

Successes— *Our Major Accomplishments*



2001

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Southern Pine Ecosystems

2

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

Southern Pine Ecosystems

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

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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.

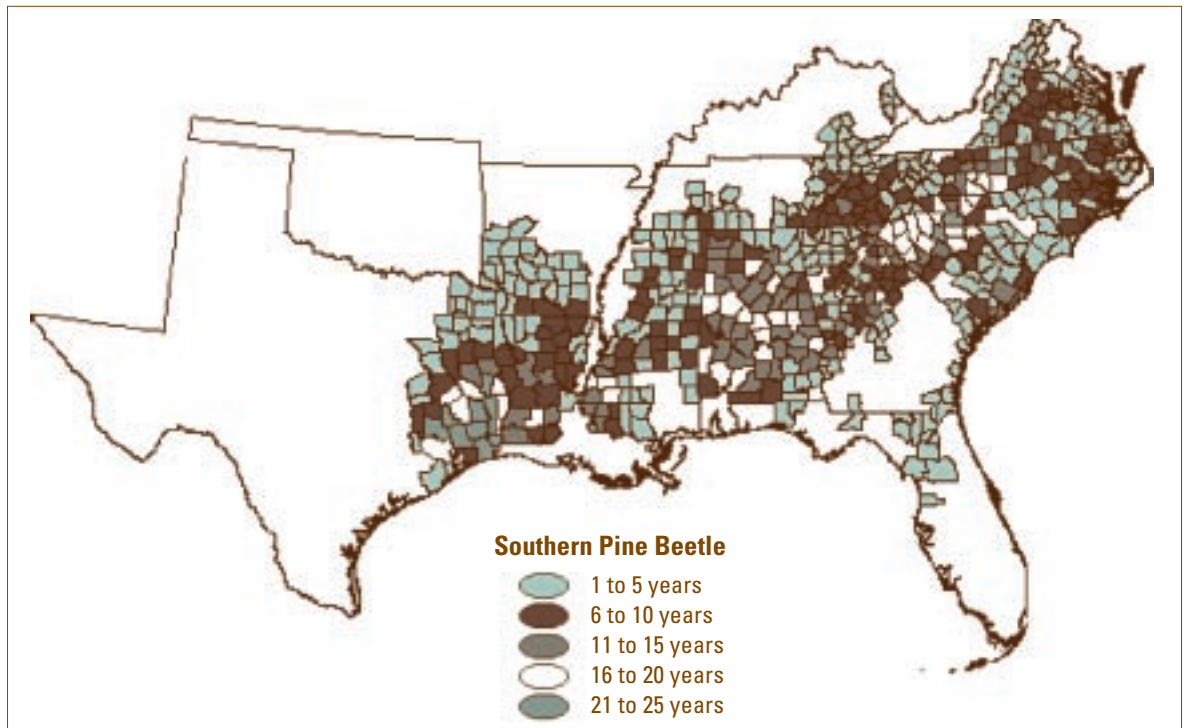
Research by the Bark Beetle and Invasive Insect RWU has revealed a series of complex interactions among trees, beetles, fungi, mites, parasitoids, and predators. SPB is greatly affected by the abundance of mites that ride from tree to tree

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



Southern Pine Ecosystems



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.



2001

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



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



Wetlands, Bottomlands, and Streams



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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.

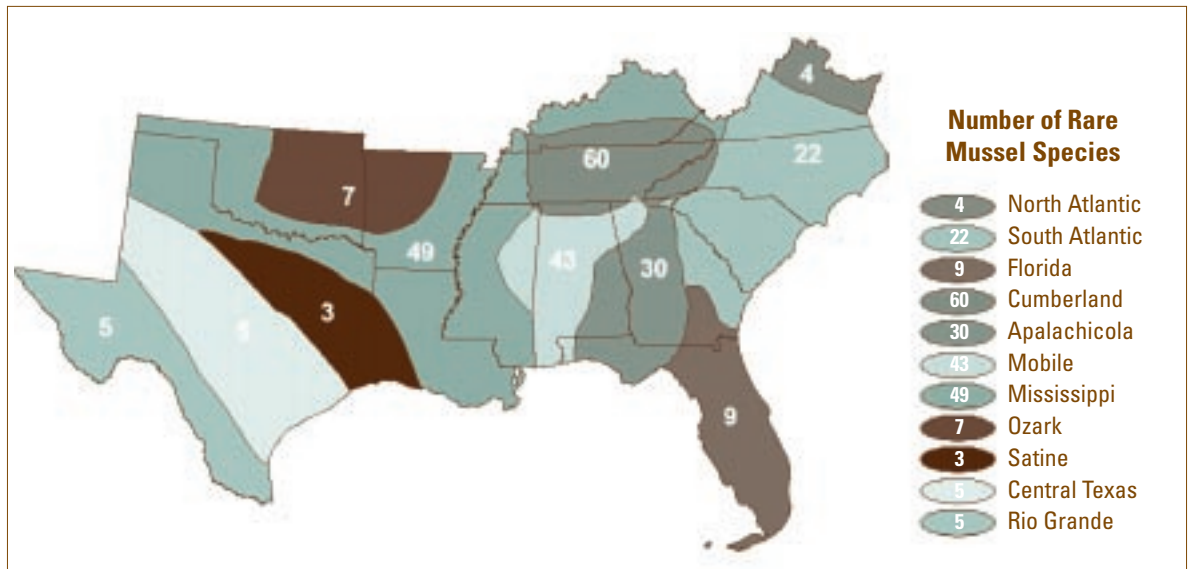
Native freshwater mussels in the southeastern United States are at risk—many species considered threatened, endangered, or sensitive—due to loss of habitat and invasions of exotic species. Some of the most important remaining populations of freshwater mussels occur in streams that drain from public and 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

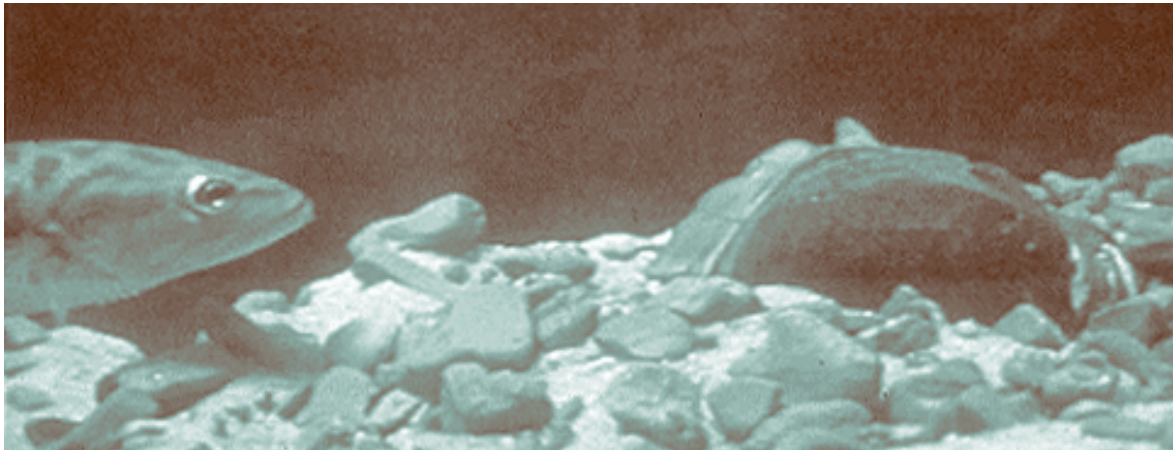
fish species. Two mussel species that occur on National Forests in Alabama and Tennessee—*Villosa nebulosa* and *V. vibex*—rely on bass and sunfish as hosts for their larvae. In the recent work, the researchers discovered that females of the two mussel species display “lures”—modifications of the mantle 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 “cocoon” 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



Wetlands, Bottomlands, and Streams



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).



Wetlands, Bottomlands, and Streams



Live oak

An Added Line of Defense Against Oak Wilt

Oak wilt, a disease caused by the fungus *Ceratocystis fagacaerum*, 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. ▲

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. ▲



Prothonotary warbler



Wetlands, Bottomlands, and Streams



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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

Wetlands, Bottomlands, and Streams

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.





Mountain and Highland Ecosystems

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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



Mountain and Highland Ecosystems

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

Bent Creek researchers with Mead Corporation managers



by private and industrial landowners. Little research has been done to determine how these southern Appalachian forest systems respond to disturbance.

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.



Mountain and Highland Ecosystems



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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



Mountain and Highland Ecosystems



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 (*Oncorhynchus 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 streambanks. 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

Mountain and Highland Ecosystems

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.

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



Natural water slide



Mountain and Highland Ecosystems

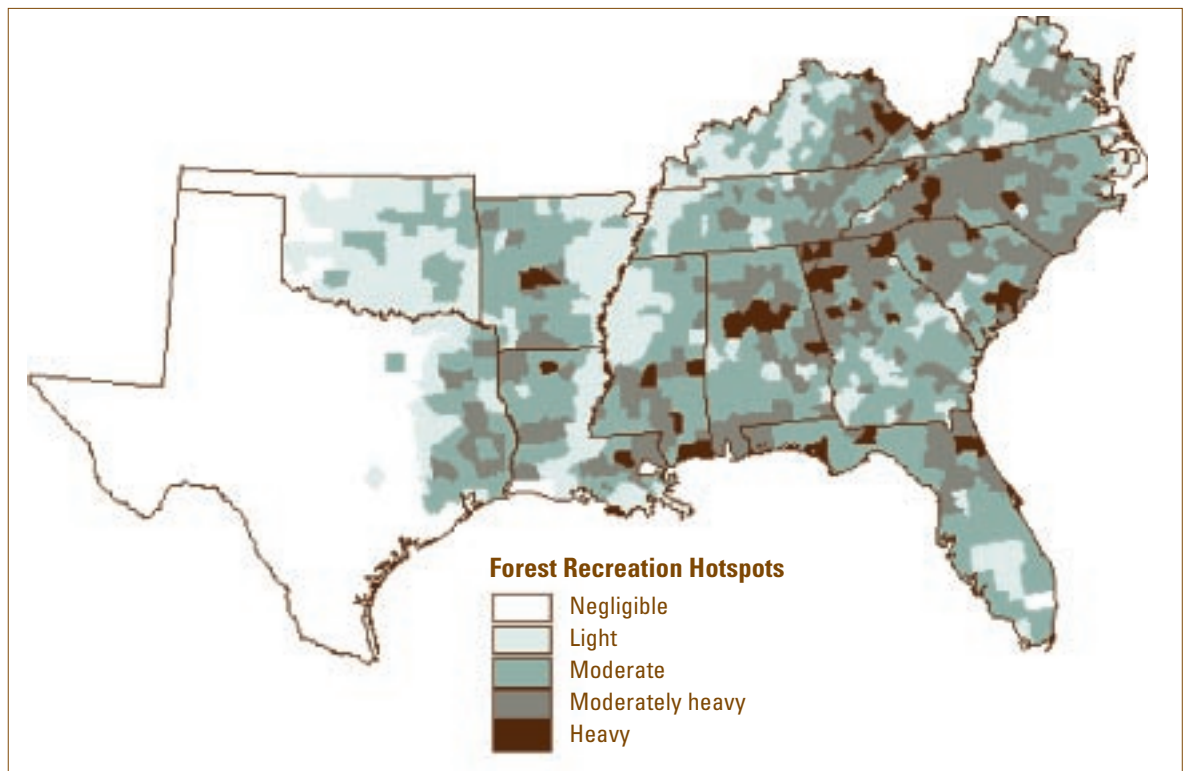


- Race and gender influence the demand for wildland recreation trips.
- User fees can influence the number of visits made members of some ethnic groups.
- The economic values for many outdoor recreation activities are increasing faster than the rate of inflation.
- Most Americans support user fees for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

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



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.

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

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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



Large-Scale Assessment and Modeling

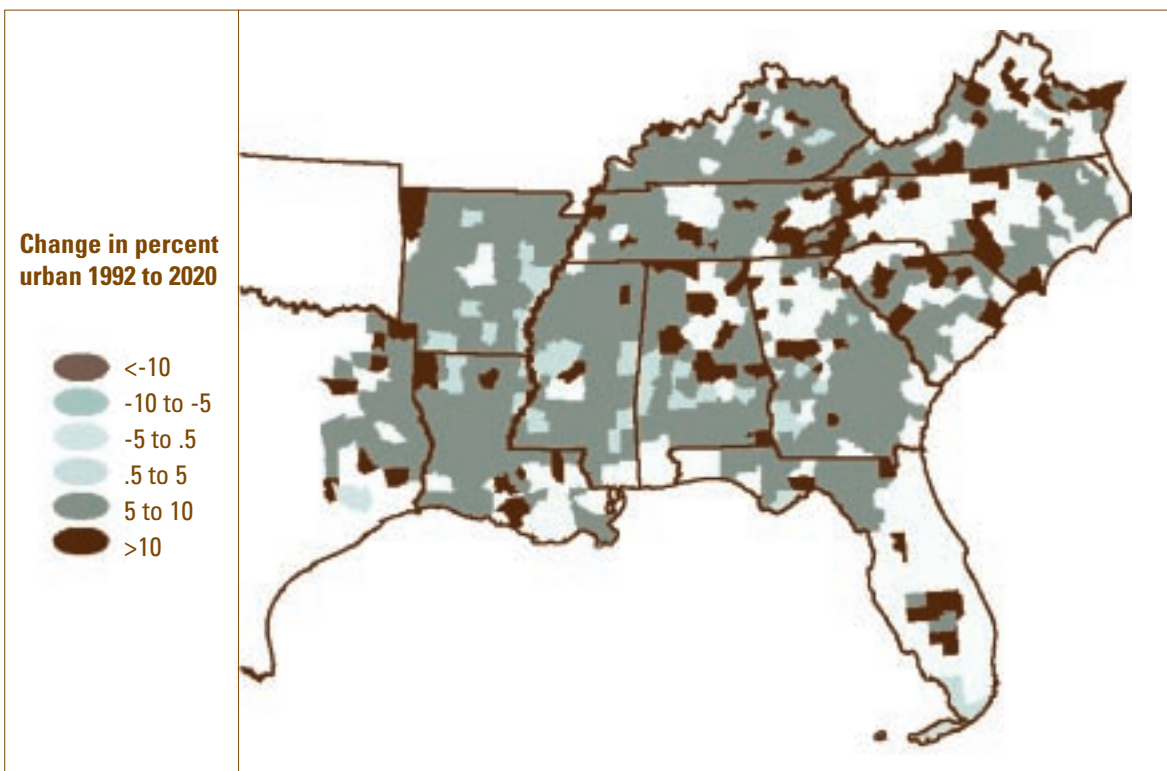


Bank fishing

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

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



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



Large-Scale Assessment and Modeling



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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.



2001

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Inventory and Monitoring

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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.

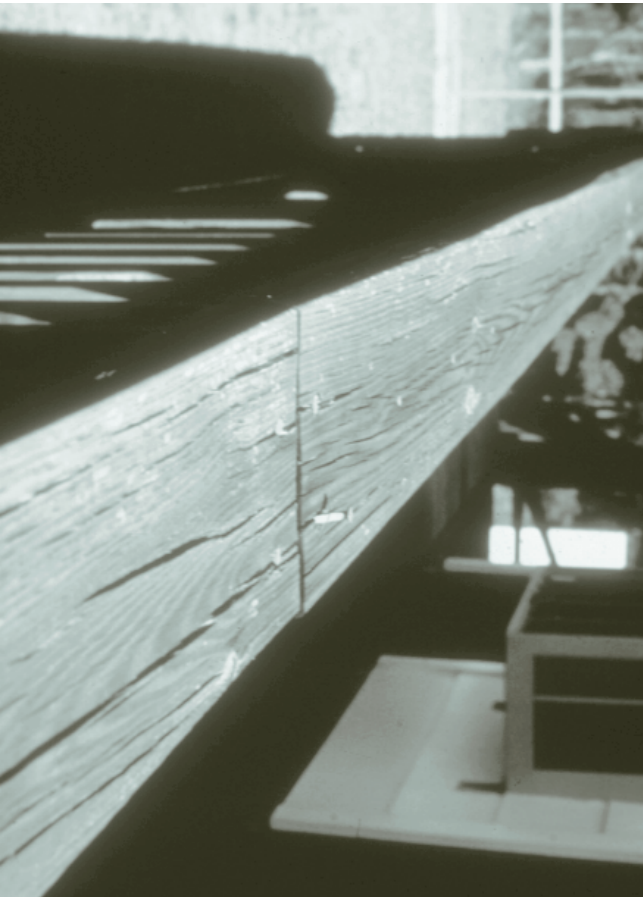
Presented information about scientific methods for global monitoring criterion and indicators of forest sustainability to the International Environmetrics Society.

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.

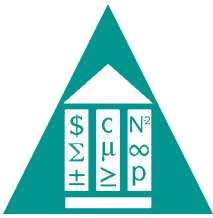
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Pallet recovery continues to increase, which results in saving trees by reducing the need for new wood. It also leads to a decrease in disposal of pallets in landfills. A business plan model and economic evaluator was developed that encourages recycling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

Discarded pallets



Foundation Programs



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. ▲

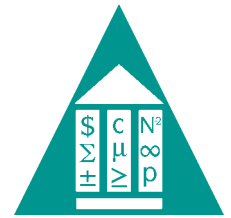
Providing Economic and Tax Information to Forestland Managers and Owners

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

Foundation Programs



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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. ▲

Foundation Programs



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Successes—Our Major Accomplishments

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. ▲