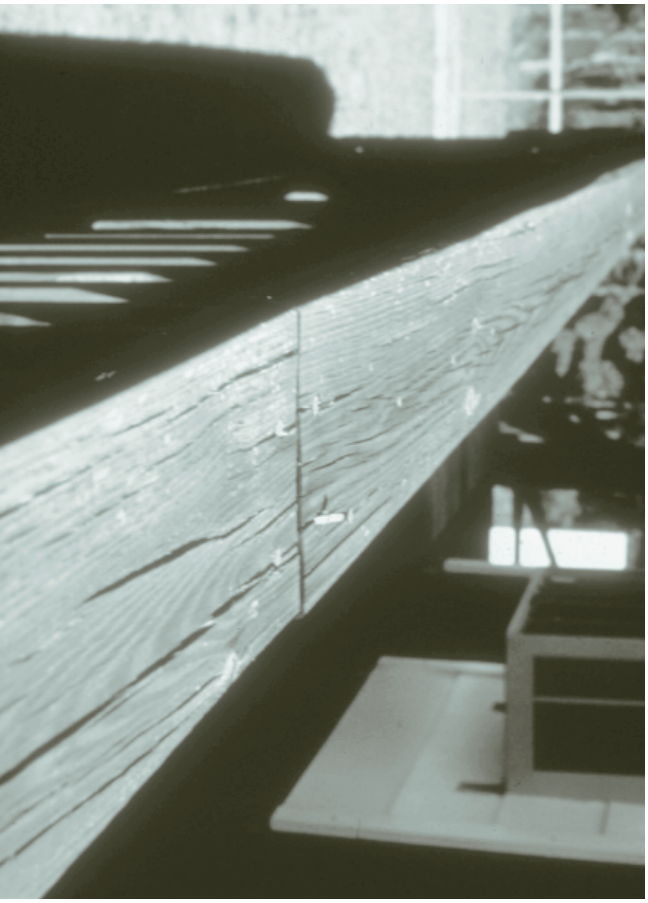
Presented information about scientific methods for global monitoring criterion and indicators of forest sustainability to the International Environmetrics Society.

Collaborated with the Food and Agricultural Organization and Mexico to determine that the SRS modeling process was effective for land cover classification in areas with persistent cloud cover, such as the tropics. ▲

Greg Reams was recognized as part of a group with a Forest Service FIA (Forest Inventory and Analysis) Director's Award for outstanding outreach and technology transfer through conception and implementation of the Annual FIA Science Symposium Series.

The **Southern Group of State Foresters** was recognized with a Forest Service FIA Director's Award for Excellence for their active support and partnership in helping the Southern FIA program transition to an annualized inventory approach.

Foundation Programs



CCA-treated deck materials

Recycling and Reusing Wood Products

Research continues to evaluate repaired pallets, to find ways to make high valued products from discarded wood, and to determine the status of wood pallet disposal and recovery at landfills throughout the United States. Surveys found a decrease in the number of pallets entering landfills from 1995 and 1998. These results indicate that previous efforts on pallet repair research are being heavily used by the pallet recovery and reuse industry. A major paper was published on the strength properties of used pallet parts. This information allows designing pallets for specific uses when using recovered parts.

Pallet recovery continues to increase, which results in saving trees by reducing the need for new wood. It also leads to a decrease in disposal of pallets in landfills. A business plan model and economic evaluator was developed that encourages recycling of used pallets and fosters

Discarded pallets

high value uses of well-used pallets; previously, such pallets would have ended up in landfills.

Estimates are that nearly 60 percent of southern pine lumber receives some type of preservative treatment, with creosote, chromated copper arsenate (CCA), or penta. These treatments improve the durability of wood and greatly extend its service life. They also create a disposal challenge at the end of the product life cycle. Because preservative treatments may be formulated with hazardous chemical compounds to resist the decay induced by the environment, they are not acceptable for landfill disposal. The presence of harsh chemicals in the wood also precludes its use in conventional recycling systems.

Scientists at Blacksburg, VA and Pineville, LA are addressing these issues. Research efforts on the potential recovery and reuse of discarded treated (CCA) wood products, like old wood decking materials attached to residential homes, have been completed and a comprehensive report has been published. Studies are in progress to look at potential solid-wood uses for recovered CCA-treated lumber.

Repaired pallets

The research effort has resulted in the development of a novel method for the removal of the heavy metal component (copper, chromium, arsenic) from spent CCA-treated wood. The CCA-treated wood was first converted into liquid through a chemical reaction. The liquefied wood was then diluted with water to result in a solution that was easy to process. More than 90 percent of the hazardous components were then removed by precipitation with selected agents. The remaining liquefied wood solution was then concentrated and used as a raw material to produce polymer products. Development of the patent application for the process to remove the CCA components is progressing. ▲

Providing Economic and Tax Information to Forestland Managers and Owners

The pattern and structure of forestland ownership and management has been changing rapidly in the South. Institutional timberland investments by pension funds, insurance companies and others have increased rapidly since the 1980's. In general, most institutional timberland investments are placed and managed through timberland investment management organizations (TIMOs). At the same time, there has been a strong call for the realization of the monetary value of the industrial timberland holdings.

Research by the Legal, Tax, and Economic Influences RWU found that the long-term growth of institutional timberland investments depends on the ability of TIMOs to deal effectively with securitization, leveraging, arbitraging, supply contracting, portfolio

Bald cypress swamp in Mississippi

Log loader timber harvesting

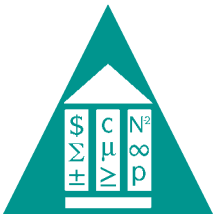
insurance, tax efficiency enhancement, and other issues. The study examined the alternatives and found that financial engineering holds great promise for many of these issues. The techniques can improve the incentives of the TIMOs to effectively manage their lands at a reduced risk, and provide forest products companies the ability to meet their needs for raw materials.

Another study considered the value of forest products companies holding timberland in the context of the overall manufacturing operations of the forest products industry. Scientists examined the nature of capital investments in the forest products industry. The industry has cyclical prices, requires large amounts of capital, and its assets can only produce one type of product (asset specificity). A model assessed the effect of holding timberland on various operating decisions facing the company and showed that holding timberland can enhance the ability of companies to make decisions that can result in financial success in the long term.

Both studies provide valuable research on changing institutional patterns impacting the ownership and management of forests both in the South and across the nation. An economic examination of changing institutional ownership patterns will help ensure that there is an economic basis for long-term, sustainable forest management and economic production.

The Forest Landowners Guide to the Federal Income Tax, Agriculture Handbook 718, is the latest in a series of handbooks describing the provisions of the Federal income tax that affect nonindustrial private forests. It updates the previous handbook for tax legislation passed and administrative changes promulgated through the year 2000. In addition, it contains substantial additional information on depreciation and the Section 179 deduction, like-kind exchanges, the alternative minimum tax for individuals, and sources of tax assistance.

The handbook is recognized as the single most comprehensive source of information on the Federal income tax available to nonindustrial forest owners, and to the forestry, tax, and legal professionals who serve them. It is the principal reference for forest taxation workshops provided throughout the United States by the Forest Service's "Tax Team." During FY01, over 800 forest owners and forestry, tax, and legal professionals attended workshops given by Tax Team members. ▲



Incorporating Economics and Environmental Law into Forest Management and Investment Decisions

The paper "Characterizing the Sustainable Forestry Issue Network in the United States" was published in the journal *Forest Policy and Economics*. New information from the research for this paper indicates that policy research tools incorporating Delphi methodology can produce meaningful results in an area where Delphi had not been previously utilized. While a highly diverse set of participants (including Federal government entities, State government entities, forestry and environmental interest groups, academia, and others) engaged in debating the merits of sustainable forest management (SFM), no single stakeholder group dominated the debate. These debates are not expected to result in new public sector policies, although the USDA Forest Service, several State forestry agencies, forest industry, and academia, are projected to change internal policies and procedures to reflect sustainable forest management concerns.

Practical applications of this new knowledge are primary methodological. For example, a similar approach is being utilized to prepare a chapter of the 2003 National Report on Sustainable Forest Management. Accordingly, while the primary benefits of this work will be to policy and other social science researchers as it provides an additional methodological tool, interest group leaders and other interested members of the public will benefit from a clearer understanding of the current state of politics associated with the issue of SFM.

The paper that shows that while sustainable forest management concepts originated through United Nations sponsored programs in the developing world, the main factors motivating stakeholder participation in the United States are dissatisfaction with past practices, societal interest in the environment, and desire to sustain forests. These findings strongly suggest that SFM has been absorbed into the broader debate over the desired management of forests and is therefore not a transitory issue. ▲

Other Significant Accomplishments

Researched developing digital camera technology to quickly, accurately, and nondestructively determine tree volumes and values, and potential products.

Determined that monetary exchange rates are important determinants of southern wood exports.

Completed a long-term study of alternative erosion control treatments which showed that erosion matting, native grass species, or exotic species were similarly effective in reducing sediment yield.

Organized an Internet workshop on exotic pest movement through trade in wood products and solid wood packing materials: http://www.exoticpests.apsnet.org/

Planned studies to investigate native termites to provide critical data to assess the impact of the Formosan Subterranean Termite on southern forests.

Developed tools to aid in controlling and managing nonnative invasive plant species.

Contributed to the registration and use of termite control products.

Compared reduced-impact and conventional logging methods in the eastern Amazon; results indicated that reduced-impact operations generate competitive or even superior returns when compared with conventional logging approaches.

Gave 3 invited presentations to international audiences in Argentina and France on the impacts of forest herbicides on soil, water, wildlife, forest, and aquatic ecosystems.

Presented a paper about USDA termiticide tests to the Second International Symposium on *Coptotermes formosanus*.

Helped organize an international three-week long Internet workshop on exotic pest movement through trade in wood products and solid wood packing materials. ▲

What's Ahead–

Emerging Research Priorities

2001

Emerging Research Priorities

Knowledge Gaps from the Southern Forest Resource Assessment

Available information used in developing the Southern Forest Resource Assessment has allowed identification of several emerging issues about the sustainability of southern forests, but additional information is needed to refine understanding and more clearly identify problems and solutions. Each chapter in the Technical Report identifies key uncertainties in specific topic areas. The following are some key issues that cut across the various topic areas:

• **Expanding populations and impacts on ecosystems**. More heavily populated rural and urban landscapes will impact wildlife, water, and other benefits derived from forested ecosystems in the South. Additional information is needed to reduce uncertainties regarding: (1) forecasts of how and where these changes might occur, (2) how human population density influences forest ecosystems and options for their management, and (3) how development can be designed to promote forest sustainability.

• **Markets, management, and values**. Because private landowners control most southern forests, forest conditions are determined by private management choices. These choices are heavily influenced by markets for forest goods and services and by other values derived from forests. A full accounting and understanding of how values are formed and how decisions are made is crucial for clarifying how forest uses and the flow of benefits will change in the future.

• **Forest Productivity**. The productivity of forest ecosystems is a key factor in determining land allocation, forest use, and ultimately forest conditions across the South. Productivity extends beyond timber production to include the provision of wildlife, clean water, and other benefits of forests, and is influenced to uncertain degrees by several forces of change.

• **Forecasting ecological changes**. This Assessment has highlighted the multiple forces of change at work in the South's forests. Yet tools are not available for: (1) forecasting the implications of these multiple, interacting changes on the area, structure, and function of southern forest ecosystems, and (2) fully understanding the impacts on values that are derived from these systems. Such tools would help identify emerging scarcities within the region.

• **Analysis at landscape and regional scales**. Science and management conducted at these broad scales are relatively new endeavors. Most forest research has been conducted at very fine scales, often without the information needed to develop implications at broader scales. When the scale at which the science is conducted does not match the questions that are being asked, answers are often incomplete.

• **Fire ecology and management**. Elimination of natural fire cycles is one of the most substantial alterations imposed by humans on the forested ecosystems of the South. Uncertainties exist regarding: (1) the role of fire in specific ecotypes, and (2) strategies for effectively and safely reintroducing fire into forest ecosystems.

• **Pine plantations and ecosystem functions**. Some portions of the South will see increased concentrations of pine plantations. Landscape-level ecological implications of increased pine plantations are uncertain. Additional information on the wildlife implications of expanding pine plantations is needed, especially in the Coastal Plain of Georgia, Alabama, Florida, and Mississippi. ▲

Emerging Research Priorities

Longleaf pine seedlings

Longleaf Pine Restoration

The Longleaf Pine and Vegetation Management RWU has a long history of successes in developing forest vegetation management research for sustaining southern forests, and working in collaboration with the Longleaf Alliance to restore and manage longleaf pines. Scientists will continue work to enhance research related to nursery technology and reforestation needed to support the restoration of the longleaf pine ecosystem. The SRS will support the national reforestation specialist position that is jointly funded by the three branches of the Forest Service, meeting its commitment to the Virtual Center for Reforestation. Guidelines are being developed for longleaf pine regeneration and management through prescribed fire, application of selective vegetation treatments, and use of innovative mechanical systems. ▲

Bent Creek Experimental Forest

Bent Creek Experimental Forest has been the site for multiple studies on the forest regeneration process since 1921. Research on tree and vegetation response is complemented by studies on the response of small animals and birds to changes in forest structure and composition. Ongoing and new studies by the Southern Appalachian Forests RWU at Bent Creek include:

- GIS-based methods for predicting site quality, species composition, and productivity
- Creation of the Southern Appalachian variant of the national Forest Vegetation Simulator
- Development of a new ecological framework based on overstory tree information
- Vertebrate responses to forest canopy gap disturbance
- Fleshy fruit and mast production in the Southern Appalachians
- Response of mammals, snakes, lizards, and birds to fire

A subunit of the Southern Appalachian Forests RWU has been established in Huntsville, AL to address Cumberland Plateau Forests research needs: 1) expand efforts to develop silvicultural strategies to reestablish American chestnut, 2) establish studies to examine successional change in upland forests of the Cumberland Plateau impacted by the southern pine beetle, and 3) establish studies to enhance capability to predict development of small trees in productivity models. ▲

Hypertext Encyclopedia

The methods used to create, store, and communicate knowledge have changed little since the invention of the printing press in the middle of the fifteenth century. Repositories of knowledge still largely consist of static, linear print media that assume a single, fixed skill level by the intended audience. In southern forest science an overwhelming body of information exists that is neither easily accessible nor readily useable for ecosystem management because it has not been synthesized and integrated into a coherent, meaningful knowledge structure.

Web-based, hypertext encyclopedia theory and practice have matured enough to offer an opportunity for the Southern Research Station to significantly improve its ability to narrow the huge gap between what scientists know and what natural resource managers and decisionmakers are able to easily apply on the land. An example system has been developed by SRS scientists in cooperation with the Southern Region State and Private Forestry, Athens, GA, and the Artificial Intelligence Center of the University of Georgia, also in Athens. SRS is investigating using Web-based hypertext methodology as a new and additional method to provide a practical, efficient, and affordable way to access and use a large and ever-expanding mass of scientific knowledge. ▲

Urban Forestry Research and Technology Transfer Center

A new problem area is being added to the Recreation, Urban Forests, and Human Dimensions Research Work Unit in Athens, GA to identify the human perceptions, uses, and values of urban forests in the South. This research program would measure the contributions of these urban forests to quality of life, recreation, safety and health of urban residents; and develop indicators of sustainable urban forest management, including both the ability of urban forests to provide sustained benefits to urban residents and the ability of urban managers to sustain urban and interface forest ecosystems over time. The technology transfer program associated with this research program will be funded jointly by the Southern Region and the Southern Research Station. ▲

Wildland-Urban Interface

The Southern Forest Resource Assessment has described an increasingly complex environment for conducting forest management and suggests a need for a broader array of management strategies. New management approaches are especially needed for managing forests in "wildland-urban interface" areas. Continued development of the newly formed Southern Center for Wildland-Urban Interface and Technology Exchange in cooperation with the Southern Group of State Foresters and the University of Florida in Gainesville is planned. This new research work unit will address research, development, and application issues for interface lands throughout the South.

To date, the Center's research and technology transfer has focused on fire in the wildland-urban interface, but further funding would expand this research program to address: (1) forest management issues in areas of increased human influence (e.g., nonnative invasive species, restoring degraded ecosystems, maintaining forest health in the context of urbanization, fragmentation, and small scale private nonindustrial forest land management); (2) public policy and planning issues in the interface, particularly as policy affects land use change, forest management and public health and safety; and (3) the need to monitor and forecast demographic and land use changes in the South. Tools developed by this program would help policy makers, urban planners, and natural resource managers address the myriad issues facing them. A strong technology transfer program will ensure application of this research and development to interface situations throughout the South.

SRS and Louisiana State University will also develop a cooperative research program in social science to address legal, regulatory, and economic dimensions of natural resource management decisions in the wildland-urban interface: (1) local ordinances and regulatory impacts on forest management in the interface, and (2) address social and economic challenges related to the wildland-urban interface along the north shore of Lake Ponchartrain. ▲

Coweeta Hydrologic Laboratory

The Coweeta basin was set aside as an experimental forest in 1934. Measurements of rainfall, streamflow, climate, and forest growth continue today, providing an important long-term data source. Researchers have

Suburban sprawl covers foothills

published extensively from the first decades of data on the effects of management alternatives at the Wine Spring Creek watershed. Coweeta is one of 24 sites of the National Science Foundation's Long-Term Ecological Research program and is a National Atmospheric Deposition Program site. Nine stations collect rainfall data used to understand the effects of the atmospheric environment on southern forested watersheds. Continuing and upcoming research will include:

- Effects of ecosystem management practices on water, soil, and forest resources through a new level of experiments in areas ranging from sediment movement to nutrient cycling
- Development and validation of nutrient cycling models
- Evaluation of cottonwood trees to remediate polluted groundwater
- Effectiveness of riparian restoration on forest environments
- Long-term forest disturbance dynamics using dendrochronological techniques
- Species-specific models to assess the effects of climate change on hardwood productivity ▲

Forest Operations Research

Research at Auburn, AL supports sound scientific forest management and policy development by describing how forest operations affect ecological factors and evaluating how technology can improve mechanical, economic, or ecological performance of forest operations. This research provides a key link between increasingly complex forest management plans and desired future conditions for clean air and water, forest products, wildlife, recreation, and other benefits. Continuing research is planned on several critical areas of forest operations, including knowledge of how erosion varies among management activities and site factors, evaluation of technologies for environmental soundness and cost effectiveness, new machine designs for safe working conditions, evaluation of improvements in spatial and operational information, and development of precision forestry applications. ▲

Life Cycle of Wood

The Tree Quality, Processing, and Recycling RWU conducts research to enhance wood resource conservation and sustainability through advanced timber analysis and wood processing, and effective wood product recovery, reuse, and recycling. The largest use of hardwood lumber is for pallets, many of which end up in landfills. Work by scientists in Blackburg, VA on pallet repair and recycling has kept millions of pallets out of landfills. The RWU does extensive outreach and technology transfer to bring pallet users together with recyclers and distributes business plan software to potential recylers. Future work includes continuing collaborative efforts with Virginia Tech and the National Wooden Pallet and Container Association on research to design pallets for particular purposes with used parts. Study continues on ways to recover and reuse CCA-treated wood products and on possible solid-wood uses for recovered CCA treated lumber. The use of CCA as a preservative is being phased out. ▲

Forest Inventory and Analysis

Sending field measurement personnel to all field plots over specified, and often large, areas can be prohibitively expensive for forest management planning and applications. Development of the use of time-sequenced remotely sensed data, in the form of aerial photography or satellite spectral sensors is continuing, in order to stratify forest components by populations of interest and to detect changes. Other monitoring techniques are continuing that will improve the assessment of forest health relating to a variety of resource conditions and issues. This work is necessary to improve statistical modeling and estimation of critical resource attributes. The work will result in models that allow projection of stand growth and development for feasible future use and change scenarios.

Statistical modeling offers the potential to make risk projections for fire/vegetation and fire/insect interactions and to inventory and monitor invasive insects. To accomplish this development, data are needed to allow modeling for fire risks due to vegetation laddering in pine plantations. ▲

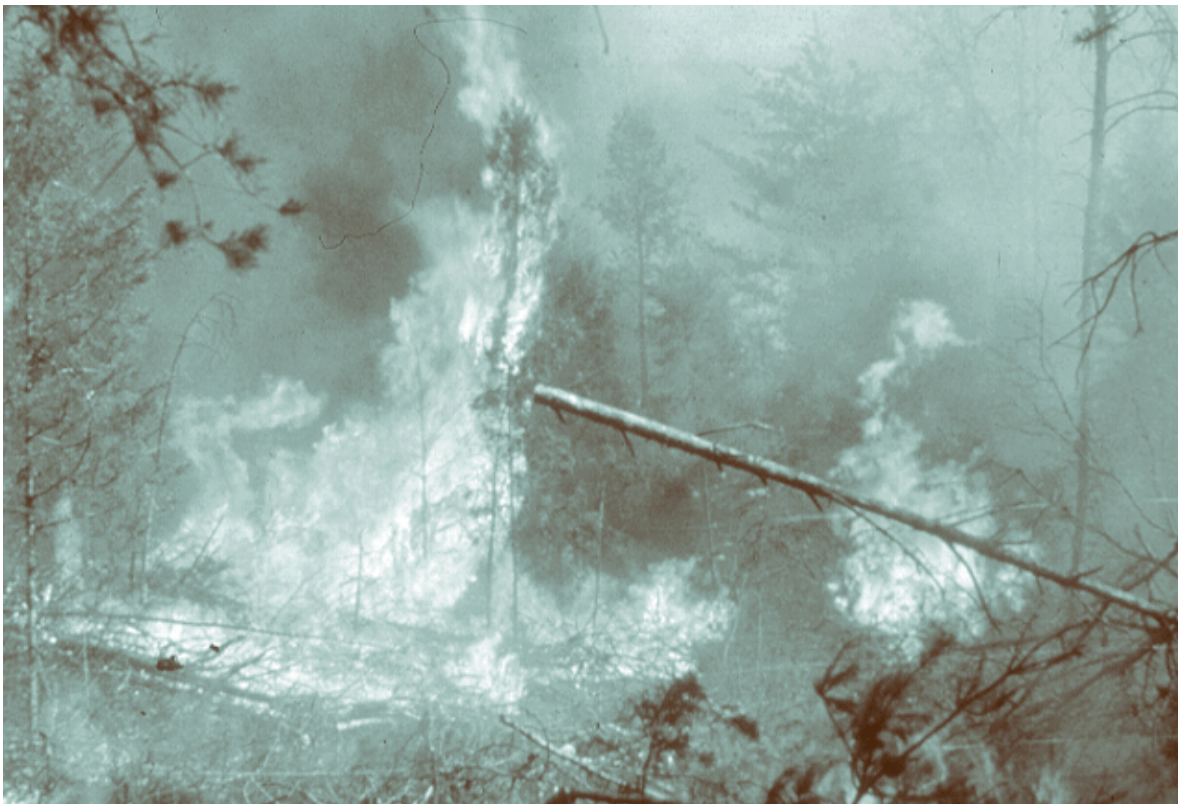
Emerging Research Priorities

Fire

Economic and wildfire production analyses performed for Florida need to be expanded to other fire-prone states in the South, including Texas and Gulf Coast States. This research will link broad-scale wildfire damages to vegetation management and ecological, demographic, and climatic conditions. Costs and benefits associated with prescribed fire will be analyzed in terms of timber management growth and yield, operational cost reductions and non-timber market and non-market values in this fire-prone region. SRS will develop models to predict weather and fire occurrence at finer levels of resolution, to predict smoke movement, and model relationships of climate to fire season severity.

Synergistic detrimental effects of fire and bark beetles are of concern to forest managers. Fires, especially growing season burns, are increasingly associated with subsequent mortality due to bark beetles. Conversely, mortality due to bark beetles leads to increased fuel loading. To better utilize fire as a management tool, and minimize unwanted effects, an increased research effort would help understanding the conditions under which fire predisposes trees to bark beetles and non-native invasive insects. Modeling research will assess the significance of bark beetle mortality on fuel loadings in the region.

It appears that oak dominance may be significantly curtailed following disturbance, including fire. The potential role of fires both historically and as a silvicultural tool in oak regeneration requires additional research. Hypotheses of fire effects will be tested and the findings will serve as a basis for development of prescribed fire regimes should results suggest positive effects of fire on oakregeneration. This work will supplement existing strategies for restoration and maintenance of upland oak ecosystems. ▲



Forest fire

Our Products–

Books, Presentations, Web Postings

2001

Each year our scientists publish several hundred journal articles, book chapters, Southern Research Station publications, and other materials. This list of the materials produced in FY01 is sorted according to the primary research programs that they support, but many of them relate to other areas as well. The last subsection lists materials that relate to multiple programs or continue important studies. Many of these publications are available online at the SRS Web site: http://www.srs.fs.fed.us/pubs/index.htm

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Fox squirrel

Appendix–

Budget and Work Units

2001

FY01 Allocations to Resource Categories

Fundamental Plant Science	$3,655,000
Silvicultural Applications	4,644,000
Quantitative Analysis	1,010,000
Forest and Rangeland Management	1,770,000
Forest Operations Engineering	1,207,000
Insects/Diseases/Exotic Weeds	5,792,000
Fire Science	1,199,000
Terrestrial Wildlife	1,971,000
Aquatic Habitat	855,000
Watershed	2,551,000
Atmospheric Sciences	1,376,000
Economics	1,630,000
Wilderness	102,000
Social/Cultural	925,000
Forest Products, Utilization, and Processing	1,990,000
Forest Inventory and Analysis	11,016,000
Forest Health Monitoring	0
Monitoring Methods/Applications	405,000
Total	$42,098,000

FY01 Allocations to Research Work Units

4101	**Southern Appalachian Forests** *Asheville, North Carolina*	$1,271,000
4103	**Center for Forested Wetlands** *Charleston, South Carolina*	1,205,000
4104	**Disturbance of Southern Pine Ecosystems** *Athens, Georgia*	1,814,000
4105	**Vegetation Management and Longleaf Pine** *Auburn, Alabama*	1,169,000
4106	**Upland Forest Ecosystems** *Monticello, Arkansas*	1,768,000
4111	**Even-aged Management of Southern Pines** *Pineville, Louisiana*	1,573,000
4153	**Southern Institute of Forest Genetics** *Saucier, Mississippi*	1,785,000
4154	**Biological Foundations of Sustainability** *Research Triangle Park, North Carolina*	2,635,000
4155	**Center for Bottomland Hardwoods** Stoneville, Mississippi	3,139,000
4201	**Endangered (TES) Species** *Clemson, South Carolina*	615,000
4202	**Coldwater Streams and Trout Habitat** *Blacksburg, Virginia*	500,000
4251	**Wildlife Habitat and Timber Resource Integration** *Nacogdoches, Texas*	1,125,000
4351	**Watershed Responses to Disturbance** *Franklin, North Carolina*	1,286,000
4501	**Bark Beetles and Invasive Insects** *Pineville, Louisiana*	1,004,000
4502	**Wood Products Insect Research** *Starkville, Mississippi*	1,035,000
4505	**Insects and Diseases** *Athens, Georgia*	1,844,000
4701	**Southern Forest Resource Utilization** *Pineville, Louisiana*	1,226,000
4702	**Tree Quality, Processing, and Recycling** *Blacksburg, Virginia*	475,000
4703	**Biological/Engineering Technologies** *Auburn, Alabama*	1,246,000
4801	**Forest Inventory and Analysis** *Asheville, North Carolina, and Starkville, Mississippi*	11,016,000
4802	**Legal, Tax, and Economic Influences** *New Orleans, Louisiana*	1,006,000
4803	**Forest Health Monitoring** *Research Triangle Park, North Carolina*	334,000
4851	**Economics of Forest Resources** *Research Triangle Park, North Carolina*	970,000
4852	**Southern Global Change Program** *Raleigh, North Carolina*	1,376,000
4901	**Recreation, Urban Forests, and Human Dimensions** *Athens, Georgia*	681,000
	Total	$42,098,000

Collaborative Research

Collaborative research and development with universities, private corporations, nongovernmental organizations, and other Federal and State agencies is a cornerstone of the SRS program. These activities involve the funding of extramural studies under cooperative agreements, grants, and interagency agreements. Working with partners is an effective way to leverage our funding to conduct research efforts that benefit a wide range of research results users.

A total of $12,653,585 supported research studies under these agreements in FY01 with the following:

Domestic Non-Federal Agreements

Alabama A&M University
Alabama Forestry Commission
American Phytopathological Society
Arkansas Forestry Commission
Arkansas State University
Arkansas Technical University
University of Arkansas
Auburn University
University of Charleston, South Carolina
Clemson University
Colorado State University
Duke University
Eastern Sierra Institute for Collaborative Education
Florida A&M University
Florida Department of Agriculture and Consumer Services
University of Florida
Forest Resources Systems Institute
Furman University
Georgia Forestry Commission
George Mason University
University of Georgia
University of Georgia Research Foundation, Inc.
Gordon Research Conference
University of Idaho
Kentucky Division of Forestry
University of Kentucky
Louisiana Department of Agriculture
Louisiana State University
Louisiana Tech University
University of Maine
Michigan Technological University
University of Minnesota
Mississippi State University
University of Missouri
University of Montana
University of Nevada
University of New Hampshire
State University of New York
North Carolina Department of Environment, Health, and Natural Resources
North Carolina State University
University of North Carolina at Asheville
Oklahoma State University
Pacific States Marine Fisheries Commission
Society of Wetland Scientists, Inc.
South Carolina Forestry Commission
Southern Illinois University
Stephen F. Austin State University
Tall Timbers Research Station
Tennessee Department of Agriculture
University of Tennessee
Texas Forest Service
Tuskegee University
Virginia Department of Forestry
Virginia Polytechnic Institute and State University
West Virginia University Research Corporation
University of Wisconsin

International

Chinese Academy of Sciences
Danish Forest and Landscape Research Institute
Thomas Schmidt, Institute for Crop Science and Plant Breeding

Interagency Agreements

USDA Agricultural Research Service
USDI Geological Survey, Biological Resources Division

External Funding

Many research work units have agreements to receive external funding from other sources. The FY01 total for these dollars was $823,625 from non-Federal sources. The SRS received $1,880,253 from other Federal sources to support research and development projects designed to meet the missions of the agencies involved.

This external funding came from the following:

Non-Federal Cooperators

America's Byways Resource Center
American Forest and Paper Association
Arkansas Game and Fish Commission
Auburn University
Aventis Environmental Science
Batelle Memorial Institute
Dartmouth College
Duke University
Franklynn Industries
University of Georgia Research Foundation, Inc.
Hardwood Forestry Fund
HPC Enterprises, Inc.
J.M. Huber Corporation
Indian Council for Forest Research and Investigations
International Paper
J.J. Mauget
Joseph W. Jones Ecological Center
McLaughlin Gormley King Co.
Mississippi Commission on Wildlife, Fisheries, and Parks
National Council of the Paper Industry for Air & Stream Improvement (NCASI)
Rayonier, Inc.
Resource Management Service
Roy O. Martin Lumber Co.
Ruffed Grouse Society
Temple-Inland Forest Products
Texas Parks and Wildlife
Valent USA
Wes Min RC and DC
Westvaco
Weyerhaeuser
Willamette Industries, Inc.

Federal Cooperators

Environmental Protection Agency
Department of Agriculture, Agricultural Research Service
Department of Agriculture, Foreign Agricultural Service/International Cooperation and Development (FAS/ICD)
Department of Agriculture, Animal and Plant Health Inspection Service (APHIS)
Department of Agriculture, Cooperative State Research, Education, and Extension Service (CSREES)
Department of Agriculture, Economic Research Service
Department of Agriculture, Natural Resources Conservation Service
Department of the Army
Department of Defense
Department of Energy
Department of the Interior, Bureau of Land Management
Department of the Interior, Fish and Wildlife Service
Department of the Interior, Geological Survey
Department of the Interior, National Park Service
Department of the Navy, Office of Naval Research
National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration

Research Work Unit Directory

SRS-4105, Vegetation Management and Longleaf Pine; and SRS-4703, Forest Operations Research, are located at:

G.W. Andrews Forestry Sciences Laboratory
520 Devall Drive
Auburn, AL 36849
334-826-8700
Web site for SRS-4105:
http://www.srs.fs.fed.us/4105/index.html
Web site for SRS-4703:
http://www.srs.fs.fed.us/forestops/

SRS-4106, Upland Forest Ecosystems, is located at:

Forest Resources Building, Room 114
University of Arkansas at Monticello
P.O. Box 3516, UAM Station
Monticello, AR 71656-3516
870-367-3464
Web site for SRS-4106:
http://www.srs.fs.fed.us/4106/

SRS-4104, Disturbance of Southern Pine Ecosystems; SRS-4505, Insects and Diseases; and SRS-4901, Recreation, Urban Forests, and Human Dimensions, are located at:

Forestry Sciences Laboratory
320 Green Street
Athens, GA 30602-2044
706-559-4222
Web site for SRS-4505:
http://www.srs.fs.fed.su/4505/
Web site for SRS-4901:
http://www.srs.fs.fed.us/trends/

SRS-4802, Legal, Tax, and Economic Influences, is located at:

T-10034, U.S. Postal Service Building
701 Loyola Avenue
New Orleans, LA 70113
504-589-6652
Web site for SRS-4802:
http://www.srs.fs.fed.us/4802/

SRS-4111, Even-aged Southern Pine Forests, SRS-4501; Bark Beetles and Invasive Insects; and SRS-4701, Southern Forest Resource Utilization, are located at:

Alexandria Forestry Center
2500 Shreveport Highway
Pineville, LA 71360
318-473-7216
Web site for SRS-4111:
http://www.srs.fs.fed.us/4111/
Web site for SRS-4501:
http://www.srs.fs.fed.us/4501/
Web site for SRS-4701:
http://www.srs.fs.fed.us/4701/

SRS-4153, Southern Institute of Forest Genetics, is located at:

Harrison Experimental Forest
23332 Highway 67
Saucier, MS 39574-9344
228-832-2747

SRS-4502, Wood Products Insect Research, is located at:

101A G.T. Thames Drive
Starkville, MS 39759
662-338-3100
Web site for SRS-4502:
http://www.srs.fs.fed.us/termites/

SRS-4155, Center for Bottomland Hardwoods, is located at:

Southern Hardwoods Laboratory
P.O. Box 227
Stoneville, MS 38776-0227
601-686-3154
SRS-4155 Web site:
http://www.srs.fs.fed.us/cbhr

SRS-4101, Southern Appalachian Forests, is located at:

Bent Creek Experimental Forest
1577 Brevard Road
Asheville, NC 28806
828-667-5261
SRS-4101 Web site:
http://www.srs.fs.fed.us/bentcreek/

Research Work Unit Directory

SRS-4351, Watershed Responses to Disturbance, is located at:

Coweeta Hydrologic Laboratory
3160 Coweeta Lab Road,
Otto, NC 28763
828-524-2128

SRS-4852, Southern Global Change Program, is located at:

920 Main Campus Drive
Venture Center 11, Suite 300
Raleigh, NC 27606
919-515-9489
SRS-4852 Web site: http://www.sgcp.ncsu.edu/

SRS-4154 Biological Foundations of Sustainability; SRS-4803, Forest Health Monitoring; and SRS-4851, Economics of Forest Resources, are located at:

Forestry Sciences Laboratory
3041 E. Cornwallis Road
P.O. Box 12254
Research Triangle Park, NC 27709
919-549-4000
SRS-4154 Web site:
http://www.rtp.srs.fs.fed.us/soils/soilhome.htm
SRS-4803 Web site:
http://willow.ncfes.umn.edu/fhm/fhm_hp.htm
SRS-4851 Web site:
http://www.rtp.srs.fs.fed.us/econ/

SRS-4103, Center for Forested Wetlands, is located at:

Center for Forested Wetlands Research
2730 Savannah Highway
Charleston, SC 29414
843-727-4271
SRS-4103 Web site:
http://www.srs.fs.fed.us/charleston/

SRS-4201, Threatened and Endangered Species, is located at:

Department of Forest Resources
Clemson University
Clemson, SC 29634-1003
864-656-3284
SRS-4201 Web site:
http://www.srs.fs.fed.us/4201/

SRS-4801, Forest Inventory and Analysis, is located at:

Southern Research Station
4700 Old Kingston Pike
Knoxville, TN 37919
865-862-2027
SRS-4801 Web site:
http://www.srsfia.usfs.msstate.edu

SRS-4251, Wildlife Habitat and Timber Resources Integration, is located at:

Wildlife Habitat and Silviculture Laboratory
Box 7600, SFA Station
506 Hayter Street
Nacogdoches, TX 75962
936-569-7981
SRS-4251 Web site:
http://www.srs.fs.fed.us/wildlife/index.html

SRS-4202, Coldwater Streams and Trout Habitat; and SRS-4702, Tree Quality, Processing and Recycling, are located at:

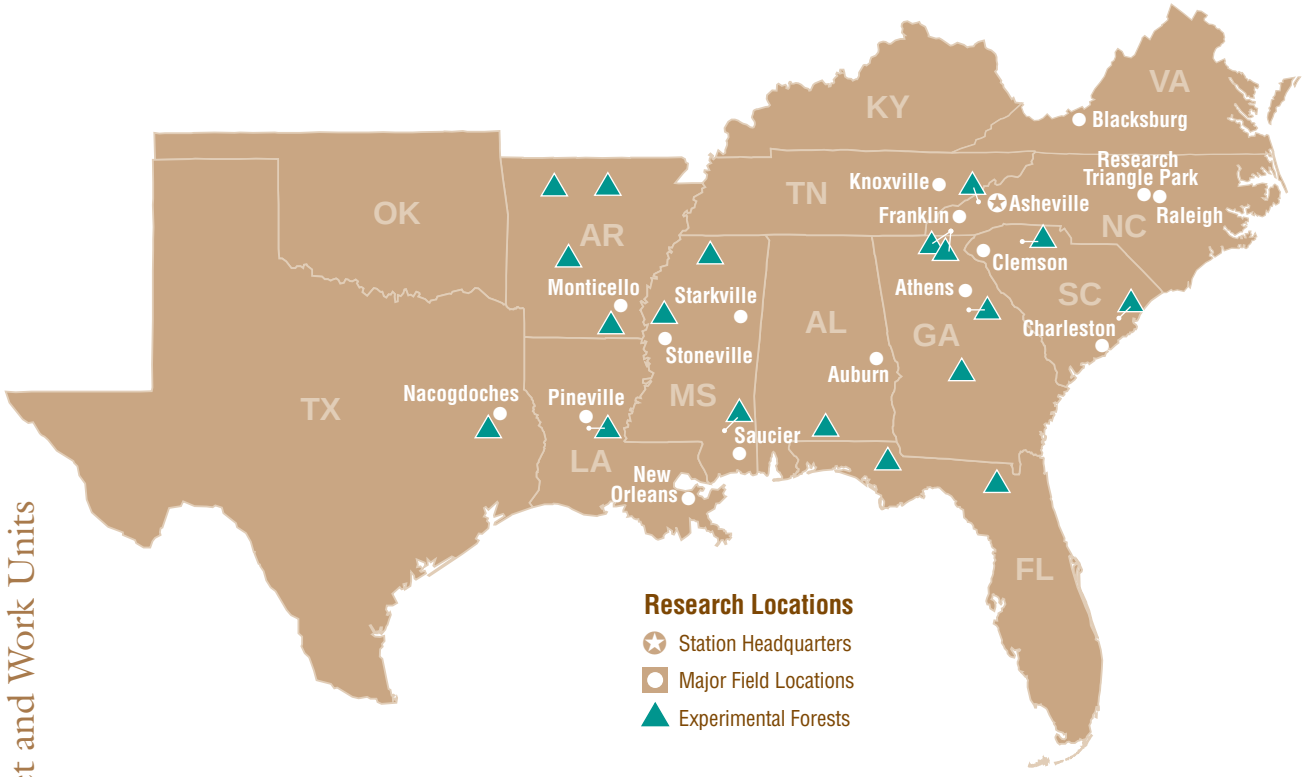
Southern Research Station
1650 Ramble Road
Blacksburg, VA 24060
540-231-4016
SRS-4202 Web site:
http://www.trout.forprod.vt.edu/
SRS-4702 Web site:
http://www.srs4702.forprod.vt.edu/

Examining specimens

Experimental Forests

The SRS maintains 19 experimental forests located on or near National Forest System lands. Scientists in RWUs use these as sites for their studies and demonstration projects in conjunction with the managing national forest unit. Experimental forests are designated to represent a specific ecosystem or forest type, and to present opportunities for the study of different approaches to sustaining forested ecosystems. Several of the experimental forests in the South were selected for their potential to demonstrate rehabilitation of deteriorated farm forests and soil resources that occurred during early European settlement and plantation farming of the region.

Among the experiments conducted on these forests are studies on stand management and regeneration; restoration of wildlife and plant populations; watershed management; and the effects of pollution, climate change, and timber harvest. Many experimental forests also provide educational and nonmotorized recreation activities, including interpretation to enhance public understanding of forest management principles. Research on experimental forests plays a vital role in the conservation of America's natural resources.



Experimental Forests

State	Experimental Forest	National Forest	Acres	Date Established
Alabama	**Escambia**	(private)	2,990	06/14/61
Arkansas	**Alum Creek**	Ouachita	4,281	04/02/59
	Crossett	Ouachita	1,675	08/27/40
	Henry R. Koen	Ozark	720	09/17/51
	Sylamore	Ozark	4,180	03/28/34
Florida	**Chipola**	(private)	2,760	06/21/61
	Olustee	Osceola	3,135	03/28/34
Georgia	**Hitchiti**	Oconee	4,602	12/04/61
	Scull Shoals	Oconee	4,487	09/17/38
Louisiana	**Palustris**	Kisatchie	7,515	07/19/35
Mississippi	**Delta**	(private)	2,580	06/14/61
	Harrison	DeSoto	4,111	07/19/34
	Tallahatchie	Holly Springs	4,569	04/12/50
North Carolina	**Bent Creek**	Pisgah	5,242	06/25/27
	Blue Valley	Nantahala	1,400	06/23/64
	Coweeta	Nantahala	5,482	03/28/34
South Carolina	**John C. Calhoun**	Sumter	5,082	10/08/47
	Santee	Francis-Marion	6,000	07/06/37
Texas	**Stephen F. Austin**	Angelina	2,499	06/28/61

Administration

The Information Resources staff is responsible for computer and network services to both internal and external customers. During FY01, some major network infrastructure enhancements were completed, converting many of our laboratory locations from low-speed frame-relay circuits to high-speed T1 lines, and transitioning our 32 voice and data lines to fiber optic cable. Scientists will be able to take full advantage of future information technologies. Software products were installed that will enhance ability to support employees by using management concepts and tools. A cooperatively-developed, state-of-the-art computing facility for meteorological modeling applications is being established at the Athens, GA Forestry Sciences Lab.

The Human Resources section is leading the SRS effort to refine a workforce plan. This effort involves gathering specific information from RWUs and administration groups about anticipated turnover, planned hiring, and changes in skills needed for a 1-year and 5-year period. The plan is part of a nationwide Forest Service effort to provide more accurate information on hiring needs, attrition, and skills mix. It will also serve as a needs assessment for the National Recruitment Plan and college recruitment activities. As will other government agencies, lower hiring levels over the past decade, and the expected attrition as "Baby Boomers" retire, has left serious age and skills gaps in our workforce.

Recruitment Initiatives

The Southern Research Station continues to manage recruitment assets for the Forest Service through two highly successful multicultural Recruitment Initiatives: Alabama A&M (AAMU) and Florida A&M (FAMU). The purpose of the Initiatives is to attract traditionally underrepresented individuals to forestry and other natural resource science occupations. Thirty-eight students in forestry programs were hired by the Forest Service as summer employees. Three graduates were converted to full-time positions in forestry or closely related occupations. The programs are producing a consistent stream of well-qualified minority students who are interested and experienced in Forest Service work, with promise for adding to the diversity of the agency's workforce. The Initiative schools continue to be valuable research cooperators as well.

Branching Out to the Youth of America

The Conservation Education Outreach Program (CEOP) continues to be an integral part of the overall education effort of the Southern Research Station.

The concept of the CEOP is to engage youngsters in conservation education activities in urban settings in the inner cities where they live. The target audiences are selected for cultural, sociological, and economic diversity specifically including underserved, nontraditional publics. The goals of the program are: (1) to interact with urban youth from diverse age groups, socioeconomic backgrounds, ethnicities, and geographic locations helping them to gain an appreciation for natural resource conservation and sustainability; (2) to create an interest in Forest Service careers among underrepresented populations in urban environments; and (3) to provide contact between scientists and the summer interns to encourage them to pursue advanced degrees, thereby expanding the pool of diverse candidates for research positions.

Administration

Two teams of 3-4 interns were employed by SRS, with one stationed in Asheville, NC and the other in Huntsville, AL. They worked with youngsters from preschool through high school, at locations throughout the South. They did a variety of teaching activities with groups from 30 to 200 youngsters at each site visit, reaching over 4,000 youngsters during the summer of FY01. Additional teams trained in Asheville worked out of Philadelphia, Milwaukee, and Atlanta.

Civil Rights and Workforce Diversity

The Civil Rights (CR) program continues to have a strong emphasis at SRS, with a full-time Civil Rights Director and a Station-wide CR committee. Policy assures that SRS seeks to find and hire diverse candidates for positions and encourages a healthy, affirming work environment that contributes to retention. Three minority employees were hired at SRS in FY01 under the National Scientist Recruitment Initiative. The FAMU and AAMU recruitment initiatives, the CEOP environmental intern program, and recurring multicultural events are part of our commitment to workforce diversity. While completing the CR training from USDA, over the last few years, SRS has been implementing a "human rights" perspective – an inclusive program to encourage employees to work together to resolve issues and misunderstandings and to give them the needed training and tools.

Improving Customer Service

The Catalog of Recent Publications has been revamped into the ***Compass***, which is distributed hard copy and electronically. The hard copy now features an eye-catching full-color cover to make it competitive for attention with all the other material that people receive. It also includes information about the Southern Research Station and personnel, a theme focus on some of the recent publications, as well as the current abstracts that have always been its primary content.

The Southern Research Station Web site is a keystone of our customer service and technology transfer efforts. With over 14 gigabytes of information available to the public electronically, we have seen dramatic increases in the number of visitors to the site in the past three years. Following are estimates of numbers of publications distributed for the past four years. All of the publications listed in our ***Compass*** catalogs are put online before the catalog is distributed, with the count now over 2,400 documents available for downloading.

Lab work in Athens, GA

A recent addition to our publication service is developing a publication evaluation comment card, that is now operational online (www.srs.fs.fed.us/pubeval). We anticipate having the printed version of the comment card early in FY02 for distribution to readers who request "hard copy" printed publications.

Please contact us anytime you have questions or comments about the services of the Southern Research Station. ▲

To receive our quarterly catalog of recent publications, the "Compass," send us your name and address and we will be happy to add you to our mailing list. The catalog is also on our Web site and you can subscribe to a listserv to receive it by e-mail.

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Caring for the Land and Serving People